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NAVAL POSTGRADUATE SCHOOL
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Fleet Battle Experiment Juliet
Final Reconstruction and Analysis Report

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Section I: Experiment Description

1.0 Introduction

This Section provides a high-level overview of the entire experiment to acquaint the reader with the general background, context, and objectives for each of the initiatives. Background on categorization, data collection, and analysis methodologies is also presented.

1.1 Fleet Battle Experiments Purpose and History

Historically, Fleet Battle Experiments (FBEs) have existed in order to streamline and invigorate warfare doctrine refinement, and to bring innovation to the processes of developing and prosecuting warfare concepts. They have been designed to speed the delivery of innovation and advanced warfare capabilities to the fleet by identifying concept-based requirements and evaluating the merit of new operational capabilities.

More recently, in an effort to improve the overall, integrated capabilities of U.S. forces, an over-arching set of experiments called Millennium Challenge (MC) was instituted. The MC experiments are sponsored and implemented by U.S. Joint Forces Command and are operated at the same time as, and in the conjunction with, service experiments. MC-00, the first of the MC series, was carried out at the same time as FBE-H. FBE-J was carried out with MC-02. This combination of over-arching joint and service experiments provided a common venue for the service experiments, and leveraged them into examinations and improvements in joint warfighting capabilities.

A significant focus of both MC and FBE experiments has been the use of information to support warfare areas. The primary goal is to enable commanders to make fast, accurate decisions in battle. The range of information-related objectives has been broad, including content, accuracy, timeliness, dissemination, distribution, display, and also the processes by which the information is used for decision making.

The experiments involve live forces but make extensive use of simulations to minimize the expense of employing operational resources. Simulation is especially valuable as a means to insert opposing forces into an operation. Simulation also permits playing some future systems, primarily weapons and sensors, by introducing their performance into the simulation.

The experiments improve awareness about the most pressing operational challenges of the future and have led to recommendations for changes in doctrine, organization, training, material, leadership, personnel, or facilities (DOTMLPF). They examine how a robust, common information environment coupled with collaborative tools, increases shared battlespace awareness and simultaneous planning necessary to achieve decision superiority. Weaknesses in today’s crisis action planning processes and battlespace executions are identified, quantified, and appropriate resolutions are recommended.

There have been ten FBEs conducted since 1997:

Experiment	Timeframe	Principal Warfare Areas or Concepts
FBE-Alpha	Apr -May 1997	MAGTAF
FBE-Bravo	Aug-Sep 1997	Fires
FBE-Charlie	Apr-May 1998	Ring-of Fire; AADC
FBE-Delta	Oct-Nov 1998	Land Attack from Sea
FBE-Echo	Mar 1999	Asymmetric Threats
FBE-Foxtrot	Nov-Dec 1999	Joint Maritime Access
FBE-Golf	Apr 2000	Theater Air Missile Defense
FBE-Hotel	Aug-Sep 2000	Flexible Command and Control
FBE-India	May -June 2001	Forced Entry and Access for Contingencies
FBE-Juliet	July-Aug 2002	Assured Access; Maritime Command and Control

FBE Alpha used the U. S. Marine Corps' Hunter Warrior scenario, and was designed to test the ability of a sea-based Special Marine Air-Ground Task Force to conduct dispersed operations on a distributed, non-contiguous battlefield.

FBE Bravo was designed to leverage the lessons and observations from FBE Alpha with a focus on the Joint Vision 2010 Precision Engagement operational concept, and precision fires in a littoral Joint Operating Area. FBE Bravo was hosted by Commander Third Fleet and conducted in the southern California operating area.

FBE Charlie examined an area air defense commander (AADC) separated geographically from the Joint Forces Air Combat Coordinator using a prototype AADC system to plan and execute an air defense plan for theater air and missile defense. FBE Charlie also explored a warfare concept called Ring of Fire, using integrated deconfliction tools, sophisticated target prioritization, close air support, improved weapon-target pairing, and automated checks for protected or prohibited targets. Commander Second Fleet hosted FBE Charlie.

FBE Delta, conducted during Exercise Foal Eagle '98, an annual joint and combined exercise sponsored by Combined Forces Command Korea, was the first forward deployed joint and combined experiment. FBE Delta examined a land-sea engagement network, which linked 22 Land Attack Weapons System stations at sea to 80 automated deep operations coordination systems ashore. Commander Seventh Fleet hosted FBE Delta.

FBE Echo was conducted concurrently with the U. S. Marine Corps experiment Urban Warrior. Operations focused on humanitarian assistance, asymmetric threats, precision engagement, littoral air and missile defense, disaster relief, undersea warfare, information assurance and casualty management. FBE Echo was hosted by Commander Third Fleet and conducted in the San Francisco and Monterey Bay areas.

FBE Foxtrot was built around the U. S. Central Command's operational need to assure Joint Maritime Access to the Arabian Gulf. The experiment included concurrent Anti-Submarine Warfare and Mine Countermeasures, with simultaneous operations by a Joint Fires Element against air, coastal missile, artillery, and asymmetric attacks. FBE Foxtrot was hosted by Commander Fifth Fleet and conducted in the Arabian Gulf.

FBE Golf focused on Time Critical Targeting (TCT) and examined joint and combined theater air missile defense (J/CTAMD) with NATO participation and information management. FBE Golf was hosted by Commander Sixth Fleet and conducted in the Mediterranean Sea.

FBE Hotel was conducted in conjunction with the U.S. Joint Forces Command Millennium Challenge experiment, MC-00, the Army's Joint Contingency Force Advanced Warfighting Experiment, the Air Force's Joint Expeditionary Force experiment (JEFX-00) and the Marine Corps' Millennium Dragon experiment, making it the first all-service experiment. FBE Hotel focused on flexible command and control processes, at the component level, using a Joint Force Maritime Component Commander (JFMCC) structure. FBE Hotel was hosted by Commander Second Fleet and conducted in the Gulf of Mexico and southern U.S.

FBE India was conducted in conjunction with the U.S. Marine Corps Capable Warrior (CW) and extending the Littoral Battlespace (ELB) initiatives focusing on forced entry and access for expeditionary contingency operations. FBE India initiatives included information management and integration, battle space preparation, real time sensor management, time critical targeting (TCT), medical casualty and non-governmental organization management, virtual collaborative planning and experimental command and control (C2) architecture. FBE India was hosted by Commander Third Fleet and conducted in the Southern California area.

1.2 FBE-Juliet: General Description

The two major experimentation areas for FBE-J were:

(1) Sea-based Joint and Maritime Command and Control
(2) Assured Access

Sea-based joint command and control was an opportunity presented by Commander Joint Task Force (CJTF) and Joint Special Operations Task Force (JSOTF) plans to base portions of their staffs afloat on the Fleet Command Ship. FBE-J examined C4ISR information and support needs to fully enable joint command from a Fleet Command Ship.

For assured access, the scenario presented concurrent threats by submarines, mines, coastal cruise missiles, and enemy land and air assets. The joint environment and warfighting scenario presented an opportunity to experiment with Maritime Command and Control across almost all maritime warfare areas in a difficult littoral environment.

As noted above, FBE-J was conducted in conjunction with MC02. The experiments were conducted from 24 July to 15 August 2002 in the US western sea and land ranges. The Congressional mandate for MC02 included direction to integrate service and joint experimentation. MC02 was conducted primarily at the strategic and operational levels while FBE-J was at the operational and tactical levels, with coordination occurring at the operational level. Separate simulations were utilized for the two experiments, necessitating passing information between them to coordinate tactical actions and joint-level decisions.

The timeframe for the experiment setting was 2007. This limited experimentation to those capabilities resident in the future years defense program (FYDP) in 2002 that are reasonably achievable by 2007.

MC02 was essentially a command post exercise. The JTFC staff passed directives to the service components where execution was accomplished. J9 operated a Red Cell that initiated OPFOR actions. The J9 simulation passed actions to service simulations, with situational awareness provided by GCCS. A White Cell provided adjudication, when needed. A high degree of coordination was needed between the various simulations if the play were to be realistic.

FBE-J was a mix of live and simulated activities in order to examine operational and tactical warfighting issues in a real environment. There were periods during the experiment when FBE-J operated independent of the joint environment. At such times, Navy simulation provided Red-Force activities. At the service level, simulation is used to examine systems that do not yet exist, to fill out orders of battle, and to determine effects due to force numbers.

FBE-J was much more tightly integrated into a joint warfighting context than prior efforts. This involved a greatly increased level of effort, a need for subject matter expertise not resident at NWDC, and much greater expense. The advantage was an experimental venue that was completely joint. This provided greater validity to Navy operational level experimentation and greater validity for acquisition-based lessons learned.

FBE-J was an attempt to experiment in almost every maritime warfare area. The scenario supported experimentation in strike, anti-submarine warfare, mine warfare, anti-surface warfare, information operations, and intelligence, surveillance, and reconnaissance.

This FBE was preceded by a series of Limited Objective Experiments (LOEs) for high speed vessel and mine warfare. These iterative experimentation processes used the FBE as the largest venue in a series of experiments.

The FBE-J/MC02 pair involved concurrent and mutually reinforcing joint doctrine development and joint/service experimentation. A coherent series of seminars, organizational process model development, organizational workflow depictions, and workshops were developed into a new paradigm for doctrine development. The experiment also provided a live, joint environment for field-testing proposed Joint Maritime Component Commander doctrine.

Overview of Activities in FBE-J

FBE-J Activities in Joint and Maritime Command and Control

- Maritime Operational Planning Process
  - Objective: Field test the draft joint doctrine for JFMCC.
  - Action: Refine the roles, functions, and planning process for the Joint Force Maritime Component Commander.

- Sea-Based Joint Command and Control (C2)
  - Objective: Lessons learned for doctrine, organization, training, manning, and technology in support of ship-based joint command and control.
  - Action: Refine C4ISR and support for a sea-based Joint Force Commander.

- Netted Force (NF)
  - Objective: Provide lessons learned for development of expeditionary networks.
  - Actions: Develop innovative solutions to the seams between forward based forces and rear echelon forces through exploration of innovative networking. Additionally, improve coalition information exchange using software agent-based systems.

- FBE-J Naval Fires Network (NFN (X))
  - Objective: Provide field-tested NFN TACMEMO for Fleet use. Provide lessons learned for NFN converged architecture development. Provide lessons learned for joint doctrine, organizations, training, and manning when joint intelligence, surveillance, and reconnaissance (ISR) assets can be shared and distributed across the CJTF.

- Actions: Assess Naval Fires Network (Experimental) (NFN (X)) system and develop TTP and CONOPS to support sea-based fires in a joint environment. Explore innovative linkage of NFN (X) to the joint fires network. Provide field-tested results for bandwidth, weapon-target pairing, and deconfliction.

FBE-J Activities in Assured Access

- Unmanned Sensors and Platforms
  - Objective: Provide CONOPS leading to TACMEMOs for airspace, waterspace, and sea-surface management; deconfliction; and asset optimization in a highly mixed manned and unmanned environment. Provide lessons learned for doctrine, organizations, training, and manning based on use of manned and unmanned sensors and platforms.
  - Actions: Refine the concepts of employment for distributed, networked, manned and unmanned platforms, and remote sensors, for anti-submarine warfare (ASW)/anti surface warfare (ASUW) / Mine Warfare (MIW).

- Theater Air and Missile Defense
  - Objective: Provide field-tested CONOPS leading to TACMEMO for Navy lower tier, Navy theater-wide, and Navy Area Air Defense Commander Module systems in a joint environment. Provide lessons learned for doctrine and organizations in use of these emerging systems.
  - Action: Examine multi-mission pull and joint C2 of Navy TBMD capable units.

- Anti-Submarine Warfare (ASW)
  - Objective: Provide field-tested CONOPS and technological recommendations to mitigate seams between local and theater ASW efforts.
  - Action: Examine coordination from theater ASW commander to local ASW Commander, in integrating unmanned sensors and platforms with manned sensors and platforms.

- Anti- Surface Warfare (ASUW)
  - Objective: Provide field tested CONOPS leading to TACMEMO development or fleet use of joint and Navy assets versus the swarming small boat threat.
  - Action: Examine joint tactical packages to counter swarming small boat threat.

- Mine Warfare (MIW)
  - Objective: Provide field tested CONOPS leading to TACMEMO development for fleet use of emerging mine warfare systems
  - Action: Refine concepts of employment for organic and dedicated MIW forces in assured access mission

- Information Operations (IO)
  - Objective: Determine if IO forward and JFMCC IO staff contribution were incorporated in the Maritime Planning Process and were sufficient/insufficient to produce the products, information, guidance, or feedback necessary to construct an MTO. Where insufficient, determine contributors to lack of process, products, information, collaboration, or control.
  - Action: Integrate kinetic and non-kinetic engagement options to develop computer network defense CONOPS. Evaluate the impact of cross-component engagement network and supporting TTP.

MC-02 Activities Proposed by NWDC

- Joint Fires
    - Objective: Provide recommendations for acquisition of system enabling coordination of joint Fires across the CJTF.
    - Action: Evaluate the impact of cross-component engagement network and supporting TTP.

- High Speed Vessel (HSV)
    - Objective: Provide lessons learned for development of future Navy combatants and support vessels to include littoral support craft, logistics, and vessels.
    - Action: Evaluate vessel speed, size, range, and endurance along with reconfigurable payload characteristics for assured access missions. Explore use of HSV for transport, USW, fire support, sensor support, medical support, and sea-based C2.

2.0 Initiative Descriptions

Following are brief overviews of the individual initiatives. They provide an overall description of the background for each initiative; a statement relating the initiative to the warfighting challenge in approximately five years; a brief characterization of the initiative itself; and then one or more questions, which provide the foci for the subsequent analyses.

2.1 Joint Forces Maritime Component Commander (JFMCC) Maritime Planning Process (MPP)

Description: The JFMCC process is a collective interaction among a number of processes that interpret guidance from the JFC, produce a Joint Maritime Operations Plan (JMOP), define Maritime Support Requests (MARSUPREQs), prioritize actions in a Maritime Master Attack Plan (MMAP), and assign actions to individual maritime commanders in a Maritime Tasking Order (MTO).

Relationship to warfighting challenge in 2007: In the 2007 timeframe, there will be multi-functional maritime platforms with multiple weapons systems, sensors, organic capabilities, highly sophisticated C2 systems, and low manning. Providing access to the littorals will be a requirement for maritime forces, often ahead of Time Phased Force Deployment and Joint capabilities. A Maritime Tasking Order will be required to optimize, synchronize, and interrelate forces that are both maritime and joint. The principal warfighting areas included in this initiative, as produced within the context of the experiment scenario are:

- Production of a Maritime Tasking Order through a Maritime Planning Process.
- Collaboration with Joint and Principal Warfare Commanders.
- Support for, and feedback to, a jointly constructed Effects Tasking Order (ETO).
- Tracking and redefinition of MTO events as they are executed.
- Definition of requirements for manning, tools, and C2.

Initiative Definition: The JFMCC process was analyzed to determine the overall efficiency and effectiveness in generating an MTO. The analysis was structured to decompose complex processes into their component sub-processes, and then assess their relative merit and contributions to the commander's understanding of the operational situation. Processes that were overly complex or time consuming were to be identified.

Overarching Question: Did the JFMCC Maritime Planning Process add structure, organization, management, feedback, optimization, and situational awareness to maritime force employment, and did it support the intent of a jointly developed Effects Tasking Order (ETO)?

2.2 Joint Fires Initiative (JFI)

Description: This was the application of common tools, processes, CONOPS, and architecture to conduct joint integrated Fires, which deconflicted Fires in space and time, but did not divide the battle space geographically according to land, sea, and air. NFN is the Naval subset of joint Fires.

Relationship to warfighting challenges (2007): The timely engagement and assessment of TSTs by Joint forces across components presents the following warfighting challenges:

- Establishment of a timely, accurate COP/CROP.
- Application of effective cross-component collaborative capabilities.
- Timely integration of Joint capabilities against tactical objectives.

Initiative Definition: Design and deliver a Joint Fires C2 network. The primary tool was ADOCS/LAWS software that was modified to incorporate a joint TST Mission Manager (i.e. DTL Manager) function that was used for C2 among component level commands and the Joint Task Force. The Joint Fires Initiative required that a TST be developed and nominated by one component and the mission passed by the supported Commander, to another component for execution.

Overarching Questions

- Did the proposed (experimental) joint targeting (cross-component) architecture enable timely engagements of TSTs?
- In what ways did a common toolset within the joint architecture improve the ability of the joint force to conduct effective cross-component TST operations?
- The initiative required the design and delivery of a joint Fires C2 network. The primary system of this network was ADOCS, modified to incorporate a joint TST mission manager (i.e. the Dynamic Target List (DTL) Manager) function that was used for C2 by the component level commanders and the Joint Task Force. The Joint Fires initiative required that a TST be developed and nominated by one component, and the mission passed by the supported commander to another component for execution

2.3 High Speed Vessel (HSV)

Description: The FBE-J/MC02 High Speed Vessel (HSV) joint initiative was a major milestone in the Joint HSV Project. The HSV project is a joint, multiyear effort between the Army, Navy, Marine Corps, and Naval Special Warfare Command. The project explores the concepts and capabilities associated with commercially available advanced hull and propulsion technologies integrated with advanced communications technology. New designs for surface vessels permit significantly increased speeds that can improve support for Intra-theater logistics and combat service (logistics movements within the operations area). Other characteristics possessed by the HSV appear to be particularly well suited to littoral operations, especially mine warfare, command and control, and possibly support to medical forces.

For MC02/FBE-J, there were two test-bed HSVs (Joint Venture (HSV-X1), and Sea SLICE) serving as surrogate platforms in a number of LOEs. HSV-X1 is a semi-planing wave-piercing aluminum catamaran originally built and operated as a commercial high-speed car and passenger ferry. The project leased HSV-X1, made enough modifications to the vessel to support experimentation and demonstration needs, and installed an advanced (and experimental) C4I system. The Sea SLICE is a small waterplane twin hull (SWATH) ship owned and built by Lockheed Martin on behalf of the Office of Naval Research as a technology demonstrator. While significantly different in size and capabilities, both of these unique platforms are a departure from traditional Navy monohull ships. FBE-J was a valuable opportunity to demonstrate the technology of these two vessels.

In addition to the test bed platforms, 5 simulated HSVs (Agile, Aggressive, Exultant, Impervious, and Hercules) also participated in the experiment. All of these vessels are more fully described in chapter 7.

HSVs' participation in FBE-J/MC 02 provided an opportunity to validate previous LOE findings in an operational setting. Against the backdrop provided by the experiment scenario, the Project’s partners put the vessel and their experimental systems and concepts through their paces. Joint Venture's ability to support alternative mission configurations was tested as first multiple mine warfare (MIW) functions were exercised; followed by simultaneous MIW C2 (MIWC) and Naval Special Warfare (NSW) operations; simultaneous MIW C2, NSW C2, and Marine Corps ship-to-objective-maneuver (STOM) operations; simultaneous logistics, surveillance, and NSW operations; and closing MC02 with an Army validation of its ability to conduct an operational retrograde of a Stryker Brigade Combat Team (SBCT). In addition to Joint Venture's participation, FBE-J/MC02 provided an opportunity to:

- Conduct mine countermeasures, fires, surface warfare, and NSW experimentation with Sea SLICE.
- Experiment with a simulated force of five HSVs operating as a force of Littoral Surface Combatants to explore Fleet concepts of operation (CONOPS).
- Test the HSVs' ability to quickly reconfigure in support of different mission areas.

Relationship to Warfighting Challenge in 2007: HSV technology in Joint Venture leverages proven commercial design to bring an added dimension to modern naval warfare. Commercial shipyards already manufacture vessels with a number of militarily relevant capabilities including high-speed, long range at endurance speeds, reasonably good sea keeping ability, shallow draft, and rapid adaptability to multiple, changing missions. Additionally, the cost and manning requirements of a militarized version of these vessels is estimated to be substantially less than that of a more traditional military ship of comparable size and capability. To the extent these commercial vessels can be further modified to meet military needs, they potentially offer significant, near term capabilities.

In 2007 these enhanced capabilities could offer clear advantages to the Joint Force Commander (JFC). An HSV's inherent speed and ability to operate from austere ports enhance its operational mobility and reduces an enemy's ability to maintain situational awareness across extended battlespace. As sensors improve in numbers and capabilities, the HSV's ability to deploy manned and unmanned sensors, collect, process and disseminate information, and host a forward-based commander and his staff will become increasingly important to gaining and maintaining situational awareness. The HSVs' increased mobility and situational awareness create new opportunities to exploit those advantages. Ship design characteristics in the HSV such as high speed, high payload fraction, minimal manning requirement, and shallow draft lend themselves to sustaining combat forces across the access battlespace. Enable by system interfaces and a baseline architecture built into an HSV's command, control, communications, computers, and intelligence (C4I) system, the HSV's ability to accept C4I modules extends the JFC's ability to push his command and control forward into the battlespace.

The improvement in capabilities that HSV technology offers has direct applications in Rapid Decisive Operations (RDO) as they provide the JFC an enhanced ability to accelerate his tempo of operations. As a result, HSV technology creates opportunities for developing transformational operational concepts aimed at bringing military power to bear from long range at responsive speeds.

Initiative Definition: The High Speed Vessel Joint initiative was part of a yearlong series of experiments that explored the military use and suitability of advanced hull and propulsion technologies integrated with advanced communications technologies. For FBE-J/MC02 there were two test-bed HSVs (JOINT VENTURE (HSV-X1), and SEA SLICE). In addition to the test bed platforms, 4 simulated HSVs (AGILE, AGGRESSIVE, EXULTANT and IMPERVIOUS) also participated in the experiment. As an enabling technology, the HSV initiative overlapped other FBE-J/MC02 initiatives, as described below.

Sub-initiatives: The HSV sub-initiatives provided context and interactions between maritime missions and potential HSV roles. HSV evaluations and analyses extended across a number of mission areas, e.g., MIW, Naval Special Warfare (NSW), support to Ship to Maneuver (STOM), and Joint support (e.g., IBCT redeployment and logistics ashore). The relationships between hull-type and the capabilities resulting from this hull form, and design for multi-purpose roles was the central analysis perspective in FBE-J.

In support of different missions, both the test-bed ships and simulated HSVs were reconfigured and switched between missions during the experiment. Free-play within the scenario simulation also resulted in mission shifts and was an additional source of important data.

Overarching Questions

- What additional value added did having a number of high speed, reconfigurable, and multi-mission platforms provide the JFMCC and JFC in a littoral campaign as part of an access mission?
- What are the appropriate missions best suited to this concept of maritime operations?
- In a netted environment with many and varied types of sensors, what are the advantages or disadvantages of the C2 construct used in this concept?
- What conditions and design features must be considered in engineering the capabilities requisite in meeting the challenges in a 2007 campaign?

2.4 Naval Fires Network – Experimental (NFN (X))

Description: This initiative was to provide support for fully autonomous platforms that were capable of performing all aspects of targeting and to simulate future power projection platforms and weapon systems.

Relationship to warfighting challenges in 2007: In 2007, the timely engagement and assessment of TSTs by the JFMCC will present the following warfighting challenges:

- Establishment of a timely, accurate COP/CROP.
- Maintenance of effective collaborative capabilities among and within engagement nodes.
- Timely integration of capabilities against tactical objectives.

Initiative Definition: The Naval Fires Network (Experimental) initiative in FBE-J / MC 02 was designed to implement experimental Navy targeting systems and processes. These support joint targeting and Fires requirements across service components, up to CJTF and down to tactical Naval forces, using defined CONOPS, TTP, systems, architecture, and organization. Navy Fires was to project power ashore through the integration of long-range surface, sub-surface, and air-delivered fires.

Overarching Questions

- What was the contribution of Naval platform self-targeted engagements to the TST engagement problem?
- What are the operational planning and employment considerations required for the effective utilization of future power projection platforms in the TST engagement process?
- How successful was the defined TST architecture in engaging asymmetric TST targets?
- How successful were Naval platforms in responding to multi-mission tasking?
- What was the contribution of the Mensuration Manager to the TST process?
- What did the introduction of a ground COP contribute to the TST process?

2.5 Intelligence, Surveillance, Reconnaissance Management (ISRM)

Description: This initiative was to integrate the management of the JFMCC, ISR planning and execution, asset management, manning requirements, Unattended Ground Sensors (UGS), and multi-platform SIGINT tracking, with dynamic ISR management.

Relationship to warfighting challenges in 2007: In order to reduce the time needed to make critical decisions, particularly with regard to TCTs, it is vital to improve the efficiency of managing various ISR systems. It is likewise important to improve the efficiency in the construction and management of the resultant comprehensive database and COP/CROP in order to make optimal decisions in minimum time.

Initiative Definition: The primary objective of this sub-initiative was to provide a representative construct from which UAV ISR assets (e.g. a tiered-UAV architecture) can support the Maritime Planning Process (MPP), Joint Dynamic ISR Management (JDISRM), Time Sensitive Targeting (TST), and Assured Access (AA) experiment initiatives. In doing so, the areas of tactical utility, connectivity, and C2 structures (e.g. concept of operations) of a tiered UAV ISR&T architecture, as well as the required level of effective control of UAV assets to allow for dynamic management, could also be explored. For the experiment, Global Hawk, Joint Operational Test Bed System (JOTBS), and Pioneer UAVs were used to examine UAV tasking, data processing, exploitation and dissemination afloat.

Overarching Questions

- Can dynamic ISR management be effectively employed to engage high priority targets?
- Can unattended ground sensors and unmanned aerial vehicles be effective sources of information for DISRM?
- Are the communications links sufficient for the purpose?

2.6 Mine Warfare (MIW)

Description: The overall objective of the MIW experiment in FBE-J was to examine the application of network-centric warfare concepts and other emerging technologies as they might apply to mine warfare.

Relationship to warfighting challenges in 2007: In 2007, the littorals will be increasingly important and challenging for maritime and joint forces to access quickly and safely. New platforms such as High Speed Vessels (HSVs), and technological advances in sensor capabilities increase the organic MCM capability and present the MIWC with organizational, resource allocation, information, and C2 challenges, only partially addressed in FBE-J.

Initiative Definition: The command and control structure in FBE-J encompassed an experimental organization, an HSV as a surrogate future Mine Warfare Command and Support Ship (MCS) capable platform, new command and control equipment,and some new MCM capabilities, which replicate future MCM capabilities in the 2007-2010 time frame.

Overarching Question: How can the efficiency and effectiveness of mine warfare be enhanced through the use of network-centric operations?

2.7 Anti-Submarine Warfare (ASW)

Description: The anti-submarine warfare (ASW) initiative in FBE Juliet addressed tactical, operational, and command decision processes within this warfare area.

Relationship to warfighting challenges in 2007: Network-centric ASW is the underlying concept for success in ASW in littoral waters. This concept of multi-level commands and multi-disciplinary forces, well-connected by common communications, and guided by solid doctrine, planning tools, and commander's guidance will be central to rapid and successful prosecution of submarines in these complex and dangerous situations.

Initiative Definition: There were four ASW sub-initiatives in FBE-J:

- The submarine locating device initiative investigated the operational concept of installing submarine locating devices. This included issues of when, where, and how to achieve the installation, and what type of capabilities the locating devices should have. The problems of permissive ROE were considered. Submarine Locating Device signals were utilized in the ASW picture.
- The remote autonomous sensor initiative investigated the ability of remote, autonomous systems to independently identify submarine contacts and report them in real time or near real time. The purpose was to determine if remote autonomous sensors could, if necessary, provide the commander the ability to effectively cover large areas without risking manned assets, yet be able to attack threat submarines efficiently with the use of air assets.
- The experimental common undersea picture initiative provided basic tools for network-centric ASW. It had three major functions that provided the backbone for this operational concept: force collaborative planning, shared situational awareness, and common dynamic tactical decision aids.
- Using the experimental naval Fires network for ASW Targets sought to determine if incorporating ASW targets in the experimental Navy Fires network (NFN (X)) in conjunction with the Land Attack Warfare System (LAWS) could improve the ability to attack ASW targets successfully as time critical targets.

Overarching Question: How can network-centric ASW operations improve detection, classification, localization, and neutralization of enemy submarines to assure rapid and successful maritime access to, and operations in, littoral regions of interest?

2.8 Information Operations (IO)

Description: The FBE-J Information Operations initiative was designed to provide the full range of IO capabilities (Offensive, Defensive, and Collaborative) in support of the JFMCC planning process. It incorporated experimental and emerging organizational constructs, processes and capabilities to accommodate simultaneous offensive and defensive operation at the tactical and operational levels.

Relationship to warfighting challenges in 2007: As the number of sensors, platforms, exploitation sites, and command and control nodes continue to proliferate with advances in technology, commanders and analysts require assurance that data, information, and knowledge, are being managed effectively and efficiently. Likewise, any disruption that we can create in opposition force data flow, which will confuse or delay decision making by the opponent, provides us with a relative advantage. The role of IO and the IO Cell is to simultaneously protect friendly information and information systems while denying, degrading, disrupting, and destroying the adversary’s system to produce a more favorable information differential between the two.

Initiative Definition: The following four sub-initiatives comprised the IO effort and were researched during FBE-J:

- IO enrichment to the JFMCC planning process.
- Collaborative IO planning.
- Defensive IO – Computer Network Defense.
- Offensive IO – Tools incorporated to support deliberate and time critical targeting.

Overarching Question: Is IO sufficiently incorporated into the MPP operations to yield high quality products, information, guidance, and feedback to support the MTO generation process?

2.9 Coalition Command and Control (Coalition C2)

Description: The operational commander should be able to ensure that coalition partners are assets to enhance relevant information exchange, and not a liability that could potentially decrease speed of command. The use of coalition forces can reduce the risk to US forces, and increase nodal sensor (or weapons) coverage, as long as architecture exists to support their integration.

Relationship to Warfighting Challenge in 2007: Coalition operations, including those of ad hoc coalitions, have been a fundamental reality in virtually every recent operational engagement of the U.S. Navy and multi-service forces. Examples include operations Desert Storm, Allied Force, Joint Forge/ Guardian, and Enduring Freedom. Coalition operations will be most effective if they serve as not only a political instrument of national power, but contribute to the warfighting effectiveness of the combined forces. Situational awareness that combined Naval operations should be able to leverage might be compromised by the varying strengths that regional coalition partners bring to a theater of engagement. Interoperability is a potential source of friction between network-centric warfare and multi-national operations. There are also potential concerns among allies and coalition partners that the disparity in technology advancement between partners, particularly network-centric warfare, will inhibit effective coalition command and control.

Initiative Definition: The initiative addressed the following warfighting challenges:

- Multi-national interoperability.
- Dynamic reconfiguration of networks supporting multi-tasked platforms or those with disadvantaged or intermittent C4 capabilities.
- Reliability of network-centric architectures to exchange relevant information for distributed planning and decision-making.
- Needs for a better mechanism to support secure information sharing to enhance the coordination of operational forces while protecting national sources and data deemed not releasable.
- The extent of future desired operational capability supported.
- Information Superiority.
- Secure cross-service, -platform, -discipline, -echelon, -coalition and -agency integration
- Real-time battlespace awareness.
- Comprehensive battlespace awareness to support the full range of military operations.

Overarching Questions

- Can a coalition force be effective and dynamic, reconfigurable, and tailored to the threat and theater?
- Can partners join and leave C2 networks with minimum difficulty?
- Can national information data and sources be protected while decision-making with a coalition force is shared?

2.10 Netted Force (NF)

Description: This initiative consists of three sub-initiatives: Knowledge Management Organization (KMO), Collaborative Information Environment (CIE), and Ground COP. All are designed to improve the management of, and access to, information within the battle force to permit fast, confident decision-making.

Relationship to warfighting challenges in 2007: The proliferation of data from disparate source sensors, particularly those generating continuous data streams, the potential reduction in platform signatures, and the concomitant increases in speed and lethality of weapons systems all mandate efficient distribution and management of information in order for a joint force to make the best decisions in battle.

Initiative Definition

- Knowledge Management Organization (KMO) Initiative focused on the Knowledge Information Officer who answered directly to the JFMCC and coordinated the JFMCC Commander, Chief of Staff, and Battlewatch Captain to ensure that watch team knew where to find critical information.
- Collaborative Information Environment (CIE) Initiative focused on the ability of the CIE to support rapid decisive operations by giving the commanders the information they need to have confidence in their decisions.
- Ground COP Initiative- attempted to automate the linkage between traditional COP track management, engagement tools, target management, and intelligence order-of-battle tools using the capabilities of the emergent GCCS 4.X architecture.

Overarching Questions

- Does the netted force (NF) support improved planning and execution by improving the commander's situational awareness while decreasing information overload?
- Does the KMO concept provide for improved bandwidth management in support of combat operations?
- Does the NF improve the understanding and decision making of tactical ground forces?

2.11 Joint Theater Air Missile Defense (JTAMD)

Description: Navy Theater Air and Missile Defense (TAMD) capability was hosted as one of the multi-functional capabilities onboard select surface combatants.

Relationship to Warfare Challenge in 2007: Navy Theater Air and Missile Defense (TAMD) capability will be hosted as one of the multi-functional capabilities onboard surface combatants. Navy planners will require solutions that balance joint (critical asset defense) and maritime (force protection and access) requirements and effectively, and more optimally, employ limited numbers of ships in a dynamic battlespace environment. Doctrine and organizational constructs will have to support the command, control, and coordination of capabilities simultaneously shared by Navy and Joint commanders. Evolving innovations in technology include improvements to the Area Air Defense Commander (AADC) module to develop and evaluate alternative courses of action. Evolving weapons technical capabilities include sea-based mid-course and terminal phase TAMD capabilities, Cooperative Engagement Capabilities (CEC), and improvements in weapons platforms such as the enhanced E-2 and F/A-18 aircraft.

Initiative Definition: FBE-J provided the dynamic interactions necessary to further mature joint TAMD/AAW operations for TACMEMO development. Data were collected with respect to command relationships and mission planning processes to optimize allocations of multi-mission TAMD capabilities on surface ships, using the capabilities of an AADC module. System elements were evaluated for joint employment, providing input to a future USN AADC module TACMEMO and to mature the initiative for further refinement and analyses in upcoming LOEs and FBEs. JTAMD sub-initiatives were designed to define further the internal processes developed within the AADC module to support the JFMCC's Maritime Planning Process (MPP) and to provide guidance for the interaction of Navy TAMD with JTAMD.

Overarching Questions

- Can a single commander appointed as both the battle force Air Defense Commander (ADC, also AW) and a Regional Air Defense Commander (RADC), supported by the AADC Module planning capability and process, effectively support the air and missile defense requirements of both commanders?
- Does the capability to rapidly wargame alternative courses of action with the embedded war gaming (M&S) capability and to provide graphic displays provide value added to the Joint Force Maritime Component Commander (JFMCC) and Joint Forces Air Component Commander (JFACC)?
- What emerges as functional relationships between the JTFHQ (production of the Effects Tasking Order and/or the Defended Asset List), the JFMCC (Maritime Tasking Order), and JFACC/AADC (Air Tasking Order)?
- What emerges as the organizational relationship between the SJTFHQ Theater Missile Defense (TMD) Cell, JFACC/AADC, Deputy Area Air Defense Commander (32nd AAMDC), Regional Air Defense Commanders (RADC), and the maritime Air Defense Commander?
- What elements of the experimental organization, TTP and C2 learned from this event are suitable for inclusion in a future USN AADC module TACMEMO?
- Does the JFMCC Maritime Planning Process mitigate the dilemma posed by competing demands for multi-purpose surface combatants?

2.12 Sea-based Command and Control (Sea-based C2)

Description: This initiative analyzed the potential for network-centric computing to support the objectives of a sea-based CJTF, and provided insight to the manning structure and functional capability of the JFHQ.

Relationship to Warfighting Challenge in 2007: The network-centric computing paradigm of the near future can provide a vastly improved exchange of information, with improved situational awareness and greatly reduced response times, thus streamlining the execution of battlefield scenarios. This will require improved data communication capability in terms of bandwidth, reliability, and accessibility. Fleet Battle Experiment - Juliet (FBE-J) was a platform to demonstrate these increased capabilities and to test the feasibility of network-centric solutions to naval warfighting situations of the future.

Initiative Definition: Network data were collected to determine the necessity, sufficiency and effectiveness of the wide-area network connections used in FBE-J. An assessment was made as to the effectiveness of the COP in supporting sea-based command and control.

Overarching Questions

- Document the CJTF staff perceptions of their capabilities as a CJTF that is sea-based within the context of the MC02 scenario and FBE-J/MC02 architecture.
- Are the manning, structure and functional capability of the JFHQ sufficient for the requirement?
- Is the “reachback capability” of the JFHQ (Forward), on-board USS CORONADO, to the JFHQ (Main) at Suffolk, VA, sufficient to ensure information superiority?

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Section II: Principal Results

(Principal Results are also contained in the Summary Analysis Report.)

3.0 Principal Results

3.1 Summary of Findings

The following principal results have been extracted from the Fleet Battle Experiment -Juliet (FBE-J) Reconstruction and Analysis Report's key observations. They are a fraction of the results that were obtained from the experiment. They are deemed to be the most significant for reasons such as operational impact, importance of further study, etc.

These results have been determined under conditions that existed during FBE-Juliet. Whether they are applicable outside those conditions is speculative. Section II of this report provides an abbreviated description of the general context for the experiment. A more complete description can be found in the Reconstruction and Analysis Report. Section III provides a brief description of the context as related to any experiment, followed by the specific context that is pertinent for each initiative. These two Sections will allow one to assess the validity of these principal results and the conditions for which they apply. It also allows one to plan the conditions under which further experimentation should be carried out.

Each principal result is presented in two formats. The first format is a set of brief summary points presented as in a table. The second is a brief description of each point on the same page. These formats can be used for presentations, with the first being projected and the second to verbally describe the results. Again, full descriptions of these results can be found in the Reconstruction and Analysis Report.

A semantic difficulty has been encountered in presenting these results. The distinction between a time sensitive target (TST) and a time critical target (TCT) has been lost in current common usage. Their definitions are:

- **TST**. A target that is to be attacked by a particular time. Such a target can be on the deliberate targeting list.

- **TCT**. A target that "appears" and must be attacked within a definite time period. This target will be on a priority list, but will not be on the deliberate targeting list.

TCTs are a special class of TST. It is important to differentiate because they are managed differently and conclusions with respect to the ability to manage them can differ.

MPP #1 - The Maritime Planning Process Is Viable

- All required tasks were executed and required products produced.
  - Full process from ETO ingestion to MTO production executed
  - Three overlapping, 72-hour planning cycles executed simultaneously

- The range of planning done in the experiment was limited.
  - Competition for assets between PWCs was largely nonexistent.
  - Execution results were not fed back into the planning cycle.
  - There was no determination of the plans' quality.

- Process difficulties need to be addressed.
  - Individuals needed to multi-task; there is no process for coordinating tasks with individual availability.
  - Synchronization was ad-hoc rather than a planned process.

Maritime Planning Process #1

The maritime planning process (MPP) was implemented by a staff structure under the Joint Forces Maritime Component Commander (JFMCC). Effects tasking orders (ETOs) from the Joint Forces Commander (JFC) were ingested, and maritime tasking orders (MTOs) were produced and coordinated with the air tasking order (ATO). Principal warfare commanders (PWCs) participated in the process, producing maritime support requests (MARSUPREQs) that were a component of MTO production. Three overlapping planning cycles of 72-hours each were simultaneously executed. The process executed all required tasks and produced required products.

Applicability: The range of planning done in the experiment was limited. The range of situations that the process can manage is unknown.

- Competition for assets between PWCs was largely nonexistent. The process was not stressed.
- There was no MTO-ATO feedback cycle for plan adjustment.
- There was no determination made of the plans' quality.
- Execution results were not fed back into the planning cycle; no process exists to do this.

MPP details and causes. It was observed that the MPP is viable, but also observed was that the process did not go well. Principal problems and their causes were:

- The need to simultaneously support three planning cycles with a limited number of individuals appeared to be a primary cause for process difficulties. Individuals needed to be multi-tasked, and there was no process for coordinating tasks with individual availability.
- A high level of synchronization of tasks was needed, along with the information that supports the tasks, and the individuals that perform them. Synchronization was ad-hoc rather than a planned process.
- Various inputs to a given MTO were observed to contain essentially the same content as submissions for previous plans, creating the impression of resubmission rather than new plan development. The cause for this duplication is not known, nor whether it is a real problem. Possible causes are overloading of multi-tasked individuals and information synchronization difficulties.

Recommendation

- Assume at this time that MPP should be implemented and refer to the following MPP principal result for pre-implementation requirements.

MPP #2 - MPP Implementation Study Needed

- Little information is available for MPP improvement.

- Further progress with MPP requires:
  - o Detailed mapping of the planning architecture
  - o Parameterization of planning sub-processes
  - o Mapping of planning decision processes
  - o Mapping of information flows that support planning and decisions
  - o Better personnel assignments to tasks

- Process modeling is required.
  - o Develop a detailed MPP process model
  - o Parameterize the model with data from FBE-J and other experiments
  - o Determine from model simulation runs how to synchronize the process
  - o Determine MPP personnel requirements and multi-task coordination
  - o Determine how to synchronize asynchronous feedback from execution

Maritime Planning Process #2

MPP principal result #1 identifies that the process is viable, that difficulties remain to be resolved, and overarching problem areas. The experiment revealed process problems but provided little information about how to resolve them.

MPP implementation context. It is assumed that the MPP will be implemented with staffing that is approximately the same as in FBE-J. This means that personnel multi-tasking and synchronization of tasks, supporting information, and the identification of the individuals performing tasks will be required.

A process is needed to feed back information into all three planning processes on the results of actions and executions. An effects cell and a process for synchronizing its output with planning cells are proposed, and definition of this process is required.

Recommendations

Further progress with MPP requires detailed mapping of the planning architecture, parameterization of planning sub-processes, mapping of planning decision processes and information flows that support the decisions, and better personnel assignments to tasks. This can only be done by process modeling. Specifically:

- Develop a detailed MPP process model. This should be done for both the system tested in FBE-J and for the more comprehensive system needed for adequate MPP execution.
- Parameterize the model with data from FBE-J and JFMCC limited objective experiments (LOEs). Run the model to identify principal process shortfalls.
- Determine, from a model, how to synchronize the process. Model iterations and runs can identify requirements.
- Determine MPP personnel and multi-task coordination requirements from a model.
- Determine how to use an effects cell to synchronize the asynchronous feedback from execution.

HSV #1 - HSV Rapid Reconfiguration For Different Missions Is Viable

- HSV reconfiguration was accomplished for:
  - C2 platform for MIWC and MCM operations
  - Navy Special Warfare
  - Intra-theater lift/movement of a brigade combat team unit
  - Sensor management platform
  - Support for helicopters, small boats, USVs, and UUVs

- Five reconfigurations accomplished, time for each less than one-half day

- Further tests for more configurations and operations needed:
  - Reconfiguration profiles, their difficulty levels, resource needs, and times to accomplish
  - Fits between reconfiguration profiles and orders of battle
  - CONOPS and TTP for HSV use and reconfiguration for littoral warfare
  - Numbers of ships needed to support various operations
  - Optimal reconfiguration profiles to minimize the required number of ships

High Speed Vessel #1

During the experiment HSV-X1 was reconfigured five times, with time to achieve reconfiguration never more than one-half day. It was tested as a command and control (C2) platform for Mine Warfare Command (MIWC) as well as for mine countermeasures (MCM) operations, Navy Special Warfare (NSW), intra-theater lift/movement of a brigade combat team unit, and a sensor management platform. Opportunities arose during the experiment to provide support for helicopters, small boats, unmanned surface vehicles (USVs), and unmanned underwater vehicles (UUVs).

Applicability: A subset of possible HSV missions was tested during the experiment. The full range of missions an HSV can support, and the numbers of ships needed to support a particular mission are not yet known. Reconfiguration works, but will have differing difficulties and times to accomplish, dependent on specific missions.

An operation may involve more than one HSV. Varying numbers of ships will be involved in the various missions within the operation. The number of ships to be reconfigured, and the schedule, will depend on how missions and ships use are synchronized. A process will be needed to optimize reconfiguration.

Recommendations

Studies should be undertaken immediately to determine:

- Reconfiguration profiles, their levels of difficulty, resource needs, and times to accomplish
- Numbers of ships needed to support various operations
- Fits between reconfiguration schedules and orders of battle
- CONOPS and TTP for HSV use and reconfiguration for littoral warfare
- The optimal reconfiguration profiles necessary to minimize the required number of ships.

HSV #2 - HSV is Able to Operate as a Simultaneous, Multi-Mission Platform

- HSV-X1 simultaneously conducted MIWC, MCM, and STOM operations.

- A subset of possible HSV simultaneous missions was tested. Outstanding questions:
  - Efficient single ship multi-mission profiles
  - How more than one ship would support several missions
  - How to coordinate multi-missions within and between HSVs

- Undertake studies to determine:
  - Needed simultaneous multi-mission support for various orders of battle
  - Manning required to support single-ship multi-mission capabilities
  - Required information exchange and coordination for multi-ship simultaneous missions

High Speed Vessel #2

During the experiment HSV-X1 conducted MIWC, MCM, and STOM operations simultaneously, while also functioning as a forward deployed sensor management/C4ISR platform.

Applicability: A subset of possible HSV simultaneous multi-mission support was tested during the experiment. Multi-mission support with a small platform works, but the extent to which such support can be provided is not known.

A single ship can perform two or more missions simultaneously. However, it is not known which multi-mission combinations are most efficient and for which mission conflicts might arise. This needs to be determined before multi-mission tactics, techniques, and procedures (TTP) can be developed.

How the Navy would use more than one ship to support several missions, and coordinate their activities has not been investigated. A combination of single-mission and multi-mission HSVs could be the preferred option.

Coordination of the activities of all HSVs will be required. Planning such coordination would be a part of the MPP, would necessarily involve the HSVs, resulting in a distributed JFMCC. Standard operating procedures (SOPs) for command and control (C2) of multiple HSVs operating in the littoral, with an HSV as the principal C2 ship, must be developed.

Recommendations

Studies should be undertaken immediately to determine:

- Needed simultaneous multi-mission support for various orders of battle
- Manning required for support of single-ship multi-mission capabilities
- Required information exchange and coordination for multi-ship simultaneous missions
- TTP for multi-ship, multi-mission command and control.

HSV #3 - HSV Vulnerabilities Not Understood

- Concern emerged about HSV vulnerabilities, even to small arms fire

- No information was obtained during the experiment to address this issue.

- A study should be conducted to:
    - Determine likely threats to an HSV operating in the littoral
    - Determine HSV vulnerabilities to these threats
    - Develop force protection systems and processes against those threats
    - Test and train to these force protection measures.

High Speed Vessel #3

Concern emerged about HSV vulnerabilities, even to small arms fire. No information was obtained during the experiment to address this issue.

Planned HSV operations are in the littoral. This will put it within range of numerous threats in addition to those normally faced by Navy ships: shore batteries, small surface and air craft, hand-held launchers, small arms, etc. Threats can emerge rapidly, with little warning. Protection systems and processes that allow rapid reaction are needed.

Physical vulnerabilities of these ships to a wide range of fires are not understood.

Recommendation

Conduct a study to:

- Determine threats that are likely to be encountered by an HSV operating in the littoral.
- Determine the vulnerabilities of the current HSV to these threats.
- Suggest the capabilities needed for new HSV designs.

New training procedures will be needed for these force protection measures.

HSV #4 - HSV Sleep Patterns May Interfere With Duty Performance

- Sleep quantity and quality were substantially less than sailors working nights during combat.

- Small number of test cases studied, factors neglected were:
    - Data compromise due to greater motion of an HSV
    - If HSV tasks more or less subject to interference from sleep deprivation
    - Effect of low manning and fast pace of HSV operations

- Studies are needed to:
    - Develop a methodology to account for HSV motion.
    - Perform a comprehensive study of HSV sleep patterns.
    - Determine if HSV duties' pace is unusual with respect to other Navy operations.
    - Compare HSV sleep patterns with those of personnel performing equivalent.

High Speed Vessel #4

Comparisons of data taken on the HSV with data previously obtained indicate that the quantity and quality of sleep are substantially less than that of USN recruits during boot camp and sailors working nights during combat. Current human factors research indicates such sleep patterns lead to greatly increased risk of mishaps due to lapses in attention and fatigue.

Applicability: These results are preliminary, from a small number of test cases. Factors such as data compromise due to the greater motion of an HSV have not been taken into account.

It is not known if tasks aboard the HSV are more or less subject to interference from sleep deprivation. Because of low manning and the fast pace of HSV operations, this may be a more critical factor than on other ships.

There has as yet, been no comparison of individual HSV tasks with equivalent tasks on other ships. Such studies should determine if there are substantial differences in the expectations of how tasks are to be performed, as well as a determination of sleep patterns.

Causes: It is possible that ship motion and pace of operations could be contributing factors to sleep deprivation. Causes are not understood, and their determination must wait until further data are obtained to determine if sleep deprivation is a real effect.

Recommendations

- Develop a methodology to determine sleep patterns in the presence of HSV motion.
- Perform a comprehensive study of HSV sleep patterns.
- Determine if the pace of HSV duties is unusual with respect to other Navy operations.
- Compare HSV sleep patterns with those of personnel performing equivalent Navy tasks.

COP #1 - GCCS-M Information Inconsistencies Exist

- GCCS-M versions 3.X and 4.X show inconsistent track information.

- GCCS-M displays on different platforms sometimes showed different information.

- Causes for inconsistencies and the impact of this observation are not known.
    - Reliability of the COP can be questioned.
    - Magnitudes of differences are not known.
    - Potential impact on operational decision-making is not known.

- An immediate study should be undertaken to determine causes and fix the problem.

<u>Common Operational Picture #1</u>

During the experiment, track information was displayed on both 3.X and 4.X versions of the Global Command and Control System-Maritime (GCCS-M) and on different platforms. There were instances of information not being the same on the two versions and between platforms with 3.X. The extent and magnitude of inconsistencies are not known.

Causes: The causes of the inconsistencies are not known.

Impact: This observation causes the reliability of the common operational picture (COP) to be questioned. However, the significance of this difference is not known, either in terms of the magnitude or potential impact on operational decision-making.

It is believed that this is a technical problem that may have an easy fix. Thus, determination of the impact of the observed differences on operations is not deemed an efficient use of resources. Effort should be expended on finding the cause and solution to the problem.

Recommendation

- Determine the reason(s) for the differences and fix the problem.

ASW #1 - CUP Tools Provide Needed ASW Support

- Provided shared understanding of environment and support for collaborative planning

- Advantages and limitations of the tools were:
    - Improved planning of optimal search patterns and execution monitoring
    - No information obtained on use in conjunction with or part of COP
    - Connectivity with submarines is a significant limitation
    - Chat monitoring required almost a full-time person
    - TTP required for efficiency and to control information quality

- Studies should be undertaken to:
    - Develop a consistent set of TTP, tools, manpower needs, and training.
    - Determine bandwidth and connectivity requirements for all platforms.
    - Determine any needed CONOPS changes for CUP implementation.
    - Determine total system loading for CUP used in conjunction with other information systems.

Anti-Submarine Warfare #1

Common tools, networked to common data sources, provided needed support for distributed, collaborative planning. Shared understanding of the undersea environment was produced. Production and use of an ASW Common Undersea Picture (CUP) is viable and will enhance ASW capabilities.

Applicability: No information was obtained on use of the CUP in conjunction with, or as part of other COP systems, such as GCCS. Possible competitions for bandwidth and personnel attention have not been evaluated.

Advantages and limitations of the tools were:

- The CUP enabled collaborative planning of optimal search patterns and monitoring of execution.
- Connectivity between submarines and the force is a significant limitation. Bandwidth and connectivity must both be considered for a solution.
- Chat was one of the primary collaboration tools and used extensively. Efficient collaboration by this means appears to require almost full-time monitoring, which is probably unacceptable and indicates some type of scheduling is needed.
- There are no rules for who may provide information or for controls on information content. Support tools use-discipline is required for efficiency and to control information quality.

Recommendations

- Develop a consistent set of TTP, tools, manpower needs, and training for a CUP.
- Determine bandwidth and connectivity requirements for all platforms participating in ASW.
- Determine any changes needed in CONOPS for CUP implementation.
- Determine total system loading for CUP used in conjunction with other information systems.

ASW #2 - Remote Unmanned Sensors Improve ASW Operations

- Sensors utilized:
    - Bottom-moored acoustic arrays
    - Unmanned surface vehicles (USVs)
    - Submarine-locating devices (SLD)

- Advantages and limitations:
    - Pre-hostility SLD reports enabled optimization of Blue-force assets.
    - ADS success requires advanced identification of critical locations and choke points.
    - USV sensors did not function as designed.
    - Seaworthiness of USVs and included sensors is a problem.

- Improved use of these sensors requires:
    - Develop USV and sensor seaworthiness and maintainability requirements.
    - Development of TTP for the coordinated use of various sensors.

Anti-Submarine Warfare #2

Bottom-moored acoustic arrays, unmanned surface vehicles, and submarine-locating devices (SLD) provided valuable information for localization and attack prosecution.

Advantages and limitations of the tools were:

- Periodic reports from SLD during pre-hostilities provided sufficient information to allow Blue-force assets to be assigned to search exclusively for unreported submarines.
- It would be desirable to be able to prompt SLD reports rather than operate on a pre-determined schedule.
- A portion of the success of an Advance Deployable System (ADS) field was due to identifying critical locations and choke points for installation of a sensor field ahead of time and concentrating installation there.
- The ability to coordinate USVs with air ASW platforms was demonstrated, however sensors did not function as designed.
- Seaworthiness of USVs and the included sensors is a problem.

Recommendations

- Develop a set of seaworthiness and maintainability requirements for USVs and their sensors.
- Develop TTP for the coordinated use of various remote, unmanned sensors.

ASW #3 - NFN (X) Use For ASW Had Limited Success

- LAWS and GCCS-M were used for ASW engagements.
- Non-NTDS platforms realized the most benefit from the system.
- Greater utility would be realized from incorporation into existing submarine weapons control systems and/or surface ASW tactical data systems.
- LAWS occasional latency of several minutes is unacceptable for this application.
- Before further testing of NFN (X) for ASW:
    - Develop plans for fusion with existing ASW information.
    - Develop combined information displays.

Anti-Submarine Warfare #3

The use of the NFN (X) systems, especially LAWS and GCCS-M, for ASW engagements was investigated. Opinions about the usefulness of these systems are mixed.

System usefulness context: There was a pattern to perceptions about the usefulness of these systems. Personnel on platforms that do not use the Naval Tactical Data System (NTDS) and other tactical data links viewed the system as providing added value.

Applicability: The usefulness of this approach is not known for situations where there are simultaneous, intensive operations, such as a ir and ASW. Ultimately, tests will have to be undertaken under expected battle rhythm and conditions.

System limitations

- The systems would have greater utility if incorporated into existing submarine weapons control systems and/or surface ASW tactical data systems. Dealing with an additional and separate system is difficult.
- LAWS' occasional latency of several minutes makes it unacceptable for this application.

Recommendations

- Before another round of testing NFN (X) for ASW applications, it is necessary to develop viable plans for fusing this information with existing ASW information.
- A study is needed, followed by system development, for how the combined information will be coherently displayed.

JFI #1 - ADOCS Provides Improved Fires Situational Awareness

- ADOCS use demonstrated for TST management and to track engagement progress
- Deconfliction of Fires and fratricide avoidance were improved.
- GCCS-M / simulation interface issues prevented a full test of ADOCS use.
  - Cannot evaluate across-the-board improvement to Fires SA.
  - Cannot differentiate situations for which this system does/does not improve SA.
- DTL display and IWS chat were used in lieu of ADOCS graphical displays.
- It is necessary to:
  - Conduct tests of ADOCS use for situational awareness across a broad TST spectrum of users and situation.
  - Provide more individual and unit training to maximize ADOCS contributions.
  - Determine if modifications to graphical displays are needed.

Joint Fires Initiative #1

The JTF and components were able to manage TSTs and track progress across the full engagement cycle using ADOCS. The system provided an understanding of the overall joint TST operation and improved confidence in Fires decision-making. Using the system to visualize the operation aided in deconfliction of fires and the avoidance of fratricide.

Applicability: There were situations in the experiment where interface issues between GCCS-M and the simulation prevented a full test of ADOCS use for situational awareness. As a result, it is not possible to use the results of this experiment to state an across-the-board improvement or to differentiate those situations for which this system does or does not improve situational awareness.

Graphical displays were not used as the primary means for situational awareness. For example, in the Maritime Operations Center decisions were being made primarily from the DTL display and IWS chat. It is not known if this is because of a deficiency in the displays, greater familiarity with chat, some affinity for chat's use, training insufficiencies, etc. This uncertainty indicates the need to learn more about this use of ADOCS.

Recommendations

- Conduct tests of ADOCS use for situational awareness across a broad TST spectrum.
- Provide more individual and unit training in order to maximize the contributions of ADOCS.
- Determine if modifications to graphical displays are needed.

JFI #2 - DTL Manager Provides Cross-Component Fires Coordination, TTP Problems Exist

- DTL Manager was a successful cross-component coordination tool evidenced by:
    - Number of targets engaged
    - Components contributed to a usually complete and consistent display

- Departures from established TTP occurred:
    - Targets were passed from nominators with no indication of inability to engage.
    - MSN block was changed from white to yellow, an undefined action.
    - These departures can interfere with coordination.

- It is necessary to:
    - Provide better ADOCS TTP training for operators.
    - Determine if current TTP are adequate for all TST situations.

Joint Fires Initiative #2

The DTL manager was a successful cross-component coordination tool. Evidence is the number of targets engaged and the degree to which all components contributed to a usually complete and consistent DTL manager display. However, departures from established TTP, which can interfere with coordination, were observed.

TTP departure examples:

- Targets were passed from nominators who had not indicated an inability to engage.
- The MSN block was, at times, changed from white to yellow, an undefined action.

Recommendations

- Provide better ADOCS TTP training for operators.
- Determine if current TTP are adequate for all TST situations.

JFI #3 - 33 Minute Median Interval For ADOCCS Target Prosecution

- Interval is the median elapsed time from receipt of a target nomination in ADOCS until weapon firing.

- The elapsed time includes the median time delays for the following processes:
    - Nomination receipt to mission passed 15 min
    - Mission passed to coordination block green 1 min
    - Block green to execution intent 2 min
    - Execution intent to weapon fire 15 min

- Interval may not include mensuration.
    - Nominating component was responsible for mensuration, and may have done this before target nomination was received in ADOCS.

Joint Fires Initiative #3

This is the time elapsed from receipt of a target nomination in ADOCS until weapon firing.

This interval does not necessarily include target mensuration time. The nominating component was responsible for mensuration and may have done this before the target nomination was received in ADOCS.

Recommendation: None

NFN (X) #1 - Fully Autonomous NFN (X) Engagements Not Possible

- Autonomous TST engagements were not possible because:
  - The JFMCC MOC maintained TST approval.
  - MOC maintained TST platform assignment control.
  - TST system architecture required all mensuration requests to pass through a single DTMS workstation.

- TST CONOPS and system architecture must permit autonomous engagements.
  - As a fall back position in the face of a centralized system or communications failures
  - To improve chances of successfully engaging short dwell time TSTs.

- Recommend configuring the system so that the target nominator and LAWS can send:
  - Target nominations
  - Associated imagery
  - Mensuration requests directly to the mensuration workstation

Naval Fires Network-Experimental #1

The TST CONOPS and system architecture must permit autonomous engagements both as a fall back position in the face of a centralized system or communications failures and to improve the chances of successfully engaging short dwell time TSTs.

Causes: Autonomous TST engagements were not possible because the JFMCC MOC maintained approval and platform assignment control of TSTs and because of the TST system architecture, which required all mensuration requests to pass through a single DTMS workstation. Both system and process changes are required to enable autonomous engagement with NFN (X).

Recommendation

- Configure the NFN (X) system so that target nominations, with associated imagery, and mensuration requests can be sent directly from the target nominator and LAWS, respectively, to the mensuration workstation.

NFN (X) #2 – Diminished LAWS Utility As TST Management Tool

- LAWS Manager was populated with additional, non-TST targets in this experiment, reducing attention to TSTs:
  - Ship-self-defense
  - Mine
  - Submarine
  - Test targets
  - ATO and call for fire missions

- Some TST targets were passed to other components and their actions and resultant engagements were not reported in LAWS.

- System and TTP recommendations:
  - Restrict the Fires Manager to TSTs
  - Create LAWS Managers for other classes of targets
  - Automatic status change updates in the LAWS Fires Manager
  - Establish procedures for target accountability.

Naval Fires Network-Experimental #2

One of the principal uses of LAWS is as a Fires manager for TSTs. Past experiments have concentrated on this use. This use was expanded in FBE-J. The result was diminished utility for TST management.

Situation: In this experiment, the manager was also populated with ship-self-defense, mine, submarine, test targets, and air tasking order (ATO) and call-for-fire missions.

Some TST targets were passed to other components, and their actions and resultant engagements were not reported in LAWS.

Causes: Several causes for this result are possible:

- Lack of personnel for the additional workload
- Display confusion with the additional objects
- Lack of training for the expanded usage

Which, or what combination, of these effects is causal is not known. Rather than undertake to determine causes, the recommendation at this time is to correct the immediate problem.

Recommendations

- Restrict the Fires manager to TSTs and create LAWS managers for other classes of targets.
- When TSTs are passed to other components for execution, and the ADOCS DTL is updated to reflect engagement actions, have these status changes automatically update the LAWS Fires manager.
- Establish procedures for target accountability. The action or request originator must be responsible for ensuring his action or request was received at the target workstation. This is ideally done automatically.

NFN (X) #3 - Geo-Refinement TTP Development Needed

- The geo-refinement process must be a function of target type:
  - Mensurate short dwell-time targets immediately, prior to weapon-target pairing.
  - For longer dwell time targets, request mensuration after weapon-target pairing.
- Current process difficulties:
  - TST target nominations were almost always received without any indication of the accuracy of the reported target location.
  - Geo-refinement validation increased the median processing time from 10 to 29 minutes.
  - The target location accuracy provided was unrelated to the requested accuracy.
  - All requests to pass through the DTMS, a single point of failure.
- TTP are needed that address directly these processing difficulties.

Naval Fires Network-Experimental #3

For short dwell-time targets, time is of the essence and targets must be mensurated immediately, prior to weapon-target pairing. A risk in this approach is that target mensuration will not be required and the mensuration effort will be wasted. For longer dwell time targets, mensuration should not be requested until after weapon-target pairing so as to determine whether target geo-refinement is required.

Factors contributing to process difficulties:

- TST target nominations were almost always received without any indication of the accuracy of the reported target location.
- FBE-J introduced a workstation (DTMS) into the geo-refinement process and a geo-refinement validation process that necessitated message exchange between LAWS and DTMS. As a result, it required a median of 29 minutes between a LAWS request for mensuration and receipt of the mensuration result, compared to a median of less than 10 minutes to obtain the geo-refined target position at the geo-refinement workstation. Data show that the validation process made no contribution to the geo-refinement process, since the provided target location accuracy was unrelated to the requested accuracy.
- Architecture required all requests to pass through the DTMS, making it a single point of failure.

Recommendations

- Geo-refinement TTP should depend on the dwell time of the TST.
- For high priority, short dwell time targets (TCT), mensuration of the target should begin immediately, even if the geo-refinement might ultimately prove unnecessary by virtue of the weapon-target pairing decision.
- For non-TCTs, the original target nomination needs to contain an estimate of the accuracy of the reported target location. Without this, a reasoned determination of the need for further geo-refinement subsequent to weapon-target pairing cannot be made.
- To permit an informed decision on the requirement for a geo-refined target position, target nominations should be required to contain an estimate of the accuracy of the reported target position.
- Eliminate the validation procedure.
- Reconfigure so that LAWS can send geo-refinement requests directly to a mensuration workstation.

NFN (X) #4 - Median Time, TST nomination To Weapon Release= 60 min

- Represents the median time from receipt of GISRC nomination in LAWS to weapon release.

- Median times of included processes are:
  - Generate geo-refinement request 6 min
  - Geo-refinement production 29 min
  - Weapon-Target pairing 5 min
  - Ready to fire decision 6 min
  - Approval to fire 4 min
  - Time to fire 10 min

- TST timelines include a JFMCC decision/evaluation interval.

<u>Naval Fires Network-Experimental #4</u>

This is the elapsed time from receipt of a GISRC nomination in LAWS to weapon release.

Causes

- The geo-refinement interval (29 min) was lengthened compared to previous experiments due to the validation process.
- Autonomous TST engagements were not permitted; therefore all TST timelines include a JFMCC decision/evaluation interval.

Recommendation: None

ISR #1 - ISR Management Improved; Shortfalls Remain

- The ISR Ops Cell in the MOC was effective in dynamic retasking of ISR assets.

- Deficiencies:
  - No established process to assess sensor re-tasking effects.
  - No confirmation of ISR coverage of the area of operations.

- To provide dedicated cradle-to-grave TST ISR management, studies are need to:
  - Determine required manning levels.
  - Develop a graphic display system to illustrate synchronized ISR planning.
  - Develop TTP emphasis on re-tasking and dynamic planning.

Intelligence, Surveillance, and Reconnaissance Management #1

The ISR operations cell in the MOC was effective in dynamic re-tasking of ISR assets.

There was not an established process to assess the effects on the deliberate ISR plan when sensors were re-tasked to support TST operations. There was no confirmation that there was "seamless" ISR coverage of the area of operations.

Causes: Apparently tools, TTP, and sufficient personnel are lacking to enable full-spectrum ISR operations. Considerable investigation is needed to understand requirements.

Recommendations

- Determine manning levels required to provide dedicated cradle-to-grave TST ISR management.
- Develop a graphic display system to illustrate synchronized ISR planning.
- Develop TTP for ISR management with emphasis on re-tasking and dynamic planning.

ISR #2 - TES-N Can Be An Effective ISR Tool; Further Development Needed

- TES-N excelled at display of near-real-time location of Red assets.

- Limitations:
  - TES-N/NFN lacks effective means for integration with other systems.
  - Lack of direct downlink operations limited NFN system TST capability.
  - NFN needs faster, more reliable communications to deal effectively with TSTs.
  - There was no TTP for sharing GCCS-M and TES-N information.

- Studies should be undertaken to:
  - Develop a means for providing appropriate, near real-time TES-N information to the fires cell.
  - Develop a means for displaying TES-N information in GCCS-M.
  - Develop TTP for use of TES-N information in the TST process.

<u>Intelligence, Surveillance, and Reconnaissance Management #2</u>

TES-N excelled at display of near-real-time location of Red assets for decision makers. The system can be effective but several issues need to be resolved.

Technical improvements are needed in the following:

- TES-N/NFN lacks effective means for integration with other systems.
- Lack of direct downlink operations limited NFN system's TST capability.
- NFN systems need faster, more reliable communications to deal effectively with TSTs.
- There was no established operational context for when or how to share GCCS-M and TES-N information.

Recommendations

- Develop a means for providing appropriate, near real-time, TES-N information to the Fires cell.
- Develop a means for displaying TES-N information in GCCS-M.
- Develop TTP for use of TES-N information in the TST process.

ISR #3 - Time Critical Targets Do Not Appear In The COP

- Most Time Critical Targets in FBE-J were detected or confirmed using:
    - Imagery from satellite
    - Air reconnaissance operations
    - Unmanned air reconnaissance operations

- Target nomination process currently excludes sending TCT tracks to GCCS-M.
    - Applies only to tracks resulting from imagery

- Tracks sent to C2PC from DTMS are also not forwarded to GCCS-M 3.X.

- DTMS has current requirement to send tracks from imagery to the COP.
    - Interface will not be fully implemented until DTMS version 4 (companion with GCCS-M 4.X).

Intelligence, Surveillance, and Reconnaissance Management #3

Most time critical targets in FBE-J were detected or confirmed using imagery from satellite, air, or unmanned air reconnaissance operations. The process for nominating these targets for strike currently excludes sending such TCT tracks to GCCS-M.

Applicability: This result applies only to tracks resulting from imagery. DTMS has the requirement to send tracks from imagery to the COP. This interface will not be fully implemented until DTMS version 4 (companion with GCCS-M 4.X) is released. Tracks sent to C2PC from DTMS are also not forwarded to GCCS-M 3.X.

Recommendation

- Continue with implementation of requirement already in place.

ISR #4 - MIUGS Terminal Was Able To Send Track Data To GCCS-M; Reported Results Inconsistent

- MIUGS inputs can be functionally used to identify TCTs to augment the COP.

- Data sent by MIUGS was not reliable for precision strike.
    - MIUGS sent the wrong coordinates; tracks did not match actual target location.

- There were large inconsistencies in reported MIUGS performance:
    - Reports that everything worked perfectly
    - Reports of substantial tracking errors
    - Reports of errors in passing of data from one system to another

- A review of MIUGS results is needed to determine actual versus supposed performance.

Intelligence, Surveillance, and Reconnaissance Management #4

The Micro-Internetted Unmanned Ground System (MIUGS) provides information to augment the COP. GISR-C was requested by MIUGS to nominate a MIUGS target from GCCS-M to LAWS. The exercise demonstrated that MIUGS inputs could be functionally used for TCS.

Limitations

- MIUGS sent the wrong coordinates to the system. Tracks sent to the system did not match the actual target location. Data sent by MIUGS could not be relied on for precision strike.
- There were large inconsistencies between reported MIUGS performance, ranging from everything worked perfectly to there being substantial errors in tracking and the passing of data from one system to another.

Recommendation

- A review of MIUGS results is needed to determine actual versus supposed performance.

MIW #1 - Engagement Of Mine Targets In LAWS Possible;
Process Development Needed

- Feeding mine contacts into LAWS and engagement through that system is workable:
  - Procedures need to be simplified.
  - TTP needed.

- Treat mine nominations as another target within LAWS:
  - Mine nomination weapon-target paired
  - Engagement conducted within mine nomination entry in LAWS Fires manager.

- Test of the concept is needed using a combination of live mine and other targets.

Mine Warfare #1

The concept of feeding mine contacts into LAWS and engaging them through that system appears workable. Procedures need to be simplified and codified. Mine nominations should be treated like other target nominations within LAWS, i.e., mine nomination weapon-target paired and the engagement conducted within the mine nomination entry in the LAWS Fires manager. This recommendation conflicts to some degree with NFN (X) #2, where a separate manager for non-Fires targets was recommended.

Applicability: The engagement problems were exacerbated and, to a degree caused, by problems with the FASM methodology and simulation. Thus, definitive results on this application are not yet available.

Recommendations

- Develop a methodology that handles mines the same as other targets within LAWS.
- Test the concept with a combination of live mine and other targets.

MIW #2– HSV Appears to be Excellent Platform for Supporting MIW

- Advantages include:
  - High speed
  - Shallow draft
  - Large cargo volume to provide future hotel services for support of RAVs and mission and maintenance crews

- Disadvantages and risks include:
  - Potential vulnerability of the HSV to hostile fire
  - Loss of one HSV with large number of RAVs (est. 25 to 30) could risk entire MIW mission success and/or timeline if additional resources are not readily available
  - MIW may have to compete with other missions for the use of the HSV

- Studies are needed to mature the CONOPS for HSV support of MIW
  - Determine the appropriate number and distribution of MIW assets on HSVs
  - Assess requirement for redundant back-up operational databases and MIWC SA in case of losses
  - Estimate likelihood that competition for HSV resources will impact on MIW mission success

Mine Warfare (MIW) #2

The HSV appears to be an excellent platform for supporting the MIWC and MCM.
Advantages include:

- High speed to area of operations and while conducting various MIW missions
- Shallow draft will allow operations in relatively shallow water
- Large cargo volume can provide ample workspace and support areas for supporting future RAVs and their operational mission and maintenance crews

Disadvantages and risks include:

- Potential vulnerability of the HSV to hostile fire due to its aluminum composition and small crew
- Loss of one HSV with large number of RAVs (est. 25 to 30) could risk the entire MIW mission success and/or timeline if additional resources are not readily available
- Under the concept of rapid reconfiguration for HSVs, MIW may be competing with other missions for the use of the HSV

Recommendations

Undertake studies to mature the CONOPS for HSV support of MIW, including

- Determine the appropriate number and overall distribution of MIW assets on HSVs
- Assess the requirement for redundant back-up operational databases and MIWC SA in case of loss
- Likelihood that competition for HSV resources will impact on MIW mission success

MIW #3 – JFMCC is Challenged in Management of MIW

- MIW missions are longer than typical JFMCC MSR missions and may not be suitably managed within the overall JFMCC process at present. .
- The ATO tasking vehicles are not optimal for MIW missions
- Direct tasking of platforms in MIW is preferable to the indirect tasking associated with MSRs
- Present reduction of data and the development of tasking is unnecessarily manpower intensive

- Studies are needed to:
  - Develop a more workable interaction dynamic between JFMCC and MIW
  - Evaluate the impact of lengthy MIW missions on shared resources and vice versa
  - Evaluate the potential for manpower reductions with automation of data reduction and tasking in MIW

Mine Warfare (MIW) #3

JFMCC management of MIW is a challenge that presently strains players on all sides. There are several reasons for this:

- MIW missions are longer than typical JFMCC missions and may not be suitably managed within the overall JFMCC process at present. This is a resource allocation issue, as the JFMCC staff may reallocate HSVs and other resources after the expiration of the 24-hour MTO/ATO, but MIW missions initiated during the valid period may still be on-going, due to the length of some MIW missions.
- The ATO tasking vehicles are not optimal for MIW missions
- Direct tasking of platforms in MIW is preferable to the indirect tasking associated with MSRs
- Present reduction of data and the development of tasking is unnecessarily manpower intensive

Recommendations

Conduct studies to

- Develop a more workable interaction dynamic between JFMCC and MIW
- Evaluate the impact of lengthy MIW missions on shared resources
- Evaluate the potential for manpower reductions achievable with automation of data reduction and tasking in MIW

MIW #4 --- RAVs are the Future in MIW

- Remote Autonomous Vehicles (RAVs) offer advantages in speed, effectiveness, and covertness. HSVs will be able to host 25 to 30 systems per HSV

- Potential issues
  - Data should be retrieved in or near real-time
  - More complicated management and control
  - Present inability to operate in kelp requires additional engineering
  - Launching and retrieval should be done at high speeds

- Studies are needed to:
  - Assess methods to optimize the receipt and management of data
  - Develop reliable ways to control multiple systems operating concurrently
  - Re-engineer systems to reduce or eliminate their present vulnerability to kelp
  - Investigate alternative approaches to launching and retrieving RAVs at high speed

Mine Warfare (MIW) #4

Remote Autonomous Vehicles (RAVs) offer tremendous potential for rapid, effective, and covert MIW operations to ensure assured access to hostile territory. Future HSVs could host 25 to 30 of these RAVs per HSV. The management of a multiplicity of these systems, possibly among several HSVs will be far more complex than anything experienced to date in MIW or demonstrated in FBE-J. There was no stressing of the RAV systems in FBE-J, so no assessment can be made of problems or issues that will arise when one HSV attempts to manage, control, and exploit a number of these systems.

Potential issues include:

- Data should be retrievable in or near real-time so as not to delay follow-on planning actions
- More complicated management and control can be expected
- The present inability to operate in kelp requires additional engineering to RAVs to reduce potential risks and mission impairment
- Launching and retrieval of RAVs should be accomplished at reasonably high speeds

Recommendations

- Assess methods to optimize the receipt and management of data
- Develop reliable ways to control and minimize potential interference of multiple systems operating concurrently
- Re-engineer systems to reduce or eliminate their present vulnerability to kelp
- Investigate alternative approaches to launching and retrieving RAVs at high speed

IO #1 - Hardened Client Defeated Red-Team Attack.

- Hardened client successfully deflected direct Red team attack using:
  - Layer 1, e-mail wrappers blocked behavior contained in e-mail attachment macros.
  - Layer 2, ADF prevented outbound FTP as well as outbound root shell jump point.

- ADF was an effective defensive technology scalable to full operational deployment, however:
  - ADF equipped machines easily detected using basic scans.
  - Partial ADF coverage permits quick identification of unequipped computers and an attack from that point.

- Configuration management issues associated with all machines containing ADF cards:
  - Scalability; ability to manage 1000+ systems
  - Legacy and custom software applications complications
  - Correlation of audits across policy servers for incident handling

- A policy for ADF equipage as a function of network and machine is needed.

Information Operations #1

A Hardened Client successfully deflected direct Red team attacks through operating system (OS) wrappers and autonomic distributed firewall (ADF) configuration. The Red team was not successful in achieving the goal of disrupting time critical targeting during attack periods.

Defense systems

- First layer: safe e-mail wrappers blocked harmful behavior contained in e-mail attachment macros sent by Red team participants.
- Second layer: ADF prevented outbound file transfer protocol (FTP) as well as outbound root shell jump point. ADF demonstrated an effective defensive technology that can be scaled to full operational deployment.

Limitations

- ADF equipped machines were easily detected using basic scans. A network with only partial ADF coverage would permit quick identification of unequipped computers and an attack from that point.
- Configuration management issues associated with incorporating ADF cards in all network machines include; scalability, the ability of one person to manage 1000+ systems, legacy and custom software applications complications, and the correlation of audits across policy servers that would make incident handling difficult.

Recommendation

- Develop a policy for ADF equipage as a function of network and machine.

IO #2 - E-Strike Munitions Extensively Used.

- Kinetic and non-kinetic IO Fires were integrated into TST operations.

- Control of IO weapons by the operational commander is critical for synchronizing kinetic and non-kinetic warfare.

- E-strike weapons not being in TBMCS had a negative impact on weapon use planning.

Information Operations #2

Operational commanders required the capability to launch theater-level, information attacks when appropriate. The offensive information operations experiment conducted during FBE-J centered on utilizing E-Strike munitions in support of time critical strike scenarios. As FBE-J progressed, kinetic and non-kinetic IO Fires were integrated into TST operations.

Comments

- Placing control of information operation weapons with the operational commander is critical for synchronizing kinetic and non-kinetic warfare.
- E-strike weapons were not loaded in TBMCS. This had a negative impact on weapon use in the Strike Warfare Commander (STWC) planning effort (30-50 percent of planned missions came from ATOs).

Recommendations

- Operational commanders should control IO weapons systems.
- TBMCS should contain E-strike weapons.

NF/KM #1 - KMO Achieved Technical But Not Organizational Objectives

- Knowledge management operations were a technical success:
  - Decision support information was timely and accurate
  - Reduced uncertainty
  - Increased situational awareness
  - Shortened decision cycles.

- Organizational/process inadequacies:
  - Lack of high-level gleaning of information
  - Information not processed into knowledge needed, at the right time and place, by critical decision makers.

- Indiscriminate distribution threatens information overload.
  - Shift focus to providing relevant information, correlated to task.

- Required development:
  - Shift of focus from technical to process solutions.
  - Determine required information content as a function of task and situation.
  - System that filters information into relevant blocks with targeted dissemination.

<u>Netted Force / Knowledge Management #1</u>

Decision support information was timely and accurate. The knowledge management organization (KMO) is effective in reducing uncertainty, increasing situational awareness, decreasing information overload, and shortening decision cycles. An effective technical process was responsible for information reaching critical decision-makers. There was not an active and high-level gleaning of information and processing of that information into knowledge needed, at the right time and place, by critical decision makers.

Implications: There exists the possibility of producing accurate information, disseminating it widely, and insuring all recipients receive the same information, but having the result be information overload because there is not a focus on providing relevant information to those performing specific tasks.

Information relevancy, and KMO processes to identify and manage information and then keep that information relevant to critical decision-makers, would require different organizational and information processes than those present in the experiment.

Causes: There is a continuing tendency to focus on technical solutions to information dissemination at the expense of process. The contribution of KMO to information management was secondary to technical aspects of information communications, and its use did not achieve high-level or strategic objectives envisioned.

Recommendations

- Determine required information content as a function of task and situation.
- Develop a system that filters information into relevant blocks, with attendant targeted dissemination.

NF/KM #2 - KMO Stressed Communication, Computing, Display Resources

- KMO stressed available resources. TTP are needed to optimize:
  - Bandwidth allocation
  - Server utilization
  - Application utilization
  - Communication utilization

- Studies are needed to:
  - Determine expected utilization of KMO systems as a function of operational situation.
  - Determine KMO resources required for maximum load.
  - Develop a services prioritization scheme for KMO utilization.

<u>Netted Force / Knowledge Management #2</u>

The need for the KMO functionality was demonstrated. However, KMO put a significant load on available bandwidth that was not taken into account when making operational bandwidth allocation decisions.

Utilization of the servers, applications, and communication processes within the infrastructure was not optimized. More effective and detailed TTP in this area are required if the potential benefits from KMO are to be realized.

Recommendations

- Determine expected utilization of KMO systems as a function of operational situation.
- Develop a services prioritization scheme for KMO utilization.
- Determine KMO resources required for maximum load.

CIE #1 - Collaborative Information Environment Technical Objectives Achieved

- SPPS integrated critical systems through a portal and application framework.
  - Planning and execution timelines reduced
  - More efficient integration of information and communications
  - Enabled flattened organizational hierarchies and decision-making
- JFMCC components integration accomplished
  - Standardized applications within the portal framework
  - Information present within a browser-based application
  - Visibility in and across cells from any network access point
- Needed developments:
  - Workflow automation applications
  - Compatibility of information and communication systems with portal interfaces
  - Improved search and retrieval functions
  - Reduction in the number of environments
  - TTP and training programs for CIE use

Collaborative Information Environment #1

The collaborative information environment (CIE) was designed to: reduce planning and execution timelines; enhance organizational effectiveness for distributed operations; flatten organizational hierarchies and decision-making; enable self-synchronization; and integrate ADOCS/LAWS for situational awareness in distributed operations. The overall objective was to enable rapid decisive operations (RDO) through more efficient integration of information and communications. Technological aspects of CIE were achieved with impressive utilization of cutting-edge technologies. SharePoint Portal Service (SPPS) integrated critical systems through a portal and application framework that effectively reduced planning and execution timelines.

Portal/browser structure: The integration of JFMCC components was accomplished through standardized applications within the portal framework. Most component information was present within a browser-based application that could be viewed in a cell and across cells, from any network access point. The common relevant operational picture (CROP), secondary information relevant to the COP, was available within the web site and on pages of SPPS, where users could browse or search for information.

<u>Limitations</u>

- Workflow automation routines that would send pertinent information to appropriate personnel for action and provide automated routing through the chain of command have not yet been integrated into the process.
- SPPS provided an integrated, customizable interface into pertinent information, but not all information or communication systems were compatible with portal interfaces or display technologies.
- Search and retrieval functions appeared operational but not comprehensive or well used.
- IWS and IRC collectively provided means for communication and collaboration, albeit the requirement that two distinct systems be in operation was a significant disadvantage.

Recommendations

- Continue development of CIE with increased focus on reduction in number of required environments.
- Develop TTP and training programs, and institute them for CIE use.

JTAMD #1 - Navy Forces Provide Significant Contributions To TAMD/TBMD.

- Navy unique capabilities provide a JTAMD force multiplier:
  - Protected critical assets on the DAL
  - Augmented PATRIOT units
  - Provided the lower tier component for THAAD
  - Projected missile defense over amphibious landings
  - Provided a key complement to Army Air Defense Artillery

- Critical support provided for:
  - Terminal phase TBMD
  - Mid-course TBMD

Joint Theater Anti-Missile Defense #1

The inherent mobility and flexibility of Naval forces constituted a unique joint capability and a force multiplier during the experiment. Navy ships protected critical assets on the Defended Assets List (DAL), augmented Patriot units, provided the lower tier component for Theater Phase High Altitude Defense (THAAD) system, and projected missile defense over amphibious landings ashore.

Ships provided a key complement to Army Air Defense Artillery (ADA) surging to meet anticipated threats or to respond to other operational changes, while THAAD and PATRIOT batteries focused on the defense of fixed critical assets.

Applicability

For the situations tested during the experiment, Navy forces appeared especially valuable for the following:

- Terminal Phase TBMD: A robust terminal phase TBMD capability was critical to joint missile defense. Although extensive Army Air Defense Artillery (ADA) forces were in theater, Navy forces played a critical role defending designated critical assets either alone or in conjunction with sea-based mid-course defense (SMD), THAAD and PATRIOT.
- Mid-Course TBMD: The contingency SMD capability was critical to achieving the Joint Task Force Commander's (JTFC's) desired probability of negation. Against longer-range threats the extensive defended footprint provided an upper tier component of a two-tiered defense for a large number of critical assets.

Recommendations: None

JTAMD #2 – Current Limitations To Navy Joint TAMD/TBMD

- Limitations experienced:
  - ADC/RADC was never fully integrated into Air Operations Center (AOC).
  - Unsuccessful integration of Army and Navy missile defense forces covering common critical assets.
  - Limited ability to handle the threat posed by large numbers of relatively unsophisticated short-range missiles and artillery rockets.
  - Weapons systems models in decision aids did not yield common solutions.

- Required developments:
  - Common TTP and joint doctrine for roles, missions, and responsibilities between functional component commanders and their subordinate commanders.
  - Tactical decision aid models for short-range missile and artillery defense.
  - Cross-service planning and tactical decision aids.
  - Develop joint doctrine for cross-service JTAMD.

Joint Theater Anti-Missile Defense #2

The Air Defense Commander/Regional Air Defense Commander (ADC/RADC) was never fully integrated into AOC battle rhythm, and the organizational relationship between the Joint Forces Air Component Commander/Area Air Defense Commander (JFACC/AADC) and the ADC/RADC remained ambiguous. The absence of joint doctrine defining the role of a RADC and the lack of direct communication between the JFACC/AADC and the RADC most likely contributed to the difficulty.

Attempts to develop coordinated engagement procedures when both Army and Navy missile defense forces covered common critical assets were unsuccessful. Doctrinal and technical differences between Army firing units and Navy ships formed a barrier and did not allow coordination beyond spatial deconfliction ("engagement zones"). Without changes to existing doctrine, systems, and operational concepts, dynamic battlespace coordination including integrated engagements will not be possible.

Though it received less high-level attention than longer-range missiles, the threat posed by large numbers of relatively unsophisticated short-range missiles (<300 km) and artillery rockets was a significant factor in operational planning and caught many planners by surprise. Coordination between the DAADC and the maritime ADC/RADC was hindered, as existing planning tools did not include models for these threats and the numbers present required intense considerations of interceptor inventory. The widespread distribution of these types of weapons warrants increased consideration in operational planning.

Collaboration was hindered when weapons system decision aid models did not yield common solutions, even with identical data input. For distributed collaboration to be effective, all participants must have a common understanding of the capabilities and limitations of the individual systems.

Recommendations

- Develop common TTP and joint doctrine that defines roles, missions, and responsibilities between functional component commanders and their subordinate commanders.
- Develop models that can be used as tactical decision aids for short-range missile and artillery defense.
- Develop models and decision aids that yield identical solutions when given the same inputs and implement their use across services.
- Develop joint doctrine for cross-service JTAMD.

3.2 Initiatives' Context

Data and information are obtained from an experiment under a set of conditions. Analysis results have known validity only for those conditions, their range of applicability. Specifying its range of applicability is as important as the result. We refer to "context" as the set of conditions that existed during the experiment. There is a hierarchy of conditions:

- General conditions - are the overall setting under which the experiment was conducted. This was provided in the former Section of this report.

- Initiative conditions - are special conditions that were set up to meet the objectives of an initiative.

- Results conditions - are special conditions that are pertinent to understanding a particular result. For example, an initiative condition could be use of short-dwell-time transporter / erector / launchers (TELs) for Fires capabilities testing. A particular result condition could be three TELs per 15 minutes, causing TCT prosecution to break down. Results conditions, if needed, are reported along with the principal results in the first Section of this report.

From a carefully designed experiment it may be possible to extract cause-and-effect. This can provide a model of the behaviors of systems and the processes within which the systems operate. Cause-and effect relations allow extending results to conditions other than those under which they were obtained. Two related conditions are necessary if an experiment is to produce cause-and-effect understanding: control of variables and change. Knowledge of variable states is necessary, and control of variables is preferred, in order to produce data for quantitative analyses. This is especially important for complicated experiments such as FBEs.

One cannot observe the effects produced by a variable without changing it. All cause-and-effect relationships are "if this influence is applied, that happens". A force/influence being applied is a change in that variable, and the response is a change in state of the system of interest. A well-designed experiment is one that controls and changes a variable so as to observe a desired effect, under desired conditions. In experimental situations as complicated as FBEs, it is not always possible to control variables. Whether or not control can be exercised, it is necessary that everything that influences a result be recorded.

An assessment of "experiment quality" is also needed. This is an expression of how well the experiment was designed to meet its stated objectives. FBEs consist essentially of many experiments within an overarching exercise/experiment. Initiatives are individual experiments. Because there is variability in how well individual initiatives are designed, an expression of experiment quality is needed for each.

The next part of this Section will be a description of the important facets of experiment quality. This is followed by context for each of the initiatives.

<u>Experiment Quality Condition</u>

Figure 3-1 illustrates experiment design principles for a particular initiative considering two parameters (A and B) that could influence the results. The initiative could be, for example, MIW, with parameter A representing target density, and parameter B the transit and operational speed of a mine clearance vessel. These are only two of the many possible parameters that establish experiment conditions. We use speed and target density to describe the meanings of various parts of the figure.

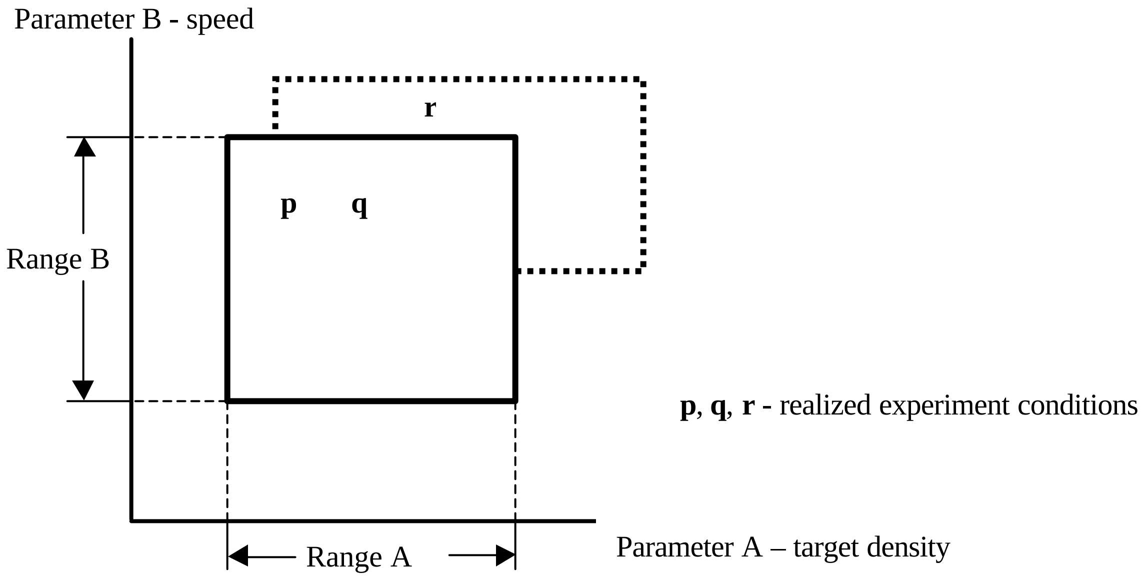

Figure 3-1. Representative Ranges of Parameters within an Experiment (notional)

The notional experiment is to examine employment of an HSV as a mine warfare platform and determine its effectiveness for various speeds as a function of mine density.

The solid box and ranges are conditions for which experimentation results are needed to satisfy the initiative objectives. Parameter B is vessel speed (10 to 40 knots), and parameter A is target density (10 to 30 per square kilometer).

The dashed box depicts the ranges of conditions under which the experiment was actually conducted (25 to 55 knots, 15 to 45 per square kilometer).

Points p, q, and r are conditions existing when data were obtained (p is operating at 35 knots against 15 targets per square kilometer, etc). Experiment data are obtained at a particular time, under particular conditions. Point p could be early in the experiment, q later, and r towards the end. Changes in parameters A and B with time could be by design or by natural experiment evolution.

The positions of the dashed box and conditions points p, q, and r show that the experiment was carried out only for high vessel speeds (or that data were collected or analysis done only for high speeds). Thus, the full objectives of the initiative (a wider range of speeds) were not met.

Several observations can be made about the conditions points:

- The difference in points p and q are due to a change in only target density. This may represent good experiment control, holding speed fixed.
- The change in conditions from q to r is due to changes in both density and speed, which makes cause-and-effect difficult to determine. If an experiment purpose is to determine reasons for different results produced between conditions q and r, the experiment is poorly designed because influences due to changing both density and speed are mixed. One also needs data for density held fixed and speed varied, a point vertically above q.
- A conditions point may represent several observations or results. If this is the case, statistical analysis can be performed for that set of results.

- It is possible (likely) that conditions are not exactly the same for a set of results. The condition points would then cover a small area (or line if only one parameter varies). Whether or not such results are treated as having the same conditions is a matter of initiative definition.

Subjective opinions (information rather than data) about experiment performance will often apply over a range of experiment conditions, perhaps the whole or some portion of the dashed box.

If there is no overlap between the solid and dashed boxes, either or both experiment design or execution is poor. The objectives of the initiative will not be met. A statement of how well the two boxes overlap, the "quality" of the experiment, is part of initiative context. There are no quantitative measures for "quality" of experiment design or execution. Rather, a subjective statement is made about "quality" and an explanation for the reason(s) included. Experiment Quality is stated on a sliding scale:
Very low Low Marginal Good Very good

The fact that condition r is outside the design box is not necessarily an experiment flaw, however. It may actually be beneficial because it can provide results by the process of discovery.

The variation of conditions with time, represented by p, q, and r being different, provide the opportunity to observe results changing in response to parameter changes. This is one potential source of information for determining cause-and effect. Especially unnerving, and of marginal use, are observed changes in results that cannot be associated with parameter changes. Such results represent poor experiment design or execution.

Overarching Context

New initiatives within the Department of Defense focus largely on three things:

- Network-centric operations – wherein critical information is accessible throughout the force.
- Transformation – integrating new technology and innovative operations fostered by new technology into military operations to improve agility, effectiveness, and efficiency.
- Joint operations – the ability for the military services to operate together seamlessly.

The initial experiment plan for FBE-J, which was the foundation for subsequent planning, mentioned net-centric, largely ignored transformation, and focused on joint capabilities. From subsequent plans through actual execution of Juliet, however, there was a distinct metamorphosis toward emphasizing and executing the initiatives toward:

- More traditional and narrowly scoped military objectives, and
- There was no injection of stress into operations execution.

Thus, a sense of transformation was not achieved and critical real-world pressures that typically affect decision-making were absent.

Initiative Context Descriptions

The following provides context for each initiative, and characterizes experiment quality. Any needed conditions or details that are not contained in the general description in Section II are included here.

JFMCC Maritime Planning Process

MPP context is the most difficult to describe of all initiatives. It is an evaluation of the effectiveness of a new process, one for which no definite data nor design conditions could be specified. The initiative was an exploration of what is needed to make the process work, and also one where what was learned was to be included in further development of the MPP as doctrine with included TTP.

A statement of what was to be learned was posed as a question: "Does the JFMCC maritime planning process provide the structure, organization, management, feedback, optimization, and situational awareness to maritime force employment and support the intent of a joint effects tasking order (ETO)?"

The contextual meaning of this question is whether or not the specified attributes exist in the MPP. Clarifying definitions of the attributes are:

- *Structure* – information, knowledge, and decision structure relationships contributing to MPP system performance.
- *Organization* – functional, personnel, and task relationships contributing to MPP system performance.
- *Management* - the MPP operating as a C2 function, providing internal and external synchronization, and managing planning functions.
- *Feedback* - feedback information of different kinds and levels, contributing to organization management and process control at the operational level.
- *Optimization* – merging of battlespace situational awareness and asset planning to produce an optimized plan.
- *Situational Awareness* – presentation of battlespace actions in a COP, within the context of the ETO, providing continual assessment of operational and tactical status.

The following provides specific context for each attribute, followed by an experiment quality condition for the initiative as a whole, with an explanatory statement.

Structure Context; focus on workflow information

- A workflow tool was integrated technically but not into the process.
- Course of analysis tools (e.g., Navy Simulation System) were not integrated.
- InfoWorkSpace (IWS) was integrated into the process.
- Knowledge management provided only web-space maintenance.

Organization Context

- Personnel assignment changes were made between spirals and experiment execution.
- Insufficient training on systems, processes, and relationships was provided.
- Relationships and organization could not be varied to observe effects.
- Personnel and functional relationships, and their contributions, could not be well determined.

Management Context

- Technical interfaces for internal MPP coordination were in place.
- Plan changes were implemented only at Maritime Operations Center.
- Inadequate integration of tools and processes made it difficult to evaluate adequately the MPP as a C2 function.

Feedback Context

- Feedback from and to different levels of organization, process, and command was nearly absent.
- Feedback on changes in battlespace environment was absent or little used.

- The absence or use of feedback means this process could not be observed.

Optimization Context
- Optimization software was not ready for the experiment; hence no results could be obtained.

Situational Awareness
- Briefings were used for shared understanding rather than the COP or distributed knowledge management. Information could not be obtained on use of knowledge systems for the MPP.

MPP Experiment Quality Condition
The quality of the experiment with respect to being able to obtain information that applied directly to stated objectives within the initiative was **very low**. However, if one accepts that a significant part of the reason for this initiative was to determine if the MPP could work and to provide guidance for future developments, the quality was **good** for illuminating difficulties and possible cures.

A significant amount of detailed information emerged about process difficulties and means by which they could be improved, basically through a process of discovery.

Joint Fires
The timely assessment and engagement of time sensitive targets (TSTs) across components poses challenges in establishment of a timely and accurate common operational picture (COP), effective collaboration across components, and timely integration of joint capabilities against the target.

The overarching questions were:

- Does the proposed (experimental) joint targeting (cross component) architecture enable timely engagements of TSTs?
- In what ways does a common toolset within the joint architecture affect the ability of the joint force to conduct effective cross component TST operations?

Timely engagements context
- No means were available to capture the interval between the component identification of the target and the promotion of the target into the automated deep operations coordination system (ADOCS).
- The dynamic target list (DTL) was unstable due to frequent updates.

Contribution of architecture to cross-component engagements context
- Training in the prescribed tactics, techniques, and procedures (TTP) was inadequate.

JFI Experiment Quality Condition
The quality of the experiment with respect to being able to obtain information that applied directly to the stated objectives within the initiative was **good.**

High Speed Vessel (HSV)
The High Speed Vessel initiative, with both real (JOINT VENTURE, HSV-X1, Sea Slice) and simulated vessels, was to be an enabler of MIW and MC02 initiatives. In the FBE, these platforms were to provide the Mine Warfare Commander with a sensor platform and C4I platform. Within the context of MC02, HSVs were to provide the Joint Force Commander with an enhanced ability to accelerate the tempo of operations.

A statement of what was to be learned was posed as a question:

"What additional value added does having a number of high speed, reconfigurable, and multi-mission platforms provide the JFMCC and JFC in a littoral campaign as part of an access mission?"

Specifically the desired added value was to contribute to support to the Mine Warfare Commander in planning and execution of a mine warfare campaign, support to naval special warfare operations, support in a ship-to-objective-maneuver, employment in an interim brigade team redeployment, and logistics support to deployed forces ashore.

Context of HSV Contribution to MIWC Operational Planning and Execution

- ISR management procedures and processes were not in place at multiple levels.
- There was lack of feedback from previous missions.
- There was insufficient familiarity with use of such a vehicle amongst high-level planners so its possible impact on operations and planning was not tested.

Context of support to Naval Special Warfare Operation

- Only whether the ship would physically support Special Operations personnel was tested.

Context for Logistics Support to Deployed Forces Ashore

- There was no "ownership" of the HSV asset because they were managed by placing them in a common pool.

HSV Experiment Quality Condition

This experiment was mainly to introduce the concept of using an HSV. This quality was **good**. The quality of the experiment for testing how to physically use the ship, such as how to reconfigure was also **good**. Determination of the effect on operations was **poor**.

Naval Fires Network--Experimental (NFN(X))

NFN (X) implemented experimental Navy targeting systems and processes that supported joint targeting and Fires requirements across components, up to CJTF and down to tactical Naval Forces through defined CONOPS, TTP, systems architecture, and organization. Navy Fires projected power ashore through the integration of long-range surface, sub-surface, and air delivered Fires.

The overarching questions guiding this initiative were:

- What is the contribution of Naval platforms self-targeted engagements to the TST engagement problem?
- What are the operational planning and employment considerations required for the effective utilization of future power projection platforms in the TST engagement process?
- How successful is the defined TST architecture in engaging asymmetric TST targets?
- How successful were Naval platforms in responding to multi-mission tasking?
- What is the contribution of the mensuration manager to the TST process?
- What will the introduction of a ground COP contribute to the TST process?

Self-targeting context

- Architecture prevented appropriate tests by requiring all target nominations to be centralized via the DTMS.

- TTP also precluded testing by establishing rules of engagement that mandated that the MOC maintain TST authority.

Operational planning and employment context

- Minimal weapon systems discriminators were included to differentiate these new systems from current systems.

Asymmetric target engagement context

- Major asymmetric attacks that were planned for simulation were by small boats in a SWARMEX, which was cancelled due to weather. Other smaller simulation-generated small boat attacks were executed, but did not represent the equivalent intensity of the larger exercise.
- The weapon-target pairing system did not contain conventional arms to use against small boats.

Multi-mission targeting context

- There was minimal, if any, multi-mission targeting undertaken.
- Multi-mission targeting systems (including personnel roles) were not pressured, so that the range of performance for these systems under stress could not be determined.

Mensuration manager context

- The mensuration tasks were not demanding enough to test adequately the system over a range of performance.
- These systems were not tasked in a controlled manner to determine maximum capacity, thus no "management" of the mensuration assets was required.

NFN (X) Experiment Quality Condition

The quality of the NFN (X) initiative of FBE-J with respect to being able to obtain information that applied directly to stated objectives within the initiative was **low**. FBE-J did, however, produce a level of data for the mensuration process that was unprecedented in the history of FBEs. This permitted a detailed examination of the mensuration process and led to recommendations for improvements.

Intelligence, Surveillance, Reconnaissance Management (ISRM)

The Joint ISR concept of operations for MCO2 outlined a network-centric approach conducting joint-force-wide ISR in which all ISR players will be linked by a collaborative command and control ISR (C2ISR) network. The underlying JFCOM hypothesis was that this collaborative linkage of all ISR players would enable coordinated execution of ISR operations that were widely distributed, while at the same time maintaining cohesion, coordination, and unity of effort.

The overarching objective for FBE-J was to examine doctrinal implications and to refine the TTP for joint and maritime C2 and assured access. FBE-J experimented with the convergence of deliberate and dynamic ISR management, in support of joint force and component-specific ISR requirements, within the JFMCC construct.

JFMCC ISR planning context

- The ISR C2 architecture did not include a TST manager to validate targets. Decisions regarding assets allocation were based on operator perspective only.
- TES-N could not create manual contacts due to software problems and TES-N contacts were not viewable on GCCS-M COP display.
- There was no operationally sound interface to link TES-N and DTMS/RRF.

Dynamic ISR management context

- There was no consistent live air picture for correlation of link tracks with the ATO.
- There was no graphic depiction of the synchronized ISR plan.

Distributed UGS and unmanned UAV context

- The unattended ground sensors (UGS) system was not fully tested prior to the experiment.
- Data were not made available from the contractor to establish accuracy of MIUGS tracks.
- Weather (fog) precluded many flight operations for the Predators, which were the last link in the delivery of munitions to targets identified by the UGS. When Predator was available, MIUGS tracks were not transmitted to the STWC, and when the communications systems worked, the UAVs were unavailable.

Multi-platform SIGINT context

- Networked Specific Emitter Identification (SEI) was tested under reasonable battle scenario conditions.

ISRM Experiment Quality Condition

The quality of the experiment for obtaining information that applied directly to stated objectives was **low.** Much was learned which should lead to improved results from subsequent experiments.

Mine Warfare

It is likely over the near-term, that the littoral seas will become increasingly important and challenging for maritime and joint forces to access quickly and safely. New platforms such as high speed vessels (HSVs), and technological advances in sensor capabilities increase the organic MCM capability and present the MIWC with new challenges and opportunities in organization, resource allocations, information management, and C2.

As a first step in dealing with these new realities, the MIW experiment in FBE-J was to examine the application of network-centric warfare concepts and other emerging technologies as they might apply to mine warfare and to determine how they could enhance the efficiency and effectiveness of mine warfare. HSVs were to be assessed as MCM sensor support and management platforms, and an examination was to be done of the integration of MIW with NFN, and the MIW use of the common undersea picture (CUP).

HSVs as MCM sensor support and management context

- HSV operations were independent of JFMCC requirements and decisions. Planning was internal to the ship and could not be related to the MPP.

MIW integration with NFN context

- It is unknown whether mine contacts were valid physical realities. Reconstruction is required before this initiative can be evaluated.

MIW use of the common undersea picture (CUP) context

- MIW Cup and ASW CUP were independent, so no examination of a common picture can be made.

MIW Experiment Quality Condition

Overall quality of the experiment was **marginal** because of an inability to match needed experiment conditions and execution.

Anti-Submarine Warfare

Because the naval contribution to rapid decisive operations requires assured access, ASW forces are required to establish zones of operations free of enemy submarines. To do this effectively, the forces are forced to employ network-centric ASW operations. This is the concept of multi-level commands and multi-disciplinary forces that are well connected by common communications, doctrine, planning tools and commander's guidance. In order to improve detection, classification, localization, and neutralization of enemy submarines, these commands must possess the ability to:

- Rapidly share information.
- Correlate their situational awareness as it pertains to the larger operational and tactical pictures.
- Conduct distributed, collaborative planning and self-synchronize their actions with other joint or coalition ASW platforms.

The primary issue formed as a question was:

"How can network-centric ASW operations improve detection, classification, localization and neutralization of enemy submarines to assure maritime access?"

Submarine locating devices context

- The ASW commander had no control over the frequency of these reports.

Remote autonomous sensors context

- Virtually all of the RAS initiative C2 procedures and processes were devoted to simulating the autonomous distributed sensor (ADS) fields and autonomous USVs.
- USV technical difficulties precluded successful observations.

Experimental common undersea picture (X-CUP) context

- Parts of the undersea picture resided in several different, un-integrated systems.
- Loss of satellite communications caused the loss of the network.

ASW Experiment Quality Condition

Experiment conditions matched the initiative well. Quality was **good.**

Information Operations

This initiative was to develop specific functional responsibilities for each IO forward billet to ensure maximum enrichments to all dimensions of JFMCC operations. IO rear critical support billets and functions were to be identified. Four IO sub-initiatives were incorporated in the experiment to investigate emerging organizational constructs, processes and capabilities to support JTF and JFMCC processes with a full range of IO options.

IO enrichment to the JFMCC planning process context

- Originally, 28 billets were identified in joint doctrine to populate the IO cell, but the actual manning was a less than adequate 11 people (inclusive of two each, USAF and USA liaison).
- JFMCC maintained tactical control over individual units, effectively eliminating the need for the IWC.
- The MTO was not designed to accept missions without targets, such as typical in IO actions.
- PWCs were removed from consistent JFMCC interaction and they lost touch with all dynamic updates shared through the JFMCC staff and had insufficient oversight of the IO plans being developed.

Collaborative IO planning context

- The JFMCC did not have an information warfare planning capability, which is required for integrating, synchronizing, and optimizing IO weapons with kinetic and non-kinetic maritime operations.
- The presence of readily prepared operational net assessments (ONAs) largely minimized the opportunity to explore the full possibility of timely, extensive IWPC utility and potential.
- IO staff was largely forced to rely on ONA database vice real world information, so targeting did not use IWPC data.
- An insufficient number of workstations forced collaboration to be face-to-face or via telephone rather than via the CIE, restricting data collection opportunities.

Offensive IO context

- IO weapons were not integrated into the simulation (SIM) federation.
- E-strike weapons were not loaded into the theater battle management core system (TBMCS).

Information Operations Experiment Quality Condition

Testing of the concept of including the IO Commander into the planning process was **good.** Testing of defensive IO capabilities was **good** especially for initial methods and a way ahead, overall development was **marginal.** There was no way to test offensive IO results, quality for this aspect was **very low**.

Netted Force

The Netted Force Initiative focused on knowledge processes, use of collaborative tools, and supporting organizational structures. There were three sub-initiatives: knowledge management organization (KMO) (use of KMO to support JFMCC and battle-staff), collaborative information environment (CIE) (technical systems to support rapid decisive operations (RDO)), and ground common operational picture (COP) (links between traditional COP track management, engagement tools, target management, and intelligence order of battle tools). Each of the sub-initiatives was to document or define the KMO contribution to:

- Commander's situational awareness
- Decrease in information overload
- Bandwidth management in support of combat operations

KMO sub-initiative context

- The contribution of KMO to information management was secondary to the technical aspects of information communications. Data capture was at a lower level than originally envisioned.
- Active bandwidth management was not implemented.

Context for CIE sub-initiative

- Shared Point Portal System (SPPS) interface was used for collaboration.
- LAWS/ADOCS were proprietary systems and difficult to integrate with SPPS or JFMCC applications, although some displays were transitioned to other systems.

Netted Force Experiment Quality Condition

The overall quality of the initiative was **marginal**, and the CIE sub-initiative was **good**. Greater specification of roles, objectives, processes, authority, and support will be needed for future experimentation.

Joint Theater Air Missile Defense (JTAMD)

In the future, Navy theater air and missile defense (TAMD) capability will be hosted as one of the multi-functional capabilities onboard surface combatants. Navy planners will be required to balance joint (critical asset defense) and maritime (force protection and access) requirements and effectively and optimally employ limited numbers of ships in a dynamic battlespace environment. FBE Juliet simulated the dynamic interactions necessary to assist in developing a Joint TAMD/AAW TACMEMO.

The overarching questions to be addressed were:

- Can a single commander appointed as the Battle Force Air Defense Commander (ADC or "AW") and a Regional Air Defense Commander (RADC) supported by the AADC module planning capability and process effectively support the air and missile defense requirements of both commanders?
- Does the capability to rapidly wargame alternative courses of action with the embedded wargaming (M&S) capability and provide graphic displays provide value added to the Joint Force Maritime Component Commander (JFMCC) and Joint Forces Air Component Commander (JFACC)?
- What emerges as functional relationships between JTFHQ (and production of the effects tasking order and/or the defended asset list), the JFMCC (maritime tasking order) and JFACC/AADC (air tasking order)?
- What emerges as the organizational relationship between the SJTFHQ theater missile defense (TMD) cell, JFACC/AADC, Deputy Area Air Defense Commander (32nd AAMDC), Regional Air Defense Commanders (RADC) and the maritime Air Defense Commander?
- What elements of the experimental organization, TTP and C2 learned from this event are suitable for inclusion in a future USN AADC module TACMEMO?
- Did the JFMCC maritime planning process mitigate the dilemma posed by competing demands for multi-purpose surface combatants?

Balancing requirements between joint and maritime responsibilities context

- Focus was primarily on joint responsibilities.
- There was little demand for assets to support maritime needs, thus competition was not exercised.

Optimal employment context

- There was little to no competition for multi-mission ship resources so optimization, which would typically occur in times of over-commitment, could not be analyzed.

Single commander context

- The C2 structure was not predefined as part of TTP.
- Role and responsibilities of the RADC were not well documented; complicating plans execution of plans and attainment of experiment goals.
- The RADC/ADC was not integrated into the AOC or battle rhythm.

Demands on multipurpose ship context

- Without multiple, and conflicting, demands for support, it was not possible to analyze and draw conclusions.

Functional and organizational relationships context

- The relationships of the major commanders had to be structured informally and refined during the experiment, because there was no formal joint architecture for C2.
- FBE-J did not stress the relationships with conflicting, time-critical demands on resources; thus, it was not possible to predict the ultimate endurance or success of the informal relationships.

The quality of the TAMD initiative of FBE-J with respect to being able to obtain information that applied directly to stated objectives within the initiative was **marginal.** However, the simulations of FBE-J provided a rich environment for constructing a joint architecture for missile defense, producing a **good** methodology for future experimentation.

3.3 FBE Experimentation Status and Recommendations

General Status

Fleet Battle Experiments are minor miracles in one sense, inappropriate events in another. They are minor miracles by virtue of the fact that such huge, complicated, multi-organization events get planned, executed, and produce results. They are inappropriate in that they are not the best means for obtaining the information desired.

The "good" in FBEs is in their intent-- i.e., to provide a multi-level and dynamic environment for process, practices and technology to work within, and which may be markedly or completely different from current status quo. "Concepts" can be better understood within this framework.

However, the question being asked in this Section is, "Are FBEs properly constructed to deliver their maximum learning potential?" The answer seems to be "no."

Therefore, the following focuses on improvements that need to be made to FBE experimentation— rather than what is right about them. The intent is to provide recommendations that, if incorporated, will yield improved results from future experimentation.

Expectations for Experiment Design

FBEs in general have experienced a mismatch between experiment plan (EXPLAN) expectations with regard to attaining experiment objectives derived from concepts and the realities of experiment design. Assumptions are made in the definition of experiment initiatives that find their way into experiment planning without the benefit of experiment design and practicalities with respect to what is physically possible to be known from the experiment. These mismatches tend to continue as part of the planning process until handed off to data collectors, with an expectation that analysis will produce the intended learning. At the very least, there must be additional and close coupling between definition of the experiment, its design, an analysis method that is attainable, and the data that is required by those methods. Current planning methodology for FBEs does not enhance this coupling.

Process Improvements

A more productive process would be:

- Define the learning objectives.
- Determine the events (workshops, war games, T&E, experiments of all types) necessary to meet those objectives.
- Lay out a study plan in a coherent sequence of events.
- Execute the events needed to build a body of knowledge.
- When sufficient background knowledge is produced, execute an operational experiment, if needed.

The above process recognizes that operational experiments are but one learning tool, rather than an end in themselves, as has been the case to date.

Experimentation in general suffers from lack of internal cohesiveness. In essence, it is not thought of from the perspective of a "systems approach." Incorporating this systems perspective would automatically eliminate many of the emergent contradictions and constraints found in FBEs to date, and includes the analysis of results in a "total systems analysis."

Total-System Analysis

Experimentation needs to concentrate on the total system. There is currently too much emphasis on hardware system performance and not enough on processes within which those systems operate. The "total system" is made up of:

- Hardware components
- Systems of hardware components
- Information structures
- Command structures
- Decision processes
- TTP
- Human machine interactions
- Human factors, including training

In addition there are factors that have to do with the fact that a military operation is being investigated:

- Red and Blue objectives
- Red-Blue physical interactions
- Red-Blue psychological and political interactions

Experiment design needs to consider the "fitness" of all of these factors with learning objectives and the analyses by which results may be determined.

The idea of "fitness" between concept, objective, execution, and evaluation (all within a total-system perspective) has additional pieces, such as the role of high-level concepts (e.g., network-centric warfare), simulation, systems architecture, and various relations with data collection and analysis.

Net-Centric Warfare/Information Management

Net-centric warfare contains several basic concepts, three of which are especially pertinent to work that has been done in FBEs.

- All pertinent battlefield information can reside in a common system (COP).
- This information can be made available to all participants in an operation.
- Decision quality will be improved by having this information available.

Realizing these concepts requires a different approach to data, information, and knowledge accession, maintenance, and distribution, yet the systems and processes in Juliet and other FBEs tend to be straightforward extensions of the past.

FBE-J results demonstrate that more attention is needed toward providing information that is relevant to a particular task and on designing new decision processes that recognize the new information environment. A significant shift from systems to processes is needed.

Transformations of concepts that are occurring:

- From a common "picture," to a common database from which information is drawn.
- From "common" information, to information that is relevant to performing a task.
- From common displays, to presenting information in a way that is task pertinent.
- From fitting information to processes, to redesigning processes around information.

Achieving this transformation requires intelligent agents to fuse and sort information. It also requires developing processes that fit the new information environment, which can probably only be done by sophisticated process modeling. FBE examination of net-centric concepts needs to move in these directions.

Simulation

Simulation is used to provide event stimulation of FBEs. This is required for a variety of good reasons. The underlying physics for events reside in the simulation. From a total system understanding point of view, one cannot adequately analyze experiment events without having a complete understanding of what is occurring in the simulation. However, this level of understanding is not available to those analyzing FBEs. There are two issues:

- Reconstruction of events is an analysis imperative that requires simulation and live action data. Experiment objectives should define the kinds of reconstruction required, and must be engineered prior to the experiment. Data extraction from simulation (e.g., joint semi-automated forces (JSAF) or the high level architecture of which it may be part) must be built in as part of the simulation system requirements.
- Understanding events requires knowing their underlying physics, in this case the physics modeled into the simulation. For example, is weapon-target interaction based on an extended range guided munitions (ERGM) or a Tomahawk; does a sensor's probability of detection depend on foliage; etc.? The needed level of understanding within the simulation is not available to analysts.

System Architecture

There is a tendency to bring systems into an FBE with an incomplete overall architecture design. One of the minor miracles is that the systems perform as well as they do. However, inconsistencies do emerge during an experiment and they can obscure the information one is trying to gather. FBEs need a master architect, who has appropriate authority, and focuses not only on whether systems will work together but also on whether the resulting configuration and use will meet experiment objectives.

Data Capture

Each FBE initiative requires significant amounts of data and information in order to perform adequate analyses. As experiments have moved toward more rapid uses of information, it has become increasingly necessary to acquire data electronically in order to track processes. It has been difficult to acquire all needed data. This applies to both simulation data (stated above), and transaction data (e.g., the electronic data from systems such as the Land Attack Warfare System (LAWS)). FBE priorities need to place capturing adequate electronic data near the top.

Data collection should be as automated as possible. All data should be regularly transported to a central site and copied to another site so that there is some measure of insurance against loss. Problems exist with having data stored on PCs that were then shipped to various organizations across the country, necessitating a special effort to re-acquire the data, always with the potential that this effort may not be successful.

Besides the "fitness" described above, there are engineering standards and best practices that should be followed, such as pre-experiment testing. Although the spiral structure of FBE Juliet provided some opportunity to perform testing, it could not make up the entire differential between immature systems and experiment execution. At best, the final spiral event pre-FBE Juliet was an opportunity to wring out possible threads that might be activated in execution. This was not the correct forum to engineer systems into proper performance. Those activities should have been accomplished in the process leading each system towards successful performance in the FBE.

Process and Decision Structure Testing

In keeping with the net-centric approach, much FBE effort has been expended on use of information for rapid decision-making, with Fires as a major thrust. Adequate testing should include stressing the process. To date, FBEs have dealt with environments that are not target rich or do not have large numbers of targets to deal with in a short time. Thus, it is not known what performance parameters will be under those circumstances, which are critical in actual combat.

Engineering Support

Complete planning, engineering, and testing of systems needs to be done before trying to demonstrate possible functionality in an FBE. Several FBE-J initiatives relied on or evaluated equipment that failed. Examples include the micro-netted unattended ground sensors (MIUGS), ASW remote autonomous sensors (RAS), and knowledge kinetics (K2), a work-flow software program that at the technical level was successful, but was not integrated in processes to actually do the job it was intended to do. Because many initiatives are predicated on the successful operation of equipment or sensor suites, or integration of new software (as in the case of K2) new equipment should be given sensibly exhaustive checkouts beforehand so there will be reasonable certainty that it will work as advertised when it is expected to be operating during the experiment.

It has been argued (incorrectly) that while systems, technology, processes or software may not perform; the experiment concept is not at risk. In other words, the thought is expressed that there is autonomy between concept and the means to learn more about that concept in an experiment. This is a faulty notion. While it may in fact be true that the piece of hardware or software, or perhaps even system is not the point of the experiment, furthering the concept (which is the point) cannot be accomplished in the face of inadequate performance of supporting equipment.

ISRM MIUGS and the ASW RAS are examples that warrant description to better illustrate this point. As yet there is no agreement on MIUGS performance emerging from the experiment. Characterizing this performance is a necessary component to modeling and supporting the larger concept of which this is a part. A thorough check of sensor performance and communication links beforehand would have eliminated problems and enhanced what was learned. For the ASW system, robo-skis were understood to be a difficult platform on which to place very sensitive sensors, which were designed for stationary employment. In another ASW example, modifications to DICASS buoys for use with helicopters moved the power source too far from the transducer for adequate performance. Thus, neither experiment could be said to adequately support the concept of autonomous sensor employment, nor was parameterization for further experimentation obtained. All three systems could have been matured and tested prior to STARTEX in order to achieve a higher order of success. In addition, fielding the deficient systems during an FBE did not provide good data on how to improve the systems, thus representing a waste of effort and resources.

There are other factors in the complex interrelations of these experiments that are not adequately addressed, but would contribute to overall context and performance. An example is the role of logistics.

Logistics Metrics

FBEs are not realistic in terms of logistics or assets use, which leads to artificial/unrealistic results. Simulation provides most of the event stimulation necessary to engage experiment systems and processes. However, there is very little feedback that incorporates use of metrics to account for logistics and expenditures, i.e., how long resupply would take, how many missiles are available in a particular ship. In addition to the tracking of expenditures, the quality of those expenditures is not considered. For example, Harpoon missiles were used to destroy motor whaleboats – a tremendous asymmetry in values and a potential future opportunity cost, thus an unrealistic action in the real world.

Post-Experiment Requirements

Past FBE analyses have suffered from a lack of continuing participation by the initiative leads, concept definers, principal participants, observers, and analysts. To date, the only group engaged in all three phases of experimentation (planning, execution, analysis and reporting) is the data collection and analysis group, which has not included leads from planning. Post-experiment dialogue should include the entire group to determine what events took place, produce a narrative of the interactions, come to consensus on context that impacted results, and determine what is necessary for final reconstruction, analysis, and reporting. Quicklook reporting does not provide the necessary forum for this dialogue and provides neither cause and effect analyses nor quantitative conclusions.

It is highly recommended that all principal participants in each of the initiatives be retained for all three phases of the experiment, not just the first two.

Scope of Complex Experimentation

It is likely that the Navy would find value in narrowing the focus of the complex experiments, which will also include "not to interfere" demonstrations. Rather than try to do many things, at great expense and with insufficient designers, observers, or analysts, it would be better to focus on only a few initiatives and do them very well. There must be assurance that this limited number of objectives are all well designed (with overall priorities and the ultimate analysis in mind), thoroughly observed and documented, and comprehensively analyzed. Additionally, each formal Fleet Battle Experiment should be part of a continuing mosaic, designed to build mounting improvement in capability beginning with the highest priority processes over a number of years.

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Section III: Reconstruction

4.0 Experiment Reconstruction

4.1 Scenario and Timeline

- The year 2007.
- Country Red sits astride a strategic waterway important to the world's economy.
- A faction inside of Country Red has seized islands in the waterway that belong to a neighboring nation and has interrupted the shipment of oil.
- This interruption of international shipping has exacerbated existing world economic problems.
- Country Red has weapons of mass effectiveness (WME) that it is using to threaten surrounding countries to prevent them from supporting any international efforts to reopen the waterway.

Figure 4-1. FBE-J Locations and Settings.

4.2 Actual Setting

- Southwest US DoD training and weapons ranges represent Country Red.
- Portions of the Southern California Navy operating area represent the critical waterway.
- San Clemente Island, San Nicholas Island, Santa Barbara Island, and Santa Catalina Island represent islands seized by Country Red in the critical waterway.

4.3 Joint Forces: Live and Computer Simulated Forces

- Navy: two Carrier Battle Groups and two Amphibious Ready Groups.
- USMC: Marine Expeditionary Brigade.
- Army: Airborne and Medium Brigades.
- Air Force: Aerospace Expeditionary Force.
- Joint Special Operations Task Force.

Live Forces / Ranges

Joint Force HQs
- XVIII ABN CP HQ

Army
- ARFOR/DIV HQ
- 1 x ABN BDE HQ
- 1 x ABN BN TF
- 1 x IBCT BDE TOC (& CSS PKG)
- 1 x IBCT IN BN TOC
- 1 x IBCT RSTA SQN TOC
- 1 x MEP (2-3 PATRIOTS)
- 32nd AAMDC (-) TOC/ABMOC
- 1st BCD
- JICC-D
- DEEP ATTACK PKG (AH, HIMAR & C2)

STRATCOM
TPRC

Navy
- JFMCC and CWC Staffs
- 1 x LCC (C2-CORONADO)
- 1 x LHD
- 2 x AEGIS (DDG)
- 2 x SSN
- 2 x HSV (Joint Venture & Sea Slice)
- 4 x AHCM (H-53)
- 8 x F-18
- 1 x E-2C Hawkeye
- 1 x EA-6B Prowler
- 2 x P-3C Orion
- 2 x SH-60B Seahawk
- 2 x MK V

Marines
- JFLCC (T)
- MEB (C2 ELE)
- GND CBT ELE (BN (+))
- AVN CBT ELE
- CBT SVC SPT ELE

Air Force
- JFACC
- 8 x A10/OA 10
- 2 x B1
- 2 x B2
- 1x B52
- 2 x E3 AWACS
- 1 x E8 Joint STARS
- 10 x F15E Strike Eagle
- 6 x F15C
- 8 x F16
- 10 x F16CJ
- 1 x F117
- 1 x HH60
- 6 x KC135
- 1 x RC135 RJ
- 1 x U2
- 2 x Predator UAV
- 1 x Global Hawk UAV

Special Operations
- JSOTF, JSOGC, JSOMC, JSOAC HQ
- JSOGC SF BN (-), NSWTG, SOS (-)
- 528 SOSB, 112 SIG BN
- JPOTF RESPONSE CELL
- JSOC RESPONSE CELL

SPACECOM
- JOINT SPACE SPPT TEAM
- SPACE, JIOC, JTF-CNO

Ranges

Army
- (Ft. Irwin)

Navy
- NTC Pt Mugu
- China Lake

Air Force W. Islands
- NTTR W. Ranges (Nellis, AFB)

Marines
- Camp Pendleton
- SCLA (George, AFB)

Figure 4-2. Live Forces and Ranges.

4.3 Operations Overview

The overall Blue Mission was to conduct Rapid Decisive Operations to assure access through the strategic international waterway. The operations can be summarized as follows:

- A pre-hostilities situation existed through 27 July, during which both Red and Blue were positioning forces.

- On 27 July, Red initiated hostilities by attacking the Abraham Lincoln Battle Group and the Tarawa Amphibious Ready Group.

- From 27 through 29 July, the main effort was engagement of Red maritime forces and air strikes against critical Red C2 targets and TSTs.

- On the 30 July, the Joint Force executed a planned land assault on Red WME sites, including ship-to-objective-maneuver (STOM).

- Starting 2 August, the main effort shifted back to Maritime Access operations to support civilian tanker traffic through the straits to restore the flow of oil.

- The Fleet Battle Experiment concluded on 5 August 2002.

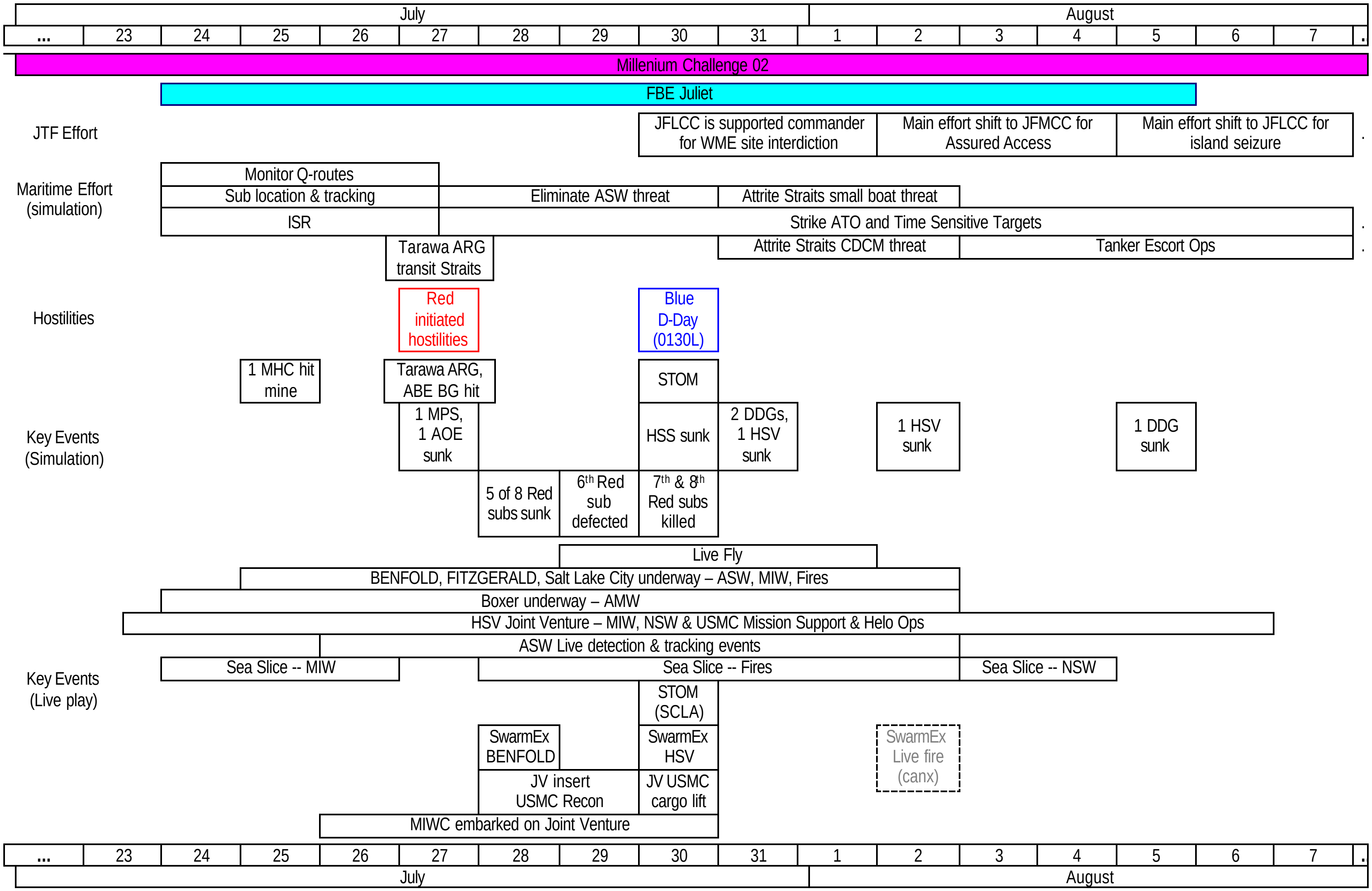

Figure 4-3. FBE-J Timeline

Section IV: Key Observations

5.0 JFMCC Maritime Planning Process (MPP) Initiative Key Observations

In future maritime operations multi-functional maritime platforms are envisioned, with multiple weapons systems, sensors, organic capabilities, highly sophisticated C2, and minimum manning. Providing access to the littorals will be a requirement for maritime forces, often ahead of scheduled flows for joint capabilities. A maritime tasking order will be required to optimize, synchronize, and interweave maritime and joint forces.

Structures and processes exist to produce plans for using maritime forces in response to Commander's Guidance. The increased pace of operations and increasing coordination needed between service components for joint operations have resulted in needed changes. The Joint Forces Maritime Component Commander (JFMCC) Maritime Planning Process (MPP) Initiative was a proposed system of processes for deliberate planning and command and control (C2) to be employed by the JFMCC. In FBE-J, this initiative provided the first in-depth, critical examination of JFMCC and the MPP in a joint, operational environment.

The JFMCC MPP is a collection of interactions between many processes with feedback required between them (e.g., effects assessments resulting from actions). In discussing the MPP, as noted above, it should be thought of as a system, vice process. Among other actions, the MPP interprets guidance from the Joint Force Commander (JFC); produces a joint maritime operations directive (MOD); defines maritime support requests (MARSUPREQ's); prioritizes actions in a master maritime attack plan (MMAP); and assigns action to individual maritime commanders in a maritime tasking order (MTO).

Because JFMCC and MPP are recent concepts, desired results were at a basic level:

- Did JFMCC and MPP work in Juliet?
- Can they work or are there fundamental flaws?
- What is needed for them to work sufficiently?
- Was Juliet structured correctly to answer these questions?
- Develop a set of recommendations for future JFMCC learning objectives.

The fundamental, overarching concern to be addressed by this initiative is flow of information and work. (A "process" is defined as an element of organization that does "work" to information, passing the result to other processes or to storage for later use). MPP is a linear, segmented process, with seven basic steps (outlined in section 5.3 below) for the production and execution of the MTO. This is essentially a complex workflow, analogous to an assembly-line type process. As an example of one assembly node: within the current planning cell, individuals acting as subject matter experts (SMEs) represent the needs of their Principal Warfare Commander (PWC), and do specific jobs in the production of the MTO. They need a variety of information, such as available assets, guidance from their PWC and the effects tasking order (ETO), etc., in order to produce their contribution to the MTO. Within a 72-hour period, there can be as many as 3 MTOs in various stages of production at the same time.

The MPP is designed to coordinate activities of all principle warfare areas and support the production of effects desired by JFC and JFMCC. A "campaign" is developed to meet JFC objectives with each MTO meant to optimize combined effects from each warfare area rather than sub-optimizing individual areas. Each PWC must contribute assets in a coordinated and coherent plan in order to perform optimized, maneuver operations. This implies a great deal of coordination between the SMEs, and between SMEs and their PWCs, during planning. Such coordination is complex, and it is theorized that different "battle rhythms" associated with each warfare area contributes to this system's complexity. Thus, shared asset utilization may not be constant through a full MTO execution cycle.

Information and work within this assembly line (actually three parallel lines) must be highly synchronized. Sufficient coordination must be enabled between various Commands so that individual and collective goals can be adjusted in a timely manner in order to produce an optimized plan. Thus, the following basic MPP components examined in this initiative are:

- Coordination of asset utilization between Maritime or Joint commands
    - Some, but there is little evidence of this in data.

- Coordination/adjustment of daily goals between commands
    - From CINC to CJTF to JFMCC, principle coordination was by numerous briefings.

- Synchronization of information and work
    - Info Work Space (IWS) and SharePoint Portal System (SPPS) provided virtual briefing space chat rooms and alternate virtual conference rooms for information sharing, synchronization of effort, and work.

- Information feedback, primarily BDA
    - Data do not reveal a high degree of coupling between the results of missions and the MPP. Participant data and comments establish feedback as a critical area for improvement. (As an experiment design note, the lack of feedback may or may not represent the same paucity of information from actual combat. However, the point of this analysis is that at the system level, feedback was largely not available as the enabler required to make the experimental MPP system perform adequately, or the process to use information in feedback was not part of the organizational construct. More is said on this topic later in this report).

- Manpower requirements to maintain three MTO assembly lines
    - Heavy operational tasking is placed on available personnel. It is very likely that the experimental organization would not be capable of performing 24-hour operations over an extended time. Also, the number of maritime support requests, approximately 3,000 over a 10-day period, would not be adequately serviced. It is not possible, in these data, to separate, as independent variables, organization, technologies present, and those technical capabilities that were assumed.

To properly understand the JFMCC MPP a process model to visualize complex relationships is required. One of the goals of this initiative is to produce a first iteration model based on the experimental organization structure and associated parameters, which may then be used for simulation studies for different parameters associated with manpower, technology, organization, and CONOPS.

5.1 Experiment Objectives

The stated, primary objective of this initiative is to answer the following broad question:

- Does the JFMCC maritime planning process provide structure, organization, management, feedback, optimization, and situational awareness to maritime force employment and support the intent of a joint effects tasking order (ETO)?

In this experiment, specific terms from the question have specific meaning:

- Structure: The relationship of information and knowledge systems to the MPP system
- Organization: Personnel and functional relationships, and how these contribute overall to the MPP.
- Management: The MPP as a C2 function, internal and external synchronization, management of planning functions.
- Feedback: Information as feedback of different kinds, and levels, that contributes to organization management and process control at the operational level.
- Optimization: As a potential measure of its utility, the MPP as a whole would be expected to merge together battlespace situational awareness with asset planning in an optimized plan.
- Situational awareness: Feedback from actions within the battlespace (e.g., BDA), a common operational picture (COP), and the intent of the ETO to provide an overall and continual assessment that actions at the operational level are in accordance with a campaign plan.

Results from this initiative are almost completely reliant on the analysis of processes. The basic types of operational and tactical plans that need to be produced and general characteristics of organizations to produce them in a maritime environment are understood and have been in use for some time. But, the MPP executed by JFMCC is a significant departure. Even though there is some mapping of past processes on the new organization, there are fundamentals in the processes that need to be investigated, understood, and for which implementation recommendations need to be developed. Former FBEs and Limited Objective Experiments (LOEs) have produced initial, but limited, information. This FBE-J process analysis produces the first set of detailed results. Using these results to produce a process model will then produce quantitative requirements for successful MPP implementation.

The required process analysis has the following distinct, interconnected objectives:

- Identify the products that are produced by the MPP process, information, and its flow, needed to produce these products.
    - This was proposed in pre-experiment CONOPS and observed in the experiment.

- Identify essential process components in the MPP, the organization elements that perform those processes, the interrelationships between components, and develop and evaluate performance parameters for component processes.
    - These processes were identified in pre-experiment CONOPS. An organization was constructed based on CONOPS definition. Interrelations were defined in social-network analysis of IWS chat data. Performance parameters are implied in results, but not directly defined. The results are ambiguous due to combination of experiment organization, technologies, and lack of control over experiment conditions.

- Identify essential timing/synchronization within components of the MPP process, determine whether required synchronization is achieved, and identify behavior cause-and-effect.
    - Timing and synchronization are determined by context analysis, participant "requests for information," commentary, interviews, and surveys.

- Identify relationships between the MPP process and other processes outside of it. Identify constraints and requirements these relationships place on the MPP process.
    - Primarily related to execution in the maritime operations center (MOC), ISR management and feedback to the ETO.

- Determine the requirements for decision support and planning tools and evaluate tools currently in use within the MPP process.

It is important to note that there is much discovery at the current stage of the MPP process analysis rather than quantitative analysis of well-developed processes. For this reason, the above questions do not form a complete definition of needed analyses. Other important questions and results, undoubtedly related in some way to the above, will emerge both during the experiment and analyses.

In support of the above objectives, the following data collection actions were undertaken:

- The production of an MTO was followed, through an MPP. System constraints, further requirements, doctrinal implications, and utility within the scenario were determined.

- Quality and effect of collaboration between Joint and Principal Warfare Commanders on the construction of MTOs, and subsequent execution were collected.

- Instances of support to, and feedback of the results of MTO/ATO execution to the joint-constructed effects tasking order (ETO) were noted.

- MTO execution of events and changes to MTO requirements (MARSUPREQs) were collected.

- Recommended modifications to requirements for manning, tools and C2 to implement JFMCC capability at sea were collected.

- The following planning tools were considered, with regard to the quality of decision support provided:
    - TAPS-VSS
    - Naval Simulation System (NSS)
    - Info Work Space collaborative environment
    - Knowledge Kinetics (K2)
    - Theater Battle Management Core System (TBMCS)

5.2 Analysis Specifics

The following analysis objectives were specified in the data capture plan (DCP).

O1. Determine if processes are sufficient to produce the products, information, guidance or feedback necessary to construct an MTO from an ETO.

O2. Where insufficient, determine contributors to lack of process, products, information, collaboration or control.

O3. Determine if decision support tools are enablers to decision making within the JFMCC process, or where lacking, what decision support tools are required.

O4. Characterize the information bandwidth requirement to conduct the JFMCC process afloat, and network characteristics, related to normative, specific events and usage distributions.

O5. Construct a mapping of intra-process constraints and synchronization across processes.

O6. Investigate MMAP contributions to the USN mission and interactions with other processes in the MPP.

The Data Capture Plan also specified the following measures associated with these objectives. Quantification methods for these measures were not specified.

M1. Manning sufficient to perform functions outlined in MPP CONOPS.

M2. The experimental JFMCC maritime planning process does/does not adhere to the experimental MPP CONOPS.

M3. JFMCC MPP is/is not a capable means to coordinate requirements.

M4. Planning tools (NSS, TAPS-VSS, Knowledge Kinetics (K2) contribute to MTO production and synchronization of assets.

M5. TBMCS is successfully used to translate MTO into an ATO format.

M6. Future planning cell (FPC) produces a timely and effective maritime operations directive (MOD) (as determined by requests for information, or re-work required to pass the MOD forward in the process).

M7. The FPC maritime operations directive is coupled to process in which maritime intelligence cell information (combat assessment, current enemy situation, etc.) is used.

M8. ISR plan developed in the MPP is flexible and adequate to support MTO (related to requirements for amplifying information, or reconstruction of ISR plans already forwarded).

M9. That the current planning cell (CPC) accomplishes the following tasks: prioritize tasks, focus efforts, apportion resources, articulate desired effects, conduct platform-mission pairing, ensure timing of missions.

M10. The CPC synchronizes maritime support requests (MARSUPREQ) requirements in terms of time, space, and assets (includes surface fires and TACAIR employment (related to requirements to fill information voids--using requirements for information (RFIs) or other information means; that coordinating instructions or other change is not required after CPC processing).

M11. The MTO production cell adequately synchronizes MTO with JFHQ and components (related to instances in which conflicts emerge after MTO is sent to PWCs).

M12. Web-based collaborative tools are sufficient and useful for the current planning cell and FPC to accomplish tasks

M13. The CPC produces an MTO that was stable, timely, flexible, and executable.

M14. Interfaces between processes support participant's use of graphical user interfaces (GUIs) and web tools (human factors).

M15. The workload of current planning cell and future planning cell is in line with workload requirements in a high tempo, operational environment.

M16. Converging the MTO into the ATO format meets component commander's requirements, and PWC's requirements.

M17. VSS-TAPS produces situational awareness visualization useful to decision makers in employing effects in the battlespace.

M18. Knowledge Kinetics workflow tool provides accurate, useful and timely processing information related to the production of multiple MTOs by contributing situational awareness of internal MPP processing to JFMCC CPC and FPC staffs.

M19. Tools and processes are used to synchronize the master maritime attack plan (MMAP) (related to shortfalls in required information, innovations in use of tools at hand, and documentation of capabilities shortfall).

The following, pertinent context questions arose during FBE-J execution:

Q1. What responsibility was assigned to the JFMCC by the JFC? (JP 3-32: "The JFC will establish subordinate commands, assign responsibilities, establish or delegate appropriate command/support relationships and establish coordinating instructions for the coordinating commanders.")

Q3. What forces were assigned to the JFMCC by the JFC at the start of the experiment? Did these force assignments change as the experiment progressed?

Q4. Was a JFMCC area of operations (AO) established? How? (When an AO is defined for the JFMCC, the maritime component becomes the supported commander per JP 3-32.)

Q5. Were the authority and responsibility of the JFMCC in agreement with JP3-32, Chapter 2, and paragraph 3? Were they modified during the course of the experiment? (Note in particular that the JFMCC, "Provides the Deputy Area Air Defense Commander (DAADC) for maritime-based air and missile defense or joint theater missile defense (JTMD), as assigned by the JFC.")

Q6. What operational control (OPCON) and tactical control (TACON) relationships were defined by the JFC at the beginning of the experiment, and how did these relationships change? Did implications for inter-component collaboration arise as a result?

Q7. What support relationships were defined by the JFC between components at the beginning of the experiment? Did these changes produce cross-component operational problems? Why and how? What was done to resolve them?

Q8. What relationships and mechanisms existed between the JFMCC and JFC to provide for feedback and control? Were there examples of the quality of these relationships?

Q9. How was targeting authority passed to JFMCC, and when?

Q10. In what JTF boards, groups, and cells did the JFMCC have representation? (The JFMCC is to maintain liaison with other service and functional components and agencies.)

Q11. What examples of coordination and deconfliction can be cited, in which there was a coordination or deconfliction recommendation to JFC, other components, or agencies?

Q12. Did the JFMCC C4ISR architecture and plan support JFC operational requirements?

Q13. What examples of recommendations from the JFMCC to the JFC for movement and maneuver of assigned forces emerged in the course of the experiment?

Q14. How were the JFMCC alternate courses of action (COAs) developed, tested and prioritized?

Q15. What was the joint targeting concept established by the JFC? What did it include?

Q16. What were the relationships established between JFMCC and JFACC for targeting responsibilities at the beginning of the experiment? How and why did this relationship change over the course of the experiment?

This experiment was exploratory in its learning objectives, resulting in a lack of one-to-one mapping of the objectives, measures, and questions onto the MPP system results.

5.2.1 Experiment Design

Details of the operational and coordination level of FBE Juliet are found in the Experiment Plan[1] published shortly before experiment execution. Each of the experiment initiatives shared some requirements for data and control of conditions. Each initiative area also had specific learning objectives for the experiment.[2] However, specific data design to meet experiment objectives was hampered by lack of design control by experiment designers. For the JFMCC MPP initiative, lack of experiment design had systemic (cascading) impacts on experiment control. These system effects became constraints to the production of useful experiment data, and are accounted for in the consequent constraints to analysis that results. These are stated for the purpose of bounding experiment results in this report, and as learning opportunities for future complex experiments. Specifically, for the MPP initiative:

- FBE Juliet was planned and executed within a larger effort, Joint Forces Command's Millennium Challenge 02. Experiment control of the scenario was not possible at the level of the Maritime Component Commander.

[1] Navy Warfare Development Command, FBE Juliet EXPLAN, July 2002.
[2] Meyer Institute, Naval Postgraduate School, FBE Juliet Data Collection Plan, July 2002

- Analysis objectives at the Joint level were greatly different from those of the Maritime component, resulting in lack of data resolution required to meet some of the Maritime Component objectives. For example, quantitative data to produce TCT timelines was of interest to the Maritime Component, but at the Joint level, qualitative surveys of participant expectations were sufficient.

- Within the Maritime component, most of the experiment objectives revolved around two categories of interest, 1) process, and 2) technology. With both of these being immature, understanding the performance of process becomes very difficult when combined with misunderstood, or immature technology.

- Simulation is necessary to complex experimentation. However, the Joint experiment tended to over-play the tactical level of simulation, to the point that simulation operators were expected to fight their platforms as if involved in actual combat operations. While Juliet was focused at the process level of data collection, platforms could be lost from inadequate tactical employment by simulation operators, and not as a result of organization, C2, or process.

- Iterations of conditions or variables were not possible. With the Joint experiment in the lead, the decision was to employ nearly complete free-play, vice scripted events. This was valuable as a wargame experience, but worked against any possibility of resetting conditions for multiple iterations. In addition, it was very difficult to employ a Master Scenario Event List.

- For this mixed type of play there was not an opportunity to provide effects feedback into the process because there was little real correspondence between planning and execution play. This led to an unreality in planning and led to such things as reiterations of plans that were similar (nearly identical as someone reported) to those provided earlier. Also, it meant that there was no way to determine if a plan had been successful, and there was no learning for the planners.

5.3 JFMCC/MPP Baseline Model

A "baseline" for the MPP refers to a current iteration of the concept, organization, technologies and supporting structures present at the beginning of the event. Because the JFMCC MPP is not a standard used throughout the Navy, no other grounding reference is possible. One difficulty with attempting to baseline this initiative for comparisons is the tendency to conduct rapid prototyping of the initiative during experiment execution, resulting in low stability of what was being observed. Also, metrics for comparisons are not available.

5.3.1 Background

The maritime planning process (MPP) was developed in the course of FBEs Hotel through Juliet. In general the concept was intended as a response to the principal issue that: "The Maritime operational planning/execution process is not optimized to integrate Navy core competencies into the CJTF campaign doctrine."[3]

[3] Navy Warfare Development Command briefing, Maritime Planning Process Description, "Issue Statement."

A concept of operations (CONOPS, "baseline") document was produced to define the operational means answering the above issue.[4] In addition, this baseline experimentation document was intended to provide input to a Joint publication.[5]

This section will summarize important aspects of the MPP as it was designed specifically for FBE Juliet.[6]

In this experiment, the MPP was intended to be an incremental step bridging past experimentation (FBEs H and I) and a next iteration of a Joint Publication (JP 3-32) or Navy Warfare Publication. In this iteration of the concept, the MPP was designed to specifically deal with shortcomings in Navy operational planning. The concept of operations (CONOPS) expresses these shortcomings as:

> "Currently, the naval operational level planning process is not well defined and does not dynamically prioritize and assign joint maritime tasks to multi-mission platforms. Nor does it then position those platforms to best perform the tasking of the naval mission in the littorals, all within the construct of a Joint Task Force. To synchronize and schedule these naval air, surface, and subsurface platforms, these units must operate within a planning and execution process to use the limited platforms across surface warfare (ASUW), strike warfare (STW), mine countermeasures (MCM), air defense (AD), undersea warfare (USW), amphibious (AMW) while applying "in-stride tactics," not sequential tasks. The JFMCC does not have a defined process of selecting precision targets, applying appropriate assets to those targets, wargaming for optimal positioning and scheduling, promulgating this plan in a CJTF parsable format and then execute the plan while conducting time sensitive target acquisition, engagement and assessment utilizing dynamic weapon target pairing."

FBE Juliet provided the venue for iteration of the MPP, but with the following constraints:

- The MPP would not replace the need for functional naval warfare commanders. Principle Warfare Commanders (PWCs) would still be required for tactical planning and execution of plans. PWCs for FBE Juliet included:

    - Sea Combat Commander (SCC, which also included duties as the ASWC and Surface Warfare Commander, SUWC),
    - Mine Warfare Commander (MIWC),
    - Strike Warfare Commander (STWC),
    - Information Warfare Commander (IWC),
    - Amphibious Warfare Commander (AMWC), and
    - Air Defense Commander (ADC).

- The MPP would be required to support deliberate planning of a maritime campaign tasked with several separate naval warfighting missions.

- Many decision, planning, and awareness tools would be necessary to assist separate warfare areas. None were available to tie together all maritime missions together, yet such a tool is a requirement for a successful MPP.

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[4] NWDC produced "FBE Juliet JFMCC Concept of Operations"

[5] JP 3-32

[6] The baseline documentation for these processes is included in the draft of JP 3-32, *"Command and Control of Joint Maritime Operations,"* and in *"Concepts of Operations for Maritime Planning Process in FBE-J."* Multiple briefings, point papers, and e-mail memoranda provided additional information.

5.3.2 MPP Processes

An iterative model of the MPP is included in the CONOPS, beginning with a Maritime Operating Directive (MOD).[7]

- Upon JFMCC approval of the MOD, Principle Warfare Commanders (PWCs) submit maritime support requirements (MARSUPREQs) to the MPP current planning cell (CPC).

- Subject matter experts, employing a variety of collaborative and decision support tools, produce a master maritime attack plan (MMAP), for approval by the CPC Chief.

- Upon approval, a maritime tasking order (MTO) is produced, for approval by the JFMCC.

- In FBE Juliet, the approved MTO was then forwarded to the Joint Forces Air Component Commander (JFACC), for inclusion in the Air Tasking Order (ATO). The ATO was then effective within the Joint Task Force, and was passed to the MOC for further distribution to the PWCs for execution.

- Assessment of execution results would be fed back into the next iteration of the MPP.

The time scale for a complete iteration of the cycle is 72-hours.

At a more detailed level, the MPP can be described as a set of sequential, interdependent (but also fairly linear) steps:

- STEP 1 – Draft the MOD. The future planning cell drafts the maritime operations directive delineating maritime operations to support the CJTF campaign plan. The MOD is distributed to Principal Warfare Commanders. Each day the JFMCC would focus priorities set forth in the PEL and ETO based on battlespace dynamics and campaign tempo. (There were additional inputs to the MOD, including a prioritized effects list (PEL) and effects tasking order. These, as well as their relationship to the MOD production process, are defined later.).

- STEP 2 – Development of MARSUPREQs. Principal Warfare Commanders take the tasks directed by the JFMCC in the MOD, as modified by daily guidance, and submit to the JFMCC a listing of assets required to accomplish the tasks required to support the commander's priorities in formatted maritime support requests (MARSUPREQs).

- STEP 3 – Develop the master maritime attack plan (MMAP). The current planning cell (CPC) combines tasks encompassed in the MOD, mission plans from PWCs submitted in MARSUPREQs, and current tactical environment to develop prioritized tasks, scheme of maneuver, apportionment, and desired effect for the next 48 hours, and detailed in a maritime master attack plan.

- STEP 4 – Collaboration between PWC's, around the MMAP. The MMAP is distributed electronically (in FBE Juliet, this was through the SharePoint Portal Service web space) to appropriate planning groups located within each PWC staff. Warfare commanders collaborate with the current planning cell to modify the "shell" (an interface designed for this purpose) to

[7] The term "MOD" had previously been referred to as the Joint Maritime Operations Plan (JMOP).

incorporate platforms. This could also include preplanned mission and asset pairing; the expected sequence in which missions are to take place, time-on-target estimates, collection requirements to measure desired effects, and any other specific detail only available at the warfare commander level.

- STEP 5 – Produce the maritime tasking order (MTO). In the baseline CONOPS, after the PWCs have agreed to the master maritime attack plan and it has been approved by the JFMCC, the MTO production cell coordinates missions with the JFACC and JFLCC and consolidates this information into a single MTO, for promulgation. In the experiment, the output of the MTO production cell was sent directly to the JFACC for inclusion in the ATO, and subsequent publication within that document.

- STEP 6 – Execution of the MTO and time critical targets (TCTs). A Maritime Operations Center (MOC) executes day-to-day missions published within the MTO (or in the case of FBE Juliet, the ATO, hereafter referred to as M/ATO.) and asserts dynamic battle control of emerging targets and requirements. Modifications to the M/ATO are published here. In addition, the MOC dynamically manages ISR assets, and is central to distributing feedback of battlespace damage assessments to the MPP.

- STEP 7 - Combat Assessment. The maritime intelligence cell assesses maritime battlespace results and as quickly as possible, provides appropriate feedback at the required levels of the process.

Figure 5-1 shows the flow of information from the Joint Force Commander staff down through the various Navy levels of command to execution, and the feedback back up the chain. The principal products between the levels are Commander's Guidance, effects tasking order, maritime tasking order, maritime support requests, and direct commands to produce actions, which are not shown. Feedback is used as input information at the beginning of a planning cycle. Feedback should also be inserted into planning that is ongoing, which requires it be available at the proper time in the planning process if it is to be useful in producing modifications.

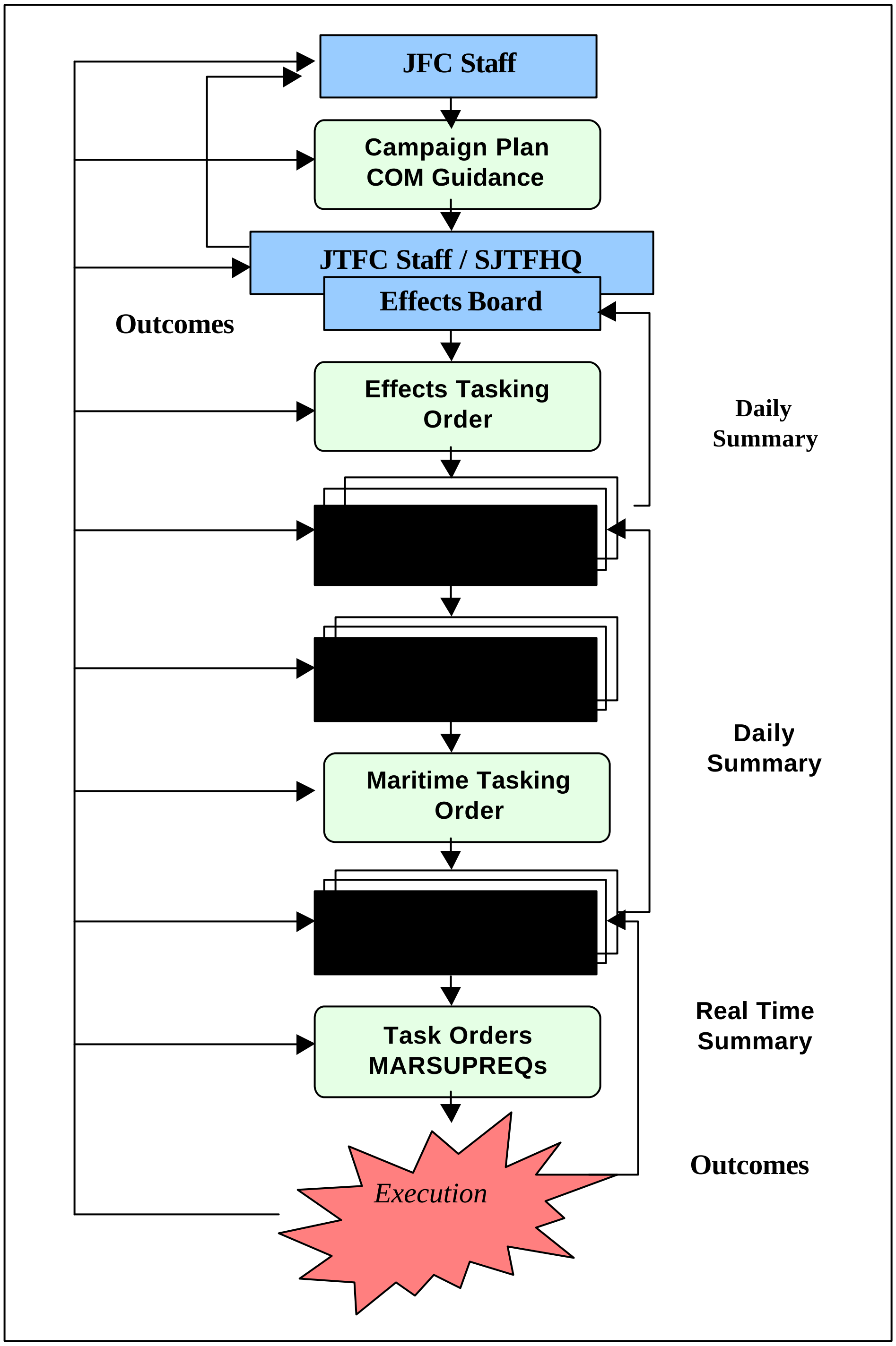

Figure 5-1. MPP Flow of Information

Figure 5-2 presents a more detailed view of the Navy FBE-J planning process. It provides a context data flow model view of JFMCC MPP, the related products from that process, and simple external relationships. This view is based on what was developed in the CONOPS for JFMCC MPP, with numbers associated with the steps discussed above.

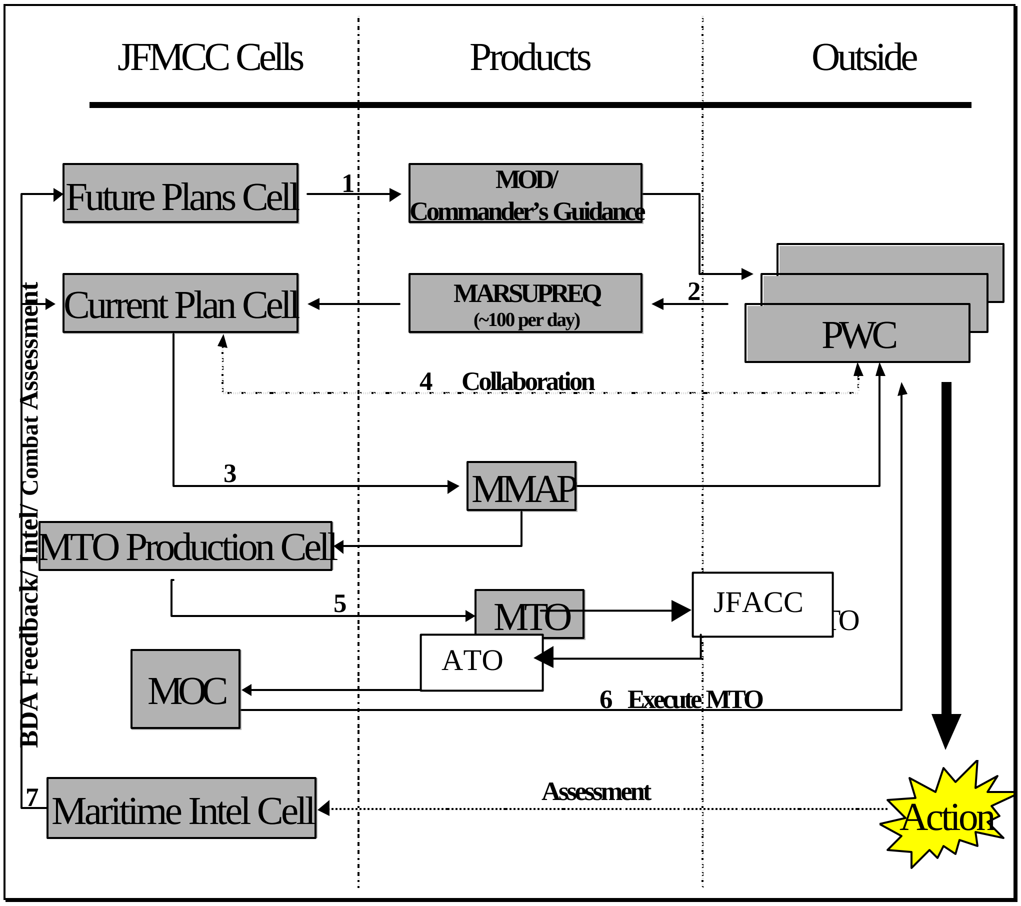

Figure 5-2. JFMCC MPP Data Flow Process

Note that in the model above, the "JFACC to ATO" is not filled in, to underscore that although it is necessary that the MTO be easily integrated with other component planning documents, for the purposes of this experiment combining the MTO with the ATO was necessary to comply with current doctrine.

5.3.3 Baseline MPP Decomposition by Process

The above view provides the "stepwise" perspective of the MPP. However, a more functional view of MPP is one defined by interrelated processes. A process is defined as work or actions that are performed by people, machines, or computers on incoming data flow to produce outgoing data flows. All data flows must begin and/or end at a process, because data flows either into a process or results from a process.[8] In

[8] Quite often the term "process" is incorrectly used. The definition in this report is taken from Whitten, Bentley and Dittman, Systems Analysis and Design Methods, 2001.

other words, processes do work to information. The results of this work can only feed other processes, or become part of a repository of information for use later by other processes. A process model of JFMCC MPP was produced prior to experiment, as a means to help develop a CONOPS, but was not used further as a means to understand interactions or metrics in execution of FBE Juliet.

Process to Coordinate Joint Forces Commander (JFC) Effects Tasking and JFMCC Operations: The ETO is an output of the JFC, produced in collaboration with functional commanders and reachback cells at the CINC's headquarters, supporting CINCs, and external agencies. ETO development is intended as a continuous, interactive process between the plans team, component commands, and executing organizations. The ETO expresses the Joint Forces Commander's intent by assignment of missions to appropriate functional commanders that are designed to achieve specific effects and outcomes. After it is developed, the ETO is passed to components. At the component level the ETO is articulated in component plans. The JFMCC is responsible for the articulation of maritime plans to support the ETO.

Process to Produce a Maritime Operations Directive (MOD): This process specifies directives to integrate and coordinate joint maritime operations. Producing the MOD serves to achieve the Joint Force Commander's operational and/or overall campaign objectives. The MOD (which is modified as required, and reviewed and approved by the JFMCC at the beginning of each MTO cycle) is a compilation of plans used to achieve mission objectives based on the dynamics of the battlespace and the tempo of the campaign.

As a general description of this process, the future planning cell (FPC) develops the JFMCC daily strategy to accomplish JFMCC tasks. An integrated plan provides tasking to the Principle Warfare Commanders (maritime component PWCs), with requirements for effects to be accomplished by the other functional warfare commanders (JFACC, JFLCC and JSOTF). Products from the FPC include an input to the future ETO, inputs to a prioritized effects list (PEL), the joint integrated target list (JIPTL), and the MOD.

Participants in this process include the current planning cell Chief, and subject matter experts (SMEs) from Intel, Information Operations, Sea Combat Commander, ship to objective maneuver (STOM), strike warfare, air defense, ISR (intelligence, surveillance and reconnaissance), mine warfare, ATFP (anti-terrorism and Force Protection), logistics, and amphibious warfare. In FBE Juliet, SMEs provided coordination and collaboration horizontally between other PWC SMEs in the current planning cell, and vertically with the operational PWC. A representative from the current planning cell provided continuity between the current planning cell and the future planning cell.

Maritime Support Requests (MARSUPREQ) Production Process: This process is the means by which PWCs list required assets submitted by the maritime service components and subordinate commanders to the JFMCC to accomplish the maritime tasks specified in the MOD.

The current planning cell combines tasks from the MOD with mission plans and asset requirements submitted by PWCs in MARSUPREQs. The current tactical environment is an input to the CPC for development of prioritized tasks, scheme of maneuver, apportionment, and the desired effects for the coming 48 hours.

Maritime Tasking Order (MTO) Production Process: This process tasks specific missions related to maritime forces and maritime operations. It also may be used to disseminate projected sorties/capabilities/forces against targets to components, subordinate units and command and control agencies. Specifics such as call signs, targets, controlling agencies and general instructions are included. Some of the specific maritime missions and sorties included in the MTO may duplicate other component commanders' task orders. In FBE Juliet the MTO was merged with the Air Tasking Order (ATO) prior to publication and execution.

MTO Execution and Feedback Processes: These processes occur outside of the current plans or future planning cells. However, feedback from the results of MTO execution is required as an input to planning of follow-on MTOs.

<u>Synchronization</u>

Synchronization of interdependent processes is the most difficult task. The MTO is typically produced on a 72-hour cycle, but can vary dependent on JTF battle-rhythm. Normally, three MTOs are in various stages of production at any one time. During execution of an MTO, results obtained (damage assessments) will impact planning of subsequent actions. These results must be inserted at an appropriate point in planning and at the correct time, or planning process components must be adaptable to modifications at any time. Battle damage assessment is the primary feedback from current operations.

Planning by PWCs occurs in parallel. However, it is possible that different missions will require the same assets. When this occurs, coordination between PWC staffs must occur or there must be an adjudication function. In either case, planned synchronization of processes must occur or there can be a time-out for the more rapid process until the other reaches the asset deconfliction point.

<u>Processing Capacity</u>:
The rate at which required products can be produced depends on the processing capacity of the various system process components of JFMCC and PWC staffs. In the absence of multi-tasking, it is fairly simple to determine the capacity of each component and the manpower needed to complete expected workloads within time requirements. However, multi-tasking in the MPP can be expected to occur. If a processing component has more than one task, and if tasks overlap during processing, determining needed manpower becomes complicated. It is not true that one can simply add the requirements for the two tasks because no tasks are independent. Efficiency can be achieved if one component works on two tasks that are closely related.

<u>Process Requirements - The Baseline Model</u>:
The following requirements provide the parameters for the MPP baseline model as employed in FBE-Juliet. Baseline means these parameters reflect expected performance for JFMCC/MPP processes, established prior to the experiment. Results are compared to this baseline and deviations noted. The model consists of the above process architecture and process descriptions, and a set of expectations for overall performance and performance of internal processes. At this point in MPP development, the expectations are broadly stated and the parameters fairly loosely defined. The results of this experiment provide recommendations for process improvement and better parameter definition to provide an improved baseline model.

MPP in total:

- Produce one MTO per day.
- Process three MTOs simultaneously
- Provide daily effects summary to JFC
- DPG courses of action analysis to FPC once per day

Future plans cell

- Produce one MOD per day
- Consideration of two future MODS in addition to current day

Deliberate plans group

- Daily briefing at 1900

Current planning cell

- Meet to de-conflict MARSUPREQs once per day prior to MMAP production
- Produce one MMAP per day
- Work on 2 MMAPs in queue

MTO production cell

- Produce one MTO per day
- Deconflict one MTO and ATO cycle per day

5.4 Experiment Design, Data Collection, and Analysis Methods

Data collection and analysis focused on information content, information flow, and decision-making within the MPP process. Figure 5-2, discussed above, set forth the processing components of JFMCC and the products being considered. Information regarding processing performance was obtained for authority relationships, synchronization with JFC processes, and the usefulness and requirements for decision support tools. The basic quantities to be determined for all components of the MPP process, as appropriate, follow.

- *Product quality* is determined by its acceptability at the next for an input to their process. This is measured by
    - Number of instances of request for clarification
    - Number of instances of request for additional information
    - Time spent on interpretation
    - Degree to which an input provided boundary conditions or guidance.

- *Processing time* is the elapsed time from the time the first data is provided that can initiate the process to the time the product is delivered to the next component. In addition, elapsed times for internal sub-processes are needed.

- *Process capacity* is the number of operations that can be carried out per unit time. This applies to existing sub-processes, not the complete process for which one product is produced per day, and for which the basic measures are its quality and the processing time. For example, development of the MMAP will require processing several MARSUPREQs.

- *Process capacity* has several associated parameters that must be captured, which fall in the context category. They are:
    - Number of personnel working on each sub-process
    - Instances of multi-tasking for personnel or units
    - Multi-task time overlaps.

  Note that the above three measures are not independent. Processing time will depend on quality of input information, etc. There is no current methodology for quantifying these correlations and only weak methods for identifying them.

- *Coordination between production teams* focuses on instances where there is possible or actual competition for assets, e.g., MIWC and ASWC needing to use the same ships for their missions. Two determinations are made:
    - Whether PWCs coordinate when producing their MARSUPREQs
    - If this coordination does not occur, whether subsequent adjudication occurs.

- *Synchronization of processes* is required throughout the MPP. This applies to:
    - Information passed between processing components during planning
    - Feedback during and after execution
    - Coordination of multitasking for the three simultaneous production cycles.

- *Bottlenecks or constraints* to process performance are determined for information flow and organization relationships, particularly for decision-making authority. The data are the number of instances and when and where they occurred.

- *Authority relationships* are mostly predetermined and part of experiment context. Of special interest here are relationships when competition for assets occurs and what authority is utilized for the resultant asset allocation.

The data used to arrive at the observations presented below come from a number of sources:

- Subject matter expert observations
- Participant surveys
- Initiative stakeholder observations
- Human factors
- JFMCC briefings (including maritime operations directive decision briefings, and master maritime attack plan decision briefings)
- Maritime support requests
- MTO catalogue
- Battlespace context and scenario events
- Principle Warfare Commander interviews
- Chat room dialogue from Info Work Space (IWS).

5.5 Sub-Initiative Observations

Due to the exploratory nature of this initiative, the results include a determination of how the various MPP sub-processes were executed. This is described at the start of each of the following observation subsections for each of the products. Included in the subsections are summaries of significant subjective observations about the processes. Indications are that MPP is a process in evolution, not yet robust, which is to be expected.

A subsection on synchronization of the various aspects of the MPP follows discussions of production of the various products. Lastly, there is a discussion of the decision-support tools.

5.5.1 MOD (JMOP) Production Process

The maritime operations directive (formerly the joint maritime operations plan) specified instructions to integrate and coordinate joint maritime operations to achieve the Joint Force Commander's operation or overall campaign objectives. The MOD (which was modified as required, with at least an opportunity to modify daily) was a compilation of plans used to achieve mission objectives based on the dynamics of the battlespace and the tempo of the campaign.

As a general process, the future planning cell (FPC) developed the JFMCC daily strategy to accomplish the JFMCC tasks. An integrated plan provided tasking to the Principle Warfare Commanders (PWCs), with requirements for effects to be accomplished by the other functional warfare commanders (JFACC, JFLCC and JSOTF). Products from the FPC include an input to the future ETO, inputs to a prioritized effects list (PEL) and joint integrated target list (JIPTL), and the maritime operations directive.

In this experiment the objective with regard to the MOD production process was to define the information architecture, the decision support architecture, tools, and organizational impacts between issuing of the ETO and production of the MOD via the FPC. Enablers and constraints to information, organization, and decision-making were all noteworthy as data in this experiment process.

Contributors (members) of this process included the Cell Chief, and planners for intelligence, information operations, Sea Combat Commander, ship to objective maneuver (STOM), strike warfare and air defense, ISR, mine warfare and anti-terrorism, logistics, and amphibious warfare. A representative provides a coordination function to the PWCs from the PWCs, and similarly a representative from the current planning cell provides continuity between what is being planned for current operations and for future operations.

The archived maritime operations directive (MOD) briefs were intended to delineate to the PWC's the operations to support the CJTF campaign plan. The JFMCC future planning cell (FPC) was responsible for the daily drafting of the MOD. The figure below shows a very basic description of the overall MOD process.

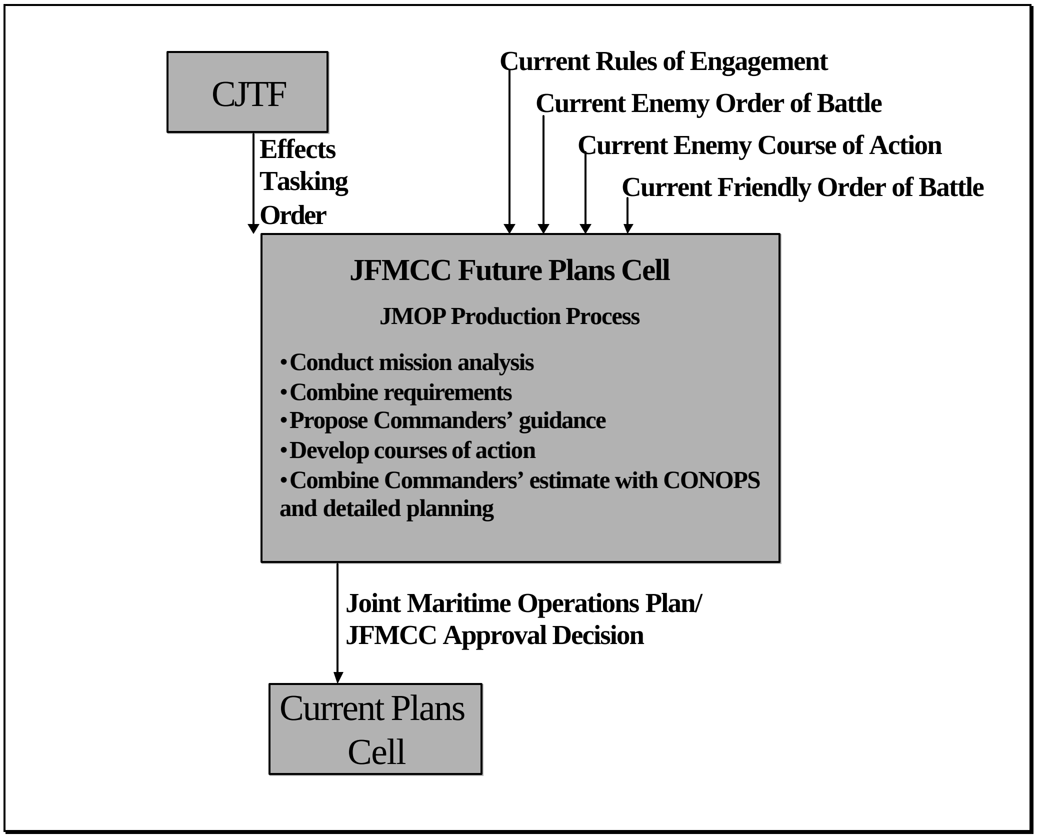

Figure 5-3. The Overall Maritime Operations Planning Process

The central "process box" from figure 5-3 can be further decomposed into discrete functions and information needs. Figure 5-4, below illustrates all of the required inputs for a complete MOD.

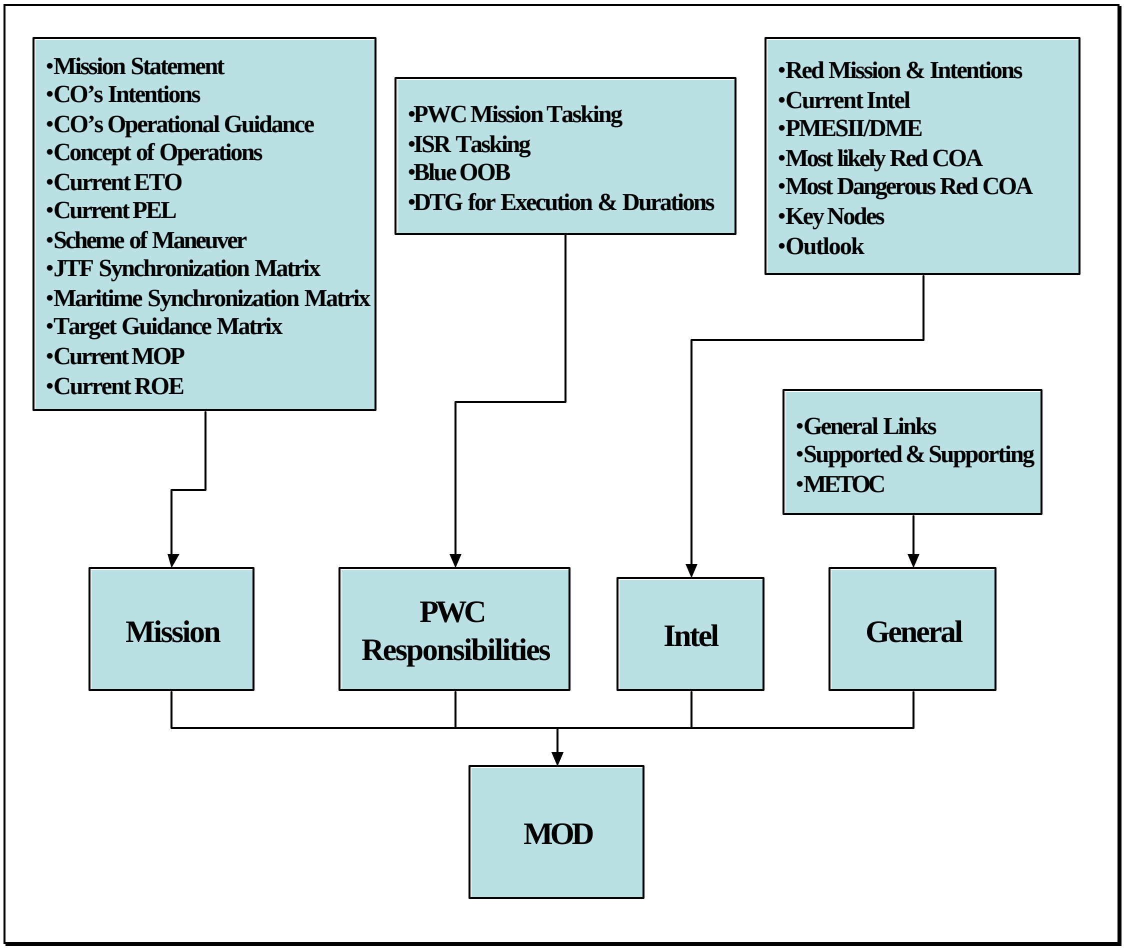

Figure 5-4. Input Requirements to the Maritime Operations Directive

<u>Manning</u>

Initially, the future planning cell was challenged to complete the MOD in a timely fashion. MOD briefs were extremely concise (1 PowerPoint quad chart). On 25 July, the FPC created a deliberate planning group (DPG). Its purpose was to assist the FPC in the definition of COAs for executing various tasks. These included WME destruction and attack of the disputed islands in the scenario.

Workload with respect to MOD production elicited comments such as this from the FPC Chief: "For MOD development, I was underutilized. The MOD (could) potentially be a sub-cell within the current planning cell. I spent a majority of my time doing collaborative planning with the JTF."[9]

From the logistics planner within the FPC: "As logistics planner, I had lots of play in spiral 3 building TPFDD and deploying forces. However, during execution, logistics issues were not being addressed as part of the MOD. This is because PWCs were not articulating these up to me. The process I followed was simply to remind other FPC planners to ensure that logistics issues were considered. As a member of the logistics cell, I pushed current laydown and status of combat power for planning use. How much it was used I don't know. My logistics crystal ball was only clear during high-level briefings rather than at the PWC or JFMCC plans (level). Intelligence was put together from multiple sources and intel nodes to

[9] From survey of personnel, in response to the statement "Workload for my position is about right."

include targeting and effects/BDA. I used both the face to face and collaborative tools to form a predictive picture to insert into plans."

Other respondents reported negatively that their workload was not appropriate to their position, without amplifying information. The result of this survey is ambiguous. It cannot be determined from data that the workload is, or is not appropriate due to manning, or whether negative responses were indicating that they were under-employed. A more focused and controlled workflow analysis should be conducted, followed by execution in an experiment.

Information Content

Initially the MOD, as evidenced by the MOD briefings, did not contain sufficient information. It consisted of the following, presented in a single PowerPoint "quad chart" format:

- Section containing a geographic map of the exercise region with major OOB assets depicted
- Section outlining: objectives, desired effects, and component and PWC relationships
- Section outlining: PWC tasks
- Section setting forth concerns and issues, such as ROEs, asset allocations and shifts, etc.

Concern was expressed that the briefing did not present "clarity" and the impression was created that the JFMCC Plans Chief was in a “planning vacuum” and having difficulty getting a good view of the PWC’s 3-day outlook. Also there was little feedback on operations. It was decided to provide much more extensive information and also include a "current operations summary," which would provide situational awareness (SA) from the Principle Warfare Commander's perspective.

However, within the FPC the perspective with respect to applicability of MOD information was not consistently the same as within the CPC:[10]

"The MOD process still needs work. Lack of interface between FPC SMEs and PWCs (from the logistics perspective) perhaps affected this. (The) MOD had to balance being too specific with being too broad. Wanted the PWCs to have freedom to plan but within the bounds of the JFMCC intent/guidance."

The FPC Chief agreed, however, that: "(We) Tried to respond to (PWC) needs. Info was available either directly in the form or through links to files."

Finally, with regard to JFMCC structure (referring back to the overarching question), the MPP provided a structure within which to support the intent of the Joint ETO. That structure is incomplete, however, lacking firm definition of maritime operations directive process, as evidenced by the need to create the deliberate planning group early in experiment execution. Documentation of the baseline planning process does not show the full range of inputs to MOD production. It mentions only “Feedback and assessments, BDA, and Intel and data collection,” with nothing input from the joint planning process. The CONOPS describes the future planning cell and adds the effects tasking order as an input, while also discussing the MPP as a TACTICAL (vice OPERATIONAL) planning model, despite numerous references to JFMCC Planning as an operational level planning process. Additional structure regarding the interface between operational and tactical level planning and the role of the future planning cell is required.

Planning and reporting evolution demonstrated a need for the following information to be included in the MOD:

- Operations update

[10] Response to survey question: "The MOD has detail required for PWCs to initiate planning."

- From previous day, Mod K
    a. MOD K force protection map
    b. PWC tasking details
    c. PWC issues
- From SCC (Sea Combat Commander)
    a. SCC asset-to-mission allocation scheme
    b. SCC asset-to-mission allocation quad chart
    c. Maritime superiority metrics- last 24 hours' histogram
    d. Maritime superiority metrics- current histogram
    e. Maritime superiority metrics focus areas quad chart
- From ADC (Air Defense Coordinator)
    a. Air defense for island dispute details
    b. Defense of Alpha Islands map
    c. SOH vice escort details
    d. 3-ship strait patrol plan map
    e. 2-ship strait patrol plan map
- From IWC (Information Operations Warfare Commander)
    a. IWC MOD K06 details
- From STWCC (Strike Warfare Commander)
    a. STWCC MOD K06 details
- From AMWC (Amphibious Warfare Commander)
    a. AMWC MOD K06 details
- From MIWC (Mine Warfare Commander)
    a. Q-route map of the exercise area undergoing mine clearing ops
    b. Second Q-route map of the exercise area undergoing mine clearing ops
    c. "RECOMMEND CONOPS APPROVED"
    d. "PROJECTED THREAT UPDATE"
    e. Projected operational CJTF-S threat graph
    f. JFMCC weight of effort list
    g. Force protection map
    h. PWC tasking details
    i. Issues details

Producing this quantity of information increases PWC inter-collaboration and planning and increases time spent preparing situational awareness overviews for JFMCC.

All evolutions during the experiment indicated the need for additional resources if MPP is to be a viable process.

The MOD needs to describe the JFMCC desires rather than present only a list of priorities.

<u>Timeliness</u>

The current planning cell doesn't add the appropriate timely value to the direction given by the MOD. They do not have the tools, information, or personnel to understand what changes are necessary to react to current events. The MMAP becomes a sequential manifestation of the MOD.

> "JFMCMIWSME2 to MIWC and SCC: MARSUPREQ shell for B28 has been created.... the MARSUPREQs for B28 MOD are not due till 2100 tomorrow but we need your intent of operations for 28 Jul by 2100 tonight.... MARSUPREQ inputs for A27 MOD will close out at 2100.

> Anything you want changed for today or tomorrow ops must be handled through the operations cell."[11]

> "JFMCMIWSME2: I'll be reviewing the MARSUPREQs for B28 now to interpret your plan for 28th.... our next time deadline here is any hard target nominations you want ISO C29 MOD which was briefed at noon in aud 112."[12]

> "JFMCMIWSME2: Please rework your target nomination for MOD D30 using the Target Nomination Matrix found on JFMCC home page --> Warfighting --> Targets...our understanding here is that the raids will be helo born and this will be a requirement for follow-on logistics MIW line 293"[13]

> "JFMCMIWSME2: One other item on F01--I left 1805 as one mission of 2 rhibs since they were going to the same location.... your MOD slide was very useful and it's the image for the MMAP brief at 0530. MIW 530"[14]

> "I was the cell chief. I reviewed the MOD for approval. To get it ready, I led off the process by developing the Commanders Intent on a daily basis. This started of the daily cycle. We had an internal rhythm that culminated at noon each day with a MOD approval briefing."[15]

The current friendly order of battle (Blue force list) was never up-to-date with all available assets at game start or updated when assets were lost. MIWC was conducting covert ops long before tasked but would not have been able to support the war if done with the MOD timeline. The MOD never stipulated what not to do.

Collaboration

Processes within the MPP matured as participants learned to coordinate and collaborate tasks in the course of the experiment. It was noted in participant comments that the CPC, FPC and MTO production leads were competent at communicating with each other from the beginning.

> "The cells act somewhat independently while producing their specific products, but the output of one cell is the input to the next. The leads were good at hashing-out, and explaining to their watch-teams, details of the MOD, the MMAP, and the MTO so that the transfer of the plan from one cell to the next plan went well."

As expected, there were points of conflict between the different process nodes in the MPP. However, meetings between principles ironed out difficulties as operations progressed:

> "There is too much ambiguity in the amphibious MOD process since JFLCC isn't following the JFMCC process. The amphibious warfare FPC LNO is not clear on how to best deal with the (individual needs between the) PWC (the AMWC) and JFLCC. They will meet at 0600 on 27 Jul to refine their process."[16]

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[11] Excerpted from IWC chat files for 25 July.
[12] Excerpted from IWC chat files for 26 July.
[13] Line 293 of MIW chat files for 27 July.
[14] Line 530 of MIW chat for 31 July
[15] FPC Cell Chief observation in survey
[16] Comment from From the JFLCC Amphibious warfare LNO.

Synchronization

A deliberate planning group (DPG) was established to assist the FPC to consider, in greater depth and detail, multiple courses of actions (COA). The intent overall was to improve internal JFMCC planning and to try to better understand the needs of the supported PWC. This innovation to the process in the course of experiment execution resulted from participant perspectives that the organization and capabilities of the baseline FPC was too heavily tasked and too inexperienced, to properly consider numerous COAs while creating the MOD in a 24 hour cycle. Also, the Current Plans Chief asserted not having this as part of the MPP process amounted to a fundamental flaw in the baseline MPP. Leadership of this group was provided by a participant dedicated specifically to this task, with inputs provided by, PWCs, their subject matter experts as require, and LNOs. A 1900 daily DPG briefing was added to the battle-rhythm schedule, as part of the FPC.

Initially the DPG cell was tasked to concentrate on COAs for employment of potential weapons of mass effect and campaign plans concerning the disputed islands included as part of the scenario (operations to be conducted in day D+3). Additional DPG responsibilities were established:

- Provide early coordination for deliberate planning efforts identified at JFC and JFMCC levels.
- Provide an organized set of products to help the FPC "look" three days in advance, with respect to specified tasks, assumptions and limitations of COAs, missions, mission analysis, recommendations, and threats.

Although the intent matched a perceived process requirement, the DPG was not provided any additional tools to perform the functions required. It is also not clear that if provided an adequate COA analysis capability, that the FPC would still require the DPG as a function apart from the FPC, or whether those functions could be absorbed within the FPC. At the very least, the experiment provided this additional requirement to the MPP.
Commentary by FPC participant:

> "The DPG is just getting moving. They are working on COAs for WME and the attack of the disputed islands. They (DPG) may have arrived too late in the game to be effective for this particular attack plan. The attack plans for WME and the disputed islands are to be executed around D+3 (30 July), so they have little, if any, time to consider options and give inputs to the FPC before the FPC begins the MOD process. FPC is working MOD C, for 29 July, on the 26th, and MOD D, for 30 July, on the 27th. The DPG has only a few dedicated workers, and the rest of the team is pulled from SMEs and LNOs from the FPC and the CPC. These people are already working issues with the PWC in their capacity as members of the FPC and the CPC. The DPG adds the additional task of having the same PWCs develop CONOPS for optional plans that are more than three days from execution. They are not necessarily over tasking the PWC, who is also fighting the war, but the DPG must be careful in keeping straight current plans, future plans, and potential future plans when they are discussing these over the phone with the PWCs."[17]

> Of note in the above commentary is the multiple tasking of personnel to roles as PWC subject matter experts, to the FPC, and to the DPG. Difficulty for individuals to maintain task identification without ambiguity between these roles is an issue for further human factors experimentation. Specific instances of task ambiguity, mis-identification or confusion were not observed directly. It is also unknown whether the DPG was, or was not tasked to capacity in the course of the experiment.

[17] From JFMCC observer report and participant comments, 26 July.

MOD

> "The JFMCC plan cell (FPC, CPC, and MTO) completed the first full cycle of MTO production - from MOD A27, published by the FPC on 24 Jul, through MTO production and MTO-ATO merge on 26 Jul. I believe the process went surprisingly smooth. The CPC watch leads drove the current-plan cycle well, kept their subgroups pointed in the right direction, and established and met periodic deadlines for the interim steps of the planning process (target noms, msrs from PWCs, MMAP production). In Lcdr Evart's words, he feels the watch team is operating at a "high school JV" level, when they need to be operating at a college, div-I, level. The watchstanders are certainly still coming up to speed with the JFMCC planning process, but they are doing it quickly."[18]

5.5.2 MARSUPREQ Production Process

The maritime support requests list assets submitted by the maritime service components and subordinate commanders to the JFMCC to accomplish the maritime tasks in the MOD. A current planning cell (CPC) combined tasks from the MOD, mission plans from the PWCs that are submitted in MARSUPREQs, and current tactical environment to develop prioritized tasks, scheme of maneuver, apportionment and desired effects for the coming 48 hours.

In this experiment the CPC was co-located with the FPC on the 5th deck of USS Coronado. It comprised a CPC Director, subject matter experts from each principal warfare area, joint subject matter experts from USAF (TACAIR, bomber, strike and ISR), an offensive coordinator for information operations, an ISR coordinator, and a knowledge officer.

As with the FPC, data collection in this process was focused on the in-flow of information to the membership (architecture, usefulness, timeliness, validity) to support decision-making that contributes to collation of MARSUPREQs. Also, at this level of the JFMCC process, the PWCs are enabled to collaborate between themselves to coordinate resources and plans. This cross-collaboration is critical to the success of the process. Data collection with respect to collaboration sought to determine the scope of the collaboration required for each PWC or SME, and other members of the CPC and FPC.

The following figure shows the process elements required to produce a MARSUPREQ.

[18] Ibid

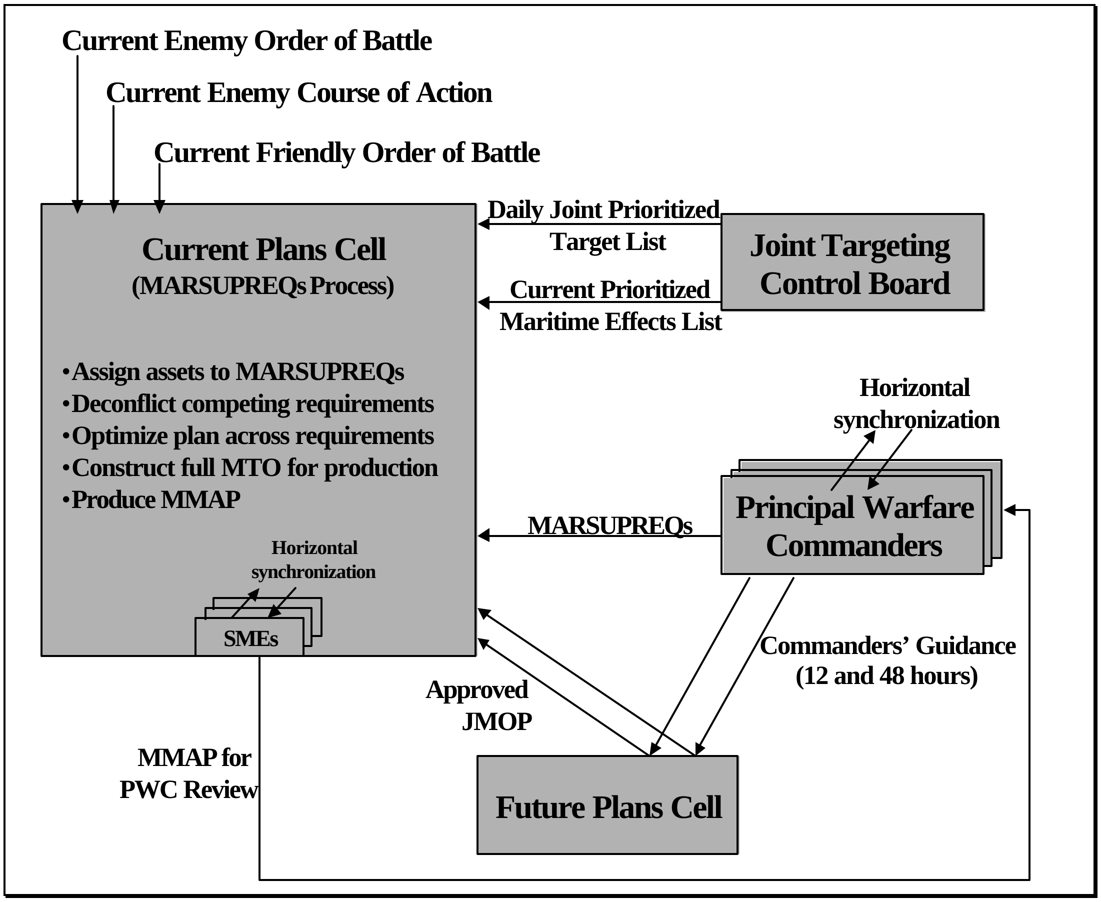


Figure 5-5. Process Elements Required to Produce a MARSUPREQ

<u>Dynamic Re-Planning</u>

As the process is currently structured, the FPC and CPC cannot participate in planning for the current day or for tomorrow. MARSUPREQs for execution on D-3 must be submitted by 2100 on D-2. This means they cannot use today's execution results in their planning process. After 2100 on D-2 all changes to an MARSUPREQ become part of the execution process, handled by the operations cell. This results in planning inconsistencies and inefficiencies.

There is a shift (by design) from the deliberate planning process (fed by MARSUPREQ's and coordinated through the current planning cell) and the execution process (fed by LAWS/ADOCS and coordinated through the MOC). MW125s are NOT appropriate as a tasking methodology in this concept because of the dynamic nature of asset-to-PWC relationships. What needs to occur is an integration of MEDAL with a COA or mission rehearsal tool to facilitate the deliberate planning process, as well as the operation of the LAWS/ADOCS part of the execution process. These two "air gaps" would then be bridged by automation tools to connect the COP (MEDAL for MIW) to the deliberate planning process on the one hand, and the execution process on the other.

Dynamic re-planning is an unresolved problem in MPP.

Process Efficiency and Manpower

The following are comments extracted from surveys of participants:[19]

> "Lack of promulgation of information such as Q-routes, times of assaults, areas around islands need by AMWC, the planning part of the MARSUPREQ was done mostly in a vacuum. One suggestion for future experimentation is to put a person and the tools from each of the PWC cells directly with the JFMCC and do all of the future plans at the JFMCC level."
>
> "MIW is so dynamic that the MARSUPREQ process was difficult to incorporate. The only way to work with the MARSUPREQ process would be to incorporate a system that would allow changes throughout the three-day timeline. I think the process increases the workload on the staffs. Not only do you have to do MARSUPREQ's but you also have to do the old way of tasking."
>
> "MARSUPREQ and MMAP database was not match with what was loaded in TBMCS...all UUVs were absent from TBMCS and were all virtually gamed.... improve this by turning MARSUPREQs directly into TBMCS (the procedure did not look that difficult), thereby eliminating MMAPs."
>
> "It doesn't allow for short notice task easily. It appears that it has caused more work. MIW is a very slow process that changes quickly. It is hard to make accurate plan three days in advance when as more data is gathered the plan constantly changes, and with each mirror change there was a mountain of MARSUPREQ to do. It seems that it would be easier if the MARSUPREQ were more flexible."
>
> "As was played in FBE-J/MC02, the MARSUPREQ submission-to-platform execution process was manpower intensive and ended up taking too much of the staff's time when it could have been better spent developing COAs in NMWS, evaluating the choices, and selecting one to support the MARSUPREQ submission. Because the MARSUPREQ submission itself took so long, that could not be done. The MARSUPREQ format itself was also manpower intensive. Some time could be cut if the PWC could have the ability to save MARSUPREQ shells and could merely select or cut and paste to fill out the basic parameters required for the platform."
>
> "MARSUPREQ forms would work better for MIW if it was used in conjunction with GCCS-M posit windows. For instance, if you selected a ship in GCCS-M and its update window appeared, it would be nice to have an option for MARSUPREQ for that specific unit. You should also be able to use MARSUPREQS in the same format as CASREPS, CASCORS, and CASCANS. This would provide up to date and accurate info with regards to dynamic changes in MIW."
>
> "We had to work around MARSUPREQS with opnotes and phone calls due to the increase of dynamic planning."

In figure 5-6, below, the number of MARSUPREQs submitted by each Principle Warfare Commander is compared for each experiment execution day, beginning with "Series A" and ending with "Series 010." It is obvious that this is a large number, too large to be handled efficiently and allow for the needed collaboration by the manpower that was available.

[19] FBE-J Qualitative Survey, Mine Warfare – New Survey, Questions 1 and 2

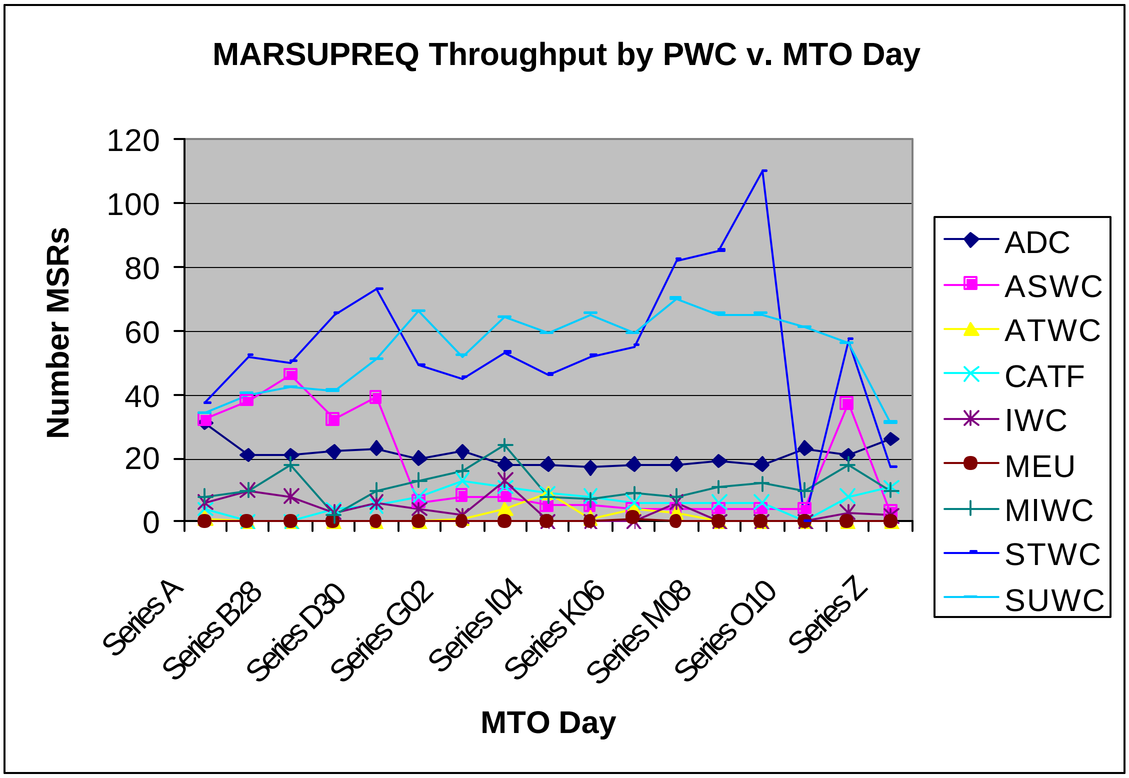


Figure 5-6. Comparison of the Number of Maritime Support Requests by Principle Warfare Commander

5.5.3 Master Maritime Attack Plan (MMAP) Production Process

The MMAP is a compilation of tasks from the MOD and MARSUPREQs, shaped by the current tactical dynamics of the battlespace, to develop a prioritization of tasks, scheme of maneuver, apportionment, and the desired effects for the next 48 hours of the operation. Figure 5-7 depicts this process.

> "The JTF 72-hour planning cycle is more than a decade old. This cycle is driven by three key events: the joint guidance, apportionment, and targeting (JGAT) board, MAAP / MMAP, and ATO/MTO production. There are many efforts to reduce this time line in order to be more responsive. The strike or interdiction missions appear to be the long pole in the tent. There appears to be no requirement to hold missions that do not require a 72-hour planning cycle, such as defensive counter air (DCA), close air support (CAS), undersea warfare (USW), surface warfare (SUW), etc. to such a long lead time. The ability to schedule missions with short planning timelines in the MTO is probably a requirement for the MPP. Changes to the MTO were apparently infrequently made to align with changing plans or ships out of action."[20]

[20] Debrief comments by MTO Production Coordinator

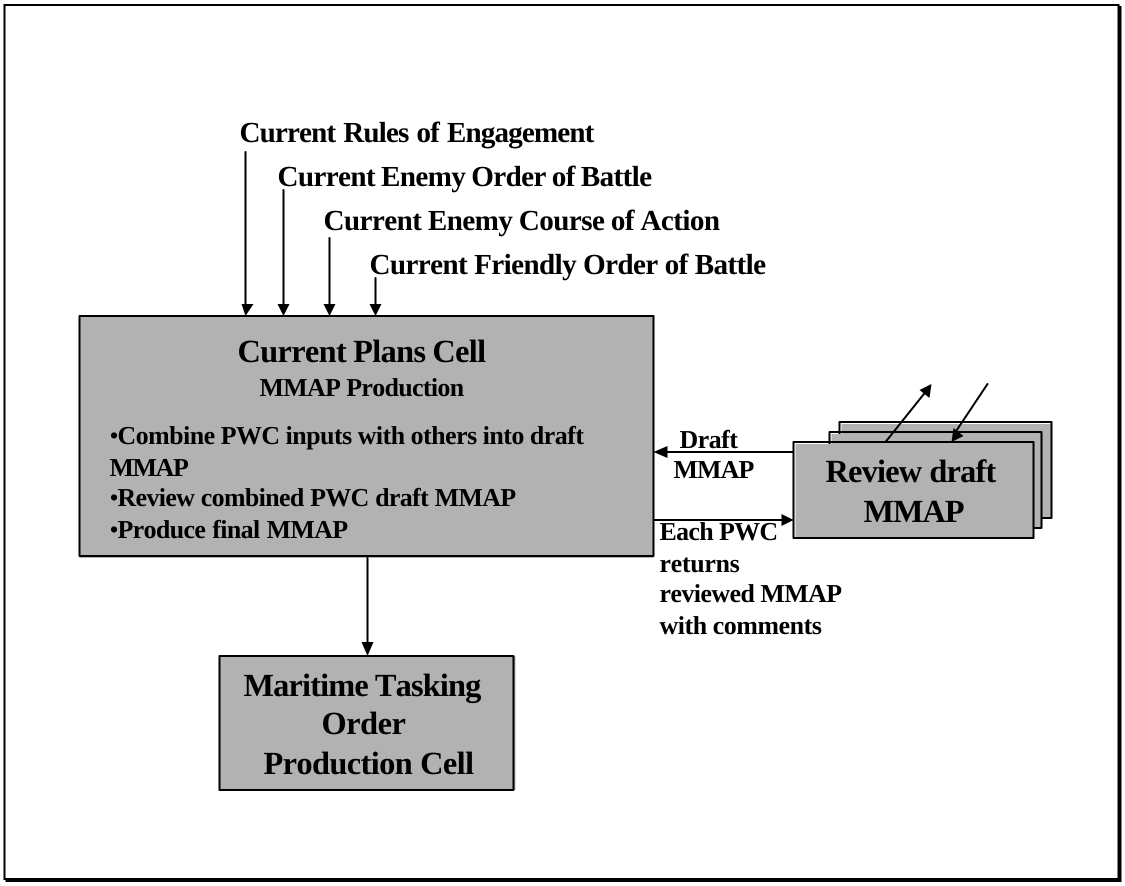


Figure 5-7. Master Maritime Production Plan Production Process

"The (MMAP) brief did not support (JFMCC) SA - (JFMCC) comes in at 0525, grabs a cup of coffee, shows up at MMAP brief (which concerns plans for 48 hours ahead), and tries to get situational awareness. There was nothing presented to him at the beginning of the MMAP brief to connect where we are to what's coming down the road. Plans (not clear if this is Future or current planning cell Chief) eventually presented some slides that brought the admiral some SA, which were useful to him. JFMCC stated his requirement that the PWCs give him an overall picture of their intentions, and how those fit in the plan to support JFMCC and JFC objectives. Recreating SA in the morning may be an artificiality of the experiment, since the Admiral is not living and breathing the battle 24 hours a day, but is conducting other business." [21]

[21] Observer notes from 1 August 2002.

5.5.4 Maritime Tasking Order (MTO) Production Process

The MTO provides a means to task specific missions related to maritime forces and maritime operations. It also may be used to disseminate projected sorties/capabilities/forces against targets to components, subordinate units, and command and control agencies. Specifics such as call signs, targets, controlling agencies, and general instructions are included. Some of the specific maritime missions and sorties included in the MTO may duplicate other component commanders' task orders. To publish the maritime tasking order in FBE Juliet, the USMTF ATO 2000 format was used to merge the MTO and ATO, providing the CJTF with a single, searchable database of all maritime and aerospace missions within the Joint operations area. Figure 5-8 depicts this process.

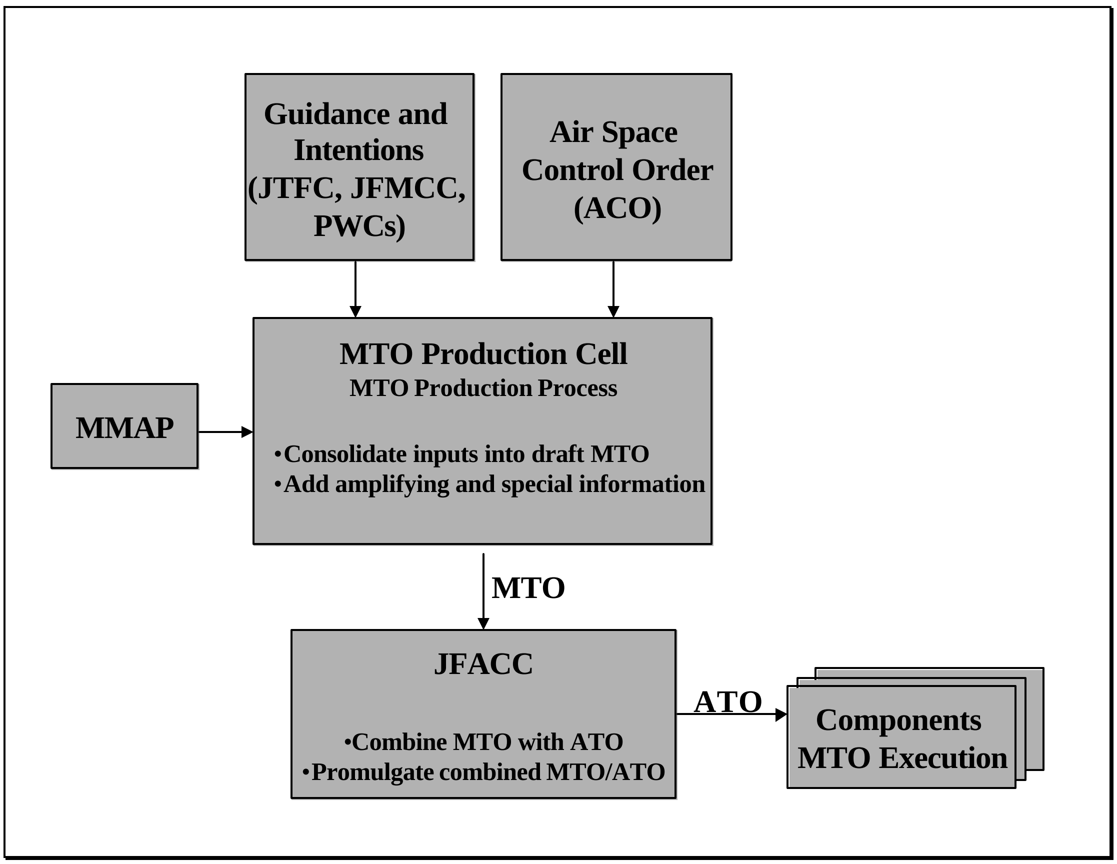


Figure 5-8. The Maritime Tasking Order Production Process

5.5.5 MPP Synchronization, Manpower, and Production Quality

This subsection focuses on only processes within the MPP. It is a rollup of the principal points presented in the former sections concerning the various production processes. These are only processes internal to JFMCC. Following this is a brief subsection on interaction with the JFC and the ETO process in MC02.

The MPP is a set of tightly linked sub-processes that cannot be carried out completely sequentially and must be well coordinated. In addition, there are three production cycles going on simultaneously which further complicates matters. In order for this overall process to work and to produce a plan of high quality, the following considerations must be addressed:

a. The number of people needed for each sub-process to produce its product within the required time

b. Alternately, the time required to produce a quality product given constraints on the number of people available for that subtask

c. The total number of people required for the MPP and how multi-tasking can keep that number within acceptable bounds

d. Synchronization of people and product timelines so that multi-tasking is viable

e. Skills needed for required tasks and individual multi-skill-set requirements to enable multi-tasking

f. Synchronization of information needed to produce the various products and of the products along the production timeline.

Consideration f, above, may seem redundant with d but it is listed because of the need to synchronize with information from the execution phase, which in a sense is outside the planning cycle. Actually, the issue of how to use information from execution in a deliberate planning process is one of the challenges because of the inherently asynchronous nature of feedback from execution.

The following figures illustrate the synchronization challenge. Figure 5-9 shows the observed MPP timeline for production of the MTO/ATO combined product to be executed on day 8. This timeline is generalized in figure 5-10 to show parallel timelines for simultaneous multi-MTO production.

The following discussion focuses on the production of the MOD, MMAP, MARSUPREQs, and MTO to illustrate the basic production problems that occurred in the MPP. It is not definitive with regard to details of personnel use and the status of the various products as functions of time. Sufficient information is not available for that level of detail. There is enough information however, to identify the basic roadblocks that occurred within the MPP process.

In the following descriptions the underlying assumption is that future planning cell personnel have a single task, creation of the MOD, and that the current planning cell and the PWCs share some of the same SMEs. This means that there is multi-tasking for production of the MMAP, MTO, and MARSUPREQs. The above is not strictly true, but it is close enough to reality to illustrate the basic design and illuminate adjustments that need to be made to the JFMCC and the MPP.

Example Planning Battle Rhythm

	05Aug02 (J05)	06Aug02 (K06)	07Aug02 (L07)	08Aug02 (M08)
0530	MMAP Brief (K06)	MMAP Brief (L07)	MMAP Brief (M08)	MMAP Brief (N09)
0600	Execute MTO (J05)	Execute MTO (K06)	Execute MTO (L07)	Execute MTO (M08)
0600	JGAT (L07)	JGAT (M08)	JGAT (N09)	JGAT (O10)
0800	ISR Changes Due (K06)	ISR Changes Due (L07)	ISR Changes Due (M08)	ISR Changes Due (N09)
0800	ISR Requests in (L07)	ISR Requests in (M08)	ISR Requests in (N09)	ISR Requests in (O10)
1200	MOD Approval Brief (M08)	MOD Approval Brief (N09)	MOD Approval Brief (O10)	MOD Approval Brief (P11)
1300	Begin MOD creation (N09)	Begin MOD creation (O10)	Begin MOD creation (P11)	Begin MOD creation (Q12)
1500	MTO to JFACC (K06)	MTO to JFACC (L07)	MTO to JFACC (M08)	MTO to JFACC (N09)
1630	TGT Noms Due (M08)	TGT Noms Due (N09)	TGT Noms Due (O10)	TGT Noms Due (P11)
2100	MSR's Due (L07)	MSR's Due (M08)	MSR's Due (N09)	MSR's Due (O10)
2130	Create MMAP Shell (M08)	Create MMAP Shell (N09)	Create MMAP Shell (O10)	Create MMAP Shell (P11)
2200	Create MMAP Brief (L07)	Create MMAP Brief (M08)	Create MMAP Brief (N09)	Create MMAP Brief (O10)

Figure 5-9. Scheduling of Time During Production of an M/ATO to Execute on 8 August

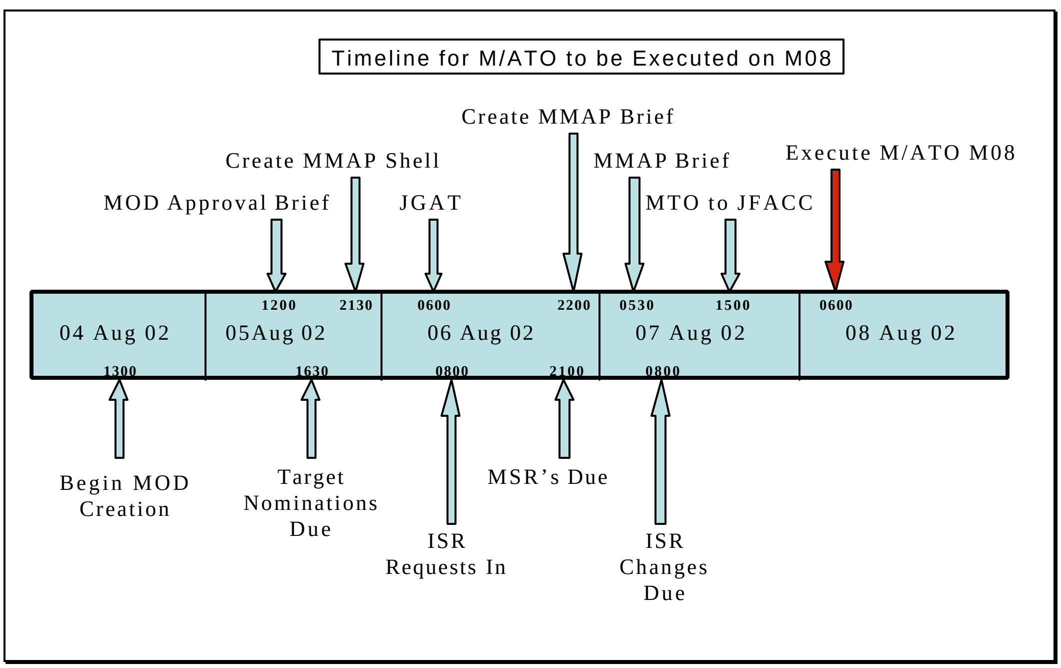


Figure 5-10. Summary Timeline for a Single M/ATO To Execute on 8 August

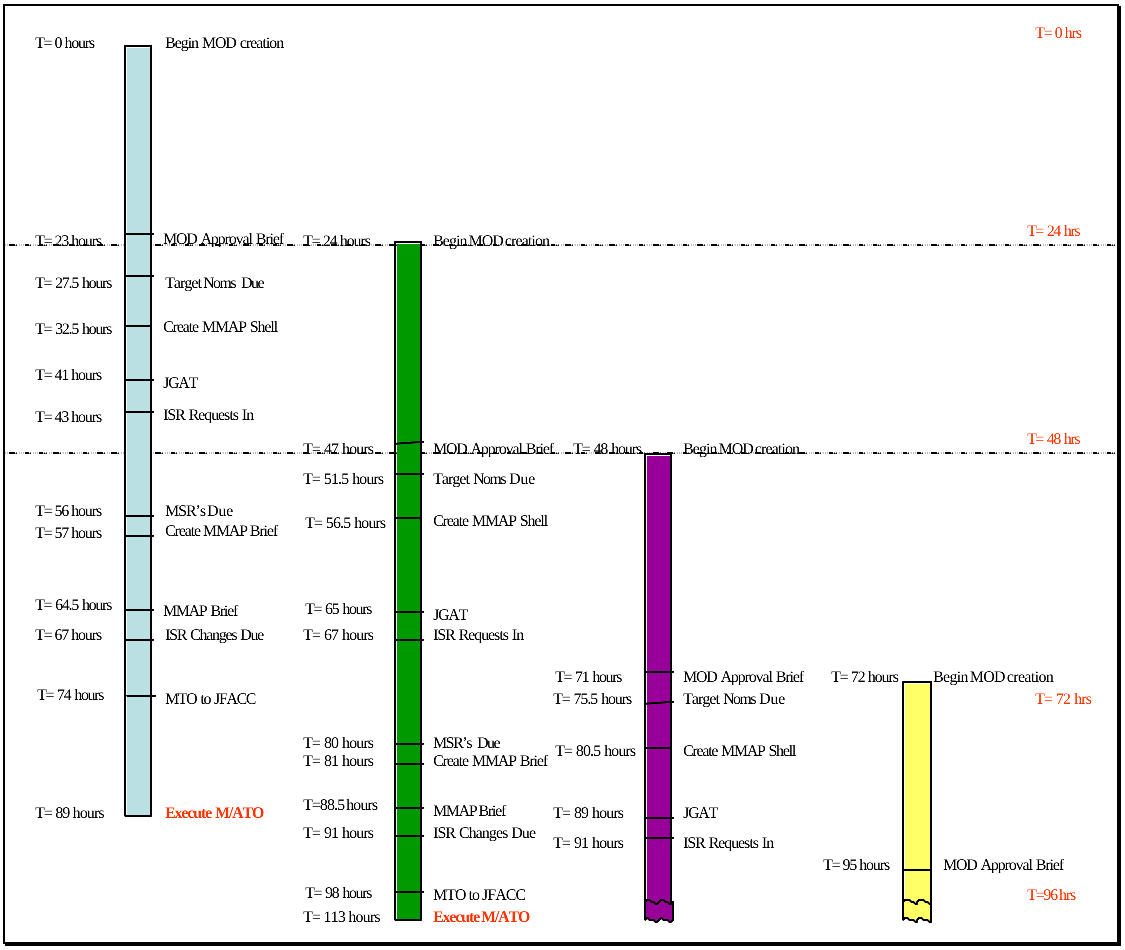


Figure 5-11. The M/ATO Parallel Production Process

The overall process of activity is shown in figure 5-9 and generalized in figure 5-10 to a single M/ATO. Figure 5-11 provides another perspective to show the parallel activity by MOD.

Figure 5-12 shows only the outline of production processes of interest to the analysis. This also shows the elapsed times involved in each item's production rather than the times at which actions and items within the process are due. Each bar at the bottom of the figure represents 24 hours.

The production processes that are shadowed share personnel. The figure shows that three productions are commonly going on at the same time. The results found in FBE-J were that some products took too long to produce, some products were only small revisions of what had been produced formerly, and some products were incomplete. (See former JFMCC personnel comments in this section.)

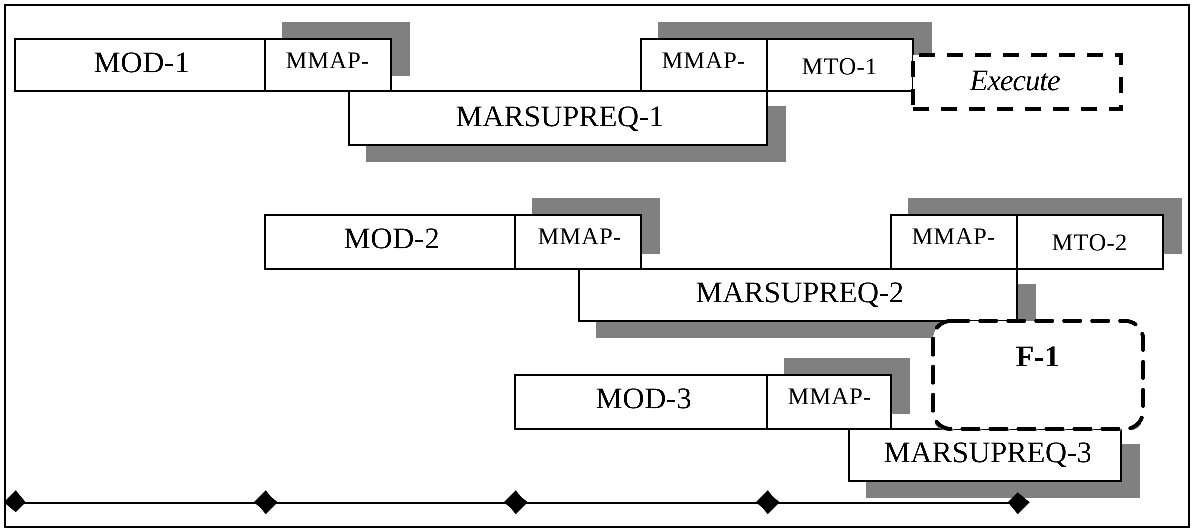


Figure 5-12. Production Cycles for M/ATO

The solution to this production problem is to schedule work such that production processes are segmented, with the segments coordinated. This implies that needed information is available and the appropriate SMEs are in place. This coordination requires a high degree of synchronization.

The block titled F-1 in figure 5-12 indicates the first time that feedback from the execution of MOD-1 would be available. After this time, feedback will always be available as long as execution assessments are being made. Thus, they would normally be available during the MOD process beginning on day four. As indicated in former sections, such feedback was little used during the planning process; used only by the execution cell. This leads to obvious planning inefficiencies.

The synchronization of execution assessment feedback is an issue because it is available both semi-continuously and aperiodically. As the process is presently structured, it cannot accept feedback at any time during the planning process to effectively consider it in planning. This means that there must bean improved process would incorporate a means to synchronize execution feedback with the rhythm of planning. An effects cell that accumulates, assesses, bundles, and distributes the results to appropriate planning functions at appropriate times could do this. These functions could provide not only proper information phasing but also a better product. This process is generically illustrated in figure 5-13.

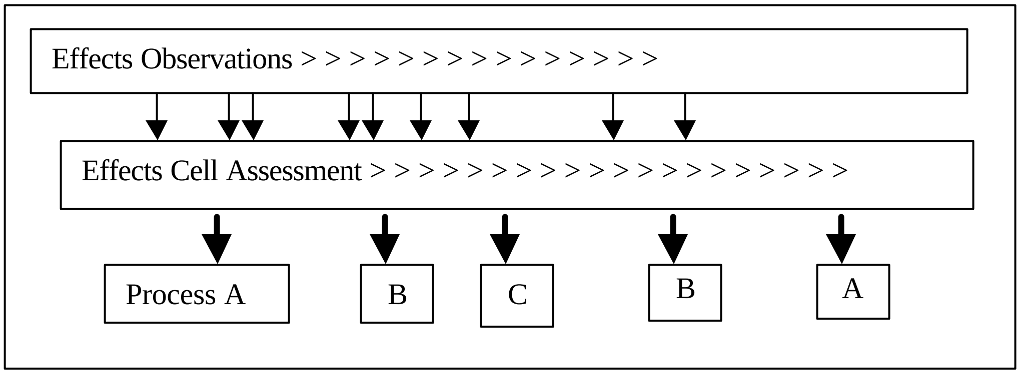


Figure 5-13. A Generic Synchronization Process for Efficient Feedback

The light arrows indicate asynchronous input from effects observations. The heavy arrows indicate scheduled input to the various planning cells. A crucial aspect of this assessment process is not just scheduled inputs to planning, but that planning has a scheduled process for using this input.

5.6 Decision Support and Planning Tools

5.6.1 Maritime Asset Optimization Tool (MAOT)

Experimentation results from FBEs Hotel and India showed that visualization of assets, and the optimization of those assets in response to the environment and planning, needs to be available directly to the MPP. This becomes part of the MPP's ability to plan, adapt and re-plan dynamically. In FBE Hotel, the visualization was a vertical paper map, on a magnetic board that supported magnetic bits representing different assets for PWCs' use. FBE India attempted use of a "Knowledge Wall," and other electronic means. Neither was useful as an "optimization" which is the principle on which the JFMCC MPP is based: Optimal planning is the efficient use of multi-capable platforms in a dynamic environment.

An optimization tool was proposed, and some development work accomplished prior to FBE Juliet. One of these projects included the use of a process model, identifying "use cases," but not optimizing the assets. Although work continues on the problem, no useful tool for optimization was employed in the experiment, leaving the MPP with another significant decision-making hole in the planning process.

5.6.2 JFMCC – JFC Coordination in Effects-Based Operations

The ETO is the output of the JFC produced in collaboration with functional commanders and reachback cells at the CINC's headquarters, supporting CINCs, and external agencies. ETO development is a continuous and highly interactive process between the plans team, component commands, and the executing organizations. The ETO expresses the intent of the JFC in terms of missions assigned to appropriate functional commanders to achieve specific effects and outcomes. After it is developed, the ETO is passed to components. At the component level the ETO is articulated in component plans. The JFMCC is responsible for the articulation of maritime plans that support the ETO.

In essence, the ETO and MTO processes are the same. ETO is at the JFC level and MTO at the JFMCC level. All of the above results and comments with respect to MPP thus might also apply to the ETO process. A component of the JFC, the Standing Joint Force Headquarters, has an effects assessment cell, the purpose of which is to modify the ETO in response to execution effects.

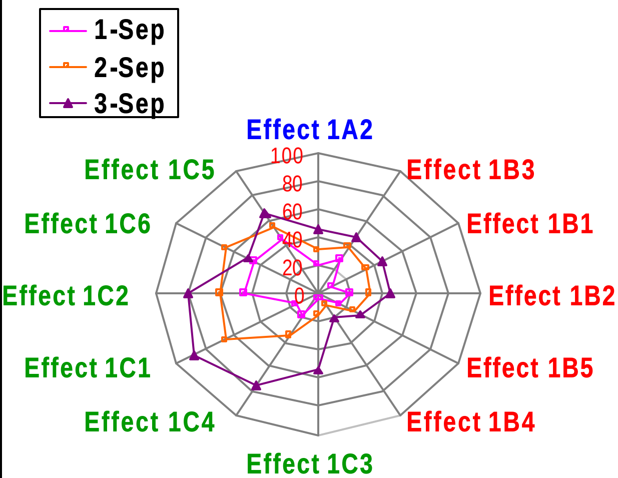
In general, there was little observed connection between the priorities of the MPP process and the effects that the ETO was seeking.

5.6.3 Theater Assessment Profiling System and Valuated State Space (TAPS-VSS)

TAPS-VSS is a visual display coupled with a logic engine that enables staff members from any component, CJTF, or CINC to view measures of effectiveness and performance throughout all aspects of the battlespace in a relevant context. The display also provides for visualizing the planned effects progression on the enemy, and tracks unintended consequences in the JOA and beyond. This capability is web-based and functions as a thin client, allowing web-accessed users at each workstation to view and "drill down" within the data to reveal relevant issues about the battlespace. TAPS-VSS is built in close coordination with deliberate planning staff activities (COA development process). As conditions in the battlespace change, metrics can be adjusted, added, or removed -as needed. TAPS-VSS is designed as an effects-based process medium that enables a self-briefing capability. This allows staffs to discontinue the time-consuming practice of capturing disparate information, and then having to build presentation slides manually. As a decision support tool, TAPS-VSS is able to portray both objective and subjective information in a relevant display for any environment where the initial state or condition is understood.

For display, TAPS-VSS produced "spider-diagrams" of the battlespace. Defining selected measures of the battlespace to be "vectors" which all emanate from the center of a graph produces a diagram similar to a sunburst. Quantifying measures of effectiveness related to each of the vectors produces a point along each respective vector. When all such points along their vectors are connected, a diagram that resembles a spider web is produced. Its purpose is to graphically depict the aggregate of a campaign's effectiveness in meeting the effects tasking, from which the measures of effectives were drawn. This roll-up of information was intended to produce situational awareness for the JFMCC, and to allow feedback to planners in the form of Commander's Guidance, that would then realign the boundaries of the state space. In other words, if it became apparent that (as an example) "degrade enemy C2" was not meeting effectiveness measures, then conceivably the Commander could then give more definitive and focused guidance to improve the effectiveness of this portion of the campaign.

An example of TAPS-VSS diagram is shown in figure 5-14.



- Effect 1A2: Red does not take action to impede shipping.
- Effect 1B3: Red does not conduct fishing operations in disputed area.
- Effect 1B1: Red loses prestige on world stage.
- Effect 1B2: Red populace denounces government actions.
- Effect 1B5: Morale in Red Navy is degraded.
- Effect B4: Red Navy lacks will to engage Blue Naval forces.
- Effect 1C3: Blue gains international support for actions against Red.
- Effect 1C4: Red loses international support and "moral high ground".
- Effect 1C1: Red populace lacks will to enter conflict with Blue.
- Effect 1C2: Red unable to conduct import/export operations.
- Effect 1C6: Red unable to operate from disputed area.

Figure 5-14. Example TAPS-VSS Diagram.

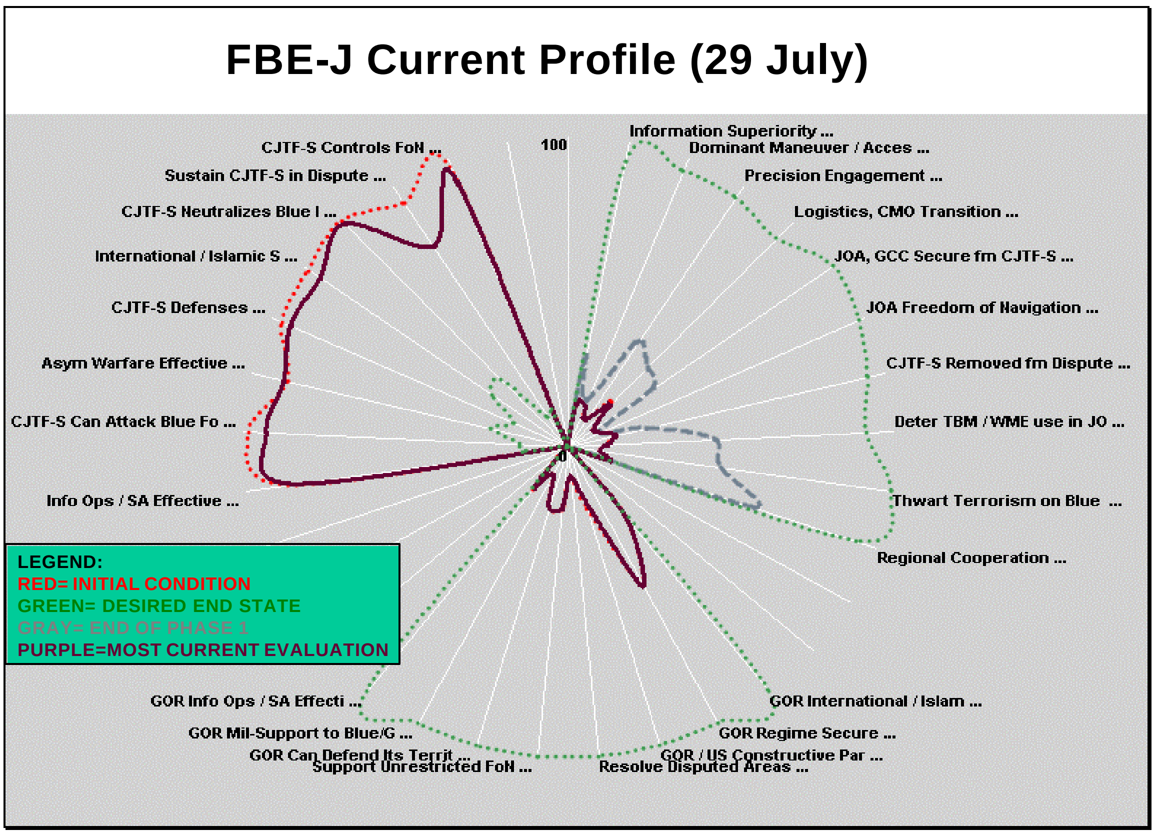


Figure 5-15. TAPS Current Display During FBE-J

TAPS-VSS Observations

The TAPS-VSS display in figure 5-15 was presented to the JFMCC on 29 July, as part of the maritime operations directive brief. It was provided in response the JFMCC's request from the previous day that metrics be associated with warfare tasks, in order to build a day-to-day situational awareness for decision making. The initial conditions are in red, and the desired end state is the green dashed line. The gray line shows the state of the previous day's actions on the state space. Purple depicts the analysis of damage to the enemy to date.

Although the vector displays could be opened by clicking a cursor over each of them, thereby opening high-resolution definitions of the measures of effectiveness and performance, this was not accomplished in the course of the brief. Also, while the slide above depicts the environment for the Commander v. Red state space, another TAPS-VSS display was created to specifically show the environment of Blue.

Neither display was useful to the JFMCC however. "This may be an OK tool for gauging long term effects, but it fails miserably as a day to day tool," was a common perception. There were, however, contributing factors that are related to this view of TAPS-VSS in FBE J:

- TAPS-VSS was not integrated into the process for decision-making through the spiral process. Therefore, there was limited understanding of its intended use and potential utility. This fact was amplified by the JFMCC request for MOEs and MOPs, which are included in this model, but were not judged to be useful, because they were not immediately visible.

- TAPS-VSS was essentially a visualization of effects. However, there were many indications that coupling between the high level effects tasking order (ETO), the prioritized effects list (PEL) and the maritime planning process (MPP) was not close (i.e., little direct relationship between each). As a result, there was little perceived need for information at this level.

- As the experiment continued, there was a continually perceived need for the JFMCC to interact with information at the tactical level. TAPS-VSS is neither designed nor suited to supporting the tactical level. Rather, it is suited to providing high-level situation awareness, with the intent of assisting in the development of the Commander’s Guidance.

In future experimentation, it is advisable to bring this capability to bear throughout experiment definition. This is an extremely information rich tool, and requires training of the operators and decision makers in translation and entry of information relevant to the associated measures for each vector. It also requires very close coupling between an idealized effects-based campaign, and guidance for future intentions that can be turned into plans through the MPP.

5.6.4 Web-Based Tools

Information and a comprehensive discussion on a range of collaborative tools, including those that supported the JFMCC MPP, are contained in Chapter 15 and Appendix 5. Information on network loading is contained in Appendix 9.

SharePoint Portal Server (SPPS) was a knowledge management success. The right data got to the right user at the right time. Specifically, the data could be found (search capabilities), the data was the most current (no other versions), and the data was authoritative (could be trusted). MC02/FBE-J may be the first exercise to use a customizable web portal as a single source of data for storage and retrieval. SPPS was the one collaborative tool where Warfare Commanders or groups could publish and take ownership of their data for JFMCC-wide use. Figure 5-16 depicts the usage of this resource.

The data from hit counters shows that in the first few days of the experiment, each major page received 250 to 1000 hits per day as users explored the portals content. Subsequently, there was a steady decline to approximately 100 hits per page per day. Indications were that users were figuring out where to find the data they needed and were spending less time "surfing". During this same time there was an increasing use of the search page starting at about 500 hits per day and increasing to over 1000 hits per day. It appears this was because users became more familiar with the search functionality and found it faster than "surfing."

An important caveat to this success is that the JFMCC portal was not a real-time system. Its data often lagged the battlespace action by hours, unlike IWS, ADOCS, and GCCS, which were actively used in prosecuting the action. SPPS contained analysis and "knowledge" that reflected long-term trends and where the JFMCC was headed.

SPPS has several drawbacks that would need to be addressed prior to implementing it operationally:

- Configuration control was difficult to maintain. The functionality demonstrated on the JFMCC site required the modification of several core SPPS files, which required extensive familiarity with the program so as not to lose data.

- Standard tools for managing security should be developed. Managing security is labor intensive and without tools, interest in maintenance soon wanes.

- SPPS should be integrated with other collaborative tools. Users typically worked in either SPPS or IWS, but not both. There would be value in linking these two programs and in linking SPPS with other collaborative programs.

- More and better documentation is needed to realize the full potential of this program.

Information and a comprehensive discussion on collaborative tools, including those that supported the JFMCC MPP, are contained in Chapter 15 and Appendix 5. Information on network loading is contained in Appendix 9.

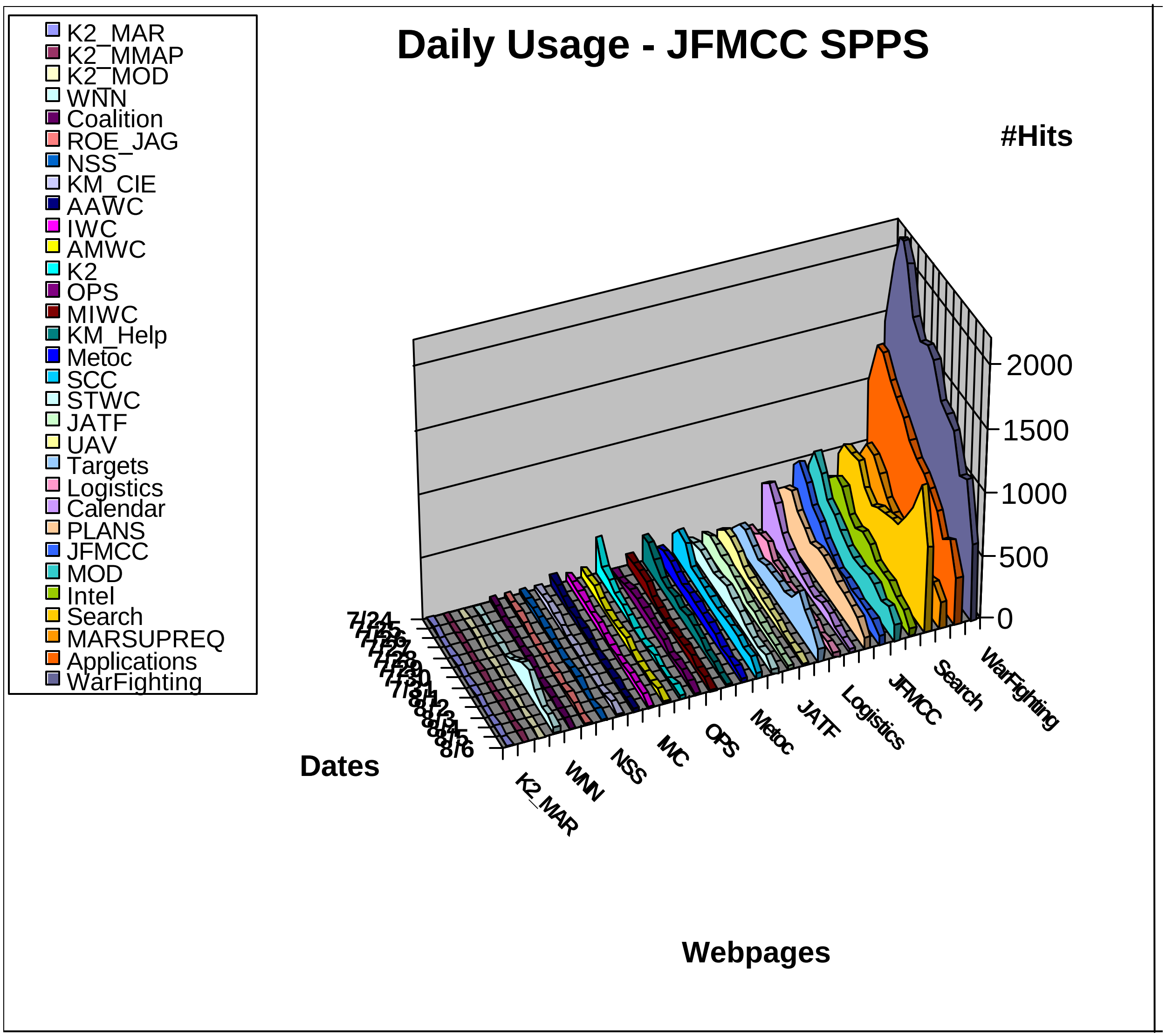


Figure 5-16. Daily Usage of JFMCC SharePoint Portal Server

5.6.5 Knowledge Kinetics (K2)

There was little visibility and utilization of K2 from the JFMCC lead's perspective. In concept, K2 was to provide a visualization of the status of the JFMCC process for JFMCC support personnel to monitor. The concept of a process workflow tool is sound; but use of the tool was minimal. It is also possible that the use of a linear workflow tool modeled on a linear workflow is inappropriate.

> "K2 was limited in it's ability to monitor the (JFMCC) process because the process was envisioned as a linear sequence of events and in actuality was composed of a number of parallel events that took place in a sporadic manner. Thus when the completion of a part of the K2 flowchart was

> entered, it was the culmination of a number of events and the details were not captured. So, what was envisioned as a linear process became a series of overlapping parallel tasks, leading to a final result."[22]

In many cases, some of the sub-processes were never completed if the information was not needed or was not available when the product was required. Additional information on the integration of workflow tools in the dynamic environment of military operations needs to be developed.

Dynamic evolution of the JFMCC process throughout the experiment also limited K2 use. The flow diagram used by K2 was the experiment baseline for the JFMCC process. A principle of the experiment was to prototype by improving the process in-stride. However, the K2 flow diagram did not evolve. The tool was more suited to mature process workflows vice experimental ones. As the JFMCC process matured and changed, the less representative the K2 flow diagrams became. Post experiment web site analysis shows that the K2 website had over 600 hits. It is possible that the majority of these system inquiries were from technology monitoring and not process utilization. No evidence is available that the technology was used in anywhere in the MPP.

Although there were a large number of new tools to be used in the experiments, there was no formal K2 training for any of the JFMCC staff. Due to the already high learning curve, the JFMCC staff was not likely to be interested in further training in support tools.

Knowledge Kinetics Observations, Opinions, and Recommendations

- *Process*. K2 may be useful if applied to a mature process, or if adequate time and effort are expended to evolve K2 flow diagrams to accurately represent processes.

- *Detail.* K2 must have enough detail to adequately represent the processes it will be used to control.

- *Visibility*. To be useful the tool would have to be visible to users, available and readily understood in its application. K2 was not included in spiral development, with consequences for user visibility and training. While the K2 server was tested technically on Spiral 3, there was no user/functional use.

- *Documentation*. Make documentation readily available to the users.

- *Training*. Train the users. If the tool is visualized to be part of the process, the tool should be shown in the process.

- *Overall Evaluation.* Although process visualization, monitoring, and control, as implemented by the K2 tool, may be a good objective and a possible requirement for complex process control, it’s application to the JFMCC process was incomplete, premature, immature, and less than successful.

5.6.6 Naval Simulation System (NSS)

The basic experiment design of the NSS demonstration in FBE Juliet was to locate the simulation capability at the JFMCC CPC and FPC (onboard USS CORONADO), at the Sea Combat Commander (SCC), located ashore at Fleet Combat Training Center, Pacific, and at China Lake in support of the

[22] Observer report by web developer SME

Strike Warfare Commander. The intent was to take inputs of current information, possible courses of action by decision makers, and simulation MOEs to produce the most likely COA for execution. This was to be done within the time span that would necessitate course of action analysis be available in preparation for deconfliction of MARSUPREQs that would contribute to producing the MMAP, and the production of the best possible MTO.

> "NSS participated in previous Fleet Battle Experiments (FBEs) and Wargames, most recently Global '01, where it supported the Naval Forces (NAVFOR) Commander and provided a course of action analysis (COAA) capability. Based in part from the successes achieved at Global '01, NSS was a late add-on into FBE-J to test its capability as a planning and decision support tool for the Joint Forces Maritime Component Commander (JFMCC) and Principal Warfare Commander (PWC) within the maritime planning process (MPP). FBE-J represents the first in a series of planned NSS-FBE integration events. Data from post-experiment analysis will be used to help determine what capabilities or deficiencies exist with NSS as a JFMCC/PWC planning and decision support tool. Furthermore, post-experiment analysis will help to focus development on refining and expanding NSS capabilities so that the tool will better support the JFMCC/PWC planners in the MPP during FBEs K/L."[23]

> "At the JFMCC level, the parser did not function to the level expected due to software problems, again causing a backup of data. This problem caused the NSS analyst to [perform] a man-hour intensive crunching of data, and only allowed the NSS tool to complete the single task of deconfliction of the MARSUPREQs for the entire duration of the experiment."[24]

Also, due to TMS database problems, NSS was not able to fully integrate itself in the planning process at the Strike Warfare Commander. However, working in parallel, NSS was able to produce candidate plans for weapon-to-target pairing to support strike missions.

A proposed stepwise process to fit within the MPP battle-rhythm was developed for the experiment. The following are elements of that process. (A full description is available in the NSS Final Report cited in the footnotes):

1. PWC receives the MOD
2. NSS used by PWC to develop metrics and help in determining the most appropriate COA for upcoming 24-72 hours.
3. NSS operator simulates each COA, using reachback capability for computational support if required.
4. PWC produces candidate plan, which is a shell for the MARSUPREQs to be submitted in the next 24-72 hours.
5. NSS Analyst reviews results with the PWC planners, allowing them to visualize the their plan. The planner can choose to either accept the plan or modify and send back to NSS for another round of simulations based on the feedback received.
6. PWC accepts the chosen iteration with desired results and inputs the finalized MARSUPREQs into the JFMCC web tool.
7. NSS Analyst aboard the USS Coronado downloads all PWCs MARSUPREQs from the JFMCC web tool to NSS program. NSS automatically determines a variety of different conflict types (primarily time, distance, and mission).
8. Conflicts are brought to JFMCC planner's attention, who manually adjust conflicts (in collaboration with the PWCs) and modify the final draft plan.

[23] SPAWAR PMW 153 "Final Report, NSS in Fleet Battle Experiment Juliet," 03 September 2002.
[24] Page 5, ibid

9. The deconflicted and synchronized MARSUPREQs from the PWCs are submitted for MMAP production.

The majority of NSS objectives in FBE Juliet were not conclusive. Technical problems described above prevented full inclusion of the simulation within the processes for planning and analysis of plans. However, some individual successes were attained, primarily by providing weapon to target pairing for STWC, and in the SCC.

Details of SCC interactions with NSS are more fully described in the PMW 153 Final Report. In general, some COA analysis was performed, and as relationships between the NSS analyst and decision makers matured, the NSS analyst was able to begin "tuning" of the simulation to meet SCC needs, and there are instances in which innovative approaches were established to improve results. The following vignette is an example:

> "Country Red's primary threats were high speed small boats (swarm attack) CDCM, specifically mobile C-802 launchers. The liaison officer and NSS analyst had collected Red Force small boat data, and assessed this threat against a variety of assets via previous simulations and were able to re-use a good portion of it for this scenario. From these previous simulations, the planners had learned that to reduce the impact of the small boat swarm it was important to have early warning to the threat launch so that they could be engaged while still in tight formation, in this way AC-130 or helo assets were most effective in eliminating the threat. If the small boat swarm was allowed to disperse, the effectiveness of single asset defenses went down significantly. Intel confirmed that Red Forces would most probably launch small boat swarms in 20-30 boat strengths, 3-6 (Boghammer, PTG) of which would have CDCM launcher capability and the remaining would be Boston Whaler type boats to provide OTH CDCM positioning for shore-based launchers. Merchants would be escorted both ways through the SOH. Through simple time-speed-distance calculation we found that in one day only two transits could be accomplished (a round trip took approximately 20 hours). That meant that the planners had to find out how many merchants could be protected by the DDG at one time."

NSS represents both technology and process. To fully understand its contribution to defining courses of action, within the maritime planning process, both the MPP and NSS will need to be mature, and stable within an experiment. In this experiment, the MPP was executed for the purpose of furthering understanding of process, meaning that the process is not yet mature. Few of the participants had full appreciation for the use of the range of tools that were at hand, and therefore did not extend to any greater degree the utility of real-time simulation for decision-making embodied in NSS. Success at the SCC, however, indicates the road ahead for future NSS development.

It is recommended that MPP process modeling be conducted, with NSS functionality contributing as a single process. From here, the process model should be further refined to include the details of NSS integration into the process, in parallel with stabilizing its technical difficulties.

5.7 Modeling the Interaction Between MPP and ETO

To support post-experiment analysis and the development of recommendations for planning process improvements for inclusion in future experiments, a simulation of the maritime planning process exercised during FBE-J was developed.

5.7.1 FBE-J Maritime Planning Process Simulation

The FBE-J MPP simulation models the execution of the seven-step planning process outlined above. The graphic below shows the top-level structure and functional outline of the model.[25] Each segment of the model contains a hierarchy of underlying logic to process, interconnect and execute the required sub-functions and information exchange.

Measures of effectiveness were calculated relating to MTO production, MARSUPREQ production, MMAP production, and overall resource staffing utilization.

5.7.2 Key Attributes:

In summary, the key attributes of the FBE-J MPP simulation are as listed below:

- Based on measured and observed data taken during FBE-Juliet
- Aligned with 72 hour cycle joint-service battle rhythm
- Accounts for resource constraints and staffing levels available to support plan development
- Accounts for interdependencies and feedback occurring between planning sub-processes
- Measures the flexibility of the overall planning process to accommodate change and re-planning required as a result of changes in the battlespace observed during plan execution

[25] The FBE-J MPP simulation was built using the commercially available Extend™ simulation software.

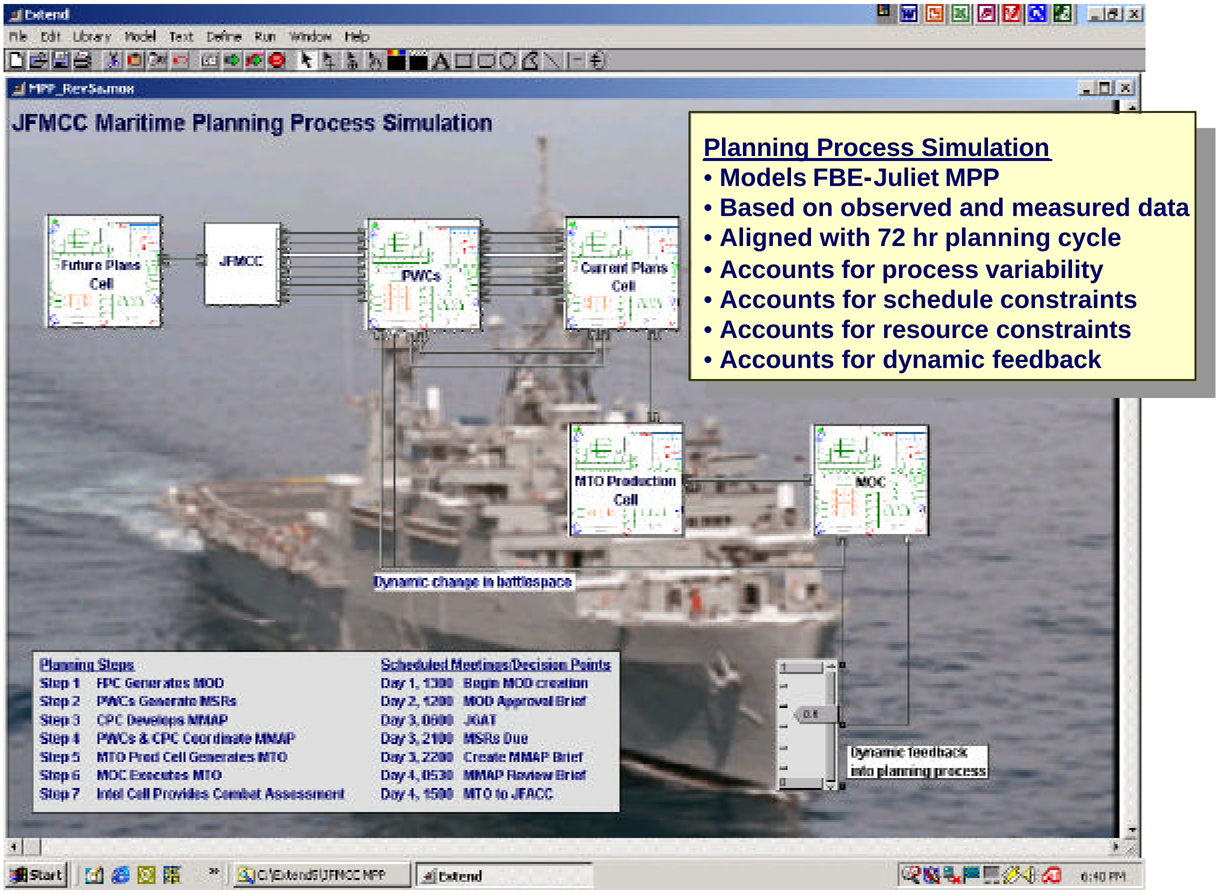


Figure 5-17. The JFMCC Maritime Planning Process Simulation

5.7.3 Input Parameters

Relevant input parameters were obtained for each warfare area from data observed in FBE-J.

5.7.4 Model Execution

The FBE-J MPP simulation is structured around the seven-step planning process described above and is aligned with the 72 hour battle rhythm depicted in Table 5-1 below. With respect to the results presented later within this document, the end objective is to measure the performance of the planning process used during FBE-J, and to identify those areas within the planning process that limited performance in order to develop recommended changes in the planning process and/or areas where technology insertion would be most effective.

The FBE-J simulation is intended to provide a baseline for comparing the relative value of future process, organization, and technology improvements, and to assist in the development of future planning process development and wargame design.

Example Planning Battle Rhythm

	05Aug02 (J05)	06Aug02 (K06)	07Aug02 (L07)	08Aug02 (M08)
0530	MMAP Brief (K06)	MMAP Brief (L07)	MMAP Brief (M08)	MMAP Brief (N09)
0600	Execute MTO (J05)	Execute MTO (K06)	Execute MTO (L07)	Execute MTO (M08)
0600	JGAT (L07)	JGAT (M08)	JGAT (N09)	JGAT (O10)
0800	ISR Changes Due (K06)	ISR Changes Due (L07)	ISR Changes Due (M08)	ISR Changes Due (N09)
0800	ISR Requests in (L07)	ISR Requests in (M08)	ISR Requests in (N09)	ISR Requests in (O10)
1200	MOD Approval Brief (M08)	MOD Approval Brief (N09)	MOD Approval Brief (O10)	MOD Approval Brief (P11)
1300	Begin MOD creation (N09)	Begin MOD creation (O10)	Begin MOD creation (P11)	Begin MOD creation (Q12)
1500	MTO to JFACC (K06)	MTO to JFACC (L07)	MTO to JFACC (M08)	MTO to JFACC (N09)
1630	TGT Noms Due (M08)	TGT Noms Due (N09)	TGT Noms Due (O10)	TGT Noms Due (P11)
2100	MSR's Due (L07)	MSR's Due (M08)	MSR's Due (N09)	MSR's Due (O10)
2130	Create MMAP Shell (M08)	Create MMAP Shell (N09)	Create MMAP Shell (O10)	Create MMAP Shell (P11)
2200	Create MMAP Brief (L07)	Create MMAP Brief (M08)	Create MMAP Brief (N09)	Create MMAP Brief (O10)

Table 5-1. The JFMCC MPP 72 hour planning cycle

Step One: Develop the MOD

The total timeline addressed within the simulation is measured from the time a given MOD cycle originates to the time at which the MTO is passed to the JFACC for joint coordination. The top-level module titled "Future Plans Cell" in figure 5-17 contains logic for modeling the development of the maritime operations directive. Within this module, an item is generated at 1300 hours daily corresponding to the beginning of a new MOD cycle as depicted in Table 5-1, above. Each day the beginning of a new MOD cycle was initiated while processing of the current and prior MOD cycles are on going. In this way, the model accounts for the fact that multiple MOD cycles are being processed simultaneously, each in various states of maturity. By running the simulation over an extended period of time it is possible to measure the performance of the system as observed over many MOD cycles.

As MODs are developed within future planning cells they are passed to the JFMCC module for approval. As indicated in table 5-1 above, JFMCC approval of a given MOD occurs as a result of a meeting held at 1200 hours the following day. The implication of this is that even though a MOD may be complete and ready for review, that review does not occur until the JFMCC approval meeting takes place. This is a good example of how the battle rhythm itself imposes a constraint on the process. The output of the approval meeting is either an approved or disapproved MOD. Approved MODs are passed downstream to the PWS module thereby triggering the initiation of the next step in the process. Disapproved MODs are returned to the future planning cell for revision and resent back to the JFMCC for approval. Revised MODs are assumed to receive immediate attention and are reviewed directly upon receipt. The fraction of MODs approved or disapproved is controlled within the simulation by means of a probability factor. In the baseline case, this factor is set at a 90% approval rate.

Step Two: Develop Maritime Support Requests
The module titled “PWCs” in figure 5-17, models the process of MARSUPREQ development performed by the staffs assigned to each primary warfare commander area.[26] The size of the staffs assigned to develop MARSUPREQs across each warfare area is controlled within the simulation by means of resource pools. These pools represent shifts of people that are allocated to perform various tasks, as available. In this way, we directly account for time delays resulting from a resource not being available at the current time to execute a given task because that resource is busy elsewhere. Tasks may be prioritized such that a lower priority activity may be stopped part way through if a higher priority job comes in. An additional load on the system is due to the fact that multiple MARSUPREQs corresponding to MOD cycles make are in work at any given time, but the pool of people available to process and/or revise the plans is fixed.

Within MARSUPREQ development, sub-process are defined for 1) initial MARSUPREQ generation, 2) MARSUPREQ coordination at the PWC level, and 3) MARSUPREQ revision and modification due to feedback from battle assessment. Each of these sub-processes are defined by the time it takes, on average, to perform the task and the personnel required to perform the task.[27] The percentage of MARSUPREQs that need to be modified or regenerated as a result of combat assessment or a change in commander’s intent is controlled by means of an input probability factor.

The number of MARSUPREQs generated and processed during FBE-J varied significantly across each warfare area. Figure 5-18 presents data collected during the experiment showing the number of MARSUPREQs processed during the course of the experiment.

[26] PWC staffs are divided between MIWC, STWC, SUWC, ASWC, ADC, IWC, and AMWC warfare missions.
[27] Distributions for the time it takes to perform a given task are input into the simulation based on measured and observed data taken from FBE-J post-experiment analysis

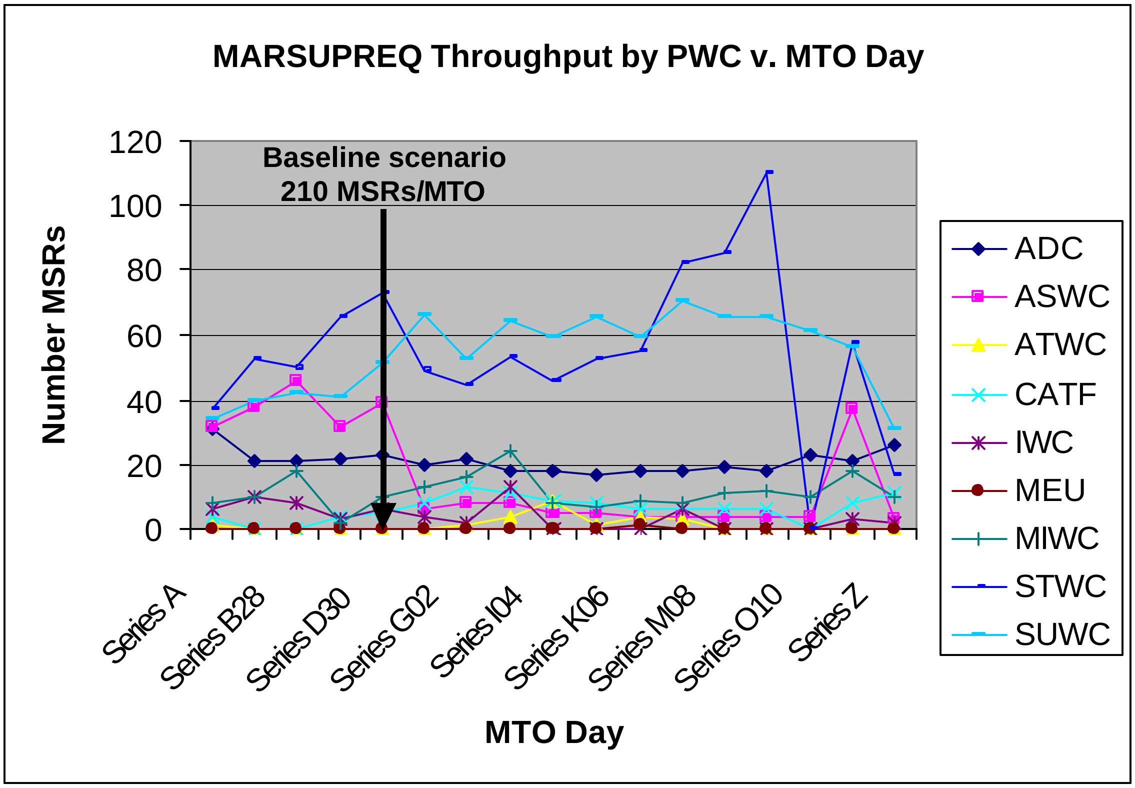


Figure 5-18. FBE-J MARSUPREQ Throughput by Warfare Area

For the purposes of baseline analysis, a MARSUPREQ generation rate corresponding to series D30 was chosen as a reference condition.

Referring to table 5-1, a battle rhythm related constraint imposed on the system was the MARSUPREQ cut-off time. For any given MOD cycle, MARSUPREQs would be accepted only up to a scheduled cut-off time. Approximately 32 hours was available from the time an MOD was approved until the time at which no more MARSUPREQs would be accepted. MARSUPREQs not fully processed by this time would not be included in the current corresponding master maritime attack plan (MMAP). Key metrics within the simulation include the number of MARSUPREQs generated within the prescribed timeline, and the variation in system performance due to changes in staff sizing, number of MARSUPREQs required, and other related parameters.

Steps Three and Four: Develop and Coordinate the Master Maritime Attack Plan

The module titled "Current Plans Cell" in figure 5-17, models the process of MMAP development, coordination, and adjudication. As MARSUPREQs are generated by each of the PWC staffs they are passed to the current planning cell for incorporation into a master maritime attack plan. Sub-functions are included to account for the:

- Initial review of incoming MARSUPREQs to determine if they are both complete and contain sufficient information
- Process of generating additional information, as required
- Process of loading the MARSUPREQs into the MMAP.

Within the simulation these sub-processes are modeled in terms of time delays and resources required. The MMAP is not complete until all MARSUPREQs have been incorporated.[28] Once the MARSUPREQs have been incorporated into the MMAP shell, the draft MMAP is passed back to the PWC staffs for coordination and approval. This coordination step takes additional time and imposes additional tasking on the PWC and CPC staffs.

Step Five: Develop the Maritime Tasking Order
Once the MMAP has been coordinated and finalized, it is passed to the MTO production cell responsible for developing the maritime tasking orders. As with the preceding steps, the time it takes to develop the MTO was characterized by random distributions selected based on data taken and observed during the actual experiment.

Steps Six and Seven: Execute the Maritime Tasking Order and Perform Combat Assessment
Modeling of the actual execution of the MTO and subsequent combat assessment was beyond the scope of the current effort. Rather, the focus here is in the planning process used to develop the maritime tasking orders. However, the ability of the system to respond to a requirement to re-plan missions and tasking orders based on combat assessment or other events was accounted for.

5.7.5 Sample Results

Results have been generated using the FBE-J simulation for comparison against actual data collected during the experiment and observation provided by personnel involved in the experiment.

The following charts provide a summary of top-level results. Five key top-level measures of effectiveness are presented:

- Time to develop the MTO
- Percent of MTOs developed within the required 72 hour planning cycle
- Percentage of MARSUPREQs generated and processed within required deadlines
- Loading and utilization levels for each of the warfare staffs.

Figure 5-19 presents the top-level total end-to-end timeline for developing the MTO. The x-axis of the chart represents scenario duration. Superimposed on the chart is the 72 hour threshold required by the battle rhythm in order for the MTO cycle to link up with the Air Force ATO cycle. While these results were generated over a long scenario duration, the input assumptions and scenario conditions were held fixed for any given run. In this way, the system is allowed to run over a long duration in order to achieve steady state and observed any changes over time for a given set of input parameters.

As evidenced in the results, the time taken to develop the MTO is increasing over time indicating an increasing backup in the overall process. Inspection of data generated within the simulation indicates that the current planning cell is the principal limiting constraint. This may be explained by recognizing that the FBE-J process evaluated had independent warfare area commanders, each of which were generating maritime support requests, that in turn were all sent to the CPC for final adjudication and incorporation within the MMAP. This planning cell represents a potential bottleneck in the overall process. The implication is that the MMAP production cell could not sustain these levels of MARSUPREQ generation rate over a sustained period of time. In fact, backups are predicted that will continue to increase over time.

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[28] The MMAP will only incorporate, at most, the number of MARSUPREQs generated by the CPC within the prescribed deadlines. In the event constraints in the system limit the number of MARSUPREQs generated, the resulting MMAP is considered incomplete. Thus one proposed metric related to the quality of a plan is the percentage of plan completeness.

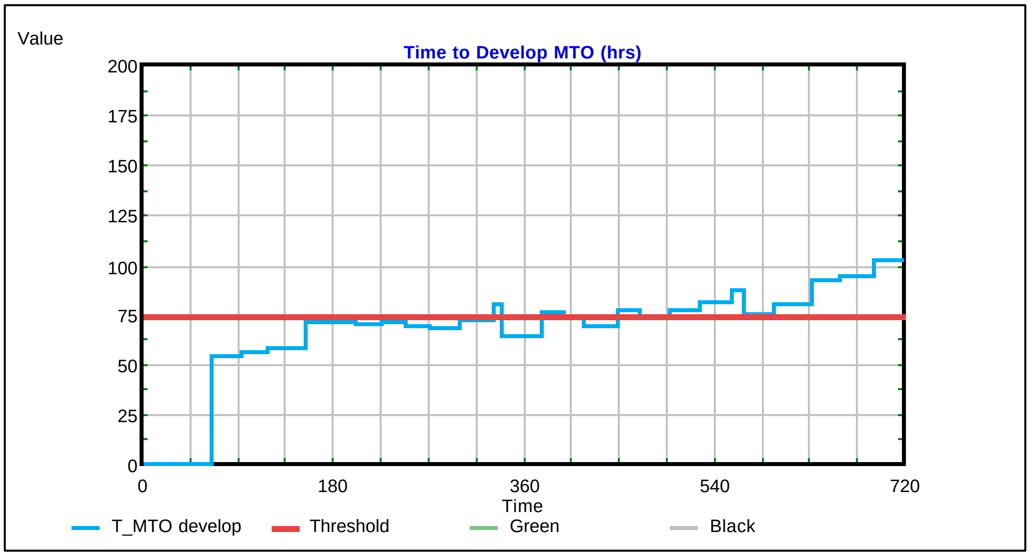

Figure 5-19. Model MTO Production Time

Figure 5-20 presents the corresponding fraction of MTOs generated within the required 72 hour deadline. As shown, the fraction of MTOs generated within the 72-hour deadline is decreasing over time due to the accumulating MARSUPREQ backlog during the MMAP production within the CPC.

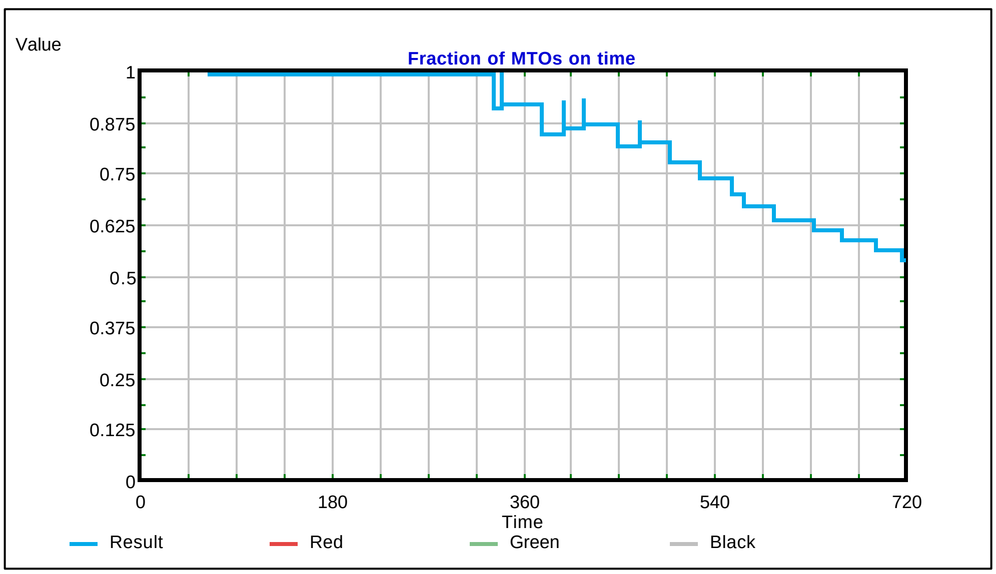

Figure 5-20 Fraction of MTOs Generated On Time

Figure 5-21 represents an example of the MARSUPREQ production capability of the PWC staff for the strike warfare area. Whereas each PWC area is assumed to generate its own set of MARSUPREQs, referring to Table 5-1 points out that in general, the Strike Warfare Commander has the most missions to execute. The jaggedness in the chart is due to the way the simulation generates the data contained in the plot. A design decision was made during model development to first set up a queue of items representing all the MARSUPREQs that would need to be generated by a given warfare area during a given MOD cycle, and then to work them off sequentially subject to loading levels and resources available. The correct interpretation of the chart is that for the baseline scenario parameters assumed, this warfare area was able to generate, process, and transmit to the CPC 100% of the required number of MARSUPREQs. However, it should be noted that after lengthy deliberation, the baseline set of assumptions made corresponds to a low requirement for MARSUPREQ cross-PWC coordination and a near-zero level of dynamic battle combat assessment inject back in to the planning process. Overall, post-experiment analysis and on-scene observation of the conduct of the experiment indicates that these assumptions best match what actually occurred during FBE-J. Subsequent simulation runs aimed at stressing the system both in terms of increased levels of collaboration and dynamic combat assessment feedback indicate the system would have experienced significant performance penalties under these higher stressing conditions.

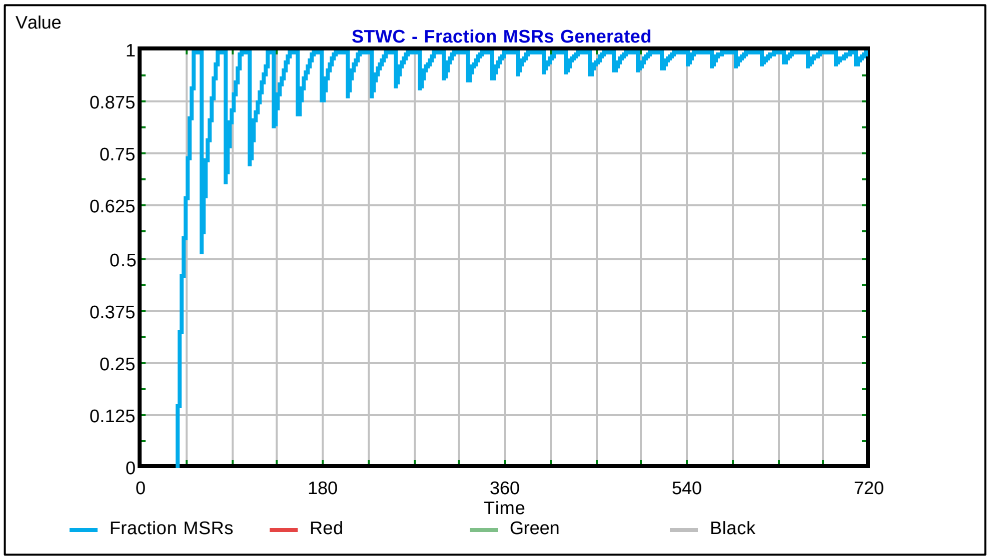

Figure 5-21 – Fraction of Strike Mission MARSUPREQS Generated Within the Planning Deadlines

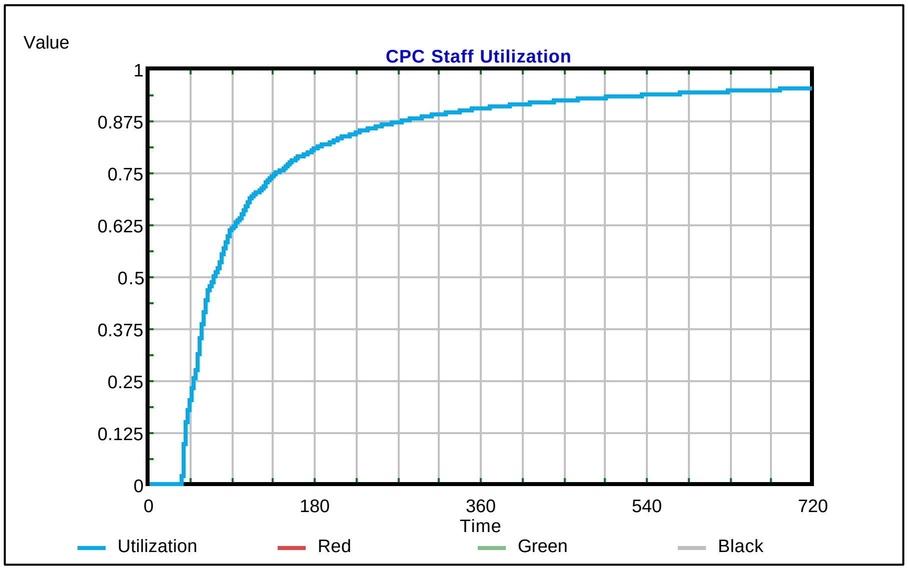

Figure 5-22. CPC Staff Utilization

Figure 5-22 shows the staff utilization rates associated with the current planning cell staff. This graphic reinforces the conclusion that this area is the principal bottleneck in the process. Average utilization rates approaching 100 percent are indicated. As a practical matter, it is generally assumed that people cannot sustain more than about 70 to 80 percent attention to a given set of tasks on a prolonged basis. The current simulation is optimistic in its treatment of staffing, in that it assumes for simplicity that all resources may be used up to 100 percent of the time on just the tasks they are allocated to. Not addressed in this treatment, are other ancillary activities that personnel might be engaged in at any given time.

5.8 JFMCC Maritime Planning Process Key Observations Summary

The overarching question FBE Juliet was intended to answer was:

- Does the JFMCC maritime planning process provide structure, organization, management, feedback, optimization and situational awareness to Maritime force employment and support the intent of a Joint effects tasking order (ETO)?

This question is too broad to consider as a single idea, requiring that it be decomposed to essential elements, or meanings for this experiment:

5.8.1 Structure

- This is the relation of information and knowledge systems to the MPP system.

InfoWorkSpace (IWS) provided an information system that was effective as a coordination means between MPP processes. Interfaces for use by personnel to interact within and between processes were useful and represented a step forward in collaborative information environment (CIE).

IWS architecture, although useful as described above, was also a limitation for the experiment, due to the architecture imposed and inability for direct IWS interactions between JFMCC MPP and JFCOM JFC staffs.

Knowledge Management organization was not effective as a means to conserve knowledge between processes. Instead, PowerPoint briefings on schedule aligned with battle rhythm provided cross-process awareness and understanding.

PWCs had the perspective that their warfighting expertise was not included in development of MPP products. For the most part, PWCs and SMEs had little direct interaction apart from MARSUPREQs. A result of this was questioning with respect to what level is the correct one in which warfighting expertise should be included in planning; at the PWC, where that competence is expected to reside, or at the MPP (future and current planning cells) through subject matter experts?

Co-location of FPC and CPC contributed to process effectiveness. The FPC Chief and CPC Chief routinely resolved issues and gained understanding of their combined efforts by constantly exchanging information and perspectives in an ongoing dialogue that would have been difficult to reproduce in IWS or briefings.

5.8.2 Organization

- Personnel and functional relationships, and how these contribute overall to the MPP.

The MPP is primarily accomplished by linear workflow, similar to assembly line process (although virtual) regulated by battle rhythm (process triggers are mostly initiated by clock and product) No clear relationship between other triggers, e.g., emergent PWC requirements.

There were ambiguous results with regard to manning levels and workload. Some participants felt the workload was appropriate, others that it was too high, and still others that it was too light. Further analysis needs to map workload to functional requirements in each role of the FPC, CPC and MTO production. Experiment design had artificial work-hours, which loaded workflow into fewer hours. A better design will allow workflow to be established by battlespace and PWC requirements.

Process synchronization, PWC synchronization and current operations synchronization were a challenge. Synchronization of interdependent processes was the most difficult task. The MTO was produced on a 72-hour cycle (or dependent on JTF battle-rhythm), with (possibly) three being in various stages of production at any one time. During execution of an MTO, results obtained (damage assessments) impact the planning of subsequent actions. These results must be inserted at an appropriate point in planning, at the correct time, or planning process components must be adaptable to modifications at any time. Battle damage assessment is the primary feedback from current operations.

Time scales of maritime warfare areas may be quite different. This affects the planning timeline for each warfare area, and ultimately leads to cascading change in the MTO.

The synchronization of maritime and JTF targeting cycle is enhanced by the MTO. However, this is both blessing and curse. Lack of feedback makes working effectively within the targeting cycle problematic, which contributes to cascading change in MTO and relationship to Joint missions.

Deconfliction management must be improved. Planning by PWCs occurs in parallel. However missions may require multi-tasking of the same assets. Adjudication and coordination between PWCs is required. Collaboration between PWCs was made possible by IWS, although there was little allocation collaboration required. It was not clear throughout the experiment what was already being used, was planned to be used, or unavailable for other reasons. Asset levels and use of assets could be determined by reviewing MARSUPREQs and MTO/ATO, however, this was a lengthy process in itself. In either case, planned synchronization of processes must occur. Alternatively, a more rapid process could be temporarily halted until a slower process reached the asset deconfliction point.

5.8.3 Management

- The MPP as a C2 function, internal and external synchronization, management of planning functions.

FPC and PWCs: PWCs report the MOD did not have sufficient information for them to conduct planning, and hence place added burden at the PWC level to do this. It is not clear that this is a result of the process or the experiment (operational and other information may have not been of sufficient depth for FPC to produce what was perceived to be needed by the PWCs).

There is continued confusion with regard to OPCON and TACON. This resulted in some confusion on the employment of organic assets by PWCs.

Changes to the M/ATO were not possible within the experiment organization. Change was a function of the maritime operations cell, contributing to potential overload of those personnel, technologies and processes.

MPP afforded increased planning participation by Joint Forces in maritime mission planning.

MPP created a common lexicon between joint planners, which increased coordination.

A standardized MTO and ATO should allow greater sharing of assets to missions, and lowered misunderstandings between component warfare commanders. Ultimately, this theoretically contributed to higher degree of combat synchronization across all components, with an implication for improved combat power. However, it is also not possible to prove any of this at this time.

5.8.4 Feedback

- Information as feedback of different kinds, and levels, that contributes to organization management and process control at the operational level.

The MPP MARSUPREQs by PWCs to the CPC for development of MMAP and ultimate output of the maritime tasking order (MTO) does not offer enough flexibility to be effective in an environment where own force assets and enemy targets are continually moving. Continuous updates and changes to produce agility of the process, and account for MTO execution requires significant internal feedback processes. The experiment did not provide feedback possibilities (low level of BDA, for example), and internal processes to use feedback to change MTO within the production process were not developed.

5.8.5 Optimization of Resources

- As a potential measure of its utility, the MPP as a whole would be expected to merge together battlespace situational awareness with asset planning in an optimized plan.

Optimization tools were not available for use by the PWCs, their SMEs or decision makers within the process.

Accountability of assets was difficult to determine, which had direct impact on any requirement for asset allocation between competing warfighters. There were isolated asset deconflictions, e.g., around use of live HSV assets. However, most simulation assets could be reconstituted, or were without feedback to a system whereby use of an asset would decrement that asset from the pool of assets—with awareness by all those who might be interested in use of those assets. This had the effect of producing a never-ending pool of resources on the part of the planners within the CPC.

The Military Asset Optimization Tool (MAOT) was not present.

Knowledge Kinetics (K2) was not integrated into workflow processes, and therefore had no impact on decision-making or workflow management of the MPP.

NSS was intended for use as a COA analysis tool at three sites: CORONADO, China Lake and at the SCC. NSS was ineffective (software and hardware difficulties) on CORONADO, partly successful at WTP COA comparisons at China Lake, and was most successful at the SCC in support of surface and ASW COAs. A weak point is that an NSS operator analyst must currently be employed directly with the supported staff, and this is not an organic capability.

Dominant Battlespace Command (DBC) system, a visualization tool, was present on CORONADO, in spaces at the SCC, and in support of the MIWC. It had low integration at STARTEX, with improved visualization and fidelity by the end of the experiment. In general, visualization has not been incorporated into decision making and planning and has not been thought out or understood in relation to the use of other similar tools (e.g., MEDAL). There is considerable potential in this area, however, and greater application will pay substantial dividends.

MPP software interfaces, for production of the MOD, MARSUPREQs and MMAP were quantum leaps ahead of previous mission planning management tools employed in the MPP. These software tools were very effective at collating information between planners. In general, once participants became adept at suing these forms, they were comfortable with them. Many recommendations were made, however data collection suffered from combination of these tools (as prototypes) with what was likewise, a prototype MTO production process. The combination of new mission planning and management tools, within a prototype and evolving process yielded only ambiguous results. Additional wargaming of process and tools should be done, with one or the other held stable. It would be advisable to model first, wargame the process based on those results, and then mature the next generation prototypes of mission construction and management tools.

5.8.6 Situational Awareness

- Feedback from actions within the battlespace (e.g., BDA), a Common Operational Picture and intent of ETO to provide an overall and continual assessment that actions at the operational level are in accordance with a campaign plan.

The MTO/ATO may provide enhanced awareness of the maritime and joint asset employment, however it is not clear that this SA was used in this experiment, or that it would be considered high quality, timely and accurate by participants.

SA of the immediate battlespace environment, or shifts in that battlespace in real time, were not available to FPC, CPC or MTO production cells.

Internal SA of the MPP process was to be provided by the K2 workflow tool, which did not work in this experiment.

SA is one form of feedback, and feedback in general was very lacking, both internal to the MPP, and between MPP and current operations or joint operations.

5.9 General Conclusions on JFMCC MPP

The maritime planning process (MPP) was implemented by a staff structure under the Joint Forces Maritime Component Commander (JFMCC). Effects tasking orders (ETOs) from the Joint Forces Commander (JFC) were ingested, and maritime tasking orders (MTOs) were produced and coordinated with the air tasking order (ATO). Principal warfare commanders (PWCs) participated in the process, producing maritime support requests (MARSUPREQs) that were a component of MTO production. Three overlapping planning cycles of 72-hours each were simultaneously executed. The process executed all required tasks and produced required products.

The scope of MPP planning done in the experiment was limited. The range of situations that the process can manage is unknown.

- Competition for assets between PWCs was largely nonexistent. The process was not stressed.
- There was no MTO-ATO feedback cycle for plan adjustment.
- There was no determination made of the plans' quality.
- Execution results were not fed back into the planning cycle; no process exists to do this.

It was observed that the MPP is viable, but also observed was that the process did not work well. Principal problems and their causes were:

- The need to simultaneously support three planning cycles with a limited number of individuals appeared to be a primary cause for process difficulties. Individuals needed to be multi-tasked, and there was no process for coordinating tasks with individual availability.

- A high level of synchronization of tasks was needed, along with the information that supports the tasks, and the individuals that perform them. Synchronization was ad-hoc rather than a planned process.

- Various inputs to a given MTO were observed to contain essentially the same content as submissions for previous plans, creating the impression of resubmission rather than new plan development. The cause for this duplication is not known, nor whether it is a real problem. Possible causes are overloading of multi-tasked individuals and information synchronization difficulties.

It is assumed that the MPP will be implemented with staffing that is approximately the same as in FBE-J. This means that personnel multi-tasking and synchronization of tasks, supporting information, and the identification of the individuals performing tasks will be required.

A process is needed to feed back information into all three planning processes on the results of actions and executions. An effects cell and a process for synchronizing its output with planning cells are proposed, and definition of this process is required.

Further progress with MPP requires detailed mapping of the planning architecture, parameterization of planning sub-processes, mapping of planning decision processes and information flows that support the decisions, and better personnel assignments to tasks. Process modeling can only do this. Specifically:

- Develop a detailed MPP process model. This should be done for both the system tested in FBE-J and for the more comprehensive system needed for adequate MPP execution.

- Parameterize the model with data from FBE-J and JFMCC limited objective experiments (LOEs). Run the model to identify principal process shortfalls.

- Determine, from a model, how to synchronize the process. Model iterations and runs can identify requirements.

- Determine MPP personnel and multi-task coordination requirements from a model.

- Determine how to use an effects cell to synchronize the asynchronous feedback from execution.

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6.0 Joint Fires Initiative (JFI) Key Observations

6.1 Experiment Objectives

- Produce measured means, medians, and distributions for various processes in the cross-component engagement timeline from target nomination to assignment including ADOCS approval block actions.
- Determine the proportion of TSTs engaged that were cross-component engagements.
- Determine what fraction of cross-component target engagements were performed using surface Fires.
- Determine the fraction of cross-component TSTs that were engaged by JFMCC controlled weapons systems.
- Determine the number of cross-component TSTs missions that were denied as a function of reason for denial and denying component.
- Determine how many maritime TSTs were nominated as cross-component targets.
- Compare the timelines of TSTs engaged within the JFMCC with those timelines resulting when the target was nominated by another component and passed to the JFMCC.
- Apply timeline reconstructions and contextual information to identify architecture and TTP improvements necessary to reducing the engagement timeline.
- Determine the adequacy of the collaborative tools employed (ADOCS, IWS, IRC, etc) to provide accurate SA and to support the successfully prosecution of TSTs.

6.2 Analytic Questions

6.2.1 Cross Component Architecture

- Does the proposed (experimental) Joint Targeting (cross-component) Architecture enable timely engagements of TSTs?

6.2.2 Common Toolset

In what ways does a common toolset within the joint architecture affect the ability of the joint force to conduct effective cross-component TST operations?

Each component develops, nominates, and mensurates TST targets within its own engagement system (NFN (X) in the case of the JFMCC). If the component is unable to internally prosecute the target in a timely manner, the target is passed, through the ADOCS DTL Manager, to the supported commander (JFMCC, JFACC or JFLCC depending on the phase of the experiment) who passes it, using the ADOCS, to another component with the capability of executing the mission.

6.3 Sub-Initiative Observations

6.3.1 Time Sensitive Targeting (TST) Operations and Situational Awareness: General Observations

The Joint Battle Center (JBC), US Joint Forces Command, conducted the MC 02 Joint Fires Initiative primary data collection and analysis effort. The Naval Postgraduate School agreed to support this data collection analysis effort as it pertained to JFMCC operations in FBE-J.

FBE-J used a common set of automated tools and a common system architecture (JFI) that would enable effective TST C2 and joint task force coordination. The JFI C2 architecture was designed to enable a seamless, cross-component coordination and transition from the supported to supporting commander role, and from a supporting to supported commander role.

The JFI interfaced to the JFMCC through the Naval Fires Network (Experimental) (NFN (X)). NFN (X) was a Navy initiative and was a system centered on Tactical Exploitation System-Navy (TES-N), Global Command and Control System (GCCS-M), and the Land Attack Warfare System (LAWS). NFN (X) is discussed in chapter 8 of this report.[29]

The data collection efforts were confined to TST operations at the Maritime Operations Center (MOC) on USS CORONADO. No attempt was made to collect internal data for analysis at the JOC at Suffolk, VA, JFASC at Nellis AFB, NV, or the JFLCC at Camp Lejune, NC. The initial data collection plan addressed the following analytical objectives:

- Provide insight into decision making in joint TST operations.
- Provide insight into joint situational awareness within the MOC.
- Produce measured means, medians, and distributions for various processes in the engagement timeline from target nomination to assignment including ADOCS approval block actions.
- Determine the proportion of TSTs engaged that were cross-targeted (nominated by one component and prosecuted by another).
- Determine what fractions of cross-component target engagements were performed using surface Fires.
- Determine the number of TST missions that were denied as a function of reason for denial and denying component.
- Determine how many JFMCC TSTs were nominated as cross-component targets.
- Determine the fraction of cross-component TSTs that were engaged by JFMCC controlled weapons systems.
- Compare the timelines of TSTs engaged within the JFMCC with those timelines resulting when the target was nominated by another component and passed to the JFMCC.

Three types of data were collected: ADOCS/LAWS electronically provided time-tagged mission history data. All participants in the Maritime Operations Center were surveyed using a TST operations survey that covered all aspects of TST operations. Info Workspace collaborative tool chat files were recorded. Finally, observational data were recorded in the MOC.

TST Operations Survey – General Comments

A TST Operations survey was administered to participants in the Maritime Operations cell. The following is a summary of the general comments provided by the participants:

- “With multiple parties entering information in the Dynamic Target List fields, it was difficult to maintain situational awareness on what is happening, who is requesting ISR support, and how to deconflict with JFACC and other components to satisfy requirements.”
- “More training was needed to really employ the capabilities of the system.”
- “It was a challenge to sort multiple targets by priority.”
- “To maximize its capability, more screen space is needed on the computer.”
- “It was hard to track moving targets.”

[29] TST Concept of Operations for FBE-J, NWDC, June 2002.

- “ADOCS provided better situational awareness of TST operations.”
- “Believe that lack of knowledge of the current situation was due to process problems.”
- “It was difficult to maintain situational awareness on assigned sensor assets and monitor the Dynamic Target List.”
- “ADOCS along with chat capability provided pretty good situational awareness.”
- “Most operators did not understand how to use the ADOCS collection request page. Use improved later in the experiment.”
- “Deconfliction of weapons was consistent using ADOCS.”
- “There was some concern about fratricide because operators were restricted from using the fire support control measures option.”
- “An automated tool is needed to help the ISR manager see what happens to pre-planned collection if a sensor is retasked to look at a TST.”
- “JISR synch matrix was not useful as tactical/operational tool. Need a graphical tool to display collection plan. Did not help visualize the impact on the collection plan if a sensor is retasked.”

TST Decision Event Timelines

Five event timelines were reconstructed using IWS chat and ADOCS mission histories. The purpose of these timelines was to provide insight into the decision making process in joint TST operations using ADOCS. These timelines should not be a reference to determine times. There were several constraints to these timelines. Some of these constraints were individual and group training, COP latency, and GCCS-M simulation interfaces. While operators identified several issues concerning ADOCS in TST operations; the reconstructed decision timelines indicate that TST operations were consistently executed using ADOCS.

Time	Event	Data Source	Remarks
031200Aug	Target Acquired	Mission History	Nat Imagery
031230Aug	Recommend handoff to other component	Mission History	JFLCC cannot engage
031227ZAug	Target in ADOCS	Mission History	
031256Aug	JFASC states that it will engage JL0030 and JFMCC will engage JL0031	IWS Chat	
031346Aug	JFASC asks JFMCC if they can engage target.	IWS Chat	
031349Aug	JFMCC states that the target is being worked.	IWS Chat	
031351Aug	ADOCS indicates target passed to JFMCC	Mission History	
031352Aug	JFASC confirms that JFMCC will engage target	IWS Chat	
031408Aug	JFMCC states that TOT will be 1418Z hrs.	IWS Chat	
031411Aug	JFMCC orders VSSGN to execute target with TACMS-P	IWS Chat	
031414Aug	JFMCC corrects TOT to 1419Z	IWS Chat	
031417Aug	JFMCC Intel asks JFMCC ISR Ops for BDA support.	IWS Chat	
031509Aug	JFMCC Intel informs that it is still trying to determine BDA—asks for any available sensor support in area.	IWS Chat	
031759Aug	Global Hawk provides BDA—no damage to target	Mission History	
032055Aug	JTF fires watch orders JL0030 be removed from the DTL.	IWS Chat	Target has relocated

Table 6-1. Target JL0030. The Process of JFASC Passing a Target to JFMCC for Engagement.

This example illustrates the process in which JFASC passes a target to JFMCC for engagement. The indication that JFASC is maintaining control over target allocation by clearly delineating that JFMCC will execute this target while JFASC will execute JL0030. The JTF Fires watch is also monitoring the TST operation by determining that the target should be deleted because of restrike.

Time	Event	Data Source	Remarks
292056Jul	Target Acquired	Mission History	RPV
302354Jul	Target in ADOCS	Mission History	Re-strike Mission
310020Jul	Target passed from JFASC.	Mission History	
310122Jul	JFMCC sends target to DDX for engagement.	IWS Chat	
311444Jul	JFMCC BDA desk requests BDA imagery of target	IWS Chat	
311517Jul	Request confirmed. Will have National Imagery asset in 15 minutes.	IWS Chat	
311530Jul	National Imagery is received	Mission History	
311557Jul	Imagery sent to BDA desk from ISR Ops	IWE Chat	

Table 6-2. Target JA0067. The Handoff of a Restrike Target.

Table 6-2 illustrates the handoff of a restrike target. Over a 19-hour period, TST decision makers were able to maintain situational awareness on this specific TST target.

Time	Event	Data Source	Remarks
062146Aug02	SCUD TEL entered in ADOCS by JSOTF	Mission History	
062157Aug	JFMCC acknowledges that it will engage target with TTLAM with a TOT of 2210 hrs	IWS Chat	
062158Aug	JFMCC asks JSOTF for clearance of Fires.	IWS Chat	
062212Aug	JFMCC BDA desk requests BDA support for JS0044	IWS Chat	
062213Aug	JFACC sends JSOTF contact info to JFMCC (Spider 13 on 286.75)	IWS Chat	
062225Aug	JFMCC contacts JSOTF	IWS Chat	
062228Aug	JSOTF reports a miss on target. JFMCC acknowledges.	IWS Chat	
062237Aug	BDA confirmed by UAV	Mission History	
062259Aug	JTF Fires watch informs components that JS0044 is deleted and restrike in progress	IWS Chat	

Table 6-3. Target JS0044. A Target Nominated by JSOTF and Passed to JFMCC for Engagement.

JS0044 was a target nominated by JSOTF and passed to JFMCC for engagement. There are indications that JFMCC is concerned about fratricide and takes steps to minimize this possibility. JFMCC requests

JSOTF to give clearance of Fires. It also asks JFASC for frequencies and call signs so that they can directly communicate with the JSOTF unit.

Time	Event	Data Source	Remarks
011216Aug	JFLCC acquire SA-6 from ASARS. Target in ADOCS	Mission History	
011224Aug	JFASC asks JFLCC if they can engage target.	IWS Chat	
011225Aug	JFLCC acknowledges that it can engage. However, needs JFMCC to clear Fires.	IWS Chat	
011355Aug	JFMCC says target may be same as GC0040. JFMCC asks what is the precision of ASARS MASINT.	IWS Chat	
011401Aug	JFASC directs that GC0040 be deleted from ADOCS.	IWS Chat	

Table 6-4. Target JL 0023.

Time	Event	Data Source	Remarks
031249Aug	CSSC 3 detected by National Imagery.	Mission History	
031250Aug	JFLCC acquires but cannot engage.	Mission History	JFLCC ATACMS has collateral damage restrictions
031255Aug	Target in ADOCS is passed to JFMCC.	Mission History	
031256Aug	JFASC directs that target is to be engaged by JFMCC	IWS Chat	
031337Aug	JFMCC directs VSSGN to execute target.	IWS chat	
031337Aug	JFMCC BDA desk requests BDA imagery of the target.	IWS Chat	
031443Aug	Global Hawk reports no damage.	Mission History	
031453Aug	JFASC directs that this target be restruck as JA0114.	IWS Chat	
031455Aug	JFASC asks JFMCC if they can strike JA0114.	IWS Chat	
031535Aug	JFMCC states that target TS0076 is in the same location as JA0114.	IWS Chat	
031642Aug	JFMCC directs VSSGN to execute TS0076.	IWS Chat	
031735Aug	JTF Fires watch directs components to delete JL0031 and JA0114.	IWS Chat	

Table 6-5. Target JL 0031.

Table 6-5 illustrates an example where TST situational awareness was maintained when three target numbers identified the same CSSC 3 target. This decision making process included JFASC, JFLCC, JFMCC, and the JTF. Initially, JL0031 was nominated by the JFLCC from national imagery sources. JFLCC cannot engage the target because of collateral damage restrictions from their ATACMS. JFASC passes the target to JFMCC for prosecution. JFMCC prosecutes the target using thee VSSGN platform. The BDA indicates no damage, and JFASC orders a restrike and re-numbers the target as JA0114 in accordance with the concept of operations. JA0114 is passed to JFMCC for engagement. JFMCC determines that the target is the same as previously nominated TS0076. At this time, the JTF Fires watch intervenes and directs the components to delete JL0031 and JA0114.

Summary of TST Observations

While experimental constraints in MC02 affected the full demonstration of ADOCS capabilities, several insights concerning TST operations emerged. These insights were based on the above information as well as observations during the experiment.

- More individual and unit training were needed to maximize ADOCS capabilities. Confidence in the system capability improved over time.

- Cross-component sustained TST operations were conducted using ADOCS.
- Because of GCCS-M—simulation interface issues, ADOCS could not be fully tested for situational awareness.
- The JTF and components managed TST targets in a warfighting environment, and were able to track F-F-T-T-E-A progress with the assistance of ADOCS.
- Graphical displays were not used as the primary means for situational awareness. For example, in the Maritime Operations Center, decisions were primarily being made from the Dynamic Target List display and IWS Chat.
- There are some indications that ADOCS aided in deconfliction of Fires.
- There are indications that ADOCS contributed to fratricidal avoidance.
- JISR synch function contribution to ISR management was minimal.
- ADOCS capability to help visualize the enemy situation was rarely used.
- Majority of the respondents in the JFMCC MOC (77 percent) agreed or strongly agreed that ADOCS provided an understanding of the overall Joint TST operations.
- Majority of the respondents (62 percent) agreed that that ADOCS provided situational awareness confidence to make decisions without concern for fratricidal incidents.
- Majority of the respondents agreed (83 percent) that they had confidence in the TST coordination page to manage deconfliction of engagements.
- Majority of the respondents (70 percent) disagreed that ADOCS provided them the enemy situation.
- 60 percent of the respondents agreed that the ADOCS assessment page provided sufficient feedback on engagement effects.
- 100 percent of the respondents used the ADOCS Collection Request page to manage pre- and post-strike combat assessment requests (BDA).
- The majority of the respondents (89 percent) agreed or strongly agreed that ADOCS Mission Coordination: Time Sensitive Targets Page provided them situational awareness for current TST operations.

6.3.2 Analysis of JFI Objective Data

6.3.2.1 JFI Data Analyzed

The Automated Deep Operations Coordination System (ADOCS) Joint Dynamic Target List (DTL) Manager was the mechanism used in MC02/FBE-J to implement the JFI. The JFI analysis discussed here is based on a review of the data captured from ADOCS. These data include the end state of the ADOCS DTL Manager display, the Mission History Reports for each of the nominated targets, and the information contained in the tabs or pages linked to each target. The pages include: target data, engagement, coordination, collection request, BDA, and assessment.

The ADOCS database used for this analysis contained data from 24 July to 8 August and included 345 target nominations. The analysis discussed below was limited to the 120 target nominations made in the interval August 1 through 5 inclusive, for several reasons:

- The Mission Histories in the database for the period prior to July 30 were absent or fragmentary
- Constraints on the time available for analysis limited the amount of data that could be reviewed
- The period selected for review addressed the matured JFI TTP process (e.g., for the period of July 24 to 30 inclusive, of 73 target nominations, only six nominations were passed to another component using the DTL Passed (PSD) block; for the 120 nominations in the interval examined here, 67 were passed using the PSD block)

6.3.2.2 Nomination and Engagement Statistics

Table 6-6 contains the nomination and engagement statistics for the 1-5 August period. In the second column of the table, the numbers of Combat Search and Rescue (CSAR) missions that were nominated are listed. These CSAR missions are not considered further in this analysis.

Date	Nominations		TST Nomination Source					TST Prosecution					Self Prosecution			
	CSAR	TST	A	AA	L	M	S	A	L	M	TOT	DEN	A	L	M	TOT
5-Aug	3	28	8	0	3	9	8	8	4	14	26	1	4	1	6	11
4-Aug	1	21	7	2	2	8	2	7	1	10	18	3	5	1	5	11
3-Aug	1	11	3	0	4	4	0	1	2	8	11		1	2	4	7
2-Aug	5	14	5	1	1	6	1	2	2	10	14				3	3
1-Aug	1	35	12	1	6	13	3	10	4	17	31		8	2	9	19
Totals	11	109	35	4	16	40	14	28	13	59	100	4	18	6	27	51

Key: A = JFACC; AA = AAMDC; L = JFLCC; M = JFMCC; S = JSOTF; DEN = Mission denied

Table 6-6. DTL TST Nomination and Prosecution Statistics.

Of the 109 nominated TSTs, 96 (88 percent) were prosecuted. Prosecution is defined as a nomination with the DTL Mission block (MSN) set to green. The total prosecuted includes three instances (JA0081, JA0120 and JL0039) where the MSN block was not green, presumably due to operator error, but other evidence indicates the missions were fired. The total number of engagements prosecuted appearing in Table 6-6 is 100 but this included four targets (ET0016, JA0124, JA0092, and JA0095) that were each engaged by two components. Four of the 109 nominations were not engaged because a component coordination block was red prohibiting the engagement. Of the 100 engagements, in 51 cases the component that nominated the target was also the component that engaged it. This will be referred to as self, or autonomous, prosecution. The JFMCC executed 59 percent of the engagements.

6.3.2.3 Event Time Accuracy

In the DTL mission histories, the time stamps associated with the PSD block and the Component coordination block actions are accurate since the event automatically captured is the actual action of altering the status of the DTL block. However, the accuracy of the time tags for the events captured for the other blocks (MSN, CM, BDA, CA) is less definitive. In these cases, the operator manually instituted a block color change to report an event or action that is external to the DTL manager. In some cases, there is evidence that the operator did not report that information in a timely manner. The Collection Management (CM) block provides an example of this. In many cases, the operators have entered comments on the DTL Collection Request page that specify the time that ISR support was requested to obtain BDA on the target engaged. It is expected that the time the CM block was changed from white (to yellow or green) would correspond to this time and in most cases the times agree to within a few minutes. But there is a more than five-minute discrepancy in 25 percent of the observations. These differences are interpreted as a failure of the operator to update the DTL block display in a timely manner. This problem is anticipated for other blocks listed above. It is therefore anticipated that the measured median intervals for the various steps in the engagement should provide credible data, but the mean intervals are likely to be skewed by anomalous outliers. In the following discussion median time intervals are normally cited.

6.3.2.4 Experiment DTL Tactics, Techniques, and Procedures (TTPs)

The experiment TTPs were developed for the prosecution of TSTs with the DTL Manager in MC02/FBE-J and set forth before the experiment began[30]. Described below is the mature MC02/FBE-J TST engagement process as defined by the DTL data. This observed process is compared with that originally defined.

6.3.2.5 Target Nomination

Each of the nominating components (JFMCC, JFASCC, JFLCC, JSOTF, and AAMDC) was to nominate all acquired TSTs into the DTL Manager. This was the case whether or not the component intended to prosecute the target with its own assets. The prosecuting components (JFMCC, JFASCC, JFLCC, JSOTF) and the JTF, acknowledged the DTL target nomination by entering "X" into the appropriate DTL coordination block.

6.3.2.6 Target Assignment

The TTP specified that if a target nominator was unable to prosecute a target he had nominated, he should turn his DTL coordination block yellow indicating to the supported commander that the target needed to be passed to another component for execution.[31] This rarely happened. In only 10 cases of the 109 TST nominations, did the target nominator turned his coordination block yellow.

For the whole period covered by this analysis, the JFACC was the supported commander. Passing a mission consisted of turning the DTL PSD block green and inserting into the PSD block the three-letter code for the component to which the mission was passed. Sixty-seven nominations (this includes two anomalous nominations in which the DTL Mission Histories attributed the passing action to the JFMCC and JFLCC) were passed. A review of the data shows missions were not passed if:

- The JFACC was the nominator and prosecutor.
- Another component was the nominator and the JFACC chose to prosecute the target.

It was anticipated that a mission would not be passed if the nominator intended to execute the mission autonomously and did not set his coordination block yellow.[32] In fact, there are many examples where the same component was both the nominator and prosecutor, but nevertheless the nomination was passed by the JFACC. For example, out of the 27 autonomous JFMCC missions, 20 were passed by the JFACC to the JFMCC. This appears to indicate that the JFACC was exercising control over all TSTs rather than exercising control only over its own TST missions and those TST missions where the nominating component had specifically abrogated responsibility.

The TTP specifically called for each component to provide a weapon-target pairing options if, the supported commander nominated a target in his area of responsibility[33] or if a component had indicated it was unable to engage the target it had nominated.[34] These component weapon target-pairing options

[30] MC02 TST CONOPS, Annex H: Tactics, Techniques and Procedures (TTPs) for Coordinating Collection Efforts in Support of Time Sensitive Targets. Version 1A, dated 5 May 2002
[31] Millennium Challenge 02 Concept of Operations for Time Sensitive Targets. Final Coordinated Draft dated June 2002, page 33.
[32] Ibid, page 32.
[33] Ibid, page 27
[34] Ibid, page 34

appear in the DTL engagement page. A review of this page for each engagement shows that these options were not normally offered. In 73 cases, only a single weapon-target pairing option appears, in 21 cases, there were two options offered and in three cases there were three.

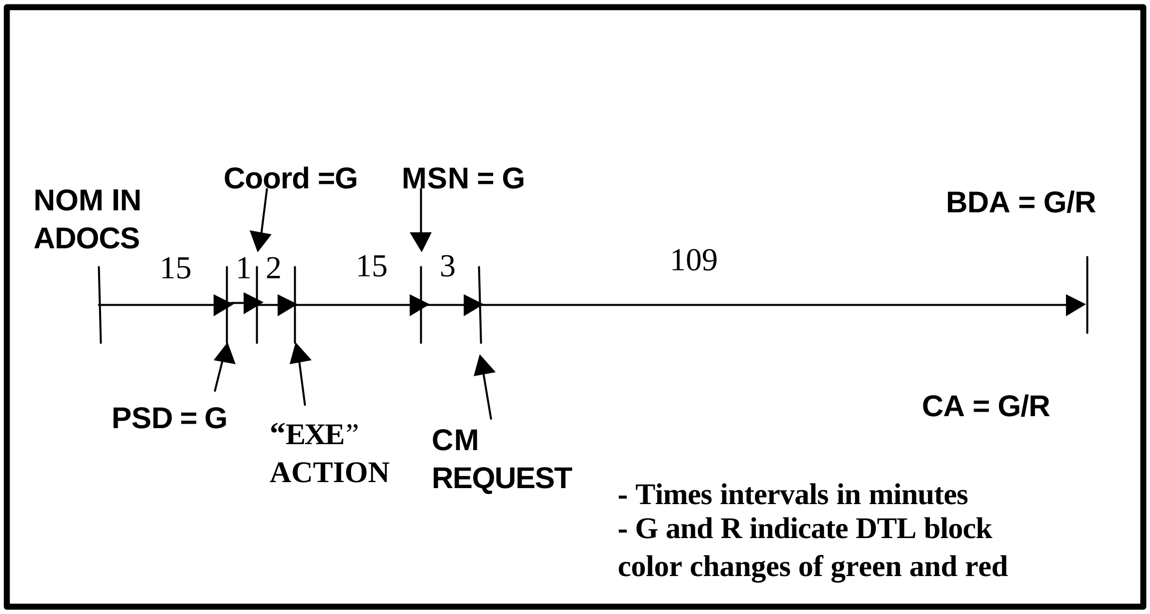

Figure 6-1. DTLTST Engagement Timeline.

As seen in figure 6-1, the median interval between a nomination being received in ADOCS and the passing of the nomination by the supported commander is 15 minutes.

6.3.2.7 Target Engagement

When the component responsible for engaging a target obtained a weapon-target pairing he turned his DTL coordination block green. The interval between the nomination being passed and the target prosecutor turning his coordination block green was very short. As shown in Table 6-7, the median interval for 59 observations was only one minute. In 18 cases, the coordination block turned green before the target was passed. Ten of these 18 cases were JFMCC autonomous missions implying JFMCC target processing was proceeding independent of JFACC PSD actions.

TIME INTERVAL	MEDIAN	MEAN	STD DEV	SAMPLE
Nomination rec'd in ADOCS to PSD action	15	52	102	65
PSD action to coord. Block=G	1	2	44	59
Coord block=G to EXE action	2	9	19	97
EXE action to MSN block = G	15	38	98	93
MSN block = G to CM request	3	93	343	90
CM request to CM block turns from Y to G	55	127	137	45
CM turns Y to G to BDA block = G/R	4	138	424	43
CM request to BDA block=G/R	109	267	616	74
BDA block = G/R to CA block = G/R	0	9	80	70
Times are in minutes. Block colors: G = green, Y = yellow, R =red				

Table 6-7. DTL Engagement and Assessment Timeline Intervals.

To indicate his intent to execute the mission, the target prosecutor added "EXE" to the coordination block display. The action of turning the coordination block green and the indication of the execution intent followed in quick succession. The EXE action occurred a median of two minutes after the coordination block was turned green. It was not usual for the two events to be simultaneous (to the one minute resolution of the ADOCS time stamp). Finally, when the weapon had been fired or the bomb released, the Mission (MSN) block for the mission was turned green. The MSN action followed the EXE action by a median 15 minutes. Thus, the median time from the nomination in ADOCs to engagement was 33 minutes.

6.3.2.8 Deconfliction

If any component had questions or concerns regarding an in-process mission this was to be indicated by turning the coordination block yellow of the component executing the mission. If the concern was critical, the component turned his coordination block red prohibiting or denying the engagement. Both these circumstances were unusual for the experiment interval reviewed. There were only five cases where the prosecutor coordination block was yellow implying concerns by another component regarding the mission. In all these of these cases the EXE block subsequently went green and the mission was fired. There were four cases where missions were denied (two because friendlies were in area, one because engagement was not authorized by the commander, and one because target dwell time was exceeded). Two missions were temporarily blocked, both because the engagement was not authorized by the commander.

6.3.2.9 Collection Management

The TTP called for the operator to turn the DTL Collection Management (CM) block yellow to indicate that collection assets were requested for BDA purposes.[35] The block was to be turned green to indicate that a collection plan has been approved. Actual procedures in MC02/FBE-J departed from the TTP in the following ways:

1. In a substantial number of cases (21 out of 93), the CM block was changed directly from white to green. The CM block was never set to yellow.

[35] MC02 TST CONOPS Errata Sheet: Passing Geopositioning-Related Information Among Components Using JFI Tools. Version 1 dated 17 July 2002, page 5.

2. In the 43 cases where there is a reported time for the CM block change from yellow to green and there is a reported time for the BDA block changing to green or red, the median difference between these two actions is only four minutes, and in a number of cases the changes were simultaneous. It appears the CM block change from yellow to green is based on the receipt of the BDA information, rather than on the approval of the collection plan as required by the TTP.
3. In 15 cases, the final state of the CM block is yellow even though the BDA block was set to green or red. This suggests the operator was negligent in setting the CM block to green.

As mentioned above, there was a discrepancy between the time the first CM color change was reported in the Mission Histories and the time it was recorded that the CM request was issued in the DTL Collection Request page. In the 71 cases where both reports are available, the median difference between the times was one minute and the mean difference 13 minutes. Generally, when available, it is the CM request time as reported in the collection request page that was used in calculations. Table 6-7 presents the statistics for the interval between the MSN block going green and the issuance of the CM request. The median interval is only three minutes, but in 35 of the 90 cases, the CM request was sent before the MSN block went green. The individual measurements of this interval show a large dispersion.

6.3.2.10 Battle Damage Assessment (BDA)

The TTP required the BDA block to be turned yellow when the requested mission was flown but no BDA had yet been received.[36] On receipt of BDA, the block was to be turned green if the strike was successful or red if unsuccessful.

Actual procedures in MC02/FBE-J departed from the TTP in the following ways:

- Of 96 cases in which BDA was reported (red or green block), only 38 went from white to yellow. The rest went directly from white to red/green.
- The CM block at times went from yellow to green at essentially the same time that the BDA block was changed to green/red; these two actions were redundant.

The BDA block was changed to green/red a median interval of 109 minutes after the BDA request. In some instances it was clear there was no clear-cut event that stimulated the BDA block action. The operator comments on the DTL BDA page indicate on some occasions the BDA block was turned red at an arbitrary time, after the operator had waited long and futilely for a BDA report or BDA confirmation.

6.3.2.11 Combat Assessment (CA)

The TTP dictates that the CA block was to be turned yellow when assets have been assigned.[37] It was to be turned green when the collection assessment was complete and the mission was accomplished; red if the mission had not been accomplished.

Actual procedures in MC02/FBE-J departed from the TTP in the following ways:

1. Few CA blocks were turned yellow. Of 74 instances in which a CA status was reported, only 16 blocks first went from white to yellow, the rest all went from white to red/green.
2. The median interval between the BDA block turning red/green and the CA block turning red/green was zero minutes. These actions were essentially the same event.

[36] MC02 TST CONOPS, Annex H: Tactics, Techniques and Procedures (TTPs) for Coordinating Collection Efforts in Support of Time Sensitive Targets. Version 1A, dated 5 May 2002, page 6.
[37] Ibid, page 9.

3. In the great majority of cases (66 out of 84) in which one or both of the BDA and CA blocks are red/green, the two blocks are the same color. Therefore the CA and BDA blocks are set at the same time and almost always to the same colors. It appears the CA block adds little value to the DTL manager. In the 18 cases where the CA and BDA blocks are not the same colors some of the block combinations do not make sense. For example, there are five cases in which the BDA block is white or yellow but the CA block is red or green. How can an assessment be made if no BDA was reported? These block settings appear erroneous.

6.3.2.12 Not Later Than (NLT) Time

Each target nomination is required to contain a target dwell time; an estimate of the time the nominated target is expected to remain at the location where it has been detected. In ADOCS, this dwell time is automatically converted to an absolute NLT time. In most cases, after performing the weapon-target pairing, the ADOCS operator reported a Time On Target (TOT) in the DTL Target Data page. These two times permit a simplistic timeline measure of success for TST engagements.

For those engagements in which an NLT time and a TOT were both reported, the NLT time and TOT were compared to determine if the engagement met the NLT time. In some cases, the TOT was less than the MSN time. This could either be due to the fact that the operator forgot to update in the DTL a revision to the TOT time or that the MSN green status was reported late. In those cases, as well as those with no TOT time, the NLT time was compared to the MSN time. Of the 58 engagements evaluated, 25 did not meet the NLT times.

6.3.2.13 Georefinement

The TTP requires that the component that nominated the target be responsible for the georefinement of the target when this is required.[38] If the mission is passed to another component, the nominator a priori does not know what weapon will be paired to the target and whether georefinement will be required. If the passed mission does require georefinement, the target prosecutor must request the nominator to provide these data. The DTL display provided no means of displaying mission georefinement status or for communicating a georefinement requirement between components. If a target position was georefined this was indicated by the entry of Circular Error (CE) and Linear Error (LE) values on the DTL Target Data page. For the 109 nominated TSTs, only 22 were reported to have georefined positions. This appears to be as a small percentage, but it is not possible to determine if this represents a problem without additional information:

1. The DTL engagement page does not specify the aircraft-delivered weapons, therefore it is not known whether they would require a georefined target position.
2. Do ATACMS and TACMS missions, particularly where multiple rounds were employed, require georefined target positions?
3. Is it assumed that all SOF nominated target positions are specified to high accuracy and do not require georefinement?

All participants involved in weaponeering need to be issued a matrix that defines what level of target positional accuracy is required, for a specified level of damage, as a function of target type, weapon type and number of rounds delivered. In addition, even for unmensurated targets, there must be some indication in the nomination of the accuracy to which the target position is known. At the least,

[38] MC02 TST CONOPS Errata Sheet. Passing Geopositioning-Related Information Among Components Using JFI Tools. Version 1 dated 17 July 2002, page 3.

weaponeering participants need to be furnished with a matrix defining the expected positional accuracy as a function of the nomination source (Global Hawk, U2, Predator, SOF, etc.).
The georefinement process and data for the JFMCC in MC02/FBE-J will be analyzed in a separate report.

6.3.2.14 Restrikes

The TTP indicates if a restrike of a mission was necessary the operator was to select the retarget button, which would generate a new mission number and mission, duplicate the track number, and append RESTRIKE to the target description.[39]

In the data analyzed, 17 missions were identified as restrikes on the basis of the term RESTRIKE appended to the target description. In most cases, the original target number that was being restruck was identified in the remarks on the Target Data page. All the restrike missions were initiated by the JFACC. The automated process for generation of restrike missions described in the TTP did not function or did not work reliably. The following anomalies were observed in the data.

- In seven cases, there were no track numbers, or the track numbers did not agree between the restruck and the original target
- In three cases in which the connection between the restruck and original target was made on the basis of a common track number, the original and restruck targets were at different locations

6.4 Summary Comments and Observations

- Ninety-six (88 percent) of the 109 DTL TST targets were engaged. Another four (four percent) were denied execution. Nine targets were not engaged.

- Sixty-seven (61 percent) of the nominations were passed to a component for execution by the supported commander (JFACC).

- Contrary to the TTP, the JFACC passed targets in cases where the nominator did not indicate he was unable to engage the target; there are a number of cases where the JFACC passed the target to the target nominator.

- The JFMCC executed 59 percent of the firings.

- A representative DTL engagement timeline is shown in figure 6-2. The times associated with each of the intervals are the medians from the observations discussed in the above Sections.

The DTL Manager may be considered a successful cross-component coordination tool as indicated by the percentage of targets engaged and the degree to which all components contributed to a usually complete and consistent DTL manager display. However, there were a number of instances, as described in the preceding Sections, where block actions indicate the experiment TTP was neither understood nor followed. The degree to which a collaborative or situational awareness tool is valuable depends on the consistency, accuracy, and timeliness of the information it displays. Because operators in some instances departed from the TTP, were time late in updating the display; and, in some cases, used component unique rules in setting DTL blocks; the value of the DTL was degraded. An example of the latter point; the data contain eight instances where the MSN block was changed from white to yellow – an action that is not defined in the TTP. In seven of those instances, the JFLCC was the prosecutor and turned the MSN

[39] Ibid, page 12.

block yellow at the same time that he entered EXE into his coordination block. Most of the display consistency, accuracy and timeliness issues can be addressed through operator training and perhaps TTP simplification. A proposed revised DTL TTP is presented in Table 6-8. Providing operators with a single page summarizing the TTP, similar to Table 6-8, would be helpful in obtaining adherence to the TTP.

The target nominator turns his coordination block yellow if he is unable to prosecute the target.

1. Each component places an "X" in his coordination block to acknowledge the target nomination.

2. **The supported commander passes a mission to another component only if the nominator indicates he cannot engage.** Turning the PSD block green and inserting the three-letter code of the component to which it is passed passes the mission.

3. **The supported commander requests a weapon-target-pairing from a component by turning the component's coordination block blue.**

4. A component indicates he has a weapon target pairing by turning his coordination block green.

5. **If georefinement is needed, the prosecutor turns the georefinement block yellow. The target nominator is required to provide the georefinement. When the georefinement is received the block is turned green. This georefinement block is an addition to the DTL.**

6. A component with questions or concerns regarding a mission turns the block of the component executing the mission yellow. This is not a mission prohibition.

7. A component prohibiting a mission will turn his own coordination block red and insert the three-letter code giving the reason for the prohibition.

8. The component directed to execute, or who is executing autonomously, places "EXE" in his coordination block to indicate his intent to fire the mission.

9. When the mission has been fired the prosecutor turns the MSN block green.

10. **When BDA support is requested, the BDA block is turned yellow (in this proposed TTP, the CM and CA blocks are deleted).**

11. When BDA is received, the BDA block is turned green if the mission goals were satisfied and red if they were not or the result is unknown. **If a decision is made to restrike the target, the restrike code (RST) is inserted in the BDA block.**

Table 6-6. Modified DTL TTP. A target nominated by JSOTF and passed to JFMCC for engagement. (Where the TTP action is different from the MC02/FBEJ TTP or the way operations actually executed in MC02/FBE-J, the action is in **bold type**.)

7.0 High Speed Vessel (HSV) Initiative Key Observations

HSV technology is immediately applicable to Rapid Decisive Operations (RDO) as it enhances the Joint Force Commander's (JFC) ability to accelerate his operating tempo. As a result, this technology creates opportunities to develop transformational operational concepts that bring military power to bear from long range at responsive speeds.

The technology found in today's HSVs leverages proven commercial design to bring an added dimension to modern naval warfare. Shipyards already manufacture commercial vessels with a number of militarily relevant characteristics (see figures 7-1 and 7-2), including high-speed, long ranges at high speed, good sea keeping ability, shallow draft, and an ability to rapidly adapt to multiple and changing missions. To the extent these commercial vessels are further modified to meet military needs, they offer the near-term capabilities that make HSV support to RDO in 2007 possible.

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These characteristics offer clear advantages to the Joint Force Commander (JFC). Inherent speed and the ability to operate from austere ports increases the Joint Task Force's (JTF) operational mobility and reduces an enemy's ability to maintain situational awareness across an extended battlespace. As their numbers increase and capabilities improve, the ability to deploy sensors; collect, process and disseminate information; and to host a forward-based commander and his staff become increasingly important to gaining and maintaining a tactical advantage. The HSV's design characteristics of high-speed, high payload fraction, and shallow draft lend themselves to operating throughout the battle space, but particularly in littoral seas. Finally, with enabling systems interfaces and baseline architecture built into an HSV's command, control, communications, computers, and intelligence (C4I) system, the HSV's ability to accept C4I modules extends and enhances the JFC's ability to push his command and control forward into the battlespace.

One characteristic of HSV employment shared with other types of vessels is the inherent risk of operating in a littoral environment. Mines, attacks from small boats, fires from shore batteries, and any number of other threats must be addressed in vessel design and in planning maritime operations. During FBE-J, a number of simulated Navy ships and vessels were attacked and sunk during littoral operations. The simulated HSV experience vis-à-vis those threats are summarized later in this chapter (see figure 7-5), and on the whole are indicative of the wider fleet experience within the simulation. While many observers question the validity of those losses/results, there is no question that there are significant threats associated with littoral operations.

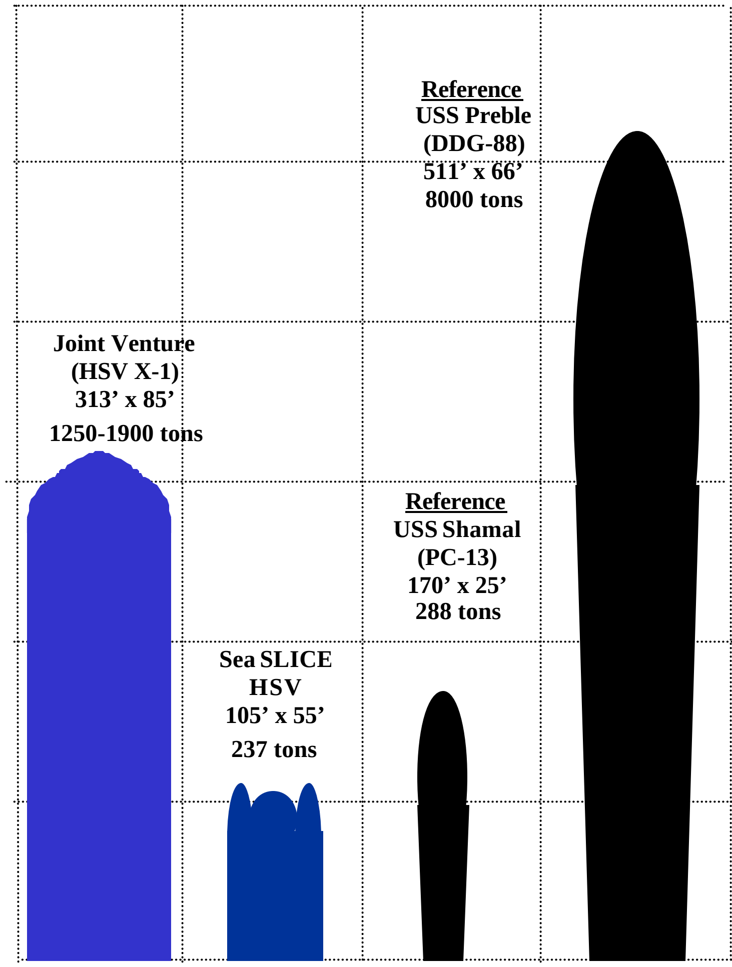

Figure 7-1. Vessel Sizes[40]

For HSVs, and for any future vessels that the HSV is a surrogate for, littoral operations and their attendant threat are issues that must be addressed. Defining and quantifying the threats populating that environment is a needed first step. Assessing HSVs' vulnerability to those threats is the second step. Addressing those vulnerabilities through changes to vessel design, installation of counter-measures and armaments, and developing compensating concepts of operations (CONOPS) and tactics, techniques, and procedures (TTPs) is another step that must be taken. Finally, maritime planners must have knowledge of and an appreciation for HSV capabilities and limitations. Areas of specific relevance to HSVs are any increased vulnerabilities accruing to vessel design and construction, and the ability of an optimally manned vessel to protect itself and to control damage from an attack.

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[40] Adapted from the Lockheed Martin Sea SLICE Team Report for FBE-J and MC02 Initiatives, 2002

Selected Vessel Statistics		
	Joint Venture	**Sea SLICE**
Ship particulars	Wave Piercing Catamaran (CAT)	Small Waterplane Area Twin Hull (SWATH)
Length (ft)	313	105
Beam (ft)	85	55
Draft (ft)	11-13.5 (total displacement)	~14
Displacement (ST)	1250-1900	237
Year Built	1998 (Refit 2001)	1997
Cost ($m, estimated)	~50	~15
Speed - Sea State 3	39 knots full, 45 knots lightship	30 knots
- Sea State 4	39 knots full, 45 knots lightship	30 knots
- Sea State 5	35 knots, 15 knots in head seas	30 knots
- Sea State 6	30 knots, 15 knots in head seas	Unknown
Max Speed	45 knots	30 knots
Range (nm)	3000 nm @ 35 knots, 250 tons payload 6000 nm @ 15 knots, 250 tons payload 1200 nm @ 35 knots, 545 tons payload	2500 nm @ 8 knots, no payload 2000 nm @ 12 knots, no payload 600 nm @ 25 knots, no payload
Crew size	About 31	About 18
Weapons	None	35mm gun; torpedoes; NetFires; 8 NSM SSM; SAMS, Note 1.
Sensors	Decca Bridgemaster X and S band radars. Fathometer.	Sea FLIR; Sea SAFIRE; Silent Sentry; Electro-optical director; commercial radar; Furunda fish finder as fathometer. Note 5.
C2 Systems	Modular (incl. Ku band SATCOM, LAWS, ADOCS, GCCS-M, MEDAL, IKA for FBE-J.), as needed for mission.	Modular (including Ku band SATCOM, LAWS, ADOCS, GCCS-M, MEDAL, IKA for FBE-J.) Note 2.
Note 1. Weapons on Sea SLICE were modular mock-ups installed for FBE-J.		
Note 2. Sensors and C2 systems listed for Joint Venture and Sea SLICE were either organic of modular systems installed for use during Fleet Battle Experiment – Juliet.[41]		

Figure 7-2. Selected Vessel Statistics[42]

7.1 Experiment Objectives

In order to evaluate overall HSV capabilities and utility in support of RDO circa 2007, experiment and data collection plans established a framework of overarching questions and supporting analysis questions, developmental objectives, and demonstration objectives. Those plans were augmented by sub-initiative evaluation plans.

[41] Adapted from the Lockheed Martin Sea SLICE Team Report for FBE-J and MC02 Initiatives, 2002; with additional input provided by Joint Venture's OIC.
[42] Ibid.

7.1.1 Overarching Questions

Experiment design and its supporting data collection plan addressed the following overarching questions for HSV participation in FBE-J.

- What added value do a number of high speed, reconfigurable, and multi-mission platforms provide the JFMCC and the JFC in a littoral campaign as part of an access mission?
- What are the missions best suited (or appropriate) to this concept of maritime operations?
- In a netted environment with many and varied types of sensors, what are the advantages or disadvantages of the C2 construct used in this concept?
- What conditions and design features must be considered in engineering the capabilities required to meet the challenges in a 2007 campaign?

7.1.2 Analytic Questions

In order to answer the aforementioned overarching questions, the following supporting analytical questions were identified.

- HSVs would be suitable for maritime operations if:
    - They are capable of surviving in the natural and operational environment required for vessel employment.
    - The HSV has sufficient endurance to perform its missions.
    - The HSV has sufficient sea-keeping ability to perform assigned missions (see the sub-initiatives).

- Participation of HSVs could enhance maritime and joint mission performance, due to unique HSV characteristics related to:
    - High speed
    - High payload fraction
    - Shallow draft
    - Support for off-board vehicle operations (air, includes helicopter and UAVs; surface includes USVs and small boats; and sub-surface includes UUVs)
    - C4I support for command and control
    - Self-deploying
    - Reconfiguration.

Analysis methodology relied primarily on comprehensive reconstruction of HSV events and case study analyses specific to the performance capabilities stated above.

Of the overarching questions and supporting analytical questions, data were gathered from live vessel operations to address the appropriateness of missions, sensor employment, required operating conditions, and design features questions. For the supporting analysis objectives, benign weather in both live vessel and simulated vessel operations precluded testing the HSVs ability to survive its natural operating environment.

7.1.3 Developmental Objectives

In addition to validating data gathered during previous project experimentation, FBE-J's operational setting was an opportunity to gather additional data in support of future ship and system design. Specific developmental objectives or areas of interest included the HSV's ability to:

- Launch and recover helicopters, small boats, and unmanned vehicles (air, surface, and sub-surface).
- Pier-side loading and unloading of personnel, cargo, and equipment.
- Support embarked crew and passengers (vessel habitability: berthing, messing, sanitation, work-spaces).

7.1.4 Demonstration Objectives

HSV-X1 and Sea SLICE were used by a number of agencies to demonstrate agency-sponsored system performance during FBE-J. Some of those demonstration objectives were designed to show that a system was interoperable with the HSVs. Data collected against those systems are included in this section. For other systems, the HSVs were merely platforms of opportunity to demonstrate system performance with no other HSV-system relationship. Results of this latter (opportune platform) grouping are not recounted in this chapter.

For both developmental and demonstration objectives, data collection relied on participant observations of performance, documentation of processes used to perform tasks, and operator interviews.

7.2 Sub-initiative Analytic Questions

In addition to satisfying sponsoring command or agency experimentation requirements, the sub-initiatives also provide data that helped answer the overarching, supporting analytical, and developmental questions. Sub-initiative objectives are summarized in the following paragraphs.

7.2.1 HSV Support to Mine Warfare (MIW)

Data collection on MIW missions evaluated a live and/or simulated HSV’s ability to provide or support:

- Live vessel C4I (including specialized tools for mission planning and execution), office space, and hotel services for the embarked MIW Commander (MIWC)

- Embarked mine counter measures (MCM) vehicles including SH-60 helicopters (simulated vessels only) and a variety of remote off-board MCM systems (live and simulated vessels). Included in the evaluation is HSV's ability to support off-board MCM systems mission planning, maintenance, mobility, launch, and control during missions; recovery; and post-mission processing activities.

- An embarked explosive ordnance disposal mobile unit (EODMU) with dive boats and diving equipment, including mobility, office space, mission planning support, hotel services, and maintenance and supply storage

- Providing force protection for other vessels and systems (Sea SLICE only)

- Towed sonar for environmental survey, search, detection, and localization of mine-like objects.

7.2.2 HSV Support to Navy Special Warfare (NSW)

Data collection on NSW missions evaluated a live and/or simulated HSV's ability to provide an afloat forward operating base (FOB) for NSW forces. In the FOB role, the HSV-X1 embarked a task unit (TU) headquarters, three SEAL platoons, tactical mobility platforms (RHIB, SDV, etc.), and other required personnel and equipment. Included in this evaluation was the HSV's ability to provide or support:

- A platform for C4I support (including specialized tools for mission planning and execution control), office space, and hotel services for the embarked TU headquarters
- A platform to move NSW forces and equipment
- Launch, recovery, mission preparation, and maintenance of tactical mobility platforms (small boats).

7.2.3 HSV Support to Ship to Objective Maneuver (STOM)

In light of the fact that the Marine Corps developed an independent experiment and data collection plan,[43] FBE-J planners opted not to duplicate their efforts with a separate Navy-generated evaluation of HSV support to Marine Corps STOM operations. Marine Corps evaluation of the HSV focused on assessing the role of high-speed vessels during Marine Air-Ground Task Force (MAGTF) operations in a littoral environment. Included in that evaluation was the HSV's ability to provide or support:

- Insertion/extraction of Reconnaissance, Surveillance, Target Acquisition (RSTA) elements
- Reinforcement and sustainment of MAGTF forces ashore in order to maintain operational momentum
- Humanitarian evacuation of personnel (non-combatants)
- Command and Control of landward and seaward forces
- Operational intra-theater lift of cargo, vehicles, and personnel.

7.2.4 HSV in Logistics Support to Deployed Forces Ashore

As originally envisioned, live and simulated HSVs would be evaluated for their ability to support sustaining logistics to forces deployed ashore. Due to competing requirements for simulated vessels, there was very little logistics play within the simulation. Live vessel support to logistics operations were incidental to the Marine Corps' STOM and the Army's Force Deployment LOEs. Those results are addressed in other sections of this chapter.

[43] Marine Corps Warfighting Lab (MCWL) report, "MILLENNIUM CHALLENGE 02 LIMITED OBJECTIVE EXPERIMENT, JOINT HIGH SPEED VESSEL ANALYSIS REPORT," 16 August 2002.

7.2.5 HSV Support to Army Intra-theater Force Deployment

Like the Marine Corps, the Army developed an independent experiment and data collection and plan for MC02.[44] Consequently, FBE-J planners opted not to duplicate those efforts as well. The Army's principal objective for their use of the HSV-X1 during MC02 was the first-time demonstration of the vessel's ability to transport complete packages of combat-ready soldiers with their equipment. Although that LOE was not formally a part of FBE-J, many of the observations and conclusions have relevance to Navy operation of such a vessel, so comments from that effort are included and referenced in this report.

7.3 Summary of HSV Support in FBE-J

There were both live and simulated HSVs in FBE-J. Day-to-day employment of the HSVs is shown in figures 7-3, 7-4, and 7-5. The first two figures summarize live HSV employment[45] while 7-5 summarizes simulated vessel employment.

JOINT VENTURE OPERATIONS 24 JULY - 7 AUGUST 2002		
DATE	**MISSIONS**	**REMARKS**
7/24	MCM, MIW EOD	U/W. Conducted U/W BPAUV, REMUS(2), and OWL III USV launch and recovery along with three supporting RHIBs. SH-60 DLQs. Planned embarkation of COMMCMRONTHREE as MIWC delayed due late vessel delivery to Navy, need to groom C4I capability. MIWC operated from FCTCPAC while C4I problems resolved.
7/25	MCM	U/W. Embarked DVs and media and demonstrated BPAUV, VSW/REMUS and OWL ops. Disembarked DVs via CH-46. MIWC remained at FCTCPAC. Completed C4I installation and testing.
7/26	MCM, MIWC	U/W for MIW ops with MIWC embarked and C4I fully functioning. BPAUV and OWL daylight mission launch and recovery. BPAUV overnight mission launch. SH-60 DLQs.
7/27	MCM, MIWC, NSW	U/W-overnight for MIW ops with MIWC embarked. Recovered BPAUV after all night mission. USMC CH-46 DLQs. Inserted NSW Hydro Survey team after dark and recovered very early AM.
7/28	MIWC; NSW, USMC	RTP AM. Offloaded MCM equipment but MIWC remains embarked. Unloaded USMC Recon and SOF team. Pier-side SDV trials. U/W for SDV day and night trials and night USMC Recon insert.
7/29	MIWC, STOM rehearsal	U/W. Engine casualty en route Camp Pendleton forced cancellation of Del Mar Boat Basin rehearsal. USMC vehicles loaded at NAVSTA San Diego. Engine repaired. MIWC operations continued.
7/30	MIWC, STOM	U/W. Entry into Del Mar Boat Basin via very narrow and shallow channel. JV moored unassisted to a causeway pier rapidly offloaded USMC vehicles and on loaded CODEL and media simulating evacuees. Entire evolution completed in just over one hour. Flight ops immediately upon leaving harbor and CODEL disembarked by HELO. MCMRON 3 as MIWC disembarked and shifted to FCTCPAC as planned.
7/31	Medical	U/W Medical LOEs. Refueled. Established NSWTU command center in C4I space.
8/1	NSW	U/W. Embarked CINCPACFLT and media for underway demonstration and returned to port. NSWTU C2 ops.

[44] Military Traffic Management Command Transportation Engineering Agency [MTMC-TEA] report "JOINT VENTURE (HSV-X1): TRANSPORTABILITY ANALYSIS OF VESSEL LOADING DURING MILLENNIUM CHALLENGE 2002, Port Hueneme, California, to Port of Tacoma, Washington, (11 Thru 13 August 2002), " 29 OCTOBER 2002

[45] See the Joint Venture and Sea SLICE daily summary reports for additional information on vessel activities during FBE-J. Additional input provided by Joint Venture's OIC.

8/2	DVs; NSW, SCORE Range	U/W overnight for NSW ops with NSWTU embarked. Embarked CNO for underway demonstration. CNO disembarked via SH-60S. Conducted DLQs with two SH-60S. Ran SCORE range with USS ALABAMA. Conducted FAST rope training and DLQs with three HH-60 and embarked SEALs. Transited north at 35 knots to vicinity Pt Hueneme.
8/3	NSW VBSS	Ex-scenario. Night rendezvous and recovery of SDV at sea. RTP, offloaded SDV. U/W overnight for VBSS rehearsals and operations. Launched 11m RHIBs. Daylight VBSS rehearsal using JV as target for boat teams and helo fastroping followed by night VBSS operation with forces originating from and controlled by NSWTU aboard JV. Successfully demonstrated UAV control from JV. Successful TCDL link from VPU P-3.
8/4	NSW VBSS	Ex-scenario. Operating out of Pt. Hueneme. U/W for VBSS rehearsals and operations.
8/5	NSW VBSS	Operating out of Pt. Hueneme. U/W overnight conducting in-scenario VBSS ops. Embarked CPG-3 and staff and disembarked by Helo.
8/6	NSW VBSS Transit SD	Ex-scenario: Operating out of Pt. Hueneme. Recovered 11m RHIBs. RTP NAVSTA San Diego. Offloaded NSWTU Hawk. U/W 1000-1500 for MC02 DV embark.
8/7	DV Ops	U/W 1000-1400 for CODEL embark. Turnover to Army.

Figure 7-3: Joint Venture Operations 24 July - 7 August 2002.

LIVE SEA SLICE OPERATIONS 24 JULY -7 AUGUST 2002		
Date	**Missions**	**Remarks**
7/24	MCM	Concurrent live and simulated ops. Used Klein sonar in support of Q-route clearance for Red Beach. Had 17 contacts at sea but was unable to enter data into MEDAL
7/25	MCM	Concurrent ops. Using Klein sonar in support of Q-Route clearance of Red Beach
7/26	MCM	Concurrent ops. Using Klein sonar and REMUS in support of Q-Route clearance of Red Beach.
7/27	Pier side, San Diego	Ex-scenario. Installing Net Fires canister launchers
7/28	At sea	Ex-scenario. Underway conducting gun alignment checks.
7/29	AMWC	Concurrent ops. Supporting USMC STOM into Del Mar Boat Basin. Fired 80 LAM and PAM munitions against fixed land targets such as SAM, 122 mm artillery, and CSSC-3 Coast Defense Batteries. During night, patrolled south of ARG to protect against small boat and submarine attack using Millennium gun and torpedoes.
7/30	ASUW, Fires for STOM, SWARMEX	Concurrent ops. Provided ASUW and Net Fires support for STOM. Simulated remote launch of PAM/LAM. Transited @26 kts. Used FLIR/EO and Millennium Gun to engage small boats. Supported JV entrance to Del Mar Basin. Transit to Pt. Hueneme for RON.
7/31	Live Fire demo	Ex-scenario. 35mm Millennium Gun successfully engaged towed surface target.
8/1	Live Fire demos	Ex-scenario. Successful demo of Millennium Gun against periscope-sized target at range of 500 yds.
8/2	Fire demo	Ex-scenario. Live fires Net Fires Blast Test Vehicle (BTV).
8/3	In port, Pt. Hueneme. U/W VBSS	Ex-scenario. Completed live fire demo, returned to Pt Hueneme. Replaced workshop module with crew berthing module (20 min). U/W 1800 to join JV for VBSS ops.
8/4	VBSS	Concurrent ops. U/W 1730 to join JV for VBSS. Passive sensors detected and tracked targets rapidly and accurately
8/5	Transit San Diego	Ex-scenario. Prepare for DV operations.
8/6	In port, SD; local ops	Ex-scenario. DV tours morning; U/W for medical personnel tours in afternoon
8/7	In port SD, DV	Ex-scenario. DV tours

Figure 7-4: Live Sea SLICE Operations 24 July -7 August 2002.

SIMULATED HSV EMPLOYMENT IN FBE-J						
Date	**HSV(M)-21 Agile**	**HSV(M)-22 Aggressive**	**HSV(M)-23 Exultant**	**HSV(M)-24 Impervious**	**HSV(M)-25 Hercules[46]**	**Sea SLICE (Simulated)[47]**
7/24	MIWC, MCM	MCM	Direct support (DS)-XMEB ITL	DS-NSW	7th Fleet ITL	N/A
7/25	MIWC, MCM	MCM	DS-XMEB ITL	DS-NSW	7th Fleet ITL	N/A
7/26	MIWC, MCM	MCM	DS-XMEB ITL	DS-NSW	7th Fleet ITL	N/A
7/27	MIWC, MCM	MCM	DS-XMEB ITL	DS-NSW	7th Fleet ITL	N/A
7/28	MIWC, MCM	MCM	DS-XMEB ITL	DS-NSW	7th Fleet ITL	N/A
7/29	MIWC, MCM	MCM	DS-XMEB ITL	DS-NSW	7th Fleet ITL	N/A
7/30	MIWC, MCM, ITL for MIWC	MCM	Sunk by missiles	DS-NSW	7th Fleet ITL	N/A
7/31	MIWC, MCM, ITL for MIWC	MCM	Sunk	DS-NSW	7th Fleet ITL	Escort defecting Kilo sub
8/1	Sunk	MCM	Sunk	DS-NSW	7th Fleet ITL	Escort defecting Kilo sub
8/2	Sunk	Sunk	Sunk	DS-NSW	7th Fleet ITL	transit; STWC
8/3	Sunk	Sunk	Sunk	DS-NSW, on-call CSAR	7th Fleet ITL	STWC; ARG sppt
8/4	Sunk	Sunk	Sunk	DS-NSW	Chopped to 5th Flt, in transit to Straits to support JFMCC/ JFLCC ops.	ARG sppt; Sunk
8/5	Sunk	Sunk	Sunk	DS NSW	In transit	Sunk
8/6	Sunk	Sunk	Sunk	DS X-MEB (island seizure, landings)	DS NSW	Sunk
8/7	Sunk	Sunk	Sunk	DS X-MEB (island seizure, landings)	DS NSW	Sunk

Figure 7-5: Simulated HSV Employment in FBE-J

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46 Early in FBE-J planning and based on Joint Venture's commercial, off-the-shelf technology and previously established CONOPs, NWDC proposed establishing significant numbers of HSVs within the scenario simulation. Included in that proposal were 4 HSVs and 6 Sea Slice variants supporting Assured Access missions, 4 HSVs supporting logistics missions, and 4 Army Theater Support Vessels (TSVs) to support Army requirements. See the "Naval Blue Force Master w/ TPFDD info" spreadsheet dated 25 Feb 02 for additional details. JFCOM turned down that proposal. With the sinking of the third simulated HSV, exercise controllers decided there was a need to bring additional HSVs into the scenario. NWDC resurrected its earlier work and established a global inventory of 10 HSVs in accordance with the aforementioned CONOPS, with Hercules coming into theater from 7th Fleet. See the NWDC paper "Global HSV Assets" created 1 August 2002.

47 There was never more than one Sea SLICE in the scenario at any one time. Early execution planning called for live Sea SLICE operations to be portrayed in the common operating picture using that vessels embarked JSAF terminal. When live vessel operations were conducted outside the scenario, the JSAF operator and the Sea SLICE's systems operators would continue to 'fight' the vessel in the scenario. During execution, it was discovered that the live Sea SLICE would not be able to support day-in and day-out operations within the simulation. In response to that change, a simulated Sea SLICE was established at FCTCPAC to keep the vessel in play whenever the live Sea SLICE was ex-scenario.

7.4 HSV Analysis Results

This section discusses analysis results from those objectives adequately supported by data. Overarching questions are answered in this chapter's summary, section 7.6.

7.4.1 Suitability of HSVs for Maritime Operations

The HSV experiment and data collection plans posit that a force of littoral surface combatants with the characteristics of an HSV will be suitable for Naval operations.[48] Suitability was addressed in those plans in terms of survivability, endurance, and sea keeping. Technical data on sea keeping had already been collected for Joint Venture as part of the joint HSV project, so only those conclusions discussing survivability and endurance are summarized here.

7.4.1.1 Survivability

For any vessel, survivability is a function of its ability to operate in its natural (or physical) and its physical operating environment. For both live and simulated vessel operations, natural environmental conditions were not tested due to the very benign weather and sea conditions experienced during FBE-J. Consequently, only issues associated with simulated vessel survivability in its operating environment are addressed.

One characteristic of HSV employment shared with other types of vessels is the inherent risk of operating in a littoral environment. Mines, attacks from small boats, fires from shore batteries or any number of other threats must be addressed in vessel design and in planning maritime operations. During FBE-J, a number of simulated Navy ships and vessels were attacked and sunk during littoral operations. The simulated HSV experience vis-à-vis those threats is summarized below, and on the whole is indicative of the wider fleet experience within the simulation.

- HSV (M)-23 sunk by a missile on 30 July 2007 while supporting the Marines.
- HSV (M)-21 sunk on 1 August 2007 while conducting MCS/MCM ops. Cause unknown.
- HSV (M)-22 sunk by a missile on 2 August 2007 while conducting MCM ops.
- Sea SLICE (simulated) sunk by missiles on 4 August 2007 while providing fires support to the TARAWA ARG.

Each loss was due to the vessel coming in range of a threat, primarily missiles. Vessel operations within range of a fatal threat can be attributed to not knowing of the threat's existence, a breakdown in command and control, a lack of knowledge on vessel capabilities and limitations, or a determination by the operational commander that such risk was warranted. There is no evidence from the simulation that those vessels fired their weapons (SEARAM, machine guns, grenade lauchers) in defense against the threats.

While some observers question the validity of those losses/results, there was no question in participant minds of the significant threats associated with littoral operations.[49] For HSVs, and for any vessels that the HSV acts as a surrogate, littoral operations and their attendant threat are issues that must be addressed. Defining and quantifying the threats populating that environment is a essential first step. Assessing HSVs' vulnerability to those threats is the second step. Addressing those vulnerabilities through changes to vessel design, installation of counter-measures and armaments, and developing compensating CONOPS and TTPs is another step that must be taken. Finally, maritime planners must have knowledge of and an

[48] FBE-J Experiment Plan, Joint Initiatives – High Speed Vessel
[49] Qualitative Survey, MIW, Question 16

appreciation for HSV capabilities and limitations. Areas of specific relevance to HSVs are any increased vulnerabilities accruing to vessel design and construction, and the ability of an optimally manned vessel to protect itself and to control damage from an attack.

7.4.1.2 Endurance

Endurance is directly related to a vessel's ability to conduct sustained operations. Endurance encompasses considerations such as equipment and systems reliability; fuel storage, fuel consumption; crew ability to support long-term, high tempo operations; and essential support to embarked systems and personnel, i.e. hotel services such as water, food, power, and air conditioning.

In a vessel where those considerations were not principal design factors, endurance is very limited. Sea SLICE, built as a hull-form technology demonstrator, is an example of such a vessel. Sea SLICE's endurance during FBE-J was very limited, and experimentation CONOPS were developed to accommodate that limitation. As a surrogate for other vessels however, Sea SLICE's limited endurance had very little impact on its ability to meet planned experimentation objectives.

In vessels where endurance considerations were given more weight in their design, greater endurance can be expected. Joint Venture, as a car ferry designed for short duration, high speed transits between ferry terminals, could be expected to have reliable commercial equipment and systems but only a limited ability to conduct sustained, high tempo military operations. To the extent that the vessel was modified with extra fuel and water storage, water-making capability, food storage, increased crew size, permanent (but austere) crew berthing, etc., its endurance increased. Due to funding and time constraints, those modifications were limited, so increases in vessel endurance were also limited.

Available data do not support drawing conclusions on equipment and systems reliability as they relate to the vessels themselves. It is sufficient to observe that equipment reliability was adequate to the task and that each vessel completed its planned experimentation. There are enough data, however, to evaluate the other endurance considerations of fuel storage and consumption, support from the crew, and support to the crew and/or passengers.

7.4.1.2.1 Fuel Storage and Consumption

By far the best opportunity to evaluate vessel endurance as it relates to fuel storage and fuel consumption is the Army's delivery voyage of Joint Venture from CENTCOM to San Diego and its subsequent turnover to the Navy for FBE-J execution. Covering a total distance of 13226 nautical miles in an elapsed time of 23 days 6 hours, with an average underway speed of 28 knots, with only four stops for fuel the statistics speak for themselves. HSV technology strongly enhances vessel endurance vis-à-vis fuel storage and consumption.[50]

7.4.1.2.2 Crew Manning and Performance

During FBE-J, both Joint Venture and Sea SLICE had core crews augmented by embarked personnel and staffs to create their respective warfighting capabilities.

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[50] Additional information on the Army's transit voyage is available in a 16 July Power Point brief "Army Route Persian Gulf to San Diego;" a 16 July spreadsheet "Army Route Persian Gulf to San Diego;" and U.S. Army Combined Arms Support Command report "HSV-X1 (Joint Venture), U.S. Army Snapshot, 20 March 02 to 13 July 02" dtd 15 Jan 03.

Joint Venture's core (or baseline) crew consisted of 31 sailors and soldiers. As a result of lessons learned from previous operations, crew size increased to 42 in order to support embarked staff operations. Embarked staff more than doubled those numbers. Sea SLICE's four core crewmembers were augmented with an additional 10 systems operators to give that vessel its warfighting capabilities.

While all deck evolutions, support for embarked staffs, and appropriate services were safely and effectively accomplished, Joint Venture's experience during FBE-J suggests that assumptions regarding adequate crew size need to be reviewed for any vessel similar to HSVs. As an example, when the vessel went to flight quarters, 19 crewmembers were pulled away from their primary duties to support flight operations.[51] Although not quantified, the opportunity cost associated with flight operations was not insignificant.[52]

More insidious, and with more potential impact on vessel endurance and ability to accomplish assigned missions, is the impact of reduced crew size and vessel habitability on individual crewmember performance. Optimal vessel manning only makes sense to the extent that it takes into account individual performance.

During FBE-J, a small, very limited experiment was conducted to evaluate the relationship between the Joint Venture, its crew, and fatigue. Activity levels for 4 crewmembers were monitored during the experiment. As a group, these crewmembers averaged approximately 3 hours sleep per night, with a range from 2 to 5 hours. Individuals with sleep patterns such as those seen on the HSV have predictable decrements in performance and a greatly increased risk of mishaps due to lapses in attention and fatigue.[53] Given those conditions, Joint Venture's successful completion of missions without mishap during FBE-J is testimony to a superb, well-led crew. Nonetheless, while the small sample size limits conclusions, these results warrant further investigation for their risk management implications and impact on future ship design (and endurance).[54]

Additional discussion and information on this issue is available in Chapter 19 and Appendix 11.

7.4.1.2.3 Hotel Services

As mentioned earlier, neither Joint Venture nor Sea SLICE were designed to accommodate significant numbers of crew and embarked staff for long periods of time. The limited amount and quality of hotel services limited each vessel's endurance. A known constraint before experiment execution, CONOPS for these surrogate vessels was adjusted to compensate for these limitations. Participants, while noting shortfalls,[55,56] took the minor hardships in stride and completed their missions. The predetermined conclusion from this aspect of vessel operations is that if greater endurance is desired, more consideration must be given to hotel services.

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[51] Fleet Battle Experiment – Juliet, HSV Initiative, Summary Report, Additional Information
[52] MCWL report, p. 21
[53] Hursh, S. R., Redmond, D. P., Johnson, M. L., Thorne, D. R., Belenky, G., Balkin, T. J., Storm, W. F., Miller, J. C., and Eddy, D. R. (in press). Fatigue Models for Applied Research in War Fighting. Aviation, Space, and Environmental Medicine, 2002.
[54] Manning lessons learned from FBE-J confirmed the need identified earlier to increase HSV crew size. While the FBE was being conducted, Navy planners were working on design criteria for Joint Venture's replacement. As a result of this data, crew size for HSV-2 (scheduled for delivery to the Navy in July, 2003 is set at 40.
[55] Fleet Battle Experiment Juliet (FBE-J), Survey Results, HSV.
[56] MCWL report, p. 21.

7.4.1.3 Suitability Summary

Conclusions as to vessel suitability for Naval operations must be reached cautiously. Both Joint Venture and Sea SLICE are surrogates for future vessels. As surrogates, during FBE-J they were super-imposed into artificial operating environments in order to gather data on their suitability. Despite these artificialities, there are enough data to suggest that HSV technology, and in the case of the Joint Venture the vessel itself, are potentially suitable for Naval operations. To the extent that these surrogates were modified, they became even more suitable. With greater emphasis given to survivability, manning, personnel services, and other considerations in vessel design, their suitability for Naval operations will increase further.

7.4.2 HSV Characteristics and Mission Performance

As surrogates for future vessels, assessing the value of selected HSV characteristics provides program offices with important data during their design deliberations. As an example, if one of the HSV's unique characteristics is speed, then the FBE-J experience should identify numerous opportunities where speed was a deciding factor in mission success. Confirming the value of HSV speed should suggest to program managers that there is a need to invest in future vessel's speed. Conversely, if the FBE-J experience suggests speed is not that critical, then the investment in speed can be reduced in favor of other characteristics more important to mission accomplishment. In this section, the HSV characteristics of high speed, high payload fraction, shallow draft, support to other vehicle operations, and a sampling of other considerations are discussed.

7.4.2.1 High Speed

Navy officers know intuitively that some speed is good, and more speed is better. At first glance, as simulated vessels conducted transits into the scenario's theater of operations, the ability to close the force quickly by taking advantage of the vessels high speeds seems to bear out this intuition. The simulated vessel HSV (M)-25 entered the theater of operations at 51 knots. [57] Joint Venture routinely demonstrated speeds of 25 knots in transit and when engaged in VBSS operations. It also "conducted daily high-speed transits to and from the southern California (SOCAL) operating areas in support of multiple tasking (to include 17 unassisted port entries and departures)."[58] During the health services DV operations demonstration, its speeds averaged 31 knots in 2-3 foot seas.[59] Sea SLICE transited at 26 knots during FBE-J and made speeds of 30 knots during VBSS operations. The Army live vessel delivery of Joint Venture from CENTCOM to the San Diego, the transit into and out of Del Mar Boat Basin, and some limited anecdotal comments from the MIWC staff also reinforce the conclusion that speed has value.

A review of both live and simulated vessel usage during FBE-J suggests however that high speed, while still an important characteristic, was not as important as other characteristics within the scenario. With the exception of transits to, and occasionally within a theater, see tables 7-3, 7-4, and 7-5, high speed was not a principal determinant in mission success. The primary reason for the limited display of vessel speed is their assigned missions. Speed has limited utility in MCS and MCM roles (HSV (M)-21 and -22), or while in port waiting for missions (HSV (M)-23 and -24). If those vessels' primary missions had been logistics support or force closure, speed as a premium would have been valuable.

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[57] IWS Chat Log, 6 Aug 02
[58] HSV Preliminary Quicklook Report
[59] "Underway Evaluation of the HSV for Health Service Support Capabilities," NWDC Trip Report

The FBE-J experience suggests that future vessel designs should not ignore other HSV design characteristics in favor of speed. As an example, through modeling and careful analysis of anticipated vessel CONOPS, program managers may find that vessel ability to enter austere ports and discharge cargo may have greater value than speed.

7.4.2.2 High Payload Fraction

Simply stated, payload fraction refers to that portion, or fraction, of total vessel displacement that can be devoted to payload. Maximum payload (high payload fraction) is also a function of fuel and cargo. For HSVs, the greater the fuel load and subsequently greater range and/or higher speeds, the smaller the cargo. Greater cargo loading, however, results in a smaller fuel load and subsequently shorter range and/or lower speeds.

Joint Venture's maximum payload is 840 tons; nearly equal to its deadweight 915 tons (the basic vessel weight without fuel or cargo). Sea SLICE, as a hull-form technology demonstrator, was not designed to have a high payload fraction.

With one exception in an associated action, payload fraction was not a principal determinant for mission success during FBE-J in either live or simulated vessel play. The exception was the Army's SBCT movement from Port Hueneme, California to Tacoma, Washington. With vehicles (386 tons), trip fuel, and fuel reserve the Joint Venture's payload was only 668 tons, well under her maximum payload. No other live HSV action in the experiment came close to demonstrating the values of high payload fraction. This one exception however, demonstrates the efficacy of ships with high payload fraction.

7.4.2.3 Shallow Draft and Vessel Maneuverability

Shallow draft and vessel maneuverability were principal determinants in the success of live vessel missions. During FBE-J, both Joint Venture and Sea SLICE took advantage of their relatively shallow drafts of 13 and 14 feet, respectively to provide support. Both vessels moved into shallow water, close to shore, to support MCM operations. Additionally, in a demonstration of fine seamanship and as a validation of the value of shallow draft coupled with great maneuverability, Joint Venture entered Del Mar boat basin, moored, offloaded equipment, and departed without assistance. To improve maneuvering visibility, the vessel was backed up the relatively long, narrow (150 yards wide), and shallow (18 foot depth) channel. The transit took approximately 20 minutes at 2 to 5 knots, was done without assistance from tugs, and passed without problems. Once in the basin, the vehicle ramp was lowered onto a pre-positioned causeway and vehicles were offloaded, people loaded aboard, and the vessel departed, all in approximately an hour.[60] Joint Venture was by far the largest vessel to ever enter this basin.

The importance of Joint Venture's Del Mar boat basin operation to force closure; reception, staging, onward-movement, and integration (RSOI); STOM; and force sustainment, cannot be overstated. Depending on the operating theater, independent studies suggest that the number of ports available for military use increases by nearly 600% when depth requirements are reduced from 36 feet to 15 feet (or under).[61] Expanding the number of available ports in turn, expands the freedom and opportunities available to a joint force conducting the aforementioned operations.

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[60] MCWL report.

[61] CNA Research Memorandum D0005440.A1/Final, World Ports: Pier Depth and Harbor Size—Parts I & II: The Mediterranean and Black Sea, by Daniel P. Roek, January 2002.

7.4.2.4 Support for Air, Surface and Sub-Surface Vehicle Operations

HSVs' ability to support air, surface, and sub-surface operations was a principal determinant in successful completion of their assigned missions. The ability to support these operations makes each vessel more than just a ship moving through the water. The ability to support these operations transforms these vessels from a car ferry or a technology demonstrator into a warship, even if only as a surrogate in an artificial environment. Support to those operations is discussed more fully in the following paragraphs.

7.4.2.4.1 Air Operations

Both vessels' ability to support helicopter operations contributed to successful mission completion. Sea SLICE, without a landing deck, was not able to support helicopter takeoff or landings. Nonetheless, it demonstrated an ability to support limited vertical replenishment and movement operations when a CH-46 from HC-11 lifted Joint Warfighter's Counterfire System (JWCS) from Sea SLICE to shore. JWCS provides fires support to troops ashore.

Although limited to day, visual flight rules operations by her Naval Air Systems Command Certification,[62] Joint Venture made good use of her ability to support helicopter operations.

- SH60F – Deck Landing Qualifications (DLQs) (30 takeoffs/landings)
- HH60H - NSW fast rope (16 takeoffs/landings)
- H60S - DLQ/CNO transfer (6 takeoffs/landings)
- Navy CH46 - Passenger transfers (2 transfers)
- USMC CH46- DLQs (14 takeoffs/landings)[63]

Joint Venture's helicopter support limitations are entirely due to previous decision to limit the amount of modifications made to this former car ferry. Only enough modifications were made to evaluate or demonstrate the value of helicopter operations from HSVs during concepts-based experimentation. Night lighting, NAVAIDs, fuel storage, and aviation refueling systems were not installed.

Among the comments accruing to FBE-J include the small size of the helicopter deck, and obstacles or restrictions to approach and landing.[64] Lessons learned from Joint Venture's continuing helicopter operations need to be distilled and provided to program offices using HSVs as surrogates for development of their vessels.

7.4.2.4.2 Surface and Sub-Surface Operations

Even more critical to HSV success during FBE-J than air operations were the vessel's ability to support an impressive array of surface and subsurface vehicle operations. The Joint Venture and/or Sea SLICE successfully launched, operated, and retrieved the following vehicles:

- Battlespace Planning and Autonomous Undersea Vehicle (BPAUV)
- Rigid Hull Inflatable Boat (RHIB)
- Remote Minehunting System (RMS)
- Remote Environmental Monitoring Unit System (REMUS)

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[62] COMNAVAIRSYSCOM PATUXENT RIVER MD R 172102Z DEC 01.
[63] Fleet Battle Experiment – Juliet, HSV Initiative, Summary Report, Additional Information
[64] MCWL report

- Klein side-scan radar
- The Unmanned Harbor Security Vessel (UHSV) OWLIII
- Swimmer/SEAL Delivery Vehicle (SDV)
- Combat Rubber Reconnaissance Craft (CRRC)

Due to her small size and limited deck storage space, Sea SLICE support to surface and sub-surface operations was limited to Klein sonar deployment and interoperability demonstrations with REMUS and RHIB deployment. CONOPS were developed to take advantage of her capabilities. Sea SLICE's Klein side scan sonar operations in support of Q-route clearance for the Mine Warfare Commander provided a valuable demonstration of the vessel's capabilities to work in shallow waters while deploying surface and sub-surface systems.[65]

Joint Venture's greater size, particularly its 12,000+ square foot mission bay/vehicle deck make it ideally suited to support surface and sub-surface operations. Advantages cited for using Joint Venture for autonomous underwater vehicles (AUVs) deployment included:

- The large bay to prepare for launch
- Flexibility and room aboard
- Robust C4I suite
- Speed and maneuverability of the vessel
- The large number of AUVs that can be carried and deployed.[66]

With recognition that these were surrogate vessels and while applauding their capabilities, participants noted that both vessels vehicle deployment systems were not optimized for surface and sub-surface system deployment and retrieval. Mention was made of Sea SLICE's knuckle-boom/A-frame.[67] Joint Venture's well-documented deficiencies in the crane used to launch and recover surface and sub-surface vehicles were a source of comments as well.[68] Passenger unloading off of Joint Venture's port quarter was identified as an area of concern.[69] All of these and other comments are valid concerns that should be taken into account when the lessons learned from these surrogate vessels are carried forward into future ship design.

Additional discussion of HSV support to surface and sub-surface operations is available in Chapter 11 (Mine Warfare).

7.4.2.5 C4I Support for Command and Control

Within the HSV initiative, evaluation of the vessels' ability to support C4I functions was limited to determining the relative worth of C4I as an important vessel characteristic. Both live HSVs were configured to provide C4I support through robust systems underpinned by high bandwidth Ku-band satellite communications.

Most of Joint Venture's C4I evaluation came from the MIWC and his staff (see chapter 11, MIW). Without duplicating the discussion in the MIW chapter, "… There was widespread support and praise for the HSV [Joint Venture] as a command and control platform (Chapter 11, par. 11.3.3). The NSW Task

[65] Lockheed-Martin Sea SLICE report
[66] Qualitative HSV Survey, Question 31
[67] Lockheed-Martin Sea SLICE report, p. 26
[68] MCWL report, pp. 8 & 9
[69] Ibid, p. 14

Unit embarked and used their own C4I equipment, and Marine Corps STOM operations made only light use of the vessel's C4I capabilities (PRC-117, ICS 2003 Matrix Plus monitoring system).[70]

Sea SLICE's ability to support C4I functions was limited principally by her small spaces and consequent inability to support embarked C2 staffs.

Like the ability to support air, surface, and sub-surface operations, the HSVs' ability to support C4I operations is what distinguishes the HSVs in FBE-J from a car ferry or a technology demonstrator. C4I is a fundamental underpinning for RDO.

7.4.2.6 Self-deploying

As previously mentioned during the vessel endurance discussion, Joint Venture demonstrated a superb capability to self-deploy over great distance at high speed with no support from auxiliary refueling vessels. Although no data were gathered to evaluate the impact of that self-deployment, or the impact of simulated vessel self-deployment within the scenario, there should be no doubt as to this characteristic's value to the Joint Force Maritime Component Commander (JFMCC) and his staff.

7.4.2.7 Reconfiguration and Modularity

The value of these vessels to reconfigure for different mission sets was demonstrated through live vessel operations, although only one simulated HSV was reconfigured. In order to meet the demand for live vessel access by various staffs, Joint Venture was configured or reconfigured for different missions five times over a two and a half week period.[71] Sea SLICE was configured or reconfigured four times over that same period, as shown in figure 7-4. In the fluid environment characterizing RDO, there is no question of the utility of vessels that can reinvent themselves to meet a variety of requirements.

Special note should be made of Sea SLICE's superb use of mission modules to give that hull-form technology demonstrator its warfighting capability. Sea SLICE had a comprehensive system for standard installation of deck-mounted equipment associated with particular missions. This standardization permitted installation and securing of equipment or modules very quickly, usually within minutes.[72] From a modularity perspective, the vessel itself was a communications backbone supported by a series of interfaces that allowed Sea SLICE to accept and integrate the following capabilities.

- Three C2 containers
- A storage/maintenance shelter
- Crew quarters
- Weapons modules
    - 35 mm Millennium Gun
    - Torpedo Launchers
    - NetFires Live Fire Launcher
    - JWCS STOM Support Launcher
    - NetFires mock up launchers
- Small boat crane

There is much to learn from the Sea SLICE team's innovative approach to modularity.

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[70] Ibid, p. 22
[71] HSV Preliminary Quicklook Report.
[72] Lockheed Martin Sea SLICE Report.

7.4.2.8 Characteristics Summary

This brief review provides insight into how various HSV characteristics contributed to successful mission accomplishment. Every one of the aforementioned characteristics has value. Clearly, HSV's ability to support air, surface, and sub-surface operations enabled by a robust C4I system gives the vessels military utility and is arguably their most important characteristic. This 'most important' category also includes vehicle loading, unloading, and cargo handling considerations. A close second are the characteristics of shallow draft and vessel maneuverability. The ability to move into and out of large numbers of austere ports provides the JFC a distinct advantage in the conduct of his operations. While not fully exploited during this experiment, the value of high speed, high payload fraction, and self-deployment are characteristics that ship designers must keep in mind when developing future ships and vessels. Finally, in the continuing era of austere funding, the flexibility inherent in reconfigurable vessels will be of significant value to future JFMCCs as they shape the battlespace with ever-smaller numbers of ships.

7.4.3 Other Considerations

In addition to the discussion on the value of vessel characteristics or the vessel's suitability to support Naval operations, there were other observations that should be noted in this report.

7.4.3.1 Health Services Support Assessment

Although not formally a part of the HSV initiative, NWDC took advantage of the proximity of San-Diego based health services expertise to conduct a preliminary evaluation of the Joint Venture's ability to host or provide health services support (HSS). Those evaluations,[73, 74] conducted before and during FBE-J, provided a wealth of information for use in HSV design and HSS CONOPS development. Included in those reports were observations of certain environmental or other conditions aboard the vessel that warrant consideration in design or additional study. These include:

- Noise levels ranging from 85 to 96 decibels in the mission bay deck, requiring all personnel working on that deck use hearing protection and interfered with basic medical procedures such as hearing manual blood pressure and lung sounds with a stethoscope
- The passageways were too narrow and elevators too small for litters
- A ramping system is needed as a backup for the elevators
- The vessel might be better suited to be rapid transportation out of a combat area rather than a mobile treatment facility
- Poor air quality due to diesel fumes was evident in the mission bay when the vehicle was loitering
- Seasickness and fatigue while underway would impair the effectiveness of medical personnel.

7.4.3.2 Vessel Allocation

An unlooked for challenge affecting simulated HSV usage and the data that should have flowed from that usage was the difficulty the JTF HQ and its component staffs had in effectively planning for and using this emerging, multi-mission asset. Symptomatic of the problem were simulated HSVs not showing up on maritime tasking orders (MTOs), not planned for or requested in maritime support requests (MARSUPREQs), and not controlled in the simulation. While there is no evidence to suggest that a lack of control contributed to the sinking of any of the simulated HSVs, there is no evidence to suggest

[73] "Underway Evaluation of the HSV for Health Service Support Capabilities," Trip Report, CDR Sara Marks, NC, USN

[74] "Fleet Hospital Specific Pier Side And Underway Evaluation Of The High Speed Vessel (HSV) For Health Service Support (HSS) Capabilities," Trip Report, 16-20 July 2002 and 31 July 2003.

otherwise. The challenges these staffs faced were primarily due to a still maturing maritime planning process (see chapter 5) and an immature HSV CONOPS.[75]

As the experiment continued to unfold, the JFMCC staff adopted a work-around procedure of placing all HSVs in a common-user pool used to manage logistics assets. This practice was widely acknowledged as a less than optimum solution as PWCs would always be uncertain as to HSV availability, and never have "ownership" of the asset for detailed planning. This problem was noted in MIW, when clearance tasks took several days to accomplish, but repetitive MARSUPREQs were not issued to ensure continuity of tasking. Unfortunately, no other allocation solution evolved during the experiment. The opportunity cost associated with this problem was a less-than-effective employment of the simulated HSV assets.[76]

7.5 Sub-Initiative Results

7.5.1 Results for HSV Support to Mine Warfare

Chapter 11, MIW, provides a detailed discussion of all aspects of MIW during FBE-J. Summarized here are findings relevant to an evaluation of HSVs.

The HSV-X1 provided MIW support as a platform for experimentation from 23-28 July with launches of BPUAV, REMUS, OWL III, and a VSW Detachment; and as the MIW Commander's flagship from 26 – 30 July. While functioning in that flagship capacity, it embarked the Tadpole data processing system for BPAUV and used MEDAL, LAWS, GCCS-M, and IWS software.[77]

Sea SLICE acted as an MCM platform from 24-26 July, clearing Q-routes with an embarked Klein side scan sonar and REMUS. MEDAL was the software system used aboard Sea SLICE during MCM operations.

"The concept of using the HSV as a MIW C4ISR platform to support the MIWC was highly successfully. The HSV proved to be a "good test platform and a suitable interim solution to the MIW C2 issue."[78] The C4ISR suite provided the MIWC with adequate space and sufficient tools to participate in the JFMCC collaborative environment and net-centric warfare. Communication interruptions had periodic adverse impacts on the total effectiveness, but when the suite worked it was highly effective. Although there were shortcomings, they did not stem from the location of the MIWC aboard the HSV.

- The HSV appears to be an excellent platform for supporting the MIWC and MCM. Advantages include:
  - High speed to area of operations and while conducting various MIW missions
  - Shallow draft will allow operations in relatively shallow water
  - Large cargo volume can provide ample workspace and support areas for supporting future remote autonomous vehicles (RAVs) and their operational mission and maintenance crews.

- Disadvantages and risks include:
  - Potential vulnerability of the HSV to hostile action due to design and construction factors, lack of countermeasures or compensating CONOPS

[75] Fleet Battle Experiment – Juliet, HSV Initiative, Summary Report, Additional Information
[76] Fleet Battle Experiment Juliet (FBE-J) Juliet Report, Final Summary Report, Section I. Principal Results
[77] Fleet Battle Experiment – Juliet, HSV Initiative, Summary Report, Additional Information
[78] JFMCC MIWC Top Three Lessons Learned Report, 3 Aug02

    - Loss of one HSV with large number of RAVs (est. 25 to 30) could risk the entire MIW mission success and/or timeline if additional resources are not readily available
    - Under the concept of rapid reconfiguration for HSVs, MIW may be competing with other missions for the use of the HSV.

- Studies will need to be undertaken to mature the CONOPS for HSV support of MIW, including
    - Determination of the appropriate number and overall distribution of MIW assets on HSVs
    - Assess the requirement for redundant back-up operational databases and MIWC SA in case of loss
    - Assess the likelihood that competition for HSV resources will impact on MIW mission success
    - Designing/determining launch and recovery systems optimized for surface and subsurface vehicles.

7.5.2 Results for HSV Support to Navy Special Warfare

Both HSVs were used to support various NSW operations.

Joint Venture supported hydrographic reconnaissance missions on 27 and 28 July; SDV launch and recovery operations on 28 July and 1 August; and provided an afloat forward operating base for an embarked NSW Task Unit commander (NSWTU Hawk) from 31 July through 6 August. During the latter, 3 SEAL platoons, 2 11-meter RHIBs, and a SENTRY UAV control station were operated from the HSV-X1. Embarked NSW C4ISR equipment was supported by an HSV-provided TCDL data/video link. Voice communications, GCCS-M, and IWS software were also used in support of NSW operations.

These activities generated the following observations from the Joint Venture's crew:

- 16 NSW fast rope cycles were completed without discernable problems from an HH-60H (16 bounces)
- The HSV's TCDL system supported a satisfactory video link with a VPU aircraft
- Transom modifications (based on previous experimentation) made to the HSV to support NSW 11 meter RHIB operations were effective
- An SDV full of water stresses the crane’s 10-ton limit. Further research is needed to identify the full SDV’s weight.

The best overall evaluation of Joint Venture's NSW support comes from the NSWTU after action report.

> “Live embarkation of HSV by a NSWTU proved the operational feasibility of using this platform as an afloat staging base. The embarked NSWTU was aboard the HSV for 5 days and conducted 3 consecutive days of VBSS operations. This platform proved ideal for supporting NSW operations but several major items were identified as needing modification to meet the following needs:
>
> (1) Ability to launch, recover, and store 4 X NSW RHIBS at sea.
> (2) Ability to land and store a minimum of 2 X HH-60 helicopters.
> (3) Ability to house 2 X SEAL platoons and equipment.
> (4) Ability to house 1 X NSWTU headquarters element.

(5) Ability to have integrated comm. suite."[79]

Sea SLICE teamed with Joint Venture from 3 to 5 August to successfully support NSW visit, board, search, and seizure (VBSS) operations. Her Sea FLIR and Sea Star SAFIRE II equipment proved particularly beneficial in covertly locating targets from over four miles away. The equipment's laser and infrared capability proved far superior to the standard starlight night vision equipment, particularly on nights when there was no starlight. It was also able to precisely observe and locate individual crewmembers trying to hide on the target vessel before the SEAL team boarded. The FLIR also tracked a target ship that tried to obscure its radar identification by merging its reflected signals with another vessel.[80]

7.5.3 Results for HSV Support to STOM and Logistics

As mentioned earlier in this chapter, the Marine Corps Warfighting Lab (MCWL) developed an independent experiment and data collection plan,[81] and FBE-J planners opted not to duplicate their efforts with a separate Navy effort. Highlights and findings from MCWL's report follow:

- Over the period 28 to 30 July, Joint Venture supported an insertion of a reconnaissance team via CRRCs, and introduced follow-on forces (3 LVS, 4 LAVs, 2 5-ton trucks) into an austere port (as represented by the Del Mar boat basin.
- Joint Venture successfully demonstrated its ability to support both MAGTF operational maneuver and the intra-theater movement of cargo and passengers between ports.
- Joint Venture acted as a communications relay between the Marine Reconnaissance and USS Boxer.
- Joint Venture successfully conducted SEAL swimmer delivery vehicle (SDV) operations and a Marine reconnaissance insertion at night. Different standard operational procedures were required for each evolution.
- HSV advantages include its shallow draft, high speed, maneuverability, and the ability to conduct independent operations in austere ports permit operations not available to other shipping.
- Joint Venture is an excellent platform to move considerable equipment from ship to a non-hostile shore environment in minimal time.
- Since it is not armored or hardened, its aluminum hull is more vulnerable to shore-based weapons. Its use in a hostile environment would pose considerable risks.
- CONOPS should take this vulnerability into account and call for its use after initial assaults create the "permissive" environment needed for its employment.
- Support equipment presently available on Joint Venture was not optimized for the missions undertaken. This includes everything from cranes for boat launches, the type of lines used as safety lines, essential night lighting, minimum widths for turning vehicles on the vehicle deck, insufficient crew to conduct multiple operations simultaneously, inadequacies of the helo deck, and other similar comments which were observed in various reports.[82]

Sea SLICE support to STOM, while not included in the MCWL LOE, was provided on 29 and 30 July in the form of ARG escort and protection, and fires support for the amphibious landings that ultimately led

[79] Extracted, unclassified information from a confidential, Commander, Naval Special Warfare Group One report "Millennium Challenge-02, Post Exercise Quick-Look for Special Operations Task Force Raven," 10 Aug 2002. To view the full report, see the Navy Warfare Development Command website at http://nwdc.navy.mil.smil/hsv.
[80] Fleet Battle Experiment – Juliet HSV Initiative, Sea SLICE Report
[81] MCWL report.
[82] MCWL report.

to the capture of the Del Mar boat basin. In support of those missions, Sea SLICE fired 80 Loitering Attack Munitions (LAM) and Precision Attack Munitions (PAM) against fixed land targets such as surface to air missile (SAM), 122 mm artillery, and CSSC-3 Coast Defense Batteries. No data are available to evaluate Sea SLICE's impact on STOM operations.

7.5.4 HSV Support to Army Intra-theater Force Deployment

The Army also established an independent experiment and data collection plan. Highlights from their post-experiment report[83] are summarized below.

- With 686 tons of passengers, cargo, and fuel, HSV-X1 completed a 1,200 nautical mile transit from Port Hueneme, California to Tacoma, Washington in 41.5 hours at an average speed of 29 knots. Average speed would have been higher were it not for a 6-hour, 15 knot channel restriction approaching Tacoma.

- Offloading the cargo at Tacoma took only 13 minutes.

Specific observations from that experience include:

- In rough seas (sea state 5), vessel slamming caused Stryker combat vehicle suspensions to move in a violent vertical motion. Lashing gear became very loose on downward vehicle motion and they slid on the wet deck (as much as one foot). Extra straps were needed to reduce movement and prevent damage.

- Vertical movement of this equipment was due to inadequate lashing gear and vessel tie-down strength.
    - Tie downs should be flush with the deck and replaced with stronger fittings to avoid damage.
    - Fittings should be placed on a 4'x 4' grid throughout the cargo area.
    - A minimum requirement for the Stryker tie down should be eight 35K Peck & Hale restraints with rubber snubbers to absorb the shock load.

- Deck heights and axle load ratings on the interior ramps restrict the type of cargo that can be stowed in these areas. These areas should at least accommodate a fully loaded HMMWV and trailer combination.

- The quarter stern ramp should be redesigned to automatically adjust to aprons of various heights and tidal conditions without using wooden inserts.

- The center area of the mission bay/vehicle deck should be free of obstructions to support maneuvering large vehicles and truck trailer combinations.

7.6 Summary

While simulated vessel experimentation lagged, live vessel experimentation exceeded expectations. Flexibility, speed, and modular design made HSVs, particularly Joint Venture, high demand assets during

[83] MTMC-TEA report.

FBE-J. The demonstrated value of open architecture, multi-mission platforms was clearly evident in Joint Venture's and Sea SLICE's support to MIW, NSW, STOM, and SBCT operations.

Indicative of the potential the potential inherent in these vessels is this excerpt from the FBE-J Quicklook report.[84]

> Joint Venture (HSV-X1) successfully demonstrated operational capabilities by (1) self-delivery into experiment joint operations area through the Army's actual 23 day, 13,000 nm, 4-refueling stop voyage from Djibouti to San Diego; (2) configuring/reconfiguring the vessel five times … in a two and half week period to support multiple missions; (3) … daily high speed transits to and from the SOCAL operating areas in support of multiple taskings (to include 17 unassisted port entries and departures); (4) delivering follow-on forces and sustainment into austere ports; (5) acting as a forward based C2 platform for MIWC operations; (6) acting as a NSW forward operating base; (7) demonstrating the value of an open architecture, multi-mission platform through simultaneous MIWC/MCM/NSW/STOM operations; and (8) highlighting the possibilities as forward deployed sensor employment and C4ISR platform.

Sea SLICE's contribution to HSV outcomes was also very strong, as she demonstrated the ability to support MCM, Fires, and NSW support, including 4 configurations or reconfigurations over that same period. Sea SLICE's approach to systems integration and modularity are particularly noteworthy.

7.6.1 Lessons Learned

Accolades are fine, but the real value of system participation in FBE-J comes from the lessons that are learned and addressed. For the HSVs, those lessons should help answer the overarching questions identified earlier in this chapter.

- What added value do a number of high speed, reconfigurable, and multi-mission platforms provide the JFMCC and JFC in a littoral campaign as part of an access mission?
- What are the appropriate missions best suited to this concept of maritime operations?
- In a netted environment with many and varied types of sensors, what are the advantages or disadvantages of C2 construct used in this concept?
- What conditions and design features must be considered in engineering the capabilities required to meet the challenges in a 2007 campaign?

7.6.1.1 Value Added

The easiest way of providing an assessment of the value-added of HSVs is to start with results from the sub-initiatives and comments from supported staffs.

- "The concept of using the HSV as a MIW C4ISR platform to support the MIWC was highly successful. The HSV proved to be a "good test platform and a suitable interim solution to the MIW C2 issue."[85]

- "Live embarkation of HSV by a NSWTU proved the operational feasibility of using this platform as an afloat staging base. The embarked NSWTU was aboard the HSV for 5 days and conducted

[84] COMNAVWARDEVCOM 271709Z AUG 02.
[85] JFMC MIWC Top Three Lessons Learned Report, 3 Aug02

3 consecutive days of HVBSS operations. This platform proved ideal for supporting NSW operations …"[86]

- "Joint Venture successfully demonstrated its ability to support both MAGTF operational maneuver and the intra-theater movement of cargo and passengers between ports."[87]

- With 686 tons of passengers, cargo, and fuel, HSV-X1 completed a 1,200 nautical mile transit from Port Hueneme, California to Tacoma, Washington in 41.5 hours at an average speed of 29 knots.[88]

As demonstrated by the Joint Venture, vessels that can cover great distances at high speed, that can enter shallow, austere ports without assistance to discharge troops, cargo, and equipment, and that have the open architecture and flexibility to fulfill mission requirements for the Army, Navy, Marine Corps, and Naval Special Warfare provide tremendous added value to not only the JFMCC, but to the entire JTF.

[86] Naval Special Warfare Group One report.
[87] MCWL report.
[88] Paraphrased from the MTMC-TEA report.

7.6.1.2 Appropriate Missions

During FBE-J, Joint Venture successfully demonstrated its ability to support MIWC and MCM missions, NSW missions, STOM support, and intra-theater movement of forces. Sea SLICE successfully supported MCM, Fires, and NSW missions. No mission failed, so at first glance it might appear that all of the missions assigned to the HSVs would be appropriate missions.

That assumption needs to be tempered by some of the questions raised during the experiment.

- First and foremost of those questions is that of vessel survivability. The loss of so many vessels in the simulation, including HSVs, is cause for concern. For HSVs, and for any vessels for which the HSV acts as a surrogate, littoral operations and their attendant threat are issues that must be addressed.
    - Defining and quantifying the threats populating the littoral environment
    - Assessing HSVs' vulnerability to those threats
    - Addressing those vulnerabilities through changes to vessel design, installation of counter-measures and armaments, and developing compensating CONOPS and TTPs
    - Ensuring widely held knowledge of HSV capabilities and limitations.

- Vessel endurance for longer-term operations as it relates to crew size and the ability to provide hotel services to embarked crew and passengers needs additional study.
    - The ability of a small crew to handle multiple requirements simultaneously, e.g., flight operations during surface and subsurface vessel launches
    - Fatigue levels among crewmembers, whether induced by workload or vessel motion
    - The ability to operate for long(er) periods of time with large numbers of embarked staff or passengers.

- Observations surfaced (or resurfaced) of less than optimum on-vessel environmental conditions that require additional attention.
    - High noise levels on the mission bay deck
    - Air quality/exhaust fumes on the mission bay deck
    - Crew motion sickness in response to sea conditions.

7.6.1.3 Netted Command and Control

The question of advantages and disadvantages of the networked C2 construct used in FBE-J transcends the HSV initiative and is arguably the major recurring theme throughout all of the experiments various initiatives. Results from the HSV-MIW experience discussed in chapter 11 can, however, answer parts of that question.

The variety of experimental autonomous sensors available to the MIWC aboard the HSVs enhanced overall MIW capability. The size of Joint Venture permitted a comprehensive mix of MCM assets from RHIBs, AUVs, and helicopters to be hosted. The experimental set of autonomous sensors significantly increased the overall capabilities of the MIWC in a qualitative sense. The HSVs were able to support the use of embarked sensors, although there were issues of launch, recovery, and working conditions that were largely associated with the use of vessels that had been modified to accomplish the MIW mission, but had not been specifically designed for MIW/MIWC.

The HSVs had a fully equipped, modular C4ISR command center and a state-of-the-art communications and computer suite, which provided unparalleled connectivity up and down the battle force. This capability allowed real-time communications, chat, VTC, and the exchange of information, data and the common operational picture and common undersea picture. This exchange and data sharing was provided through a high speed, high data capacity shipboard local area network (LAN) tied into a robust new communications suite.

These two observations do not address the system-wide advantages and disadvantages of a network C2 system. They do suggest that within MIW, the ability to employ off-board sensors, process data into information, feed that data into common operating pictures, and then participate in the networked planning and execution process that takes advantage of that data is a valid concept.

7.6.1.4 Conditions and Design Features

The suitability and characteristics discussions in sections 7.4.1 and 7.4.2 address this question.

7.6.1.4.1 Suitability.

Greater emphasis should be given to:

- Survivability
- Manning
- Hotel services.

7.6.1.4.2 Characteristics.

From the FBE-J experience, all of the following characteristics are desirable:

- Ability to support air, surface, and sub-surface operations (and employ off-board sensors)
- A robust C4I system
- Vehicle loading/unloading and cargo handling capabilities
- Shallow draft and vessel maneuverability
- High speed
- High payload fraction
- Self-deployment
- Reconfigurability

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8.0 Naval Fires Network – Experimental (NFN (X)) Initiative Key Observations

8.1 Experiment Objectives

MC02/FBE-J provided an opportunity to configure NFN related components for rapid decisive operations within the context of the MC02/FBE-J architecture and scenario. Data collection and analysis planning focused on evaluating the experimental NFN technical architecture and procedural processes observed during ISR and Fires engagement operations. The post-experiment analysis effort was not intended to focus on a technical evaluation of NFN components, but rather the integration of capabilities and the impact on the TST process.

One purpose of this initiative is to document preliminary NFN findings from the MC02/FBE-J effort for C3F, NWDC, and the NFN Virtual Program Office (PMS 454, PMA 281, PMW 157) representatives. The initiative focused on providing insights on the role, functions, and contribution of NFN in a relatively high-tempo warfighting context defined by the MC02/FBE-J experimental design, scenario, and architecture. Key findings are relevant to the four primary analytical objectives for NFN in this effort: Joint Interoperability, NFN Impact on TST Timeline, NFN architecture characteristics evaluation, and NFN impact on enhanced situational awareness. NPS analysts' review of manual logs, electronic system data, and discussions with operators and technical team members formed the basis for these preliminary findings.

8.2 Analytic Questions

The NFN in MC02/FBE-J high-level analytical objectives highlighted below were deduced by NPS analysts from several informal documents plus discussions with NFN Program office representatives:

- Joint interoperability.
- NFN contribution to timely engagements of time sensitive targets.
- NFN architecture characteristics (Spiral 1a evaluation (GCCS-M/TES-N interface)).
- NFN contribution to enhanced operational and tactical level situational awareness.

Enhancement of platform level self-targeting is follow-on to work initially done in earlier FBEs. The hypothesis is that given a certain level of technological capability and specialized training in sensor management, target identification, and weaponeering, that a single naval platform can sense, target, and successfully engage TSTs.

8.3 Ground COP

An accurate and complete ground COP is fundamental to the success of any aspect of Naval Fires. The GCCS-M 4.x will provide extensions that will enhance the ground COP and contribute to the timely engagements of TSTs. In FBE-J, GCCS-M was not a component of the TST engagement system and the introduction of GCCS-M was in the form of a demonstration.

8.3 Baseline Model

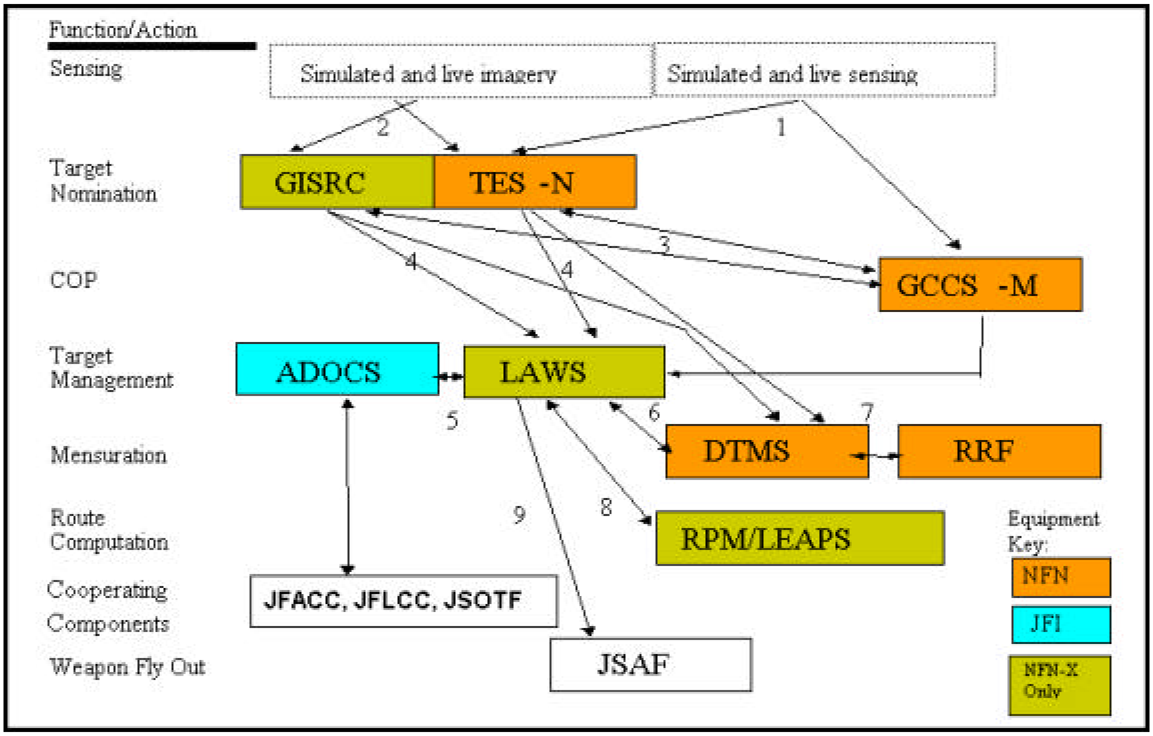

Figure 8-1. The JFMCC NFN (X) Fires Architecture.

Figure 8-1 displays a schematic diagram of the JFMCC NFN (X) Fires architecture. The key indicates which blocks within NFN (X) constitute NFN and JFI. All systems shown in color were part of NFN (X), but some components are normally part of JFI or NFN. The numbered lines, representing the interactions between the component systems of the Fires network, are discussed below.

1. Target sensing (e.g. ELINT) originating with live sensors and simulated sensing from within the simulation are received in GCCS-M and in TES-N.

2. Live and simulated sensor data are received directly by the target nomination systems (GISRC and TES-N, including RTC). The data are primarily simulated and primarily imagery. The imagery is normally accompanied by telemetry.

3. When GISRC and TES-N identify targets they create tracks and transmit those to GCCS-M. Both systems received GCCS-M tracks (GISRC through C2PC). The GCCS-M tracks are also superimposed on the LAWS map display.

4. If GISRC and TES-N identify a target as a TST, a target nomination, with attached imagery, is transmitted to LAWS and to DTMS.

5. LAWS performs the weapon-target pairing and, if necessary, transmits a georefinement request to DTMS. If the JFMCC is unable to prosecute the target, the mission (through the ADOCS DTL) is passed to another component for execution. Conversely, if other components are unable to prosecute their TST nominations, they may be passed through ADOCS to the JFMCC for execution.

6. Through an exchange of messages described as the georefinement validation process, LAWS and DTMS agree on required mensuration accuracy and a time within which the georefinement is to be completed.

7. The Mensuration Manager at the DTMS assigns the mensuration task to one or more RRF workstations. The RRF workstations return the mensuration result to DTMS. DTMS transmits the result to LAWS.

8. If the mission involved TLAM or LOCAAS, LAWS transmits a route request to the appropriate route generating workstation (RPM or LEAPS). The workstation responds to LAWS with the route.

9. After the missions has been approved by the MOC TCSO, and georefined target locations and projectile route have been received (if required), the mission is executed in LAWS, and the fire command is transmitted to JSAF for projectile launch, fly out, impact and assessment.

After the mission has been approved by the MOC TCSO; and georefined target locations; and projectile route have been received (if required); the mission is executed in LAWS and the fire command is transmitted to JSAF for projectile launch, fly out, impact, and assessment.

8.4 TST Process

This Section provides a qualitative description of the NFN (X) TST process in FBE J (Figure 8-1).

8.4.1 Target Detection

The great majority of target detections were made on the basis of imagery from simulated sensors (Predator, TUAV, Global Hawk, U2). Most of the targets were detected as targets of opportunity found in random searches of the patrol area rather than as a result of cued searches for TSTs. Each of the simulated sensor assets appeared in the ATO with an assigned operational area and scheduled time of operation. The simulated ISR assets were essentially exclusively assigned to the prosecution, and Battle Damage Assessment (BDA), of TSTs.

There was some variation in the C2 procedures for ISR, but for the majority of the experiment the procedures were as follows. The UAV operator controlled the path of the UAV within the ATO-assigned operational area while the GISRC operator assigned to that UAV controlled the aircraft's sensor. There were six separate IRC chat channels used for coordination between the paired GISRC and UAV operators. If the UAV was re-tasked, the new tasking originated with the ISR OPS officer in the MOC and was passed to the ISR Manager at FCTCPAC who in turn communicated it to the UAV operator. Coordination between the JFMCC ISR OPS officer and the UAV Manager were conducted using the IWS ISR chat room.

In FBE-J weather was introduced into the simulation. As a result, coastal cloud cover inhibited the simulated UAVs' E/O sensors for a significant percentage of the morning hours for most of the experiment.

8.4.2 Target Identification

The GISRC or TES-N workstations received a streaming video feed and telemetry from the simulated UAVs or U2. When the operators of these workstations recognized an imaged object of potential interest, a target track was created. The tracks were transmitted to the Global Command and Control System - Maritime (GCCS-M). If the target was recognized as a TST, a target nomination was initiated. For GISRC, the interval between the track creation and the initiation of the nomination was typically six seconds. When the nomination process was initiated, the target was assigned a target number. The GISRC logs show that about 30 percent of the targets assigned target numbers were never sent to LAWS. The median interval from track creation to transmission of the GISRC nomination to LAWS was 5.8 minutes. For TES-N, the median interval between initiation of the nomination and the transmission of the nomination to LAWS was 3 minutes.

8.4.3 Target Nominations

Nominations, with associated imagery, were to be sent simultaneously to LAWS and DTMS, but the latter node was to take no action on the nomination until a mensuration request was received from LAWS. TES-N, as a result of a software problem, was unable to send its target nominations simultaneously to LAWS and DTMS.

Over the period July 28 to August 5, 835 target nominations were recorded in the LAWS data logs. The majority of these targets were not categorized as TST targets. Most TSTs were contained in the 186 GISRC nominated targets (these do not include China Lake GISRC nominations, which in LAWS are a small number of live fly nominations), 60 TES-N nominations, and 57 targets associated with cross-component nominations. These three classes of targets are hereafter referred to as G, T, and J targets, respectively.

- G = GISRC Nominations
- T = TES-N nominations
- J = Cross-component Nominations

8.4.4 NLT Time

When LAWS received a nomination, LAWS added the target dwell time, which was normally contained in the target nomination message, to the time the nomination was received at LAWS to produce the Not Later Than (NLT) time. On receipt of the target nomination in LAWS, the NLT block was set to yellow and displayed a countdown clock showing the time remaining until the NLT time was reached. If the NLT time passed, the block turned red and displayed the interval past the NLT time to a maximum of one hour. For those G, T, and J targets for which both an NLT and fired time were reported in LAWS, the difference between these times was taken as a measure of whether the NLT time was met or not. The results are shown in the table below. This simplistic approach does not address the projectile time-of-flight.

Condition	GISRC Nominations	TES Nominations	Joint Nominations
NLT time met	22	16	5
NLT time not met	8	3	12

Table 8-1. Meeting the NLT Time

The sample sizes are small but the result for the cross-component engagements appears different from the internally processed JFMCC engagements. It should be noted all the dwell times provided by TES were set at a default value of one hour, thus there was no correlation between a meaningful requirement and the observed resultant action.

8.4.5 Georefinement

The FBE-J TTP requires a georefinement request to be directed from LAWS to DTMS. This georefinement request message contains requested mensuration accuracy. After an exchange of messages, mensuration accuracy, and the time interval required to produce it, were agreed upon between LAWS and DTMS. This validation process was to be completed before DTMS actually initiated the georefinement process. The implication of this mensuration validation process was that the weapon-target pairing would be completed before the georefinement request in order that the selected weapon would provide the basis for determining the needed mensuration accuracy (or whether mensuration was required at all). In fact, in the experiment, the mensuration request for G and T targets was issued a median of 7 minutes after receipt of the nomination and usually long before the weapon-target pairing was performed.

After the georefinement request was validated, the Mensuration Manager, through DTMS, tasked the georefinement to one or more RRF workstations. On receipt of the georefined target positions from RRF at DTMS, the Mensuration Manager evaluated the positions and forwarded a result to LAWS. The DTMS Mensuration Manager and the RRF operators used the targeting IRC chat channel to coordinate the mensuration process.

As discussed in the georefinement Section below, this georefinement validation process appeared to provide no benefit but it resulted in the lengthening of the georefinement process. The median time required for the actual georefinement measurement at an RRF workstation was 9.8 minutes, but the validation of the mensuration request and the overhead of the mensuration management process resulted in a median time between the issuance of the mensuration request and the receipt of the results in LAWS of 27 minutes.

In the LAWS Fires Manager display, on issuance of the mensuration request, the georefinement block would turn yellow and display a countdown clock showing the time remaining until the expected receipt of the mensurated target position. On receipt of that georefined target position, the block would turn green. Otherwise the block would turn red if the expected receipt time was reached, and no mensuration data were received. If the mensuration request could not satisfied by DTMS/RRF, the georefinement block was turned purple.

Almost all nominations were received in LAWS without any indication of the accuracy of the reported target position. Without these data, regardless of the weapon paired to the target, it is almost always necessary to request georefinement. To avoid unnecessary georefinement, all nominations need to include an estimate of the accuracy of the target position. In addition, weaponeers require tables relating weapon, target type, and target positional accuracy to the probability of successful engagement.

8.4.6 Weapon-Target Pairing

For all JFMCC TST engagements, the MOC Time Critical Strike Officer (TCSO) was the approving authority. His cell normally performed the weapon-target pairing and pushed the mission to a selected platform for execution. There were no autonomous target engagements in the experiment. The table below shows the percentage of the nominated targets that were weapon-target paired in LAWS. This percentage is quite low for the G and T targets but it is somewhat misleading because some of these targets were pushed to other components for prosecution, although those actions are not reflected in the LAWS data.

Condition	GISRC Nominations	TES Nominations	Joint Nominations
Nominated targets	186	60	57
Number weapon-target paired	48	26	53

Table 8-2. Weapon Target Pairing in LAWS

The data for the J nominations are very different from the G and T nominations, for unknown reasons. Based on the G and T data, weapon-target pairing was performed a median of 34 minutes after the receipt of the nomination in LAWS.

8.4.7 Weapon Routes

In the case of TTLAM/TLAM missions, the LAWS operator requested a missile route from a Rapid Planning Mode (RPM) workstation. This route generation was handled by one of the two RPM workstations located on CORONADO and VSSGN. The route was returned to LAWS and the LAWS server transmitted the route to JSAF for application to the projectile fly out. The VSSGN also employed a LEAPS mission planner workstation to generate routes for LOCAS missions

8.4.8 Mission Approval/ Deconfliction Action

The only authority for approval of JFMCC TST engagements was the MOC TCSO. Turning the MCC block green in the LAWS Fires Manager display indicated this approval. This action happened a median of 50 minutes after the nomination was received in LAWS. The MOC collaborated with other cells in the coordination of TST engagements primarily through the IWS BWC Coordination and STWC chat rooms.

8.4.9 The Fire Command

In principle a JFMCC shooter was free to fire a mission if:

- The MCC approval block in the LAWS Fires Manager display was green.
- A georefined target position had been received and incorporated into the aim point if the mission required georefinement; a green georefinement block indicated this.
- The NLT clock had not expired.
- A route had been received to fire the mission if the mission was a TTLAM/TLAM or LOCAAS mission.

The median time for issuance of the Fire When Ready (WRD block goes green in the Fires Manager display) command was 51 minutes after the nomination was received in LAWS. This is to be compared to the median JFMCC approval time of 50 minutes. The implication is that the shooter actions were delayed in waiting for the approval action. The median time from receipt of the nomination until issuance of the fire command (FRD block turns green in the LAWS Fires Manager Display) was 56 minutes.

There were indications that inexperienced LAWS operators sometimes believed they were firing TTLAM/TLAM LOCAAS and TACMS missions from the LAWS Fires Manager. Many of these missions show a green FRD block in the Fires Manager but do not appear in the Missile Manager at all, or do so with a “launch required” status. In fact, these missions must be fired from the Missile Mission

Manager. Only when the mission is fired in Mission Missions Manager does LAWS send a fire command to JSAF.

8.4.10 Assessment Engagement

On receipt of the fire command from LAWS, JSAF simulated the weapon firing, fly-out, and impact of the projectile. In FBE-J, many of the target entities were present in other simulations so that the assessment of the target required the exchange of entity status between different simulations in the federation.

8.4.11 Battle Damage Assessme nt

Subsequent to weapon-target pairing, LAWS was to transmit an engagement message to the nominator, giving weapon TOT. The nominator was to respond to this with a BDA support message indicating when BDA would be available. The BDA page in the LAWS Fires Mission Manager has fields to contain the expected and received time for the BDA report. These fields are almost never filled, even when a BDA result was given, indicating the BDA support message did not work reliably or was rarely used. In most cases a BDA result was not reported for fired missions. Many missions reporting BDA results are missions that were listed in LAWS as not having been fired.

When a BDA report was received the LAWS operator manually turned the BDA block green and inserted a three-letter code to indicate the target status. In the LAWS Fires Manager, in contrast to the ADOCS DTL Manager, the BDA block was turned green on receipt of a BDA report whether or not that report was favorable.

In many cases, the UAV that provided the imagery for the nominated target was kept on station at the target position to image the impact and provide BDA. The UAVs were often kept on station for hours waiting for impacts that were never observed, at least some of the time because the weapons were never fired in the simulator or because the weapons missed the target. The UAV operators frequently had no indication of when the impact was supposed to occur.

8.5 Analysis of Objective Data

8.5.1 Participating Nodes - Future Power Projection Platforms

The future power projection platforms were defined as: DD-X, VSSGN, ABCC, and Net Fires on the Sea Slice. Table 8-3 shows for the G, T, and J TST targets the final state of platform selection of weapon-target pairing as displayed in LAWS. The total absence of TACAIR is conspicuous. This is a dramatic change from FBE-I where 45 percent of TST missions were weapon-target paired with TACAIR despite software and command and control problems. The China Lake GISRC, which is not included in the nominations considered here, nominated a few TACAIR paired missions into LAWS, but these were specifically intended to support the live fly missions out of China Lake. The Sea Slice made no significant contribution to the engagement of TSTs. The other two platforms, the VSSGN and DD-X, conducted the majority of the TST engagements.

Platform	Platform Type	Number of Targets
VSSGN	Virtual	36
DD-X	Virtual	28
Preble	Simulated	19
BENFOLD	Live	14
SALT LAKE CITY	Live	13
FITZGERALD	Live	12
Arleigh Burke	Simulated	2
San Jacinto	Simulated	2
Sea Slice	Live	1

Table 8-3. TST Targets Paired to Platforms

Table 8-4 shows how these same targets were paired with weapons. The plurality of missions was conducted using TLAMs. These were almost exclusively tactical Tomahawks but were employed in a conventional manner with no loitering or retargeting.

Weapon	Number of Targets
TLAM	34
ERGM	23
TACMS Unitary	23
LRLAP	14
TACMS Antipersonnel	8
TACMS Penetrator	8
ERGM ES	8
LOCAAS	8
Net Fires Precision	1

Table 8-4. TST Targets Paired to Weapons

8.5.1.1 Self (Autonomous) Targeting

There was no autonomous TST targeting in FBE-J. The JFMCC Time Critical Strike Officer (TCSO) maintained control of TST weapon-target pairing and mission approval. In addition, the TST system architecture required all georefinement requests to pass through a CORONADO-based Mensuration Manager and a single centralized DTMS.

8.5.1.2 NFN (X) Data Fidelity

Much of the analysis of the operation of NFN (X) Fires systems depends on event data automatically logged by the systems. Though electronically captured, the fidelity of these data in defining and representing the engagement process is limited by the following factors:

- **Player training.** Player training is a chronic problem with FBEs (e.g., PTW operator certification requires approximately 12 weeks, yet RRF operators in FBE-J received roughly one day of instruction). There are two aspects to this:
    - **Availability.** Much of the training difficulty stems from player (both reservists and active duty) availability for training prior to the experiment. It is not unusual for participants to

arrive at the start of the experiment with no training. The problem is exacerbated when new participants (with no training) enter part-way through the experiment.

  - **Duration.** In part because of the player availability problem, the system training programs are often forced to be truncated and are provided in less than optimum environments. Consequently, even the trained operators often start the experiment with a relatively rudimentary knowledge of their systems.

- **TTPs.** Beyond the question of participant training, TTPs are often inadequately defined and sometimes evolve during the course of the experiment. This degrades participant and system performance and counters the normal improvement expected as teams work down the learning curve.

- **System Software.** Many of the systems employed in NFN (X) are prototypes with unvalidated software. Inevitably, software problems are encountered and workarounds have to be developed, which delays and complicates the execution actions.

The issues addressed above undoubtedly contributed to a lengthening of the observed engagement timelines in MC02/FBE-J. But these problems are more artifacts of the experiment than inherent limitations in the systems or procedures. They are addressed in two ways in the treatment of the data:

- Statistics relating to intervals in the engagement process focus on the median rather than on the mean. The latter statistic is much more affected by long intervals that are associated with any problems, such as those described above, which thus yield unrepresentative averages.

- Generally, the data collected in the first few days of the experiment are either not considered or are given low weight. Data collected near the completion of the experiment are assumed to be far more valuable and representative of the performance typically expected.

8.5.2 Land Attack Warfare System (LAWS)

LAWS represents the core NFN (X) system. This Section provides counts for the target numbers appearing in LAWS and engagement timeline statistics for the actions that occur in LAWS in the course of prosecuting TST targets.

8.5.2.1 Mission Counts

In previous FBEs, LAWS was populated almost exclusively with TSTs. In FBE J, many different types of targets nominations were entered into LAWS. Table 8-5 presents a breakdown of the target nomination types, by day, for the interval July 29 to August 5. The nominations types are defined as follows:

- **Mine Mission (M).** These primarily have target numbers of the form MMxxxx and were nominated by the HSV LAWS. A few of these targets were nominated by HSV GISRC and have target numbers of the form GHxxxx.

- **Test missions (X).** These were test targets nominated by various nodes. Target numbers with the XX prefix indicates many of these missions. Others were identified on the basis of remarks in the LAWS targeting page.

- **ATO (A).** The LAWS on the shooter platforms nominated these missions. They were identified on the basis of remarks in the LAWS targeting page.

- **LAWS (L).** This is the largest category of nominations with 258 entries. These include all LAWS nominations (target number prefixes LB, LC, LD, LF, LM and LO) not already included in the ATO or test missions categories. These may include unidentified ATO missions and test missions. The many Sea Slice LAWS nominations (53) executed by the Sea Slice are considered to be test missions. The biggest contributor to this class of missions was the DD-X (141 nominations). Many of the DD-X nominations were Call For Fire (CFF) missions in support of the Marines that were conducted late in the experiment, LAWS nominated targets are generally not TSTs.

- **Sea Component Commander (S)**. These nominations were of the form SCxxxx. These nominations were for OPFOR submarines or boats.

- **Cross-Component Targets (J).** These include the target number prefixes AA, JA, JM, JL, JS, and ET. These were primarily targets nominated by other components and moved into LAWS from the ADOCS DTL.

- **TES-N (T).** This category includes all TES-N nominations except for those that were included in the test cases. These target numbers are primarily of the form TSxxxx but a few RTC nominations (RTxxxx) are included.

- **GISRC Nominations (G).** These include target number prefixes: GB, GC, GF, GS, GV, and GX, not already included in the test mission category. This category does not include China Lake GISRC nominations (AXxxxx).

- **Miscellaneous TSTs (TM).** This category includes China Lake GISRC nominations (AXxxxx), which were target nominations for live fly missions, and restrike nominations (RSxxxx).

NOMINATION	DAY								TOTALS
TYPE	29-Jul	30-Jul	31-Jul	1-Aug	2-Aug	3-Aug	4-Aug	5-Aug	
X	7	1	6	8	4	6	6	5	43
A	0	16	3	10	10	2	35	19	95
G	29	48	52	32	8	5	6	2	186
T	6	12	11	13	4	2	7	5	60
TM	1	3	4	5	1	0	2	0	16
J	10	18	5	7	6	6	4	1	57
L	13	53	49	16	11	9	34	73	258
SC	3	10	6	6	3	0	0	0	28
M	26	1	4	0	9	15	32	5	92
TOTALS	95	162	140	97	60	45	126	110	835

Table 8-5. Target Nominations Appearing in LAWS

Table 8-5 presents the number of targets, by nomination type that were prosecuted over the experiment interval considered. A green FRD block in the LAWS Fires display was taken as an indication that the mission was executed. In a few cases, the FRD block was not green but the LAWS Mission History for the nomination indicates the mission was fired. These targets were considered engaged. In many cases of

Tactical Tomahawk Land Attack Missile (TTLAM), Tomahawk Land Attack Missile (TLAM), Low Cost Autonomous Attack System (LOCAAS), and Tactical Missile System (TACMS) engagements that exhibit a green FRD block in the Fires Manager either did not appear or show a "launch required" indication in the LAWS Missile Mission Manager. Despite this inconsistency, these targets were considered engaged on the basis of the FRD block status.

Nomination Type	No. Of Nominations	No. Executed	% Executed
G	186	41	22
T	60	20	33
J	57	45	79
TM	16	6	38
SC	28	22	79
A	95	78	82
L	258	171	66
M	92	50	54
X	43	9	21

Table 8-6. Engagement Rate for each Nomination Type

The data in Table 8-7 show that the GISRC (G), and TES (T) targets, which represent priority TSTs, were engaged infrequently (22 and 33 percent, respectively) while most other nomination types had a much higher rate of engagement. In particular, the J nomination types, which were primarily TSTs nominated by other components, were engaged 79 percent of the time.

In the remainder of this Section, consideration will be limited to the GISRC (G) and TES (T) target nomination types.

Nomination types	No. of nominations	No. Prosecuted	Georefinement requests	Georefinements received
G	186	41	126	83
T	60	20	47	28

Table 8-7. Mensuration Requests for G and T Target Nominations

Table 8-7 presents for the G and T nominations; the number of cases where georefinement was requested; and the number of cases where a georefined target position was received. Of note, georefinement data were requested for the great majority of G and T nominations. And, georefined target positions were provided for many more targets than were engaged. Consequently, much of the mensuration effort devoted to these unengaged targets was wasted.

Many of the G and T targets were not weapon-target paired, including many for which mensuration was requested. Out of the 186 G nominations only 47 were weapon-target paired. Out of the 60 T nominations only 26 were weapon-target paired. The LAWS Mission Histories show the JFMCC TCT Engagement Manager performed the weapon target pairing of TST targets and initiated the requests for target georefinement. It appears, even in many cases where the target position was mensurated, the JFMCC MOC did not pass the targets to the shooters for execution. The much higher percentage of engagement of the cross-component TSTs (the J nomination type) implies prosecution of these targets was given a higher priority than the engagement of TSTs nominated by JFMCC platforms.

8.5.2.2 LAWS Engagement Timeline

The LAWS engagement timeline consists of the following events in order:

1. Receipt of the target nomination in LAWS.
2. Request for georefinement of the target location.
3. Receipt of the georefined target location (Georef block goes green).
4. Weapon-target pairing.
5. Mission approval by appropriate warfare commander (approval block goes green).
6. Issuance of Fire When Ready command (WRD block goes green).
7. Fire command (FRD block goes green).
8. Receipt of BDA.

Table 8-8 gives the median, mean, and standard deviations for each of these intervals. All the intervals, except the georefinement completion time, were measured with respect to the time the nomination was received in LAWS. As is typical with FBE measured time intervals, extreme outliers drive the mean and the median values and are more characteristic of system performance. Separate tallies are presented for G and T targets. In most cases the median times are similar, but in a few cases they are different. The small sample sizes and large dispersions make these differences of questionable significance.

The BDA block usage in the LAWS Fires Manager differs from the BDA block usage in the DTL. In the latter, the BDA block was turned green if the result was favorable, i.e., the target was destroyed or suppressed. If the result was unfavorable (e.g., no observed damage), the BDA block was turned red. In the LAWS Fires Manager, the BDA block was turned green when the BDA report was received whether the result was favorable or not.

Interval	GISRC				TES			
	Median	Mean	Std dev	Sample	Median	Mean	Std dev	Sample
Receive-georef request	6	65	217	125	9	32	44	47
Georef request-georef received	29	81	296	77	21.5	34	34	28
Receive-WTP	40	235	568	45	28.5	54	65	28
Receive-MCC green	50	191	371	27	49	88	73	18
Receive-WRD green	46	165	341	22	52	83	81	15
Receive-FRD green	56.5	161	319	38	56	71	46	19
Receive-BDA green	109.5	279	588	18	206	180	124	7

Table 8-8. LAWS Engagement Event Intervals for G and T Target Nominations

The first action taken on receipt of the nomination was the initiation of the georefinement request. This occurred well before the weapon-target pairing was performed. This appears contrary to the FBE-J TTP, which requires that the georefinement request specify the accuracy required for the georefined target location. This can be reasonably determined only after weapon-target pairing. However, requesting georefinement immediately, particularly when georefinement assets were under-tasked as they were in this experiment, was a rational action taken to stimulate training. This subject is discussed in more detail in the Section on mensuration.

The median values from the table have been used to construct the timeline for G nominations shown in Figure 8-2.

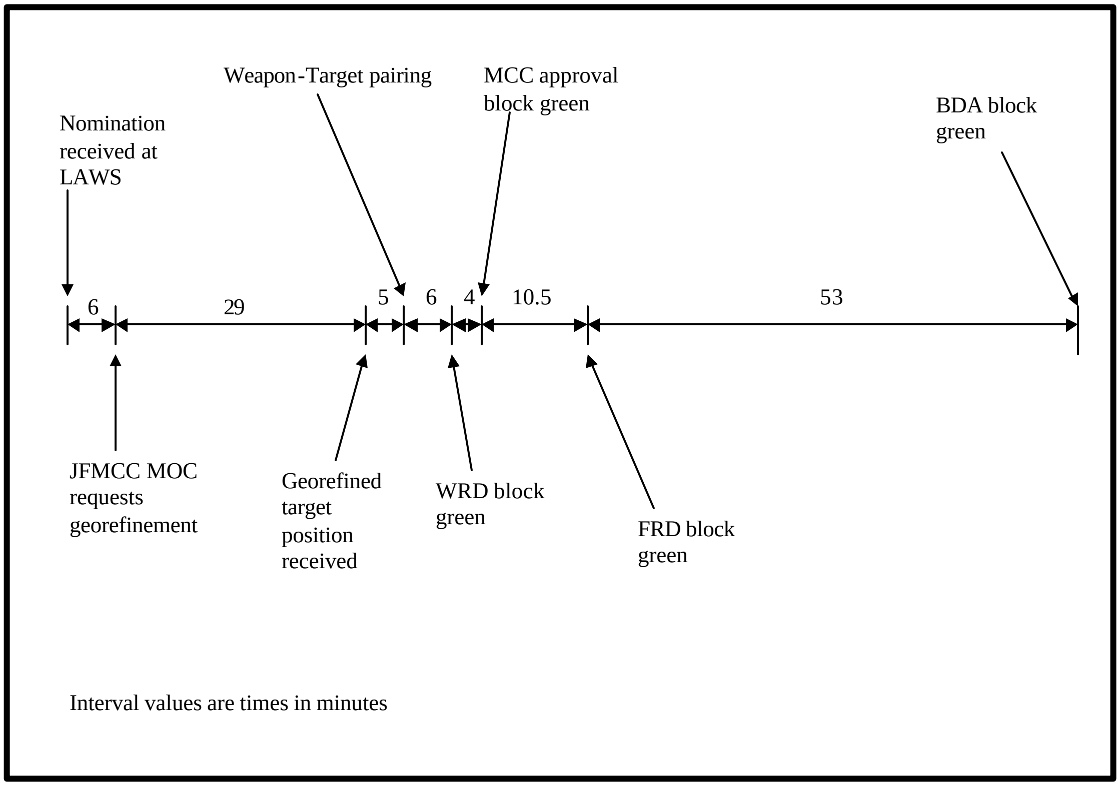

Figure 8-2. Median Interval LAWS Engagement Timeline for G-Type Nominations

8.5.3 Global Command and Control System-Maritime Intelligence Surveillance Reconnaissance Capability (GISRC)

In MC02/FBE-J, the GISRC nodes were the primary nominators of TSTs into LAWS. GISRC nodes were located on CORONADO (2), FITZGERALD, BENFOLD, DD-X, VSSGN, China Lake (STWC), and San Nicholas Island (SNI).

8.5.3.1 Nomination Counts

Each GISRC node maintained logs of their nomination actions. The nominations, included attached target imagery, were simultaneously transmitted to LAWS and DTMS. It was necessary for DTMS to receive the nomination and imagery in order to perform target mensuration on the target if LAWS issued a mensuration request. Table 8-9 presents counts of the nominations created and sent by each GISRC workstation. These tables do not include test targets.

PLATFORM	Date	August					July								
		5	**4**	**3**	**2**	**1**	**31**	**30**	**29**	**28**	**27**	**26**	**25**	**24**	**Totals**
BENFOLD	**# Nominations**					11	10	20	19	55	16	9	2	8	150
BENFOLD	**# Noms sent**					10	9	15	19	54	16	9	2	5	139
China Lake	**# Nominations**					17	15	30	15		4	10	7		98
China Lake	**# Noms sent**					2	7	23	8		4	0	1		45
DD-X	**# Nominations**			3			22	27		16	18	4			90
DD-X	**# Noms sent**			1			11	23		8	13	1			57
FITZGERALD	**# Nominations**					9	27	13	18	9	10		5	1	92
FITZGERALD	**# Noms sent**					5	14	13	4	7	10		2	1	56
GISRC1	**# Nominations**	6		3		2	9	5	3	5			2	4	39
GISRC1	**# Noms sent**	2		3		2	8	5	3	4			2	2	31
GISRC2	**# Nominations**		1		1	2	6	10	9	1				1	31
GISRC2	**# Noms sent**		1		1	1	6	8	3	1				1	22
VSSGN	**# Nominations**		4		4	10	5			9	1		3		36
VSSGN	**# Noms sent**		3		3	7	4			9	1		1		28
SNI	**# Nominations**					1				2			7	7	17
SNI	**# Noms sent**					1				0			3	0	4
Totals	**# Nominations**	6	5	6	5	52	94	105	64	97	45	23	26	21	549
Totals	**# Noms sent**	2	4	4	4	28	59	87	37	83	44	10	11	9	382

(Note: Does not include test targets.)

Table 8-9. GISRC Nomination Counts

The GISRC data logs consist of two distinct logs: the Sessions Logs, which are records of the nomination ATI.ATR messages, sent by GISRC; and the Transaction Logs which record all actions performed by the GISRC operator. In principle, each of these files should provide a record of the same events. In practice, it was found each contained nominations not included in the other. The data reported here are the merged data from the two logs. There are two points to be noted regarding Table 8-9. There are some conspicuous holes in the table where it appears there were no data logged for specific platforms on some days (e.g., for the DD-X on July 29). Secondly, the number of nominations greatly exceeds the number of nominations sent to LAWS/DTMS; 30 percent of the targets were not sent to LAWS. In a few cases, GISRC may have actually sent the nomination to LAWS and failed to record the send event, but the LAWS and DTMS data discussed below indicate most were in fact not sent.

Table 8-10 compares the number of nominations sent by GISRC with the number of GISRC nominations received in LAWS and DTMS. Features to note in Table 8-10:

- The number of nominations received in DTMS sometimes exceeds the number GISRC reported sending (e.g., August 1).
- The number of nominations received in DTMS usually exceeds those received in LAWS; they should be the same.
- It is known that the LAWS data are incomplete for July 28, but they were presumed to be complete subsequent to that date.

Date	# GISRC nominations	# nominations sent by GISRC	# nominations rcd in LAWS	# nominations rcd in DTMS
5-Aug	6	2	2	2
4-Aug	5	4	6	5
3-Aug	6	4	5	6
2-Aug	5	4	12	9
1-Aug	52	28	32	42
31-Jul	94	59	52	55
30-Jul	105	87	48	83
29-Jul	64	37	29	39
28-Jul	97	83		80
27-Jul	45	44		
26-Jul	23	10		
25-Jul	26	11		
24-Jul	21	9		
Tot	549	382	186	321

Table 8-10. GISRC Nominations received in LAWS and DTMS

To investigate the anomalies shown in Table 8-10 in more detail, the individual target nominations for July 30 - August 1 were examined. The results are shown in Table 8-11.

	Target not in GISRC but			Target sent by GISRC but		
Date	In LAWS	In DTMS	In LAWS & DTMS	Not in LAWS	Not in DTMS	Not in LAWS & DTMS
7/30	0	0	8	33	1	2
7/31	0	0	0	3	0	1
8/1	1	5	7	1	0	0

Table 8-11. Anomalies in Target Numbers Appearing in GISRC, LAWS, and DTMS

The data for July 31 are very clean showing few anomalies. On July 30 there was no GISRC data captured for VSSGN, accounting for the eight entries in column 4; LAWS and DTMS received the nominations, although there is no record of them in the GISRC data. The large numbers of nominations (33) that did not appear in LAWS (but did appear in DTMS) are almost all due to AX nominations (19) and GX nominations (10) missing in LAWS. On August 1, most of the entries in columns three and four are attributable to the fact the GISRC log did not capture DD-X nominations.

The anomalies in columns 2-4 of Table 8-11 that represent a failure of GISRC data logging are a loss to analysis, but they do not indicate an experimentation problem. The anomalies in the last three columns are of greater concern since they could represent data transmissions lost and hence a disruption of the engagement.

8.5.3.2 GISRC Timelines

The above data indicate that confidence cannot be placed in the completeness of the GISRC data logs. Nevertheless, the statistics on the timing of the actions by the GISRC operator should not be affected by these problems. There are three distinct actions in the GISRC nomination process:

- Time On Target (TOT) time is the time the operator first recognizes the target as potentially important and the operator creates a target track.
- Time first nominated is the time when the operator initiates the TST nomination process – this action usually closely follows the TOT action.
- Sending of the nomination to LAWS and DTMS.

Table 8-12 presents the intervals for each of these actions.

The data in the Sessions Logs frequently showed that the TOT time to the time of first nomination interval was negative. This resulted from the fact that the TOT data in the Sessions Logs corresponded to the last track update event in the Transaction Files rather than the initial track creation event. Consequently, wherever necessary and possible, the TOT event time from the Sessions Log was replaced with the track creation event from the Transaction Logs. The remaining small numbers of negative intervals (24 for the TOT to nominate interval) were discarded.

Interval	Median	Mean	Std Dev	Sample
TOT to nominate	0.10	0.60	2.87	316
Nominate to send	5.37	8.12	9.27	340
TOT to send	5.83	8.67	9.77	327

Table 8-12. Statistics for GISRC Nomination Actions (Time in Minutes)

In Table 8-13, the complete GISRC nomination time (the TOT to send interval), which is given in the last row of Table 8-12 for MC02/FBE-J, is compared with the same data from FBE-I. There is no marked difference between the two data sets.

EXP.	Mean	Median	Std. Dev.	Sample
FBE-I	8.0	5.0	14.4	202
FBE-J	8.7	5.8	9.8	327

Table 8-13. Comparison of GISRC Nomination Time for FBE-I and FBE-J (Time in Minutes)

In Figure 8-3, the GISRC nomination times in MC02/FBE-J are presented in the form of a histogram. The histogram includes 300 of the 327 observations.

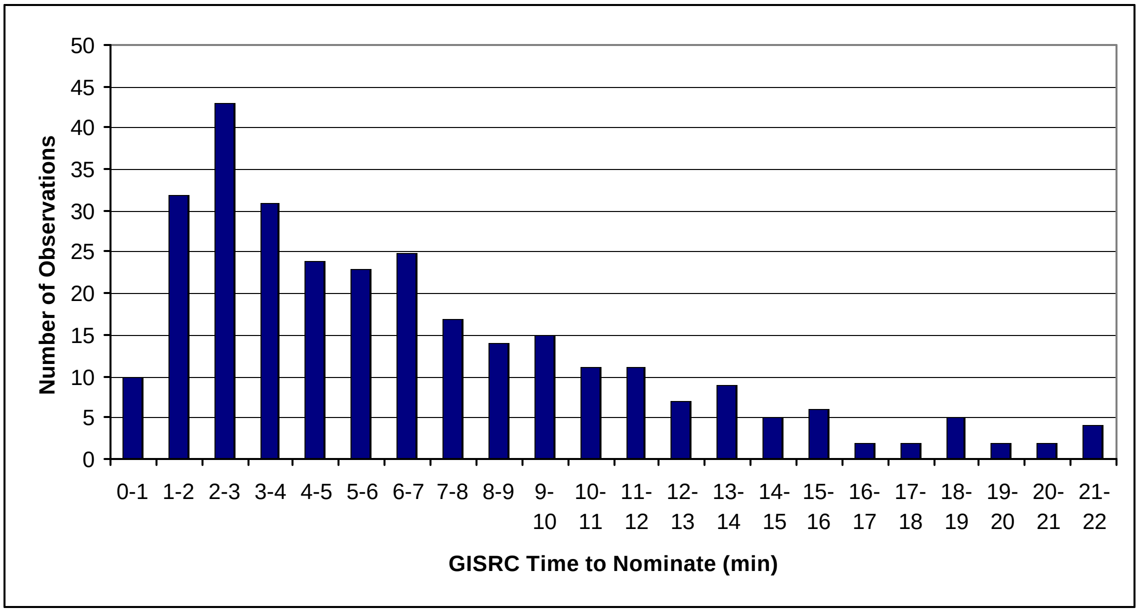

Figure 8-3. GISRC Nomination Times (Minutes)

8.5.3.3 Target Accountability

It is difficult to disentangle the problems with data logging with the various NFN (X) systems and the problems with targets and associated actions that are actually lost in the Fires system. It does appear there is a problem with target accountability. LAWS is the TST target management tool intended to provide to the participants the status of each target. For targets that have been engaged, information appears generally complete, and for missions denied execution for stated reasons, the status is clear, but for many targets for which the engagement process never starts, or where it is stalled or terminates midway, there is often no obvious indication of the status. The reason for a number of such cases in MC02/FBE-J was that a significant number of JFMCC TST targets were passed to other components and engaged, but there was no indication of this in LAWS. Worse, as tables 8-12 and 8-13 imply, there appear to be messages lost between systems. It is also known that some TES-N nominations were lost to DTMS when they were improperly formatted, which in turn led to the loss of mensuration requests between LAWS and DTMS.

Procedures for target accountability need to be introduced. Each originator of an action or request must be responsible for ensuring his action or request was received at the target workstation, ideally done automatically. Each workstation that is unable to respond to an action or request must report the reason for than inaction and ensure the target workstation is cognizant of it. These actions and responses need to be logged and displayed in LAWS to provide the complete SA necessary for effective target management.

8.5.4 Tactical Exploitation System – Navy (TES-N)

8.5.4.1 Nomination Counts

Electronic data logs were collected by the TES-N system on CORONADO for the duration of the experiment. No data were logged at the Remote Terminal Client (RTC) workstations. Table 8-14 shows the distribution of the 87 TES-N target nominations for each day. Target numbers are assigned automatically by TES-N when the nominations are sent to LAWS. Only nominations with target numbers are included in the table, and it does not include any targets for which nominations may have been created but not sent to LAWS. The TES-N ITD_TGT_NOM_HIST file shows 14 examples of target NOMINATE_CREATE events, which cannot be linked with subsequent NOMINATE_SENT events and their corresponding target numbers.

Table 8-14 lists the number of TES-N and RTC nominations received in LAWS subsequent to 28 July. The large discrepancy in the number sent by TES-N and received by LAWS on 29 July results primarily from the incompleteness of the logged LAWS data. The table also shows the number of TES-N nominations received in DTMS. For a mensuration to be performed on the target, the nomination message, with attached imagery, had to be received by DTMS. The TES-N target nomination message was not designed to send a target nomination and image in the same message. Accordingly, a separate message with an attached image had to be created and sent to DTMS. If this message, which required some manual input, was improperly formatted, it was rejected by DTMS. This is the presumed cause of the discrepancies between the nominations sent by TES-N and received by DTMS.

DATE	# Nominations sent (TES log)	# TES nominations Received in LAWS	# RTC nominations Received in LAWS	# TES nominations Received in DTMS
24-Jul	1			0
25-Jul	3			0
26-Jul	0			0
27-Jul	4			0
28-Jul	11			7
29-Jul	18	6	0	14
30-Jul	12	12	0	9
31-Jul	11	11	0	10
1-Aug	8	8	5	7
2-Aug	5	4	0	2
3-Aug	2	2	0	2
4-Aug	7	7	0	7
5-Aug	5	5	0	5
Total	87	55	5	63

Table 8-14. TES-N Nominations

8.5.4.2 Nomination Characteristics

Time to Nominate

Table 8-15 presents the median and mean times and the standard deviation for the interval from the creation of the nomination until it was first sent to LAWS, for each day of the experiment and the experiment as a whole. In 14 cases, the nomination was sent more than once. In most cases of multiple sends, the nominations were resent only once, but the number of repeat sends ranged up to four. For these multiple nominations, only the time of the first send event is used in the calculations. The mean value of the interval between nomination creation and send, and the standard deviation, are strongly affected by a small number of cases in which this interval was very large. The median value, 3 minutes, is more characteristic of system performance.

DATE	MEDIAN	MEAN	STD DEV	SAMPLE
24-Jul		1.8		1
25-Jul	15	11	7	3
26-Jul				0
27-Jul	16	80	120	3
28-Jul	5	9.1	9.7	11
29-Jul	2.7	3.8	3.8	18
30-Jul	3.4	13.7	34	12
31-Jul	2.5	9.3	21	11
1-Aug	2.6	18	38	8
2-Aug	5.5	35	72	5
3-Aug	1.3	1.3	1	2
4-Aug	1.6	8.2	11.6	7
5-Aug	0.3	0.5	0.3	5
All data	3	13	34	86

Table 8-15. TES-N Time to Nominate (All times in minutes)

Dwell Time

The contents of each of the ATI.ATR nomination messages shows that the dwell times reported for each target were not selected on the basis of target type or target status. A default value of one hour was entered for all targets for which a dwell time was reported.

Target Location Accuracy

The nomination messages contain no estimate of the CE and LE values associated with the reported target positions. The source of the nomination is reported, but in almost every case it is reported as AOBSR (airborne observer). It would be more useful if the specific platform (U2, Global hawk, Predator, satellite, etc.) and the specific sensor acquiring the image were identified. This information might provide a basis for estimating the accuracy of the reported target position and for determining the need for a georefined target location. In the three cases for which AOBSR was not identified as the source, IRAIR was identified as the source twice and ELINT once.

8.5.5 Mensuration Management Observation

8.5.5.1 Organization

The georefinement infrastructure consisted of a single Dynamic Target Management System (DTMS) located on CORONADO and Ready Room of the Future (RRF) mensuration workstations located on CORONADO (2), FITZGERALD, BENFOLD, DD-X, VSSGN, and at China Lake (Strike Warfare Commander).

8.5.5.2 Georefinement Procedures

The typical TST target engagement process began with a target nomination, including imagery, sent from the nominator, Global Intelligence Surveillance Reconnaissance Capability (GISRC), or Tactical Exploitation System – Naval (TES-N), to both the DTMS and the Land Attack Warfare System (LAWS). DTMS was to take no georefinement action on the nomination until the nomination was validated. This validation consisted of the receipt, by DTMS, of a georefinement request and a georefinement confirmation message, both originating with LAWS.

The georefinement process began with the request for georefinement issued by the LAWS to the DTMS. The georefinement request included specific mensuration accuracy and the expected time to mensurate. In principle, the requested mensuration accuracy was specified on the basis of the Weapon Target Pairing (WTP) that was performed by LAWS. On receipt of the georefinement request, the DTMS would automatically match the request with the corresponding target nomination that had previously been received. The Mensuration Manager, operating the DTMS, responded to the georefinement request with a georefinement response message, which rejected or accepted the tasking. Sometimes the acceptance incorporated a modified mensuration accuracy and time to mensurate. This DTMS response was directed to the specific LAWS workstation that originated the mensuration request, not to the LAWS server. Finally, LAWS responded to the DTMS response message with a georefinement confirmation message sent to DTMS, if the DTMS response was acceptable. With the confirmation of the proposed georefinement by LAWS, the Mensuration Manager then allocated the georefinement task to one of more of the RRF mensuration workstations. The mensuration was performed using the imagery supplied with the original target nomination message. If multiple mensuration tasks for the same target were completed by the RRF workstations and returned to the DTMS, the Mensuration Manager decided which of the results was to be forwarded to LAWS. This process is depicted in Figure 8-4.

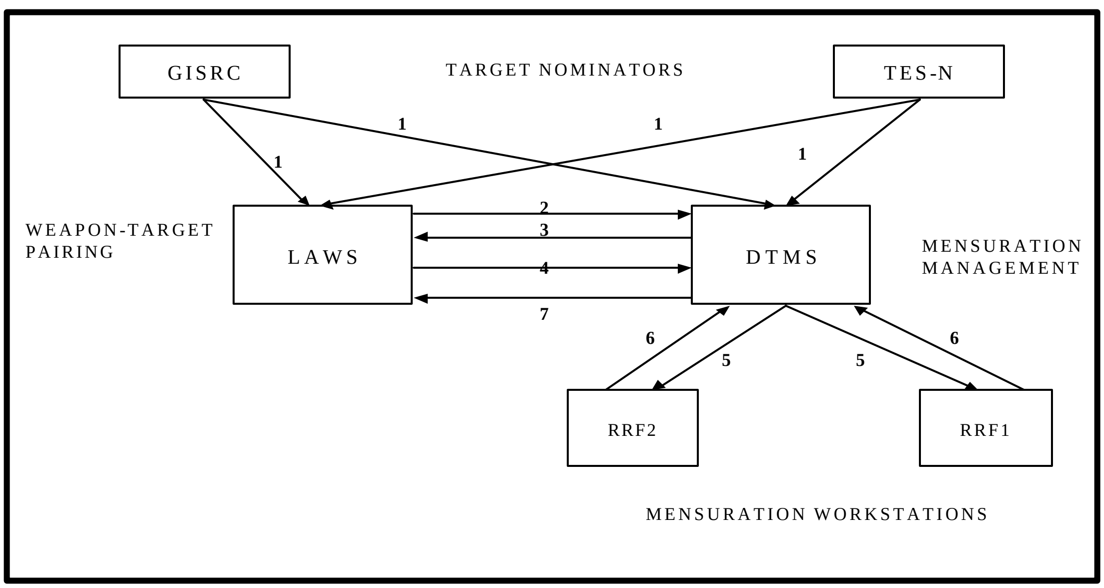

Figure 8-4. A Model of the Georefinement Process as Defined for MC02/FBE-J

The numbered lines in Figure 8-4 address operations actions:

1. Transmission of the target nomination, including target imagery, to LAWS and DTMS.

2. A message requesting georefinement is sent from LAWS to DTMS. The request includes the required accuracy of the target position.

3. A message is sent from DTMS to LAWS responding to the georefinement request. It accepts or rejects the tasking possibly modifying the requested accuracy.

4. A message is sent from LAWS to DTMS accepting the DTMS response to the georefinement request. On receipt of this, DTMS will start the mensuration action.

5. The mensuration task is assigned to one or more RRF workstations.

6. The RRF workstations send the mensuration result to DTMS. This may be either the georefined target position of an unable to mensurate response.

7. DTMS sends the georefined target position to LAWS.

8.5.5.3 Departures from the TTP

In a number of ways or at specific times, the georefinement process actually employed in the experiment differed from the procedure described above.

For TES, imagery could not be attached to the nomination message; therefore a separate message was generated and sent to DTMS with the imagery. If this nomination had not arrived at DTMS before the georefinement request was received from LAWS, DTMS could not match the request with a nomination and the request was automatically discarded.

There were cases where a georefinement result was received in LAWS but there is no evidence that a georefinement request was sent. In some instances, test cases were created in GISRC and sent directly to DTMS for mensuration as an exercise – no georefinement requests would be expected in these cases. However, this anomaly is not limited to test targets.

Prior to the experiment, DTMS was coded so that the response to the georefinement request was directed to the LAWS server. LAWS was coded so that the DTMS response was expected to be directed to the LAWS workstation that originated the georefinement not the LAWS central server. During the experiment this meant the DTMS had to manually send the response to individual LAWS adding time to the mensuration process.

There were many cases where mensuration was requested but where no WTP was ever performed.

Occasionally the response and/or the acceptance messages were absent.

It was common, particularly for these mensuration procedures that did not go to completion, to see on the LAWS georefinement page, a response time that was later than the acceptance time. This resulted from an initial response to the mission, which was accepted, but which was later followed by discovery that the target could not be mensurated (image resolution poor, no reference imagery). This necessitated a second response declining the tasking. This second response time was captured in the LAWS georefinement page but the original mission acceptance message time was retained.

8.5.6 Dynamic Target Management System (DTMS)

8.5.6.1 DTMS Task Statistics

This is the first FBE in which DTMS was an active participant in the mensuration process. The DTMS station collected an electronic data log on CORONADO. The task statistics derived from that log are presented in Table 8-16.

	Targets		No. of tgts with	Task number assignments		Tgts with georef position	
Date	Total no.	Test tgts	georef requests	No. of targets	Tot task Nos	Total	% of requests
28-Jul	106	8	35	30	69	9	26
29-Jul	76	7	57	38	80	28	49
30-Jul	102	2	69	36	120	48	70
31-Jul	87	6	52	55	93	46	88
1-Aug	66	13	26	33	71	28	108
2-Aug	18	1	8	9	19	8	100
3-Aug	8	0	7	7	18	6	86
4-Aug	15	3	10	10	16	6	60
5-Aug	10	1	9	9	18	7	78
Totals	488	41	273	227	504	186	68

Table 8-16. DTMS Task Statistics

The second column of Table 8-16 lists the total number of target numbers that appear in the DTMS logs. In principle, every target nominated by GISRC and TES-N should appear in the DTMS logs since the TTP required these systems to send all target nominations to both LAWS and DTMS. The third column shows the number of the received targets that were specifically identified as test targets (XX prefixed target numbers). The DTMS data for the period prior to 28 July were not included in the table, in part, because during the early part of the experiment a much larger proportion of the targets were test targets. For example, of the 89 targets logged in DTMS on July 26 and 27, 39 percent were test targets. DTMS was to take georefinement action on a target nomination only after the target was validated, that is, a georefinement request and confirmation message were received from LAWS. But both the DTMS and LAWS data show that georefinement result were generated for targets for which no georefinement request was logged. It is known that for some test targets, the test target nomination was generated in GISRC and the nomination sent to DTMS without being sent to LAWS. In these cases a georefinement request would not be expected. The last column gives the percentage of mensuration requests for which a georefined target position was reported by DTMS. The proportion steadily increases over the first half of the period reported here. This improvement is attributed, in part, to the experience gained by the operators involved in the imaging and mensuration process (GISRC, TES-N, UAV operators, DTMS, RRF). The greater than 100 percent result reported for August 1 results from the fact, mentioned above, that mensuration was provided for some targets for which there was no georefinement request.

Column 5 in Table 8-16 lists the number of targets for which RRF task numbers were assigned. The next column lists the total number of RRF task numbers that were created. The latter number greatly exceeds the former because in many cases the Mensuration Manager simultaneously tasked several RRF workstations to perform mensuration on the same target. Over the 28 July to 5 August interval, targets, on average, were assigned to be mensurated 2.2 times.

8.5.7 Ready Room of the Future (RRF)

8.5.7.1 RRF Task Statistics

Electronic data logs were collected from the RRF workstations. In Table 8-17, georefinement task statistics derived from these data are presented from the RRF workstations: BENFOLD, FITZGERALD, CORONADO1, CORONADO2, and DD-X. The VSSGN data were unusable, and no data were provided for the China Lake workstation. The table shows the number of tasks dealt with by each workstation for each day of the experiment. Five task results are listed for each workstation:

- **Georefined (G).** These are cases with an assigned task number from which a georefined target position was obtained and reported.

- **Unable to Georefine (U).** These are cases with an assigned task number for which the RRF workstation reported it was unable to provide a georefined target position.

- **No Action (NA).** These are cases with an assigned task number for which the task was selected by the RRF workstation but no actions were reported.

- **Georefined, but no task number assigned (GN).** These are cases with no assigned task number for which a georefined target position was logged. In some cases, the reported positions for different entries were nearly identical indicating they were likely re-measures of the same target. In those cases, the multiple re-measures were counted as a single task

- **Unable to georefine, no task number was assigned (UN).** In some cases a number of these events occurred within a short interval. In cases for which these were unable to mensurate events clustered within about two minutes of each other, they were judged to be multiple sendings of the same result.

DATE	BEN					COR1					COR2					DD-X				FITZ					TOTALS					
	G	U	NA	GN	UN	G	U	NA	GN	UN	G	U	NA	GN	UN	G	U	NA	GN	G	U	NA	GN	UN	G	U	NA	GN	UN	TOT
7/24						1						1	1		1							1			1	1	2	0	1	5
7/25						2	1			2		1													2	2	0	0	2	6
7/26	2				1			1			1			2						1			5		4	0	1	7	1	13
7/27	4	2	1			6		1			5		1		2	4			2	1	1	3	1		20	3	6	3	2	34
7/28	4	1	5		1						1	5	2		1					4	2	3		4	9	8	10	0	6	33
7/29	5	2			1	3		3			6	1	3	1		2	1			9	2	3		1	25	6	9	1	2	43
7/30	6	7	1			10	8			2	11	4	1	2		2	4	1		7	10	1		2	36	33	4	2	7	82
7/31	5	4	1		2	11	2				16			2		5	1			7	2	1		1	44	9	2	2	3	60
1-Aug	10	2			1	8	1	1		1	7		1							5	2	1	1		30	5	3	1	2	41
8/2						1					4	1													5	1	0	0	0	6
8/3						2					4		1												6	0	1	0	0	7
8/4						1					2	1	1												3	1	1	0	0	5
TOT	36	18	8	0	6	45	12	6	0	5	57	14	11	7	4	13	6	1	2	34	19	13	7	8	185	69	39	16	26	335

Table 8-17. RRF Task Statistics

For a portion of the experiment, covering the interval of July 27 to 29, RRF workstations were instructed not to send Unable to Mensurate messages to DTMS. This instruction was the result of a software problem with DTMS and presumably resulted in the classification of what should have been Unable to Mensurate results as No Action results.

The Internet Relay Chat (IRC) Targeting channel often included a reason that a target could not be mensurated. Listed below are the reasons that appeared in IRC. The order in which they appear in the list is in the approximate order of frequency that those explanations appeared:

- Tactical imagery of inadequate quality.
- Cannot find target; this was often caused when the nominator did not annotate the target on the image.
- No reference imagery of area; this was primarily a problem for San Nicholas Island for which only CORONADO RRF had reference imagery.
- Could not locate tactical imagery on reference imagery.
- System problems.
- Can't complete mensuration in the required time.
- Targets can't be georefined (e.g., ships at sea).

8.5.7.2 RRF Georefinement Times

The RRF georefinement time is defined as the interval between the time when the RRF workstation selected the task and the time that it published the mensurated target position. Table 8-18 presents the RRF georefinement mean and median times (in minutes) for each of the workstations for which data were provided and for the total data set. The workstation data show that in many cases the same task was selected several times by the same workstation before work was actually initiated on the georefinement. The mensuration times reported here was measured from the task selection immediately prior to the start of the processing of the data. The system georefinement times described later will include these false starts in the mensuration time.

RRF	Task selection - georef. result int.				Task selection - publish int.				Task selection - unable to men. int			
workstation	sample	median	mean	std dev	sample	median	mean	std dev	sample	median	mean	std dev
Benfold	36	11.8	17.7	18.6	36	13	19.3	18.7	18	10.5	14.5	13.6
Fitzgerald	34	7.8	10.9	9.2	34	8.9	11.9	9.2	19	7.4	8.4	7.9
Coronado 1	45	8.1	9.9	7.4	45	8.6	10.7	7.4	12	5.8	7.4	6.5
Coronado 2	57	9	10.2	4.9	57	10.8	11.4	4.8	14	4.2	10.7	15
DD-X	13	7.1	10.3	6.9	13	7.9	11.1	7.1	6	7	8.5	8.1
All	185	8.7	11.7	10.6	185	9.8	12.8	10.8	69	6.9	10.3	11.2

Table 8-18. RRF Mensuration (Times in Minutes)

In MC02/FBE-J, for the first time, the mensuration measurements times were determined from electronic data logs. In previous FBEs, the mensuration time data were based on manual logs maintained by the mensuration workstation operators. Table 8-19 compares the workstation mensuration time results (in minutes) from the last three FBEs. There is no significance difference in the times between FBE-J and FBE-I. Although the RRF electronic data logs for the VSSGN were not useable, the VSSGN operator reported in IRC on August 2 that his average mensuration time for 60 successful mensurations was 13.2 minutes. If delays resulting from system lock ups were excluded, he reported the average mensuration time would have been 10. 9 minutes.

Experiment	sample	median	mean	std dev
FBE-J	185	9.8	12.8	10.8
FBE-I	84	9	12.7	12.2
FBE-H	33	4.5	7.9	

Table 8-19. Comparison of Mensuration Station and Mensuration Times across FBEs

Based on the times to mensurate shown in Table 8-18 and the number of mensurations performed shown in Table 8-17, the busiest workstation on the busiest days attempted no more than about 20 mensurations, it appears that most RRF workstations were not heavily tasked most of the time. This point will be addressed more fully later.

8.5.8 LAWS

8.5.8.1 Georefinement Requests

The LAWS georefinement data are based on a review of 185 GISRC nominations and 60 TES-N/RTC TST missions for the interval 29 July to 5 August. The numbers of these nominations for which georefinement was requested, and for which georefined target locations were received, are shown in Table 8-20.

Nominator	GISRC	TES/RTC
July 20 – Aug. TST nominations	185	60
Number for which georefinement requested	111	44
Number for which georefinement was received	79	28
Percent received/requested	71	64

Table 8-20. LAWS TST Georefinement

8.5.8.2 Georefinement Timeline

The statistics for the time intervals in the georefinement process, as viewed from the LAWS perspective, are summarized in Table 8-21. The table presents, in minutes, the intervals between each of the four actions in the georefinement process: the interval between the request being issued by LAWS and LAWS receipt of the DTMS response to the request; the interval between LAWS receipt of the response and LAWS transmission of the acknowledgement of the response; and the interval between LAWS transmission of the acknowledgment and receipt of the completed georefined coordinates. Also included in the table are the statistics for the complete interval between LAWS transmission of the mensuration request and LAWS receipt of the georefinement result. The upper half of the table applies to GISRC nominations; the lower portion to TES-N/RTC nominations.

Interval	Median	Mean	Standard Deviation	Number of Observations
Georef requests for GISRC Nominations				111
Request – response	3	16	38	98
Response-accept	1	55	34	72
Accept-complete	18	30	47	57
Request-complete	31	84	300	73
Georef requests for TES-N nominations				44
Request – response	2	64	290	32
Response-accept	0	0.2	11	28
Accept-complete	18.5	26	26	26
Request-complete	21.5	34	34	28
Request-complete Total	27.0	70	259	101

Table 8-21. The LAWS Georefinement Timeline

For both GISRC and TES nominations, a significant number of the response- accept intervals had negative values; 18 percent for the GISRC nominations and 14 percent for TES. Most of these anomalies can be explained by the fact that DTMS responded favorably to the georefinement request, LAWS accepted, but the DTMS subsequently responded again negatively when it was discovered the image could not be mensurated.

Since TES could not append imagery to the nomination message, a separate message with imagery had to be sent to DTMS. If LAWS had transmitted the request for georefinement to DTMS before DTMS had received the nomination from TES the georefinement request was discarded. This problem is presumed partly responsible for the fact there was no response to 27 percent of the LAWS mensuration requests for TES nominations. The corresponding figure for the GISRC nominations was 12 percent. Otherwise, the two sets of data appear similar. In both cases, extreme outliers drive the value of the means and standard deviations. Accordingly system capabilities are better represented by the median values. In particular, the values of the means for the request-response and response-accept intervals show that in some cases operator's inattention to what should have been rapid, routine responses substantially delayed georefinement.

Figure 8-5 presents a histogram for the interval between the issuance of the mensuration request by LAWS and the receipt of the georefined target position at LAWS for 102 georefined targets.

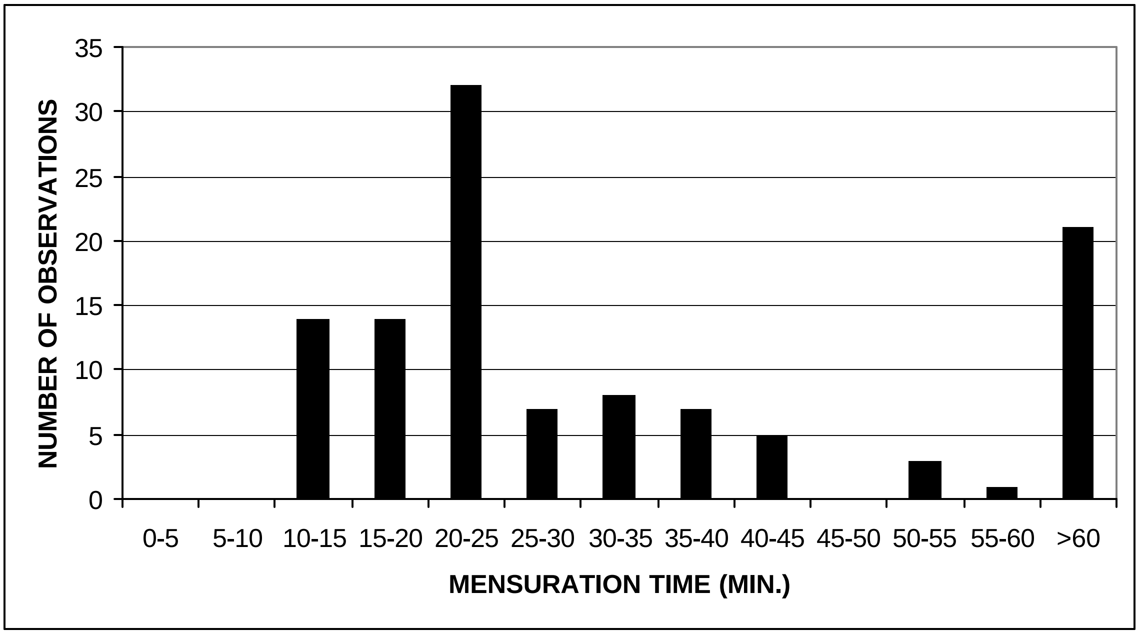

Figure 8-5. Total Mensuration Time – Interval Between Laws Mensuration Request and Receipt Of Georefined Position

8.5.8.3 Georefinement Accuracy

Figure 8-6 shows the relation between the georefinement accuracy requested (specifically the value of the requested Circular Error (CE)) in the georefinement request and the accuracy of the reported georefined target location. This former value comes from the LAWS Georefinement page, the latter comes from the LAWS targeting page. All the requested CE accuracies were 10, 15, 20, 35, or 50 meters. To allow showing the many coincident data points in the figure, the requested CE values, where necessary, have been arbitrarily offset. Three points with very large values of calculated CE (greater than 300 meters) have been excluded from Figure 8-6.

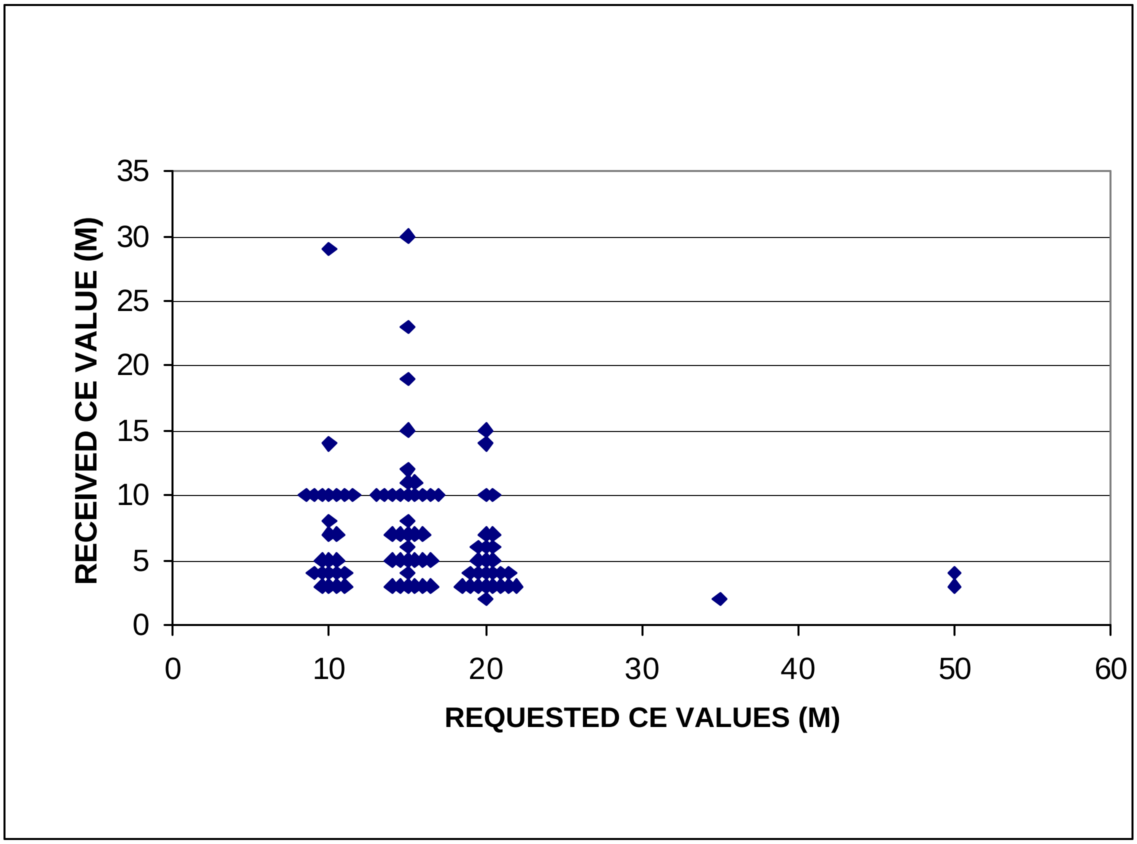

Figure 8-6. Comparison of the Georefinement Accuracy Requested and the Georefinement Accuracy Achieved

There are two principal points to be noted in Figure8-6. There is no relationship between the requested accuracy and the accuracy received, and the received accuracy is almost always better than that that requested. It would appear that the georefinement validation process, designed primarily to define target mensuration accuracy, is not useful.

8.6 Sub-Initiative Observations

8.6.1 RRF Workload

For the most active day of the experiment (July 30) Table 8-22 shows that for the workstations for which we have data, received a total of 82 tasks, for an average of 16 per workstation. Assuming they mensurated all of them, which for a variety of reasons they could not, and took an average mensuration time of 13 minutes (Table 8-23), the workstations would have been employed for less than 3.5 hours out of the 12 hour experiment day. This figure actually over-represents a realistic workload since each target was tasked for mensuration an average of 2.2 times. For certain targets that require high confidence in an accurate georefined location (e.g., hard targets, targets with a significant probability of unacceptable collateral damage) a target may need to be mensurated multiple times, but the level of multiple mensurations performed in MC02/FBE-J was not realistic. Much of the multiple mensurations occurred in this experiment simply to give RRF operators something to do. The IRC targeting channel contains frequent comments about boredom and lack of tasking by RRF operators. In addition, a small portion of the RRF tasking consisted of test targets. The conclusion is that the RRF workstation workload in this experiment was light**.**

8.6.2 Time to Mensurate

The median time to mensurate a target by RRF was 9.8 minutes (Table 8-19). The median time between LAWS issuing a georefinement request and receiving the mensuration result was 27 minutes (Table 8-21). It is not surprising that the introduction of the georefinement validation process and a new mensuration system (DTMS) lengthens the mensuration process. The georefinement validation process seems to contribute nothing but an increase in the mensuration time.

8.6.3 The Need for Georefinement

For high priority short dwell time targets, mensuration of the target should begin immediately even if the georefinement might ultimately prove unnecessary by virtue of the weapon-target pairing that is chosen.

For other targets, the original target nomination needs to contain an estimate of the accuracy of the reported target location. Without this, a reasoned determination of the need for further georefinement subsequent to weapon-target pairing cannot be made.

8.6.4 Georefinement Architecture and Autonomous Engagements

The FBE-J mensuration architecture required all mensuration requests to pass through the DTMS. This made the DTMS a single point of failure. If DTMS, or the communication link to it, went down the whole mensuration process would fail. For this reason alone the mensuration system should have been configured so that LAWS can send georefinement requests directly to RRF workstations and RRF workstations can receive target nominations. Beyond that consideration, the TST TTP should specifically address the cases of high priority short dwell time TSTs for which only a fully autonomous engagement has much hope of success. The FBE-J mensuration architecture makes autonomous engagements impossible.

8.6.5 The Contribution of the DTMS/Mensuration Manager

The value added to the mensuration process by the DTMS/ Mensuration Manager should be the proactive management of the process; efficient prioritization and allocation of tasks to those assets that have the time and databases to accomplish the task. The DTMS/Mensuration Manager should also provide a knowledgeable focus for filtering out tasks that cannot be performed due to poor imagery, unmensurable targets, or targets that do not require mensuration on the basis of weapon-target pairing. In the list of reasons the RRF workstation gave for being unable to mensurate targets, some of the responses should not occur, or should be greatly reduced in frequency by the actions of the Mensuration Manager. For example, if a workstation had no reference imagery of area, the Mensuration Manager would not allocate the task to that workstation because it did not have the necessary database. A cursory preview of the imagery by the Mensuration Manager should reduce the number of RRF workstations responses where they reported the target couldn't be georefined (e.g., ship at sea), the tactical imagery was of inadequate quality, and/or they can't find the target.

The value of the DTMS system will not be as evident in an environment where there is a low level of mensuration tasking and the RRF workstations could likely-self synchronize, as was the case in FBE-J. It needs to be demonstrated in an environment where mensuration resources are over tasked.

In FBE-J, DTMS automatically discarded mensuration requests if a corresponding target nomination had not been received. This led to the rejection of valid mensuration requests. Such requests should not be automatically rejected.

8.7 Live Fly

One of the needs that emerged from FBE-I was to provide a TST analysis product from live fly events based on the experimental architecture and CONOPS. This product would provide insights on how forces can find-fix-track-target-engage (F2-T2-E-A) and assess TSTs outside the simulation environment. Data collection and analysis of live-fly events occurred during FBE-I. However, there were significant constraints in the experiment that prevented a “pure” measurement of the events. The planning and management of live-fly events in FBE-J improved significantly. However, there were still significant constraints.

There was early planning for the experimental design. However, uncertainty on the amount and type of sensor and strike assets throughout the planning restricted scenario options. Predator and P3 AIP sensor platforms were primarily used. There was little opportunity to measure the effect of “sensor cueing,” i.e., measuring the time a target is sensed by a joint asset (e.g., JSTARS) and handed off to a service sensor (e.g., Predator). Additionally, there were several range limitations that must be taken under consideration. This includes flight routes of sensors, integration of strike flight planning with experimental objectives (how much did the pilot know about the target before), and range restrictions.

Five event timelines were reconstructed using observer notes, IWS chat, and system mission histories. The purpose of these timelines was to provide insight into the decision-making process in the conduct of live TST operations. These timelines should not be a “doctrinal” reference for F2-T2-E-A engagement times. All command and control for these events were by the Strike Warfare Commander located at China Lake. As noted earlier, there were several constraints to these timelines.

Time	Event	Data Source	Remarks
301015Jul	GISRC receives target from Predator	GISRC	Command and Control Center
301019Jul	Target nominated into LAWS	GISRC	
301024Jul	Request for georefinement sent to DTMS	Observer Notes	
301031Jul	RRF on CORONADO receives tasking for georefinement	Observer Notes	
301041Jul	Georefinement complete	LAWS	
301041Jul	STWC approves weapons release.	Observer Notes	
301041Jul	LAWS send call for fire message to TPG	Observer Notes	
301041Jul	TPG sends 9-line message to aircraft via ground station	Observer Notes	
301046Jul	Aircrew cleared for bomb run	Observer Notes	
301047Jul	Mk 83impacts target	Observer Notes	RS0008 is designated re-strike of the target at 301054Jul
Total Time: 32 min			From target acquisition

●—● DenotesTotal Engagement Time

Table 8-22. Target AX 0136

Target AX0136 had the most complete data set for reconstruction. Total time from sensing to engagement is approximately 33 minutes. BDA assessment was made from the Predator observing the target. Thus, the process for acquiring BDA assets was not stressed. The most time lapsed occurred during the georefinement process (17 minutes). The DTMS operator decided that the georefinement would be done on CORONADO.[89]

[89] Based on observer notes 20 July 2002.

Time	Event	Data Source	Remarks
300730Jul	Predator is launched	IWS Chat	
301434Jul	Predator acquires target	LAWS	
301437Jul	STWC acknowledges this target. Target Nomination received in LAWS	IWS Chat LAWS	
301455Jul	STWC acknowledges mensuration complete for target.	IWS Chat	
301457Jul	JFMCC BW acknowledges F-18 "Vampire" turning on target.	IWS Chat	
301501Jul	JFMCC assess hit off Predator video broadcast in MOC	IWS Chat	Mk-83 ordnance
Total Time: 27 min			From target acquisition

Table 8-23. Target AX 0161

●—● DenotesTotal Engagement Time

The DTMS Operator on USS CORONADO failed to clear previous coordinates for Target AX0161 from Spiral 3 and manually type in the correct coordinates, so Target Coordinates for San Clemente Island were erroneously sent in lieu of actual target coordinates (300 miles off). However Target AX0161 was successfully struck based on coordinates sent by the TPG.[90]

[90] Based on Observer Notes, 30 July 2002

Time	Event	Data Source	Remarks
011027Aug	Receives object from Predator	GISRC	
011411Aug	F-18, Predator, EA-6B, E-2C and VPU airborne	IWS Chat files	
011417Aug	Nominates target LAWS receive target nomination	GISRC LAWS	Headquarters
011418Aug	STWC acknowledges nominated target.	IWS Chat	
011427Aug	JFMCC decides to have both STWC and JFMCC georefine the target.	IWS Chat	
011428Aug	JFMCC TST cell states that mensurated targets are not 100 percent accurate.	IWS Chat	Possibly due to smoke and haze.
011430Aug	STWC states that imagery is masked by smoke and haze. Difficult to mensurate. Predator and VPU will try to reacquire	IWS Chat	
011438Aug	Georefinement completed	LAWS	
011450Aug	JDAM is released	IWS Chat	
011451Aug	STWC states that JDAM has direct hit on target	IWS Chat	
Total Time: 34 min			From time of nomination

●—● DenotesTotal Engagement Time

Table 8-24. Target AX 0204

On 1 Aug, situational awareness was enhanced for the DCAG by rearranging the STWC/IBAR room layout. The DCAG was now able to follow the targeting decision process from the GISRC to the TPG 9-line transmission, and ultimately to bomb on target. This optimally placed the DCAG within the targeting process and reduced the amount of decision-making time. USS CORONADO was unable to perform georefinement during the afternoon live-fire events. Data had to be pushed both manually and verbally between STWC LAWS and other STWC systems. STWC ISR did not keep STWC LAWS informed on what targets were being struck by JDAM or MK83 ordnance, adding confusion on Fire Orders. Due to high level of manual and verbal interventions in the afternoon live-fire events, target pairing on AX0204 was lost and had to be re-sent. There was a significant difference of target lat/long between Predator and LAWS. Later it was resolved that there were two target emitters at different locations.

Predator Tasking/GISRC were standing by in case the VPU P3 video/RTC could not nominate the target, as was planned for the afternoon live-fires. At 1415L, the Predator/GISRC was told to nominate. Predator video was asked to switch to IR because the optical video was dark and blurry. For an unknown reason, Range Control restricted the Predator to eight miles from the target. Predator video works best at 3 to 4 miles.

USS CORONADO DTMS was down through the morning evolutions. In order to run the STWC LAWS, the mission data had to be transmitted from USS CORONADO to all systems in the STWC at China Lake. ADCAG had to verbally transmit “Weapons Free” for morning live-fire.

In the afternoon event, the target coordinates from the LAWS were inaccurate, so TPG used the pre-surveyed coordinates. They had already demonstrated that LAWS could send TPG the information, but since this was a live-fire, the pre-surveyed coordinates were used so that the target could be hit.[91]

Time	Event	Data Source	Remarks
311416Jul	Predator sends image of object to GISRC	GISRC	
311418Jul	GISRC nominates target to LAWS	GISRC	
311422Jul	Georefinement complete	LAWS	
311439Jul	JFMCC Fires asks targeteer if they received target		Targeteer confirms.
311442Jul	Fire Command sent for target.	IWS Chat	Mk 83 ordnance
Total Time: 26 min			

●—● DenotesTotal Engagement Time

Table 8-25. Target AX 0182

Several problems occurred this day that prevented a true measurement of operational capability. This is reflected in AX0182 sequence of events. Because of smoke and haze from a forest fire, the Predator was only able to use its IR sensor. GISRC operators had a difficult time identifying targets. The ATO in LAWS had assets listed, but not type of ordnance. This prevented weapon-target pairing. The LAWS technician had to manually enter the type of ordnance. The data link from TPG to the F-18 was not working. The Predator was at an acute angle as it obtained video feed during this morning’s live-fire. The video feed was sending out skewed data points for location. These points (based on a very acute angle) caused the national database match-up to be one grid too far forward. The RTC operator was able to respond to this in an unrealistic manner by looking next to him at the live video images and based on his knowledge of the range. FTCPAC was not able to properly match the video feed image to the national imagery database pictures.[92]

[91] Based on STWC observer notes, 1 Aug 2002.
[92] Based on Observer Notes, 31 Jul 2002

Time	Event	Data Source	Remarks
011421Aug	STWC acknowledges target—working coordinates	IWS Chat	
011431Aug	Headquarters building Nominated	LAWS	Initially nominated by RTC
011449Aug	Targeteer states that target aimpoint sent	IWS Chat	Not sure of accuracy
011456Aug	Georefinement coordinates received	IWS Chat	
011459Aug	F-18 turns on target	IWS Chat	
011501Aug	STWC reports near miss on target	IWS Chat	Predator
Total Time: 40 min			

●—● DenotesTotal Engagement Time

Table 8-26. Target AX 0209

There seem to be several reasons for the extra time it took to strike AX 0209. The target was initially nominated by the RTC at China Lake. However, LAWS was unable to properly receive and use the data. USS CORONADO was unable to perform georefinement during the afternoon live-fire exercises. Data had to be pushed both manually and verbally between STWC LAWS and other STWC Stations. STWC ISR failed to keep STWC LAWS in the loop on JDAM versus MK83, and which targets were being engaged. These failures led to confusion on Fire Orders.[93]

8.8 NFN (X) Key Observations Summary

8.8.1 TST Operations Warfighting Context

This Section highlights the warfighting observations and findings that provide context to the analysis of the objective data in FBE-J. In concept, NFN (X) consisted of the people, processes, locations, CONOPS, and architecture that executed the daily maritime tasking order (MTO) and detected and responded to TSTs. NFN (X) was a Navy initiative and was a system centered on Tactical Exploitation System-Navy (TES-N), Global Command and Control System (GCCS-M), and the Land Attack Warfare System (LAWS). NFN (X) focused on the detection and engagement of TSTs within the JFMCC areas of interest. NFN (X) was fully integrated into the Joint Fires Initiative (JFI).

The objective for NFN (X) in FBE-J was to provide for fully autonomous platforms that were capable of performing all aspects of targeting.[94] Network-centric Warfare (NCW) concepts that this initiative related to include:

- Speed of command.
- Self-synchronizing forces.
- Improved and shared awareness.
- Virtual collaboration.

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[93] Based on STWC Observer Notes, 1 Aug 2002
[94] FBE-J Fires Report, 10 Aug 2002

- Increased tempo.
- Increased responsiveness.
- Sensor netting.

The primary nodes that were actively involved with this experimental initiative were:

- Maritime Operations Center (MOC) on USS CORONADO.
- Strike Warfare Commander (STWC) at China Lake.
- Principal Warfare Commanders located at FCTCPAC, the VSSGN at Newport, RI, USS Benfold, and USS Fitzgerald.

The JFMCC MOC was the primary command and control operations center for TST operations, and other current operations for the JFMCC. Their primary responsibility was to ensure that the Air Tasking Order (ATO) for the day was executed. Their other responsibilities were to have centralized control for F2T2EA of TST targets and to ensure that cross-component F2T2EA was executed according to the guidelines for the Joint Fires Initiative (JFI).

The execution of the ATO was not an experiment objective. Rather, the Maritime Planning Cell was experimenting with processes to develop ATOs. The ATO would be handed to the MOC for execution daily. However, because of the experiment design, the total focus of execution was on TST Operations.

In establishing the warfighting context for TST operations, the primary data collection methods that were used for this initiative were surveys, observations, and interviews. The data from the surveys were in two forms; general comments from the operators and watch officers and ratings by the respondents on certain aspects of TST operations. The general comments from the respondents were:

- Many of the issues that emerged were not necessarily technical issues, but rather process and CONOPS issues.
- Much of situational awareness came from IWS and IRC chat.
- Situation awareness was hampered by latencies in the systems; lack of sufficient screen space; and no visibility on the execution of the ATO.
- The TST architecture and CONOPS were good against fixed targets, however they were not good for targets that require meticulous search and long-term tracking.
- Very difficult to track moving targets with ADOCS/LAWS.
- ADOCS/LAWS provided little enemy situational awareness, and no awareness of weather; moving targets, or targets in proximity to other targets.
- There was little knowledge of the enemy’s COAs during the experiment.
- It was very difficult to visualize the land operations.
- Battle space area of responsibility was not clearly defined. TST strikes by aircraft cannot effectively be coordinated without knowledge of the enemy air defense threat.
- The information provided for each track in ADOCS/LAWS was inadequate to determine movement over time, age of the data, and the reporting unit.
- The “target cards” in LAWS needed to be defined better. A table was needed to improve and standardize the description of the characteristics of damage.
- Once a TST was hit, the subsequent process became confusing; there was no set process to coordinate BDA, decision criteria for re-strike, and requests for imagery.
- There needs to be better coordination and synchronization with the ISR and Fires cells.
- There was no confidence in the BDA reports.

- Assessments lacked detail. A re-capitulation of DMPI and a recommendation for re-strike were needed.
- It was difficult to coordinate collection of post-strike BDA. With multiple targets being hit, it was difficult to coordinate collection so a single sensor could collect BDA on more than one target.
- The ISR workload and low situational awareness prevented me from doing air-deconfliction of sensors and re-routing ISR assets based on the current situation.
- There was no situational awareness on the tasking and routes of all the sensors.
- There was no idea of what effect it would have on a current mission if a sensor were re-tasked.
- There was no idea on what sensors were available.
- The ISR web page had to be used to understand current UAV tasking and status, and it was poorly maintained.
- There was no correlation between planned coverage and sensors available for dynamic tasking.

The above comments coupled with observations indicate that the ISR and Fires functions were not completely synchronized. There were five distinct functions that occurred in the MOC; Fires (both JFMCC and joint), ISR management, targeteering, intelligence, and command.

Fires. The Fires cell was capable of managing TST operations. They were able to receive targets from JFACC and the JFLCC and integrate them into the JFMCC internal targeting process. Almost all targets were centrally controlled at the MOC and pushed directly to the engagement nodes for execution. The PWCs primarily monitored the TST operation. The exception was the STWC. The STWC fought autonomously most of the experiment. This decision was influenced by the STWC extensive involvement in live-fly events.

ISR Management. The ISR cell operations are covered in the ISR Section of this report. The survey data indicates that there was not an established process to assess the effects on the deliberate ISR plan when sensors were re-tasked to support TST operations. The ISR manager had neither the tools nor the established TTPs to visualize ISR operations at any given time. Thus, there was no confirmation that there was "seamless" ISR coverage of the area of operations.

Intelligence. There was an intelligence desk in the MOC. The role and TTPs for use the intelligence desk was not completely defined. The Intelligence Officer would occasionally give updates orally of significant "analyzed events" in the MOC. However, there was not any formal link between the ISR manager and Intel desk. This is indicates that it was not clear how "fresh" TST operations information from the ISR manager was being analyzed to build the current enemy situation.

Targeteering. The targeteer function was comprised of the DTMS and RRF. The primary tasks were to manage and process georefinement requests for TSTs. While this process generally functioned, the targeteers' general observations were that they did not have a good understanding of the Fires process. Basically, there was no process defined that allowed for the targeteers to efficiently georefine targets.

Command. The command function was centered on the battle watch officer (BWO) in the MOC. His responsibilities included supervising the other four functional areas in the MOC. For situational awareness, he had two overhead screens. These screens displayed the GCCS-M and ADOCS Dynamic Target List and Fires Manager. The BWO had on his desk a six-screen display. He generally kept ADOCS managers, Outlook Express and IWS Chat displayed. The BWO, Current Operations Officer, and Chief of Staff did not play an active role in synchronizing the cells within the MOC. Collaboration among the cells was at the cell leader and worker level. There seemed to be little effort in maintaining situational awareness at a higher level by analyzing the sum total of TST operations and its effect on the overall operation. Much of this lack of maintaining situational awareness may be due to the lack of confidence in the COP because of the simulation play.

8.9 Common Operational Picture (COP)

8.9.1 Background on the Analysis Process

GCCS-M provides operators with an operational picture in a real time network environment. It has many network reception, filtering, and broadcasting capabilities. NSWC Corona used a built-in function within GCCS-M to broadcast all OTH Gold Contact (CTC) messages to a file. These messages are time-stamped and contain contact number, time, position, threat identification, and source information. This information was reformatted and read into a joint common tracking analysis tool called the Performance Evaluation Tool (PET). With this tool, track files from multiple systems and nodes such as GCCS-M 3.x and 4.x, AEGIS, and HLA Simulation can be overlaid in a PC environment for detailed comparative analysis. The CTC messages obtained from GCCS-M included link-16, platform (T), J Unit, and air tracks.

For each test date, general notes about the events of that day are listed. TCT target times and positions obtained from engineering notes, ADOCS/LAWS chat messages, and Ready Room of the Future (RRF) automated logs are also listed. These notes and target lists are followed by a series of COP pictures from GCCS-M and AEGIS nodes participating on the network during the event. The TCT positions are shown on each latitude-versus-longitude display, and anomalies shown by the data are briefly discussed.

Some limitations of the FBE-J experimental design that effect the COP analysis are that GCCS-M 4.X does not read the ATI.ATR message format and no Electronic Intelligence (ELINT) tracks were extracted from either GCCS-M 3.X or GCCS-M 4.X. Also, no HLA Simulation data recordings were available to compare as truth data against the GCCS-M data.

The analysis tool used for COP analysis is the Performance Evaluation Tool (PET). PET is a PC-based computer program that reads data from multiple platforms, provides several views of track data (latitude versus longitude, altitude versus time, etc.), allows many color-coded filtering options, supports manual reconstruction (when truth data are available), calculates and displays various metrics, and simultaneously displays chronological metrics charts, link messages, and tactical track plots to aid analysts in tying metrics to performance issues. It was originally developed to support interoperability assessment for TEMP 801 (DDG 51 Guided Missile Destroyer Program) in July of 1998, and has been adapted to support assessment of Navy battle group air defense interoperability performance and C4I system analysis.

Figure 8-7 shows a PET time vs. latitude plot of track data from several sources. Note that the data do not cover the same time spans. In this case, the red 4.X data would be thrown out, and the track pictures from the other sources would only be compared during the time span where all were recording. This would correspond to the time the AEGIS data were available.

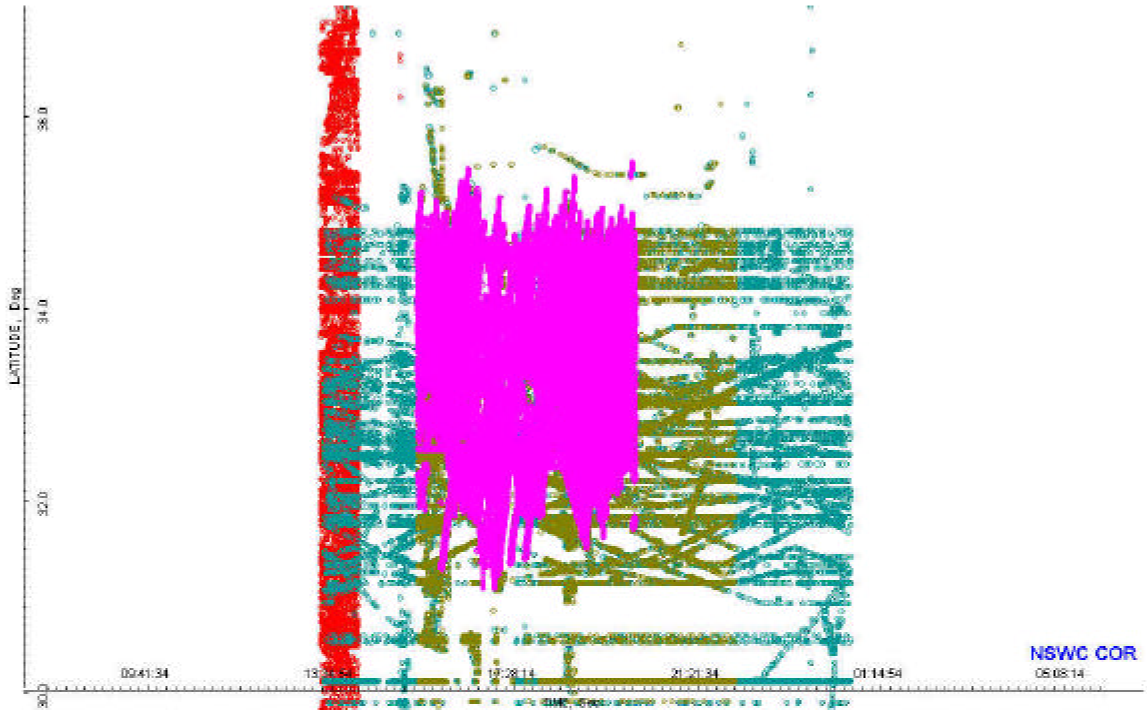

Figure 8-7. Data Distribution Example: Latitude vs. Time on 02 August. (Red is GCCS-M 4.X, Pink is AEGIS, Blue-Green is FCTC GCCS-3.X, Green is CL GCCS-M 3.X)

8.9.2 Analysis Results

The following COP relevant comments were excerpted from daily Imaging, Surveillance, and Reconnaissance (ISR) Team reports:

- TES-N to DTMS ATI.ATR message and image transfer remains unsuccessful.
- TES-N cannot nominate targets from Live Predator due to lack of telemetry display.
- Live aircraft/surface tracks (e.g. Predator@China Lake, and AIP P-3 SOCAL AOR) are not appearing in the MOC COP.
- Multiple discrepancies remain between ADOCS, GCCS and TES-N COP.
- Multiple duplicate simulated tracks remain in MOC COP.
- Track labels pushed from FCTCPAC FOTC GCCS-M are displayed as TRK Numbers vice names. Recommend FCTCPAC COP FOTC input and push tracks with call signs of units/aircraft (from daily ATO).
- Not all target nominations from GISRS are generating COP tracks.
- TES-N video/imagery problems have precluded verification of TES-N ability to generate tracks.
- MOC operators have no way of knowing which local ADOCS track number equates to which GCCS-M link track number and equates to which live event on the ATO.
- Differences in target contact/track naming schemes between GISRC/C2PC, GCCS-M, and ADOCS continue to prevent targets from appearing on ADOCS COP with the correct label (i.e., target number used in the TST nomination). For example, AX0180 (CL GISRC TST nomination for live JDAM drop) showed up in COP as BOA429 (the local C2PC track number assigned by the CL GISRC)
- The 4x picture was somewhat cluttered due to a 3x/CST/Link-16 compatibility problem that generated multiple link tracks for each platform track.

These comments are supported in the figures below which were produced from GCCS-M data.

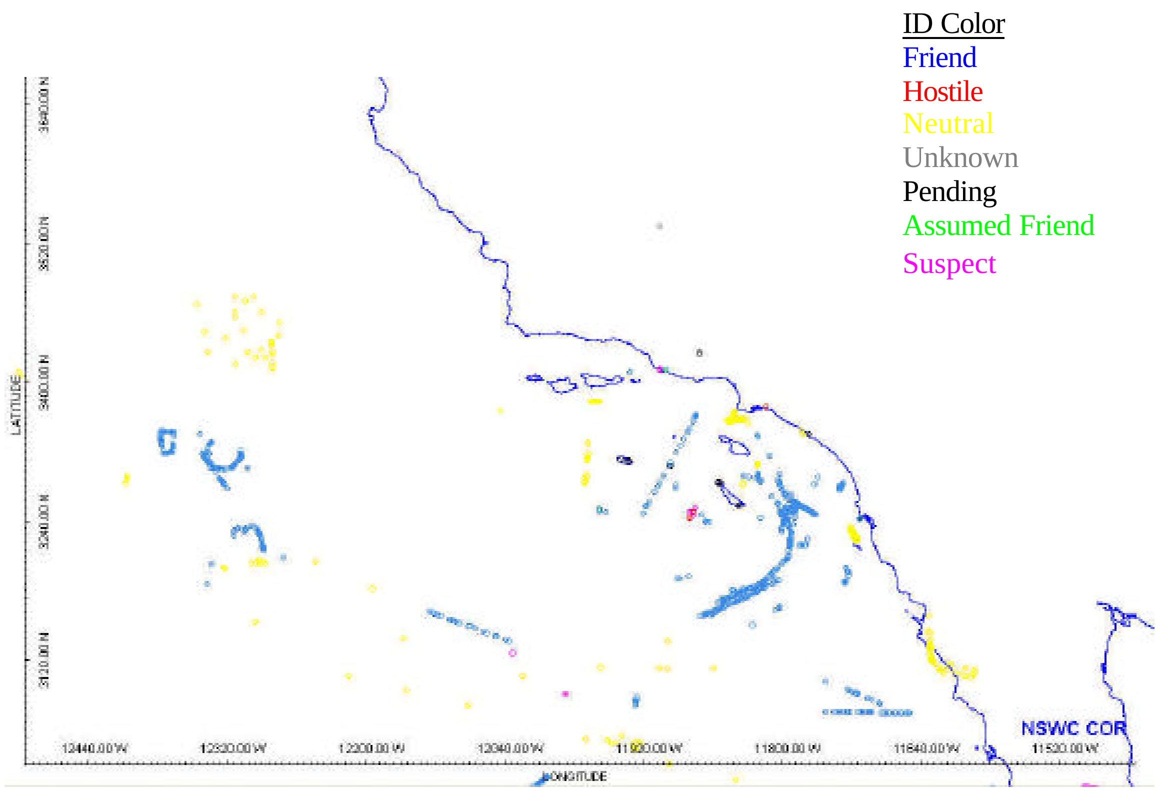

Figure 8-8. GCCS-M 3.X FCTC 0801.

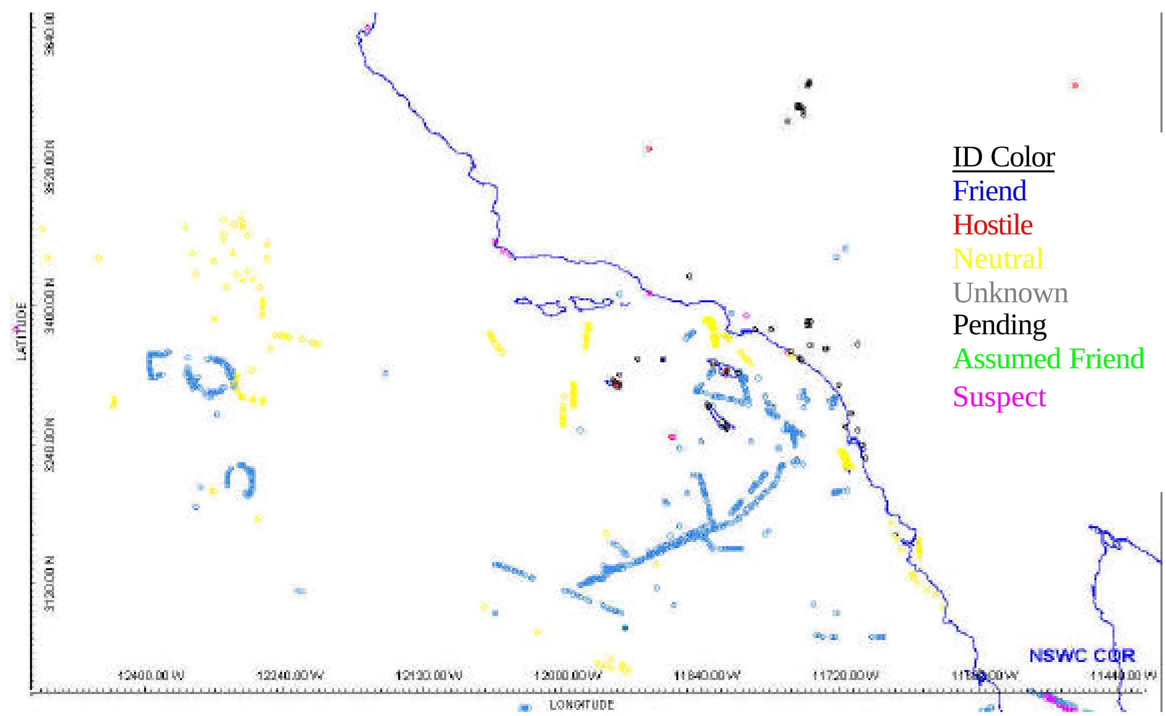

Figure 8-9. GCCS-M 3.X COR 0801.

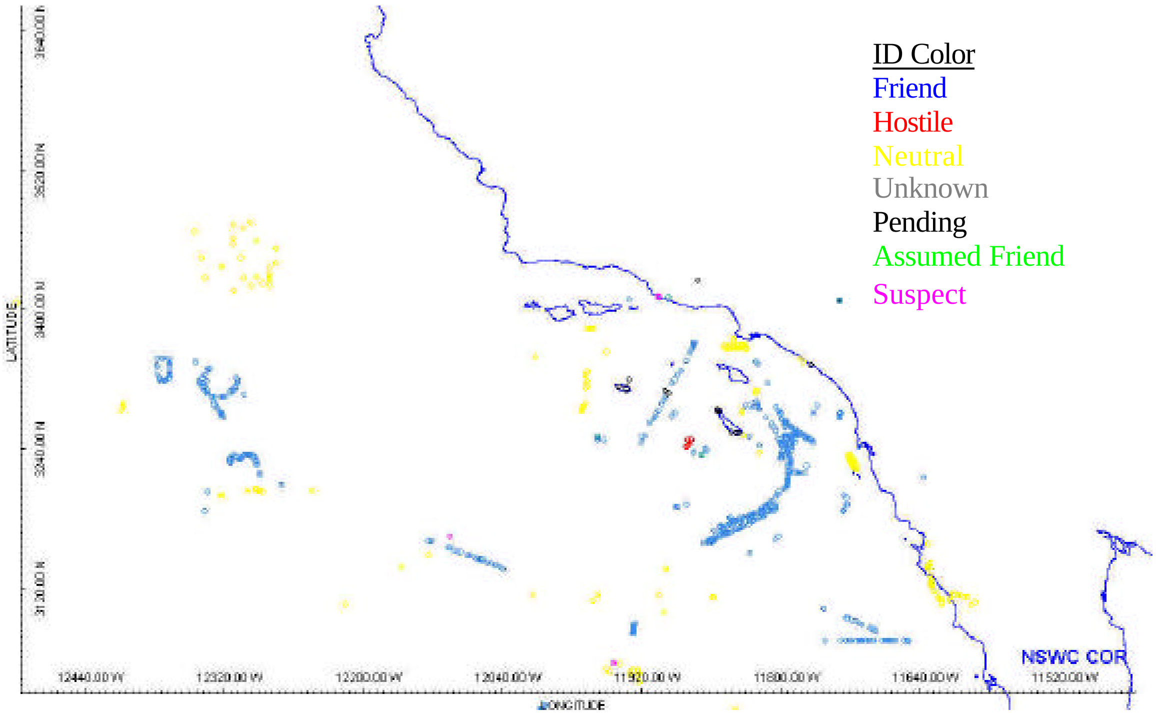

Figure 8-10. GCCS-M 3.X CL 0801.

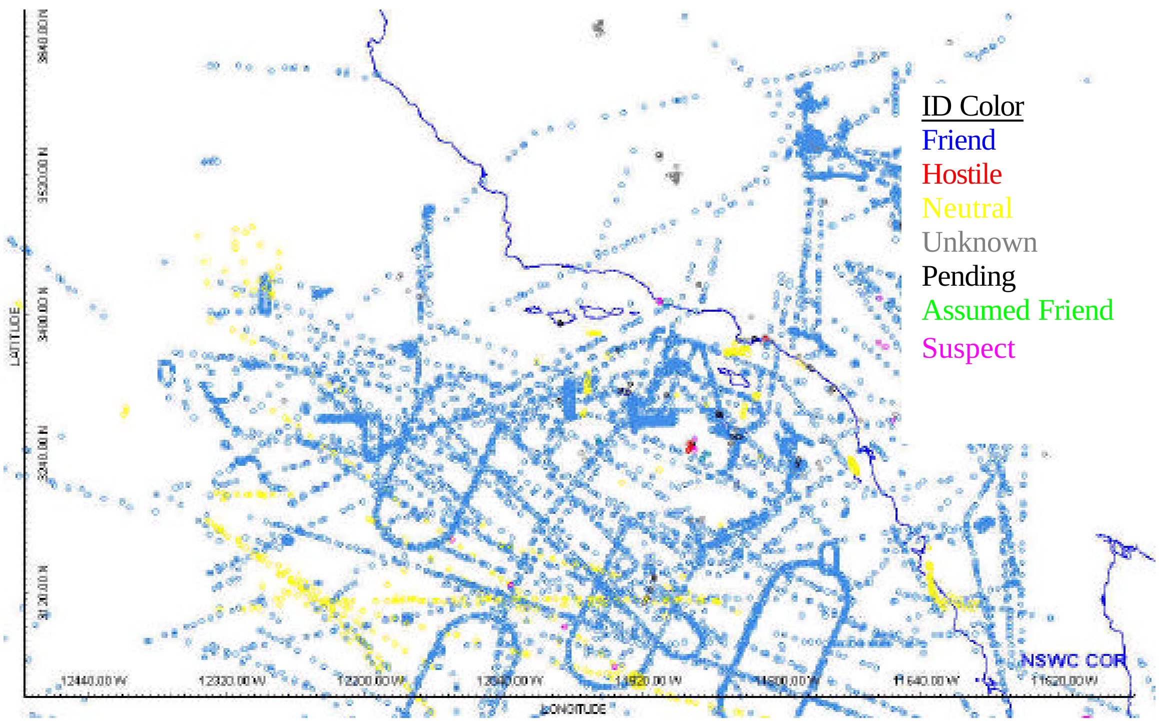

Figure 8-11. GCCS-M 4.X COR 0801.

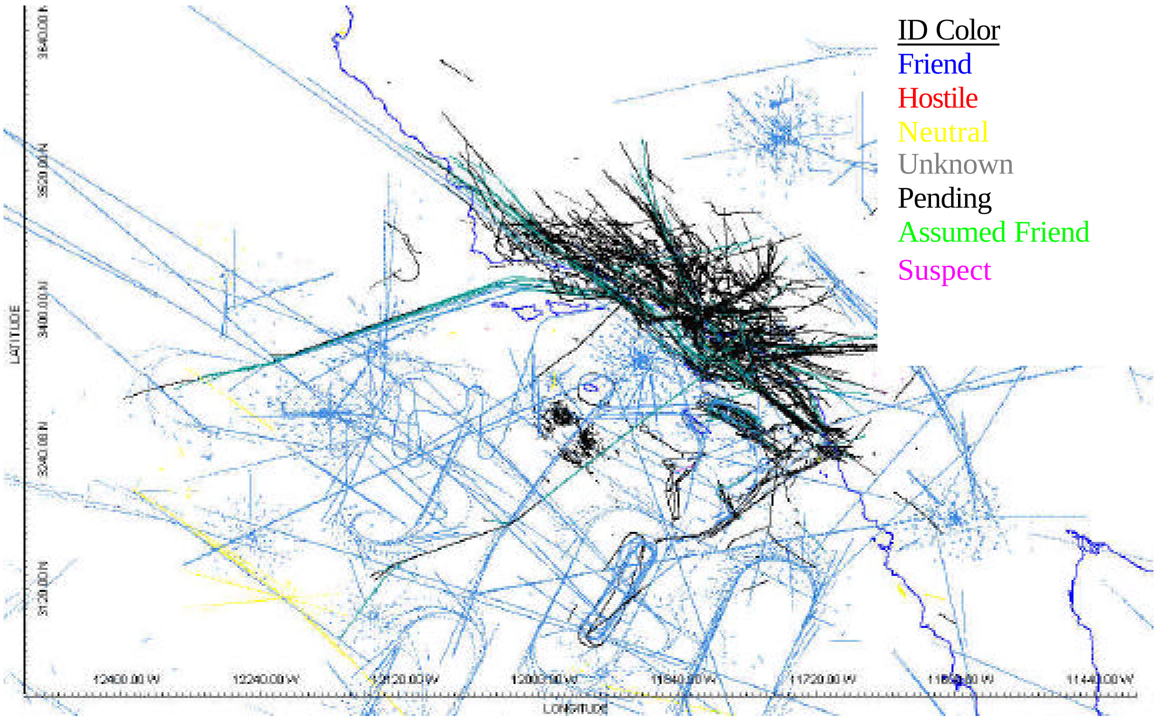

Figure 8-12. AEGIS USS Benfold 0801. Dark tracks are airliner traffic with threat ID of Pending. These live tracks were not in the GCCS-M COP.

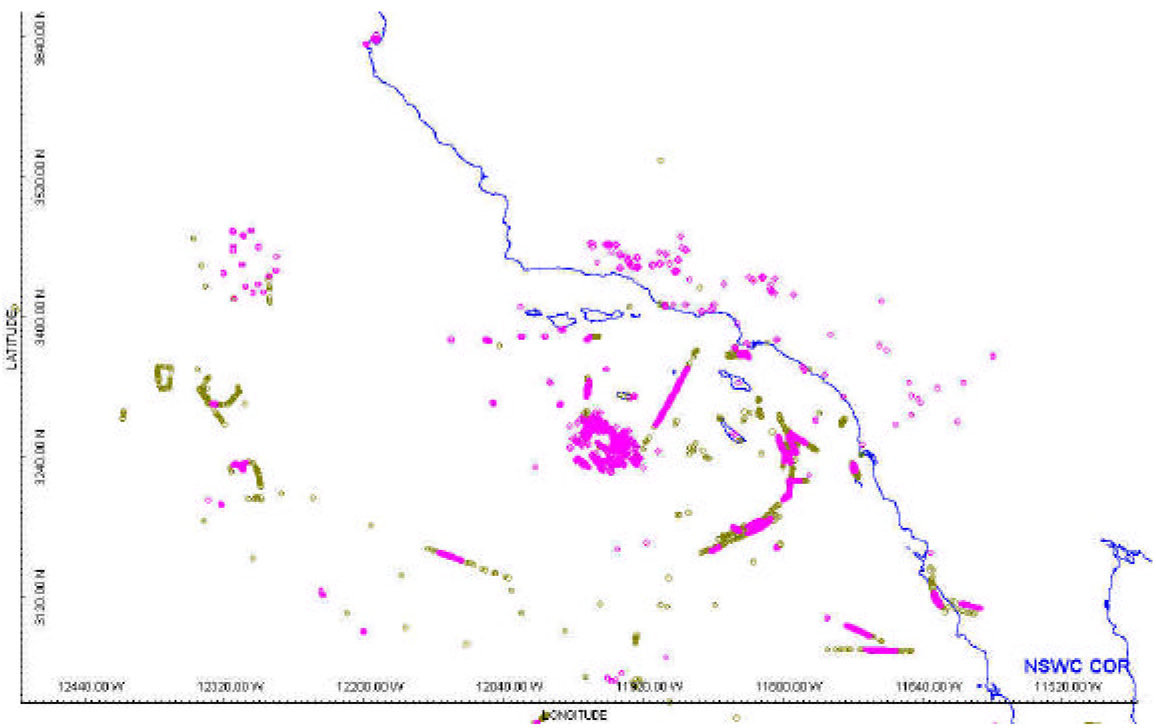

Figure 8-13. AEGIS BENFOLD-Purple and GCCS-M 3.X FCTC-Green Surface only.

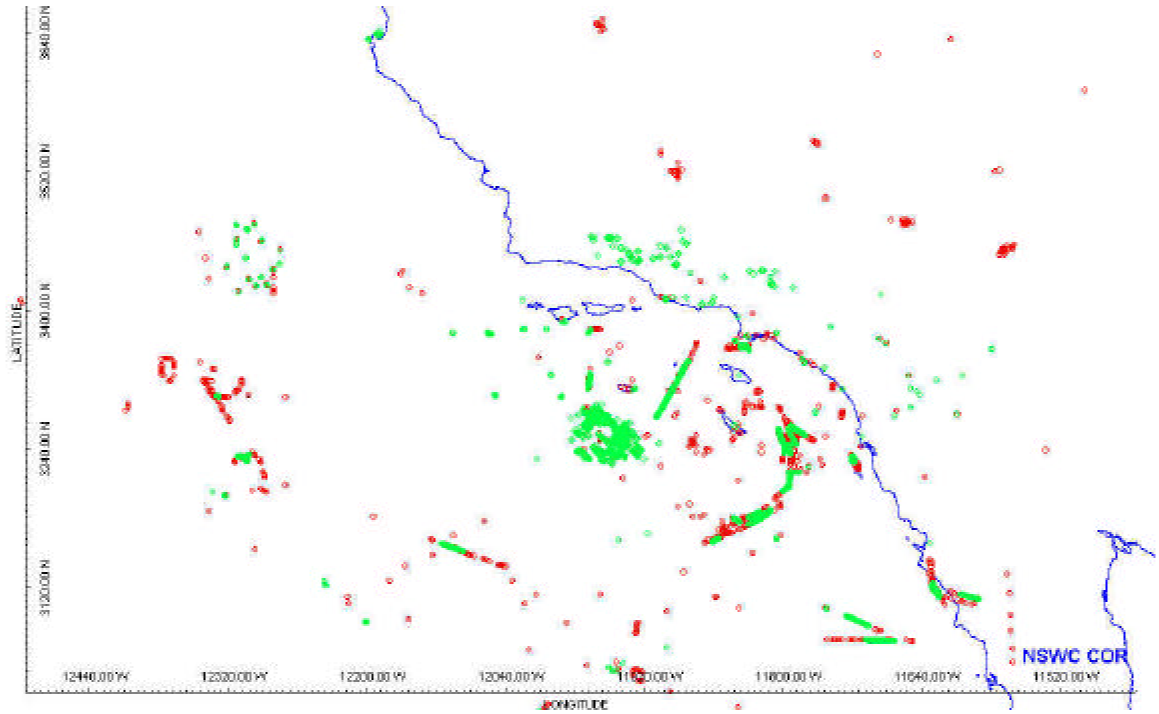

Figure 8-14. AEGIS BENFOLD-Red and GCCS-M 4.X COR-Green Surface Only.

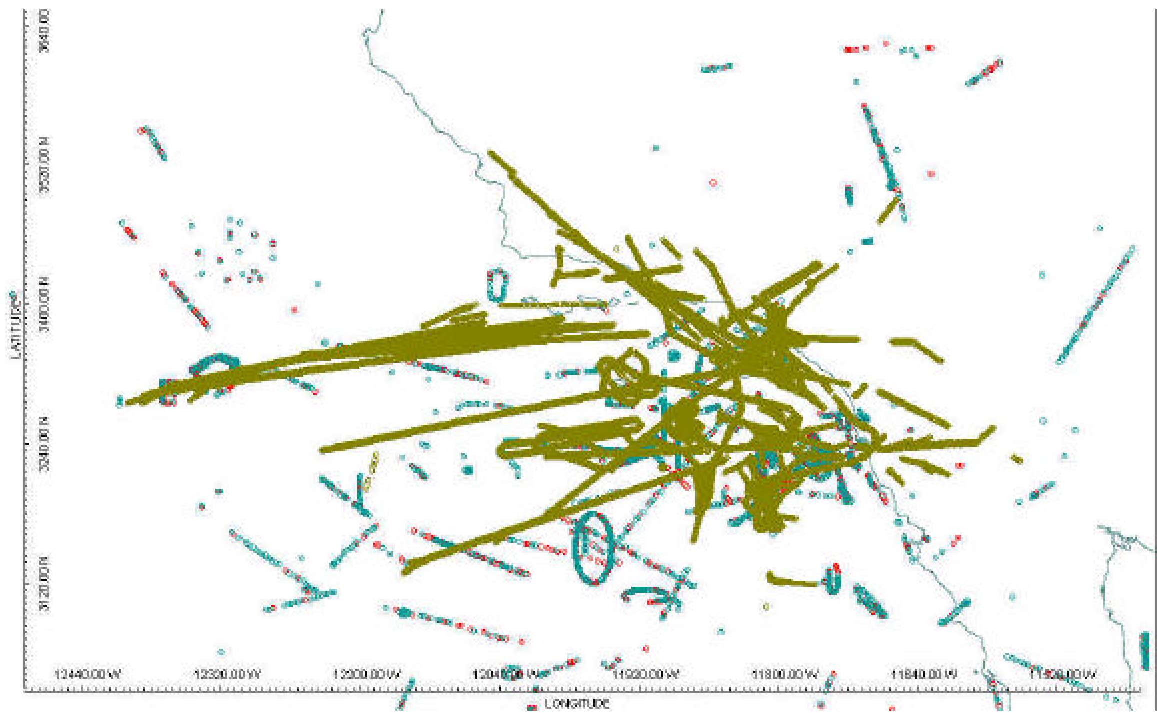

Figure 8-15. 0802 AEGIS (Green), GCCS-M 3.X FCTC (Red), and GCCS-M 3.X CL (Blue-Green).

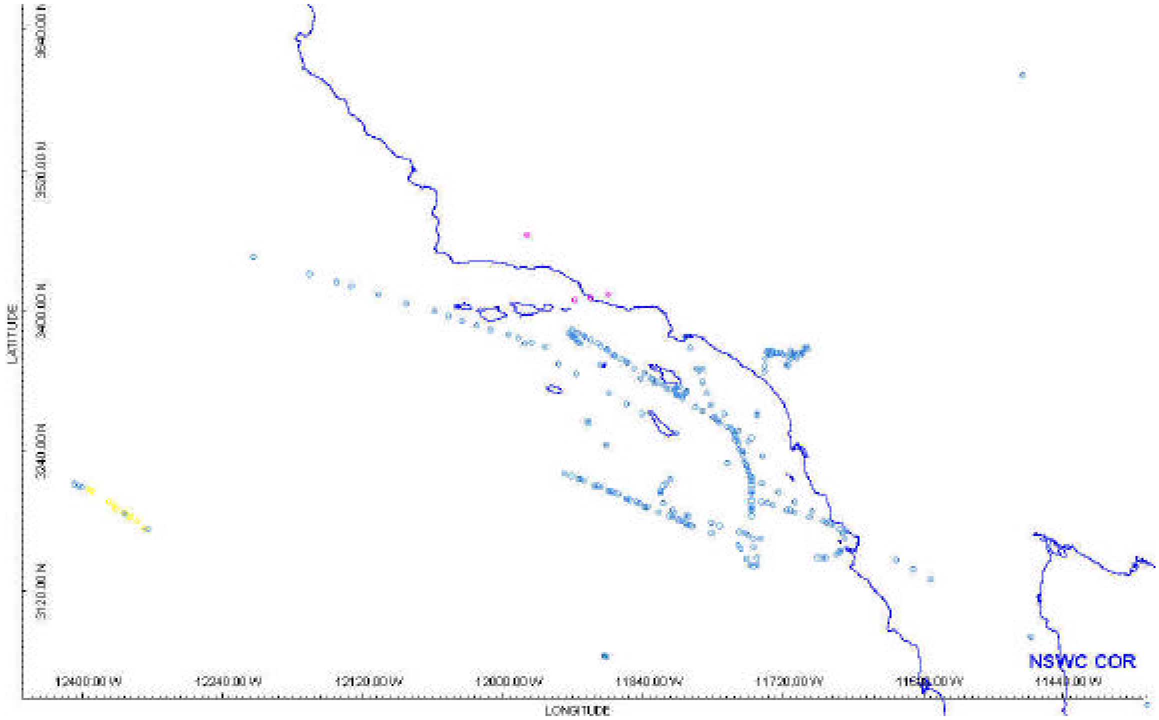

Figure 8-16. GCCS-M 3.X FCTC 0805 Air Only.

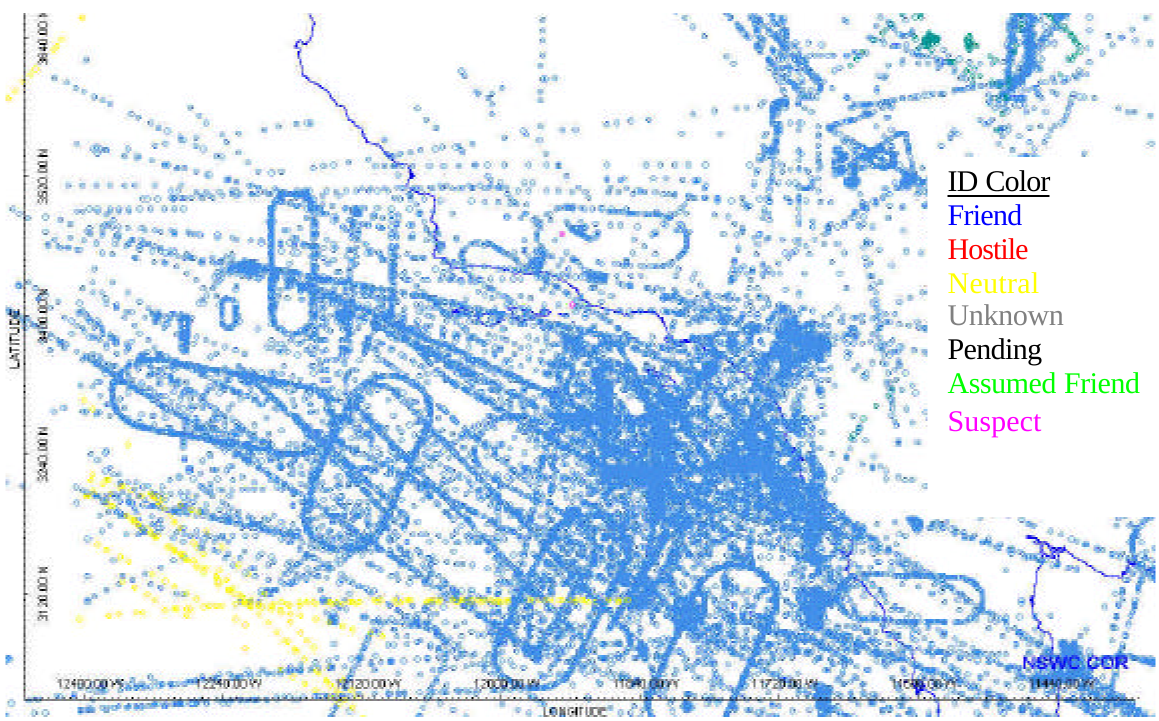

Figure 8-17. GCCS-M 4.X 0805 Air Only.

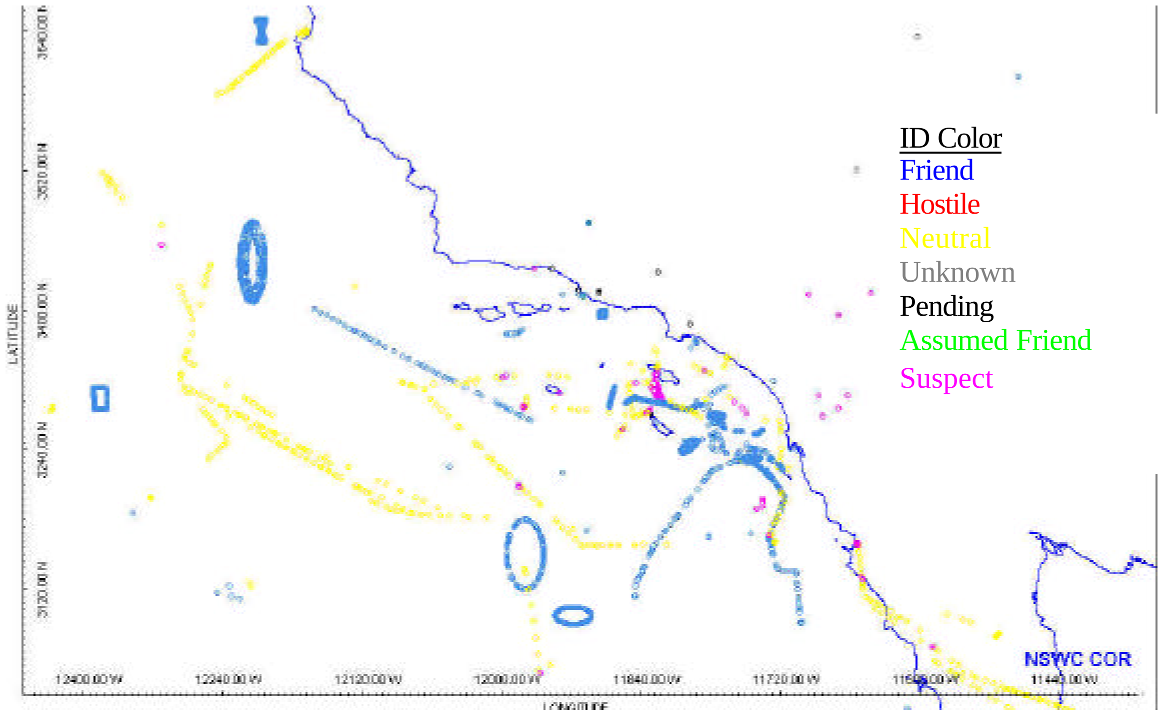

Figure 8-18. GCCS-M 3.X FCTC No Air Tracks.

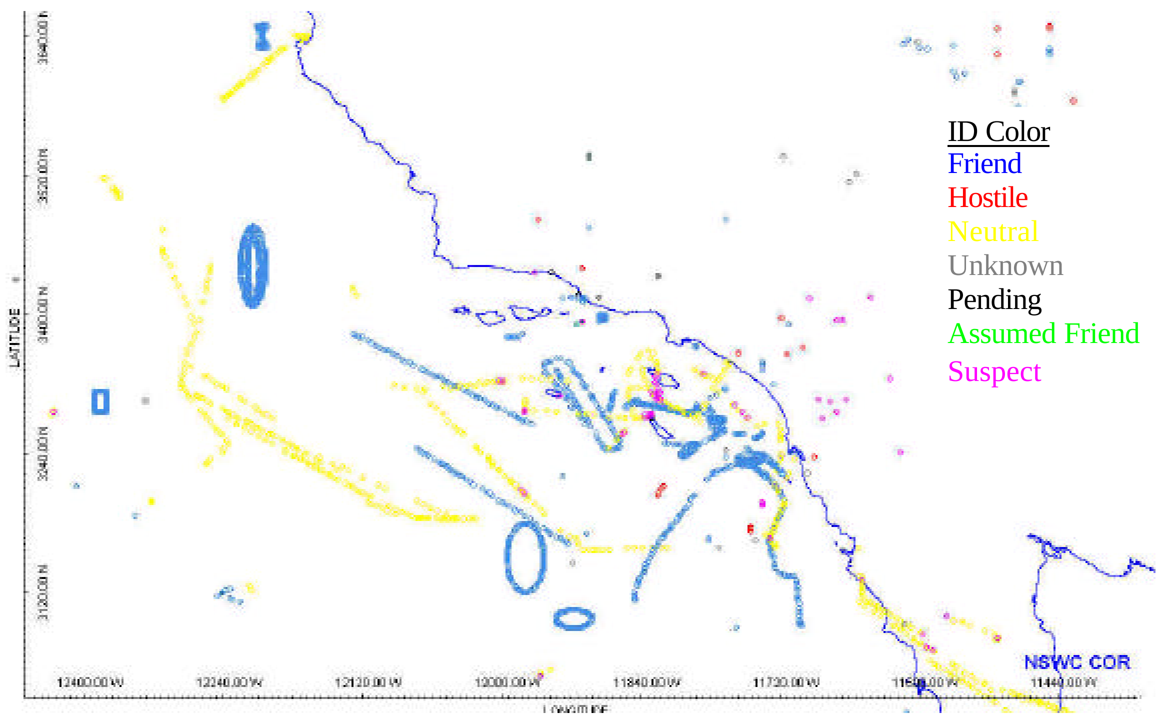

Figure 8-19. GCCS-M 4.X COR 0805 No Air Tracks.

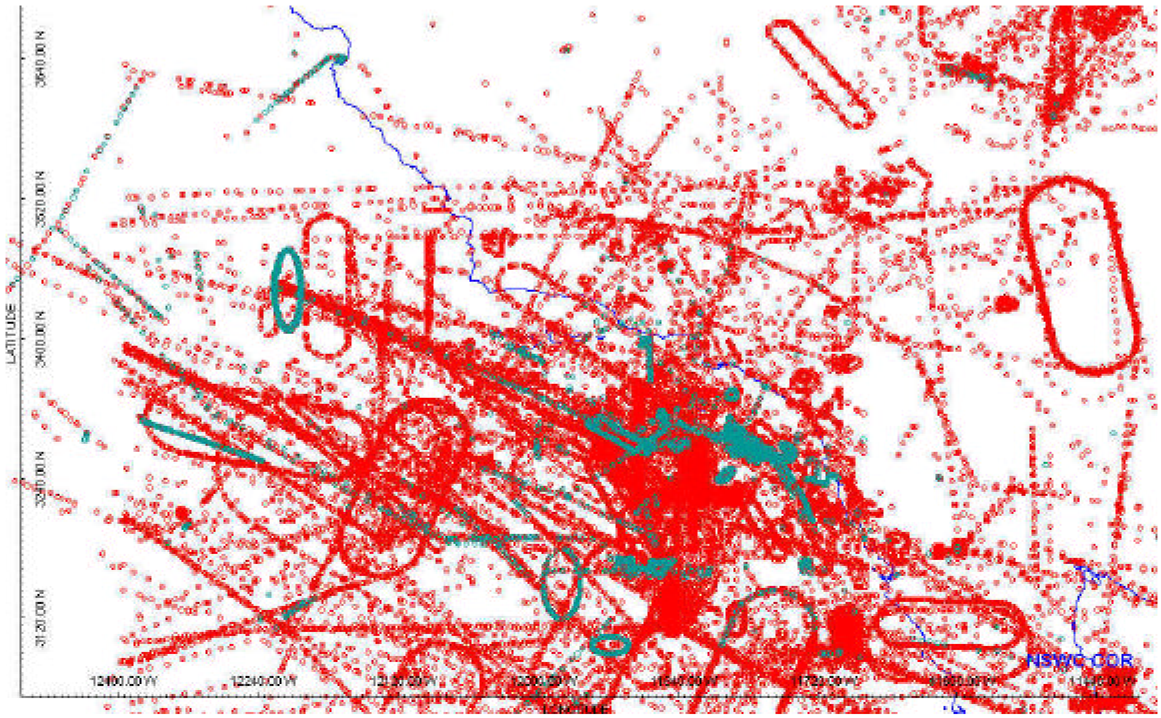

Figure 8-20. GCCS-M 3.X-Green and 4.X-Red Combined 0806.

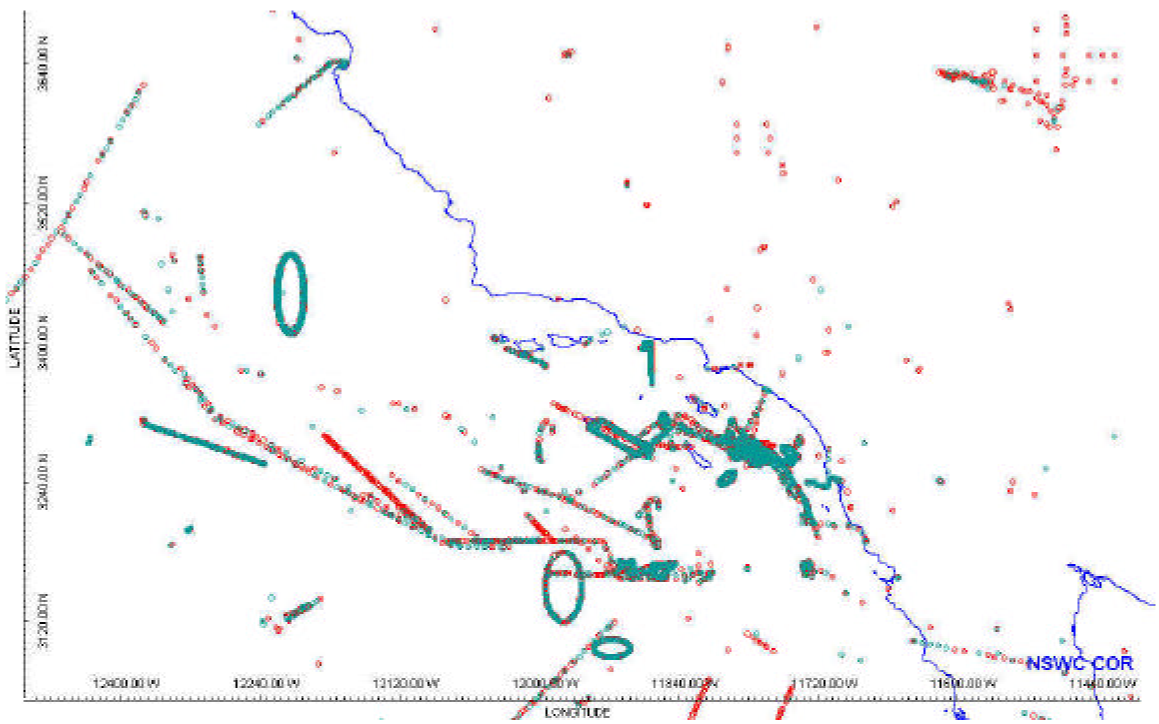

Figure 8-21. GCCS-M 3.X-Green and 4.X-Red Combined No Air Tracks 0806.

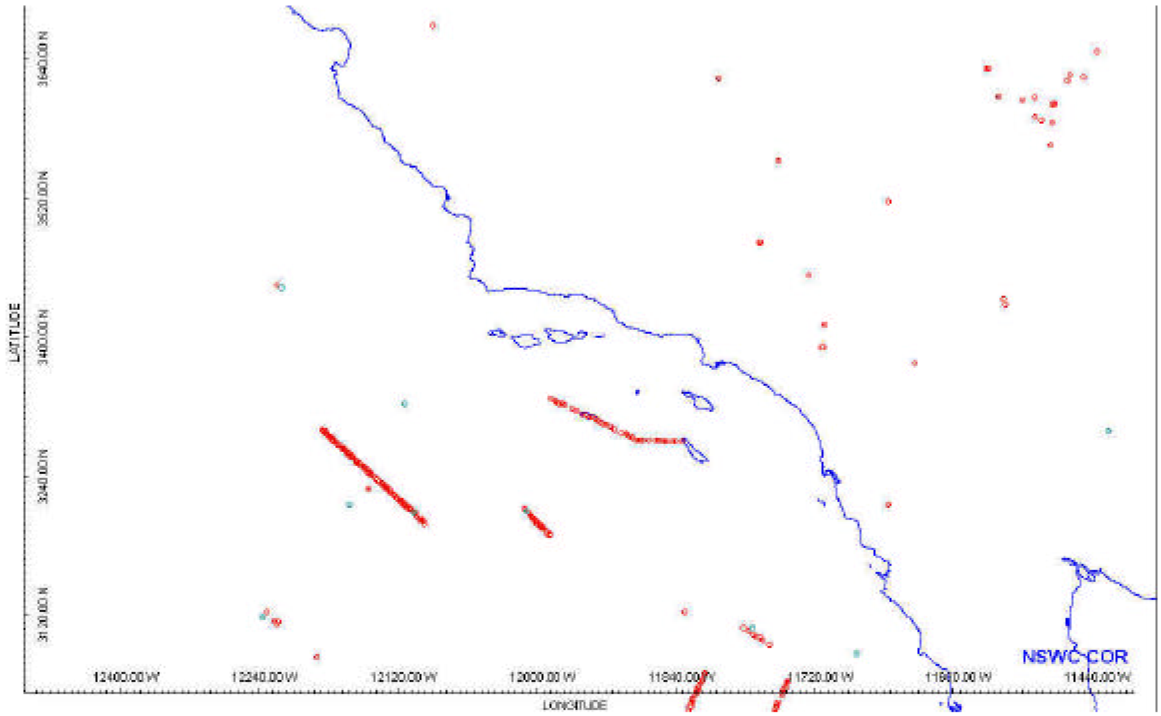

Figure 8-22. GCCS-M 3.X-Red and 4.X-Green Combined Land Friend Only.

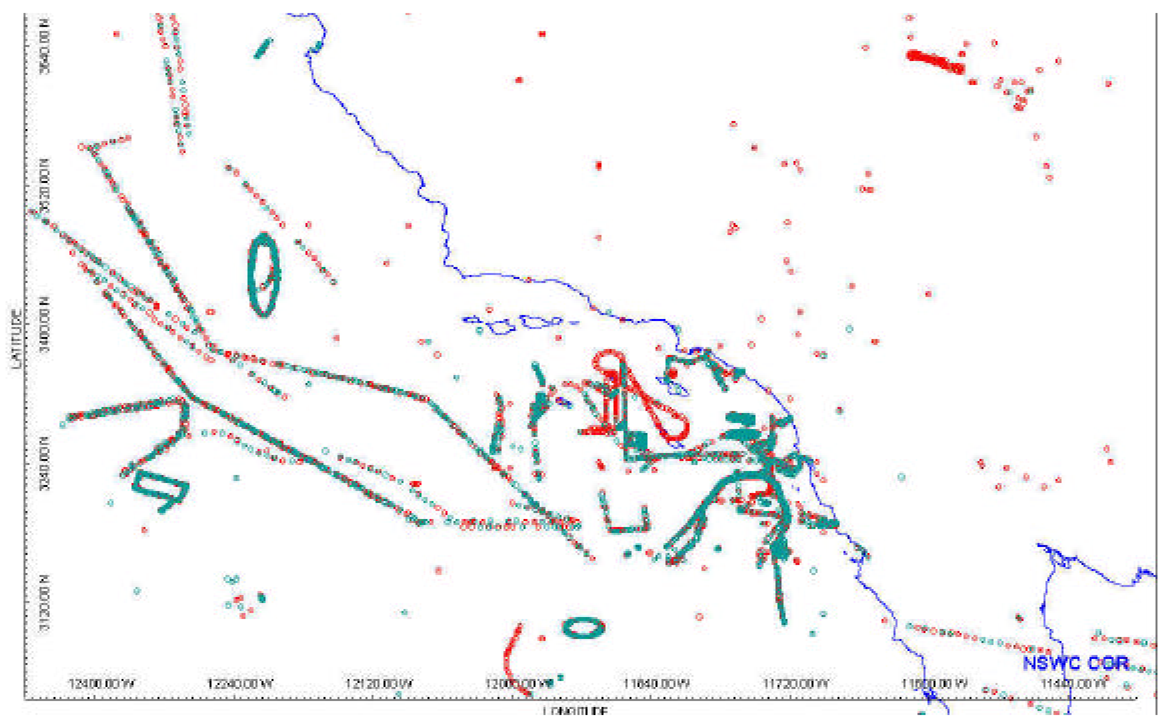

Figure 8-23. GCCS-M 4.X COR (Red) and GCCS-M 3x FCTC (Green) No Air Tracks.

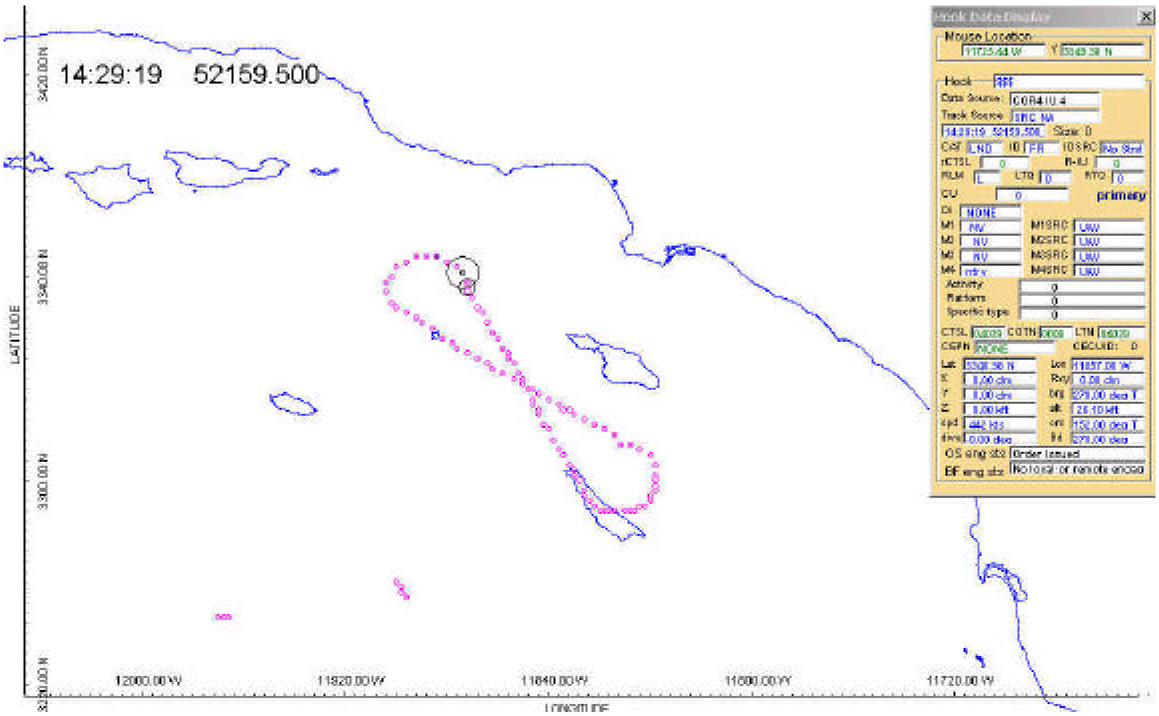

Figure 8-24. GCCS-M 4.X Track of Land Friend With Speed of 442 Knots.

8.9.3 COP Conclusions

- The surface pictures were similar but not identical; CST between FCTCPAC and China Lake appeared to work well.
- CST between 3x and 4x did not work well.
- There was very little correlation between the live AEGIS air picture and the GCCS air picture from CORONADO and FCTCPAC.
- GCCS is not receiving TCT contact messages from imagery sources.

8.9.4 Lessons Learned

Analysis of responses to a simulated environment would be greatly enhanced in both efficiency and depth if a recording of the sim/stim entity data was made and provided to the analysts.

There were many problems with the simulation itself that may not be addressed before future events, since the analysis of the HWIL HLA simulation "plant" as a whole was not an analysis objective.

Many of the war game events were marred because a simulation was not available for the type of reconnaissance or strike that was ordered.

More detailed planning of automated data collection will greatly improve future analysis efforts and may also reduce the requirement for labor-intensive, around-the-clock observers during an event.

The technology being applied should be tested in a building block approach during a spiral type phase. For example, the process for a TCT contact message to propagate through each network node can be tested in a very controlled environment using the type of setup that was available for Spiral 3. Problems that cannot be corrected before event commencement could then be documented, and that information made available to those "refereeing" the Red vs. Blue war game.

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9.0 Naval Fires Network Initiative Key Observations

9.1 Introduction

MC02/FBE-J provided an opportunity to configure NFN related components for rapid decisive operations within the context of the MC02/FBE-J architecture and scenario. Data collection and analysis planning focused on evaluating the experimental NFN technical architecture and procedural processes observed during the ISR and Fires engagement operations. The post-experiment analysis effort did not focus on a technical evaluation of NFN components but rather the integration of capabilities and their impact on the TST process.

These results provide insights as to the role, function, and contribution of NFN in a relatively high tempo warfighting context defined by the MC02/FBE-J experimental design, scenario, and architecture. Key findings relevant to the four primary NFN analytical objectives - Joint Interoperability, NFN Impact on TST Timeline, NFN Architecture Characteristics, and NFN Impact on Enhanced Situational Awareness – are included. NPS analyst observations, review of manual logs, electronic system data, and discussions with operators and technical team members form the basis of these results.

9.2 NFN Analysis Concept in MC02/FBE-J

The analysis concept focused on NFN capability to support rapid-response, tactical offensive operations required to achieve operational and strategic-level objectives. The NFN portion of the MC02/FBE-J Data Collection Plan contained the data capture requirements required to support the technical and operational analyses. The technical analyses (reconstruction analysis) was based on quantitative measures that provided insights relevant to the find, fix, track, target, engage, and assess process and the required NFN actions in that cycle. Additionally, post experiment review of electronic and manual data gathered during the experiment provided system integration and architecture insights for engineers to consider during NFN development. The operational analysis provided operational insights that include: system configuration considerations, command and control (C2) process improvements, and enhanced situational awareness realities.

9.2.1 MC02/FBE-J NFN Analytical Objectives

High-level NFN analytical objectives researched during MC02/FBE-J included:

- Joint interoperability (USN/USAF)
- NFN contribution to timely engagements of time sensitive targets
- NFN architecture characteristics (Spiral 1a Evaluation (GCCS-M/TES-N interface)
- NFN contribution to enhanced operational and tactical level situational awareness (RTC Lite)

9.2 NFN Experiment Stimuli: Simulation Feeds

- NITF: Simulated National imagery, CDL-N/CIP imagery (e.g. U2 ASARS) and IP pulls were distributed (NITF 2.1) by either TENCAP MUSE or AUTOSIGS
- ELINT: Simulated ELINT is being received over the ship's real world broadcast.
- PREDATOR: Provided by a RS-170 analog video feed.
- GH MTI: Simulated by TENCAP MUSE (one at FCTCPAC and one at Hurlburt).
- JSTARS MTI: Simulated by a VSTARS system at Hurlburt Field and delivered to MTES via the exercise network.

9.2.3 NFN Experiment Stimuli: Live Feeds

- JOTBS:Predator at China Lake – GBS downlink to CORONADO with no telemetry (metadata)
- P-3 VPU: Downlink through video server at China Lake to RTC → TES-N (CORONADO)
- ATARS: Post mission tapes reviewed by TES-N Image Analysts on CORONADO
- ASARS 2a: Ad hoc imagery, telemetry, and Navy plan forwarded from ISR-M (Nellis) to TES-N (CORONADO)
- JSTARS: Live UHF SATCOM feed integrated in M-TES (GMTI) on CORONADO.

9.3 Joint Interoperability (USN/USAF)

9.3.1 Joint Interoperability (USN/USAF): Obje ctive

Observe and document technical and procedural processes related to Joint Interoperability between Navy (TES-N) and USAF (ISR-M/JSTARS) within MC02/FBE-J architecture and scenario constraints.

9.3.2 Joint Interoperability (USN/USAF): Analytical Questions

- What are the interfaces, TTPs and types of information exchange between sea, air and land-based TES-N related nodes (ISR-M, RTC, and RTC-Lite) with USS CORONADO?
- What are the roles, functions, and interactions of NFN related systems in the Joint TST engagement process.

9.3.3 Joint Interoperability (USN/USAF): Findings

Although limited in scope, USN/USAF interoperability was exercised during this experiment. The following highlights the key findings:

- The experiment environment provided an opportunity to exercise coordinated USN/USAF TTP for sensor re-tasking (ASARS 2a) during live U-2 flights (31 Jul, 2, 8 Aug). The process to request additional (ad hoc) images from JFMCC ISR Operations through the JFACC liaison officer on board CORONADO to the JFACC ISR Operations (Nellis) for reprogramming of the sensor was successful. However, post experiment analysis of JFMCC ISR OPS and JFACC ISR COORD IWS chat rooms indicated that command and control (C2) between USAF liaison on-board CORONADO and JFACC ISR operations personnel at Nellis required extensive coordination between the participants at both locations in order to achieve these results.[95]

- Although previously reported during an NFN VPO VTC in Jun 02, that DIOP (Data Input Output Port) session between ISR-M baseline software (v4.1) and TES-N baseline software (v4.0) was not feasible because of software incompatibility, tests during MC02/FBE-J proved that report incorrect. The experiment produced successful DIOP of ASARS 2a spot imagery between ISR-M and TES-N during live U-2 flight (8 Aug 02). DIOP allowed real-time screening and exploitation of direct ASARS 2a downlink tactical imagery by TES-N operators on CORONADO. Success did require significant effort and expertise of contractors on CORONADO and at Nellis.[96]

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[95] Analyst observations and review of JFMCC ISR chat files
[96] Analyst observations and interview with PMS454 and C3F representatives

- Review of the TES-N Message and Data Log indicated an approximate 2-minute delay for TES-N to receive the reduced resolution ASARS 2a images from ISRM via DIOP. After a review of reduced resolution images, the DIOP session enabled TES-N operators to successfully pull specific high-resolution images from ISR-M server for additional examination and exploitation.

- The DIOP connection enabled the remote site (TES-N) to uplink ad hoc sensor collection requirements from the EMPS (TES-N) to the EMPS (ISR-M) at Nellis. The EMPS interface is used to plan, post, and monitor a tactical imagery collection request. Collection request test observed by NPS analyst included passing 2 SIGINT contacts from Gale Lite (TES-N) into EMPS via the XINT filter. Reviews of the JFACC ISR Coordination chat logs indicate that collection requests from TES-N EMPS (CORONADO) were visible in ISR-M EMPS (Nellis).[97]

- The TES-N system received real-time telemetry data in EMPS via DIOP that permitted TES-N operators to view the actual U-2 fly out and compare the actual versus the preplanned U-2 NAVPLAN originally forwarded by ISR-M operators prior to mission.

- JFMCC ISR operations request/receipt of ad hoc ASARS-2a imagery during live U-2 flight (2 Aug 02) was successful. JFACC LNO on CORONADO coordinated with JFMCC ISR Ops personnel (CORONADO) and JFACC ISR coordination personnel (Nellis) to upload ad hoc requests to the ASARS 2a sensor. Six (6) images were successfully from ISR-M into TES-N for analysis and exploitation via FTP. The Air Force originally claimed that 39 images were transmitted via FTP to TES-N but a review of the Message and Data Log in ISR-M (Nellis) indicated that ISR-M had only sent six images. A review of electronic TES-N history logs showed that those same 6 images were received. The table below highlights the six ASARS 2a images received in the TES-N Message and Data Log.

Date	Scene	Sensor type	Time received
0802	21	ASARS 2a	022028ZAUG02
0802	4	ASARS 2a	022009ZAUG02
0802	65553	ASARS 2a	021959ZAUG02
0802	39	ASARS 2a	021949ZAUG02
0802	65556	ASARS 2a	021926ZAUG02

Table 9-1. TES-N Message & Data Log ASARS 2a Entry – 2 Aug 02.

9.4 NFN TST Engagement

9.4.1 NFN TST Engagement/Timeline Observations

FBE-J provided an opportunity for coordinated TST operations between the NFN family of systems (TES-N, JSIPS-N (mensuration tools), and GCCS-M). The engagement process and timeline reconstruction, below, includes tasks associated with the Find, Fix, Track, Target, and Assess phases of the TST process.

[97] Analyst review of JFACC ISR Coordination Chat Log

9.4.2 NFN TST Engagement/Timeline Observations: Objective

Determine the TST Engagement process and representative timelines for NFN originated targets in the "Find-Fix-Track-Target and Assess" phases of the TST process.

9.4.3 NFN TST Engagement/Timeline Observations: Analytical Questions

- What are the NFN component roles and functions in the Find-Fix-Track-Target-Assess process?
- What is the representative timeline for NFN originated targets in the "Find-Fix-Track and Assess" phases of the TST process?

9.4.4 NFN TST Engagement Process/Timeline: Findings

9.4.5 NFN TST Engagement Process

The typical NFN TST target engagement process began with a target nomination, including imagery, sent from the nominator, the Tactical Exploitation System – Naval (TES-N), to both the DTMS and the Land Attack Warfare System (LAWS). DTMS was to take no georefinement action on the nomination until the nomination was validated. This validation consisted of the receipt, by DTMS, of a georefinement request and a georefinement confirmation message, both originating with LAWS. The portion of this report, Section 8.5.5, on Mensuration Management Observations, contains detailed analysis of the complete FBE-J mensuration process.

The FBE-J mensuration architecture required all mensuration requests to pass through the DTMS. This made the DTMS a single point of failure. If DTMS, or the communication link to it, went down the whole mensuration process would fail. For this reason alone, the mensuration system should have been configured so that LAWS could send georefinement requests directly to RRF workstations and RRF workstations could receive target nominations. Beyond that consideration, the TST TTP should specifically address the cases of high priority short dwell time TSTs, for which only a fully autonomous engagement has much hope of success. However, the FBE-J mensuration architecture made autonomous engagements impossible.[98]

The DTMS function should only be incorporated for target rich environments. FBE-J did not provide the environment required to assess DTMS functionality. The value added to the mensuration process by the DTMS/ Mensuration Manager should be the proactive management of the process – efficient prioritization and allocation of tasks to those assets that have the time and databases to accomplish the task. The DTMS/Mensuration Manager should also provide a knowledgeable focus for filtering out tasks that cannot be performed due to: poor imagery; unmensurateable targets; or targets that do not require mensuration on the basis of weapon-target pairing For example, in the list of reasons that the RRF workstations gave for being unable to mensurate targets, some of the responses should not occur or, at a minimum, they should be greatly reduced in frequency by the actions of the Mensuration Manager. Specifically, if they have no reference imagery of an area, a response would not occur because the Mensuration Manager would not allocate the task to a workstation that did not have the necessary database. A cursory preview of the imagery by the Mensuration Manager should reduce the number of RRF workstations responses where they reported the target couldn't be georefined (e.g. ship at sea); or that the tactical imagery was of inadequate quality; or where they couldn't find the target.[99]

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[98] Dr. Nelson Irvine NFN Mensuration Observations
[99] Dr. Nelson Irvine NFN Mensuration Observations

9.4.5.1 NFN Interface Impact on Engagement Process and Timeline

The poor quality of targets layered on simulated imagery increased the level of effort (time) required for a TES-N Imagery Analyst (IA) to identify targets of opportunity and nominate them (Find, Fix Phase). NFN nominations did not go through a rigorous vetting process to include a regular cross cuing of sensors prior to nominations. This is an artificiality of the experiment and would provide subtle inconsistencies with real world screening of imagery.[100]

The technical interface solution developed for the experiment between TES-N - DTMS/RRF and TES-N – GCCS-M was not operationally sound and process limitations and "work-arounds" negatively impacted end-to-end engagement timelines. For TES, imagery could not be attached to the nomination message; therefore a separate message was generated and sent to DTMS with the imagery. If this nomination had not arrived at DTMS before the georefinement request was received from LAWS, DTMS could not match the request with a nomination and the request was automatically discarded.[101]

Specifically, the experimental message set (interface) developed for MC02/FBE-J (TES-N nominations (ATI.ATR)) was automatically forwarded to LAWS but not to DTMS. A work-around identified prior to COMEX required the TES-N operator to manually add three fields (NEUT, SUR, TGSI) in the ATI.ATR nomination and attach the imagery prior to forwarding to DTMS via email.[102] Any operator error associated with adding these fields resulted in the nomination not being accepted by DTMS and subsequent discarding in that system.

Manual promulgation to DTMS accounted for 15 lost TES-N nominations. One explanation was that the LAWS Georef Request message was sent to DTMS prior to DTMS receiving the nomination (ATI.ATR) from TES-N. The delay could have been due to network congestion, manual processing, or other reasons. The NFN Operation Sequence process required LAWS and DTMS to conduct a three-way handshake, Figure 9-1 below, illustrates this handshake. If LAWS sent a Georef Request prior to DTMS receiving the nomination, DTMS would not respond with a Georef Confirmation and subsequently would discard the request. Since LAWS only requested GEOREF one time, per message specification, if the nomination arrived at the DTMS late, no mensuration action could be taken. Hence, the unprocessed nomination would remain in the DTMS unprocessed.

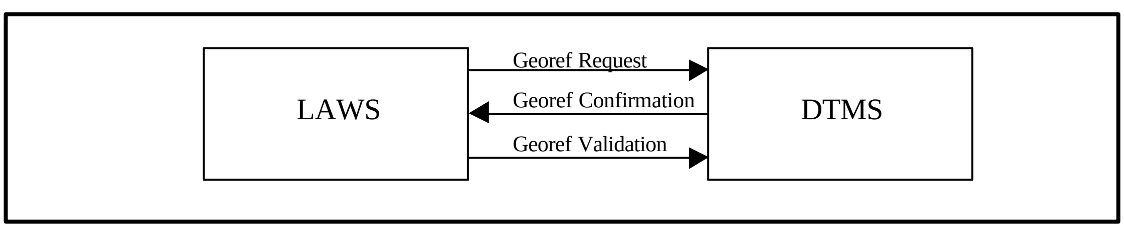


Figure 9-1. LAWS – DTMS 3-way Handshake.

A summary of the TES-N and DTMS electronic logs (28 July – 5 Aug) is presented below. Of the 68 TES-N nominated targets identified in DTMS, 60 were present in the LAWS electronic log (29 July – 5 Aug). However, of the 60 TES-N nominated targets in LAWS, only 29 were engaged. The NFN (X) section of this report, highlights the TES-N and other nominated targets that were identified in the LAWS electronic logs:

[100] Interview with LCDR J. Smith (C3F) and NFN Operators
[101] Interview with PMA 454 (TES-N) and PMS 281 (DTMS and RRF) Contractors
[102] Discussion with IS2 Taylor (TES-N Operator)

- Total number of TES-N nominated targets in TES-N Message & Data Log: 83
- Number of TES-N nominated targets that reached DTMS (Sim and Live): 68
- Number of TES-N nominated targets that did not reach DTMS: 15
- Number of TES-N targets pushed through complete mensuration cycle: 36
- Number of TES-N nominated targets in DTMS not mensurated: 32

Thus, of the 68 TES-N nominated targets identified in the DTMS logs, 36 of the 60 nominations actually forwarded to LAWS for engagement, completed the mensuration cycle. It was assumed that the other 24 TES-N nominations identified in the LAWS mission log were not mensurated.

9.5 TES-N Nominations

9.5.1 TES-N Nominations Counts

Electronic data logs were collected by the TES-N system on CORONADO for the duration of experiment. No data were logged at the Remote Terminal Client (RTC) workstations. The table below shows the distribution of the 87 TES-N target nominations as a function of the experiment day. Target numbers were assigned automatically by TES-N when the nominations were sent to LAWS. Only nominations with target numbers are included in the table, and it does not include any targets for which nominations may have been created but not sent to LAWS. The TES-N ITD_TGT_NOM_HIST file shows 14 examples of target NOMINATE_CREATE events, which cannot be linked with subsequent NOMINATE_SENT events and their corresponding target numbers.

Table 9-2 lists the number of TES-N and RTC nominations received in LAWS subsequent to 28 July. The large discrepancy in the number sent by TES-N and that received by LAWS on 29 July results primarily from the incompleteness of the logged LAWS data. The table also shows the number of TES-N nominations received in DTMS. For a mensuration to be performed on the target, the nomination message, with attached imagery, had to be received by DTMS. The TES-N target nomination message was not designed to send a target nomination and image in the same message. Accordingly, a separate message with an attached image had to be created and sent to DTMS. If this message, which required some manual input, was improperly formatted it was rejected by DTMS. This is the presumed cause of the discrepancies between the number of nominations sent by TES-N and those received by DTMS.

DATE	# Nominations sent (TES log)	# TES nominations rcd in LAWS	# RTC nominations rcd in LAWS	# TES noms rcd in DTMS
24-Jul	1			0
25-Jul	3			0
26-Jul	0			0
27-Jul	4			0
28-Jul	11			8
29-Jul	18	6	0	14
30-Jul	12	12	0	9
31-Jul	11	11	0	10
1-Aug	8	8	5	7
2-Aug	5	4	0	2
3-Aug	2	2	0	2
4-Aug	7	7	0	7
5-Aug	5	5	0	5
Total	87	55	5	64

Table 9-2. TES-N Nominations.

9.5.2 TES-N Nomination Characteristics

9.5.2.1 TES-N Nominations: Time to Nominate

Table 9-3 presents the median and mean times and the standard deviation for the interval from the creation of the nomination until it was first sent to LAWS, for each day of the experiment and for the experiment as a whole. In 14 cases, the nomination was sent more than once. In most cases of multiple sends, the nominations were resent only once but the number of repeat sends ranged up to four. For these multiple nominations, only the time of the first send event is used in the calculations. The mean value of the interval between nomination creation and send, and standard deviation, are strongly affected by a small number of cases in which this interval was very large. The median value, three minutes, is more characteristic of system performance.

Date	Median	Mean	Std Dev	Sample
24-Jul		1.8		1
25-Jul	15	11	7	3
26-Jul				0
27-Jul	16.1	79.7	121.2	3
28-Jul	5.3	9.1	9.7	11
29-Jul	2.7	3.8	3.8	18
30-Jul	3.4	13.7	33.7	12
31-Jul	2.5	9.3	20.7	11
1-Aug	2.6	18	37.6	8
2-Aug	5.5	35.3	72	5
3-Aug	1.3	1.3	1	2
4-Aug	1.6	8.2	11.6	7
5-Aug	0.3	0.5	0.3	5
All data	3	12.7	34	86

Table 9-3. TES-N: Time to Nominate (All times in minutes).

9.5.2.2 TES-N Nominations: Dwell Times

The contents of each of the ATI.ATR nomination messages shows that the dwell times reported for each target were not selected on the basis of target type or target status. A default value of one hour was entered for all targets for which a dwell time was reported.

9.5.2.3 TES-N Nominations: Target Location Accuracy

The nomination messages contain no estimate of the CE and LE values associated with the reported target positions. The source of the nomination is reported, but in almost every case it is reported as AOBSR (airborne observer). It would be more useful if the specific platform (U2, Global hawk, Predator, satellite, etc.) and the specific sensor acquiring the image were identified. This information might provide a basis for estimating the accuracy of the reported target position and for determining the need for a georefined target location. In the three cases where AOBSR was not identified as the source, IRAIR was identified as the source twice and ELINT once.

9.6 NFN Timeline Examples

Figure 9-2 provides the MOC layout during the experiment and should be referenced when reviewing timeline (TS0068, TS0024) summary.

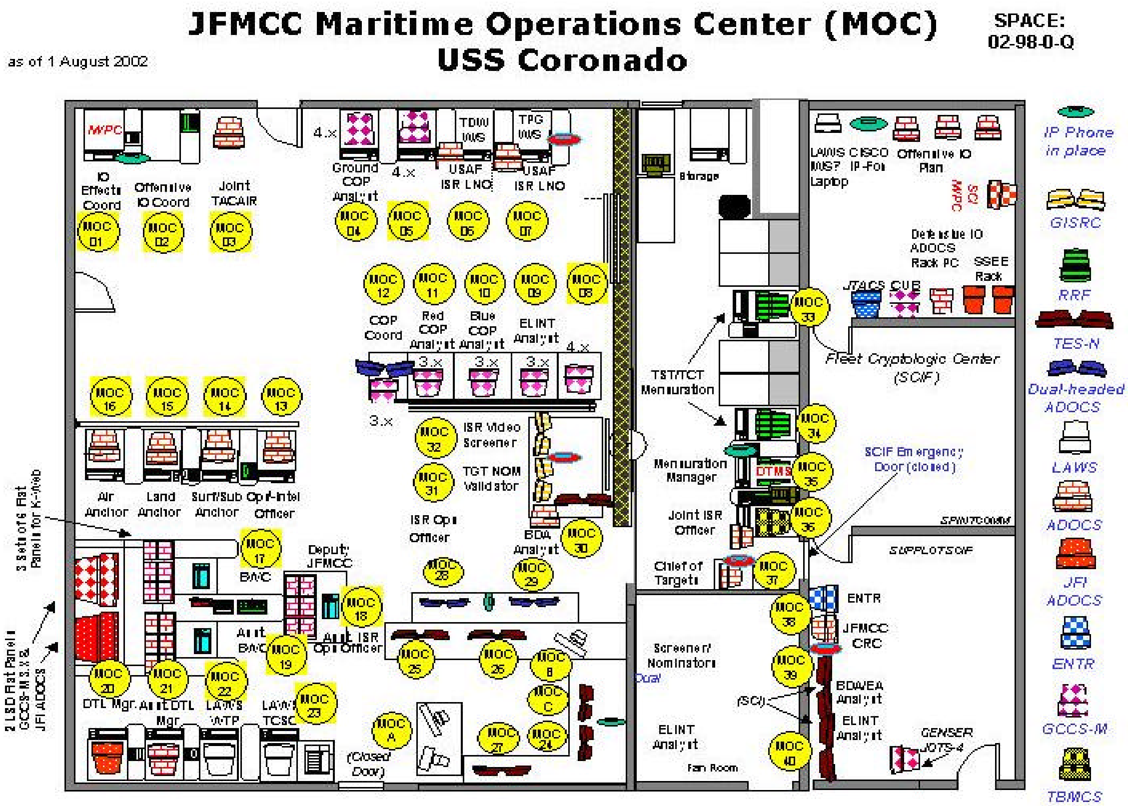
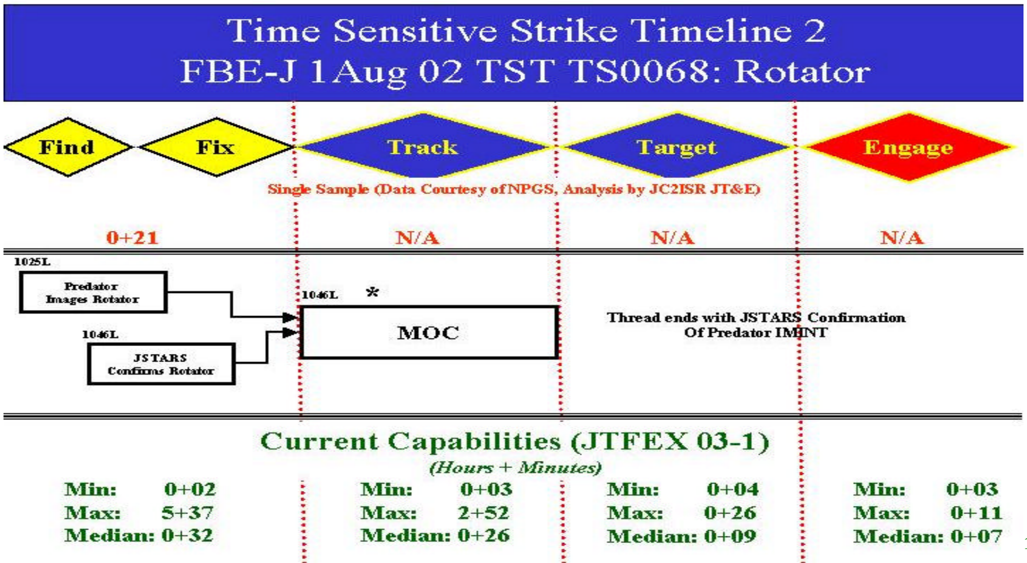


Figure 9-2. JFMCC Maritime Operations Center Layout for MC02/FBE-J[103]

9.6.1 NFN Nominated Target Example– TS0068 Timeline

The following timeline (Local PST) for the live NFN nominated target, TS0068 (stationary rotator) is detailed to highlight the NFN Find, Fix, Track, Target, Engage, and Assess process in FBE-J. Although this mission was eventually aborted due to a faulty weapon, the following timeline details provide an example of the NFN TST process adapted for the FBE-J architecture. The Maritime Operations Center (MOC) personnel responsible throughout this process are identified by MOC position.

[103] MOC layout diagram provided courtesy of Mr. Bob Stoddert, OST T&E, Hurlburt Field, FL



[104]

Figure 9-3. Live AGM-88C Sensor to Shooter TST Thread[105]. Stationary Rotator (China Lake Range) - (TS0068 on 1 Aug 02)

Find Process

Start / Stop Times: The clock starts at the time of the initial TST intercept / image event. The clock stops at the time that the sensor (e.g. IMINT) is successful in providing positive identification quality data on the TST.
Elements of Find Process Completed: When JFC Designates Target/Classes; Prioritized mission lines are on the ATO Intel Prep of the Battlefield; ISR surveillance is initiated.

> **0930:** Initial ELINT contact at 360927N 1176613W – TES-N Gale Lite Operator notifies ISR Manager - *(BWC Chat Log)*
> **1025:** TES-N Video/Imagery Screener (position MOC 26 notes on (live) JOTBS Predator Imagery - rotator at 36092727.78N 1176613.89 *(Data Collector's Manual Log: No telemetry on GBS - OK with video server)*

Fix Process

Start / Stop Times: The clock starts when the time sensor (e.g. IMINT) is successful in providing positive identification quality data on TST. The clock stops when the time precision location data on TST is available in the MOC.
Elements of Fix Process Completed: When direct sensors are on the targets; precise coordinates are obtained.

> **1031:** TES-N Team Supervisor (MOC 24) completes target nomination ATI.ATR and forwards to LAWS WTP Officer (MOC 22) *(Sidebar 3 (TES-N) Chat Log)*

[104] TST Strike Timeline diagram provided courtesy of Mr. Bob Stoddert, OST T&E, Hurlburt Field, FL
[105] Phase definitions of Find phase, Fix phase, etc. taken from Section V of Joint CFFC (Navy) / ACC (Air Force) *Joint Time-Sensitive Targeting CONOPS*, draft dated 15 July 2002, pp.31-43

1036: TES-N Team Supervisor (position MOC 24) completes target nomination ATI.ATR and forwards to Mensuration Manager (MOC 35) / DTMS with image attached (5 minute Manual Process) *(Sidebar 3 (TES-N) Chat Log)*
1037: LAWS Weapons Target Pairing Officer (MOC 22) sends "validate" message to Mensuration Manager (DTMS) (MOC 35). *(LAWS Electronic Log)*
1038: Mensuration Manager (DTMS) (MOC 35) receives image but cannot mensurate because image attached to ATI.ATR is too "zoomed in on", chats in sidebar room 3, telling TES-N Video/Imagery Screener (position MOC 26) that image was "too zoomed in" to allow tie points for precision georeference. *(DTMS Electronic Log), (Sidebar 3 (TES-N) Chat Log)*
1042: TES-N Team Supervisor (position MOC 24) acknowledges, and replies, in sidebar room 3, that he will get image from database that is more zoomed out. *(Sidebar 3 (TES-N) Chat Log)*
1044: TES-N Team Supervisor (position MOC 24) updates target nomination ATI.ATR with new image and forwards to LAWS and manually updates and sends to DTMS Manager. *(Sidebar 3 (TES-N) Chat Log)*

Track Process

Start / Stop Times: The clock starts when the time precision location data on TST is available in TST cell. The clock stops at the time that enough data exists in the MOC to make an engagement decision.
Elements of Track Process Completed: When continuous TST contact/track continuity and collaborative target verification via multiple sensors are established, to validate, identify, and prioritize the target.

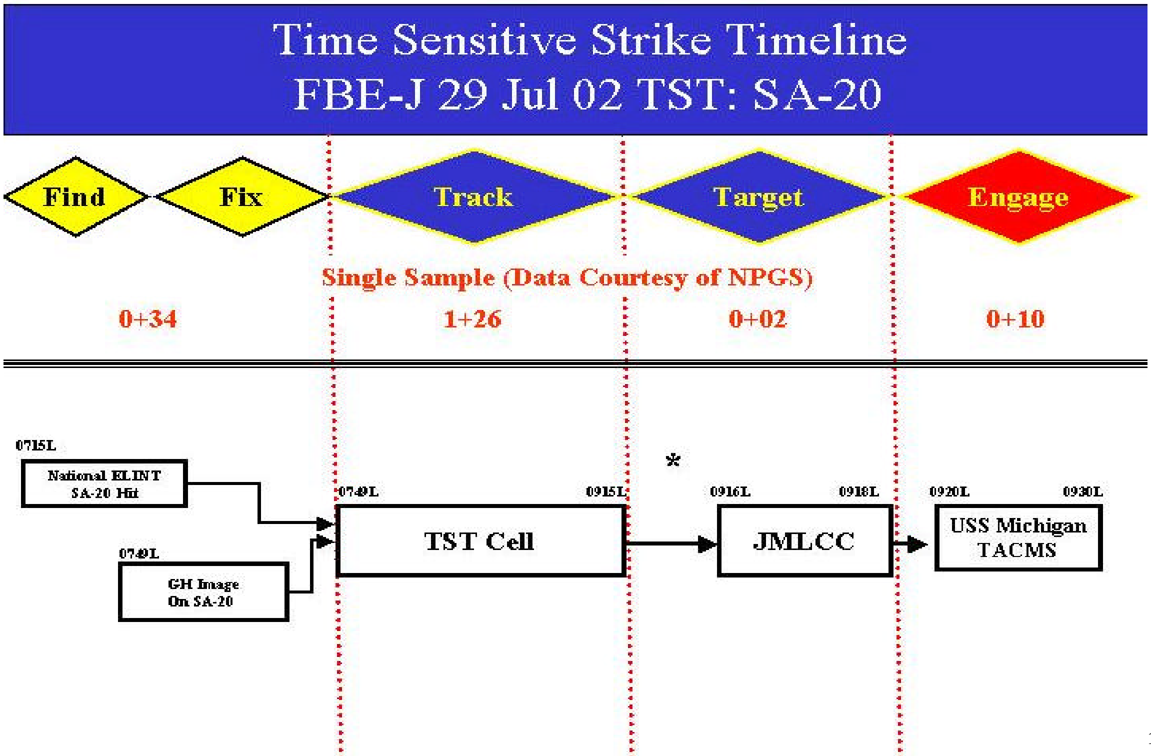
1046: Confirmation from JSTARS (via GMTI Analyst (MOC C) on stationary rotator. *(Data Collector Manual Log)*
1047: NFN-N Team Supervisor (position MOC 24) updates target nomination ATI.ATR. *(Data Collector Manual Log)*
1054: Updated TST nomination arrives at LAWS Weapons Target Pairing Officer (MOC 22). *(LAWS Electronic Log)*
1055: Mensuration Manager (MOC 35) receives "validate" message and assigns specific Ready Room of the Future (RRF) Analyst (MOC 33/34) to do precise georeference on TS0068.

Target Process

Start / Stop Times: The clock starts at the time that enough data exists in the MOC to make an engagement decision. The clock stops when the strike asset receives the time authorization.
Elements of Target Process Completed: when weapons are matched to a prioritized target, the likelihood of collateral damage is assessed, and an engagement order is issued and passed.

1110: Ready Room of the Future (RRF) Analyst (MOC 33/34) sends aim point on TS0068 to LAWS via DTMS. *(RRF Electronic Log)*
1110 Aim point data on TS0068 received by LAWS Weapons Target Pairing Officer. (MOC 22) *(LAWS Electronic Log)*
1110: Target nomination from LAWS Weapons Target Pairing Officer (MOC 22) received at China Lake for action. *(LAWS Electronic Log)*
1111: STWC takes control to act as strike approval authority. *(Data Collector Manual Log)*
1112: AGM 88C aborted - weapons malfunction, thread ends. *(Data Collector Manual Log)*

9.6.1.2 NFN Nominated Target Example– TS0024 Timeline



[106]

Figure 9-4. Simulated SA-20 Sensor to Shooter NFN TST Thread[107] TS0024 on 29 Jul 02

Find Process

Start / Stop Times: The clock starts at the time of initial TST intercept / image event. The clock stops at the time that the sensor (e.g. IMINT) is successful in providing positive identification quality data on TST.
Elements of Find Process Completed: When the JFC Designates Target/Classes; the mission lines on the ATO Intel Prep of the Battlefield are prioritized; and ISR surveillance is initiated.

0715: ELINT on SA-20 at 3352N11814W. *(BWC Chat Log)*
0715: SIGINT Analyst (MOC 25) cues ISR Operations Officer (position MOC 28) to ELINT contact. ISR Operations Officer (position MOC 28) directs Global Hawk be tasked to locate and image SA-20. *(ISR Ops Chat; CISCO Phone)*
0720: GMTI Analyst (MOC C) requests time before Global Hawk (GH) on station. *(ISR Ops Chat Log)*
0722: ISR Operations Officer (position MOC 28) reads request in ISR Ops Chat, calls GH operator and requests information via chat / CISCO phone. *(CISCO Phone)*
0724: GH Operator Getting Lat/Long for GH *(CISCO Phone)*

[106] Simulated SA-20 Sensor to Shooter NFN TST Thread diagram provided courtesy of Mr. Bob Stoddert, OST T&E, Hurlburt Field, FL
[107] Phase definitions of Find phase, Fix phase, etc. taken from Section V of Joint CFFC (Navy) / ACC (Air Force) *Joint Time-Sensitive Targeting CONOPS*, draft dated 15 July 2002, pp.31-43

0725: ISR Operations Officer (MOC 28) requests from GMTI Analyst (MOC C) Lat/Long of GH. *(ISR Ops Chat Log)*
0728: GMTI Analyst (MOC C) replies with GH's Lat/Long request via chat.
(**0736:** Data Collector Comment: No estimated time on target (EOT) for GH yet from GMTI Analyst (MOC C))
0737: ISR Operations Officer (MOC 28) is advised that it will take 25 minutes for GH to arrive at FOV (within field of view) of SA-20 *(CISCO Phone)*

Fix Process

Start / Stop Times: The clock starts when the time sensor (e.g. IMINT) is successful in providing positive identification quality data on the TST. The clock stops when the time precision location data on TST is available in the MOC.
Elements of Find Process Completed: When direct sensors are on targets; and precise coordinates are obtained.

0748: GH image sent (of SA-20); file named GH_ADHOC1. *(ISR Ops Chat)*
0749: ISR Video/Imagery Screener (position MOC 26) pulls SA-20 imagery at direction of NFN-N Team Supervisor (position MOC 24). *(Data Observer Manual Log)*
0800: ISR Video/Imagery Screener (position MOC 26) fills out target nomination ATI.ATR and forwards to NFN-N Team Supervisor (position MOC 24). *(Data Observer Manual Log)*

Track Process

Start / Stop Times: The clock starts when the time precision location data on TST is available in the TST cell. The clock stops at the time that enough data exists in the MOC to make an engagement decision.
Elements of Find Process Completed: When continuous TST contact and collaborative target verification via multiple sensors is established, validated, identified, and prioritized.

0803: NFN-N Team Supervisor (position MOC 24) sends nomination to LAWS. *(TES-N Message & Data Log, LAWS Electronic Log)*
0806: NFN-N Team Supervisor (position MOC 24) completes message with IMINT attachment of SA-20 for DTMS (an artificial step) TST designated TS0024. *(TES-N Message & Data Log, Data Observer Manual Log)*
0812: DTMS receives TS0024 nomination and sends to LAWS for target validation. *(DTMS Electronic Log)*
0820: DTMS validation message received at LAWS Weapons Target Pairing Officer (MOC 22). *(LAWS Electronic Log)*
0821: LAWS Weapons Target Pairing Officer (MOC 22) sends "validate" message to Mensuration Manager (MOC 35). *(LAWS Electronic Log)*
0824: Mensuration Manager (MOC 35). Receives "validate" message and assigns specific Ready Room of the Future (RRF) Analyst (MOC 33/34) to do precise geolocation on TS0024. *(DTMS Electronic Log)*
0824: Ready Room of the Future (RRF) Analyst (MOC 33/34) sends aim point on TS0024 to DTMS who forwards to LAWS. *(RRF Electronic Log, DTMS Electronic Log, LAWS Electronic Log)*
0854: "Mensuration block" in LAWS turns green. (Note: The LAWS Weapons Target Pairing Officer (MOC 22) is behind schedule and working to catch up prior to doing weapons-to-target pairing.) *(Data Observer Manual Log, LAWS Electronic Log)*
0856: LAWS Weapons Target Pairing Officer (MOC 22) starts weapons-to-target pairing on TS0024. *(Data Observer Manual Log)*

0856: LAWS Weapons Target Pairing Officer (MOC 22) would like to move Arleigh Burke cruiser (#) in close to use E-5 weapon. (SA-20 is in urban (e.g. downtown LA) area.) *(Verbal Request to SCC Anchor Desk – Data Observer Manual Log)*
0904: LAWS Weapons Target Pairing Officer (MOC 22) requests of Surface/Subsurface Anchor Desk Officer (MOC 14) to move Arleigh Burke in closer to shore to shoot ERGM. *(Voice over IP)*
0907: LAWS weapons target pairing officer (MOC 22) tells assistant battle watch captain (MOC 19) about moving Arleigh Burke 20 nm closer to shore. *(Voice over IP)*
0908: Surface/subsurface anchor desk officer (MOC 14) says; "You can't trust (the Blue force ship's position in) ADOCS." Asks DESRON if Arleigh Burke in simulation (ADOCS) is in the correct position. *(BWC Chat Log)*
0915: LAWS weapons target pairing officer (MOC 22) notified by DESRON that Arleigh Burke cannot move closer to shore because of SEERSUCKER coastal defense missile site. *(TST Chat Log)*

Target Process

Start / Stop Times: The clock starts at the time that enough data exists in the MOC to make an engagement decision. The clock stops at the time that authorization is received by the strike asset.
Elements of Find Process Completed: When weapons are matched to a prioritized target; an assessment is made of potential collateral damage; and an engagement order is issued and passed.

0916: LAWS weapons target pairing officer (MOC 22) talks with battle watch captain (MOC 17) and requests a low casualty weapon. *(Verbal – Data Observer Manual Log)*
0916: Battle watch captain (MOC 17) asks about collateral damage and is shown image of TS0024. *(Verbal – Data Observer Manual Log)*
0917: Battle watch captain (MOC 17) calls JFMCC for permission to use LOCAS on TS0024. *(Telephone – Data Observer Manual Log)*
0918: JFMCC give authorization to strike TS0024 with TACMS. *(Telephone – Data Observer Manual Log)*
0918: LAWS weapons target pairing officer (MOC 22) tags USS Michigan (VSSGN) for TS0024 strike. *(LAWS Electronic Log)*

Engage Process

Start / Stop Times: The clock starts at the time authorization is received by the strike asset. The clock stops at the time that the TST is struck.
Elements of Find Process Completed: When the target is destroyed/neutralized via kinetic or non-kinetic options, and this is monitored by combat operations.

0920: LAWS weapons target pairing officer (MOC 22) receives message via private chat that USS Michigan has received the strike authorization message.
0925: USS Michigan fires TALCM. *(LAWS Electronic Log)*
0930: Estimated fly out time from USS Michigan to TS0024

Assess Process

Start / Stop Times; N/A

0944 Attempt to get BDA on TS0024 fizzles out. *(Data Observer Manual Log)*

9.7 NFN Architecture Characteristics

9.7.1 NFN Architecture Characteristics: Objective

Identify and document the current NFN architecture characteristics (TES-N -- GCCS-M Interface, TES-N – DTMS/RRF) within the context of the MC02/FBE-J supporting communications configuration.

9.7.2 NFN Architecture Characteristics: Analytical Questions

- Does TES-N XINT data shared with the GCCS-M database increase overall situational awareness?
- Does having GCCS-M tracks in the TES-N COP help the TES-N operator conducts ISR analysis?
- Does TES-N – DTMS/RRF interface improve TST process?

9.7.3 NFN Architecture Characteristics: Findings

9.7.3.1 NFN Architecture Characteristics: TES-N -- GCCS-M Interface Observations

TES-N – GCCS-M Interface (Spiral 1A) was demonstrated in MC02/FBE-J. This interface demonstration required TES-N to forward manual contacts, reference points, and MTI track information to GCCS-M and GCCS-M to forward track information to TES-N. The following highlights general findings:

After technical difficulties, the TES-N – GCCS-M (Spiral 1A) interface was demonstrated as an isolated effort during the experiment. The NPS analyst observed the TES-N operator create several manual contacts and reference points that were automatically transmitted to GCCS-M via OTH-G formatted message and displayed in the GCCS-M COP. These manual contacts and reference points were not synchronized with the scenario but created only for demonstration purposes. Review of the GCCS-M database and COP display did validate that TES-N contacts were present, but shared data between these NFN systems did not enhance situational awareness during the experiment. Figure 9-5 below illustrates a block diagram of the Spiral 1A interface.

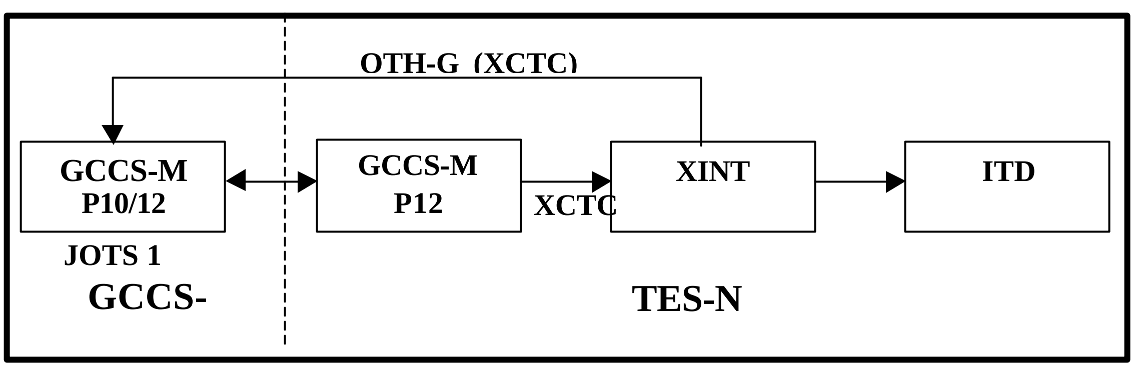


Figure 9-5. Spiral 1A Interface Block Diagram.

A review of the TES-N message and data log indicated that an OTH-G message and XCTC message were both transmitted to GCCS-M for the same manual contact. Software architecture diagrams indicate that only OTH-G messages should have been forwarded to GCCS-M during this experiment. Discussions with TES-N software engineer are required to identify the basis for the generation of the XCTC message.

The MTI track segment of the interface was not operational during the demonstration.

A review of TES-N and GCCS-M databases indicated that there are no common track numbers associated with TES-N and GCCS-M. It is currently impossible for a GCCS-M operator to view a new track and correlate its origin to TES-N.
The operational context for sharing GCCS-M and TES-N information was non-existent. Although proving the technical interface was a limited success, a full understanding of how to capitalize operationally on shared data was not gained. The experiment did not provide an opportunity to examine how the TES-N XINT data, which was shared with the GCCS-M database, impacted the overall situational awareness.

TES-N ingested GCCS-M tracks successfully but the current capability does not permit the TES-N operator to filter on the desired GCCS-M track information. GCCS-M tracks flood the TES-N display when the TES-N operator has GCCS-M tracks 'ON'. Hence, the track data from GCCS-M was not useful to TES-N operators.

9.7.4 TES-N – DTMS/RRF Interface Characteristics

Electronic logs of NFN threads captured during experiment indicate a median time of 9.8 minutes for RRF to process mensurated coordinates after receiving a request from DTMS.

NITF 2.1 formatted files created and sent by TES-N were not compatible with the format expected by the DTMS/RRF image screener tool. DTMS/RRF software engineers examined the TES-N NITF header and indicated it was missing Field 3 which was a field expected by DTMS. Additional research, dialogue, and coordination are required between PMS-454 and PMA-281 to engineer a solution.[108]

Because TES-N generated NITF 2.1 formatted image files were not compatible with the format expected by DTMS/RRF, TES-N operators created JPEG image files as a required workaround during the experiment. Although the DTMS was able to read the JPEG images, the TES-N Image Analyst annotations that highlighted target coordinates and other amplifying information on the image were not present on the DTMS image screener terminal. This increased the time required to process target nominations and resulted in additional coordination requirement between DTMS and TES-N operators to ensure accurate target locations in the image prior to sending it to the RRF for generation of an aim point.

9.8 NFN Contribution to Enhanced Situational Awareness

The objective was to observe and document the NFN contribution to enhanced operational and tactical level situational awareness.

9.8.1 NFN Contribution to Enhanced Situational Awareness: Analytical Questions

- What NFN components enhance overall situational awareness?
- How does the CJTF use the JFMCC NFN capability on CORONADO to support situational awareness and targeting?
- What products are not available to TES-N operator that should be in order to add to his tactical/operational utility?

9.8.2 NFN Contribution to Enhanced Situational Awareness: Findings

Table 9-8 provides the NFN (TES-N) system components that participated in MC02/FBE-J.

[108] Discussion with DTMS and RRF (PMS 281) Software Engineers

System	Location	C4ISR Node
TES-N	CORONADO	MOC
RTC	China Lake	STWC (Alpha Papa)
RTC (LITE)	BENFOLD	Engagement Node
RTC (LITE)	FITZGERALD	Engagement Node
RTC (LITE)	NP-3D	ABCCC
RTC (LITE)	VSSGN	Newport
RTC (LITE)	VPU P3	China Lake
ISR-M *See Note 1*	Nellis, AFB, NV	JFACC (CAOC (X))

Table 9-8. NFN (TES-N) System Components
(Note: ISR-M is a USAF Asset that Participated in Joint Interoperability Testing.)

- TES-N excelled at displaying the near real time location of Red assets for decision-makers by utilizing SIGINT and tactical video input capabilities. These near real time cues permitted decision-makers to act decisively to minimize enemy aggression.

- The remote terminal component (RTC) has many of the same capabilities as the TES-N, including multiple workstations support, imagery processing and exploitation, and signal intelligence analysis. The RTC can function stand-alone or in conjunction with another TES node (via RF communications). During MC02/FBE-J, the RTC supported the Strike Warfare Commander in China Lake. Although not fully employed during the experiment, the RTC successfully conducted database replication with the TES-N server on CORONADO prior to FINEX.

- RTC China Lake demonstrated the ability to identify and nominate a target of opportunity during the experiment. Live VPU P3 video was down linked to a ground station and then to the RTC via a video server. A review of the DTMS system logs showed that the target (RT0020) nomination was identified in the Land Attack Warfare System (LAWS) and LAWS initiated a GEOREFREQ message to DTMS. However, RTC operators in China Lake were unaware that they were required to manually forward the nomination to DTMS. Because the nomination and attached imagery were never sent to DTMS, the LAWS request for georefinement was terminated (refer to 3-way handshake in figure 9-2, above). That RTC was never able to successfully take imagery/cueing to enemy targets and turn it into a complete target nomination/engagement.

- RTC-Lite systems were installed on the following platforms: VSSGN, BENFOLD, FITZGERALD, NP3D, and VPU P3.

- **VSSGN** participants identified how to take advantage of the information that was available through RTC Lite. VSSGN participants configured their RTC-Lite system profile to view desired characteristics of the battlespace (e.g., snapshot of SIGINT, imagery). The use of the RTC-Lite system for SA and mensuration planning increased throughout the experiment. Throughout the experiment RTC-Lite played an increased role in the TST mission area on the VSSGN. Several examples are provided below:[109]

    - **Example One:** Mensuration is attempted at the RRF. The operator was unable to mensurate. The RTC-Lite operator brought up an image of the same general area. He had details that were on the nominated target image from the UAV that were not on the RRF image. These details were used as reference points and allowed the RRF operator to focus in to the correct coordinates needed for mensuration.

    - **Example Two:** Suspected target area was verified with RTC-Lite enemy SIGINT signals.

    - **Example Three:** Time late target info on a SCUD launcher was updated with SIGINT information from RTC-Lite. RTC-Lite showed where the launcher had moved. These data were used as the coordinates for the TACMS-L (LOCASS payload), which does need an exact position. Subsequent SIGINT analysis showed one of the previous two SIGINT signals was gone. The second signal was targeted as a second SCUD launcher with a second TACMS-L. Later analysis showed all SIGINT signatures gone from the area.

- RTC-Lite systems on BENFOLD and FITZGERALD were physically up and running but operationally, they were not used. Unlike the VSSGN node, the ships did not have any concept of how to use RTC-Lite to support the mission. The staff did not understand how the information from RTC-Lite could provide them with additional SA required for their mission. Training is needed to explain how to integrate RTC-Lite capabilities in the battle plan/rhythm.[110]

- RTC-Lite capability on the NP3D and the VPU P3 was not used due to faulty aircraft communication links.

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[109] Email from Mr. E. Chaum (VSSGN PM)
[110] NPS Analyst Observations on BENFOLD and FITZGERALD

10.0 JFMCC ISR Management Initiative Key Observations

10.1 Experiment Objectives

The objectives of the JISRM experiment were tied to each sub-initiative.

JFMCC ISR Planning. The JFMCC ISR Planning Process is a 72-hour planning cycle that the JFMCC Staff uses to develop an ISR collection plan aimed at meeting the commander's Priority Intelligence Requirements (PIRs). The plan ensures proper employment of available assets to develop the common ISR picture. The prime objective within this sub-initiative was to determine the effectiveness of the JFMCC Current Planning Cell (CPC) ISR planning and execution process.

Dynamic ISR Management (DISRM). Dynamic ISR Management is the process whereby collection assets are diverted from their pre-planned mission in response to rapidly changing requirements. An example of DISRM is when collection assets must be diverted to engage a high priority target that is suddenly detected. In that circumstance, the ISR Manager must assess which assets are appropriate and immediately available, and take the necessary actions to assign them to the effort. The ability to rapidly retask available sensors is essential to achieving effective Time Critical Targeting. The prime initiative within this sub-initiative was to determine the effectiveness of the MOC DISRM planning and execution process.

Distributed Unattended Ground Sensors (UGS) and Unmanned Aerial Vehicles (UAVs). UGS were used during FBE-J in the China Lake ranges to detect and identify time sensitive/high priority ground targets. The information was then relayed to operator consoles at China Lake and on the high-speed vessel (HSV) for dissemination to command personnel via the GCCS-M architecture for eventual incorporation into the time sensitive/critical targeting process. Mine Warfare UGS (MIUGS) data were used as a cueing source for retasking of electro-optic and infrared (EO/IR) sensors, primarily on UAVs employed at China Lake. UGS and UAVs were both used during FBE-J in support of the Dynamic ISR Management process. The primary objective was to provide a representative construct from which UAV and ISR assets (e.g. a tiered UAV architecture) could support the MPP, JDISRM, TST, and Assured Access initiatives.

During the experiment, the following additional objectives were also sought:

- Evaluate the tools applied to ISR management.
- Determine if UGS could provide track inputs to the COP via GCCS-M and whether those track inputs were useable for queuing other ISR sensors.
- Construct timelines for engagements initiated by UGS and SEID detections.
- Assess the accuracy of the target data generated by UGS and SEID.

10.2 Analytic Questions

The overarching objective for FBE-J was to examine doctrinal implications and refine Tactics, Techniques and Procedures (TTP) for Joint and Maritime C2 and Assured Access. In this regard, one of the primary initiatives of FBE-J was to develop and evaluate a Joint Forces Maritime Component Command (JFMCC) operational command and control process designed to provide a capability that could prioritize multiple tasks with limited naval assets and conduct full range of Effects Based Operations (EBO) in a joint environment. It is in the context of this JFMCC construct that FBE-J experimented with the convergence of deliberate and dynamic ISR management, in support of joint force and component-specific ISR requirements.

The primary objective of the FBE-J JFMCC ISR management initiative was to observe and document the JFMCC process to collaboratively plan and dynamically execute ISR operations, using limited ISR resources, in support of CJTF objectives, and in close coordination with other component commanders and supporting forces. FBE-J tested the capabilities of various automated systems, such as Naval Fires Network Experimental (NFN (X)), Automated Deep Operations Coordination System (ADOCS), and the Surveillance and Reconnaissance Management Tool (SRMT) to both plan ISR employment and, when the changing operational situation dictated, dynamically manage available ISR assets.

10.2.1 JFMCC ISR Planning Process

The JFMCC ISR Planning process was a 72-hour planning cycle that the JFMCC Staff used to develop an ISR collection plan aimed at meeting the commander's priority intelligence requirements. The intention of this plan was to ensure proper employment of available assets to develop the common ISR picture. The primary ISR Planning sub-initiative analytical questions researched during FBE-J included:

- Does the JFMCC MPP provide an adequate framework from which an ISR Plan can be generated and effectively executed?
- Is the MTO an adequate ISR mission-tasking document?
- Did JFMCC organization effectively coordinate ISR planning, tasking, processing, exploitation and dissemination (TPED) with CJTF, other component commanders, and principle warfare commanders?

10.2.2 Dynamic ISR Management

Dynamic ISR Management is the process by which collection assets are diverted from their pre-planned mission due to changing operations. The most obvious situation requiring diversion of assets occurs on detection of a high priority target. In response, the ISR manager must assess situations and courses of action and assign appropriate assets. The primary analysis goal of this sub-initiative was to examine organization and technical (ADOCS, CIE, NFN) capabilities of afloat JFMCC organization to dynamically task ISR assets/sensors, conduct multi-sensor cross cueing the correlation, and conduct hand-off between component commanders. The primary Dynamic ISR Management sub-initiative analytical questions researched during FBE-J included:

- Did the ISR operations officer (ISRO) functioning as the JFMCC-level ISR manager have the tools and situational awareness to gather, manage, and use all-source intelligence and COP during dynamic operations?
- Did the ADOCS application provide adequate situational awareness of ISR assets across the battlespace to allow the dynamic ISR manager to request support based on asset availability?
- Was the ISRO able to conduct sensor target pairing in response to battlespace dynamics?
- Did the JFMCC ISR Operations Officer maintain adequate control and oversight over all ISR assets from the theater to the tactical?

10.2.3 Multi-platform SIGINT Tracking

During FBE-J, live emitters provided targets for selected ELINT sensors. NFN (GCCS-M/SEID) correlated data gathered from these sensors with data received from national assets to ID and covertly track contacts of interest and land-based high threat emitters. The primary multi-platform SIGINT tracking sub-initiative analytical questions researched during FBE-J included:

- Does architecture of SEID-equipped platforms discriminate potential targets from background maritime traffic by electronically collecting and comparing emitter data to a database?

- Once identified, is the SEID information imported to and used by the planning and targeting processes in JFMCC and ISR organizations?

10.2.4 TES-N Role in ISR Management

- What is the specific TES-N role in the JFMCC deliberate planning process (i.e., IPB, situational awareness, etc)?

- What TES-N products enhance overall situational awareness in support of ISR management?

10.3 Sub-Initiative Observations

10.3.1 JFMCC ISR Planning Process Observations

10.3.1.1 Maritime Planning Process

The MTO did not adequately provide a daily graphic depiction of the synchronized plan based on time and geography. While the ISR cell within the Maritime Planning Process ensured USN ISR assets were scheduled in the MTO to meet collection requirements, there was no clear translation of commander's intent into an understandable product for the war fighter.[111]

A combination of the skills and experience for both the intelligence designator and operations designator (with an ISR background) was critical for success. This mix of manning expertise created the symbiotic relationship between intelligence and ISR operations necessary to ensure optimal employment of USN ISR assets through the Maritime Tasking Order (MTO) to support the commander's operational and intelligence collection requirements.[112]

10.3.1.2 Exploitation and Dissemination

Technical difficulties in the COP, as maintained in GCCS-M and displayed to war fighters in ADOCS, impacted the ISR Operations Cell's near-real time situational awareness and reduced its ability to dynamically re-task live and simulated ISR assets. These difficulties included the inability to correlate link tracks between the ATO and COP, and the inability to maintain a stable and consistent live air picture.[113]

10.4 JFMCC ISR Dynamic/Deliberate Targeting Process Observations

[111] Interview with LCDR D. Sleyton, ISR Manager
[112] LCDR W. Smith (NWDC); ISR Quicklook Summary
[113] Interview with LCDR D. Sleyton, ISR Manager; ISR Quicklook Summary

The baseline JFMCC ISR Dynamic/Deliberate Targeting Process (Simulated ISR/Targets) is provided below.[114] Analyst observation relevant to each step in the process is included in Figure 10.1.

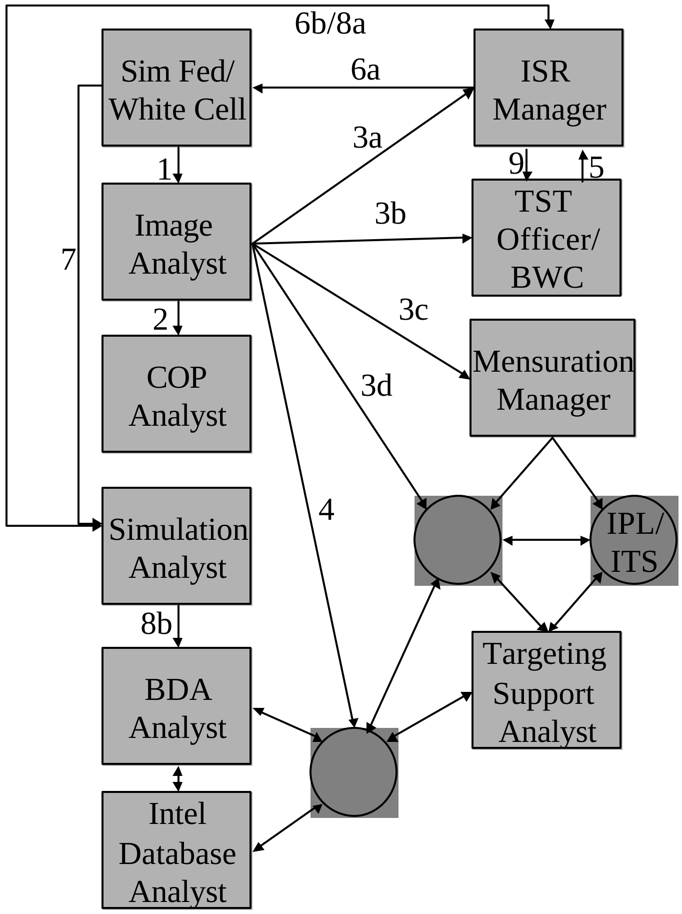

Figure 10-1. Analyst observation relevant to each step in the process

Step 1. Simulation passes 'raw' data (e.g., UAV video) to TES-N or GISRC Image Analyst (IA). IA compares potential target against Commander TST priority list then notifies the ISR Manager of target and waits for guidance.

FBE-J ISR C2 architecture did not include the TST manager function to validate targets identified by the IA. The ISR Manager decisions regarding which targets to allocate assets for were based on operator perspective only, rather than a more senior TST Manager who would be responsible for validating targets for the ISR Manager.

Step 2. IA creates a 'manual contact' report (TES-N only) to feed the GCCS-M Common Operational Picture (COP) track database. This is done automatically from GISRC.

Although the TES-N to GCCS-M interface (Spiral 1A) developed for this experiment did incorporate the capability for the TES-N operator to promote targets/contacts identified by TES-N operator to GCCS-M,

[114] LCDR W. Smith (NWDC) and Mr. Sweitzer ISR process discussion

the process for TES-N to create manual contacts (reference points and MTI contacts as well) had software problems and was not used to support COP management function. Hence, TES-N contacts were not viewed on GCCS-M COP display during the experiment, and thus could not enhance situational awareness for those using GCCS-M COP to understand the battlespace. It should be noted that an isolated test was conducted, at the end of the experiment, to show that the interface was functional. However, the process for GCCS-M COP manager to coordinate with TES-N operators to ensure manual contacts were promoted to GCCS-M was not evident. The GCCS-M COP did not reflect TES-N manual contacts, reference points, or MTI contacts.

Step 3. Image Analyst (IA) manually creates an ATI.ATR nomination message and attaches 'chipped' image and sends simultaneously to:

a. ISR operations (LAWS/ADOCS) who begins Step 6.
b. TST Officer (LAWS/ADOCS) who starts engagement sequence.
c. Mensuration manager/image analyst (DTMS/RRF) who supports engagement sequence with aim point generation. IA posts image products to JATF and/or IPL.
d. New target folder is automatically created (JATF) and is available force-wide.
e. Technical interface solutions developed for an experiment between TES-N - DTMS/RRF and TES-N – GCCS-M were not operationally sound. Process limitations and workarounds negatively impacted end-to-end engagement timelines. For TES, the imagery could not be attached to the ATI.ATR nomination message. After the ATI.ATR was completed, it was automatically forwarded to the TST officer but could not be forwarded to mensuration manager. A workaround was developed prior to COMEX that required the TES-N Operator to generate a separate modified message and send to DTMS via email with the attached imagery. This manual process caused several problems during the experiment. For example, if the nomination had not arrived at DTMS before the georefinement request was received from LAWS, DTMS could not match the request with a nomination and the request was automatically discarded.[115]
f. Almost everything dynamic occurred within the collaborative environment. Only on rare occasions did analysts observe ISR personnel accessing the target cards to obtain the status of the target.[116]

Step 4. The Image analyst sends message to the intelligence database analyst (MIDB) who ensures that MIDB and JATF are synchronous.

Because of inadequate time to conduct a thorough comparative analysis of MIDB and JATF, analysts were not able to verify step four during this analysis phase.

Step 5. ISR operations officer monitors TST officer and BWC communication (chat, voice) to identify when BWC gives order to engage the target via LAWS/ADOCS).

Step 6. ISR operations officer coordinates with the Blue cell to have simulated collection platform(s) in position to collect at strike weapon time-on-target (TOT) to collect 'first look' battle damage assessment (BDA).

Step 7. Simulation passes post-strike 'raw' data to IA (TES-N or GISRC) for review.

Analysts were not able to reconstruct any event that verified step seven.

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[115] Interview with PMA 454 (TES-N) and PMS 281 (DTMS and RRF) Contractors
[116] JFMCC ISR Post Experiment Collaborative Meeting (7 Aug 02)

Step 8. Simulation analyst takes 'first look' and:

a. Recommends change in JFI BDA column to ISR/TST ops officer who has responsibility to make a change, if required.

b. Sends 'chipped' image to BDA analyst for further analysis.

c. In current configuration, level 1 BDA required a single person to spend enormous amounts of time on a single TST[117].

Step 9. Based on the simulation analyst input, the TST/ISR ops officer makes a re-strike recommendation to TST officer/BWC. The TST officer could request additional ISR asset confirmation from the ISR manager. The ISR manager would task or re-task an available asset.

10.4.1 Dynamic ISR Management Organization

A dynamic graphic depiction of the synchronized ISR plan based on time and geography is required for dynamic ISR management.

The ISR operations cell within the maritime operations center (MOC) effectively demonstrated the ability to dynamically re-task simulated and live ISR assets in support of a simulated TST. Persistent collaboration between JFMCC ISR operations, CJTF, component and distributed JFMCC ISR nodes enabled centralized or decentralized command and control as required. Shared use of the dynamic target lists by both ISR ops and Fires personnel allowed shared TST.

ISR manning was insufficient to conduct a complete engagement process during experiment. The function requires dedicated personnel responsible for tracking a TST from cradle to grave.

10.4.2 Technical Architecture Capability to Support JFMCC

Lack of cross-joint available assets, whether sensor, TES-N "like", or C2 related, prevented full realization of the original experimental joint ISR objectives.

FBE-J achieved traditional data exchange between the systems throughout the experiment. Additionally, interoperability occurred on a single occasion when imagery from a U-2 ASARS 2a sensor was down linked to the USAF common imagery ground system test bed at Nellis, using the prototype ISR management system (ISR-M) for interface with TES-N on CORONADO. Automated system-to-system transfer of level 3 control, cross-intelligence data base exchange, and sharing of NAV/collection plans were not achieved

10.4.3 Multi-Platform SIGINT Tracking Observations

The value and power of SEI's capability to uniquely identify and consistently re-identify radar signals cannot be overstated. SEI adds another piece to the puzzle to deconflict hostile radars from friendly radars in dense, complex emitter environments. The true value added of operating SEI sensors in a networked environment is the ability to move the SEI data from sensor-to-sensor and command authorities in near-real time. It was repeatedly demonstrated during FBE-J and MC-02 that the UYX-4 SEI sensor can consistently re-ID shipboard, land-based and airborne radars on different days, utilizing SEI systems on different platforms and operated by different operators. A distributed networked SEI capability, positioned on a variety of surface, air and land-based platforms, cooperatively identified emitters and targets of interest. The following FBE-J findings were extracted from Naval Research Laboratory (NRL) AAR (Networked SEI Sensor Grid for Enhanced Situational Awareness Quicklook Report) plus post-

[117] LCDR D. Sleyton, ISR Manager Notes

experiment interviews with key NRL engineers, and NWDC and C3F N2 representatives

Evidence shows that dissemination of SEI information in real-time will shorten the decision maker's timeline to develop a course-of-action and task and manage ISR assets more effectively.[118]

Command and control ships, such as CORONADO, are not particularly well-suited to position themselves for SEI collection operations at sea. However, Naval surface combatants, such as USS Benfold, are extremely well suited to conduct SEI operations at sea, and can provide positive COI ID and SEI re-ID on potentially hostile radars.[119]

During SOF VBSS Operations, the airborne carry-on/carry-off UYX-4 SEI Sensor on the VPU aircraft and the strategically located chokepoint monitoring site at Laguna Peak illustrated that remote SEI sensors can work together in real time to provide I&W, cue other sensors, and passively monitor the movement of hostile radars. This tactic has wide ranging implications for maritime interdiction operations and Homeland Defense missions.[120]

The P-3C AIP aircraft is well-suited to conduct SEI operations in the littoral with its onboard ESM sensor suite if it had an SEI capability to utilize an SEI TACELINT message sent from the TSC for COI re-ID, as well as the capability to produce a TACELINT message and send it to the Task Force Commander in near real time via UHF SATCOM.

Other means of communications, in addition to network messages, are essential to successfully execute complex operations, and asset tasking, reporting hostile activity, coordinating and verifying receipt of message to include network Voice over IP phones, network chat capability, MS NetMeeting chat, JOTS operational notes (OpNotes), cell phones, and Iridium phones.[121]

10.4.4 TES-N ISR Observations

Lack of direct downlink operations limited the NFN (TES-N) system TST capability, but according to ISR Manager and deputy, the NFN concept is sound, and the fleet needs this capability today. However, the current NFN system suffers from a lack of effective integration. The NFN family of systems does not talk to each other as well as required to effectively accomplish TST. In addition, human factors issues were not a priority during the development effort but must be considered in the subsequent development of NFN.[122]

The TES-N Operators, all young Petty Officers, were instrumental to the success of TES-N during the experiment. This combined team possessed the talent, imagination and potential to do anything with the limited resources.[123]

Operational context for sharing GCCS-M and TES-N information was non-existent. Although proving the technical interface was a limited success, fully understanding how to capitalize operationally on shared data was not implemented. The experiment did not provide opportunity to examine how TES-N XINT data shared with GCCS-M database impacted overall situational awareness.

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[118] Interview with Mr. Dave Wallace, NRL Representative
[119] Interview with Mr. Guy Thomas, JHU APL – NWDC Representative
[120] Networked SEI Sensor Grid for Enhanced SA Quicklook
[121] Interview with John Williamson – NRL Contractor (SEI Installation/Integration)
[122] Interview with LCDR D. Sleyton and LCDR M. Aaron (ISR Managers)
[123] Interview with LCDR J. Smith (C3F – NFN Manager)

TES-N ingested GCCS-M tracks successfully, but current capability does not permit TES-N operator to filter on desired GCCS-M track information. GCCS-M tracks flood the TES-N display when the TES-N operator has GCCS-M tracks 'ON'. Hence, track data from GCCS-M was not useful to the TES-N operators.

10.4.5 Enhanced Situational Awareness Observations[124]

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RTC-Lite systems on BENFOLD and FITZGERALD were running, but operationally they were not utilized. Unlike the VSSGN node, the ships did not have any concept of how to use RTC-Lite to support the mission. The staff did not understand how the information from RTC-Lite could provide them with additional SA required for their mission. Training is needed to explain how to integrate RTC-Lite capabilities in the battle plan/rhythm.[125]

The RTC-Lite capability on the NP3D and the VPU P3 was not utilized due to faulty aircraft communication links.

[124] Extracted from FBE-J NFN Principal Results Section (MI-NPS)
[125] NPS Analyst Observations on BENFOLD and FITZGERALD

10.4.6 Georefinement Process for TES-N Generated Targets[126]

The typical TST target engagement process began with a target nomination, including imagery, sent from the nominator Tactical Exploitation System – Naval (TES-N), to both the DTMS and the Land Attack Warfare System (LAWS). DTMS was to take no georefinement action on the nomination until the nomination was validated. This validation consisted of the receipt, by DTMS, of a georefinement request and a georefinement confirmation message, both originating with LAWS.

The georefinement process began with the request for georefinement issued by the LAWS to the DTMS. The georefinement request included specified mensuration accuracy and the expected time to mensurate. In principle, the requested mensuration accuracy was determined on the basis of the weapon target pairing (WTP) that was performed by LAWS. On receipt of the georefinement request, the DTMS would automatically match the request with the corresponding target nomination that had previously been received. The mensuration manager, operating the DTMS, responded to the georefinement request with a georefinement response message, which rejected or accepted the tasking. Sometimes the acceptance incorporated a modified mensuration accuracy and time to mensurate. This DTMS response was directed to the specific LAWS workstation that originated the mensuration request, not to the LAWS server. Finally, LAWS responded to the DTMS response message with a georefinement confirmation message sent to DTMS, if the DTMS response was acceptable. With the confirmation of the proposed georefinement by LAWS, the mensuration manager then allocated the georefinement task to one of more of the RRF mensuration workstations. The mensuration was performed using the imagery supplied with the original target nomination message. If multiple mensuration tasks for the same target were completed by the RRF workstations and returned to the DTMS, the mensuration manager decided which of the results was to be forwarded to LAWS.

10.5 Specific Emitter Identification

10.5.1 Networked SEI Sensor Play in FBE-J

Networked Specific Emitter Identification (SEI) was examined during FBE-J with instructive results. Surface Naval operations in the littorals often occur in regions with high shipping/background emitter densities. Interdiction operations and strikes against surface platforms in restrictive ROE scenarios require the capability to positively identify surface contacts. However, large surface ship contact densities in the littorals can preclude rapid establishment of the surface tactical picture using traditional surface surveillance coordination tactics. In addition, visual search methods could unknowingly place aircrew at risk from potentially hostile vessels. SEI provides the ability to rapidly and safely specifically identify a large number of surface contacts by extracting platform specific emitter characteristics and inserting an accurate track into the common operational picture (COP).

Two different, but complimentary SEI systems were tested in FBE-J. The UYX-4 antenna with WINSEITACELINT automatic message generator system, and an SEI specific software modification to the GCCS-M 4.x development package called CORRUS (Correlation Using SEI).

10.5.2 Correlation Using SEI (CORRUS)

CORRUS makes modifications to the core of the Integrated C4I System Framework (ICSF), which is the basis for the GCCS-M build. CORRUS modifications are slated for introduction in the 4.6 version and

[126] FBE-J Geolocation Analysis Section

will demonstrate the ability to use SEI data in GCCS-M to improve and expedite the identification and correlation process of unknown tracks.

Figure 10-2 describes the existing use of SEI data and improvements gained through the use of CORRUS.

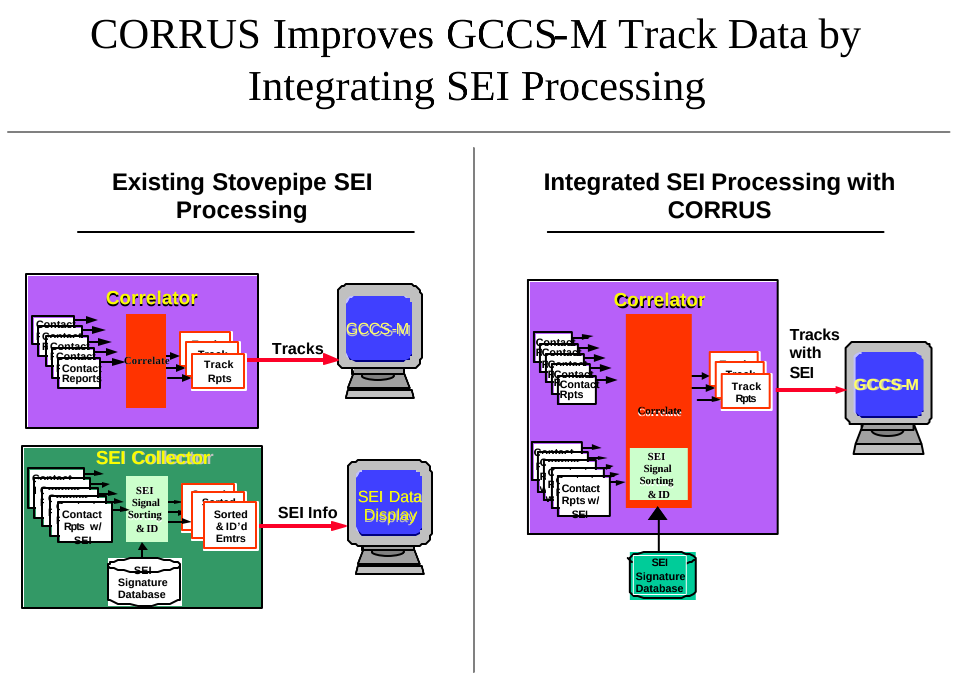


Figure 10-2. CORRUS Enhancements to SEI Data

Currently fielded data correlators and tactical processors use a variety of deployed sensors, which pass COI position, visual ID, attribute data, and other parametric ELINT information to GCCS-M. Calculations on three parameters: PRI, Scan, and RF are performed allowing emitter source identification. *CORRUS* enhances this process by applying algorithms that calculate: SEI distance and likelihood, thereby capturing unique signature attributes and allowing for more accurate emitter classification. Increasing measurements and calculations in these areas result in: 1) improved accuracy 2) a higher degree of correlation and 3) a greater level of automation. Ultimately, these enhancements can provide highly accurate, automated reliable track information in a dense littoral environment. The war fighter is provided with enhanced analysis, workload reduction, and situational awareness.

Because the FBE-J GCCS-M network was configured in the GCCS-M 3.x environment (CORRUS requires 4.x for full integration), CORRUS was tested as a "receive only, stand alone node" on the FBE-J Network. CORRUS received "live" collects from the UYX-4 SEI System via FICM TACELINT messages (TCP/IP) for processing containing SEI data. Upon receipt of TACELINTS, the data were decoded. The correlators determined an ELINT score and a geolocation score, and added an SEI score with the CORRUS modifications. The results were combined into a total correlation score. Using the improved result, a new track, updated track, or an ambiguity decision was made.

10.5.3 CORRUS Data Collection

The data collection effort sought to collect operational information that would improve future development of this capability. The following collection criteria were established for FBE-J:

- Validate a correlated track with a real world target of interest.
- Correlate the threshold level of effectiveness.
- Determine:
    - Percentage correct automatic CORRUS correlations.
    - Percentage incorrect CORRUS correlations.
    - Percentage manual intervention required.
    - Percentage error rate of associated correct and incorrect auto correlations compared to manual SEI tools embedded in CORRUS.
- Record database of SEI TACELINTS for use in future CORRUS testing.

The CORRUS system was placed inside the Fleet Combat Training Center Pacific (FCTCPAC) next to the primary collection hub for the WINSEI TACELINT automatic message generator system. A serial connection was established between the TACELINT machine and the CORRUS Sunblade UNIX machine utilizing a Solaris 8 operating system. For the experiment, two experienced ELINT operators from the National Security Agency (NSA) manned the system. A daily log was maintained to record information on collection specifics and any hardware or software anomalies that occurred. The operators met several times over the course of the experiment with the software developers and project officer to discuss any issues that may have been observed.

	TACELINTS Received	Contacts Correlated	Tracks Assigned	Auto Correlations
7/22	10	10	9	10/10
7/23	12	12	3	12/12
7/24	8	8	7	7/8
7/25	5	5	4	5/5
7/26	29	29	12	29/29
7/29	16	13	13	12/13
7/30	13	13	9	13/13
7/31	37	37	37	35/37
8/1	33	14	14	14/33
8/2	8	8	1	8/8
8/5	23	23	0	23/23

Table 10-1. ELINT Collection Data

ELINT collections were conducted from 22 July through 05 Aug. Results are noted in Table 10-1. A principal tenet of the CORRUS testing was to validate the ability of the software to conduct accurate auto correlations. The Table 10-1 results confirmed the software functioned correctly as designed. Of note are the TACELINTS received on the 1 August. Only 14 of 33 TACELINTS received were auto-correlated. This was due to incorrect message formatting that occurred at the originator, listing the time and date of collect in the future. This caused the decoder to not incorporate the data. After manual intervention and correction, the messages were reprocessed correctly, but not listed as "auto-correlations" because of this intervention.

10.5.4 CORRUS Observations and Conclusions

The CORRUS modifications to GCCS-M did perform as intended. Review of the experiment criteria shows that all the goals were met. A correlated track was validated with a real world target of interest many times throughout the experiment. Because of the close proximity to the NRL SEI hub, the picture could be confirmed with theground truth.

The correlation threshold level of effectiveness was evaluated upon the receipt of each FICM TACELINT. With the automatic threshold level set at 5, there was 100 percent correct automatic correlation with ground truth. In truth, a majority of correlation distances were extended to be closer to 1.5 and at highest 3.5. The percentage correct automatic CORRUS correlations were 88 percent. There were no incorrect CORRUS correlations. The manual intervention required 12 percent. Besides one case where PRI tolerance limits had to be widened, the manual correlations occurred because of incorrectly formatted FICM TACELINT messages that were generated by the collectors. The last goal, a record database of SEI TACELINTS for use in future CORRUS testing, was saved to disk and will be used for detailed in-depth analyses.

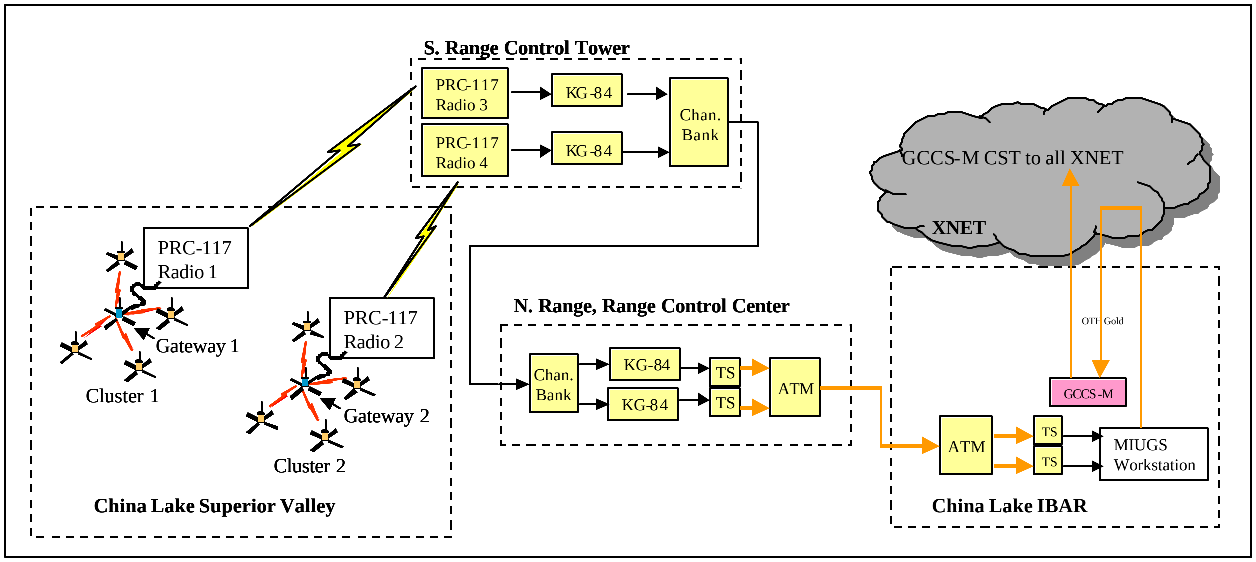
Future Considerations

The only messages received during FBE-J were FICM TACELINTS that contained SEI data, so any correlation between messages with just classical parameters and messages with classical parameters and SEI data did not occur. CORRUS will perform these correlations, which need to be tested and validated along with the regular SEI correlation. A goal of the post-exercise testing is to mix in non-SEI TACELINTS to evaluate the performance of the data. Another point for future testing is to increase the number of FICM TACELINTS that do not contain PLATID lines, or lines that specifically state what platform the emitter is on. Without it, there is greater reliance upon a SEI match to make an automatic correlation.

A large list of follow-on enhancements were generated from this experiment that were not part of the original two year scope and would require more time and funding than remain. Some of these include keeping SEI mode history reports, include storage for fields reported in USSID 351 format (16 stagger legs), enhance the TACELINT decoder, etc. From these continued refinements, the tactical uses of CORRUS capabilities will continue to be improved bringing it closer to the goal of supporting the warfighter and time critical strike (TCS) efforts.

10.6 Micro-Internetted Unattended Ground Sensors (MIUGS)

FBE-J was the setting for the use of DARPA's prototype Micro-Internetted Unattended Ground Sensors (MIUGS) in coordination with BAE Systems, Inc. The experiment integrated MIUGS with government off the shelf (GOTS) communications and commercial off the shelf (COTS) networking components. During FBE-J MIUGS provided track inputs to the COP via China Lake's GCCS-M. Targets detected from the field by the MIUGS sensors were sent from the field to the MIUGS workstation, then to China Lake GCCS-M and eventually to the USS Coronado's GCCS-M, as shown in figure 10-3. Approximately 20 seconds of track history is displayed on the MIUGS workstation screen in the form of small circles trailing behind the latest detection. A point from these tracks is selected, augmented with target characteristics and forwarded to China Lake GCCS-M.



Source: Richard Coupland—NWDC

Figure 10-3. MIUGS Range Tower Data Link

On 29 July the BAE Systems Team began sending JUNIT messages to GCCS-M containing track data, at least eleven messages were sent. Several JUNIT messages were sent from 21:36Z to 21:49Z and were not individually counted. Searching through China Lake GCCS-M, Coronado GCCS-M, and FCTCPAC GCCS-M data indicated that the JUNIT messages were not in those collected data. No MIUGS message format was recognized during the search and MIUGS operators did not receive any feedback from GCCS-M operators.[127] However, a search through FCTCPAC GCCS-M data revealed two messages from MIUGS dated 29 July, which were queued for broadcast on 30 July.

Messages sent on 30 July from MIUGS were identified in the collected data from China Lake. There were a total of four messages sent during this day. Using MIUGS's force code of 31 and the beginning three characters of the unique identifier (UID) M09, these messages were identified in both the GCCS-M data collected from China Lake and from USS Coronado. However, they were not found in FCTCPAC GCCS-M data. Data collected from China Lake could easily be read but the part of the USS Coronado messages that included the date-time group and coordinates is in hexadecimal format. This could not be properly translated and compared with the message from China Lake data. Nonetheless, this showed that messages sent from the MIUGS terminal reached the USS Coronado.

No engagements were initiated based on MIUGS inputs. However, GISR-C was requested by MIUGS to nominate a MIUGS target from GCCS-M to LAWS. The GISR-C operator stated that he had not nominated targets from GCCS-M before. This is likely attributed to the difference in CONOPS from FBE-I to FBE-J. GISR-C created and forwarded target nomination based on Predator imagery. A target nomination was forwarded to LAWS from MIUGS by GISR-C. This nomination however, did not include the required supporting imagery to approve a strike. The LAWS operator forwarded the track for mensuration and was rejected. This process has demonstrated that information from MIUGS is sufficient to begin the targeting process.[128]

[127] Coupland, Richard L. "After Action Report: Unattended Ground Sensor (MIUGS) Experiment." FBE-J Navy Warfare Development Command. 7 August 2002: 19
[128] Ibid.

10.6.1 Estimating the accuracy of the target data generated by MIUGS

An individual track coordinate was chosen from a set of tracks that were generated by MIUGS. This individual track was then sent to GCCS-M, as a JUNIT message with a description of what the track is with a force code and a unique identifier specific for MIUGS. This message also included a JPOS message indicating the time, coordinate, heading and speed for the detected track. On 30 July four individual track points were selected from tracks generated by MIUGS. These individual track points were sent to the China Lake GCCS-M as JUNIT messages and were extracted.

Coordinates from these messages were compared to GPS data generated by vehicles tracked during the experiment, which was in WGS-84 UTM format. Coordinates sent to GCCS-M were in latitude and longitude. These points were converted to UTM coordinates using two different conversion software systems. Both conversion systems converted the lat/long coordinates to the same UTM coordinates.

Comparing the data received by GCCS-M to field GPS track data indicates that GCCS-M received incorrect coordinates. Coordinates received by GCCS-M ranged from 580 to 1890 meters away from the actual target, with a median of 888 meters and average of 1085 meters. Figure 10-4 indicates the location of the vehicles compared to the location received in GCCS-M. This chart does not take into account any time delay from detection to track receipt at the MIUGS terminal. Nonetheless, it shows that the tracks received by GCCS-M were far from where the targets were located.

MIUGS Systems Engineers explained that this is attributed to the following errors.

- Sensor Reference Centroid. The gateway would report the GPS relative to a centroid of sensors reporting into it. If local communication were lost to one sensor briefly, the gateway would shift its reference coordinate. The reference positions would thus "jump" over time.

- Bit errors in messages from sensor to gateway caused apparent "jumps." These coordinates were only set once per minute to the gateway so you would see 1-minute intervals where positions were constant, but values could be wildly wrong. The really bad errors could be thrown out, but smaller errors got through.

- Bit errors in messages from gateway to operator console. Same net effect as immediately above.

- Message drop errors from gateway to operator console. These coordinates were also supposed to be updated once per minute but when messages did not get through the ground links, reference coordinates persisted longer then a minute. So if a message with errors in it arrived at the IBAR, it could persist longer than a minute due to messages being missed after the bad one was accepted.

BAE Systems is taking measures to correct these reference position issues by keeping GPS in stand-by mode, making longer term measures without updating the position until it's stable and using the gateway as the reference coordinate. To correct bit errors, BAE is inserting error detection code into the message.

In addition to reference position errors experienced during the experiment, there was also a discrepancy with time. Messages arrived at the operator console at random intervals. BAE estimated the error using vehicle ground truth data and reported positions from MIUGS. By conducting time alignment of vehicle ground truth data and shifting reported positions, BAE is able to develop a best fit at "jump" points. [129] BAE stated that measuring track errors from FBE-J data would not produce meaningful results.

No comparison between the track received and displayed by GCCS-M to the track sent by MIUGS could be made due to non-receipt of data from the contractor.

10.6.2 Using MIUGS Data for Cueing Other ISR Sensors

Due to difficulties with MIUGS communications system, tracks were not transmitted to the Strike Warfare Center (STWC) when the Predator UAV was available. And when MIUGS communications were working, the Predator UAV was not available.

The MIUGS transmit a heartbeat pulse to the gateway nodes, and on to the MIUGS workstation every second. Tracks were also updated at one-second intervals. This timing was implemented to achieve required accuracies for army fire support applications. The available radios required two seconds from initial keying until ready to transmit. This performance limitation required that the transmit radios operate continuously, resulting in excessive battery drain and rapid overheating at higher output levels.[130]

Another factor that affected communications was desert winds and 109°F temperature on 30 July. The experiment used two clusters of four sensor nodes each, providing detection and tracking ranges of about 1000 feet. This performance was experienced during the morning when the atmosphere was calm. During the afternoon atmospheric conditions changed, wind velocity increased, diverting sounds away from the MIUGS. Increasing ground temperature also diverted sounds upwards affecting acoustic sensor performance.[131] However when the sensor cluster detected sound or ground movement and communication was capable of sending track data, the data were received at the MIUGS terminal located at China Lake's Strike Warfare Center.

It was also observed that simply inserting a TCT into GCCS-M is not sufficient to cue operators to look for MIUGS targets. When tracks were injected into the system and GISR-C operator was not alerted, there was no action to deploy UAV assets to the track's location. Analysts on the USS Coronado were cueing GCCS-M operators to look for MIUGS targets, but no target nomination resulted.[132]

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[129] Ortolf, James M. E-mail interview. BAE Systems. September 19, 2002.
[130] Coupland, Richard L. "After Action Report: Unattended Ground Sensor (MIUGS) Experiment." FBE-J Navy Warfare Development Command. 7 August 2002: 19
[131] Ibid.
[132] Ibid.

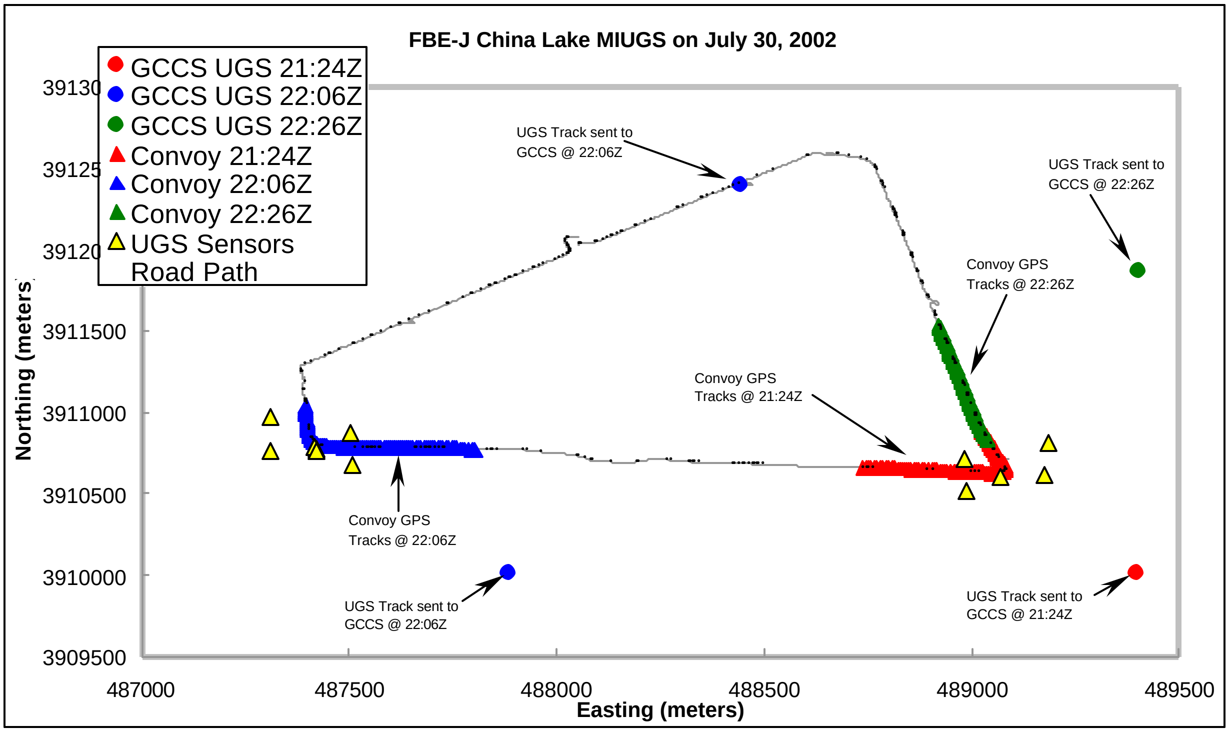

Figure 10-4 China Lake MIUGS Track Data and Observed Locations

10.5 JFMCC ISR Management Initiative Key Observations

The primary goal of the JFMCC ISR Management initiative was to investigate ISR planning, tasking, processing, exploitation and dissemination within a JFMCC staff, both up and down echelon as well as across components. In addition, FBE-J provided the forum to evaluate and refine JFMCC ISR manning and expertise requirements necessary across all levels of the organization. A JFMCC ISR operations cell was established to dynamically command and control ISR assets and the experiment provided insights into the JFMCC expertise, manning, tools and optimal maritime operations center layout required to effectively manage ISR assets. From a technical perspective, analysts evaluated the employment of unmanned aerial vehicles (UAVs), micro- netted unattended ground sensors (MIUGS), and networked specific emitter identification (SEI) assets to refine time sensitive strike (TST) prosecution procedures and enable covert target tracking operations. The following were significant observations:

- The ISR operations cell in the MOC was effective in dynamic re-tasking of ISR assets. There was not an established process to assess the effects on the deliberate ISR plan when sensors were re-tasked to support TST operations. There was no confirmation that there was "seamless" ISR coverage of the area of operations. Apparently tools, TTP, and sufficient personnel are lacking to enable full-spectrum ISR operations. Considerable investigation is needed to:
  - Fully understand the requirements
  - Determine manning levels required to provide dedicated cradle-to-grave TST ISR management.
  - Develop a graphic display system to illustrate synchronized ISR planning.
  - Develop TTP for ISR management with emphasis on re-tasking and dynamic planning.

- TES-N excelled at display of near-real-time location of Red assets for decision makers. The system can be effective but several issues need to be resolved. Technical improvements are needed in the following:

  - TES-N/NFN lacks effective means for integration with other systems.
  - Lack of direct downlink operations limited NFN system's TST capability.
  - NFN systems need faster, more reliable communications to deal effectively with TSTs.
  - There was no established operational context for when or how to share GCCS-M and TES-N information.
  - Develop a means for providing appropriate, near real-time, TES-N information to the Fires cell.
  - Develop a means for displaying TES-N information in GCCS-M.
  - Develop TTP for use of TES-N information in the TST process.

- Most time critical targets in FBE-J were detected or confirmed using imagery from satellite, air, or unmanned air reconnaissance operations. The process for nominating these targets for strike currently excludes sending such TCT tracks to GCCS-M. This result applies only to tracks resulting from imagery. DTMS has the requirement to send tracks from imagery to the COP. This interface will not be fully implemented until DTMS version 4 (companion with GCCS-M 4.X) is released. Tracks sent to C2PC from DTMS are also not forwarded to GCCS-M 3.X.

- The Micro-Internetted Unmanned Ground System (MIUGS) provides information to augment the COP. GISR-C was requested by MIUGS to nominate a MIUGS target from GCCS-M to LAWS. The exercise demonstrated that MIUGS inputs could be functionally used for TCS. In the experiment, however, serious limitations in performance were observed:
  - MIUGS sent the wrong coordinates to the system. Tracks sent to the system did not match the actual target location. Data sent by MIUGS could not be relied on for precision strike.
  - There were large inconsistencies between reported MIUGS performance, ranging from everything worked perfectly to there being substantial errors in tracking and the passing of data from one system to another.

11.0 Mine Warfare (MIW) Initiative Key Observations

11.1 Experiment Objectives

The overall objective of the MIW experiment in FBE-J was to examine the application of network centric operations to mine warfare. The command and control structure in FBE-J encompassed an experimental organization, a high speed vessel (HSV) as a surrogate future mine countermeasures (MCM) capable platform, new command and control equipment, and some new MCM capabilities, which replicate future MCM capabilities in the 2007-2010 time frame. This analysis limits its focus to the issues above and does not include an analysis of finding mine locations or clearance operations in FBE-J.

In support of these objectives, the key questions that needed to be answered were:

- Did the HSV provide the Mine Warfare Commander (MIWC) with the command, control, communications, computer, intelligence, surveillance, and reconnaissance (C4ISR) tools necessary to participate in network-centric warfare?
- Did the variety of assets available to support the MIWC enhance the overall MIW ability? Could the HSVs also use those assets?
- Was the MIWC able to operate in a network-centric environment and to use the ISR and Fires capabilities of the Naval Fires Network (NFN)? Was the NFN, in turn, able to incorporate MIW sensor information and conduct Fires with MIW specific precision-guided munitions (PGMs)?
- Were the MIWC and Anti-Submarine Warfare Commander (ASWC) able to collaborate in the management and interpretation of the common undersea picture (CUP)?

11.1.1 Sub-initiative: Collaboration of MIWC with JFMCC and PWCs

A principal area of interest in FBE-J was the amount and type of collaboration that occurred between the Mine Warfare Commander (MIWC) and the Principal Warfare Commanders (PWCs) and the Joint Forces Maritime Component Commander (JFMCC). Through the services of the C4ISR suite onboard Joint Venture (HSV-X1), the MIWC should have had several means of communicating with the JFMCC staff and other PWCs. A principal goal was to determine if the MIWC was able to effectively collaborate with the JFMCC, other warfare commanders and the units conducting MCM. The successful accomplishment of this objective would include achieving the following:

- The MIWC was able to share situational awareness (SA) with the Commander Amphibious Task Force (CATF)/Commander Landing Force (CLF) and make dynamic changes to the sea lanes clear of mines (Q-routes) and mine searching/clearing plans if necessary.
- The JFMCC/CTF provided security for the MCM forces to successfully operate.
- The JFMCC allocated assets to perform MCM.
- The communications suite aboard the Joint Venture (HSV-X1) supported the embarked MIWC with necessary tools.
- The MIWC was able to provide the JFMCC with an opportunity to conduct timely operations within a potentially mined area.

11.1.2 Sub-initiative: HSVs as MCM Sensor Support and Management Platforms

The Joint Venture (HSV-X1) and Sea SLICE had a variety of experimental autonomous sensors and an MIW team embarked during FBE-J. This initiative examined the HSV's ability to physically support the use of these sensors and to manage their apportionment and data collection. Support in this context is defined as technical and operational support. The issues were also considered by the HSV initiatives and collection plans, therefore some collaboration and redundancy between MIW and HSV data collection were expected.

11.1.3 Sub-initiative: MIW Integration With NFN

This sub-initiative investigated the NFN ability to support precision mine targeting and MIW Fires through tactics, techniques, and procedures (TTP), systems architecture, and organization. Navy Fires provided long-range surface and air delivered Fires support for the MIWC through integration of the fleet air support munition – mine application (FASM-M) and HYDRA-7, a counter mine weapon. (MIW Fires is a subset of NFN and NFN is the naval subset of the Joint Fires Initiative.)

11.1.4 Sub-initiative: MIW Use of Common Undersea Picture (CUP)

The common undersea picture (CUP) supported collaborative planning and execution for both MIW and ASW and permitted the Surface Combat Commander (SCC) (when one was assigned) to be able to use common display, planning, and execution tools for both mission areas, thereby reducing the SCC module footprint and manning for SCC. For this experiment, CUP consisted of a single CADRT installed onboard Joint Venture (HSV-X1).

This sub-initiative investigated the value and required technologies for a rapidly deployed, underwater, wide-area sensor system. This system, the Undersea Sensor Network (USN), detects and transfers data from the array to the CUP. Rapid deployment and implementation of such a system is potentially useful for quickly determining if the enemy has reseeded an area that MCM forces had previously assessed as clear of mines.

11.1.5 Sub-initiative: Remote Autonomous Sensors (RAS)

Mine Warfare and Environmental Decision Aids Library/GCCS-M Segment (MEDAL) and the naval mine warfare simulation (NMWS) system were intended to be the primary planning tools for the MIWC in determining the mission profile and specific area tasking for all of the autonomous MCM sensors. The underwater sensor network was designed to provide a means for the MIWC to monitor key areas of the shipping lanes cleared of mines (Q-routes) or the operations areas (OPAREAS) that have been cleared by MCM forces. If no enemy ships or submarines were observed to have transited through the area, then the MIWC would have a higher degree of confidence that the enemy had not reseeded the cleared area with mines. However, if an enemy ship or submarine was detected, then the network could precisely track the transit of the contact through the area, which would minimize the amount of water space that had to be re-examined.

11.2 MIWC Organization and Command Structure

One of the major objectives of this initiative was to investigate the effectiveness of a new MCM organization that named the MIWC as a Principal Warfare Commander (PWC) and placed him on an equal basis with the other PWCs to improve the effectiveness of support for the JFMCC. FBE-J had a distributed command structure, with the MIWC embarked on Joint Venture (HSV-X1) supported by a full C2 suite, with the ability to collaborate with the Joint Forces Maritime Component Commander (JFMCC) and other warfare commanders, having access to off-board, non-traditional MIW sensors and possessing new MCM planning and course of action (COA) development tools.

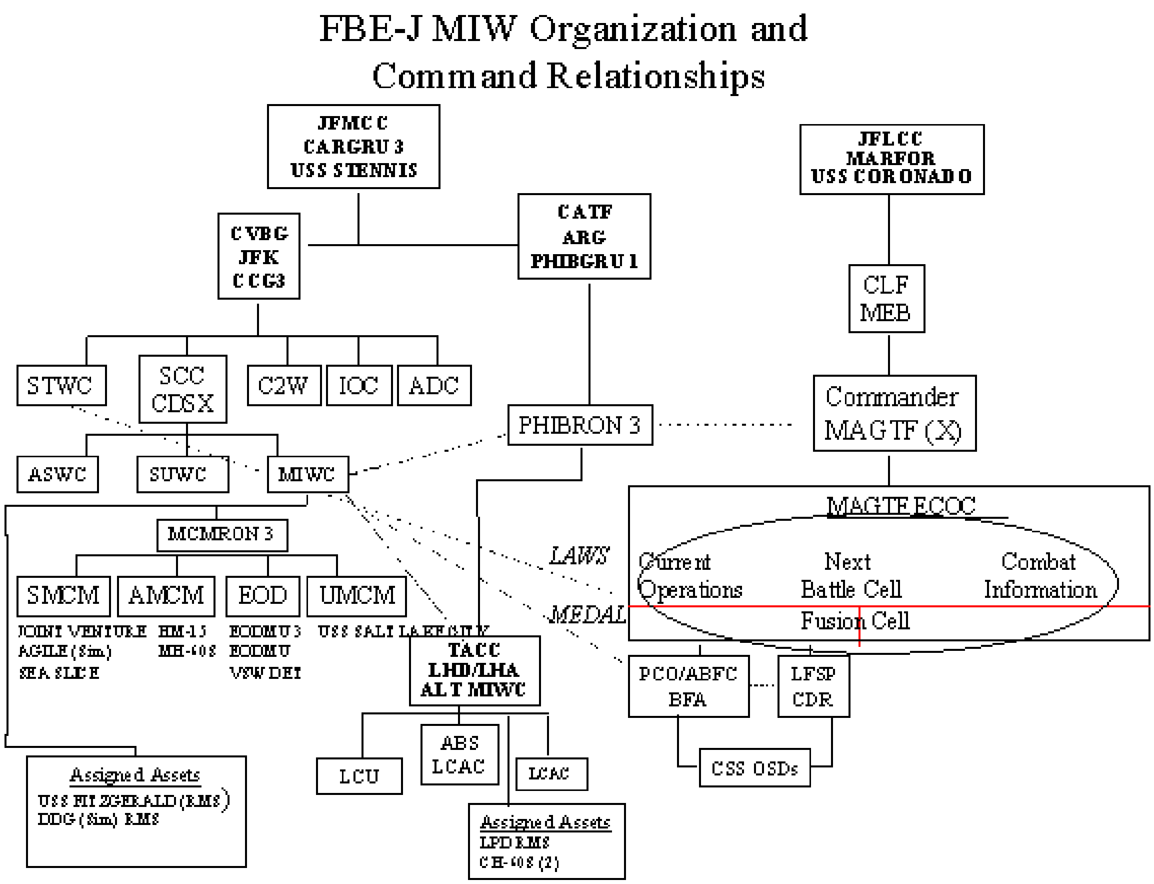

Figure 11-1. FBE-J MIW Command Structure and Command Relationships

11.2.1 Mine Warfare C4ISR Architecture

Incompatibilities among computing platforms, protocols, interfaces, and standards are some of the factors that hinder broader and better naval MIW capabilities. The use of the latest information technology (IT) resources should enable the battle force, with its MIW assets, to move from the traditional platform-centric concept of warfare to network-centric warfare (NCW), and network-centric operations. An optimal MIW command, control, communications, computer intelligence surveillance and reconnaissance (C4ISR) system must capitalize on the existing Joint and Naval C4ISR systems and doctrine. There should be very few requirements for unique MIW C4ISR hardware. However, unique software applications to support MIW are required. Where feasible, existing and planned C4ISR systems and decision support software and hardware will be used or modified to support the MIW mission.

The evolution of MIW doctrine and its introduction into the fleet C4ISR process is essential to fully integrate MIW operations into the battle group (BG) mission and activities. Access to MIW information by the fleet can only be achieved through standard systems. These software applications will be implemented as software segments in Joint Force Command and Control systems, such as the current Joint Maritime Command Information System (JMCIS) and Global Command and Control System - Maritime (GCCS-M).

For FBE-J, the MIWC embarked on a surrogate high-speed vessel (HSV) to use as his flagship. The HSV had a fully equipped, modular C4ISR command center and a state-of-the-art communications and computer suite, which provided unparalleled connectivity up and down the battle force. This capability allowed real-time communications, chat, VTC, and the exchange of information, data and the common operational picture and common undersea picture. This exchange and data sharing was provided through a high speed, high data capacity shipboard local area network (LAN) tied into a robust new communications suite. This experiment allowed the MIW community to evaluate future MIW C4ISR today in order to understand the implications and opportunities for the MIWC. FBE-J also served to further define requirements and needed capabilities for such a system. The diagram below, figure 11-2, depicts the overall MCM communications architecture for FBE-J.

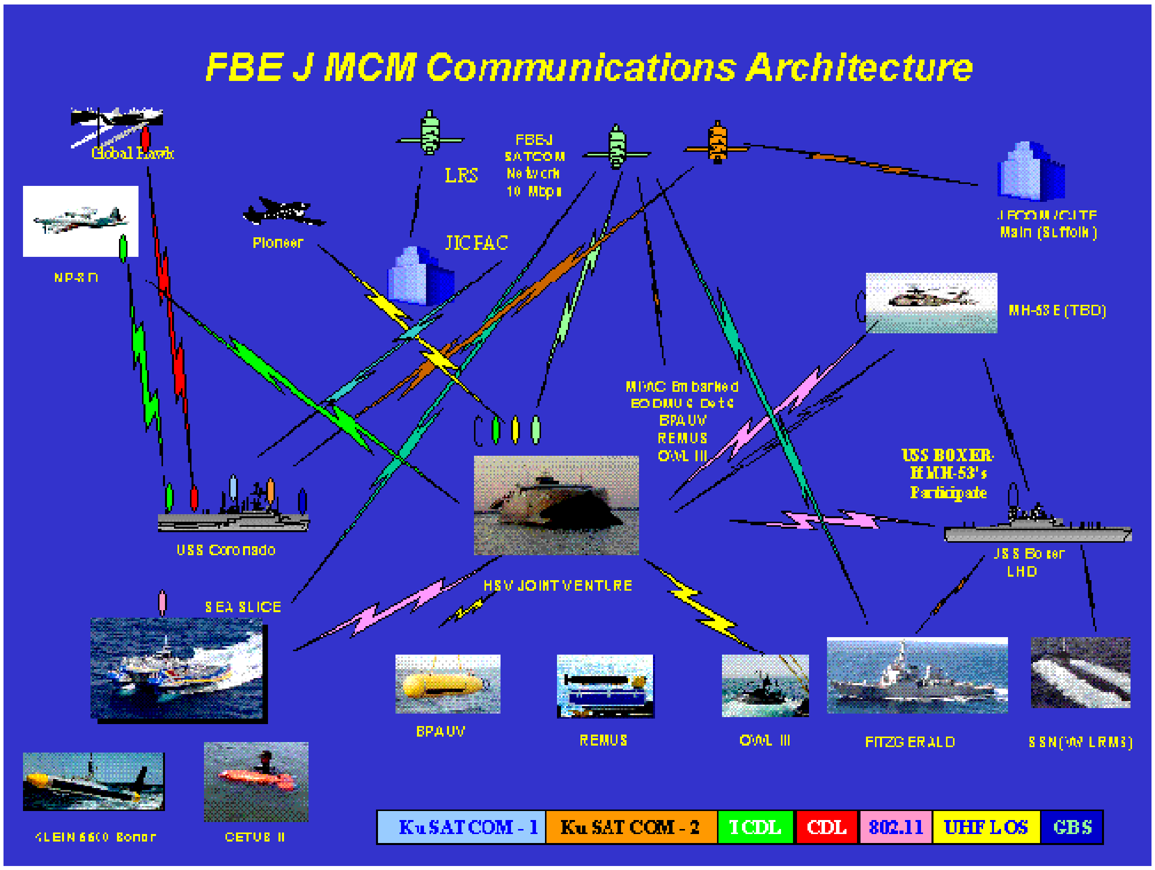

Figure 11-2. MIW Communications Architecture for FBE-J

11.2.2 Net Centric MIW in Coordinated Operations

The success of network-centric MIW operations is based upon the ability of the battle force to pass relevant tactical information from the operating forces to decision makers and from commanders back to operating forces, such that the situational awareness in the entire force is the same. The concept pairs networking and information technology with effects-based operations (EBO) to create overpowering tempo and a precise, agile style of maneuver warfare. Factors of interest to the Mine Warfare Commander include:

- In-depth knowledge of the adversary

- Real-time shared situational awareness
- Decentralized, self-synchronizing execution
- Focus on actions and reactions

FBE-J concentrated on information as a primary source of power to enable access and to provide real-time battlespace awareness for the MIWC and other commanders. It used a variety of dispersed sensors to achieve rapid and comprehensive MIW battlespace awareness

11.2.3 Development of the MIW Networks

Effective MIW relies upon the successful integration of key and relevant information from various sources to identify and clear the mines and obstacles from deep water to the Beach Exit Zone (BEZ). Capabilities for detection by sensors varies by water depth and mine type. It is therefore very important that all commands are acting in consonance to provide all relevant information to the MIWC for most effective prosecution of the MIW objectives. An integrated C2 methodology to provide this information as a common operational picture (COP) was formed around three logical networks as follows:

- Information network
- Integrated Sensor network
- Engagement Network

The Information Network

Enabled by an integrated, near real-time environmental data and MEDAL-GCCS-M and the Land Attack Warfare System (LAWS) architecture and a future alternative MIWC command structure, the information network functioned to integrate the full spectrum of sensors. Sensor inputs to the network were processed and correlated. Fused sensor information was pulled by the MIWC through adaptable, reconfigurable displays to provide situational awareness and the knowledge to make command, coordination, and synchronization possible at lower echelons.

The backbone for FBE-J common operational picture (COP) was the Global Command and Control System – Maritime (GCCS-M). GCCS-M/MEDAL, a segment of MEDAL, provided the backbone for the MIW C4ISR connectivity. MEDAL 7.4 and an engineering version MEDAL 8.0, installed on FITZGERALD only, were used in the experiment. GCCS-M/MEDAL and LAWS were interfaced to allow mine contacts to be displayed in the COP and passed to the Naval Fires Network Experimental (NFN (X)) to allow engagement of mine targets and to provide a means of getting battle damage assessment (BDA) back into MEDAL and the COP for those targets that were engaged.

The Integrated Sensor Network

A number of onboard and off-board unmanned overhead, airborne, surface and autonomous underwater sensors were netted through MEDAL/LAWS and GCCS-M, to provide the MIWC with an the ability to more quickly gain battlespace knowledge. His situational awareness (SA) was underwritten by fused environmental and tactical mine warfare picture data into a comprehensive picture. Sensors operated in FBE-J were as follows:

- Littoral Remote Sensing (LRS)
- Coastal Battlefield Reconnaissance and Analysis (COBRA) System
- Joint Surveillance and Target Attack Radar System (JSTARS)
- Battlespace Preparation Autonomous Undersea Vehicle (BPAUV)

- Semi-Autonomous Hydrographic Reconnaissance Vehicle (SAHRV)
- Remote Environmental Monitoring System (REMUS)
- Composite Endoskeleton Test-bed Untethered Underwater Vehicle System (CETUS) II
- HSV Joint Venture (HSV-X1) with BPAUV, SAHRV, REMUS, CETUS II, and EOD DET embarked
- Sea SLICE with Klein Side Scan Sonar, REMUS, CETUS II and VSW DET embarked
- AN/BLQ-11 Long Term Mine Reconnaissance System (LMRS) (simulated)
- AN/WLD-1 (REMOTE MINEHUNTING SYSTEM [RMS]) (simulated)
- AN/AQS-20X Airborne Minehunting System (simulated)
- Advanced Laser Detection System (ALMDS) (simulated)
- MH-53E (4) with AN/AQS-14E (simulated) (simulated)
- MCM-1 (2) with AN/SQQ-32, AN/SLQ-48 and EOD DET (simulated)
- MHC-51 class (2) with AN/SQQ-32, AN/SLQ-48 and EOD DET (simulated)

The Engagement Network

The engagement network was designed to fully integrate MEDAL with LAWS and provided the MIWC with control of several future weapons in support of accomplishing his assigned mission. The integration of MEDAL with LAWS brings MIW into the Digital Fires Network, which allowed all decision makers to have visibility into the MIW situation as it developed. These weapons could enable the MIWC to clear minefields more quickly, thereby significantly reducing the overall timeline for MIW operations.

11.2.4 Remote Launched Precision Guided Munitions in Support of MIW

A number of new Precision Guided Munitions (PGMs) are currently under development, primarily in support of land warfare. As a complementary effort, there is potential for these systems to support the mine warfare community. To assure the effectiveness of these weapons systems, MCM sensors must provide the precise target geo-locating data that the weapons require. These weapons must also have a distributed command and control system wherein mine warfare fires support planning and execution can be integrated into the larger Naval Fires Network. Additionally, issues of deconfliction and battle damage assessment must be effectively considered. The descriptions below describe four future mine warfare related PGMs that could be effectively integrated into the NFN architecture for support to MIW.

- *Fleet Air Support- Marine – Mine Warfare Application (FASM-M) Munition*
  Originally designed as a land attack weapons system, FASM-M provides a 5" gun round with long range, loiter capability and target imagery capability. Fitted with a different warhead to support the mine warfare mission and assuming advances in mine warfare sensor target geo-location accuracy, it is believed that a FASM-M-like capability for surface shooters will provide a needed capability to support almost real-time tactical decisions by the Landing Force Commander on LPP selection and STOM execution that cannot now be duplicated with existing weapons. In addition, it will support the single combatant, equipped with RMS, by providing a mine neutralization system option. Once the RMS has detected a mine target FASM can be the weapon of choice when an MH-60S helicopter with Airborne Mine Neutralization System (AMNS) or RAMICS is not available or cannot be used for tactical reasons. It is envisioned that the same planning tools to be incorporated into Naval Surface Fire Control System supporting extended range guided munition (ERGM) and Tactical Tomahawk Land attack missile (TLAM) planning could be modified to support FASM-M operations, which, in this FBE, will be replicated through the use of Land Attack Warfare System (LAWS) and Navy Fires Network (Experimental). This capability allows these MIW munitions to be integrated into land attack and strike operations through the joint C4ISR architecture for Joint Air Operations and Joint Fires.

- *Hydra 7*
  HYDRA 7 is a potential future system. It is an air delivered, GPS guided, breaching munition that spreads a number of hypervelocity burning darts to deflagrate surface and buried mines in the very shallow water (VSW), surf zone (SZ), and beach zone (BZ). HYDRA-7 is intended to provide a standoff air launched weapon as a counter measure to mines, particularly those that threaten amphibious landings.

- *Rapid Airborne Mine IC System (RAMICS)*
  RAMICS is a MH-60S mine neutralization system which uses a LIDAR system to provide targeting for a 30mm super cavitating gun system.

- *Airborne Mine Neutralization System (AMNS)*
  AMNS is an expendable mine neutralization vehicle which will be deployed from MH-53E and MH-60S to reacquire and neutralize moored or proud bottom mines. It will utilize a LIDAR capability to detect the mines then deploy the tethered AMNS to localize the mine with a high frequency sonar and EO capability. Once identified, the helo will back off away from the mine and then shoot a mini-torpedo at the mine and destroy it. The AMNS can then move the AMNS vehicle back to the location of the mine to verify that it was destroyed.

11.3 Observations

11.3.1 MIWC Collaboration with JFMCC and PWCs

The overall collaboration between the MIWC, JFMCC and other PWCs began slowly. While the MIWC knew what was going on in MIW, he had little insight into the overall context that the MIW operations were being conducted within, such as the larger tactical or operational picture and JFMCC/JTF operational plans. Even collaboration with the Anti-Submarine Warfare Commander (ASWC) on the common undersea picture (CUP) did not occur because the MEDAL systems were not on a common local area network (LAN). The MIWC requested that the local ship's SA be displayed in the C4ISR space. This had value in getting him a part of the bigger picture, but he still needed to know the overall common operating picture and the goals and objectives of the JTF.

Although the MIWC had newly elevated status as a PWC and the ability to employ a number of experimental assets and capabilities, there was little overall collaboration with other staffs or PWCs. A gradual awareness among the MIW staff of the need to work closely with other PWCs, particularly the AMWC and the SCC, eventually led to an improvement in collaboration. But there remained general confusion and varying opinions on the appropriate nature of this collaboration.

MIWC planning suffered because it was not co-located with the JFMCC planning. This would have alleviated much of the SA deficiency issue and would have eased the coordination between MIW and JFMCC/JTF planning personnel. However, with proper staff training in the use of collaboration and communication tools, these issues could have been resolved.

There was considerable frustration among participants associated with the dynamic between the MARSUPREQ and MIW processes.

- There was a lack of promulgation of critical MIW related information, such as Q-Routes, times of assaults, and areas around islands needed by the Amphibious Warfare Commander (AMWC).
- The MPP process appeared to be done without adequate collaboration with MIWC. One observer felt that the NATO process would be preferable to the JFMCC MPP process because it is perfected and familiar to the fleet.

- MARSUPREQs took too much time, overburdened the MIW staff, and detracted from the MCM battle rhythm. They were also insufficiently flexible for MIW, where the process is slow but changes need to be ingested and evaluated continuously. One staff member stated that there was some question as to how many MARSUPREQs were needed to cover a MIW mission; one for the overall mission or one for each functional segment.
- Virtually all were in agreement that the time consumed by managing the MARSUPREQs would have been more productively employed in direct MIW-related work, such as evaluating alternatives in the Naval Mine Warfare System (NMWS).
- A need was also expressed to integrate the MARSUPREQ process to the different systems used to prosecute MIW, e.g., a ship selected in GCCS-M should link directly to a MARSUPREQ and the format of the MARSUPREQ should match casualty reports (CASREPTs), casualty corrections (CASCORs), and casualty cancellations (CASCANs).[133]

A number of MARSUPREQ workarounds were necessary to process tasking. Significant cutting and pasting from day before missions, printing out copies of old MARSUPREQs to compare tasking for new MARSUPREQs, OPNOTEs to MEDAL to change MIW tasking (because no direct link to the MARSUPREQ form was available), telephone calls, and other OPNOTEs are examples.

Early in the experiment, the MIW staff was waiting for information that the other PWCs may not have known was needed by the MIWC. The staff was slow to request the information and sometimes resorted to unilateral, educated guesses about what the other PWCs knew or what was needed.[134] On 28 July, AMWC began to feed back information to the MIWC. By 7/31, the collaboration between AMWC and MIWC had continued to improve,[135] perhaps in part due to the assignment of a Navy officer in the M&S cell for MIW to enhance the realism. Of note however, most of the improved collaboration with other PWCs occurred after 28 July when all MIW operations were simulated, not actual.

There was little collaboration between the Sea Component Commander (SCC), the MIWC, and the ASWC over unmanned undersea vehicle (UUV) placement and SSN operations as normally would have been anticipated. It may have been because RMS and LMRS were placed such that they were not a problem, but one observer thought that not to be the case.[136]

Collaboration tools were used, but not to an optimal degree. Rather than use Information Work Space (IWS) or CISCO phones, representatives from other staffs would frequently walk into the MIW space to talk to the MIWC. Nonetheless, collaboration tools such as SharePoint Portal Service (SPPS) and IWS were used regularly between staffs and these discussions served as collaboration. Review of the chat logs points out that discipline is needed as there was both inappropriate items and significant uncorroborated information were being discussed in this venue.

MIW planning tools included GCCS-M/MEDAL, Naval Oceanographic Office (NAVOCEANO) bottom mapping and change detection (BM-CD), Naval Mine Warfare Simulation System (NMWS) and Land Attack Warfare System (LAWS). Their integration worked well to provide the MIWC a start-to-finish planning-to-engagement toolset. Dominant Battlespace Command (DBC) provided an excellent 3-D visualization tool that MIWC used for overall situational awareness (SA), although the 3-D underwater visualization was not demonstrated due to the integration program not being fully developed. GCCS-M/MEDAL requires some modifications to accommodate MPP MARSUPREQ to MCM tasking integration to reduce the MIWC planning workload. MEDAL requires some additional tool refinements to facilitate the quick planning of multiple UUV missions.

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[133] FBE-J Mine Warfare Survey – New Survey
[134] FBE-J Mine Warfare Survey
[135] MIW Daily Activity Reports of 28 July and 31 July.
[136] FBE-J Mine Warfare Qualitative Survey, ASWC, Undersea Sensor Placement

It may be that if the MIW staff had been embarked in the HSV for a longer period with more time to experiment with the display capability, additional insight and collaboration might have occurred. Slow communications links affected their impression of the utility of collaboration and planning tools. Other than MEDAL, the best planning tools were NMWS and BM-CD, which for the MIWC were standalone systems and were not affected by the HSV LAN slowdowns.[137]

Most watchstanders were unanimous in stating their need for a white board or something similar to effectively manage the various tasks, deadlines, statuses, and the general SA. Several suggested automated status boards. All indicated frustration in trying to manage the process as it was.[138] The lack of a means to organize the tasking may lead to management chaos if and when high pressure, rapid clearance operations are undertaken.

Also, the length of time that it took to obtain the results of remote autonomous vehicle (RAV) missions and get the new data into the systems had a definite impact on the efficiency of the MIW planning operation. The most extreme example was the long duration of LMRS missions with the necessary post mission analysis (PMA), which meant that the MIWC had to wait as long as two days before receiving the results of the mission and folding them into his plans.

For effective overall integrated operations, the MIWC must be able to export the MEDAL picture to CATF, CLF, JFMCC, and SCC in order to convey the MIW status, progress and level of effort for effective collaboration. It was not apparent that the ASWC, SCC and AMWC had an appreciation for the scope of the MIW problem until sometime around 3 August. In FBE-J, the SCC had MEDAL in his space, but it was on a different LAN than the MIWC MEDAL machines so it was not able to copy the MIW COP. Due to this and periodic communications interruptions, some data had to be downloaded to disk and hand carried to the receiver site and uploaded into MEDAL. This delayed information flow, sometimes by as much as days. The PowerPoint presentations that were used to display the MIW status were time-consuming to prepare, and there was a perception that the other PWCs were pre-occupied with their own problems anyway.[139] It appears that the most effective way to transfer information between PWCs must be a continuous, automatic, process standardized across all PWCs, the JFMCC, and other commanders.

The new concept for MCM under a CVBG/ARG was not used, so potential improvements and problems associated with that process could not be evaluated.

11.3.2 HSVs as MCM Sensor Support and Management Platforms

The variety of experimental autonomous sensors available to the MIWC aboard the HSVs enhanced overall MIW capability. The size of Joint Venture permitted a comprehensive mix of MCM assets from RHIBs, AUVs, and helicopters to be hosted. The experimental set of autonomous sensors significantly increased the overall capabilities of the MIWC in a qualitative sense. The HSVs were able to support the use of embarked sensors, although there were issues of launch, recovery, and working conditions that were largely associated with the use of vessels that had been modified to accomplish the MIW mission, but had not been specifically designed for MIW/MIWC.

The concept of organic mine countermeasures (OMCM) with the addition of AUVs means that any asset can be an MCM asset, as was proven in FBE-J. The Quick Reaction Mine Warfare Action Group consisting of the HSV, SSN and DDG was very effective in clearing the initial Q-route to allow other

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137 FBE-J Mine Warfare Qualitative Survey, HSV
138 FBE-J Mine Warfare Survey – New Survey
139 Ibid

forces to flow into the theater. The use of these assets provided the MIWC the ability to get to the area quickly, to deploy a wide variety of assets and to quickly gain knowledge and localize the MIW threat. The HSV permitted the MIWC to get into and out of littoral waters quickly to deploy LMRS and UUVs. Shared MIW assets tended to focus on HSV RAV/UUV assets, however, and aspects of CV helicopters, sharing of the HSVs with other missions, and maintenance of the HSVs did not receive substantial attention in the experiment. The allocation of assets was skewed by the scenario to favor AUVs over the OMCM program of record systems because of the requirement by the MIWC to remain covert during the IPB and exploratory search phases.

The Joint Venture (HSV-X1) stern vehicle loading ramp was used to successfully load two support milvans (10x20), one support trailer (8x22), and EOD detachment equipment with a forklift and truck. No problems were encountered. Procedures developed for Joint Venture launch and recovery of BPAUV and EOD RHIB required Joint Venture to slow to approximately 3 knots for the evolutions, each of which took several minutes. Consideration should be given to design appropriate launch and recovery gear and develop procedures to conduct these evolutions at higher speeds. Trailers and equipment cradles were moved around the vehicle deck with rented forklifts during FBE-J. Due to the anticipated increase of gear in the vehicle deck during future use, it might be appropriate for "yellow gear" to be provided to Joint Venture to facilitate the movement of trailers and equipment cradles.[140]

The EOD detachment rigid hulled inflatable boat (RHIB) was successfully launched and recovered by Joint Venture several times. The single overhead crane, not optimized for at-sea launch and recovery of RHIBs, proved difficult to manage. The cargo area low vertical clearance, and the inability of the crane to swivel its load restricted its utility for larger craft. The single crane configuration of Joint Venture provided the potential for a single point failure, and a failure would have denied the MIWC the ability to launch and recover MCM assets. A better mission specific system is required for operational use to conduct launch or recovery of RHIBs or UUVs. The installed system sufficed for experimental purposes but is inadequate for fleet operations.[141]

For launching RAVs, important factors considered included the time taken to launch and retrieve, particularly in view of the concern that most respondents had regarding the vulnerability of the HSV. Because of the requirement to remain covert for most of the scenario, LMRS was the workhorse for the MIWC, with BPAUV, then RMS in that order. LMRS, because of its long legs and ability of submarine to remain covert to deploy it, it was the sensor of choice. However, when the MIWC needed information as soon as possible, they chose RMS in deep water, and BPAUV in shallower water and REMUS in VSW because of the real time data transfer.[142]

11.3.3 HSV as a Command and Control Platform

There was widespread support and praise for the HSV as a command and control platform. This was particularly true of Joint Venture, which had substantially more room for staff than Sea SLICE. People appreciated the availability of high speed to and from areas of operational interest, and in the case of Joint Venture, the substantial staff space compared to Sea SLICE.

The concept of using the HSV as a MIW C4ISR platform to support the MIWC was highly successfully demonstrated. The HSV proved to be a "good test platform and a suitable interim solution to the MIW C2 issue."[143] The Joint Venture (HSV-X1) C4ISR suite provided the MIWC with adequate space and sufficient tools to participate in the JFMCC collaborative environment and net-centric warfare.

[140] Ibid
[141] COMNAVWARDEVCOM Quicklook Report
[142] FBE-J MIW Survey
[143] JFMC MIWC Top Three Lessons Learned Report, 3 Aug02

Communication interruptions had periodic adverse impacts on the total effectiveness, but when the suite worked it was highly effective. Although there were shortcomings, they did not stem from the location of the MIWC aboard the HSV.

Initially, Joint Venture (HSV-X1) was unable to support the MIWC due to the need for completion of the equipment setup. The C4I suite had an extremely short initial installation, setup and checkout period, which adversely impacted the ship's company and staff training on the C4I suite. This led to inadequate support to MCMRON Three, especially during the first two days of the experiment. Contractor and shipboard techs troubleshot and corrected several problems with the C4I suite. Upon MIWC embarkation, Joint Venture (HSV-X1) provided excellent C4I support throughout the live portion of the MIW experiment utilizing VPN, IWS and Shareport Portal System. Connectivity and reachback ability was maintained for the majority of the experiment although with the number of applications onboard, systems such as MEDAL appeared to operate slower than desired. Bandwidth was sufficient to permit large data file transfer such as environmental data from UUVs and unmanned surface vessels (USVs), which then supported the Naval Oceanographic Office (NAVOCEANO), the reachback center, in its rapid environmental assessment and bottom mapping change detection.[144]

11.3.3.1 HSV Reachback

An integral element to battlespace preparation during the early stages of MIW planning is the ability to access historical and archived databases to augment the data that are available on scene. This reachback capability facilitates an improved understanding of the battle space and more effective and efficient employment of available forces. During MIW operations, this capability facilitates Q-route clearance by comparing the characteristics of the bottom and objects found on the bottom with known bottom characteristics and objects previously observed and contained within the NAVOCEANO survey databases. Reachback is also used to leverage technical support centers and other agencies, such as:

- Command Mine Warfare Command (CMWC) for operational planning and force support
- National Imaging and Mapping Agency (NIMA) for other hydrographic and bottom mapping data
- Defense Intelligence Agency (DIA), Office of Naval Intelligence (ONI), Naval Intelligence Support Centers (NISCs), and theater Commander in Chief's (CINC) J-2 for all source intelligence data
- Naval Surface Warfare Center (NSWC): Dahlgren Division, Coastal Systems Station (NSWCDDCSS) for operational and technical support
- Naval Explosive Ordnance Disposal (EOD) Technology Division for explosive ordnance disposal operational and technical support

NAVOCEANO was designated a reachback center[145] and the NAVOCEANO bottom mapping and change detection capability was able to ingest UUV/USV sensor data via reachback. After processing at NAVOCEANO, the data were sent back as updates to the MIWC for his use and display. The change detection is currently a manual process, which is slow and subjective. For effective reachback, this and other similar processes associated with forward support should be automated.

Due to security restrictions, JFMCC and others could link to NAVOCEANO's secret Internet protocol routing network (SIPRNET) FBE-J support web page, but NAVOCEANO had no visibility into the FBE-J/MC-02 tactical wide area network (WAN), thus it could not provide unprompted expert advice.

Survey respondent's opinions on the effectiveness of the reachback capability ranged across the spectrum from "unable" to "highly effective." Although no documentation was found to support the regular

[144] COMNAVWARDEVCOM FBE-J MIW Quicklook Report
[145] COMCARGRU THREE message dated 181700Z JUL 02 PSN 984285M36.

exploitation of this capability, it may have been used by some MIW operators to link to some of the commands listed above, most probably via the JFMCC.

Nonetheless, this is an important and extremely valuable capability in the network-centric philosophy and it appears that training may be as much an issue as the connectivity by itself.

11.3.3.2 NMWS as COA Tool

The Naval Mine Warfare Simulation (NMWS) System is a stand-alone MIW course-of-action (COA) development tool. It was used to analyze the island exploratory search plan where it assessed the initial mission as unachievable in the allotted time. The system was then used to provide input to MIW missions.[146] The NMWS was used to verify every plan prior to submitting MARSUPREQs.[147]

Despite the apparent regular uses of NMWS for the applications stated above, most survey respondents indicated that they had little or no experience with the system. One believed that the NMWS "process took too long" There was also frustration in that due to the long planning cycle and the long run time of the NMWS changes were difficult to input and assess.[148]

The simulators were apparently not able to correlate mine locations. NMWS and JFAS simulator positions differed from the actual mine lay.[149]

One suggestion was made to automate the process from ATO to execution. Upon an approved MARSUPREQ coming back to the MIWC through an approved MTO, a task window for MEDAL-MCMTASK could appear. The MIWC could then enter in the additional data required for the approved tasking for the unit selected which would include the Q-route/Area segment that is to be completed, and other basic information that the unit needs to plan the mission. For a unit that has multiple, simultaneous tasking, such as HSV with LMRS, RMS, BPAUV, REMUS and MH-60 missions, if working the same area such as a Q-route, the MARSUPPREQ could be submitted as a plan, so the different sensors could be identified. At that point, the MIWC could run the plan through NMWS to determine the best employment of the systems that he is tasking, and it can be adjusted, if necessary. An updated MARSUPREQ could be submitted as changes are made. Plans could be developed automatically for each sensor system and automatically sent to MEDAL. It was suggested that such a process would eliminate a lot of the guesswork that units have today with OPNOTE tasking.[150]

MEDAL and NMWS had the capability to easily transfer information between each other. That capability had the effect of reducing the staff's planning timeline, and had the effect of potentially increasing the effectiveness of the COA selected. However, because of the MIW staff's lack of training on HSV's systems, they struggled too much just trying to get familiar with the Joint Operations Center (JOC) for the first few days of the experiment and did not get to focus on the use of NMWS and the products it produced to help the MIW problem until the 25 or 26 July. NMWS usage increased after the MIW staff moved to FCTCPAC.[151]

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[146] Daily Experiment Report, NMWS, MIW 27JUL02
[147] Observers Report-MIWC 25JUL02
[148] FBE-J-MIW, Qualitative Survey
[149] FBE-J MIW Team Survey
[150] JFMCC Initiative, MIW-JFMCC
[151] FBE-J Qualitative Survey, MIW-MEDAL

11.3.3.3 METOC Support to MIW

The Naval Oceanographic Office (NAVOCEANO) provided Special Tactical Oceanographic Information Charts (STOICS) for MIW planning, bathymetry database to support MEDAL, and a vast amount of oceanographic and bathymetric products via their web page.

MEDAL was the primary environmental situational awareness tool for current MIW operations. The specialized nature of the mission, compounded by the fact that mine warfare demands very precise navigation, required a specialized environmental situational awareness tool. The MIWC's environmental scale was often tens to hundreds of yards.

STOICS were available electronically via the NAVOCEANO FBE- support web page; however, planners expressed a desire for large paper STOIC charts. The MIWC planners, as in other cells observed, preferred to use paper charts.

NAVOCEANO provided a detachment of two bathymetry experts to embark on the JOINT VENTURE to support the Mine Warfare Commander. The NAVOCEANO riders used gathered bathymetry data using two side-scan bathymetric sonars (Battlespace Planning and Undersea Vehicle (BPUAV) and a Klein). The data were then electronically transmitted from the JOINT VENTURE while underway to NAVOCEANO. NAVOCEANO compared the newly collected in-situ data with historical bathymetric databases. Changes in bathymetry were highlighted and transmitted electronically to the NAVOCEANO team on the JOINT VENTURE. The MIWC's staff could then view the results of the "change detection" via a standard web browser. This resulted in faster, more efficient mine searches; there is no need to check every bottom contact, only the new, unidentified ones. Apparently this data was not received by the VSSGN, however, as the comment was made that “scenario environment (i.e. depth, bathymetry, sound velocity profile (SVP), clutter, etc) to support MIW operating areas was not clearly defined which caused some inefficiencies in tasking and planning of the system.”[152]

Awareness of the importance of the environment seemed to be uniformly high among the members of the MIWC staff. User survey results showed that the primary METOC product desired for MIW support was bathymetry. All respondents indicated bathymetry, or some variation thereof (e.g. bottom type) as their number one choice.

Although bathymetry was critical to the MIW staff, MEDAL’s ability to render high-resolution bathymetry suffered in comparison to the personal computer interactive multisensor analysis trainer (PC-IMAT) or tactical control program (TCP). The displays MIW operators were using showed very linear contour lines that did not appear to capture the complexity of the littoral. A 3-D type display, capable of showing exaggerated relief, would greatly assist operators trying to visualize the near shore bathymetry on their tactical display. If MEDAL has this capability it was not in evidence.

Worse, the World Vector Shoreline (WVS) database used to delineate the boundary between land and sea does not appear to have adequate resolution for use in mine warfare. Mine survey data, when plotted on the MEDAL display, carried over onto "land" when clearly it should have been plotted in the near shore. Discussions with the staff indicated this was a frequent problem with MEDAL. A high-resolution shoreline in the area of operations, in addition to high-resolution bathymetry, needs to be added to increase fidelity and enhance situational awareness.

[152] NAVWARDEVCOM Quicklook Report

Weather did not rank high on any MIW user surveys, in most cases it was not listed at all. This seems odd since sea state is known to reduce operator effectiveness, and the relatively small mine counter measures vessels are more prone to the effects of higher sea states.[153]

11.3.4` MIW Integration with the NFN (X)

Is the MIWC able to operate in a net-centric environment and utilize the ISR and Fires capabilities of the Navy Fires Network (NFN)? Is NFN, in turn, able to incorporate MIW sensor information and conduct Fires with MIW specific precision-guided munitions (PGMs)?

MIW was not accustomed to accounting for BDA of PGMs in their planning. The degree to which MIWC coordinated the use of ISR assets for MIW BDA is undetermined. The use of PGMs allows MIWC to substitute traditional MIW techniques (Helos, MHCs, MCMs) with stand off weapons. This permits MIW operations to be conducted at distance, both extending the range of MIW operations and reducing the need for traditional assets to entire hostile space.

In addition to substituting for the traditional mission, PGMs provide MIW with the ability to develop new techniques and capabilities. One such example is the ability to rapidly and efficiently breakthrough mined areas just ahead of amphibious or naval forces. This would allow for greater flexibility and increased operational tempo in amphibious and littoral operations.

11.3.4.1 Mine Warfare Target Engagements

An objective of this initiative was to determine if the MIWC was able to operate in a net-centric environment and utilize the ISR and Fires capabilities of the Navy Fires Network (NFN). Also, whether or not NFN (X) was able to incorporate MIW sensor information and conduct Fires with MIW-specific PGMs.

11.3.4.1.1 Mine Target Nominations

Mine contacts were nominated to LAWS through MEDAL and appear in the LAWS MCMREP Manager with target numbers of the form MMxxxx. The originator and equipment attributed to each of the 114 mine contacts as reported in the LAWS MCMREP Manager are listed in Table 11-1, below.

Those mine contacts appearing in the MCMREP manager that are intended to be engaged, are promoted into the LAWS Fires manager and are shown in column 2 of Table 11-2 below. The total promoted was 64, or 56 percent of the contacts in the MCMREP manager.

[153] METOC Observer's Report, FBE-J

Originator	Equipment	Number of Contacts
Agile	REMUS	60
FCTCPAC	-	25
FBE-J	WLD1-EOID	11
FCTCPAC	AGG BLQ-1 LMRS	7
RMS	RMS	2
MH60S221	AQS20	2
DKD	LMRS-SSN	1
DKD	-	1
CSSDET	LMRS –SSN	1
MEDAL	RMS	1
LMRSTEST	UUV	1
REMUS	REMUS	1
FTZ	RMS	1

Table 11-1. Source of LAWS MCMREP Mine Contacts

Date	# Of mine nominations in LAWS Fires	# Of mine nominations weapon-target paired	# Of mine nominations engaged	#Of mine BDA missions in LAWS Fires
7/28	0	0	0	0
7/29	26	26	4	0
7/30	1	1	0	0
7/31	4	3	1	0
8/1	0	0	0	0
8/2	4	4	3	1
8/3	7	6	5	2
8/4	16	15	15	1
8/5	5	2	2	0
8/6	1	2	2	0
Totals	64	59	32	4

Table 11-2. Mine Nominations and Engagement Counts

11.3.4.1.2 Weapon-Target Pairing

In FBE-J, there were two weapons available for the prosecution of mine targets, Forward Air Support Munition (FASM) and Hydra 7 rockets. The FASMs were launched from the DDGs or the DD-X. The FASM methodology required the FASM to be launched to a loiter point and subsequently retargeted to a mine target.

The mine engagement procedures evolved over the course of the experiment. The different methodologies are described below:

For July 29 to 31, the mine nominations were weapon-target paired in the Fires Manager and the engagement, by FASM or Hydra-7, occurred within the mine target nomination. This followed the normal

LAWS engagement procedures for weapon-target pairing and engagement. There were no Hydra 7 engagements subsequent to July 30.

Starting on August 2, the mine targets were no longer engaged in the mine nomination. Instead, the HSV LAWS created a FASM mission entry in the Fires manager. After the FASM was launched to a loiter point, it was retargeted, by the MIWC, to one of the mine target nominations present in the Fires manager. In the LAWS Fires manager targeting page remarks and/or target description, the target number of the mine to which the FASM was retargeted was specified.

Starting on August 4, all FASM missions inserted into the Fires manager were created by the HSV global intelligence, surveillance, and reconnaissance capability (GISRC). With one exception, none of these missions specified to which mine target the FASM was retargeted.

Column 3 of Table 11-2 reports the number of mine targets that were weapon-target paired in the LAWS Fires manager. The weapon-target pairing entries for July 31 and earlier refer to a weapon-target pairing reported in the mine nomination. From August 2 to August 4, an entry in the weapon-target pairing column means that a FASM mission was linked, in the LAWS targeting page remarks and/or the target description, to a specific mine nomination. From August 4 to August 6, the HSV GISRC FASM missions did not indicate the mine nomination to which they were paired. It is assumed they were paired to mine targets.

11.3.4.1.3 Target Engagement

Column 4 of Table 11-2 reports the number of mine targets that were engaged. Engaged is defined as a green “fired” (FRD) block in the LAWS Fires manager. Prior to August 1 this refers to the status of the FRD block for the mine nomination, subsequent to that date is refers to the FRD block of the FASM mission. Of those 64 mine nominations pushed into the Fires manager, 32 were actually engaged. Almost all the unengaged mine targets were those pushed into the Fires manager on July 29.

11.3.4.1.4 Battle Damage Assessment

The last column of Table 2 lists the number of mine BDA missions that appears in the LAWS Fires manager. There are only four, all loitering attack munition (LAM) missions launched from the Sea SLICE.

All BDA for mine targets was notional and generally BDA results were not reported in LAWS for the FASM missions or for the mine targets. There was an interval, covering part of 2 to 3 August, where four FASM missions and seven mine targets exhibited green BDA blocks in LAWS. All reported the target neutralized with an identical, unattributed message.

11.3.4.1.5 MCM Engagement Timelines

Almost all the mine target engagements occur subsequent to 1 August. Therefore, the reconstruction of the engagement timelines is limited to the period 2 through 6 August. There are two different types of timelines; those associated with the mine nominations and those associated with the FASM missions. Table 11-3 presents the statistics for the timeline actions for each of these two types of timelines. All time intervals are measured from the time the mission or nomination was received in LAWS. The values of the mean values are determined primarily by values of extreme outliers. Therefore, the medians provide more representative time values.

	FASM Mission			Mine Nomination		
Interval	Median	Mean	Sample	Median	Mean	Sample
Received to W-T pair	0	52.4	26	12	175.3	20
Received to MWC Approved	0	3.6	27	5	98.9	22
Received to Fire when ready	7.5	292.4	26	13.5	180.6	22
Received to Fire	5.5	132.2	18	13.5	192.7	20
Received to BDA	157	213	4	103	351.9	7

Note: All times are in minutes

Table 11-3. Mine Engagement Timelines

It is unclear what these reported actions indicate and how the time of these actions for a FASM mission relate to the time of these actions for their associated mine targets. For both the FASM missions and the mine targets all the events (except BDA) are usually reported. But comparisons of these event times for FASM missions and the paired mine targets show no correspondence.

11.3.4.2 Mine Warfare Engagement Summary

A consistent, rational procedure for the engagement of mine targets in LAWS was not developed in FBE-J. The procedures employed toward the end of the experiment exhibited the following problems:

- With the HSV GISRC as the nominator of the FASM missions there was no indication of what mine target the FASM was paired with. For effective engagement, it is necessary that this be reported.
- When FASMs were linked to specific mine targets there was frequently confusion. For example, FASM mission MM0112 reported in LAWS that it was directed to mine target MM0099. But remarks contained in mine target nomination MM0099 said that FASM mission MM0116 was paired to this mine target. A total of five missions in the 2-6 Aug interval show discrepancies of this nature.
- The engagement event times reported for the paired FASM missions and mine targets show no comprehensible relationship.
- The engagement problems were exacerbated and, to a degree, caused by problems with the FASM methodology and simulation.
- The FASM had to be initially directed at a loiter point and then retargeted to a mine target. The FASM should have the option of being initially targeted to a mine target.
- In JSAF, the FASMs were frequently observed to loiter endlessly without moving to attack the target to which they were retargeted.
- It was reported informally by participants that the FASMs often impacted at locations other than the aim point.
- Prior to August 2, a software problem was associated with the loading of mine information into the simulation. This resulted in a field of mines being seen as only a single mine. The individual mines in the field could not be detected. This problem contributed to the difficulty in detecting mines in the days preceding the correction.

The concept of feeding mine contacts into LAWS and engaging them through that system appears workable, but if mine targets are to be engaged with LAWS, the procedures need to be simplified and codified. It is recommended that mine nominations be treated like other target nominations within LAWS, in a manner similar to what seemed to be attempted for mine targets early in this experiment. That is, the mine nomination is weapon target paired and the engagement is conducted within the mine nomination entry in the LAWS Fires manager. This procedure should avoid the confusion and complexity introduced by having separate entries for the target and the weapon that is to engage it.

11.3.5 Common Undersea Picture (CUP)

The data generated by the MIW sensors and provided to the MIWC must be made available to the larger common operational picture (COP), and to that activity specifically below the surface, the common undersea picture (CUP). Proper COP/CUP management is necessary in order to facilitate distributed, collaborative planning and to enhance shared situational awareness (SA).

In FBE-J, parts of the undersea picture were resident in several different systems, but because the systems were not integrated, the picture was neither complete nor coherent. The commonality was that many, but not all, of the participants had many of the systems available. Due to the length of RAV missions, the locations of mine contacts were entered in non-real time into GCCS-M. Status on some contacts was entered in LAWS. Operational level chat between the SCC and JFMCC was conducted using IWS chat rooms. Much of the management detail was maintained on paper plots. The MIW environment, search planning, and search plan status were modeled and maintained in a variety of computer tools. Some chat was conducted on IWS, but it was not a comprehensive discussion link. The MIW undersea picture was best represented by the data on MEDAL, which was available on Joint Venture, Sea SLICE, FCTCPAC, VSSGN, and FITZGERALD. Bathymetry and other environmental data were provided by the BPAUV, REMUS, and OWL III, RAV systems and were transferred successfully to the CUP, although the data were frequently time-late.

Although there were no inherent organizational impediments to doing it, MIWC and ASWC were not able to collaborate effectively on the CUP because the MEDAL in the SCC Cell was on a separate LAN from the MIWC MEDAL. This deficiency was not discovered 01Aug02.[154]

A concern was the lack of a clear picture provided by chat rooms. While substantial data are available from multiple sources, there was no clear sense of the overall picture of what was going on with mines. The SCC Watch Officer needs a clear battlespace picture available to him at his console [155]. He should not have to query several other operators to help provide situational awareness with this technology. While it is good to have multiple avenues of communication (CISCO IP phone, Chat room, WeCAN, LAWS) available to SCC, in the current state it is confusing to C2 functions.[156] Primary and secondary lines of communication for battlespace awareness need to be delineated.

The SCC large display, a DBC system did not match the MIWC large display. For example, the Q-routes were displayed on the MIWC but not on the SCC large display. Knowing that mines are in an area is vital to the plans and operations of JFMCC and other PWCs. [157]

11.3.6 Operation of Remote Autonomous Sensors

A variety of experimental autonomous sensors were available to the MIWC and in general, were used with effectiveness, particularly in view of the covertness of some of the missions. The experimental set of autonomous sensors significantly increased, qualitatively, the overall ability of the MIWC. The HSVs were able to support effectively the use of embarked sensors with various issues of launch, recovery, and working conditions as discussed in chapter 7 and section 11.3.2, above. The specific achievement of the RAVs included:

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[154] FBEJ JFMCC Midway Assessment
[155] SCC Observation Notes 27 Jul 02
[156] SCC Observation Notes 26 Jul 02
[157] SCC-TSC X-CUP Observer Post-ex ASW Questionnaire

- BPAUV conducted exploratory operations detecting mine-like objects (MLOs) and inserting contact reference numbers (CRNs) and environmental data into MEDAL. BPAUV also demonstrated the capability to successfully accomplish an extended duration (17hrs) mission and rapid turn around (less than thirty minutes).
- REMUS conducted multi-vehicle operations that demonstrated the ability to search and detect MLOs, process contact data, and send prioritized contact data to the HSV over an acoustic modem and radio frequency (RF) link. The second vehicle demonstrated the capability to receive a tasking from the HSV over an acoustic modem and RF link, reacquire the assigned target, and identify it using a DIDSON HF imaging sonar. REMUS also demonstrated the capability to conduct an OTH mission using an onboard global positioning system (GPS).
- OWL III displayed the ability to conduct several missions simultaneously, and the transmission of live video, including an infrared (IR)) feed and the transmission of real time sonar data to the MIWC from an autonomous USV.
- VSSGN LMRS was used to provide initial planning of the battlespace (IPB) at the start of the experiment for Q-route clearance and potential assault sites for JFMCC/JFLCC commanders. Additionally, as the scenario progressed and a requirement for covertness continued, LMRS was used in a more tactical manner to provide the MIWC with a better MIW picture. However, the long duration of LMRS missions with the necessary post mission analysis (PMA) meant that the MIWC had to wait as long as two days before receiving the initial results of the mission. [158] After the initial sortie, PMAs were sent out every 6 to 8 hours.
- In response to a request by the MIWC, the VSSGN was able to re-plan the LMRS in simulation during a sortie via an RF window of opportunity to support a higher priority OPAREA.
- Synthetic Aperture Sonar (SAS) target images were transmitted to the MIWC. In some very unique cases (non-cylindrical shapes), the MIWC was able to make mine identification calls on those target images.

The inordinate delays at times in the ability to use RAV data had an adverse impact on decision-making. The delay in integration of RAV data into the CUP and the wide distribution of the CUP, led to inefficiencies and impacts throughout the MIW and JFMCC processes. These included the planning of reconnaissance and MCM missions and the planning the missions of other PWCs. More contemporaneous receipt of data from RAVs would pay dividends across the spectrum of operational planning and decision-making in addition to reducing risks.

The use and demonstration of the experimental autonomous sensor systems (BPAUV, REMUS, CETUS, RMS, LMRS) and helicopters constituted the majority of the MIW operations during the experiment. The MIWC had over 100 sensors and platforms at his disposal, not including airborne ISR assets. Management of these assets represents one of the greater MIW issues surfaced during the experiment. The ability to plan, task and maintain SA for such a large number of assets with minimal staff was a challenging task for the MIWC, and some shortfalls were observed in the ability of the MIWC MEDAL operator to plan multiple missions for a variety of assets.[159] This has implications if and when high-pressure operations are undertaken where multiple missions would be the norm.

Theater waterspace management (WSM) and the prevention of mutual interference for the SSGN, SSNs and UUVs did not seem to be addressed thoroughly and could be problematic if multiple submarines and multiple UUVs are operating in theater. The planned approach was that LMRS would exist in the VSSGN's waterspace, but for most of its operational time, LMRS operated in waterspace other than VSSGN waterspace. Having the same approved waterspace for both submarines and offboard UUVs could put a considerable burden on a submarine's crew.

[158] COMNAVWARDEVCOM FBE-J MIW Quicklook Report
[159] Ibid

Despite the fact that the MIWC had over 100 sensors and platforms at his disposal, not including airborne ISR assets, nearly half the MIW participants and watchstanders under-estimated the assets available to the MIWC by over two thirds. Similar estimates of tasking of those assets ranged from less than 25% on a typical day to over 75%. Most felt that the number of assets was manageable, however. Automated tools to transition data between C2 and MIW systems was believed to be key to improving the efficiency and effectiveness of management of the assets.

The size of an RAV is far smaller than that of a crewed asset, so the MIWC had far more assets available to apply toward accomplishing his mission, and was required to do so in less than the traditional time. This situation highlights the complications of requiring effective management in launching, tasking, tracking, recovering, and maintaining all those assets. Thus in some ways future MIW operations may be likened to today's flight operations, and MIW may potentially be able to adapt similar asset and sensor management practices.

All autonomous systems performed their planned missions, although engine failures suffered by OWL III adversely impacted its operational availability. All RAVs experienced problems when they encountered kelp beds, which ultimately proved to be inoperable areas. Sensor information data along with real time video (OWL) and side scan (REMUS), were passed to the C4I suite. After post mission analysis (PMA), contacts were passed to MEDAL for prosecution.

11.4 MIW Key Observations Summary

The key observations made concerning mine warfare include the following:

- The concept of feeding mine contacts into LAWS and engaging them through that system appears workable. Procedures need to be simplified and codified. Mine nominations should be treated like other target nominations within LAWS, i.e., mine nomination weapon-target paired and the engagement conducted within the mine nomination entry in the LAWS Fires manager. The engagement problems were exacerbated and, to a degree caused, by problems with the FASM methodology and simulation. Thus, definitive results on this application are not yet available. This will require that a methodology be developed that handles mines the same as other targets within LAWS and that the concept tested with a combination of live mines and other targets.

- The HSV appears to be an excellent platform for supporting the MIWC and MCM. Advantages include:
    - High speed to area of operations and while conducting various MIW missions
    - Shallow draft will allow operations in relatively shallow water
    - Large cargo volume can provide ample workspace and support areas for supporting future RAVs and their operational mission and maintenance crews.

  Disadvantages and risks include:
    - Potential vulnerability of the HSV to hostile fire due to its aluminum composition and small crew
    - Loss of one HSV with large number of RAVs (est. 25 to 30) could risk the entire MIW mission success and/or timeline if additional resources are not readily available
    - Under the concept of rapid reconfiguration for HSVs, MIW may be competing with other missions for the use of the HSV.

  Studies will need to be undertaken to mature the CONOPS for HSV support of MIW, including
    - Determination of the appropriate number and overall distribution of MIW assets on HSVs
    - Assess the requirement for redundant back-up operational databases and MIWC SA in case of loss

- Assess the likelihood that competition for HSV resources will impact on MIW mission success.

- JFMCC management of MIW is a challenge that presently strains players on all sides. There are several reasons for this:
  - MIW missions are longer than typical JFMCC missions and may not be suitably managed within the overall JFMCC process at present. This is a resource allocation issue, as the JFMCC staff may reallocate HSVs and other resources after the expiration of the 24-hour MTO/ATO, but MIW missions initiated during the valid period may still be on-going, due to the length of some MIW missions.
  - The ATO tasking vehicles are not optimal for MIW missions
  - Direct tasking of platforms in MIW is preferable to the indirect tasking associated with MSRs
  - Present reduction of data and the development of tasking is unnecessarily manpower intensive.

  Additional analyses should be able to
  - Develop a more workable interaction dynamic between JFMCC and MIW
  - Evaluate the impact of lengthy MIW missions on shared resources
  - Evaluate the potential for manpower reductions achievable with automation of data reduction and tasking in MIW.

- Remote Autonomous Vehicles (RAVs) offer tremendous potential for rapid, effective, and covert MIW operations to ensure assured access to hostile territory. Future HSVs could host 25 to 30 of these RAVs per HSV. The management of a multiplicity of these systems, possibly among several HSVs will be far more complex than anything experienced to date in MIW or demonstrated in FBE-J. There was no stressing of the RAV systems in FBE-J, so no assessment can be made of problems or issues that will arise when one HSV attempts to manage, control, and exploit a number of these systems.

  Potential issues include:
  - Data should be retrievable in or near real-time so as not to delay follow-on planning actions
  - More complicated management and control can be expected
  - The present inability to operate in kelp requires additional engineering to RAVs to reduce potential risks and mission impairment
  - Launching and retrieval of RAVs should be accomplished at reasonably high speeds.

  For optimal application, however the following assessments, at a minimum would be needed:
  - Assess methods to optimize the receipt and management of data
  - Develop reliable ways to control and minimize potential interference of multiple systems operating concurrently
  - Re-engineer systems to reduce or eliminate their present vulnerability to kelp
  - Investigate alternative approaches to launching and retrieving RAVs at high speed.

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12.0 Anti-Submarine Warfare (ASW) Initiative Key Observations

12.1 Experiment Objectives

Because the naval contribution to Rapid Decisive Operations requires Assured Access, ASW forces were required to establish zones of operations free of enemy submarines. To do this effectively, the forces were forced to employ Network-centric ASW Operations. This is the concept of multi-level commands and multi-disciplinary forces, well connected by common communications, doctrine, planning tools, and commander's guidance. In order to improve detection, classification, localization, and neutralization of enemy submarines, commands had to possess the ability to:

- Share information quickly and accurately.
- Correlate their situational awareness in conjunction with the larger operational and tactical pictures.
- Conduct distributed, collaborative planning and self-synchronize their actions with other joint or coalition ASW forces.

There were five ASW sub-initiatives in FBE Juliet:

- Submarine Locating Devices.
- Remote Autonomous Sensors.
- Experimental Common Undersea Picture.
- Theater ASWC.
- Using the Experimental Naval Fires Network for ASW Targets.

12.2 Analytic Questions

Overarching Question

- How can Network-centric ASW Operations improve detection, classification, localization, and neutralization of enemy submarines to assure maritime access?

12.3 ASW Sub-Initiatives

12.3.1 Submarine Locating Devices

This ASW sub-initiative investigated the spectrum of activities associated with using Submarine Locating Devices (SLDs). Many of the results are classified and not comprehensively discussed in this report, however the basic issues are were as follows:

- Investigate decision process for employment of SLDs.
- Investigate C2 for installation of SLDs.
- Explore current and future capabilities of SLDs.
- Investigate ROE implications for installation of SLDs.
- Investigate use of SLD data for decision-making.
- Investigate use of SLD data for its impact on times to localize and engage submarines.

12.3.2 Use of Remote Autonomous Sensors (Distributed Mobile Sensor Field)

This ASW sub-initiative investigated the ability of remote, autonomous systems to independently identify submarine contacts and report them in real time or near real time. This could provide the commander the ability to cover large areas without the expenditure of manned assets, to avoid threat contacts if necessary, and to be able to attack threat submarines efficiently with the use of air assets.

12.3.3 Common Undersea Picture

This ASW sub-initiative was intended to provide the basic tools for Network-centric ASW. It had three major functions that provided the backbone for this operational concept, force collaborative planning, shared situational awareness, and common dynamic tactical decision aids. The basic questions addressed were as follows:

- Investigate the use of X-CUP tools for situational awareness.
- Define the requirements for C2/COMM architecture and bandwidth to enable X-CUP.
- Determine which ASW nodes are required to be included in the X-CUP.

12.3.4 Theater ASWC

- Define the requirements for Theater Level ASW Command and Control.
- Determine the requirements for reach-back from local forces to TASWC.
- Determine the manning requirements to support expanding the role of TASWC.
- Investigate the ability of the TASWC to optimize the use of theater-wide ASW assets using X-CUP tools designed for the tactical level.
- Evaluate the doctrinal implications of relationships between the TASWC and the SCC and JFMCC.

12.3.5 USW Targets in NFN (X)

This ASW sub-initiative was designed to determine if incorporating ASW targets into the experimental Navy Fires Network in conjunction with LAWS could improve the ability to successfully attack them as Time Critical Targets. Associated issues are as follows:

- Determine the technical requirements to construct a USW Time Critical Strike architecture.
- Investigate the operational issues of USW target integration into NFN (X) and engagement of USW targets as Time Critical Targets.
- Investigate the times to process USW TCTs in NFN (X).

12.3.6 System Architecture

Figure 12-1 shows the ASW chain of command for the experiment. The arrow from the TASWC to the Sea Combat Commander (SCC) reflects the role of the TASWC, shore-based in Hawaii, providing support to the local SCC. This sub-initiative had originally been conceived to include a much greater command role by the TASWC, but was revised due to constraints on experimental participants because of real-world tasking.

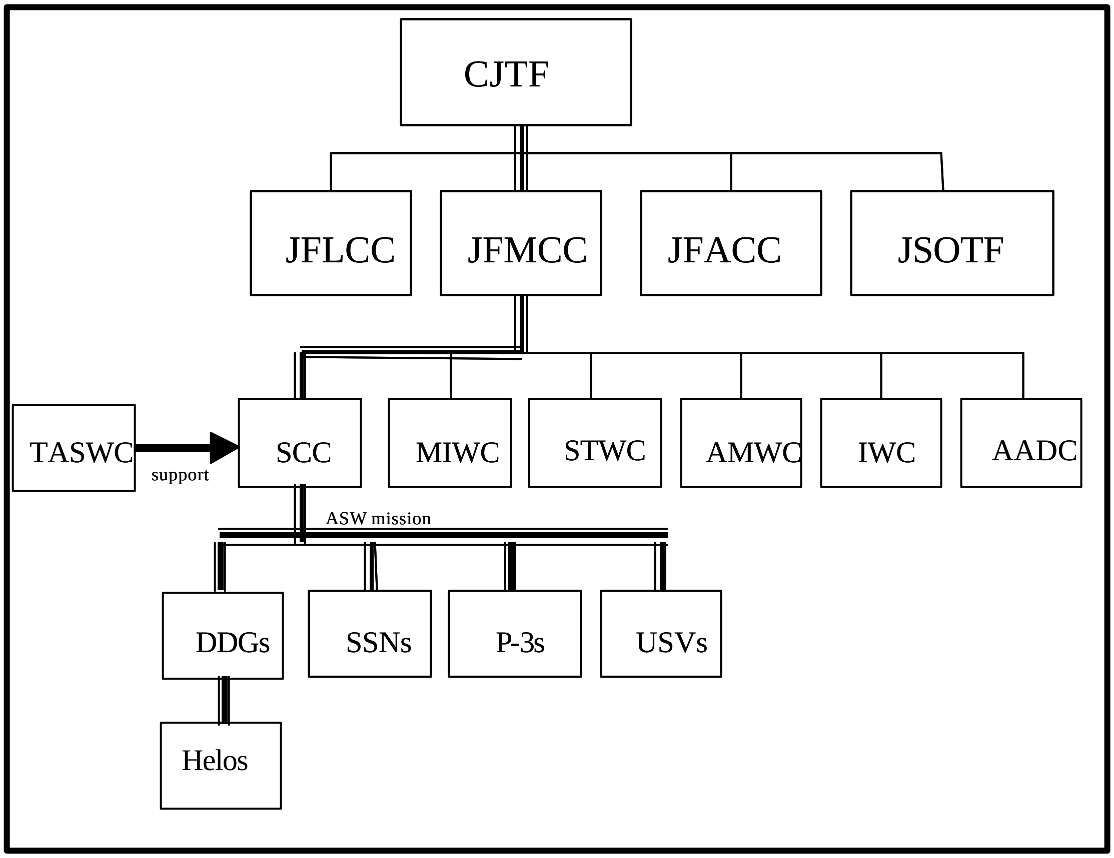

Figure 12-1. ASW Chain of Command

Figure 12-2 shows the primary ASW communications channels between actual ASW platforms in the FBE and the distribution of X-CUP tools.

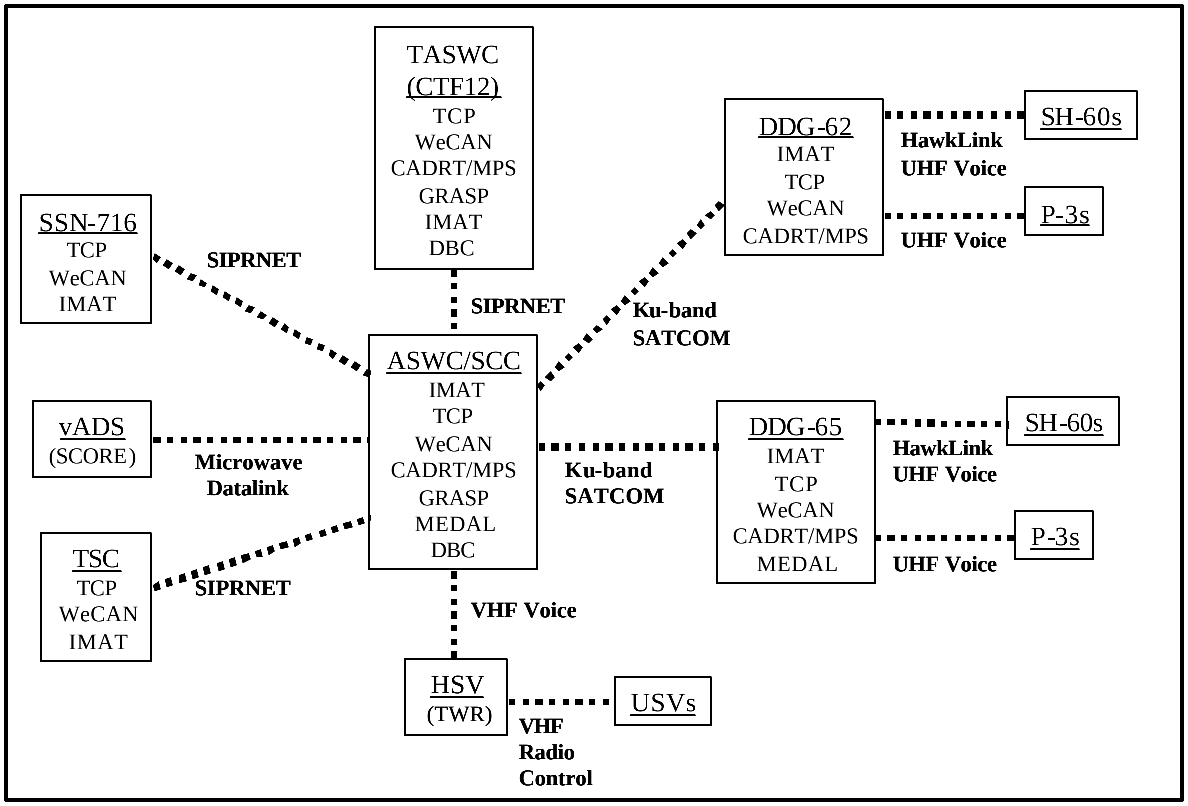

Figure 12-2. Primary ASW Communications and X-CUP Tools Suite

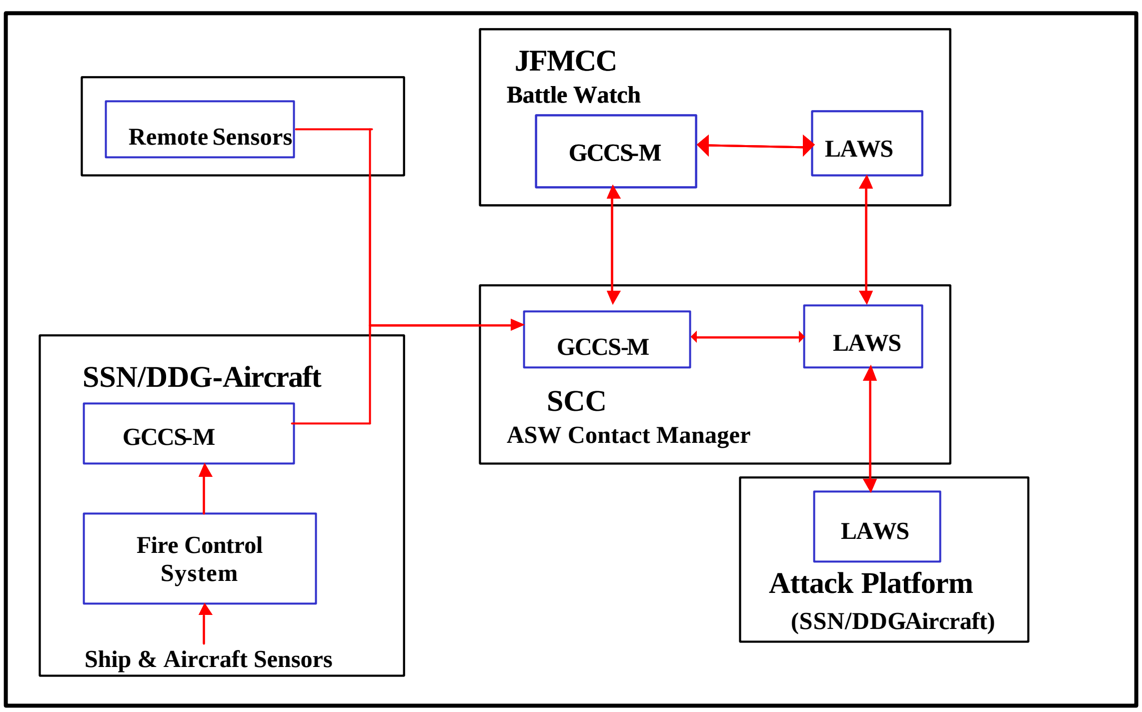

Figure 12-3. USW Targets in NFN (X)

Figure 12-3 shows the architecture for Undersea Warfare targets in the Naval Fires Network (Experimental) from sensor to shooter.

12.3.7 Submarine Locating Devices

This ASW sub-initiative investigated the operational concept of installing submarine locating devices. This included issues of when, where, and how to achieve covert installation, and what type of capabilities the locating devices should have. The problem of permissive ROE was also considered. As directed by the operational commander, locating devices were covertly placed and their signals were utilized in the ASW.

12.3.8 The Decision Process for Employment

The decision process for employment of submarine locating devices took place outside the FBE. The CONOPS for SLDs contained in the FBE-J Experimentation Plan pertains. No further observations were made during the FBE execution. Experience in the FBE prompted the suggestions from the SCC that the ASW Commander should be involved in decisions concerning the installation and monitoring of SLDs.[160]

The use of SLDs should be part of the operational/theater level plan and integrated at the CJTF/CINC level. [161]

12.3.9 Operational Value of Employment / Command and Control

Command and control for the installation of Submarine Locating Devices is a classified activity outside the scope of this report.

12.4 Current and Future Capabilities of SLDs

One particular technology for submarine locating devices was demonstrated in three live events in FBE-J, and simulated for other events. Both live and simulated SLD events were based on a technology that generated submarine locating signals at predetermined time intervals.

Two of the three live events functioned as designed and generated accurate and timely position reports (for example, one report took 2 minutes and 10 seconds from transmission until receipt by the SCC, with a measured accuracy of 267 yards between the instrumented SCORE range position and the SLD reported position[162]). One of the three live events had a technical failure.

Experience in the FBE prompted the following suggestions from FBE participants and observers:

- It would be very useful to be able to command prompt SLD reports rather than only have reports at predetermined intervals.
- In some circumstances, the ASW Commander may prefer to have SLDs report less frequently to conserve a limited number of devices.
- In other circumstances, the ASW Commander may prefer to have SLDs report at greater frequency in order to have less time-late for a subsequent prosecution, or timely information that a particular area is free of enemy submarines (e.g., the Deputy SCC suggested that data should be two hours old or less for pre-hostility transit of a maritime chokepoint; if no transit is in progress, then longer gaps between SLD reports can be adequate).

[160] SCC Plans Post-ex ASW Questionnaire
[161] ASW Lead Final Report
[162] SCC Observation Notes 1 Aug 02

12.4.1 ROE Implications for Installation of SLDs

The issues surrounding rules of engagement as they pertain to SLD installation were addressed outside the FBE execution. During the pre-FBE Spiral 3 in June, the JFCOM JAG briefed that pre-hostility cross-border operations would require Presidential approval. Permission was assumed to have been obtained. When the FBE commenced on 24 July, it was reported that SLDs had been installed[163]. No further observations were made during the FBE execution.

12.4.2 Use of SLD Data

SLD reports of enemy submarine positions during the FBE were highly regarded as valuable sources of information on enemy submarine activity. When received, position reports were entered manually in electronic logs, in various chat rooms, and in GCCS-M.[164]

Somewhat surprisingly however, but for various reasons that are explainable under the specific circumstance in the FBE, most SLD reports did not result in command actions, other than recording the positions reported (i.e., no ASW forces assigned to prosecute SLD reported positions, no modifications to previously assigned ASW search missions, etc.). Although this was generally the case, it is likely exercise artificiality and not a predictor of what might occur in the real world. Two general situations existed that affected the use of SLD data, pre-hostilities and hostilities.

Pre-hostilities

During the pre-hostilities phase of the FBE, the SCC staff did consider alternative actions that might be taken based on received SLD reports, but decided not to take any action. They considered periodic reports from the SLD as sufficient information on those enemy submarine locations, and chose to assign their Blue ASW assets to search for unlocated or unreported enemy submarines.[165]

The experience in the FBE also prompted the following thoughts about possible use of SLDs in pre-hostilities:[166]

- If a Blue force asset is assigned to respond to every SLD signal, there is a concern that this may compromise the intelligence.
- Over time, it may be possible to use SLD reports in conjunction with other ASW contact information to give a better situational awareness picture. For example, is the enemy submarine driving a particular box, or patrol route?

During Hostilities

There were two basic SLD situations during the FBE, simulation SLD reports from simulation submarines and SLD reports of actual submarines during live ASW events. After hostilities commenced, the simulation killed the simulation enemy submarines that had simulation SLDs without interaction with the actual experiment participants. This was an exercise artificiality that was somewhat obscured by all the other simulation engagements that were occurring in the opening of hostilities. Accordingly, there were no actions to be ordered by the SCC in these cases.

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[163] JFCOM In-brief 24 Jul 02
[164] SCC post-ex ASW Questionnaires, and observations and discussions with SCC staff throughout FBE-J execution
[165] SCC Observation Notes 25 Jul 02
[166] SCC Observation Notes 28 Jul 02

For live events, ASW forces were already assigned and appropriately committed at the time of each SLD report. Accordingly, orders from the SCC to significantly redirect effort generally were not required.

In one instance, a surface unit was conducting an area search plan within the designated live play area. When the SLD report was received, considering the time and distance between the surface unit and the reported submarine position, it was determined that the original search plan already covered the uncertainty area surrounding the SLD datum. Therefore, no change was made to the search plan in progress.[167]

In another instance, an SLD report did prompt the SCC to pass the position information to the surface unit that was already assigned to the area for prosecution. This particular report resulted in both the SCC watch and the surface unit to enter datum information into GCCS-M resulting in dual tracks. This experience prompted the observation that specific procedures need to be developed for SLD reporting responsibilities and methods.[168]

During one live ASW event with an actual prototype SLD, an SLD report arrived while the assigned surface unit was prosecuting an actual sonar contact at a position different from the SLD reported position. This prompted the surface unit to reclassify their sonar contact as non-sub and pursue the real submarine. It was noted that although this was coincidental in this case, it was an actual result and that sort of response could happen in a real world event.[169]

Experience in the FBE prompted the following additional idea from FBE participants to suggest that a P-3C is the preferred asset to have in the air on-station in anticipation of SLD release due to its long range and long on-station capability. It is not advisable to have a helo launched in anticipation of SLD reports due to the short on-station time of a helo.[170]

12.5 Use of Remote Autonomous Sensors (Distributed Mobile Sensor Field)

The ADS distributed sensor field, simulated by actual use of the southern California instrumented undersea acoustic range (SCORE Range) did provide contact reports on live submarines on the range. The experimental unmanned surface vessels (USVs) did not provide reports due to technical problems.

Although the technologies considered in the FBE could potentially evolve into autonomous capabilities in the future, autonomy was not actually explored in the FBE.

12.5.1 Decision Process for Employment of Remote Autonomous Sensors in Theater

The decision process for employment of remote autonomous sensors in theater took place outside of the FBE. The CONOPS for Remote Autonomous Sensors contained in the FBE-J Experimentation Plan pertains. No further observations were made during the FBE execution.

Experience in the FBE prompted the SCC staff to suggest that procedures should exist for the ASW Commander to request ADS field deployment via the JFMCC.[171] Procedures and doctrine must have due regard to lead-time requirements.

[167] SCC Observation Notes 28 Jul 02
[168] SCC Observation Notes 30 Jul 02
[169] ASW Lead Daily Report 1 Aug 02
[170] SCC Observation Notes 28 Jul 02
[171] SCC Ops Post-ex ASW Questionnaire

12.5.2 C2 for Use of Remote Autonomous Sensors

Virtually all of the command and control procedures and processes associated with the Remote Autonomous Sensor initiative were devoted to simulating ADS unmanned sensor fields and simulating autonomous unmanned surface vessels with surrogate systems.

Experience in the FBE prompted the SCC staff to suggest that when assigned, the SCC would pass TACON of the USVs to a surface ship for control like Maritime Patrol Aircraft or ASW helicopters.[172]

12.5.3 Utility and Potential for Importing Data From Unmanned Sensor Fields into the Naval Fires Network Experimental (NFN (X))

Contact reports from the ADS (SCORE range) were passed to the SCC watch for entry into GCCS-M, which passed the contact reports to LAWS. No data were generated by the USVs.
Observations concerning this analytical objective are discussed under the USW Targets in NFN -X sub-initiative observations.

12.5.4 Use of Distributed Sensor Field and Unmanned Surface Vessels (USVs) with Remote Autonomous Sensors

Not observed due to technical difficulties with the USVs.

12.5.5 Relationship of Remote Autonomous Sensors Capability for ASW with the Maritime Planning Process

The SCC Plans Officer reported that the existence of the ADS (SCORE range) field and, potentially, unmanned surface vessels were taken into consideration when planning asset allocation.[173] No further observations were made.

12.5.6 Usefulness of Remote Autonomous Sensors

The operational usefulness of an ADS field to provide cueing information was reaffirmed during the FBE. ADS employment was consistent with its genesis as an evolutionary capability from the Integrated Undersea Surveillance System that started with SOSUS. There were no other significant observations about ADS technology.

There was no operational use of information from the USV systems because of technical difficulties. However, some observations were made about the operational suitability of the technologies envisioned. There were two significant limitations, sea state limits on the USV platforms and technical difficulties associated with attempts to employ lightweight sensor packages.

Sea-state Limitation

Sea state limitation on USVs was vividly demonstrated when USV live events were cancelled due to sea swell exceeding 3 feet.[174] Specifically, it was demonstrated that the Roboski-sized USV could not effectively be used in sea states greater than 3. The Spartan-sized USV was successfully operated up

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[172] SCC Ops Post-ex ASW Questionnaire
[173] SCC Plans Post-ex ASW Questionnaire
[174] SCC-ASW Daily Data 26 Jul 02

to sea state 4.[175] The METOC observer in the SCC module commented that USVs must be capable of operations in sea states higher than sea state three. [176].

Backup events using ASW aircraft were conducted. If USVs were needed because of surface-to-air missile threat to aircraft, however, the mission could not have been conducted.

Lightweight Sensor Package Limitations

The FBE also highlighted technical difficulties relating to the modification of the DICASS buoy sensor packages onto the USVs. USV DICASS sensors were either inoperative or could not replicate the acoustic performance of an unmodified DICASS buoy. These comparisons were made on a daily basis with aircraft-dropped sonobuoys. The difficulties encountered related to the engineering of the DICASS transducer, with its power source located aboard the USV. While an unmodified DICASS transducer is a one-piece assembly with a lithium battery in close proximity to the transducer, the USV power source involved a 200 foot or 400 foot cable between the battery and transducer. As such, inadequate power and acoustic output resulted due to impedance issues. Thus, should the DICASS package be used in future FBEs, a re-engineering of the power source to transducer assembly will be required, and this modification tested against the performance of an unmodified DICASS buoy. [177]

The transducers also experienced damage during transit and towing. Several transducers experienced damage due to high tow speeds, up to 30 knots, which they were not designed to withstand. With existing lightweight sensor technology, USV transit and towing speeds must be lowered to limit DICASS transducer damage.[178] Operationally however, high-speed capability is needed for the missions envisioned for USVs. The possibility exists that an alternate sensor package needs to be considered.

During the experiment it was necessary to physically modify the cable lengths for the USV sensors because of acoustic propagation conditions. There is clearly a need for selective transducer depth for USV sensors.

Experience in the FBE prompted the following observations from FBE participants and observers concerning operational value of USVs:

- The unmanned surface vessel (USV), remote autonomous sensor concept has merit to work in areas where air ASW assets cannot fly due to the anti-air threat level encountered and where water may be too shallow for deep water combatants to effectively maneuver.[179]
- This concept also has the significant advantage of keeping manned units out of range of threat ASW contacts. [180]
- Innovative connectivity via UAVs, lighter-than-air vehicles, satellites, etc. should be considered.[181]
- USV CONOPS should be developed for wide area ASW search. [182]

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[175] ASW Technical Lead lessons learned
[176] SCC Observation Notes 26 Jul 02
[177] NWDC USV Project Lead Trip Report
[178] NWDC USV Project Lead Trip Report
[179] SCC Ops Post-ex ASW Questionnaire
[180] ASW Lead Final Report
[181] ASW Lead Final Report
[182] ASW Lead Final Report

12.6 Experimental Common Undersea Picture (X-CUP)

The use of a robust set of collaborative ASW tools and common tactical decision aids facilitated distributed, collaborative planning and enhanced shared situational awareness. [183]

In the FBE, parts of the undersea picture resided in several different systems that were not integrated. The commonality was that many, but not all, of the participants had many of the systems available. The locations of enemy submarine contacts were entered non-real time into GCCS-M. Status on some contacts was entered in LAWS. A running tactical level chat on ASW contacts with some ASW platforms was conducted with WeCAN. Operational level chat between SCC and JFMCC was conducted using Info Workspace chat rooms. Waterspace management for friendly submarine safety was maintained on paper plots. ASW environment, search planning, and search plan status were modeled and maintained in a variety of computer tools comprising the X-CUP tools suite.

The Experimental Common Undersea Picture initiative focused on the X-CUP tool suite as described in the FBE-J ASW Experimentation Plan.

12.6.1 Use of X-CUP Tools for Situational Awareness

Full use of current technology and interpretation of data requires significant training and experience with ASW tools. [184]

Chat functions at several levels can improve data and information flow, but chat discipline is necessary to avoid misinformation flow. [185]

Inclusion of attack C2 functionalities (similar to some contained in LAWS) would be a valuable addition to ASW CUP tool set. [186]

The X-CUP planning tools were used extensively. The Sonar Performance Prediction (SPP) tools gave some awareness of the environment. The AMAT search coverage diagrams conveyed how effective the coverage could be and the Cumulative Detection Probability (CDP) curves gave the planners the ability to perform asset allocation and time trade-offs. SCC feedback from the SCC, Deputy Ops Officer, and others indicated that AMAT was used to produce search plans. Specifically, AMAT was used to determine the placement of assets, the number of assets required and the duration of the search. The planners indicated that the information was very important to the planning process and to the actual operations (to a lesser extent). The information provided was complete, useful and used frequently. The Deputy Ops Officer stated that "(AMAT) is an outstanding system with incredible potential. It needs to be installed on ships and SCC modules and personnel trained to use it. (The) whole ship needs to know the importance of running the search plan." They reported a high degree of confidence in the AMAT information. [187]

One point of concern was expressed at the length of time it took the computer to generate a search plan. Search plans developed in the Mission Planner were reported to take 20 minutes to 2 hours of computer calculation time to be developed. [188]

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[183] FBE-J Quicklook COMNAVWARDEVCOM NEWPORT RI 271709Z AUG 02
[184] ASW Lead Final Report
[185] ASW Lead Final Report
[186] ASW Lead Final Report
[187] SCC-TSC X-CUP Observer Post-ex ASW Questionnaire
[188] SCC Observation Notes

At the operational level the X-CUP tools were of limited use because of the artificial tactical picture set-up of the exercise. The exercise forced a non-integrated GCCS-M picture and Web-Centric ASW Network (WeCAN) to be used rather than an integrated Link 11/16 based picture. As a result the tools designed for real-time situational awareness really had nothing to work on. For this reason, in only one case was a tactical situation effectively displayed on the AMAT suite. That occurred as the AMAT metrics were used to provide participating unit location that allowed the SCC to monitor the unit attempt to maintain an effective standoff distance. It was noted, however, that the unit was using the "default" values. Had this been a real situation the SCC could have warned that the torpedo danger area being used was over 5,000 yards smaller than doctrine for the particular threat.[189]

The GCCS-M track feed was the least useful capability in AMAT, in view of the FBE-J architecture. This data could not be effectively transferred between units and obfuscated rather than clarified the situation. This is mostly an exercise in artificiality. Lack of a track manager hindered SCC operations.[190]

AMAT planning tools need to be more flexible. Currently a plan is linked to a specific unit. Given that ships can be re-assigned, this linkage is too strong. For example, a plan called for one active and one passive DDG. This actually required the operators to have two plans, alternating the active and passive ship by name.[191]

Another concern was the lack of a clear picture provided by chat rooms. While great amounts of data were available from multiple sources, there was no clear sense of the overall picture of what was going on with enemy submarines. The SCC Watch Officer needs a clear battlespace picture available to him at his console [192]. He should not have to query several other operators to help provide situational awareness with this technology. While it is good to have multiple avenues of communication (CISCO IP phone, Chat room, WeCAN, LAWS) available to SCC, in the current state it is confusing to C2 functions.[193] Primary and secondary lines of communication for battlespace awareness need to be delineated.

The SCC large display (DBC system) did not match the MIWC large display. For example, the Q-routes were displayed on the MIWC and not on the SCC large display. Knowing that mines are in a search area is vital to ASW operations. [194]

The DBC large screen displays did not display information useful to the SCC watch. It was used more for projecting PowerPoint briefings than for tactical or operational display. [195]

12.6.2 Requirements for C2/Communications Architecture and Bandwidth to Enable X-CUP

AMAT and some of the other tools relied on WeCAN. Normally this is a distributed server but was restricted to a single site for FBE-J. This connection failed occasionally and all connectivity was lost. No significant bandwidth restrictions were noted except when trying to transfer extremely large (5-10 MB) files.[196]

[189] SCC X-CUP Lead Post-ex ASW Questionnaire
[190] SCC X-CUP Lead Post-ex ASW Questionnaire
[191] SCC X-CUP Lead Post-ex ASW Questionnaire
[192] SCC Observation Notes 27 Jul 02
[193] SCC Observation Notes 26 Jul 02
[194] SCC-TSC X-CUP Observer Post-ex ASW Questionnaire
[195] SCC Observation Notes 26 Jul 02
[196] SCC X-CUP Lead Post-ex ASW Questionnaire

Firewalls were also a problem. Sometimes they seemed to go up for no reason at all. When that occurred, it totally cut off communications.[197]

Reports indicate that engagement direction was interrupted in more than one instance by WeCAN failure. Backup systems need to be identified. [198]

Upon inspection of the C2/COMM architecture and bandwidth to enable X-CUP, it was seen that the loss of SATCOM (K band) resulted in the net going down[199]. Of note, this was observed in a non-hostile EW environment. System vulnerabilities need to be explored in hostile EW environments.

The Blue Force submarine reported being able to access the SharePoint Portal System (SPPS) in port, but that bandwidth limitations underway using EHF medium data rate through a 5.5 inch antenna precluded access to SPPS. Result was degraded crew situational awareness. [200]

12.6.3 Required Nodes in the X-CUP

One area that was identified but not formally explored, was providing visibility between the SCC and MIWC. In the very first live event FITZGERALD had to de-conflict off-loading the RMS vehicle and making its initial ASW search point. Similarly MIW Q-routes were not displayed on AMAT or other X-CUP displays. Efforts were initially made to alleviate this, but were secondary for this experiment and therefore did not get implemented. [201]

There is some question as to the value of including the TSC as an X-CUP node. For most of the FBE, there was very little value added. [202] However, on the last two days at TSC the daily ASW brief of the P3 crew included:

- Operating/Search Area developed using AMAT and displayed on the CADRT tactical plot.
- Sound propagation profiles, sonobuoy performance predictions and various sonobuoy patterns within the given search area, developed using PC-IMAT and SIIP.

TSC feedback from the TSC WO, ASW Analysis LPO and TACCOs indicated that the information provided by PC-IMAT and SIIP was used and useful. The TSC WO indicated that AMAT provided another way to communicate planning information such as aircraft schedule, status, call signs, and buoy load-outs. TACCOs indicated that the information provided by AMAT was useful. [203]

Waterspace Management (WSM) tools and procedures need to be incorporated into an automated system within the Common Undersea Picture, as well as into USW target engagement command and control architectures. Experience in the FBE prompted the specific suggestions that in order for the SCC to coordinate waterspace assignments for Blue Subs, SCC planners had to chop all MARSUPREQs submitted before approval by JFMCC. Also, SCC must work closely with JFMCC during MTO development to ensure the WSM plan supports the final product. [204]

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[197] SCC X-CUP Lead Post-ex ASW Questionnaire
[198] Daily Observation Matrix 27 July
[199] Daily Observation Matrix 27 July
[200] USS Salt Lake City Observer After Action Report
[201] SCC X-CUP Lead Post-ex ASW Questionnaire
[202] TSC Daily Report 30 Jul 02
[203] SCC-TSC X-CUP Observer Post-ex ASW Questionnaire
[204] ASW Lead Daily Report 25 Jul 02

The need for submarine communications at speed and depth has been emphasized for purposes of waterspace management. The dynamic nature of a littoral battle of the magnitude in MC02 requires the ability to attack submarines immediately whenever they are detected. The requirement to deconflict with US subs in the manner that we do today could cause loss of Blue ships. Being able to locate any Blue submarines instantaneously will pay huge benefits. [205]

12.7 Theater ASWC

CTF-12 as TASWC supported all ASW planning and operations at a rear site in Pearl Harbor. TASWC was fully connected to the SCC with the common undersea picture. During the experiment CTF-12 was able to provide significant direct support for planning and operations to SCC. TASWC recommendations were immediately understood and useable because of the commonality of the tools. [206]

12.7.1 Requirements for Theater Level ASW C2

Due to the revised scope of the TASWC role in the FBE, no observations were made concerning requirements for Theater-level ASW C2.

12.7.2 Reachback Requirements

CTF-12 did not have access to the entire network systems shared by local participants such as Info Workspace and the SharePoint Portal Server due to network connection problems. This limited their potential contributions. [207]

12.7.3 Manpower Requirements

The combination of regular CTF-12 watchstanders and reserve personnel was adequate to provide the support needed by the SCC during the FBE. No other observations were made.

12.8 USW Targets in NFN (X)

It appeared that the issue of USW targets in NFN (X)/LAWS was “a center of controversy.” [208] There was much discussion on its usefulness with advocates and detractors. However, after closer examination, and consideration of the underlying basis of the comments; a conclusion can be drawn that is entirely consistent with both sides of the debate.

Generally, the detractors were participants whose ASW experience was built around coordinated ASW, and whose platforms had existing, integrated sensor-fire control-tactical data-datalink-C2-systems. Their systems, such as the surface ship SQQ-89, P-3 integrated sensor-weapons system, SH-60 integrated sensor-weapons systems, Hawklink, NTDS, and Link-11, had all been developed to rapidly and automatically pass target contact and tracking information, and relay prosecution and engagement information, including automated, networked means of keeping the ASWC and JFMCC informed of the status of the enemy submarine picture and engagements. For a variety of specific reasons,[209] these participants generally saw little value added through non-real-time use of NFN (X)/LAWS.

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[205] ASW Lead Daily Report 27 Jul 02
[206] FBE-J Quicklook COMNAVWARDEVCOM NEWPORT RI 271709Z AUG 02
[207] SCC Plans Post-ex ASW Questionnaire, and TASWC Daily Reports
[208] ASW Lead Daily Report 27 Jul 02
[209] Key observations are described in the following subSections.

And generally, the NFN (X)/LAWS advocates were FBE participants whose ASW experience was built around single platform ASW prosecution. Their systems, such as the submarine integrated sonar and weapons control systems, lack interfaces and connectivity for automated, high-data-rate networking of ASW information with distributed ASW forces and commanders. Generally, they saw tremendous value in the rapid dissemination of ASW command and control information available to them through NFN (X)/LAWS, with the caveat that they needed that functionality to be fully integrated with their weapons control systems.[210]

The conclusion is that they are both right. All ASW platforms need fully integrated sensor-weapons control-tactical data systems, capable of high-data-rate, network communications that are fully interoperable with common operational picture systems at all levels of the chain of command. For platforms lacking such networked capability, the functionality of NFN (X)/LAWS needs to be integrated with their existing systems. But, as seen by participants whose platforms have networked capabilities, NFN (X)/LAWS itself is not the answer.

12.8.1 Technical Requirements to Construct USW Time Critical Strike Architecture

GCCS-M and LAWS did not work as hypothesized for this experiment. This was a combination of the exercise artificiality, lack of connectivity, and design. The hypothesis was that remote detections would bring down instantaneous firepower. The first failure was getting data into and out of the system. Since there was no connectivity to live systems, detections could not get entered and engagement orders could not get executed without manual data entry. Furthermore in most cases the data did not meet attack criteria, meaning that the assigned unit then had to re-acquire the contact.[211] {Doctrine (TTP) issue}

The ability to use data from remote sensors is worthwhile, but is not new to ASW. With SOSUS, the ASW community has been doing this for decades. If the sensors cannot provide attack criteria, then incorporating them into the NFN is a mistake. There is a significant difference between a SCUD launcher and a sub. The launcher can be located within targeting parameters at a position from which it won't move for some time and is engaged by a Mach 1 aircraft, which can run it down. A sub probably can't even be classified and the "shooter" is likely 15-30 minutes away and can't even see the target when it gets there.[212] {Doctrine (TTP) issue}

LAWS/NFN (X) is not the right tool for ASW and ASUW targets any more than it is for air defense. There is no target that is more of a time critical target (TCT) than an incoming missile, but that doesn't imply that NFN (X) has any applicability for that type of TCT. Air defense has other target tracking/C2 systems (i.e., NTDS, Link 11, Link 16, etc.) optimized to the air defense tempo of ops. And NFN (X) is evolving based on optimizing the timeline and interoperability with ground forces for engagement of time-critical-targets on land. Other tools used for ASW and ASUW, such as ASW Common Undersea Picture tools, NTDS, Link 11, etc. appear to be better suited to optimizing track management and C2 for ASW and ASUW. The key insight is that just because NFN (X) is being used for Fires doesn't mean that it should be adapted to either Air Defense or ASW and ASUW.[213] {Materiel issue}

There do appear to be some positive lessons arising from allowing SCC to experiment with using LAWS. Comments from watchstanders include observations that some functions in LAWS are good ideas that should perhaps be incorporated into the ASW tool suite. For example, anti-submarine weapons load out and availability status, explicit submarine BDA status, and undersea target engagement status.[214]

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[210] Key observations are described in the following subSections.
[211] SCC X-CUP Lead Post-ex ASW Questionnaire
[212] SCC X-CUP Lead Post-ex ASW Questionnaire
[213] SCC Observation Notes 28 Jul 02
[214] SCC Observation Notes 28 Jul 02

The Land Attack Warfare System (LAWS) was a centerpiece of the experiment onboard the submarine. It's use allowed the rapid dissemination of not only Fires tasking, but also the assignment of ASW targets. Its value should only increase as the system is refined and bandwidth available for use by the submarine increases. In order to fully realize its potential, however, it must be seamlessly integrated with the SSGN Attack Weapons System. [215]

As noted under the X-CUP initiative observations, inclusion of attack C2 functionalities (similar to some contained in LAWS) would be a valuable addition to ASW CUP tool set. [216]

12.8.2 Operational Issues of USW Target Integration into NFN (X) and Engagement of USW Targets as Time Critical Target

The distinctions between the ASW process of cueing-to-prosecution, and the Fires process of sensor-to-shooter need more thought. During the FBE, the understanding about whether LAWS was being used for weapons firing, or being used to assign units to localize, has bounced back and forth. [217]

The Blue Submarine units also need to be better integrated. This is both a bandwidth and combat system integration issue. [218]

A USW time critical targeting system needs to be able to distinguish between deliberate and urgent ASW attacks.[219] Also, ASW classification of PROBSUB or CERTSUB, and whether or not attack criteria are met by sensor systems are pertinent to USW engagement orders.

Observations made regarding waterspace management (WSM), discussed under the X-CUP initiative, also apply to this initiative.

12.8.3 Processing Times for USW TCTs

Units reported that the time required to get data entered into LAWS and then receive an engagement order resulted in a loss of attack criteria whether or not the unit in contact was ship or air.[220]

In one instance, a submarine locating device report got from the sub to the communications node to the SCC command center within seconds, but then took approximately 11 minutes until it was a nominated target in LAWS. However, because the reported position was already 11 minutes late at that point (i.e., no longer a fire control quality track), the SCC withheld permission to engage (Red color coding in LAWS). [221]

For the Blue submarine, communications connectivity for NFN (X)/LAWS is inadequate. The submarine experienced on the order of 10 minutes to establish connections at periscope depth. This could be due to signal propagation and bandwidth issues. [222]

[215] USS SALT LAKE CITY Observer After Action Report
[216] ASW Lead Final Report
[217] SCC Observation Notes 1 Aug 02
[218] SCC X-CUP Lead Post-ex ASW Questionnaire
[219] SCC Ops Post-ex ASW Questionnaire
[220] FITZGERALD X-CUP Tech Trip Report
[221] SCC Observation Notes 1 Aug 02
[222] SLC Daily Observations 28 July

12.9 ASW Key Observations Summary

Experimental Common Undersea Picture Tools for Network-centric ASW. (The use of an assortment of network-centric ASW tools to support distributed, collaborative planning, shared situational awareness, and common tactical decision aids.)

- As intended, common tools, networked to common sources of data, did indeed support distributed collaborative planning and a shared common understanding of the undersea acoustic environment. Tools also permitted planning of optimal search patterns and monitoring of the search plan execution.

- Some limitations were also observed. Realization of the full potential of network-centricity is limited by some fundamental technology/design/policy restrictions. The most significant limitation is the connectivity between submarines and the rest of the force. It appears that this is partly a policy issue and partly a technology issue – with current technology, submarines tradeoff continuous high bandwidth communications for stealth and freedom to operate deep. Significant bandwidth and reliable connectivity must be assured to achieve improved ASW through the benefits of network-centricity.

- Chat connectivity at several levels was utilized and created an environment of continuous and rapid information flow among all participants. In some cases, particularly amongst stations that did not traditionally have much direct communications connectivity by either voice or message communications, such as in sonar spaces on ships, Chat was perceived as a significant enhancement. However, there were also two significant difficulties observed with Chat. One is that Chat requires channel discipline to avoid transmission of bad information and to ensure uniformity of data transmission. Some policies (i.e., doctrine or tactics, techniques, and procedures) are needed for the use of Chat tactically and for operational level C2. The second difficulty observed concerns manning. In many cases, Chat required almost full-time attention from an operator monitoring and participating in from one to three Chat sessions (rooms) simultaneously.

Remote Unmanned Sensors. Bottom-moored acoustic arrays and a group of unmanned surface vehicles (USVs).

- ASW cues from the ADS fields were used to initiate prosecution (localization and attack) by other ASW platforms. It was noted that the ability to identify a critical location in an expected choke point and install a sensor field unknown to the enemy submarine force contributed to the successful use of the ADS field.

- The ability to coordinate USVs with surface and air ASW platforms was demonstrated, but USVs and their sensors did not function as designed due to a combination of prototype equipment limitations and acoustic environmental conditions. None-the-less, positive lessons were seen. The size and design of the USV is critical to its ability to contribute consistently to warfighting due to seaworthiness and recoverability issues. The durability of the sensor and control systems is an issue due to their intended high operating speeds and impact of sea state that takes a toll on small boats operating remotely. Availability and maintainability issues are critical if USVs are needed in more than just the most benign sea states.

Extending the Experimental Naval Fires Network to USW Targets. (Use of NFN (X), including GCCS-M and the Land Attack Warfare System (LAWS) for ASW engagements.)

- Participants' perceptions of the merits of using LAWS for ASW engagement command and control depended significantly on platform type because of differing prior experience with and availability of other tactical command and control systems and links (such as NTDS, Link 11, and Hawk Link). Submarines that do not traditionally use NTDS and tactical data links saw more merit with NFN-X for USW than others. This observation also adds to understanding the apparent popularity of NFN-X for Fires, where NTDS and tactical data links are not used. In the case of submarines, it was seen that the C2 functionality of NFN-X-LAWS did add value, but that the value added would be greater if the functionality were incorporated into existing Submarine weapons control systems. In the case of surface ships, including aircraft carriers (the notional location of the Sea Combat Commander), it was seen that some features of the NFN-X-LAWS functionality could add value if incorporated into existing ASW tactical data systems and/or a Common Undersea Picture system.

- LAWS demonstrated latency of several minutes on occasion that made it currently unacceptable for this application (compared to some existing ASW tactical command and control systems that are quicker). With training and better system understanding, the operators were able to reduce the latency to an acceptable level.

Expanding the Role of the Theater ASW Commander (TASWC). (TASWC reachback support for the SCC.)

- The TASWC provided significant direct support for ASW planning from a rear Headquarters in Hawaii. TASWC was fully connected to the SCC with the Experimental Common Undersea Picture tool set. TASWC recommendations were immediately understood and useable because of the commonality of the tools.

Submarine Locating Devices (SLD). (Devices used to report enemy submarines positions periodically.)

- SLD reports of enemy submarine positions during the FBE were highly regarded as valuable sources of information on enemy submarine activity. During pre-hostilities, the ASW Commander considered periodic reports from an SLD as sufficient information on those enemy submarine locations, and was able to assign their Blue ASW platforms to search for un-located or unreported enemy submarines.

- It was noted that it would be highly desirable to be able to command prompt SLD reports rather than only have reports at predetermined intervals.

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13.0 Information Operations (IO) Initiative Key Observations

13.1 Experime nt Objectives

The Information Operations initiative objective provided the full range of IO capabilities in support of the Joint Forces Maritime Component Commander (JFMCC) planning process. The goals were to incorporate experimental and emerging organizational constructs, processes, and capabilities to accommodate simultaneous offensive and defensive operations at the tactical and operational levels and to provide additional resources necessary for the JFMCC to synchronize all naval missions in the littorals. Experimenting with the IO organization embedded in the JFMCC planning process as well as utilizing IO tools and capabilities in FBE-J was intended to bring the traditionally stealthy IO capability to the forefront of the effects based planning process. The four components of the IO initiative included:

- IO enrichment to the JFMCC planning process.
- Collaborative IO planning.
- Defensive IO – Computer Network Defense.
- Offensive IO – Tools incorporated to support deliberate and time critical targeting.

13.1.1 IO Enrichment to the JFMCC Planning Process Objectives

The primary objective of this sub-initiative was to identify and develop the specific functional responsibilities for each IO forward billet to ensure maximum enrichment to all dimensions of JFMCC operations. In addition, identification was made of the critical IO rear support billets and functions.

The following were specific nodes where analysts captured process data to satisfy the over-arching objective of this sub-initiative:

- *The interface between IWC IO staff and JFMCC Future Planning Cell (FPC).* Captured the process and synchronization requirements between IWC IO Cell representatives and FPC. Documented how the IO cell coordinated with FPC to ensure IO requirements (Commander Guidance, JTF IO objectives, IWC objectives) were included in the planning process. Documented billets and dual-hat responsibilities and evaluated benefits and challenges associated with this particular organizational configuration.
- *IO staff input to JMOP production process*. Captured the process for producing the Joint Maritime Operations Plan (JMOP). As a process, documented where IO inputs originate and their relationship to Commanders/JTF IO guidance. Documented the benefits and challenges associated with incorporating IO objectives in JMOP using FBE-J organization structure. Evaluated relationships between IO staff and FPC to ensure that IO objectives were incorporated in the JMOP with enough detail to adequately feed the MARSUPREQ process.
- *IO staff input to MARSUPREQ production process*. Captured the process for producing the Maritime Support Requirements (MARSUPREQ). Investigated the various IO staff interactions required to evaluate the JMOP to ensure that the IO objectives were reflected, and that the detailed IO requirements were incorporated in the MARSUPREQ for review by the IWC and JFMCC current plans officers.
- *IO staff input to MMAP production process*. Captured the process and the various IO staff interactions required to support MMAP production process. This product is unique to the Navy and different from other component tasking orders. Investigated how JFMCC IO input contributed to the USN mission and examined interactions with other processes in the Maritime Planning Process (MPP).
- *IO staff input to MTO production process*. Investigated the role of IO staff during MTO production process (The MTO should be adaptive to dynamic change, which occurred whether

Top down, or Bottom-up.). Investigated how dynamic IO staff contributions impact MTO modifications and execution

13.1.2 Collaborative IO Planning Objective

The primary objective of this sub-initiative was to assess how IO planners, analysts, and operators utilized Information Warfare Planning Capability (IWPC) to develop, manage, and execute control over IO plans and campaigns in direct support of JFC IO and IWC requirements. Communication and coordination between IO Fwd IWPC Operator and IO Rear IWPC operator for reach-back capability was observed to determine the level that the IWPC toolset supported IO planning during FBE-J.

13.1.3 Defensive IO Objective

The primary objective of this experiment was to illustrate that a prevention strategy was a more effective approach to computer network defense (CND) than a strategy based on detection, response, and recovery. This effort relied on the prevention of network services from an attacker who has successfully penetrated other defenses. It also served to protect the network from being misused by an unintentional insider. The goal was to use process improvements enabled by current technologies to mitigate risks inherent with networked computing and information systems. Although this effort incorporated a Red team from FIWC, Red was only permitted to exploit machines that contained the Autonomic Distributed Firewall (ADF) or OS Wrapper technologies. This, in effect, limited this effort to a demonstration of the technical capabilities of the ADF and Wrapper tools, rather than a comprehensive defense of the computer network.

13.1.4 Offensive IO Objective

The primary objective of this sub-initiative was to evaluate the use of non-kinetic IO from the sea, which is designed to provide the JFC with a range of IO weapons immediately available at the operational level. In addition, a goal of the experiment included exploration of the intrinsic flexibility and complementary dimension of non-kinetic weapons available to the JTF commander, particularly those suited to a restrictive ROE environment such as:

- Electronic-Strike (simulated).
- NAVSPACE capability (actual).
- HSV suite (actual).

13.2 Analytic Issues

13.2.1 IO Enrichment to the JFMCC Planning Process

Specific sub-initiative analytic issues researched during this experiment included the following:

- Determine if IO forward and IWC IO staff contributions were incorporated in the MPP
- Determine if IO contributions were sufficient/insufficient during the JFMCC planning process to produce the products, information, guidance, or feedbacks necessary to construct an MTO. Where insufficient, determine the contributors to the lack of process, products, information, collaboration or control.
- Determine if the decision support tools (e.g., IWPC) were enablers to decision making within the JFMCC IO planning process, or where lacking, what decision support tools were required.
- Construct a mapping of IO staff collaboration process and constraints. Identify command and control (C2) processes and any adaptive C2 processes incorporated.

Specific sub-initiative analytic issues researched during this experiment included the following:

- Determine if JFMCC IO cell and IWC IO staff contribution was incorporated in the Maritime Planning Process.

- Determine if IO contributions were sufficient/insufficient during JFMCC planning process to produce the products, information, guidance or feedbacks necessary to construct an MTO. Where insufficient, determine contributors to lack of process, products, information, collaboration, or control.

13.2.1.1 Findings - IO Enrichment to the JFMCC Planning Process

- The experimental JFMCC IO cell (IO forward) did not contain manpower required to adequately represent IO options to the JFMCC staff during FBE-J. Certain IO tools (e.g., Electronic-Strike Weapon) became the cornerstone of IO support to the JFMCC planning process and that became the primary IO focus for the JFMCC. The IO cell was neither robust nor constructed in a manner that permitted decision makers to regularly consider all IO integration efforts as part of the Maritime Planning Process (MPP).

- Utilizing scaled-down (lean) versions of ideal IO organizations at both component and tactical levels, although somewhat self-imposed, highlighted the difficulty of conducting IO operations without sufficient depth and expertise.

- The experimental JFMCC IO Cell design of 28 personnel was derived from Joint doctrine that detailed requirements for a component level IO cell. However, constraints on the embarked IO cell footprint (USS CORONADO) diminished the original experimental construct from the 28 personnel identified in Joint doctrine to a less than adequate 11 personnel (inclusive of two each, USAF and USA liaison) for execution. An additional five personnel were assigned to perform specific IWC staff responsibilities, but experiment dynamics forced IWC personnel to expand their role to incorporate a component level view (e.g., dual hat responsibility). This created a difficult environment for participants to synchronize operational and tactical focus. In addition, this personnel inadequacy made identification of specific functions and the ability to assess IO roles and responsibilities during the experiment difficult.[223]

- Experiment design forced a sharing of roles and responsibilities between the JFMCC IO and IWC personnel. Each was required to perform in a hybrid role through the experiment. Participants were required to adapt to the changing experimental environment, which caused functional role and responsibility uncertainty during the effort.[224]

- IO Subject Matter Experts (SME) distributed through the planning cells is an absolute essential to integrating the various dimensions of IO and to synchronizing the effects into a scheme of maneuver, which is coordinated both vertically and horizontally.

- The JFMCC maintained tactical control over individual units during this experiment. This impacted the original functional responsibility of the IWC throughout the effort and forced IWC personnel to re-define roles and responsibilities to support the operation as the scenario developed. If the JFMCC maintains tactical control over units as during this experiment, the IWC

[223] Post Experiment interview with CDR S. Orosz (NWDC IO Cell Lead) and CDR R. Sabo (IWC)
[224] Post-experiment interview with LT M. Smith (JFMCC Future Planning Cell)

function, as outlined in the FBE-J CONOP, would not be required, and IO coordination would be conducted at the operational level.[225]

- Reviews of IO participant surveys indicate that the JFMCC IO staff must be robust and the general IO knowledge level must be high. As an example, the IO liaison officer (LNO) to the Sea Combat Commander (SCC) must have a thorough understanding of surface and sub-surface operations, the IO LNO to Strike must have a thorough understanding of strike operations, and IO representatives to the plan cells is an absolute requirement if IO options are to be synchronized with other primary warfare options. It is also critical that plans personnel have a baseline understanding of the targeting process, IO capabilities, and the Tactics, Techniques, and Procedures of JFMCC assets.

- IO actions in general were difficult to integrate. The maritime tasking order (MTO) was not designed to accept missions without targets. If the targets were non-specific or regionally oriented, they could not fit into MTO format. Navy planners are accustomed to being reactionary, that is maneuver when necessary (e.g. tactical in nature) and IO is not reactionary. Hence, it was difficult to integrate IO because it required the other PWC participants to understand how IO capabilities could improve their specific PWC objectives. It was evident during the experiment that other PWCs were not familiar with IO options and how they could support goals and objectives.[226]

- Post-experiment debriefing discussions with the IO team revealed that the JFMCC process requires current and future plans to be more robust with trained expertise from the appropriate Navy warfare areas and component LNOs. The production and JFMCC decision-making process adopted during FBE-J stymied the autonomous goals of the PWCs. Because PWCs were removed from consistent JFMCC interaction, they lost touch with all dynamic updates shared through the JFMCC staff and had zero oversight of a plan vision being developed by the JFMCC staff.[227]

- The IO representative in Current Plans highlighted that they added minimal IO missions into the planning cycle other than the easy to do Electronic-Strike (E-strike) missions, which obtained significant visibility. They further indicated that having an IWC made the process even more difficult because IO objectives for the JFMCC were driven by the JTF IO organization and not the IWC. One suggested recommendation is to include an IO representative to each of the other PWCs to ensure IO options are emphasized and organize a master IO cell at the JTF level to maintain coordination between component representatives.[228]

- The IO representative in the JFMCC Future Planning Cell indicated that it was difficult to integrate IO in the planning process. JFMCC staff was not familiar with comprehensive IO capabilities and how they could support dynamic objectives. The JFMCC commander's intention in the Maritime Operation Directive (MOD) reflected a conventional response to the target selection process and did not include IO. Because the areas JFMCC indicated as his top priority at COMEX (mines, subs), there was very little opportunity for the IO cell to recommend IO effects to support objectives. Therefore, JFMCC IO personnel emphasized targeting C2 nodes, but because this did not support original JFMCC priorities, all strike assets were devoted to sub-surface and mine targets. Only when the JTF commander asked why JFMCC was not targeting C2 nodes were JFMCC controlled assets re-tasked to target those C2 nodes.[229]

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[225] Post-experiment interview with LCDR L. Chow (IO Effects Coordinator)
[226] Post-experiment interview with LCDR L. Chow (IO Effects Coordinator)
[227] Post-experiment IO Cell Debrief Discussion
[228] JFMCC Planning Process Survey – LT D. Snee (NPS)
[229] JFMCC Planning Process Survey – LT M. Smith (JFMCC Future Plans)

- The IO Effects Coordinator highlighted that IO participants and planners must have a common familiarity with IO capabilities and assets. In order to argue for assets and asset positioning during deconfliction efforts in the planning phase, IO participants must thoroughly understand the IO capabilities and limitations that reside on each JFMCC asset.[230]

- Review of surveys from IO participants and interviews with IWC decision-makers indicated that challenges encountered in meeting tasking, planning and synchronization requirements at the JFMCC level requires an IO cell staffing requirement of approximately 33 personnel. In addition, interviews with IO Cell leads highlighted an additional requirement for a JAG, Public Affairs, Political/Military expert, and Chaplain to support planning efforts. Recommended core billets include:[231]

    IO Chief
    Deputy IO Chief
    IO Head of Ops
    IW Anchor in Maritime Operations Center (MOC) x 2
    Computer Network Defense (CND) Watch in MOC x 2
    IO Admin (webmaster)
    IO Head of Plans
    STO Chief
    STO Admin
    Computer Network Ops (CNO) planner
    CNO planner – CND
    Perception Management (PM) planner – PSYOPS
    PM planner – MILDEC
    PM planner – OPSEC
    Physical Effects (PE) – Electronic Support/Protect (ES/EP)
    PE – Electronic Attack (EA)
    IO/IW Targeteer x 2
    IO/IW Battle Damage Assessment (BDA)
    IO/IW Intel liaison RFI/CM/ISR x 2
    IO/IW SME to FPC
    IO/IW SME to CPC x 2
    Liaison Officers to: JTF IO, JFLCC IO, JSOTF IO, JFACC IO
    Liaison Officers from: JTF IO, JPOTF, JFLCC IO, JSOTF IO, USSPACECOM LNO, JFACC IO
    Required augmentation necessary on a less than full-time basis:
        JAG
        Public Affairs
        Political/Military Advisor
        Chaplain

Total: Core JFMCC IO Cell Billets – 33

[230] Interview with LCDR L. Chow (IO Effects Coordinator)
[231] Interview with CDR R. Sabo (IWC) and CDR S. Orosz (NWDC)

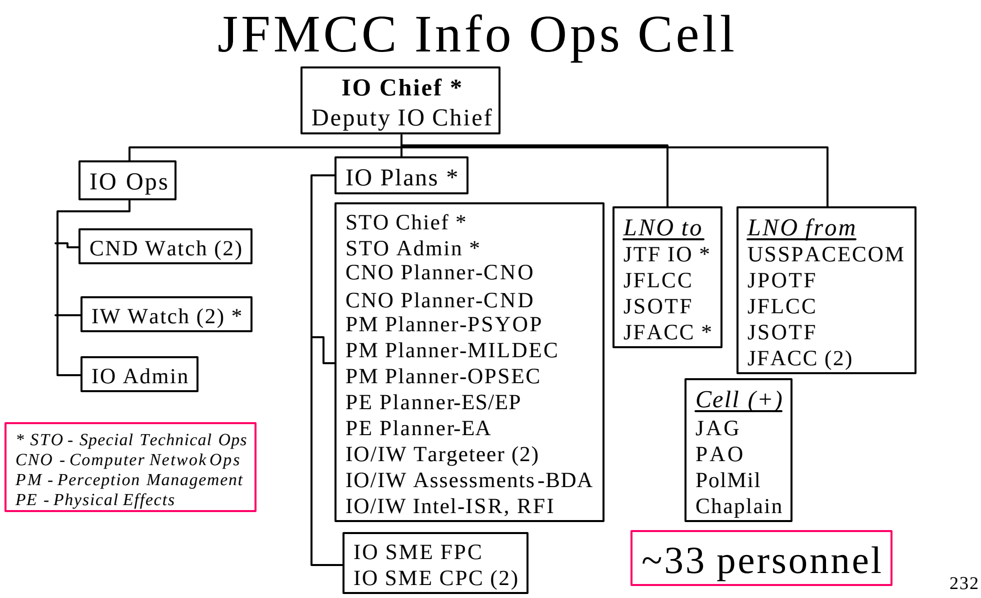

Figure 13-1. JFMCC Information Operations Cell

13.2.2 Collaborative IO Planning

A primary objective of FBE-J was to evaluate JFMCC doctrine, operational concepts, and evolve maritime force planning processes in conjunction with examining Effects Based Operations (EBO). These operations shift away from the traditional warfare of attrition by balancing kinetic effects with battlefield shaping and perception management. A key component of EBO is the ability to collaboratively integrate and synchronize Information Warfare (IW) activities with other maritime force operations to achieve the desired results. As IW and Information Operations (IO) capabilities mature into operational weapons systems, the JFMCC will require a planning capability to integrate and optimize IO weapons capabilities and effects in concert with kinetic and non-kinetic maritime operations. It will also require the ability to deconflict IW operations with other on-going conventional and non-conventional capabilities (with the JFACC and JFGCC), and have the flexibility to use IO weapons as non-kinetic responses to Time Critical Targets.

The JFMCC does not currently have an IW planning capability to accomplish this integration. It requires an integrated, non-weapon specific, non-data base specific, web-based tool set. One that is flexible enough to plan, re-plan, task, and function within a collaborative environment. FBE-J provided an opportunity to experiment with such an Information Warfare Planning Capability (IWPC). IWPC, which is currently being developed and fielded by the Air Force, supports Joint-planning activities (centralized planning/tasking, decentralized execution, and allows the opportunity for all the necessary players to be involved in the planning process).

IWPC is a standardized set of integrated, analytic tools for use in a web-based collaborative planning environment. It includes a multi-nodal reach-back capability to assist in planning IW/IO attacks (what, how, expected effects, timing, etc.) and integrating/synchronizing IW into all levels of operational planning and execution with conventional kinetic attacks (tasking, coordination, C2/execution, monitoring, etc.). IWPC accommodates planning activities for both forward and rear components and has

[232] JFMCC Information Operations recommended force layout obtained from Cdr S. Orosz (NWDC), Cdr J. White (NWDC), and Maj R. Oyola (USAF)

the reach-back capability into the necessary databases and supporting information (weapons capabilities, intelligence requirements, mission readiness status, etc.) to accomplish the required planning and C2.

13.2.2.1 Collaborative IO Analytical Objectives

Specific collaborative IO planning sub-initiative analytic issues researched during the experiment included the following:

- Identify level of horizontal and vertical collaboration.[233]
- Identify IWPC capabilities that support JFMCC IO planning process.
- Determine if the decision support tools (e.g., IWPC) are enablers to decision making within the JFMCC IO planning process, or where lacking, what decision support tools are required.

13.2.2.2 Findings on Collaborative IO Planning

The presence of readily prepared operational net assessments (ONAs) largely minimized the opportunity to explore the full possibility of timely, extensive IWPC utility and potential. Known 'experimentation and innovation trade-space' in the Maritime Planning Process (MPP) created extensive confusion as individuals endeavored to satisfy the expectations and requirements of JFMCC planning decision-makers. Meanwhile, the disparate interpretations of Primary Warfare Commanders (PWC) as to "what" the MPP entailed hindered cohesion and mutual understanding.

The FBE-J scenario lacked adequate fidelity to sufficiently and accurately replicate potential IO effects.

In this experiment the nature of IO/IW as a supporting mission area was predominant. Future multi-mission platforms, designed to facilitate the near simultaneous achievement of optimum effects, will find that exploitation of intrinsic IO/IW capabilities distributed throughout the battle force will be critical to mission success. However, deriving the associated tailored, responsive, effects-oriented, Courses of Action (COA) which are required to convert plans into effective operations will be dependent on support from, and connectivity with, rear echelon entities. Information Warfare Planning Capability (IWPC) was relied upon to provide the principal means of dialogue and timeliness to meet JFMCC IO Cell and IWC requirements. Though designed as a strategic level, deliberate planning system, IWPC was incorporated into the experiment to quantify what trade spaces exist in IWPC's diverse toolkit that address operational to tactical level planning demands.

Optimum use of IWPC was challenged for a number of reasons – most associated with taking it out of its designed niche at the SCI level. However, excellent on-scene technical support allowed for every problem to be worked through and some innovative solutions/adaptations found. Initial experiment design envisioned an SCI level IWPC in the IO forward space. This machine would have facilitated collaboration not only with IO Rear at the Fleet Information Warfare Center, Norfolk, VA, but also the CJTF IO Cell, Suffolk VA, JFACC IO at Nellis AFB, NV, and the JSOTF IO, MacDill AFB, FL. However, component and participation via IWPC was precluded as only Navy brought IWPC equipment to the experiment. Consequently, much of the vertical collaboration originally envisioned did not occur—a deficiency that was explicitly cited by the CJTF IO Chief during MC02 debriefs. SCI level collaboration did occur on a near daily basis between IO Forward and IO Rear, but the primary collaborative contribution occurred as the result of two adaptive decisions:

- An ATI.ATR conversion utility was written to facilitate USMTF dialogue from IWPC to LAWS. This revision enabled automatic target/weapon pairing methodology that initially was key to normalizing any IO target nomination in the Joint Fires Network.

[233] Interview and After Action Report review from Mr. Matt Sedlacek, IWPC Operator, USS Coronado

- The Collaborative Planning Tool (CPT) sub application was exported to ADOCs workstations, used by all JFMCC and IWC personnel. This allowed the 'big-picture' to be viewed by any IO planner or operations representatives and appreciably improved overall situational awareness and reasoning behind any specific action/effect being proposed and/or collaborated on with fellow planners—in either IO Forward or Rear. JFMCC planners using ADOCs however, were limited to collateral level dialogue. SCI planning was only possible from/to IO forward and rear IWPCs connected to JWICS, as shown in the Figure 13-2.

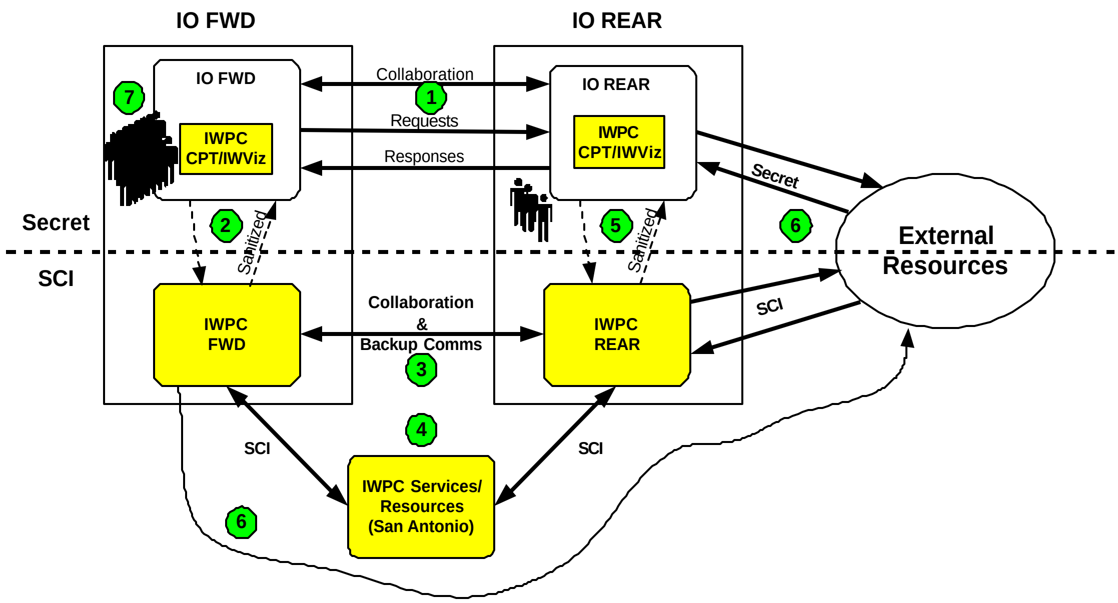

Figure 13-2. Collaborative Planning Design

At the horizontal level, IWPC's tools proved useful, appropriate, and adaptive. They allowed planners to take an efficient strategy to task approach to define guidance used in writing maritime support requests (MARSUPREQs). These led directly to IO's improved overall incorporation in the larger scheme of operations. Short-term IO tasks were easily viewed in the context of the overall IO plan and the IO staff was able to continually evaluate effectiveness and modify the overall planning as required. IWPC was the means by which an SCI request for information (RFI) was answered. The enhanced fidelity available at the SCI level was then sanitized and injected into the MPP, again offering a means to more efficiently and accurately characterize IO desired effects and the preferred means of attaining them. IWPC offered an outstanding means of IO target development that without significant difficulty could be adapted from a strategic view to an operational level. This potential was not realized to its fullest extent because the MC02 ONA database effectively mitigated applicability or utility of real world information and forced FBE IO staff to use that database. In fact, however the ONA database could have been imported to IWPC for the experiment, had sufficient lead-time been available.

IWPC was not used for targeting due to the directed use of ONA for target generation. IWPC operators selected C2 targets based on prioritized target lists and mission commanders' intent. JFMCC IO Cell and IWC staff received little direction from JTF IO, but utilized LNOs to deconflict targets with other commanders although it was difficult to get feedback and BDA on targets struck.[234]

[234] Collaborative IO Participant Survey – EWC (SW) Shuey, IWPC Operator, USS Coronado

Daily collaboration on the PWC level occurred with the Sea Combat Commander, Commander Amphibious Task Force, Strike Warfare Commander, and to a lesser degree Mine Warfare Commander. However, observer logs indicate that greater than 50 percent of this collaboration occurred on a face-to-face basis or via the telephone, rather than in the Collaborative Information Environment (CIE). This was at least partially, the consequence of the less than one-to-one ratio of workstations to IWC planners, mentioned earlier. JFMCC IO collaboration was principally accomplished in the CIE, augmented with IP teleconference and it occurred throughout the day with all components. Principal among those were JFACC, JPOTF, JFLCC and CJTF IO. Less collaboration occurred with JSOTF, USSPACECOM, all JFMCC planning cells, and anchor desks on the MOC floor. The nexus of collaboration, by far was the IW Anchor desk whose utilization of the CIE set the standard for not only IO, but also all JFMCC participants. It was not unusual for her to have as many as five IWS chat rooms, three IWS private chats, Outlook e-mail, ADOCS, LAWS Fires Mission Planner, ATO and Share Point Portal open simultaneously.[235]

Review of participant surveys indicate that IWPC was not utilized to the fullest due to dynamics of the scenario. There was little long range planning conducted for this experiment that would have benefited from IWPC capability. A tool like IWPC is needed in today's Navy at the battle group staff level and above for theater planning purpose.

The majority of the IO planning occurred at the secret level. Very little IO planning occurred at the SCI level. The SCI support was primarily in an Intel/RFI support role to IO FWD. Critical observations from the collaborative process are noted below:[236]

- Mission planning and execution occurred on the secret network. Planning occurred at the IO forward (CORONADO) position. IO Rear (FIWC) was able to participate in this process by having access to the IWS collaborative network (meeting room and e-mail). This significantly increased the participation and awareness of IO rear into the overall experiment environment.

- Upon receiving RFIs, IO Rear had the option of researching the request on the secret network, on the SCI IWPC workstations (using IWPC specific tools, other tools, or JWICS web searches), or on other SCI assets available at the rear. In addition, some phone calls were made to other organizations, in order to support responding to an RFI, if the IO rear did not have the expertise or tools to answer the RFI. IO rear sanitized and downgraded any information obtained through SCI sources to secret prior to translating it into an RFI response.

- For TST tasks, BE numbers were already known. They were entered into the CPT on the secret side under a new generic plan. As each BE number was entered, an MIDB update was performed by filling in the necessary target details (which was much faster than typing this in by hand). The plan was then saved to floppy and loaded on the IWPC FWD system. The plan was loaded into CPT and the targets were highlighted and exported to the TGIF database (located at Lackland AFB.). TGIF was started and a CTL was generated and exported to the local computer. CACU was started and the CTL was converted to the USMTF FBE-J ATI.ATR message format. These messages were copied and scrubbed to the floppy disk using the NT Toolbox functions Secure Copy, Flush, and Buster. Once scanned, the floppy was available for the IO Watch Commander on the operations floor to load into ADOCS.

- When coordinating the planning for a few targets, operators found it was easier and faster to manually enter the IO TCTs directly into ADOCS. However, if the IWPC server was installed on

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[235] Post-experiment interview with CDR S. Orosz (NWDC)
[236] Collaborative Tools AAR and interview with Mr. Matt Sedlacek, IWPC Operator, USS Coronado

the secret network and there were more than six or seven TCT targets, the creation of the ATI.ATR messages was much easier and faster using the IWPC tools.

- Collaboration on IWS took place between SCI IO Forward and Rear. Primary focus was backup communications for secret COMMS path. The secret communication path dropped out often the first two weeks, thus having the backup COMMS was useful.

- Upon receiving RFIs, IO Rear had the option of researching the request on the secret network, on the SCI IWPC workstations (using IWPC specific tools, other tools, or JWICS web searches), or other SCI assets available at the Rear. In addition, some phone calls were made to other organizations, in order to support responding to an RFI if IO rear did not have the expertise or tools to answer the RFI. IO rear downgraded any information obtained through SCI sources to secret prior to translating it into an RFI response.

13.2.3 Defensive IO (Hardened Client)

The Hardened Client initiative addressed the prevention of network services from being misused by either the unintentional insider or an intentional attacker that had successfully penetrated the other defenses. The basic paradigm of the Hardened Client being that prevention is a more effective approach to computer network defense (CND) than detection, response, and recovery. This initiative was intended to incorporate technology to augment today's perimeter defense strategy with an integrated layered defense at the host level to prevent the misuse of computers. The Hardened Client integrates two host level technologies, autonomic distributed firewall and the operating system wrappers, in an effort to harden the client computer from being used for unintended purposes.

There were two major components of the Hardened Client that were integrated with the IT-21 (GOTS Delta) workstation or other specified NT workstation:

- **Autonomic Distributed Firewall (ADF).** The autonomic distributed firewall (ADF) is a distributed packet filtering firewall with centralized management and auditing. It is intended to provide a tamper resistant, non-by-passable firewall between a host workstation or server and the ethernet cable. Note: The ADF is not an application layer proxy. Therefore, it makes no claims concerning protection from hostile code carried by e-mail or delivered via a web browser. The ADF architecture uses a master-slave approach to provide scalability and centralized security policy management and is composed of two parts; the security policy server and the distributed policy-enforcing network interface cards (NIC) installed on each protected workstation. This centralized approach is critical for rapid implementation of changes to security policy during high threat operations. The ADF NICs were installed on selected workstations and servers on the FBE J experimental SECRET LAN. Each NIC was installed on a variety of workstations and several high value servers. The ADF Policy Server controlled the security policy for each NIC. The ADF Policy Server provided centralized management of packet filter rules in each NIC. Security policies were implemented from the Policy Server for individual workstations or for implementation across the network. The NIC filtering engine supported 64-packet filter rules including "No Sniffing" or "No Spoofing". New rules were easily written and applied for use in the dynamic FBE-J operational environment.

- **Operating system wrappers.** Operating system (OS) wrappers are small pieces of code resident on the host workstation that mediate system calls in real time between the NT operating system (OS) and applications. The OS wrappers mediation enforces fine-grained security policies in a transparent fashion, i.e., no user interaction and minimal performance degradation. The OS wrappers do not rely on conventional signature based detections but perform based on predetermined acceptable behaviors for applications. An example would be the prohibition of e-mail from electronically accessing the e-mail address book; thus denying many self-propagating viruses their primary transmission mode.

13.2.3.1 Defensive IO Analytical Objectives

Specific defensive IO sub-initiative analytic issues researched during the experiment included the following:

- Determine if Hardened Client technologies (ADF, OS wrappers) prevent network exploitations on the information and/or computer resources from an adversary.

- Determine if ADF and OS wrappers alarm the system administrator when security policies on the computer under protection are violated.

- Evaluate the ability of ships force to install, establish security policies, operate, and modify ADF rule sets.

Measures of performance identified for the Hardened Client initiative included:

- **Protection.** Protection is the major metric evaluated for overall effectiveness. The ability of the Hardened Client technologies to prevent network attacks on the information and/or computer resources on which it is installed will be qualitatively compared with similar attacks on un-protected computers.

- **Detection.** The ADF portion of the Hardened Client provides alarms to the policy manager server when security policies on the computer under protection are violated. These alarms provide a potential early warning of security policy violation and possible computer misuse. The capability of the ADF alarms to automatically tip-off the system administrator of possible misuse will be evaluated.

- **Operability.** The ability of ships force to install, establish security policies, and operate the Hardened Client technologies will be evaluated. Data will be collected through observations during the installation and execution of the experiment as well as post-experiment interviews with the ships force.

13.2.3.2 Findings on Defensive IO (Hardened Client)

Hardened Client successfully deflected direct Red team attack through OS wrapper and ADF configuration. The Red team was not successful in achieving the flag of disrupting time critical targeting during attack periods.

The first layer of defense, safe e-mail wrappers, blocked harmful behavior contained in e-mail attachment macro sent by Red team participants. The attacker assumed that users would open attachment and the desktop configuration would permit macro to spawn. During experiment, e-mail with harmful macro (visual basic script) was sent from Red that was intended to provide an internal jump point for the attacker. However, the wrappers defeated attacks by effectively stopping writes to the registry and hard drive. The Red team was unsuccessful at starting a session intended to spawn the root shell back to a jump box for subsequent network exploitation.[237]

The second layer of defense, ADF, prevented outbound FTP as well as outbound root shell jump point. ADF demonstrated an effective defensive technology that can be scaled to full operational deployment.

[237] Review of DARPA presentation, 9 Sep 02

However, several configuration management issues associated with incorporating ADF cards in all network machines provided by ADF operators during FBE-J include:

- Scalability; the ability of one person to manage 1000+ systems
- Complications of legacy and custom software applications
- Correlation of audits across policy servers makes incident handling difficult.

The Red team was successful in inserting spoofed e-mail. However, it should be noted that the software used to configure the mail server was 'freeware,' and the ADF rule sets incorporated for FBE-J permitted all traffic to and from the FBE-J mail server.[238]

Discussions with Red team participants indicated that the presence of ADF equipped machines were easily detected using basic scans. A network with only partial ADF coverage would permit an attacker to quickly identify unequipped computers and launch an attack from that point. The Red team would focus attacks on unprotected machines.

Red team surveys indicate that e-mail wrappers provided good protection in addition to anti-virus software, ADF provided an adequate layer of protection in defense-in-depth configuration, and overall, the Hardened Client was a deterrent to an adversary attack. However, as mentioned above, unless the complete network is configured with Hardened Client, a persistent adversary would eventually find the weaker hosts in a network enclave and would exploit.

From an operational environment perspective, the remote management of ADF policy servers over satellite link worked smoothly and the CND staff was able to assume responsibility for operation with minimal training.

13.2.4 Offensive IO General Observations

Operational commanders required the capability to launch theater-level Information attacks when appropriate. The Offensive Information Operations experiment conducted during FBE-J centered on using E-Strike munitions in support of time critical strike scenarios. As FBE-J progressed, kinetic and non-kinetic IO fires were integrated in TST operations. Two critical findings are highlighted below:

- Placing control of IO weapons with the operational commander is critical for synchronizing kinetic and non-kinetic warfare.

- Integration of IO with Joint Fires enhanced the experimental time critical strike scenario.

13.2.4.1 Electronic-Strike Munitions

The probability of effects/"kill" (P_k) was simulated during the experiment using Directed Radio Frequency Energy Assessment Model (DREAM). The P_k results were compiled and presented in the "Target Manual for RF Directed Energy Weapon (DEW) Vs. Selected Targets" (U) for the MC02/FBE-J execution effort. The process for e-strike employment manifested during FBE-J is provided below. E-strike munitions were used extensively throughout FBE-J.[239]

[238] Interview with Ms. Dorene Ryder (DARPA/BBN), D-IO Lead
[239] Interview with Mr. Mark Henderson – Electronic-Strike Lead

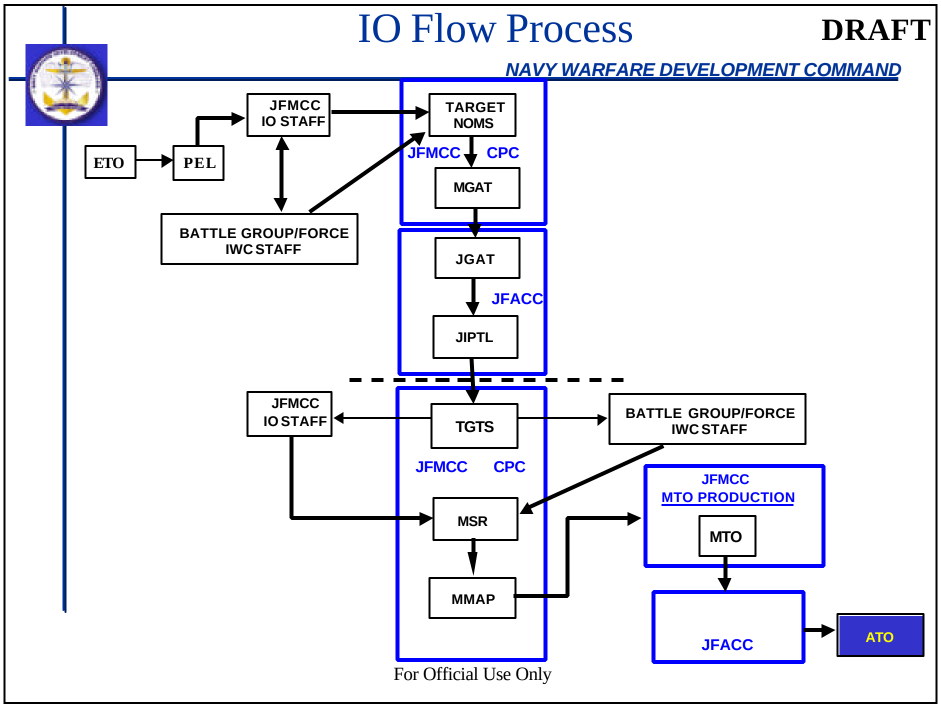

Figure 13-3. IO Flow Process Diagram.

- The Battle Group Information Warfare Commanders (IWC) Cell, located within the Ship's Signal Exploitation Space (SSES), selected each e-strike munition on a daily basis, for C2 targeting (72 hours in the future) as an item on a target nomination list (TNL).
- The TNL is sent to the Current Plans Cell.
- Current Plans Cell submits the TNL to the Maritime Guidance Apportionment Targeting (MGAT) Cell.
- The MGAT Cell passes the TNL on to the joint guidance apportionment targeting (JGAT) cell. The JGAT prioritizes the TNL based on the air operations directive (AOD) then deconflict the list based on duplicate nominations.
- The JGAT passed the results as the joint integrated prioritized targets list (JIPTL) back to the Joint Forces Maritime Component Commander (JFMCC) CPC Cell for generation of a maritime support request (MSR) for each target.
- The MSR is added to the maritime master attack plan (MMAP).
- The MMAP is passed to the JFMCC for maritime tasking order (MTO) production.
- The MTO is submitted to the Joint Forces Air Component Commanders (JFACC) Cell for review/integration and transfer to the air tasking order (ATO) for execution.

An example of an E-strike munition utilized in support of TCT on 28 Jul is shown in Figure 13-4.

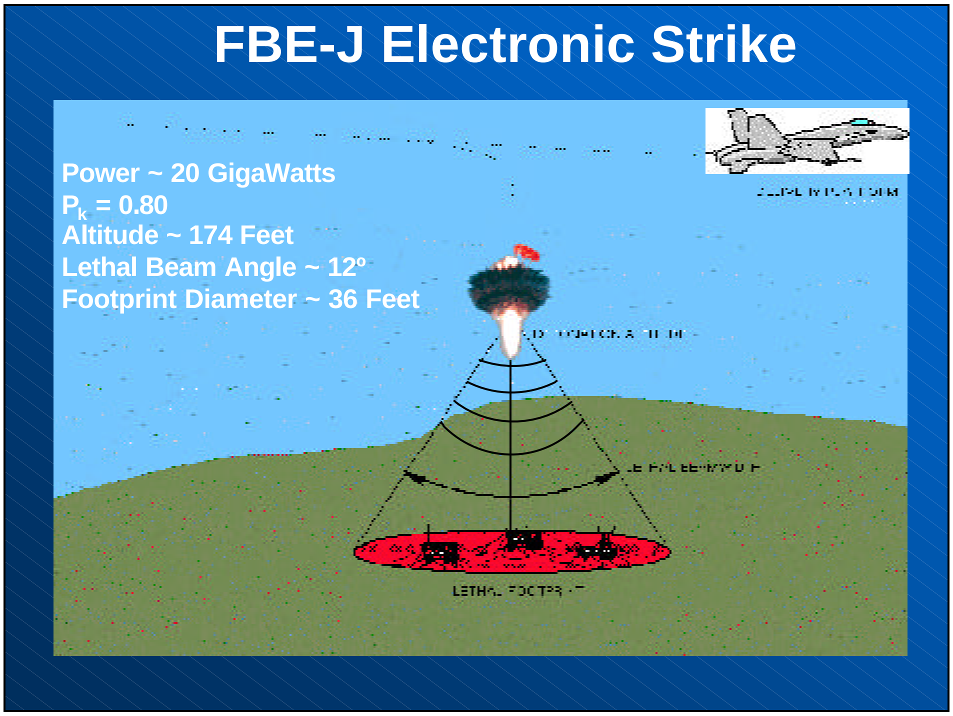

Figure 13-4. JDAM E-Strike on a C2 Small Extension Node 28 Jul 02

13.2.4.2 Findings on Offensive IO

- IO weapons not being integrated into SIM federation were initially thought to be of minimal consequence. However, the unexpected success of their incorporation and the resultant visibility created conflicts in SIM scenario play with respect to the BDA process and expectations from it.

- E-strike weapons not being loaded in TBMCS had a negative impact on weapon utilization in the Strike Warfare Commander (STWC) planning effort (30-50 percent of planned missions came from the ATO).

- The lack of BDA feedback after an E-strike detonation undermined the continued use of the Electronic-Strike weapon early in the fight. There was no E-strike BDA process and the unanticipated consequences effect of the use of this weapon on the larger MC02 scenario hindered decision-makers from regularly selecting E-strike capability[240]

- Electronic Attack options gained appreciable visibility at the CJTF level. Electronic-strike munitions were the most dominant option but other classified options also were discussed and received approval for use.

13.3 Summary of Key Observations

The IO enrichment to the JFMCC planning process was successful despite some serious shortcomings, which included:

- The IO cell was not as robust as it needed to be. More people are needed for expert support.

[240] Notes from Mr. Mark Henderson, Electronic-Strike Lead

- IO was not fully integrated into the JFMCC planning cycle. This integration is difficult to do without having the expertise and experience on both the IO and JFMCC sides of the planning process.
- IO is a different approach to warfighting and requires a different kind of thinking; proactive vice reactive for planning missions without targets, and subject matter expertise is essential to have at hand.

Collaborative IO planning in FBE-J was limited because the planning for this exercise did not require the IWPC capability. It is better applied at the theater planning level due to the SCI level of the support.

A hardened client successfully deflected direct Red team attacks through operating system (OS) wrappers and autonomic distributed firewall (ADF) configuration. The Red team was not successful in achieving the goal of disrupting time critical targeting during attack periods.

Operational commanders required the capability to launch theater-level, information attacks when appropriate. The offensive Information Operations experiment conducted during FBE-J, centered on utilizing E-Strike munitions in support of time critical strike scenarios. As FBE-J progressed, kinetic and non-kinetic IO fires were integrated into TST operations.

- Placing control of Information Operation weapons with the operational commander is critical for synchronizing kinetic and non-kinetic warfare.
- E-strike weapons were not loaded in TBMCS. This had a negative impact on weapon use in the Strike Warfare Commander (STWC) planning effort (30-50% of planned missions came from ATOs).

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14.0 Coalition Command and Control (C2) Initiative Key Observations

14.1 Experiment Objectives

The coalition initiative was the third and most ambitious experiment to examine multi-national participation in network-centric operations. FBE-F and FBE-H had examined a means for integrating coalition partners into a digital Fires network using a small U.S. enclave onboard a British warship. This initiative was to establish a multi-national command and control environment, facilitated by "smart agent" middleware technology, as a step toward pervasive sensing from an expeditionary sensor grid. It also served as an experimentation building block for developing future multi-national concepts within the U.S. Navy concept of network-centric warfare.

Doctrinally, the operational commander should be able to conduct operations more freely with a lead nation concept than with a parallel command structure, and primary warfare commanders should be able to assign forces based on how their sensor/weapon capabilities best complement U.S. forces, rather than establishing geographic separation of U.S. and other multi-national forces, creating artificial seams and vulnerabilities for a hostile force to exploit.

Information-based security should derive rule sets and policies based on the nature of the data to be exchanged and the sensor sources, rather than on platform nationalities and the connected hardware systems. It should be dynamic and responsive to the warfighter, not requiring months of review and certification, before available to provide interoperability of an ad hoc coalition force, such as Operation Enduring Freedom. Nor should different hardware be required to communicate with different multi-national partners.

The initiative focused on four primary areas:

- Interoperability of different command and control systems, facilitated by agent-based computing, to achieve shared awareness and improved collaboration thru a tactical picture derived from commonly shared data.
- Robust networking in a domain that allows for dynamic reconfiguration, using on-demand connectivity and tailored pull of relevant data for multi-mission assets. Use smart agents to improve communications reliability and network connectivity.
- Secure information sharing to constrain an environment where real-time "chat rooms" may predominate over record message traffic.
- A capability for improved collaboration with coalition partners for improved collaboration on network-centric issues.

The intention was to integrate live, virtual (manned), and simulated coalition forces across a secure wide area network, for collaboration associated with the detection, classification (including waterspace management), and localization of threat submarine contacts. This collaboration was facilitated over a "grid" to which users could register, and "subscribe to" or "publish" tracks of interest. The tracks were then handled and disseminated by rule-based software "agents". The agents, distributed across the network, provided the mechanism to share information for databases from the various, independent C2 systems.

The initiative was executed at the tactical level, with dedicated multi-national forces assigned under the tactical command of the Sea Combat Commander (SCC), primarily providing anti-submarine warfare support to assure access for maritime and follow-on expeditionary forces of the joint campaign. Once maritime superiority had been achieved, the last two days of the experiment were executed as a limited objective experiment (LOE) outside the main FBE-J scenario, focusing on combined arms command and control for maritime interdiction operations, and maintaining sea control/sea denial for logistics re-supply and freedom of navigation around a littoral chokepoint.

14.2 Analytic Questions

- What was the increase in combat capability? The intention was to quantify the value of allowing less capable coalition partners to strengthen their weaknesses in C4I and situational awareness through connectivity to U.S. and other coalition forces. At the same time, they provide additional sensor node information, which serves to augment and enhance the theater and local ASW coverage.

- What warfighting challenges does it address?
  - Multi-national interoperability.
  - Dynamic reconfiguration of networks supporting multi-tasked platforms or those with disadvantaged or intermittent C4 capabilities.
  - Reliability of network-centric architectures to exchange relevant information for distributed planning and decision-making.
  - Need for a better mechanism to support secure information sharing to enhance the coordination of operational forces while protecting national sources and data.

- What future desired operational capability does it support?

- Was it possible to:
  - Establish Coalition middleware environment in support of ASW mission?
  - Implement and use CoABS grid?
  - Evaluate information sharing/assurance requirements for Coalition ASW?
  - Integrate distributed heterogeneous C2 systems?
    - GCCS (US, CAN, UK), Horizon (AUS, CAN), and CSS (UK).
  - Use live sensors and pass live tactical data over the grid?
    - U.S. tactical data from DDG, SH-60, P-3.
  - Extend coalition battlespace awareness through rapid integration of new sensor sources (e.g., rapidly deployable system (RDS))?
  - Improve Situational Awareness through collaboration, using grid-enabled applications (browser-based collaborative sensor status, chat, e-mail)?
  - Preserve information security through the use of grid services?
  - Use policy-based tools for domain management?
  - Reduce operator workload through automation (agent-based data mining)?

- Determine if there is a common view of friendly and enemy situation by coalition participants.

- Determine if control of information available to coalition partners can be accomplished through database management.

- Identify the US/coalition security issues.

14.2.1 Establish Interoperability

This sub-initiative was primarily intended to identify developmental issues associated with implementing distributed middleware and agent-based computing, as a potential solution for requiring the same or compatible hardware (i.e. GCCS) for coalition interoperability. This effort integrated dissimilar distributed C2 systems with middleware, in order to share tactical data among GCCS (U.S., CAN), Horizon (AUS, CAN), and MTP (UK), and to demonstrate the utility of this solution for interoperability.

A secondary experimental function was to examine the effectiveness of agent-based computing in servicing U.S. and coalition platform sensors, such that common relevant information was provided, that enhanced the capability of the combined anti-submarine warfare (ASW) force in multi-national command and control decision-making.

14.2.2 Dynamic Network Reconfiguration

This sub-initiative used middleware as a tool to enable a robust network-centric environment. It was designed to permit rapid integration of sensor nodes within a wide area network. The architecture used Defense Advance Research Programs Agency (DARPA)'s project for control of agent-based systems (CoABS) grid structure of distributed database sharing, with intelligent agents managing data on the grid.

14.2.3 Secure Information Sharing

This sub-initiative assessed the requirements for secure information sharing in a coalition network-centric environment, and provided a potential alternative to implementation of the RADIANT MERCURY GUARD system with its hard-coded policies, and long lead times for policy changes. This effort experimented with the value of agent-based computing (ABC) to support selective disclosure and dissemination of information, as well as programmable firmware in network interface cards to implement policy-based management of the domain. This effort examined a model for information-based security focused on data and sensor sources, rather than on platform nationalities and connected hardware systems.

14.2.4 Develop Coalition Field Experimentation Capabilities

This sub-initiative was a "stepping stone" to build the capability to examine and resolve network-centric issues with coalition partners. The initiative gathered data for assessing the costs and benefits of agent-based computing. It was to identify technical issues and demonstrate the capability to leverage off distributed laboratories to support examination of coalition concepts in field experiments. Experimentally, this effort also examined concepts for employment for a prototype Royal Australian Navy (RAN) acoustic array technology, the rapidly deployable system.

[Additional background and data for this initiative were under the control of a separate organization. No baseline model, observational data, or other raw data were forthcoming, so no analyses were possible.]

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15.0 Netted Force Key Observations

Netted Force was an integral facet of network-centric warfare (NCW), focusing on knowledge processes, collaborative tools, and supporting organizational structures. Within Netted Force there were three sub-initiatives: (1) knowledge management organization (KMO) focused on organizational effectiveness of KMO officers in support of JFMCC command, chief of staff, and the battle watch captain; (2) collaborative information environment (CIE) addressed technical systems to support rapid decisive operations (RDO); and (3) ground COP assessed linkages between traditional COP track management, engagement tools, target management, and intelligence order of battle tools.

15.1 Experiment Objectives

The knowledge management organization was a new, exploratory concept for inclusion in FBEs. In concept the KMO could increase command situational awareness, decrease information overload, and provide for bandwidth management in support of combat operations.

The collaborative information environment (CIE) addressed systems to support information needs of distributed staff for planning and execution. Tools included the WIN 2000 active directory (AD) for shared services in support of rapid decisive operations (RDO). SharePoint Portal Service (SPPS) provided a single customized interface into information needed by war-fighters with facilities for document management and version control, subscription services to critical data, and data search and retrieval. Info Workspace (IWS) was for collaboration and real-time conferencing in support of a common situational awareness among distributed staff.

Ground COP was intended to simplify access to targeting information and thereby improve situational awareness among war-fighters. A secondary focus was a set of beta tools to help warriors understand and make decisions on targets, integrate target data from engagement systems into ground COP, and utilize GCCS 4.X and MIDB to support tactical and operational users.

15.2 Analytic Questions

Netted Force addressed high-level questions with respect to effectiveness of war-fighters conducting distributed operations, coordinated through online collaborative tools and environments. Systems integrated real-time sensor data to enable highly precise actions based on computer generated decision support technologies and instant knowledge from participants, sensors, feedback systems, and automated assistants.

Effectiveness was measured through assessment of systems and organizational processes supporting Netted Force, including KMO and CIE (and supporting systems). Performance was assessed through experiment reports, first-person observations and reports, surveys, and interviews.

KMO was observed for contributions that enabled a team of knowledge management officers to support decision-makers in their use of information, knowledge, and communications. Key participants included a JFMCC KMO that served as lead knowledge management officer, a plans KMO that worked with future and current plans cells, and an operations KMO that interfaced with the battle watch captain and personnel in the maritime operations center (MOC).

Knowledge management officers were responsible for information access and knowledge distribution including sensor linkages, new information, and application of decision support tools. Information, communication, and network technical personnel reported to the JFMCC KMO.

Effectiveness and performance measures were related to:

- Timeliness of decision support information.
- Relevancy of that information to critical decision-making.
- KMO contribution to information management.
- KMO input to bandwidth allocation decisions supporting operations.

CIE was positioned as the environment for distributed online information access, knowledge transfer, and collaboration. Use and application of web-based tools that supported information sharing, knowledge generation, and team collaboration were identified as areas for data collection. CIE included the common relevant operational picture (CROP) and supported ground COP through IWS facilities for real-time chat and common situational awareness. Data were collected with respect to CIE contributions in this capacity.

Effectiveness and performance measures in CIE were related to:

- Timeliness of information.
- Views of friendly and enemy situations.
- Technical domain structures for collaboration and communications.
- Services for document management and version control.
- Search and retrieval process for critical information.

The ground COP was envisioned to integrate all target information through a single application. Intelligence, target management, track management, and engagement tools were included. Battle watch officers were primary users. The ground COP secondarily supported common situational awareness for all war-fighters. Software for possible use in a ground COP configuration is several years from release, and MC02/FBE-J was intended to help define future functionality.

Effectiveness and performance measures with respect to ground COP included:

- Display of friendly and enemy locations and activities.
- Timeliness and accuracy of COP information.
- Mean time tracks and GCCS-M coordination.
- MIDB accessibility.
- MIDB relevancy and accuracy.

15.2.1 Events and Data Knowledge Management Organization

KMO was a new organizational concept for MC02/FBE-J. Millennium Challenge 2002 JTF Knowledge and Information Management Plan, with NWDC supplements for FBE-J, provided the basis for KMO operations. Additional guidance was from CCG3 experience and C3F work with the KMO concept. The intent was to enhance Joint Task Force and components through technical (CIE) and organizational (KMO) systems to provide critical information to decision makers. Knowledge management processes involved information "creation, receipt, collection, control, dissemination, storage, retrieval, protection, and disposition." Doctrine, manning, training and organizational impacts of the KMO concept on decision-making processes was the experimentation perspective taken in FBE-J.

Conceptually, KMO would aid in implementation of Joint Operational Doctrine and serve as an interface between the JTF mission and Commander. KMO would be fully aware of command information needs with authority to coordinate actions required to change processes to satisfy essential information needs. KMO was to work closely with JTF personnel of all ranks and coordinate procedures and capabilities to satisfy war-fighting requirements for the Commander and the entire battle staff—knowing where most, if not all, critical information and intelligence resided within a specific echelon's information environment. The conceptual model for the KMO is presented in figure 15-1. As illustrated, the KMO concept integrates three or four primary functions, with significant overlap in the fourth. This was an ambitious concept that was not fully realized.

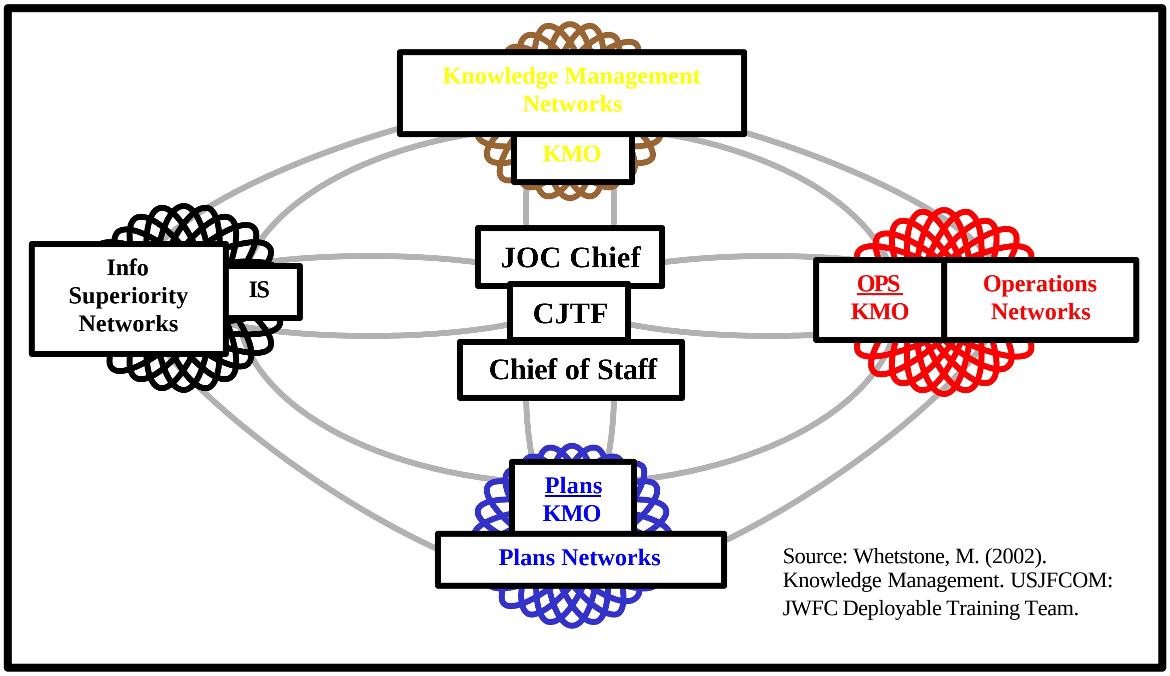

Figure 15-1: Conceptual Model for Knowledge Management Organization

CIE involved several new and prototype systems, and the KMO was responsible for training, implementation, maintenance, and utilization. CIE systems required considerable bandwidth, CPU power, and display capabilities—integrating voice, video, graphics. In addition, end-user computing platforms were required to integrate not only the CIE but also live sensor feeds, COP data, and specialized decision support tools. The collective network was itself a critical resource with KMO theoretically responsible for employing bandwidth as a war-fighting tool and directing adjustments in bandwidth to meet operational requirements. Major facets of CIE were achieved.

CONOPS for the Knowledge and Information Management Plan (KIMP) was assigned to KMO to support joint operational doctrine, JTF mission, and the Commander. JFMCC KMO was tasked to interact with the JTF KMO to coordinate knowledge and information management issues including review of JTF daily operations cycle and battle rhythms to ensure component operations were synchronized. Operations KMO was a resource for the Battle Watch Captain to help find key information and was tasked with network and communications infrastructure oversight. Plans KMO was positioned with the current plans cell and worked with planners to ensure access to key knowledge and information. These objectives were largely achieved but at an authority level less than originally envisioned.

In the original concept, key information and communications staff would directly report to the KMO:

- A maritime network control officer (MNCO), for technical aspects of the information program including physical networks, security services, communications equipment, and other information delivery technologies.
- A maritime interface control officer (MICO), for data links between forces in the theater to improve the single integrated air picture.

- A common operational picture (COP) manager to provide a timely, fused, accurate, and relevant picture to the JFMCC and Primary Warfare Commanders (PWCs) for feeding track data up to the Top COP, and for receiving Top COP data back for the JTF.

Database and web designers/developers maintained software, helped cells in the design of web sites (for access via SPPS), and assisted with maintenance of web-based decision support applications and collaborative tools. While these organizational positions were active in FBE-J, the enacted organizational reporting structure did not accurately conform to the original design.

In sum, it was the responsibility of the Knowledge Management Organization to know where most, if not all, critical information and intelligence resided. An Effects Tasking Order (ETO) would provide the basis through which information was translated into actable knowledge. The Collaborative Information Environment (CIE) would be the medium for collection, integration, value-added dissemination and coordination. These systems were in place, operational, and largely successful, albeit not at the levels or efficiency, or with the authority structure or stature originally envisioned.

15.2.2 Collaborative Information Environment

CIE is an umbrella term referring to a suite of tools intended to provide facilities through which war-fighters share information and ideas, thereby reducing planning timelines and enhancing organizational effectiveness. The environment was enabled by high-speed bandwidth connectivity and electronic collaborative tools to facilitate exchanges of information among JTF and organizations supporting or being supported by the JTF.

The set of collaborative tools were designed to coordinate distributed operations, essentially eliminating problems due to geographic separation or different time zones, to enable a level of synchronization that would permit effects based operations (EBO) and rapid decisive operations (RDO). CONOPS and evaluation criteria were based on the JFCOM Knowledge and Information Management Plan (KIMP). Common relevant operational picture (CROP) and the tactical operational planner's common operational picture (TOPCOP) were repositories for high-level decisions and CIE supported these tools by providing information targeted to tactical and operational as well as strategic personnel. Figure 15-2 illustrates the systems structure and architecture for the CIE.

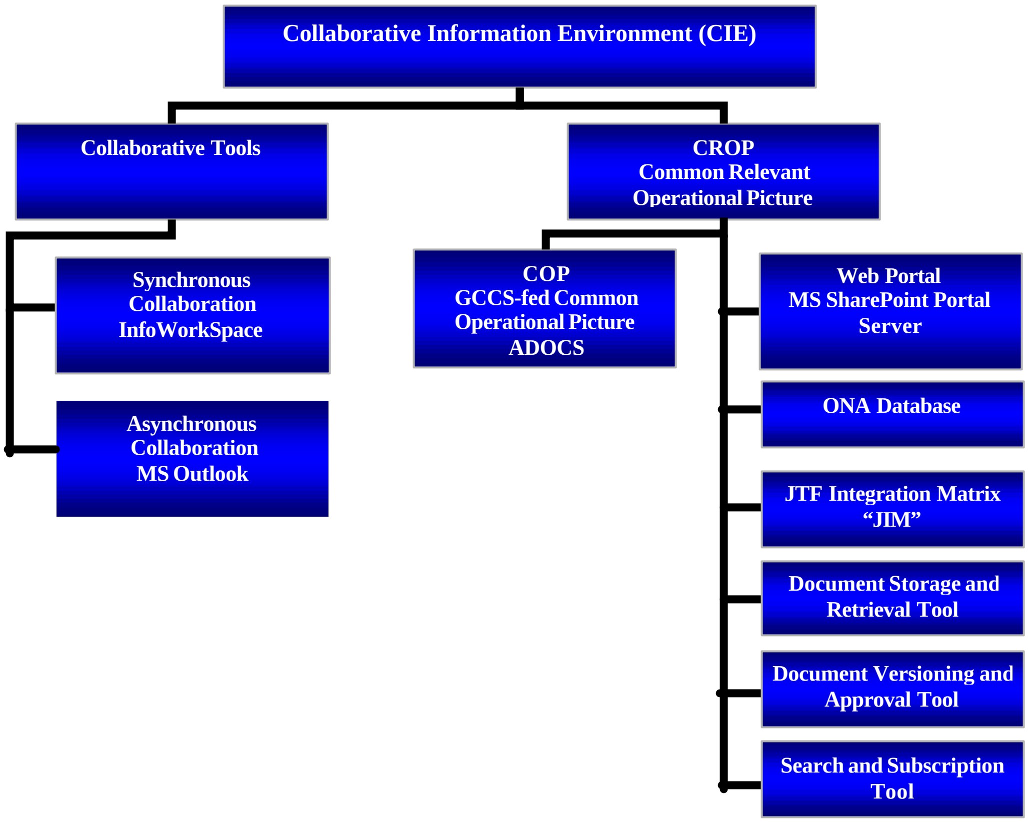

Figure 15-2. CIE Systems Architecture

A SharePoint Portal Server (SPPS) within the CIE architecture provided views into JFMCC components and links into media repositories organized by cell. SPSS used a digital dashboard layout and content interface. A search engine helped retrieve text using probabilistic ranking and auto-categorization of content. A subscription tool enabled users to subscribe to a document, folder, category, or search query and be notified when changes were made, either from within the portal or by e-mail. A document storage and retrieval tool provided built-in services for building web-based collaborative applications. SPPS was active throughout the experiment but subscription, versioning, and search facilities were not used to their optimal levels.

Documents could be checked in and out for individual updating as a component of document versioning and approval. Document changes, including metadata such as keywords, could be tracked and assigned different version numbers for auditing. Serial and parallel approval processes were supported. Applications were served through web portals (SPPS links into applications). There was a portal-based application for each JFMCC component (Figure 14-3), including a:

- Joint Maritime Operations Plan (JMOP) application that enabled JFMCC staff to translate JTF Effects Tasking Orders (ETO) for maritime operations.
- Maritime Support Request (MARSPREQ) application, through which the Principal Warfare Commanders (PWCs) input their requirements.
- Master Maritime Attack Plan (MMAP) application that allowed distributed warfare commanders to coordinate and set priorities for warfare tasking.
- Digital Target Folders (DTF) that served as the repository for information specific to an identified track or target.

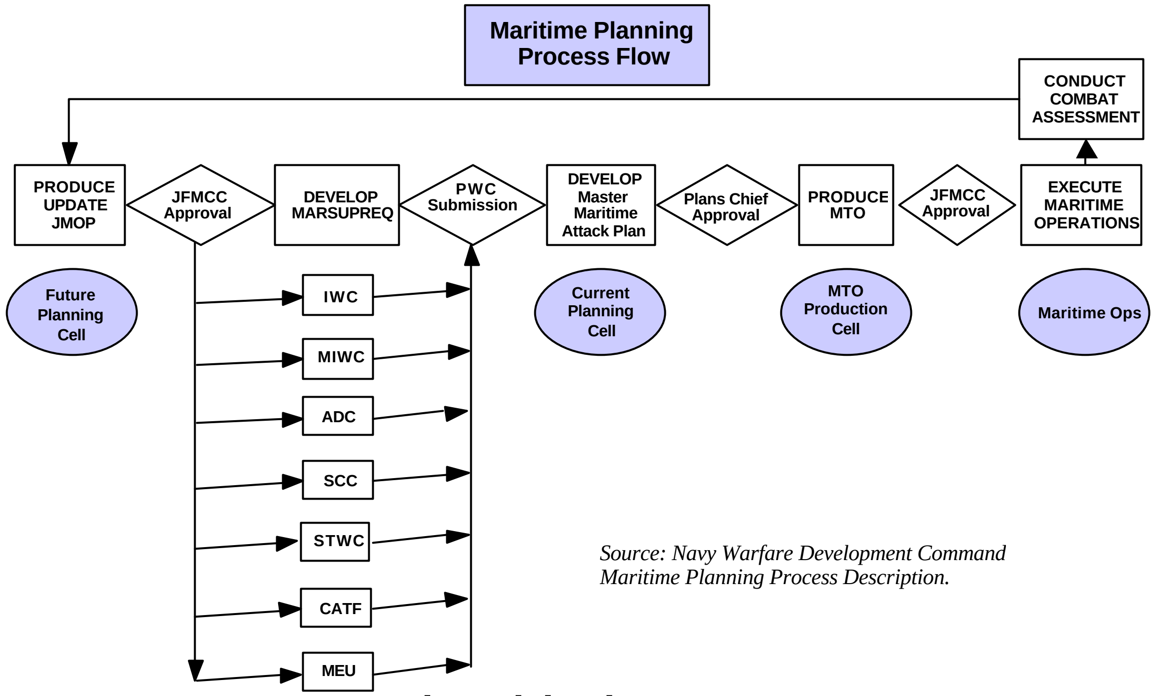

Figure 15-3. JFMCC Components and Knowledge Flow

Info Workspace (IWS) software provided facilities for real-time collaboration and chat, using the visual metaphor of buildings, floors and rooms (Figure 15-4). Real-time text chat and near real-time voice chat were supported. Participants would find the room of interest and navigate to it by logging into the appropriate server, building, floor and room. Participants in the rooms were visible, and secondary rooms could be opened for private conversations. For example, in a typical application the:

- Future Plans Cell would discuss revisions of the JMOP as dictated by current events and new ETO requirements.
- JMOP approval team would approve new and revised JMOPS.
- Master air attack plan team would develop the MMAP based on MARSUPREQ inputs, resources available and red force activities.
- MTO team would discuss development of the MTO based on the MMAP.

Figure 15-4. IWS Opening Screens and Visual Metaphors

CIE performance evaluation included assessment of observation data, daily experiment reports, interviews, and questionnaires. The objective was to ascertain the effectiveness of CIE to: (a) reduce planning and execution timelines, (b) enhance organizational effectives for distributed operations, (c) flatten organizational hierarchies and therefore decision-making, (d) enable self-synchronization, (e) enable rapid decisive operations (RDO), (f) integrate ADOCS/LAWS for situational awareness in distributed operations, and (g) utilize portal technologies (SPPS) to:

- Provide a single customizable interface into pertinent information.
- Provide information sufficient for rapid decisive operations.
- Manage documents and key version control.
- Permit subscriptions to critical services.
- Search and retrieve critical information.

15.2.3 Ground COP

Common Operational Picture (COP) was envisioned to concisely convey key information, which has always been difficult. Track management, intelligence, imagery, and target engagement functions have historically accessed different databases, conveyed different attributes, and been managed independently. Ground COP in FBE-J was to provide shared awareness of near real-time force disposition, tracking locations for enemy and friendly forces, and other relevant objects throughout the theater and supporting coalition. Ground COP would merge tracks and targets to provide the fighting forces with access to all information on a land contact, including imagery, MIDB, track history, engagement status, target folder, etc., all accessible through an icon on the COP. A single integrated picture was not fully achieved, although major facets of the concept were successful.

A key KMO role was to assist in the realization of war-fighter situational awareness by assisting with information and knowledge flows and integration to and from those systems responsible for the Ground COP. A COP information manager was to work directly for the MC02 JTF KMO. In FBE-J, a dedicated Ground COP team occupied workstations in the MOC and addressed infrastructure issues in theatre and supporting operations. Linkages between legacy COP track management and engagement tools, target management, and intelligence "order of battle" tools were through the GCCS4.X architecture. Ground COP thereby involved both new "program of record" systems and new procedures.

The centerpieces of the new technology were GCCS4.X and JTT2.1, set up as an enclave within the standard GCC3.X architecture. GCCS4.X / JTT2.1 was evaluated as a Ground COP replacement for GCCS(M)3.X, which was initially developed to support maritime warfare but proven inadequate as Naval forces increasingly engage land-based targets. Conceptually, new procedures would focus on the ability to fight a ground war from GCCS COP. Ground COP experimented with 10 to 12 deliberate or time critical targets per day to work through process flows.

Most FBE targets were processed within tradition C4I systems. Once a track was discovered that information was displayed in 4X COP. When a track was nominated as a target that information was reflected in COP and the target linked to supporting intelligence and target management information. A target could be added to TNL and an icon displayed on COP for war-fighter access. A target folder was developed in JTT and linked to the target icon in COP with users envisioned as able to access any data source accessible through a URL, in addition to the MIDB and IPL. While facets of the Ground COP were realized, there were a significant number of components that were not achieved, sometimes due to technical failures and other times due to training and support issues.

Effectiveness and performance measures in Ground COP were related to:

- Simplification of targeting information to improve situational awareness.
- Evaluation of beta tools to help warriors understand and make decisions on targets, including GCCS 4.X, JTT 2.1, MIDB, TES-N, and GISRC.
- Integration of targets from engagement systems into Ground COP, including LAWS, NFN, IWPC, and GISRC.
- Functionality and user friendliness of GCCS 4.X and JTT.
- MIBD support of tactical and operational users.

15.3 Baseline Model

Technical infrastructure for MC02/FBE-J followed initiatives advanced for the Global Information Grid (GIG), upon which servers resided. Three communications networks were available: (1) SIPRNET for classified (SECRET US ONLY) communications to provide secure access to information not available locally or on the network, (2) NIPRNET for unclassified information (E-mail, DoD and WWW pages), and (3) Top Secret/SCI Network for top secret/sensitive compartmented information (SCI) and communications with the Joint Worldwide Intelligence Communications System (JWICS).

Organizational infrastructure as outlined in KIMP was executed for Netted Force through the KMO. No specific operational sequence diagrams were associated with KMO since actions of the organization were in response to needs of war-fighters. Information processes and knowledge flows provided the basis for KMO operations, and these procedures were often tied to formal request for information (RFI) processes as charted in figure 15-5.

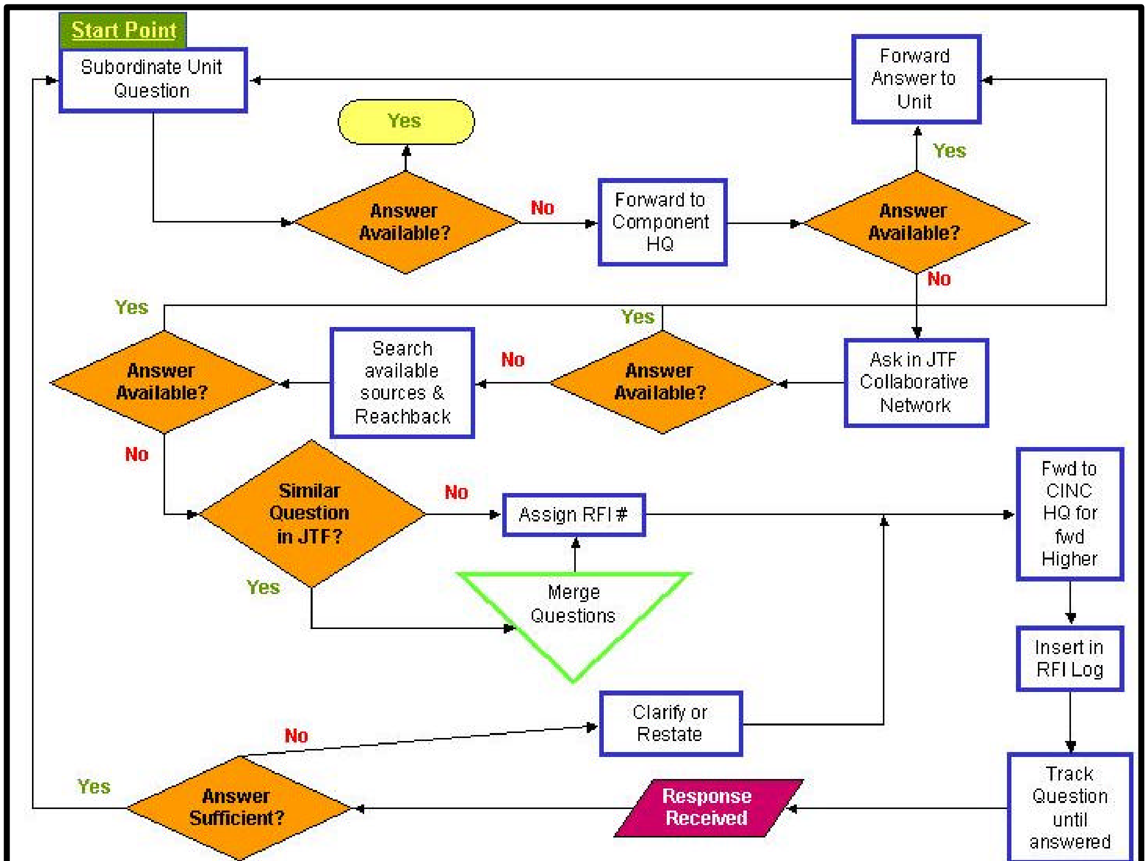

Figure 15-5. **MC02/FBE-J RFI process**
(Source: Joint Task Force Standing Operating Procedure, Information and Knowledge Management, 2002.)

KMO, as a high-level resource for information and knowledge management, was tasked to work with the Commander's Critical Information Requirements (CCIRs) to monitor the flow of operations, to identify risks, and to make timely decisions to assist in the execution of initiatives. Conceptually, a CCIR would be captured by the KMO and relayed to the Plans Director for inclusion in the planning process. After approval, the KMO would post the CCIR in the COP. The KMO would continuously monitor reports to help war-fighters maintain situational awareness. Intelligence requests and Request For Information (RFI) Processes were thereby within the domain of KMO oversight. There were conceptual and organizational problems with the RFI and CCIR processes in FBE-J and overlaps in authority with intelligence operations.

Questions posed in the collaborative environment would be researched, communications established with other KMOs, reach-back queries established when necessary, and answers input to the CROP/COP to make the information available to all JTF members. Figure 15-6 illustrates the information to knowledge transformation process.

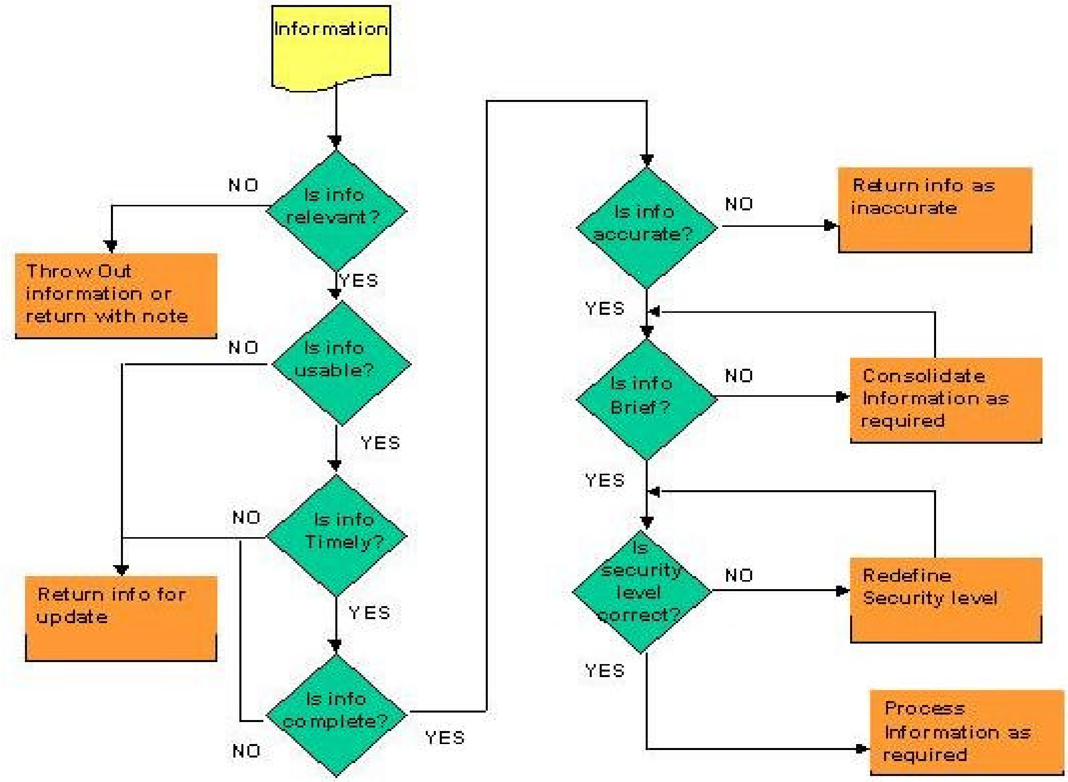

Figure 15-6. Information-to-Knowledge Transformation Process
(Source: Information to Knowledge Decision Tree. Joint Task Force Standing Operating Procedure, Information and Knowledge Management, 2002.)

SharePoint Portal Service (SPSS) was the CIE component that served as the war-fighters first point of information. The SPSS web portal aggregated content from web sites, web pages, and compliant applications such that each was available as a window or "portal" within SPSS pages. Figure 15-7 provides a screen capture of an introductory screen with a typical information layout and navigational system. Along the top is the navigation bar to other web sites, portals, and applications. A single sign-on authentication enabled war-fighters to access any resource after a general login to the system. Navigation was via a primary set of links across the top of the screen. Activation of a primary link would result in a secondary set of links positioned below the selected primary. Once in the proper area the available applications and resources would be visible.

Figure15-7. Typical SPPS Introduction Screen for FBE-J

Introductory pages provided links to component and supporting sites, and to general purpose and advisory information: daily briefing reports, new information pertinent to the experiment, etc. Information pertinent to a specific area or JFMCC component could be found in the component web site or application.

Within the conceptual framework of CIE, but not integral to SPSS, was the Info Workspace (IWS) collaborative tool. Marketed as one of the best collaboration tools available, Info Workspace ver. 2.5 provided virtual workspaces for team collaboration via the Web browser. IWS was a sophisticated system and the setup and synchronization requirements of servers across the GIG were significant. Results from Spiral 3 IWS technical tests indicated a partially federated configuration as optimal for MC02/FBE-J.

Federated JTF servers were:

- IWSIS.ad.mc02.jfcom.smil.mil.
- IWSOPS.ad.mc02.jfcom.smil.mil.
- IWSPLANS.ad.mc02.jfcom.smil.mil.
- IWSCONF.ad.mc02.jfcom.smil.mil.

JTF component servers not federated were:

- CIWS.CORONADO.ad.mc02.jfcom.smil.mil (Federated home host =IWSCONF.ad..mc02.jfcom.smil.mil).
- SIWS.norfolk.ad.mc02.jfcom.smil.mil (Federated home host =IWSPLANS.ad.mc02.jfcom.smil.mil).
- LIWS.lejeune.ad.mc02.jfcom.smil.mil (Federated home host = IWSOPS.ad.mc02.jfcom.smil.mil).
- NIWS.nellis.ad.mc02.jfcom.smil.mil (Federated home host = IWSIS.ad.mc02.jfcom.smil.mil).

Architecture of the servers is illustrated in figure 15-8. Servers had some self-synchronizing abilities such that information entered into one server could update parallel operations on other servers. However, the efficiency and effectiveness of this capability were not assessed in FBE-J since the technology was new and the primary level of interest was whether or not the basic technology worked and whether IWS was an effective replacement for IRC and sufficient to increase situational awareness to achieve a universal COP. Still, there were synchronization problems evident in the early days of the experiment.

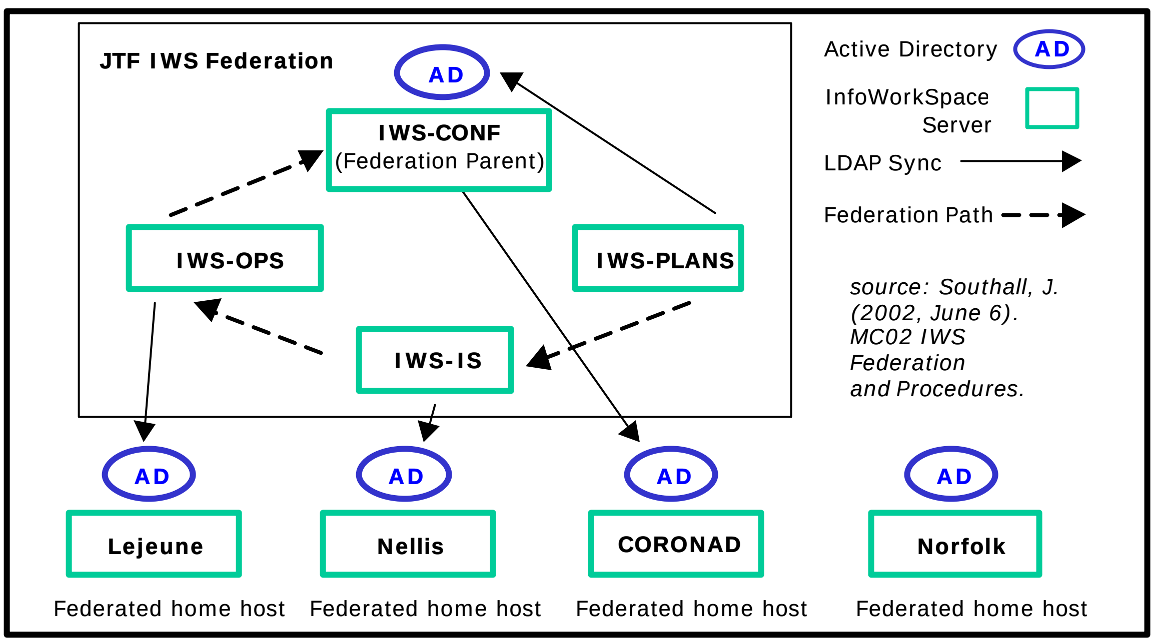

Figure 15-8. Info Workspace Server Architecture

15.4 Experiment Execution

Data were collected throughout the experiment by the analysis team, observers, and assigned data collectors. Categories of data included briefings, daily experiment reports, IWS and IRC chat logs, observer reports, e-mail messages, after-action reports and discussions of those reports, Quick-Look reports, miscellaneous memoranda and reports, notes from the analysis team, interviews with key participants in each initiative area, and administered questionnaires to key war-fighters. At the conclusion of the experiment the data and information were analyzed to produce the following sub-initiative observations:

- Cross-area assessments, wherein Netted Force initiative areas (KMO, CIE, SPPS, IWS, etc.) were secondarily addressed as parts of other initiatives and were an important facet of the evaluation

process. They revealed the effectiveness of the Netted Force from war-fighter perspectives as it supported other initiatives or operating areas (ASW, MIW, HSV, etc.).
- Cross-area synthesis, extraction, and analyses were enabled through the knowledge management capability of the Analysis Information and Knowledge Management System at the Meyer Institute of Systems Engineering at the Naval Postgraduate School.

High-level effectiveness and performance measures with respect to Netted Force helped to determine how well the Netted Force initiative, KMO concept, and CIE can:

- Reduce uncertainty.
- Increase situational awareness.
- Decrease information overload.
- Shorten decision cycles.
- Address bandwidth as a war-fighting tool.

KMO was assessed from command, staff, and war-fighter perspectives. CIE and its components were evaluated primarily from war-fighter and secondarily from staff perspectives.

15.5 Knowledge Management Organization

The quantity of information available to war-fighters has increased exponentially over the past decade. Knowledge needs have escalated, and the ability to analyze, sort, associate, correlate and fuse information to generate knowledge in support of command and war-fighter situational awareness has become a priority. KMO was intended to improve decision making through an organizational structure that ensured that the best information reached key decision makers at the correct time; that systems and processes critical to COP generation were operational and providing optimal levels of information flows and integration; and that collaborative and information processing tools were used effectively by all experiment participants.

KMO was a new organizational construct for FBE-J/MC02. Objectives were set at a high-level and were somewhat ambiguous, with goals such as the facilitation of information flows across the JTF, and support for the JFMCC process. If implemented as envisioned, demands on KMO would be significant and across all mission areas. There were mixed results. KMO leadership and staff performed with efficiency and effectiveness. There were operational problems in tasking, training, support and implementation. Technical issues prohibited a universal COP and high-efficiency CIE so in these areas KMO effectiveness was limited. As an organizational construct, the KMO in FBE-J was without the organizational stature, support structure or authority, commensurate with the assigned responsibilities and high-level objectives. In addition, KMO duties overlapped with those filled by the N2 and N6, with N2-equivalent duties focusing on the RFI process and finding critical information, and N6 duties on the management of networks and infrastructure to access that information.

The following definitions are provided to help frame the analysis:

- “Data” are sensor or machine-based output
- “Information” is processed or enhanced data, including both structured and unstructured resources (e.g., memos, letters, briefs)
- “Knowledge” is processed information such that context has been added sufficient for decision support, including situational awareness and action based upon new understanding.

Knowledge is therefore, a value-added resource to information that provides guidance, clarification, insight, and understanding. Some background on knowledge operations in the private sector may be useful for analysis given that the organizational structure as envisioned for MC02/FBE-J KMO seems to have drawn perspective from the private sector.

Knowledge operations with a chief Knowledge Officer and supporting staff are relatively new but increasingly common in corporations, especially for those companies in information-intensive industries (i.e., Xerox, Price Waterhouse Coopers, etc.). In the military, J9 has advanced knowledge management concepts and developed the Knowledge and Information Management Plan (KIMP) adopted by NWDC and upon which the KMO for FBE-J was based. The KMO concept was new to Fleet Battle and Joint Forces Experimentation and there were problems, as identified by leadership in the KMO and data collected by the observers and analysis team. The KMO was internally aware of the difficulties and repositioned itself to optimize effectiveness given inconsistent organizational directives.

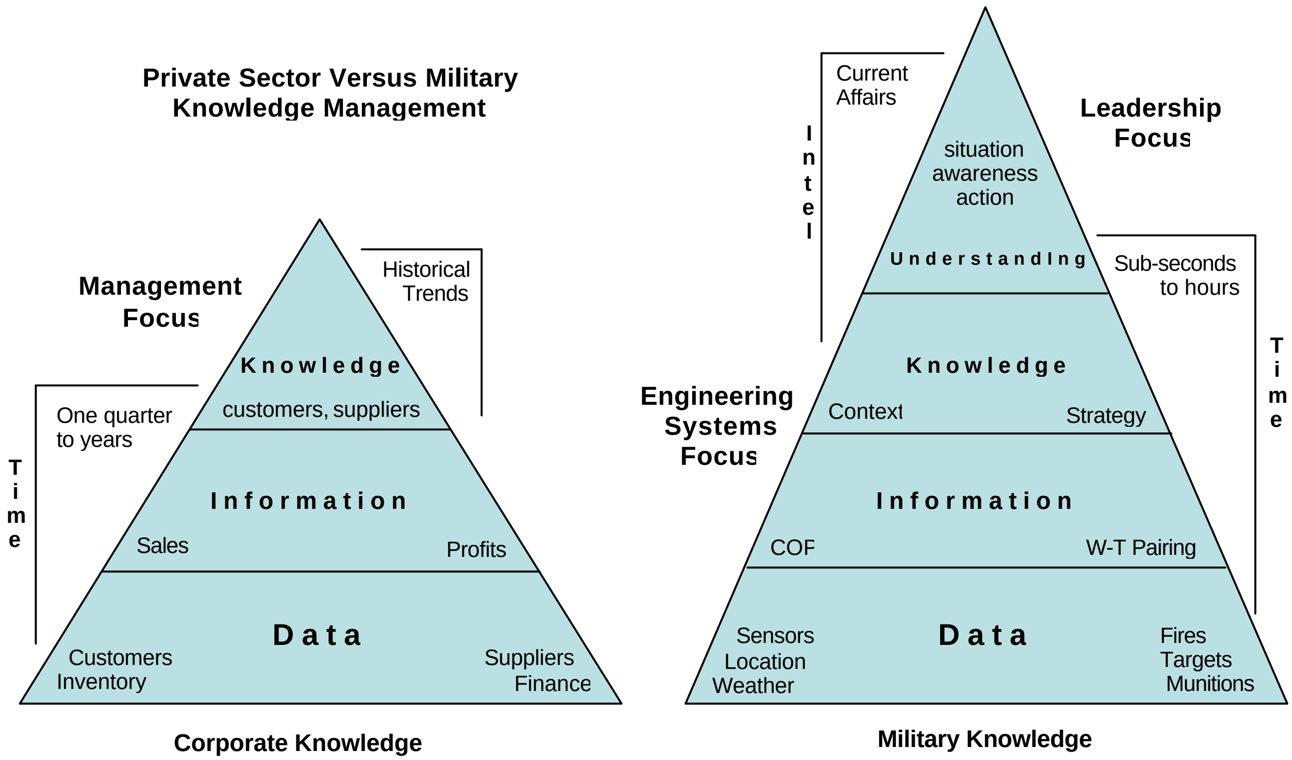

Figure 15-9. Corporate Versus Military Knowledge Management

An analysis concern is that parallels have been drawn between military and corporate KMO operations and this may have unintentionally hindered opportunities for success in FBE-J. Significant advances in private sector KM technologies have increased productivity, placing the KM concept into public awareness. However, there are significant differences between organizational structures in the military versus the private sector (figure 15-9) and it may be unproductive to superimpose corporate practices on the military. In many respects, this appears to have occurred.

Corporate KM tends to focus on historical and trend analysis. Military KM needs such historical and trend assessment for its analysis operations. However, for military operations the war-fighting need is for KM to support near real-time decision-making and situational awareness in highly dynamic environments. Knowledge tools developed in the private sector are viable for dynamic environmental and situational assessment, supporting COP and strategic decisions. However, military and corporate implementations are too diverse to attempt exact organizational parallels. This divergence was perhaps responsible for redundant responsibilities in FBE-J and for overlaps between KMO and intelligence operations in the requirement for information (RFI) and the commander's critical information requirement (CCIR) processes.

KMO was to enhance JTF and component ability to fight by getting critical information to decision makers, with KMO envisioned as overseeing internal and external information flows. This occurred only to a relatively minor extent, largely because KMO was not brought into JFMCC and command operations at a level sufficient to act at strategic levels or with control over critical communication and/or operational information flows for tactical considerations. Partly due to the high level of technical expertise the KMO brought to the experiment, the officers instead focused on implementation and maintenance of information and communication technologies, but at a technical and operational level rather than strategic. This situation could be corrected in upcoming experiments by integrating KMO into senior command strategic sessions, training both KMO personnel and senior leadership in effective KMO practices, and ensuring KMO is assigned sufficient technical support personnel to prevent that organization from becoming burdened with technical matters.

To the credit of KMO, during FBE-J the officers recognized significant technical difficulties, especially with operational aspects of the CIE (SPSS and IWS), and filled a needed technical assistance role as operational oversight for CIE services. However, once in this capacity (generally in the first third of the experiment) the KMO was effectively "out-of-the-loop" for the high-level, strategic planning and knowledge support operations originally envisioned. After technical difficulties had been resolved KMO was not able to return to, or achieve, high-level status or strategic operations. Had KMO not shifted to assume technical support, the overall experiment would likely not have been successful since technical problems in the early days of the experiment were very prominent (user training, systems interoperability, communications problems, etc.). Still, in a war-fighting operation, we can assume that end-user training would not be such an issue.

Interviews and questionnaires revealed that KM officers did not feel the position was the billet described in the Knowledge and Information Management Plan and was not adequately addressed in the JFMCC architecture. All KMO officers voiced support that their work was more in the technical and troubleshooting area, especially during the first half of the experiment, generally in JFMCC RFI and CIE processes. There was a shift to information and knowledge tasks later in the experiment, although never at the strategic level envisioned. Nor were information discovery, decision, or COP support objectives realized. KMO communications were in line with objectives, with JFMCC KMO coordinating with JTF KMO and minimally with JFACC and JFLCC KMOs. OPS KMO assisted with OPS and BWC, posting briefs, helping to find data, answering the phone, sharing information on system outages, and interfacing with tech support. Plans KMO assisted with operations in current and future planning cells, posting briefs and helping with collaborative tools. Responses to the question of position definition revealed quite different perspectives among the JFMCC, Operations, and Plans KMOs. High-level objectives for the KMO were not adequately communicated or understood, and the mix of operational, tactical, and strategic responsibilities will require better and more precise definitions. Personnel to staff the positions will need to be chosen carefully to ensure correct interpretation and execution.

A critical aspect of knowledge management, as traditionally implemented in non-military operations, involves value-adding processes through which information is placed into context or infused with critical insight to provide decision support. This would be implied in the JTF Knowledge and Information Management Plan. Yet, in assessing their role in this process, the officers in the FBE-J KMO tended to interpret charges at tactical and operational status rather than strategic. As such, FBE-J KMO found little overlap with N2 operations for RFI processes and the finding of critical information, and a great deal of overlap with the N6 and the management of networks and infrastructure. This was likely due to the absence of a military J6 (outsourced to contractors in FBE-J) and previously discussed technical voids that the KMO filled.

When asked to provide specific recommendations for the future, KMO officers identified the need for: (a) adequate military J6 technical support personnel to relieve the KMO of these duties, (b) better definitions of duties to be performed by each KMO position, (c) appropriate authority designated so that each officer could perform expected duties, and (d) KMO ownership of assigned processes to enable the completion of strategic and tactical knowledge objectives (e.g., full cycle sensor-to-BDA objectives and value-added processes).

Area 1: Information discovery and management
Area 2: Decision support information
Area 3: Overall contribution to information management
Area 4: Overall technical management
Area 5: Overall content management
Area 6: Overall workflow management
Area 7: Bandwidth management
Area 8: KMO position authority and procedures clearly defined
Area 9: Overall value added to JFMCC

Figure 15-10. KMO Assessment Areas

Areas assessed for evaluation of the KMO are identified in figure 15-10. Questionnaires distributed to KMO users revealed an overall appreciation for KMO, its officers, and the expertise provided. Respondents were primarily from current and future plans, which also had the highest level of direct contact with KMO so this was to be expected. The MOC/BWC participated. Responses ranged from generally unaware of the KMO, to dissatisfaction with the CIE and KMO, to broad-based support for the KMO, with the majority of respondents in the latter category. Still, the satisfaction was with the technical assistance provided, whether in CIE operations, briefing development, or general software troubleshooting. Questions attempting to draw a distinction between KMO as a high-level management resource versus a mid-level technical resource revealed a general inability of respondents to envision KMO as fulfilling many of the high-level objectives envisioned in the KIMP. There was general agreement that the complexity of the technologies and processes warranted an organizational unit to assist users with operational tasks.

KMO effectiveness was addressed in various sections of FBE-J experiment data, in addition to qualitative surveys. The Information and Knowledge Management System (KMS) used by the NPS analysis team was able to pull quantifiable data from qualitative FBE-J experiment data contained in survey results, chat logs, daily experiment reports from observers and initiative leads, QuickLook reports, personal interviews between analysts and KMO officers, and miscellaneous data from other areas. The NPS KMS advanced search functions and AI features were used to generate a 20 percent sample across experiment data and produce the breakouts in figures 15-11 and 15-12. No rating (no visible bar chart) indicates that war-fighters indicated an unknown, zero, or negative effectiveness (ineffective) rating in that particular area. The charts were designed to measure effectiveness in the environmental contexts present in FBE-J so that comparisons can be drawn across experiments and environmental conditions.

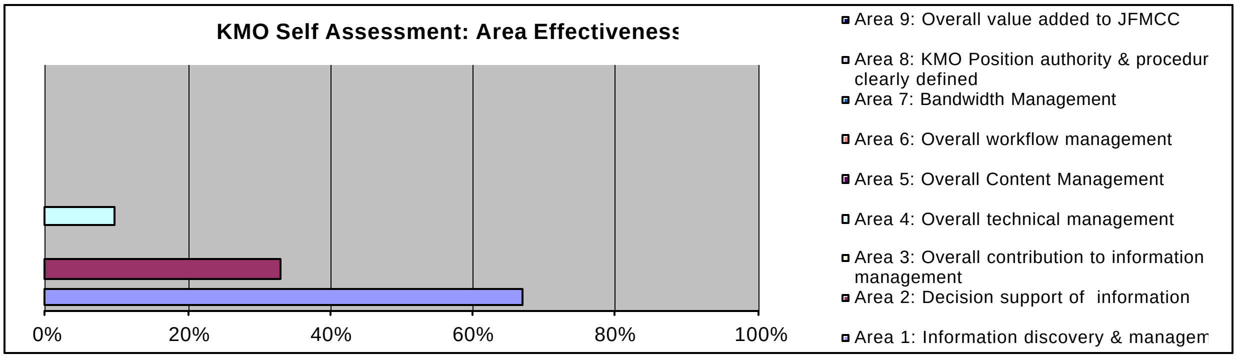

Figure 15-11. KMO Self-Assessment in Identified Areas

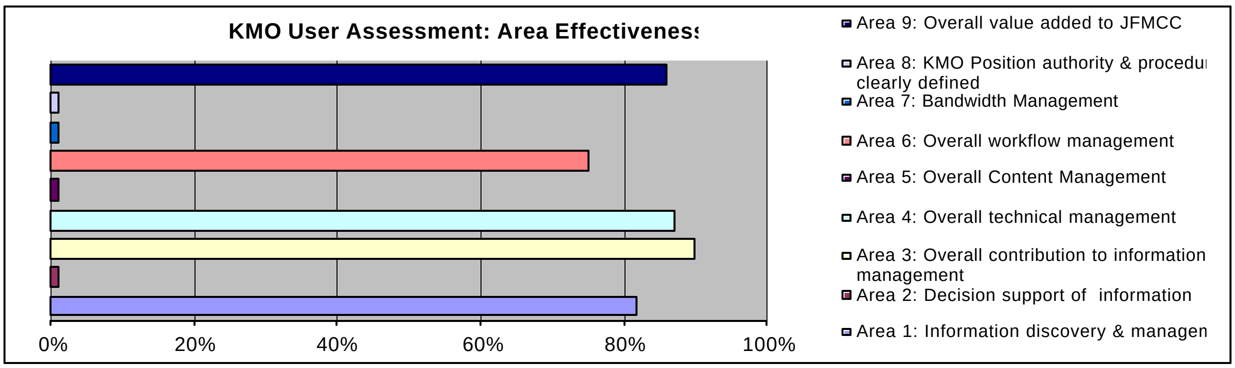

Figure 15-12. KMO User-Assessment in Identified Areas

The data indicate that users overall rated the KMO higher than the KMO personnel rated themselves (Area 9). The KMO officers did not generally perceive the organization to have achieved the expectations derived as set forth in the KIMP. They generally questioned whether the positions as implemented (versus as defined) were of value to the JFMCC. The users were likely addressing overall need for the KMO, which they ranked as very high, but were also unaware that the objectives as originally established had not been realized. Area 8 reflects this discrepancy.

Area 7, bandwidth management, was organizationally within the KMO but not operationally or in practice, as previously discussed. The concept of bandwidth as a war-fighting tool, with the KMO responsible for bandwidth utilization and dynamic reallocation of bandwidth to meet operational requirements ((i.e., COP vs. IWS) was not realized. The capability to perform this function was not readily available to the KMO, nor were appropriate management strategies defined. Still, interviews with, and observations of, technical personnel controlling LAN and WAN network communications indicated a highly sophisticated operation (organizationally within the KMO, although not in a direct reporting relationship, since KMO leadership were uniformed military and KMO information and communications technical staff were contractors). Still, KMO bandwidth management as described is highly relevant considering anticipated next-generation network management systems for dynamic allocation of CPU cycles across the network.

The very low (or negative/ineffectiveness) ranking of workflow in the KMO self-assessment versus the relatively high ranking of this service by the users reflected the assignment of the Plans KMO to work full-time and actively with the Current and Future Plans Cells. The non-existent ranking of this same category by the KMO internal staff once again indicated that the function was not implemented as originally designed, with the KMO operating effectively at the technical, operational, and perhaps tactical levels, but not achieving the strategic levels envisioned.

The very low rankings in content management by both the KMO and users indicated that a core KM objective was not realized. Technical management received a very high rating by users and a low rating by KMO, likely reflecting that while KMO was active in technical management this was not a primary objective of the initiative, or at least the types of low-level technical management KMO performed in FBE-J. A similar situation in information management where users rated the service very high yet the KMO very low, reflecting that the types of information managed was not at the strategic levels envisioned but rather at operational and tactical levels.

A reverse situation occurred with regards to decision support information where users rated help in this area very low, while KMO self-assessed at a moderate level. This discrepancy may be explained by an over-weighting of current and future plans cells in the KMO users survey (which was appropriate given the positioning and interaction responsibilities of the KMO). Decision support would typically be a primary KMO duty, but visible results would not necessarily be apparent to most users since in an electronic environment the matter of who produced the knowledge or made the knowledge processes available may not be readily discernable.

Area 1, information discovery and management, was rated highly by both the KMO and users. In this area KMO was successful, and this is likely one of the most important areas in the KMO initiative. This would also be considered a base or foundation upon which other areas could build. So, the foundation has been laid for a KMO through FBE-J, and what remains are the advanced functions for further refinement in subsequent experiments.

In sum, both technical management and knowledge coordination functions require redefinition of doctrine, manning, training, organizational practices, and implementation routines. Still, the concept is highly viable, critically important, and should be continued into the future. There are some important parallels, and differences, in the implementation of a military KMO versus a KMO in the private sector, from which the concept was likely derived. Hopefully the above discussion will aid in the recognition of critical strengths and differences between both approaches and will thereby aid in the development of more effective routines and objectives.

15.6 Collaborative Information Environment

The Collaborative Information Environment (CIE) was not a single technology but rather a collective of online services and applications. Included were facilities for information sharing, resource planning, timeline execution, workflow collaboration, and real-time multicast conferencing. CIE, along with TES-N, GCCS-M, and ADOCS/LAWS, was instrumental in realization of the COP. CIE supported radar, visualization, and weapon-target pairing operations. A prominent difference between CIE and sensor and weapon-target technologies was its focus on collaboration and knowledge transfer.

Routing within the network infrastructure was through a subscription-based multicast architecture wherein multiple war-fighters would receive the same communications at the same time, essentially the capability of a broadcast architecture without the overhead and extraneous messaging to non-interested war-fighters. Multicast routing/messaging has time-efficiency advantages over unicast or point-to-point communications but can directly impact overall bandwidth. Multicast would lend itself to the generation of an accurate and universal COP.

Bandwidth conservation requires specific identification of appropriate receivers and will likely need to accommodate dynamic re-allocation based on changed war-fighter objectives, a difficult and complex issue perhaps beyond multicast architectures, especially for multimedia communications. Alternative means, such as SPPS or portal-based messaging systems and personalized portals for individual war-fighters, may be a viable option. Early indications of this capability were evident in FBE-J. Future experiments may wish to establish a matrix of communications variables configurable between portal-based and multicast services and establish distinct communication and information priorities (matrix elements) as variables for analysis. JFMCC component applications were available within SPPS and were effective.

SPPS served as the default web page for the experiment. Overall SPPS functionality was impressive with few software crashes. The interface effectively integrated applications necessary for JFMCC project coordination. Still, key experiment systems were not available as portals, nor could they be activated or linked through SPPS, including LAWS/ADOCS, Information Work Space (IWS), GCCS-M, TES-N, and Internet Relay Chat (IRC). COP systems were thereby not integrated with SPPS. LAWS/ADOCS, with a highly intricate interface, is perhaps not appropriate as a portal or web service. A universal COP, and full integration with the CIE, would require significantly better computing and display facilities.

Web portal technologies are the preferred interface for web applications over the next 3-5 years. Integration of computer-based services into a unified interface enhances usability and war-fighter effectiveness. Future implementations of portal technologies (SPPS or others) may wish to experiment with options for the delivery of current non-portal services, or facets of those services, as web portals (e.g., LAWS/ADOCS, IWS, TES-N). This integration would enable collaboration around visualization or target-weapon pairing data while conserving bandwidth. COP systems within portals will help create a unified CROP/COP. War-fighters might select services within their desktop environment and customized, personalized portal interface.

Conceptually, the SPPS single sign-on feature enabled war-fighters to sign into one service and access all services, regardless of server or network. However, since not all services were SPPS-compatible, this feature was not operational outside the SPPS environment. IWS operations did not have single sign-on across the network. As such, IWS operations were initially somewhat hindered since several of the JTF Component servers were not federated, requiring that personnel at the non-federated sites log out of their own server and log into one of the federated servers to attend certain meetings (or open multiple windows, which was a common procedure). For each login the war-fighter would need to type in the fully qualified domain name and "federated" host. This was a hindrance during initial workstation setup when war-fighters would open Chat areas. If during an engagement war-fighters were required to attend a briefing in an IWS conference room on a non-federated server, or a server requiring a separate login, then that war-fighter would need to engage in a time-consuming procedure.

IWS security and clearances were an issue. In theory, conference attendance was monitored and personnel in inappropriate conference rooms would be asked to leave if they did not belong in that meeting. This process was not clearly defined nor were monitor personnel clearly identified, although for SCI or similar conferences this policy was likely enforced. Questions on conference privileges were to be routed to the KMO. However, in FBE-J, the conference room monitor role was not a KMO priority, and the process was likely not enforced. Still, the overall effectiveness of the IWS online collaborative environment was clearly evident throughout the experiment. IWS occupied considerable desktop space on war-fighter computer displays throughout FBE-J and was one of the primary resources in the MOC.

War-fighters would open multiple IWS windows and often cut-and-paste information from one room into another as a means of keeping peers abreast of activities in other pertinent rooms, although this was not an intended use of the system and caused problems since time stamps were often carried forward with the “paste” resulting in confusion for those later joining a conference. A mechanism to post supplemental materials was available but unused, likely due to a lack of familiarity with that feature, or perhaps ignored since this would introduce yet an additional screen and procedure.

Submarine-based participants were not able to use IWS due to bandwidth and synchronization limitations and instead used Internet Relay Chat (IRC), resulting in yet additional windows. Synchronization and time accuracy was an issue, not only between IWS and IRC but also between (virtual) buildings on different IWS servers. A time-stamp feature with Zulu time needed to be manually activated by war-fighters.

Web activity logs generated by NWDC for the period 24 July to 15 August included data from 45 different networks and 1251 unique machine IP addresses. File access and categories were recorded (Figures 15-13 and 15-14). Figure 15-13 illustrates the division of SPPS utilization between web site or portal pages and the JFMCC component applications that resided within SPPS.

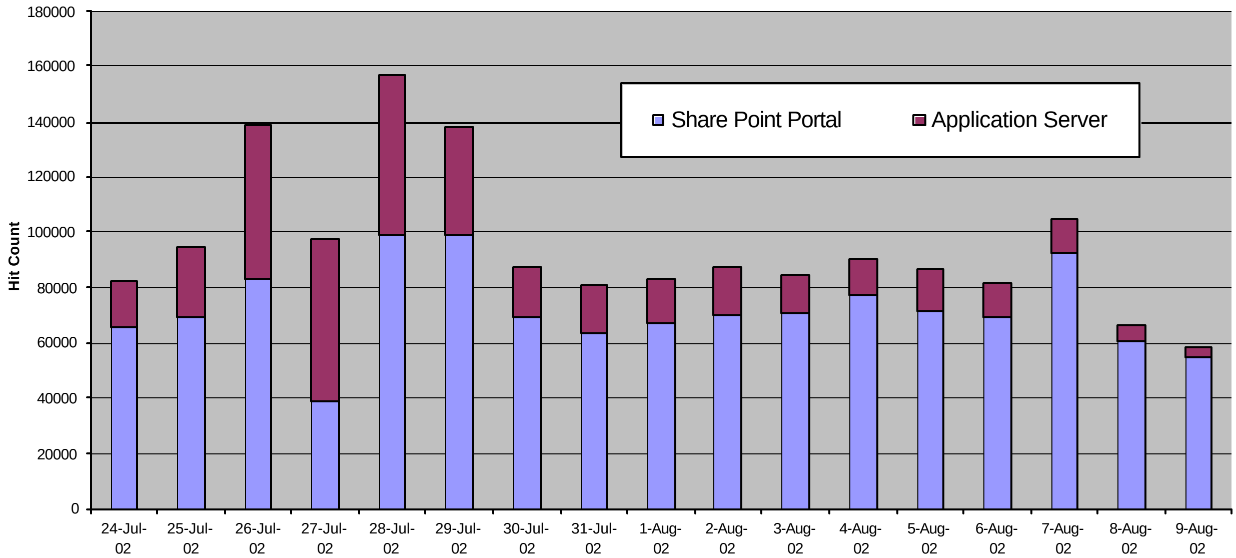

Figure 15-13. Share Point Portal Server and Application Server Utilization

Hits	JFMCC Area	Document
643424	Future Planning Cell	/jfmcc/documents/amwc/status/current issues.ppt
29516	Future Planning Cell	/jfmcc/documents/scc/nwdc supporting docs/asw dcp(060602).doc
25247	Future Planning Cell	/jfmcc/documents/scc/scc daily intentions archive/dim30jul02.doc
17108	Future Planning Cell	/jfmcc/documents/plans/future plans/archive/ bautista read file/lists/forces_army master_essink3_10may02.xls
10183	Future Planning Cell	/jfmcc/documents/iwc/io/io weapons basket.ppt
3217	Current Planning Cell	/jfmcc/documents/plans/current plans/mmap final briefs/f01 mmap brief.ppt
1352	Current Planning Cell	/jfmcc/documents/plans/current plans/resources/archive/evarts/ copy of capabilities brief-usn with hyperlinks.ppt 1.ppt
1201	Current Planning Cell	/jfmcc/documents/plans/current plans/resources/archive/aar forms/maldonado.doc
518	Current Planning Cell	/jfmcc/documents/plans/current plans/resources/archive/postspiral data form.doc
378	Current Planning Cell	/jfmcc/documents/plans/current plans/resources/archive/jcb 11june 02.ppt
87	MTO Production Cell	/jfmcc/documents/plans/mto production/blank mc02 mto process capture sheet.doc
44	MTO Production Cell	/jfmcc/documents/plans/mto production/oparea descriptionsm 10jun02.doc
35	MTO Production Cell	/jfmcc/documents/plans/mto production/mto prod battle rythym.ppt
26	MTO Production Cell	/jfmcc/documents/plans/mto production/how to save mto as a text file for web posting.doc
2	MTO Production Cell	/jfmcc/documents/plans/mto production/maritime planning process quality assurance.doc
19929	Maritime Ops	/jfmcc/documents/intel/isr cell/daily live isr post-mission reports/vc-6-2 30jul02.xls
2530	Maritime Ops	/jfmcc/documents/jfmcc/image/maritime startex_rev3 mod 2.ppt
139	Maritime Ops	/jfmcc/documents/plans/mto production/ maritime tasking order tactics techniques and procedures.doc
92	Maritime Ops	/jfmcc/documents/plans/maritime tasking order tactics techniques and procedures.doc
58	Maritime Ops	/jfmcc/documents/km-cie/processes/ maritime tasking order tactics techniques and procedures.doc

Figure 15-14. SPPS Active JFMCC Documents

The highest application utilization was for the period of 26-29 July, likely reflecting the critical events active in this period.

Figure 15-14 denotes the most active files for JFMCC components. As would be expected, the Future Plans cell contained the most activity followed by Current Plans and Maritime Ops. The current issues brief was the most accessed item. Assessing the total number of hits across all documents in each JFMCC component area revealed the order from highest to lowest viewed as follows: Future Planning Cell, MTO Production Cell, Maritime Ops, and Current Planning Cell.

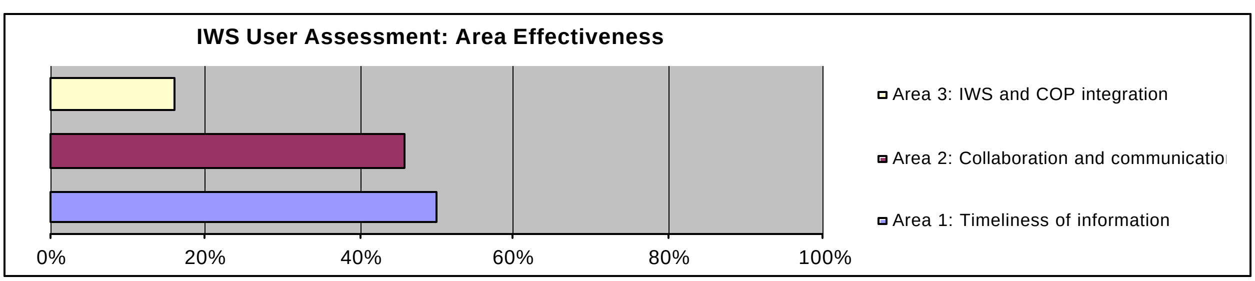

Figure 15-15. IWS User-Assessment in Identified Areas

Users of IWS services were sampled across all experiment data and a 20 percent sample was drawn (with equivalent weighting across daily experiment reports, chat areas, observer reports, survey data, questionnaires, interview data, QuickLook reports, and miscellaneous report) (figure 15-15). The response sample indicated a 17 percent effectiveness rating for IWS integration with the COP, a 43 percent rating for IWS capabilities for collaboration and communication, and a 45 percent rating for the timeliness of information provided by IWS. While these numbers are somewhat lower than would be expected they may reflect the inability of submarine forces to utilize IWS, invoking IRC Chat instead. The newness of IWS was likely a factor, as were the previously discussed problems with multiple windows, time synchronization problems in the first part of the experiment, the cut-and-paste issues between windows as previously discussed, and the predominant issue that the CIE and COP were separate, independent systems. Ideally the systems would have a much higher level of integration and the war-fighters would have better computing and display capabilities.

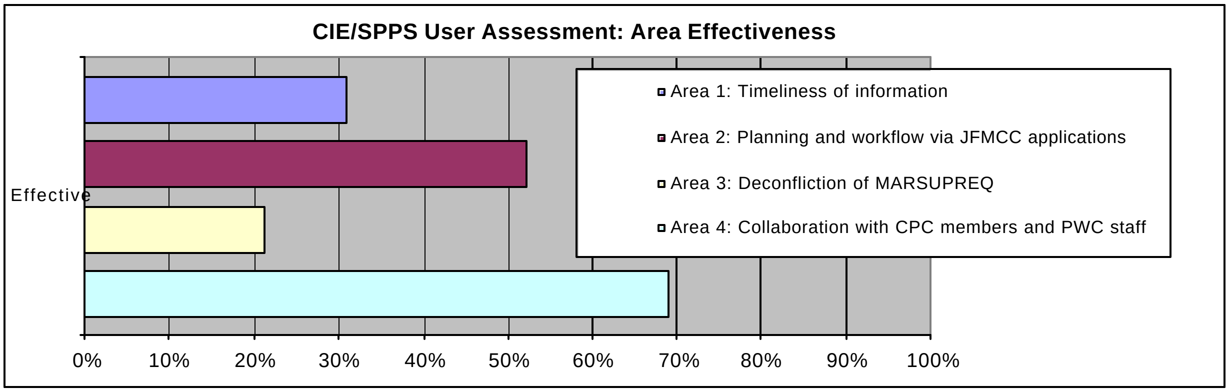

Figure 15-16. CIE/SPPS User-Assessment in Identified Areas

Assessment of the SharePoint Portal Server (SPPS) (figure 15-16) was derived from surveys, Chats, and daily experiment reports (initiative leads and observers). Timeliness of information was drawn from a 10 percent sample of queries into the daily experiment reports and the IWS chat logs. In each area the opinions and discussions revealed that about 50 percent more users regarded timeliness of information as ineffective versus effective for an overall effectiveness ranking of about 31 percent. The basis for comparison would be difficult to assess given that SPPS was an environment in which reports were posted versus a real-time or chat environment, such as IRC or IWS. Timeliness measures might therefore be expected to be lower.

Planning and workflow using the JFMCC applications within SPPS revealed a much higher level of acceptance and above the 50 percent threshold. Responses in a 10 percent sample drawn from Chats, daily experiment reports, and survey data revealed an even mix between positive and negative impressions in the Chats, a decidedly more negative impression of the effectiveness as referenced in daily experiment reports, and a significantly more positive impression in survey questions to this effect. This discrepancy is likely because the current planning cell was both a heavy user of JFMCC applications and completed survey questions addressing this area. The less favorable and ineffective impressions of Chat participants, observers and initiative leads are likely in proportion to their utilization of the applications, which were easily understood by regular users but required some serious study for casual users. This would imply that the applications themselves may require some attention to usability and integration such that the casual user might quickly understand usage strategies for other JFMCC areas, command personnel might more easily navigate among the applications, and the common threads (targets, tracks, etc.) might be better integrated and searchable across JFMCC applications and the entire portal.

Deconfliction of MARSUPREQs was addressed in a 10 percent sample drawn from responses in the daily experiment reports, chat sessions, and surveys. The negative or ineffective rating was common across all surveyed areas, with ineffective ratings triple those of positive respondents. The overall effectiveness rating was about 21 percent. The deconfliction of maritime support requests is clearly an area needing attention in upcoming experiments and in future evolutions of the CIE.

Support for collaboration is a key area for CIE and SPPS applications were a primary means for workgroup members to post and share data. IWS Chats supported data posted to applications and the SPPS environment. In a 10 percent sample drawn from initiative leads, observers, Chat logs, and surveys the responses were clearly positive, and significantly so in the daily experiment reports and chats. The overall rating was 68 percent indicating the CIE as viable for collaboration between members of the current planning cell and primary warfare commanders. This also relates to deconfliction of MARSUPREQs, which would be a primary usage of the tools. Still, the rating for such an important process, and for collaboration between those requesting services and the providers of those services, should ideally be much closer to 95 percent indicating there is still significant work to accomplish to produce a collaborative information environment representing the needs of war-fighters.

In sum, CIE was clearly beneficial although not implemented in a manner that optimized all resources. The ability to discuss projects, share information, and allow remote users to modify documents clearly improved team communication and accelerated decision-making processes. Advancement are needed to improve usability of CIE systems, enhance interoperability of applications, better integrate document and chat-based technologies, and create online environments more conducive to integrated communications with visual and document support. COP integration with the CIE would be ideal but is currently hindered by interoperability issues and hardware/display limitations for the war-fighters.

15.7 Ground COP

This section assesses war-fighter perspectives on realization of the Ground COP as evidenced from experiment data drawn from daily experiment reports, chat files, survey data, questionnaires, interviews, observer reports, QuickLook reports, after-action reports and miscellaneous data. A 20 percent sample, with equivalent weightings across the areas, resulted in the data presented in figures 15-17, 15-18, and 15-19. A separate section of the final report covers technical interface issues and specifications for the various systems involved in sensing, transmitting, or collecting data to form the COP. The following discussion is specific to war-fighter impressions of the effectiveness of COP systems used during the experiment. Areas without bars would indicate a not-effective, ineffective, or not-applicable response. The charts were assembled to indicate effectiveness in the environment and systems contexts employed in FBE-J to document system effectiveness for COP generation. Future experiments employing a similar methodology would enable a delineation of COP systems in specific environmental contexts.

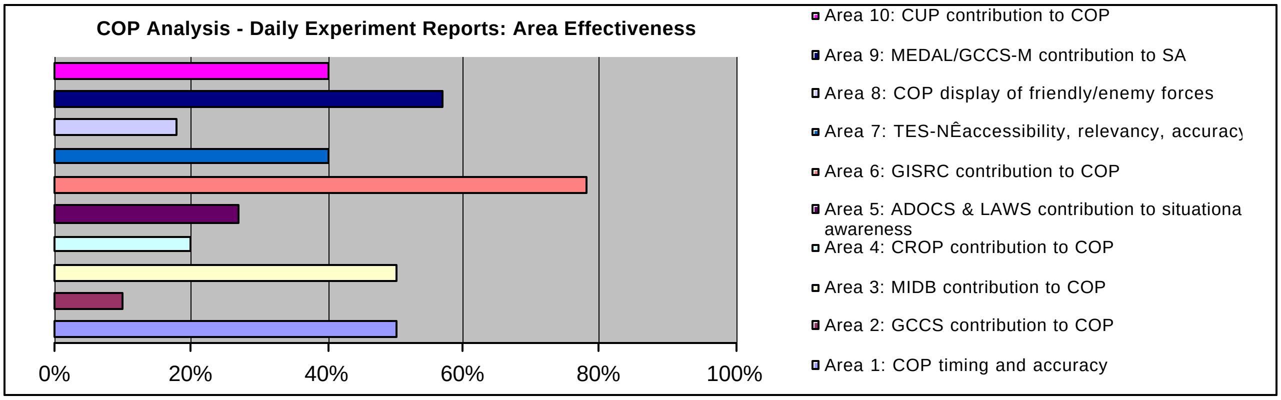

Figure 15-17. COP Effectiveness Data Drawn from Daily Experiment Reports in Identified Areas

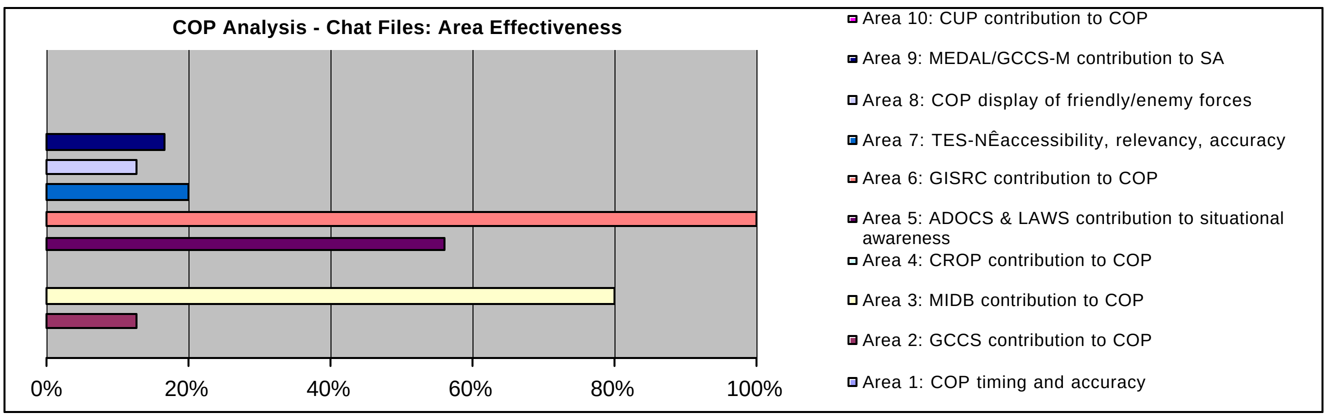

Figure 15-18. COP Effectiveness Data Drawn from Chat Files in Identified Areas

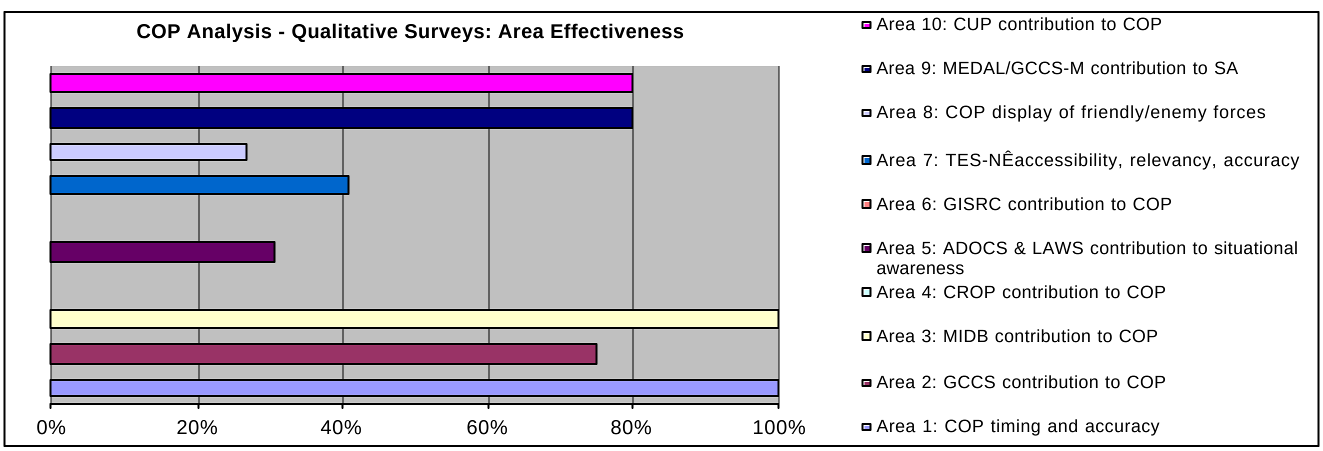

Figure 15-19. COP Effectiveness Data Drawn from Qualitative Surveys in Identified Areas

A strong correlation is evidenced between CUP and COP indicating an overall effectiveness at the systems integration level. The non-rating in the Chat files was likely because this was simply not a topic of discussion. The very high ratings in the surveys and experiment reports would indicate a strong-to-moderate level of success in CUP/COP integration as perceived by the war-fighters, observers and initiative leads. A question specific to CUP/COP was contained in the MIW survey.

A 58 percent (figure 15-17) and 80 percent (figure 15-19) effectiveness rating for MEDAL and GCCS-M contribution to situational awareness and the COP would indicate a strong approval for the use of these systems in the FBE-J context.

COP differentiation between friendly and enemy forces achieved only an average 20 percent level of effectiveness indicating failure for such a critical area. TES-N accessibility, relevancy, and accuracy achieved a 40 percent effectiveness rating from initiative leads and observer data, a similar result from qualitative survey respondents, but only a 20 percent effectiveness rating from data drawn from chat files. Areas achieving an effectiveness rating below 50 percent indicate a need for improvement. In the case of TES-N, improvement is likely needed in system accessibility and/or in the perceived value by war-fighters.

GISRC contribution to the COP was not significantly referenced in surveys but received overwhelming positive responses in the chat logs, observer data and initiative lead reports. GISRC is clearly a valued resource with successful implementation and dissemination.

ADOCS/LAWS contribution to COP and situational awareness clearly received positive responses with a 58 percent effectiveness rating from chat participants, but only a 28 percent effectiveness rating from observers and initiative leads and a 30 percent rating in survey questions specifically targeted to assess ADOCS/LAWS effectiveness. Qualitative responses to these questions seemed to indicate that ADOCS when combined with BDA processes was not effective, as evidenced through statements such as "process became very confusing.... coordinating BDA, determining whether to re-strike, requesting new imagery, etc." A particular area of concern involved BDA and processes for the identification of missed targets, with comments such as "putting re-strike targets back into the system as new targets makes things VERY confusing." Training for COP/ADOCS was addressed in the current plans cell survey, and the data indicated that training was insufficient.

CROP/SPPS contribution to the COP was not a survey or discussion item but received somewhat favorable mention in daily experiment reports. Lack of data, messaging, and communication integration across systems contributing to COP and situational awareness has been discussed earlier in this Section.

MIDB received very favorable ratings of effectiveness for COP and situational awareness with a 100 percent effectiveness ratings from survey data, an 80 percent effectiveness rating from Chat participants, but only a 50 percent effectiveness from observer and initiative lead reports. This lower rating from the daily experiment reports, from those assigned with lead and oversight responsibilities may indicate that some of the objectives for the MIDB were not achieved. This area would require further analysis to determine the reason for the lower rating. Overall, the MIDB contribution to the COP in FBE-J would be considered successful, but with the above caveat and likely need for further improvement.

A divergence in effectiveness ratings was also evident for GCCS contribution to the COP, with the observers and initiative leads awarding a rating of 10 percent, Chat participants 12 percent, but survey respondents 75 percent. This divergence warrants further investigation and assessment specific to this area in future experiments.

Overall accuracy and timing of COP data were not an active discussion area in the chats but received an overwhelming positive (100 percent) rating in samples drawn from survey data, and a rating of 50 percent effectiveness in samples drawn from daily experiment reports (observers and initiative leads). Interviews with KMO and MOC personnel indicated that a universal and ubiquitous COP was not achieved in FBE-J. Variables cited included lack of systems integration and inefficiencies in display capabilities.

15.8 Key Observations Summary

Netted Force utilized a collaborative information environment consisting of a portal, portal-compatible web pages and sites, portal-based applications for JFMCC components, and two collaborative tools for Chat, one for submarine-based participants and a broadband system with visual metaphors for non-submarine participants. CIE services, and the SharePoint Portal Server (SPPS) were collectively referred to as the CROP and considered a critical resource for support of COP and situational awareness. The COP was achieved as an integration of various systems. A KMO was organized to oversee CIE and COP systems.

Overall the systems operated as presented, and implementation was successful, albeit sometimes without the level of efficiency or functionality originally envisioned. As an experiment, the process moved several critical Netted Force initiatives closer to deployment and tested several new concepts and/or system integrations. CIE as a concept was successful with the SPPS achieving a high level of success with services compatible with SPPS and a moderate level of success with the integration of systems and resources into a portal-based environment. KMO was effective as a technical support structure but did not achieve the high-level, strategic organizational status originally envisioned.

The technical concepts of Ground COP systems and interfaces were handled separately in this report. The analysis herein (in this section) found that users considered the systems employed to create the COP as generally timely and accurate, but with much room for improvement. The COP was interpreted differently depending on locale during the experiment. Separation of systems was still evident so the concept of a universal COP, with all involved able to access the same information, appears years from fruition but the experimentation in FBE-J was an important step toward this objective. To be resolved is the need for display capabilities well beyond current standards, and conformance by systems manufacturers to some manner of universal interface standard, with portals the likely preferred solution.

15.8.1 Key Points

The Netted Force initiative, KMO concept, and CIE were assessed to determine how well they could reduce uncertainty, increase situational awareness, decrease information overload, shorten decision cycles, and address bandwidth as a war fighting tool. These were high-level objectives that were realized, with the exception of active bandwidth management that was not implemented as initially planned. MC02/FBE-J technical communications infrastructure operated as envisioned, however utilization of servers, applications, and communication processes on that infrastructure were not optimized and perhaps somewhat unexpected since full utilization stressed computing and display resources.

KMO as an organizational unit did not achieve its objectives:

- While decision support information was timely and accurate, the process through which information reached critical decision-makers included an effective technical process, which the KMO aided, but did not include an active and high-level gleaning of information and the processing of that information into knowledge, at the right time and place. This facet of KMO operations would need redefinition and/or experimentation focused on KMO interjection in strategic processes.

- Information relevancy, and KMO processes to identify and manage information, and then keep that information relevant to critical decision-makers, would require different organizational and information processes than those present in FBE-J. This was somewhat evident, but as a byproduct of technical support and not as a well defined, contemplated series of knowledge management processes.

- Contribution of the KMO to information management was secondary to the technical aspects of information communications and did not achieve the high-level or strategic objectives envisioned.

- KMO input to bandwidth allocation decisions supporting operations were not a facet of typical operations, albeit the need for this function was evident. More effective and detailed TTPs in this area would be required.

CIE was designed to reduce planning and execution timelines, enhance organizational effectives for distributed operations, flatten organizational hierarchies and decision-making, enable self-synchronization, and integrate ADOCS/LAWS for situational awareness in distributed operations. The overall objective was to enable Rapid Decisive Operations through more efficient integration of information and communications. Technological aspects of CIE were achieved with impressive utilization of cutting-edge technologies:

- SPPS integrated critical systems through a portal and application framework that effectively reduced planning and execution timelines.

- Integration of JFMCC components through standardized applications within the portal framework enhanced organizational effectiveness for distributed operations since most direct JFMCC component information was present within a browser-based application that could be viewed by war-fighters in the cell and across cells, from any network access point.

- CROP or secondary information relevant to the COP was available within the web site and pages of SPPS where users could browse or search for information and this too would enhance organizational effectiveness for distributed operations.

- Flatted organizational hierarchies for faster decision-making were possible through the JFMCC component applications within SPPS. This capability now exists as components can use networked applications to access and act upon information. Yet to be integrated into the process are workflow automation routines that would send pertinent information to appropriate personnel for action and automated routing to the next war-fighter in the chain of command.

- Self-synchronization was evident in many of the systems. The databases were reportedly self-synchronizing with this capability also evident in the IWS servers.

- LAWS/ADOCS on displays were evident across the experiment thereby achieving this objective. LAWS/ADOCS remains a largely proprietary system without a readily available means for integration with SPPS or JFMCC applications.

- SPPS provided an integrated, customizable interface into pertinent information, but not all information or communication systems were compatible with portal interfaces or display technologies. The technical foundation for a unified system, with document management, version control, subscriptions, and single sign-on to the services was achieved. However, widespread optimization of the services was not achieved. Search and retrieval functions appeared operational but not comprehensive or used to the level envisioned.

- IWS and IRC collectively provided means for communication and collaboration, albeit the requirement that two distinct systems be in operation was a significant disadvantage. Timing errors between IWS servers in the early days of the experiment created significant difficulties and the practice by war-fighters of cutting-and-pasting between IWS Chats as a means to keep participants abreast of external activities caused confusion. The requirement that multiple windows be opened to stay current, and an absence of some manner of triggering between chat areas, or the ability to identify and track events through the chats in real-time, hindered overall effectiveness. Still, the IWS system efficiently conveyed timely information. IWS was not integrated with LAWS/ADOCS, SPPS, or the JFMCC component applications.

The Ground COP in this section was assessed through questionnaires, surveys, observations, after-action reports, Quick Look reports, and interviews to determine overall war-fighter impressions of the systems:

- Targeting information was simplified to improve situational awareness, but problems with the input of missed targets into the systems as new targets caused some confusion.
- Views of friendly and enemy situations were not adequate, and war-fighters expressed concerns with their inability to make adequate differentiations.
- GCCS, MIDB, TES-N, and GISRC received strong levels of user-satisfaction as evidenced by utilization and effectiveness measures recorded in sampled user populations. MIDB supported tactical and operational users and was considered accessible, relevant, and accurate.
- COP was perceived as timely and accurate by war-fighters, but reservations by knowledge and information leadership indicated that the COP had not been achieved to the level originally anticipated.

15.8.2 Baseline Model versus Actual Performance

The MC02 broadband, wide-area infrastructure employed a component-based architecture consistent with models advanced for the Global Information Grid (GIG). Broadband was available within sites, between sites, and across the grid or backbone at 10Mbps. There were complaints of bandwidth problems throughout the experiment. However, assessments of network management consoles and discussions with network personnel indicated that bandwidth was less of a problem and server, router, and/or computer and application use more of an issue.

Non-essential voice communications within IWS, non-essential bitmaps within briefs, and multiple Chat windows all open on a single PC would tend to increase bandwidth requirements in excess of essential services while dramatically increasing RAM requirements. To address these variables (voice, bitmaps, chats, videos) would require a more careful definition of the exact services required for each war-fighter and to support the COP. In sum, infrastructure services performed as expected and outlined in the baseline model. Particular applications and usages of the infrastructure were not optimized.

A core capability of the GIG (Global Information Grid) underlying MC02/FBE-J was synchronization of servers across the grid such that servers coalesce to create a single virtual machine. This occurred only to a limited extent. While synchronization was evident, there were communication delays, problems with the single sign-on procedure, timing errors, and other technology errors. Overall the process efficiency across the backbone was both efficient and impressive, but with ample room for improvement.

Active bandwidth management, a responsibility originally assigned to the KMO, was not achieved but is of significant importance given future opportunities for bandwidth and CPU cycle management of all machines in an experiment. MC02/FBE-J was an important step toward grid-based computing and service synchronization.

SPSS as a portal to enterprise services was only moderately effective, yet a significant advance. War-fighters would uniformly access SPSS for morning and afternoon briefings, plans, and somewhat for general analysis (information or knowledge gathering). JFMCC components had specialized applications serving their needs as applications within SPSS and this was highly effective. IWS, IRC, and the sensor and targeting systems (LAWS/ADOCS) were not integrated into SPSS or available as portals or web services.

A difference between chart data and information leadership viewpoints for COP effectiveness may indicate objectives were met at certain levels but not at levels originally envisioned. Users may not have been aware of other areas or systems not included or immediately available to them (i.e., how much better their awareness may have been given the integration of all available systems into the COP). This assumption would be supported from first-person assessment of war-fighters and the tendency for those Warriors to focus on information spaces within their immediate purview, but not to venture to other systems. KMO and information leadership would be aware of all COP and situational awareness systems and be in a position to judge that full integration and a universal COP has yet to be achieved.

15.8.3 Implications

CIE and COP as systems within Netted Force continue to evolve, with targeting and timing aspects of COP successful and integration aspects of CIE in support of COP yet to be achieved. High-level tasks assigned to KMO were not achieved. Effective implementation of the KMO concept, function and process could be achieved by ascertaining information needs, likely users of that information, the most efficient means for dissemination, and the process through which context is added to the information to provide knowledge. This would require that KM officers act in strategic aspects of knowledge and information management processes rather than in the operational and technical support functions actually performed.

Personnel in communications, network, systems administration, and database operations were identified as working under KMO in organizational charts but in practice worked somewhat in parallel and in cooperation, versus a strict reporting structure. In FBE-J, duties of KM officers overlapped with those traditionally filled by N2 and N6 and this caused confusion during the experiment. KMO N2 duties focused on RFI processes and the finding of critical information. KMO N6 duties focused on the management of networks and infrastructure to access information. A clear definition of duties is needed prior to future KMO experimentation.

Interoperability is a significant issue given the difficulty of attaining synchronicity across diverse systems, technologies, platforms and networks. Overall, this level of synchronization is new, a projected core future capability of the GIG and grid computing model, and should therefore likely be a core initiative in future experiments, with its own set of variables for analysis. Such a level of analysis will be critical as both portal and non-portal environments use multimedia or voice/video enhanced communications.

Database and CIE application services supported clustering concepts with synchronization across a grid such that one server would update and synchronize other servers. Routine checks with IWS and database staff indicated that these operations were functional in varying degrees. A few days into the experiment (with all systems at full impact) indicated some discrepancies in this functionality. It was unclear whether this was a result of the network/grid, server processes, or the computer utilization habits employed by the war-fighters.

15.8.4 Recommendations

Netted Force as a core component of next-generation war-fighters should provide the foundation for network-centric activities and systems integration. Major facets of operational systems in the experiment lacked integration capabilities and inefficiencies were evident from redundant and non-communicating systems. Efforts to integrate proprietary technologies may require conformance to emerging information standards for interoperability at the display level initially, likely via portal protocols, and secondarily as distinct messaging components, which may require that vendors rewrite their code into component architectures.

While KMO did not achieve high-level objectives envisioned it was nevertheless an important step toward a needed organizational structure. Formal objectives for FBE-J KMO were both aggressive and timely, with a clear need for this organizational structure in joint forces operations. Factors hindering completion of the objectives resulted from newness of the positions, lack of sufficient pre-planning, redundancies in position descriptions, inadequate training for KMO personnel, and insufficient operational procedures for command units using or expected to use KMO services. A recommendation is that KMO should serve as a high-level command resource and interface between command and strategic operations. This will require significant transformation of existing decision-making support structures.

Documentation, training, and high-level integration of KMO into experiment strategy may further the concept as a strategic component, but personnel selected will need to have an extensive command of available knowledge across a wide variety or areas. This may require that Joint forces begin to train and educate such individuals, along with commanders who will use them. Future experiments may help refine the evolutionary process through which an effective KMO system and process is established. In an ideal setting, knowledge would be an integral, on-demand, and suggestive, providing a decision-support adjunct to COP, JFMCC, or component operations. On-demand knowledge might be most effective if delivered as a web service within portals customized with planning, timeline, and collaborative systems for command personnel and war-fighters.

A more advanced portal environment would integrate all combat services and deliver components as portlets (or web application services configured as portlets) within personalized user interfaces. Environments personalized to the needs of each war-fighter would be optimal, and SPSS developers are likely heading in this direction but will require that exact services needed by each war-fighter be fully described in advance of the experiment and providers of those services able to deliver within portal-based environments. This would provide significant additional capability in support of the COP and aid in creating shared understanding between workgroups and war-fighters. This is the trend in industry, and developers of pertinent services may want to consider adding SOAP or XML-remote capabilities to their applications.

16.0 Joint Theater Air Missile Defense (JTAMD) Key Observations

16.1 TAMD Experiment Objectives

FBE J/MC02 was intended to provide dynamic interactions necessary to further mature Joint TAMD/AAW operations. Data were collected on the role of the RADC/ADC, interactions with the JFMCC Maritime Planning Process (MPP), the employment of multi-purpose surface combatants and the functions AADC Module. This information was intended to for inclusion in future TTP or doctrine as applicable and for further refinement in future experimentation venues.

Navy air and missile defense experimentation was concentrated around the AADC Module located in the General Dynamics Advanced Information Systems (GD AIS) facility in Greensboro, NC. The experiment was not intended to evaluate the merits of the AADC Module, the adequacy of its embedded capabilities, or projected fielding plans. Instead the experiment was largely exploratory and was intended to develop insights in three major areas:

- Internal Module Planning Processes. Whether a developmental "Supplementary Planning Guidance" supported module-planning procedures.
- Allocation of Multi-Purpose Surface Combatants. Whether an experimental planning process centered on the staff of the Joint Force Maritime Component Commander (JFMCC) maximized Navy force capabilities across competing operational demands.
- Combined RADC/ADC. Whether combining the roles of a Regional Air Defense Commander (RADC) reporting to the Joint Force Air Component Commander (JFACC) with the Air Defense Commander (ADC or "AW") reporting to the JFMCC was feasible.

16.1.1 Overarching Questions

FBE J was intended to gain insights into the following questions:

- Can a single commander appointed as the Battle Force Air Defense Commander (ADC or "AW") and a Regional Air Defense Commander (RADC) supported by the AADC Module planning capability and process effectively support the air and missile defense requirements of both commanders?
- Does the capability to rapidly wargame alternative courses of action with the embedded wargaming (M&S) capability and provide graphic displays provide value added to the Joint Force Maritime Component Commander (JFMCC) and Joint Forces Air Component Commander (JFACC)?
- What emerges as functional relationships between JTFHQ (and production of the Effects Tasking Order and/or the Defended Asset List), the JFMCC (Maritime Tasking Order) and JFACC/AADC (Air Tasking Order)?
- What emerges as the organizational relationship between the SJTFHQ Theater Missile Defense (TMD) Cell, JFACC/AADC, Deputy Area Air Defense Commander (32nd AAMDC), Regional Air Defense Commanders (RADC) and the maritime Air Defense Commander?
- What elements of the experimental organization, TTP, and C2 learned from this event are suitable for inclusion in a future USN AADC Module TACMEMO?
- Does the JFMCC Maritime Planning Process mitigate the dilemma posed by competing demands for multi-purpose surface combatants?

16.1.2 Sub-initiatives

The purpose of the JTAMD sub-initiatives was to further define the internal processes developed within the AADC Module necessary to support the JFMCC's Maritime Planning Process (MPP) and the JFACC/AADC.

- **TAMD Mission Planning.** Supplemental Planning Guidance was issued to the RADC/ADC staff. High interest priorities included:
  - **Enemy Course of Action (ECOA) Development.** Employ an internal Red Cell and systematic method of predicting and evaluating alternative ECOA and selecting those that will be used to form the basis for planning efforts.
  - **Friendly Course of Action (COA) Development:** Employ an internal process to develop alternative objective based plans and evaluate the plans using embedded wargaming (M&S) capability.
  - **Risk Assessment**. Employ a formalized process to identify and communicate the operational risk of various friendly courses of action.
- **Allocation of Multi-Mission TAMD Capable Surface Combatants**. Collect qualitative data from participants on whether the centralized asset allocation process within the JFMCC Maritime Planning Process contributes to efficiently meeting both maritime force protection and joint air and missile defense tasking goals. Record instances of concurrent employment of individual units, and document conflicts preventing concurrent tasking.

- **Development of a Joint AADC Capability to Support an Ashore Based AADC and Battle Force Air Defense Commander.** Assess what capabilities of the AADC Module provided value added to the planning processes of a JFACC/AADC ashore and the Navy Battle Force Commander.

- **Designation of the Battle Force Air Defense Commander (ADC) as a (Joint) Regional Air Defense Commander.** Record the conflicts and challenges that emerged from organization from the concurrent designation of a single commander as the ADC responsible to the JFMCC for the defense of naval forces and operations and to the JFACC/AADC for the defense of designated critical assets.

16.1.3 Background: Command and Control Organization

The C2 organization employed during FBE J/MC02 was largely based on existing joint doctrine. One TAMD objective was to attempt to bridge the gap between the Combined Warfare Commander (CWC) organization detailed in Navy doctrine and the Joint Force Air Component Commander (JFACC)/Area Air Defense Commander (AADC) described in Joint Doctrine (see Joint Publication 3-01 “Joint Doctrine for Counterair”). In order to address this challenge responsibility for maritime force protection (Navy) and regional air and missile defense (joint) were assigned to a single sea-based commander. Within the experiment construct, the Commanding Officer (O-6) of a simulated cruiser equipped with an AADC module was assigned duty as both the Air Defense Commander (ADC or “AW”) reporting to the JFMCC and Regional Air Defense Commander (RADC) reporting to the JFACC/AADC, as depicted in figure 1.

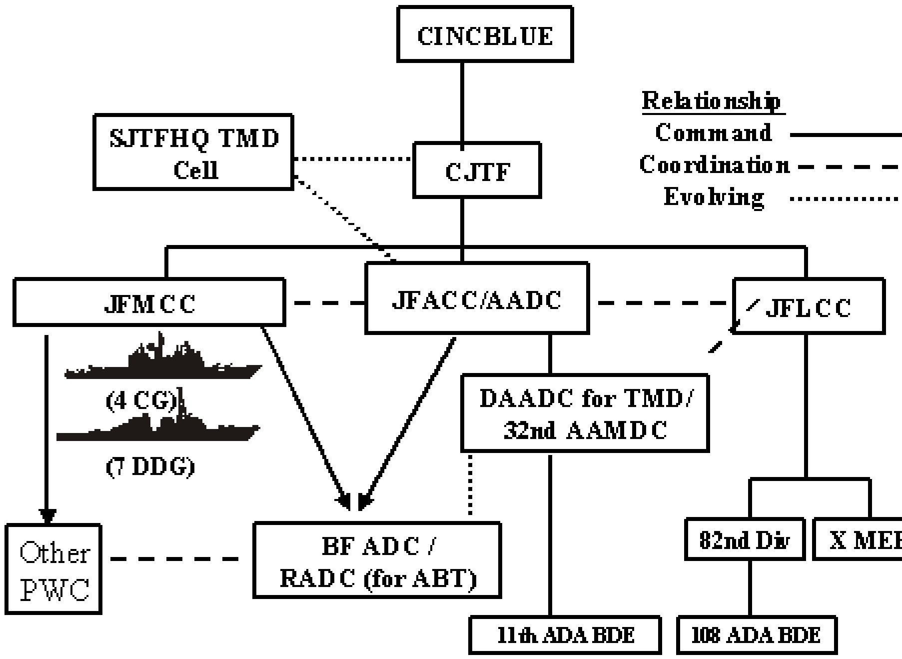

Figure 16-1. TAMD Command and Control Organization

Joint Force Maritime Component Commander (JFMCC). Commander Second Fleet was assigned duties as JFMCC and was doctrinally responsible for establishing maritime superiority. The central FBE J experimental initiatives were planning and execution processes centered on the JFMCC and staff. The JFMCC staff acted as a central clearinghouse for all force maritime asset allocation requests submitted by all Principal Warfare Commanders (PWCs), including the Air Defense Commander (ADC).

Joint Force Air Component Commander (JFACC)/Area Air Defense Commander (AADC). The Commander 12th Air Force (AF) functioned as both the Joint Force Air Component Commander (JFACC), Area Air Defense Commander (AADC) and Airspace Control Authority (ACA). As such, 12th AF had responsibility for both Offensive and Defensive Counterair (OCA/DCA) missions as well as normal strike operations.

Deputy Area Air Defense Commander (for TMD). A component of the US Army's 32nd Army Air and Missile Defense Commander (AAMDC) functioned as the Deputy AADC for Theater Missile Defense (TMD). The DAADC mission was limited to defense against ballistic missiles, and the DAADC did not assume a role in the defense of either Naval forces or land assets against air breathing threats such as cruise missiles or aircraft or in the assignment of DCA aircraft.

Standing Joint Task Force Headquarters TMD Cell (SJTFHQ TMD Cell). Co-located with the SJTF Commander, the TMD cell's role functioned to assist the Commander in matters regarding to TMD. Like the Deputy, AADC limited itself to ballistic missile defense. Unsupported by either existing or experimental doctrine, its role remained uncertain throughout the experiment.

Regional Air Defense Commander/Battle Force Air Defense Commander. The Commanding Officer, USS ANTIETAM (CG54) was concurrently assigned duties as the RADC and ADC. As ADC he was responsible for the air and missile defense of maritime forces under the JFMCC. As the RADC, he was responsible for performing those Defensive Counter Air (DCA) functions delegated by the AADC or the DAADC. In practice the RADC/ADC functioned as a linkage between the JFMCC and JFACC requesting assets to support the force protection of Naval forces and to fulfill tasks assigned by the JFACC/AADC.

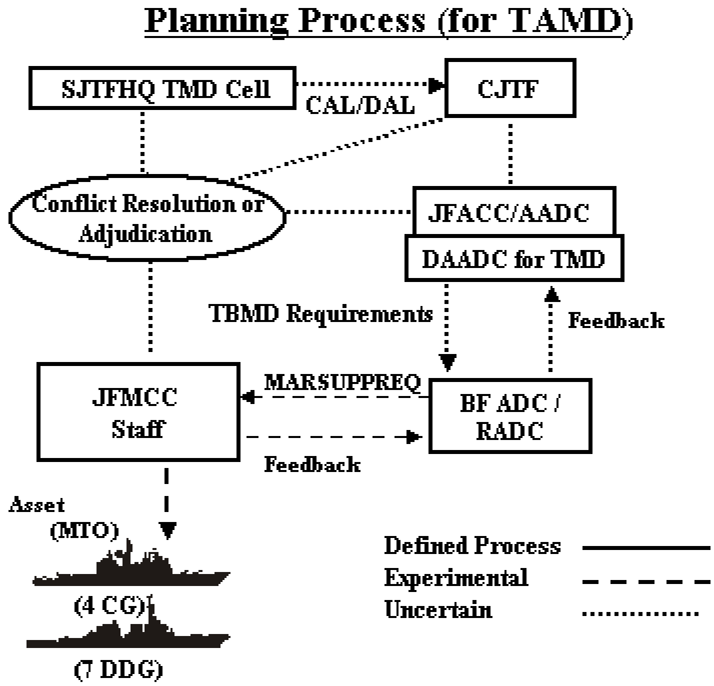

Figure 16-2. TAMD Planning Process

16.1.4 Background: Navy Air and Missile Defense Forces

Ships. Both real and simulated ships participated in FBE J. Eleven of these were simulated AEGIS ships equipped with both area air defense and a notional terminal ballistic missile defense capability. A single cruiser possessed a contingency Sea-based Midcourse Defense (SMD, formerly Navy Theater Wide) capability. All units were also equipped with Cooperative Engagement Capability (CEC).

Land-based Air and Missile Defense. US Army Air Defense Artillery (ADA) in theater were equipped with PATRIOT (PAC 2 and PAC 3) and Theater High Altitude Air Defense (THAAD) as well as short range air defense (SHORAD) capability. Roughly one half the PATRIOT and all THAAD units were designated as Echelon Above Corp (EAC) ADA units and fell under the cognizance of the DAADC.

Aircraft. Two simulated carrier airwings (CVW) participated in the experiment. Each CVW was equipped with a combination of F/A-18C, F/A-18 E/F, Improved E-2 Hawkeye 2000 with the Littoral Radar Modernization Program (RMD) upgrades, and other support aircraft. USAF DCA forces in theater included F-22 RAPTOR, F-15C/E, AWACS, and associated support aircraft.

16.1.5 Background: AADC Model

Capability. A developmental AADC module was central to Navy air and missile defense experimentation during FBE J. The AADC module consists of planning and execution elements and is intended to be installed on board guided missile cruisers (CG) and some command ships (LCC). It is currently installed on board USS SHILOH (CG 67), USS MT WHITNEY (LCC 20) and USS BLUE RIDGE and by 2007 will be installed on up to 12 CG.
The AADC module is designed to provide the Joint Force Commander (JFC) with a mobile and flexible command and control capability. The AADC Capability (module) provided a robust C4ISR capability,

including operational display, control, and decision aid capabilities directed specifically towards supporting the AADC and his staff for operational scenarios ranging from large, mature, theaters of operations to smaller scale contingency operations. It is intended to support the theater requirements of an AADC at the operational level of war.

The planning capabilities of the module include the ability to rapidly generate air defense plans (friendly force laydown) and assess those plans with an imbedded modeling and simulation capability. The AADC Capability Planning function sends and receives data through the Joint Planning Network (JPN). JPN uses a number of communication methods including voice, video teleconferencing, record messages (USMTF), facsimile, e-mail, and image transfer.

The Operations component of the module consists of advanced displays and C2 tools that allow an embarked commander to manage the battlespace and execute air defense plans. The AADC Capability Operations function receives Joint Data Network (JDN) data through the host TDS.

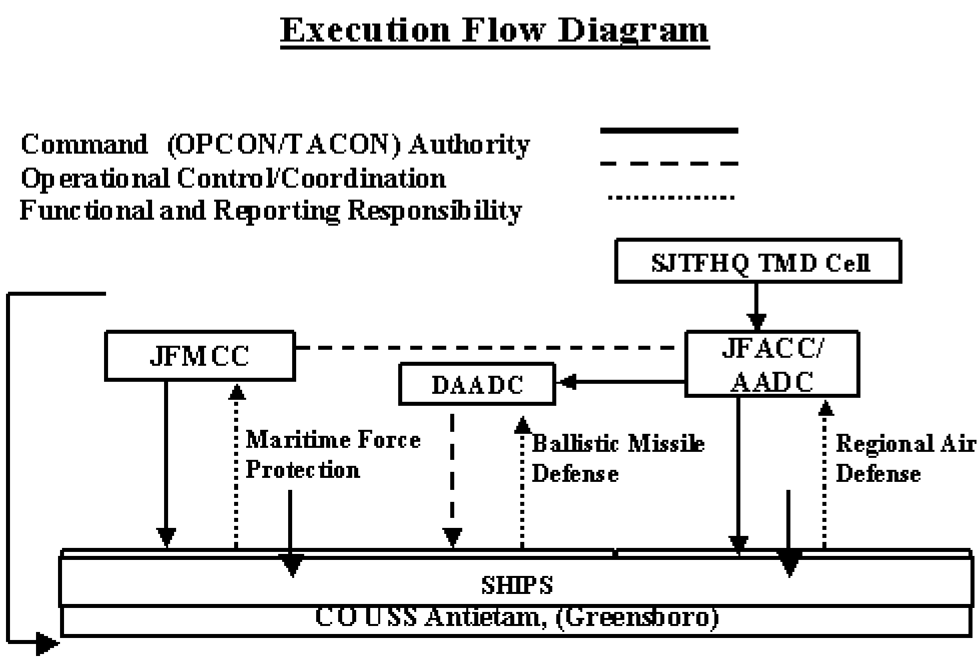

Figure 16-3. TAMD Execution Flow Diagram

16.1.6 Manning

During FBE J, the AADC was supported by a mixed staff of selected crew from USS ANTIETAM, reserve officers from both the Atlantic and Pacific AADC Units and civilian technical support from General Dynamics, AEGIS Training and Readiness Command (ATRC) and Johns Hopkins Applied Physics Lab (JHU APL).

16.2 Observations and Discussion

16.2.1 Navy Missile Defense

Observations

- The missile active defense capability provided by mobile Navy ships provided the Joint Force Commander with a unique joint capability during FBE J/MC02.
- The mobility and flexibility of Navy missile defense forces provided a complementary capability to the sustainability of Army Air Defense Artillery (ADA) missile defense forces.

Discussion. The inherent mobility and flexibility of Naval forces provided a unique joint capability and constituted a force multiplier during MC02/FBE J. Though the Joint Force had extensive Army Air Defense Artillery (missile defense) capability in theater, the Deputy AADC required the participation of Navy ships to defend designated critical assets to the desired Probability of Negation (P_n). Navy ships provided a complementary capability to ADA, each occupying a unique operational niche. Ships which feature great mobility but limited interceptor inventory provided an important adjunct to ADA that was capable of providing sustained defense but which could not be readily moved. With PATRIOT and THAAD defending fixed logistic ports of debarkation and friendly troop concentrations, AEGIS cruisers and destroyers provided the DAADC with a mobile and flexible capability that supported initial access, surged to meet emergent requirements and when required, provided sustained defense of fixed critical assets. During the course of the experiment Navy ships performed the following missions:

- Upper and lower tier coverage of fixed sites including friendly countries and critical Ports of Debarkation (APOD).
- Provided lower tier component to upper tier THAAD coverage in order to meet the required Probability of Negation.
- Augmented existing THAAD and PATRIOT coverage when required by an enhanced threat to critical assets.
- Surged to provide short notice missile defense to hostile islands following their surrender to friendly forces. This provided an incentive for enemy defection and prevented action in retaliation.
- Provided a mobile missile defense capability suitable for covering amphibious landings on disputed islands held by hostile CJTF South Forces.

16.2.2 Navy Terminal Phase TBMD

Observations. A Navy terminal phase ballistic missile defense capability was essential to accomplishing the joint missile defense requirements.

Discussion. An adversary armed with large numbers of short-range ballistic missiles (less than 300km), the necessity to provide missile defense against short-range threats on short notice and the JFC requirement for a 0.99 Probability of Negation (P_n), combined to make the notional terminal phase capability used in FBE J/MC02 essential to accomplishing the missile defense mission.

- The large inventory of short-range missiles could only be engaged by missile defense systems with an endo-atmospheric intercept capability. In the dynamic combat environment there were several short notice requirements that required rapid deployment of missile defenses best met by Naval Forces[241]. These included defending islands off the coast of the hostile country following their defection and supporting amphibious operations.
- The requirement to provide a .99 P_n necessitated a two-tier coverage. Despite the relatively large number of PATRIOT forces in theater and the decision to minimize the forces within the

[241] A more mobile PATRIOT capability referred to as "PATRIOT Light" was utilized when Navy forces could not provide defense. Though very effective, PATRIOT Light still required runways and sorties that could be spent deploying other combat capability. In general the Deputy AADC employed Navy assets for emergent requirements when he could and PATRIOT Light when he had to.

adversary's missile range, Navy ships were required to provide the lower tier component to both Sea-Based Mid-Course Defense (SMD) and THAAD.

16.2.3 Sea-based Midcourse Defense (SMD)

Observations

- The large defended footprint of the contingency Sea-Based Mid-Course Defense (SMD) capability was critical to achieving the Joint Task Force Commander's desired probability of negation for a large number of critical assets.
- The primary mission of the ship hosting the contingency SMD capability did not change throughout the experiment.
- The capabilities of SMD were not well understood by the Joint missile defense community.

Discussion

- The requirement to provide two-tier coverage over a large number of critical assets distributed throughout a extensive geographic area could not be met by available THAAD forces. As a result the DAADC deployed THAAD units defending POD closer to the hostile country where the capabilities against shorter-range missiles and more extensive interceptor inventory provided a comparative advantage. SMD was then assigned to defend critical assets in an extensive landmass against limited numbers of longer-range threat missiles. Only the large footprint provided by the ascent and midcourse intercept capability permitted the defense of all required critical assets.

- While the ship with the contingency capability performed other missions such as TLAM strike, its primary mission did not change throughout the experiment. The maneuver area was not a significant factor as the ship could fulfill its defensive requirements from virtually all navigable waters.[242] The unique capability of the ship appeared to be recognized by both the DAADC and the ADC/RADC and the issue of concurrent employment where the ship would face increased risk did not arise. However, as there were a large number of combatants available, it was unclear to what extent employment of the ship for other missions would have been impacted had the need been greater.

- The ability of the SMD missile, the SM-3 to intercept ballistic missiles in the ascent and midcourse phases of flight provides a comparatively much greater defended area and differs from other theater missile defense systems. Explaining the performance of the system and differentiating between the defended area and the area where intercepts would occur was a consistent requirement during FBE J/MC02 and indicated that the workings of the system were not well understood throughout the joint missile defense community.

16.2.4 Joint Command and Control

Missile Defense may be the "jointest" of the warfare areas. It requires the integration of Army, Air Force and Navy capabilities in a complex planning environment and execution within the most challenging of timelines. FBE-J/MC02 demonstrated considerable progress in the formation of a truly joint capability but exposed several areas where additional attention will be required.

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[242] Note. The maneuver area was calculated by the AADC module only. Radar resource limitations may have led to a more constrained maneuver area but were not modeled.

16.2.4.1 Role of the RADC: Doctrine

The lack of an accepted definition of the roles and responsibilities of a Regional Air Defense Commander (RADC) hindered missile defense planning and execution within the joint force.

Discussion

- Intense effort and the dedication of the JFACC/AADC, DAADC and RADC/ADC resulted in a workable C2 structure during FBE-J/MC02. However, these relationships were not supported by existing doctrine, and the experiment exposed considerable gaps in service operational concepts and procedures

- Difficulties in combining the maritime force protection duties of the Battle Force ADC with a RADC were exacerbated by the lack of an accepted definition of the roles and responsibilities of a RADC. FBE-J/MC02 exposed gaps between the Air Force and JFACC doctrine of "centralized control and decentralized execution" and the considerable autonomy that is normal for a Navy Air Defense Commander. The RADC/ADC believed that as a "commander", he was responsible for defense of the assigned region within the context of JFACC/AADC guidance and not merely defense of maritime forces. To achieve this, he requested USAF assets through Air Support Requests (AIRSUPPREQ) and Navy assets via MARSUPREQ and stationed them according to a plan briefed by a liaison element to the JFACC/AADC. Despite this, a fissure was exposed when JFACC/ADC assigned additional DCA stations within the assigned region without notifying the RADC/ADC. The JFACC did this after assessing DCA coverage inadequate and presumably believing that the RADC/ADC only requested those necessary for fleet air defense. That the JFACC/AADC did not directly challenge the RADC/ADC plan or instruct him to request and assign additional assets indicated that JFACC/AADC and RADC relationships are far from settled. Though the situation was discovered and resolved without incident, such confusion could have had consequences ranging from inefficient use of scarce DCA assets to blue on blue engagements.

- Despite the presence of a considerable liaison at the Air Operations Center (AOC), the RADC/ADC was not integrated in AOC battle rhythm. It appeared that the very concept of a regional commander reporting to the JFACC simply did not fit within the centralized planning structure of the AOC. Unlike the forums conducted by the Deputy AADC, the RADC/ADC (actual) was not routinely invited to participate nor were the liaisons adequately able to brief the RADC/ADC overall concepts of operations within the region. The results included the assignment of redundant DCA stations and the inability to integrate maritime force protection mission within the greater scheme of theater air superiority.

- Multi-purpose missile defense units posed a conceptual difficulty for joint missile defense planners. Concurrent assignment of tasks such as TLAM strike and missile defense caused considerable angst, particularly at the Deputy AADC. Whereas Navy commanders tended to be comfortable with dual chains of command and with resolving conflicts if and when they occurred, the Deputy AADC felt clearer chains of command and control were needed.

- The support/supporting relationship between maritime forces and the JFACC/AADC and DAADC was not well understood. FBE J/MC02 exposed considerable concern on the part of the JFACC/AADC and Deputy AADC over the degree that Navy forces could be expected to support assigned objectives. Through considerable effort the RADC/ADC was able to convince the JFACC/AADC and Deputy AADC that Navy forces would not abandon their assignments when some competing maritime mission arose. However the experiment indicated the need to develop an "establishing directive" detailing the support/supporting relationships including the relative priority of the supported mission versus other missions (including self defense).

16.2.4.2 DCA Responsibilities

Observation. The division ballistic missile defense from other DCA mission placed the RADC/ADC in an ambiguous organizational position and may have hindered integration of joint capabilities.

Discussion

- During FBE J/MC02 responsibility for ballistic missile defense was separated from other Defensive Counterair (DCA)[243] responsibilities and placed under the Deputy AADC (Army O-7). The division of the overall mission resulted in some ambiguity for the RADC/ADC who answered to the JFACC/AADC (Air Force O-9) for defense of theater assets against fixed wing aircraft, to the Deputy AADC for the assignment of ships to ballistic missile defense mission and, of course to the Joint Force Maritime Component Commander for the force protection of maritime assets. This arrangement proved workable if organizationally ungainly.

- The separation of ballistic missile defense from other DCS mission and the accepted doctrinal definitions of Point, Area and Self Defense do not match with the capabilities of Navy weapons systems. The comparatively long range of Navy surface to air missile systems and doctrine of employing aircraft and missile systems in an integrated engagement scheme, did not match USAF and USA concepts based on the clear delineation of the battlespace.

- Anti-Ship Cruise Missiles (ASCM) launched either from aircraft or mobile surface launchers provided a quandary for the MC02 C2 architecture. Although ASCM are air breathing threats (ABT), they did not readily fit into the JFACC/AADC planning process nor did they fall under the purview of the Deputy AADC. Without the direct input of the combined RADC/ADC it was unclear whether Joint commanders would have understood the ASCM posed to Joint operations. One outgrowth of the experiment was that cruise missiles, both ASCM and soon, Land Attack Cruise Missiles (LACM)/Overland Cruise Missiles (OCM) will need to be a greater joint planning consideration.

16.2.5 Organization – Combined Roles of RADC and ADC

Observation. Assigning the joint duties of Regional Air Defense Commander (RADC) with the maritime force protection duties of the Air Defense Commander was effective.

Discussion. Despite the ambiguity over the roles and responsibilities of the various command elements (JFACC/AADC, Deputy AADC, RADC etc.) most members of the RADC/AADC staff felt that combining these duties under a single commander was the best solution. The reasons expressed centered on two factors. The first was related to planning and addressed the difficulty in dividing common multi-purpose assets among even more command entities (for example a RADC and separate ADC's). The second factor was the difficulty in execution with long-range weapons in common airspace. The practical example cited was if a ship engaged a hostile aircraft at maximum range over land was that an air superiority mission or a maritime force protection mission. Most questioned felt that such distinction

[243] Defensive Counterair. DCA is all defensive measures designed to detect, identify, intercept, and destroy or negate enemy air and missile forces attempting to attack or penetrate the friendly air environment. DCA employs both active and passive measures to protect US or multinational forces, assets, population centers, and interests.(Joint Publication 3-01)

didn't matter and the attempt to distinguish between the missions would have been artificial and presented potential seems that could be exploited.

16.2.6 Modeling Differences between Service Missile Defense Decision Aids

Observations. Distributed collaborative planning was hindered by differences in the manner in which the decision aids modeled system performance and displayed the results.

Discussion. The tools used by the RADC/ADC and by the Deputy AADC (elements of the 32nd Army Air and Missile Defense Command) often yielded conflicting recommendations and assessments even when using identical entering data. Assets positioning and probability assessment are complex calculations, and decision aids were critical to the planning process. Operators were well trained in using the tools but were generally less skilled in evaluating why the tools produced a particular recommendation. The tools also displayed the results in formats that could not easily be fused or compared. With differing recommendations, unfamiliar displays, and no common basis to evaluate the products of the aids, the collaborative planning process often stalled. Satisfactory compromises between the Deputy AADC and the RADC/ADC were generally reached but this was usually due to trust developed over the course of the experiment and may have been influenced by the experimental nature of the problem itself.

AADC module assessment of Army capabilities normally exceeded those predicted by the Army ADA. It was unclear whether doctrinal restrictions entered in the ADA systems accounted for the reduced performance. In general, the AADC module appears to have fewer restrictions in determining possible engagement outcomes than the Deputy AADC system. For example, the AADC module allowed planners to increase the interceptor salvo size to reach a desired Pk while the Army planners would consider only a dual salvo. While there is a potential danger in the Navy approach if the probability calculations are not understood, it did appear a more flexible approach.

Planners at AADC module were generally unable to interpret the recommendations produced by the AADC module. This situation appeared to be paralleled at the Deputy AADC. Beyond the entering factors (EOB, FOB, DAL, and ECOA), planners experienced difficulties determining how or why a particular recommendation was reached. This observation mirrors an earlier observation from Fleet Battle Experiment Charlie (FBE C) that operators need to know what is "under the hood". (Note: During much of the experiment, JHU APL personnel were present and performed the interpretation and evaluation. This expertise was valuable, and consideration should be given to this capability when determining eventual manning plans.)

16.2.7 Battle Management

Observation. Doctrinal and Material differences between Army and Navy missile defense forces prevented coordinated engagement and dynamic battle management.

Discussion. Attempts to coordinate engagements between Army ADA and Navy were unsuccessful due to differences in the manner in which the services perceive engagement coordination and control the engagement of targets by firing units. On a Navy ship, a command element and a firing element are co-located and supported by extensive communications and organic sensors. This allows more general guidance to ship and dynamic management of engagements ("take track X with birds"). Army firing units and command elements are however, separate, and the Army tends toward procedural engagement criteria at the firing unit level. Coordination at the battalion or perhaps battery level is possible but the concept of dynamic battle management common to the Navy is very foreign to the Army.

16.2.8 Navy Missile Defense Planning Process

Intelligence. Access to timely intelligence is critical to successful missile defense operations. The AADC module requires four inputs to calculate friendly force disposition (stationing) and determine effectiveness of the joint force. These include two specific intelligence inputs, an accurate Enemy Order of Battle (EOB) and an assessment of Enemy Course of Action (ECOA). Participants generally assessed intelligence support to be inadequate during FBE-J/MC02 for several reasons that ranged from shortfalls in the module itself to experiment specific difficulties. The critical findings are detailed in the following section.

16.2.9 Situational Awareness/Access to Tactical Sensors

Critical Findings. RADC/ADC required near real time access to Intelligence, Surveillance, and Reconnaissance information.

Discussion. In order to support the planning requirements of subordinate units, the RADC/ADC needed improved access to Intelligence, Surveillance, and Reconnaissance information. In particular timely positional information is critical for individual ships to determine appropriate radar doctrine for ballistic missile defense or weapons conditions for cruise missile threats. The RADC/ADC was not integrated into the ISR operational cycle, and the intelligence cycle appeared out of step with operational requirements.

Immediate knowledge of the location of ballistic missile or cruise missile Transporter- Erector-Launchers (TEL) is critical for the RADC/ADC to evaluate the adequacy of the existing force laydown. Tactical sensors such as Unmanned Aerial Vehicles (UAV) or ISR aircraft often gained this information. Although there is a recognized danger in the release of unevaluated sensor information, the information on mobile TEL is time sensitive and the intelligence community must disseminate this information to defensive units in the same manner as Time Sensitive Targeting nodes.

Access to “negative sensor information” is an important adjunct to the planning process. The results of a mission that does not locate enemy forces can assist planners in determining most likely ECOA. The disconnect between the RADC/ADC planning effort and the ISR denied planners the ability to determine ECOA based on where enemy forces were not and may have steered ECOA development toward worst case scenarios.

16.2.10 Access to Intelligence Databases

Critical Findings. AADC module requires access to databases such as the Modernized Integrated/Intelligence Database (MIDB) and additional connectivity to utilize the full range of existing intelligence.

16.2.11 Enemy Course of Action Development

Critical Findings. Determination of potential Enemy Courses of Action is critical to the planning process but current processes do not support the level of ECOA needed by a combined RADC/ADC.

Discussion. A commander with a tactical focus such as the RADC/ADC requires tactical level ECOA often tied to specific events or operations. For example an assessment of the maximum salvo capability of an adversary does not meet the planning requirements of a commander attempting to determine how an adversary will oppose the transit of a convoy through a critical strait on a particular day. In the absence of a developed process, the commander must make the determination of what an adversary will do based on his/her own assumptions and best judgment. During FBE J/MC02, an experiment node was introduced within the AADC module to assist the commander in that decision making process.

Determination of ECOA is not solely an intelligence function. Intelligence trained personnel provided critical information into what an adversary could do and had done, but were less able to answer the question what is the adversary likely to do now or alternately “what would I do?”

During FBE J/MC02, developing tactical ECOA was hindered by an inability to access timely adversary dispositions. In order to assess what how an adversary would choose to oppose a specific action, planners needed to know what specific units could be brought into action. That information was not readily available.

16.2.12 AADC Module

General. The AADC module was developed to support a commander at the operational level of war. It was never intended to support the tactical requirements of a Regional Air Defense Commander or a Battle Force Air Defense Commander (“AW”). Nevertheless in the assessment of majority of the participants, the planning side of the module demonstrated considerable utility when pressed into this role and some of the features were a marked improvement over existing RADC/ADC planning methods. (Note: Experimentation was limited to the planning component of the module during FBE J/MC02.) Most of the participants felt that planning support for a RADC/ADC offered a potential role for the module when a JFACC retained the additional responsibility of the AADC and was located ashore. Those participants who felt the module should not be used to support the requirements of a RADC/ADC normally commented on specific technical shortfalls in the modules current configuration rather than on the basic methodology or planning processes employed by the AADC module. Observations on the module performance and any modifications that the participants detailed are noted below. Most modifications apply strictly to expanding the mission to include support of a tactical commander, though where the additional capability was required to support an AADC, it is noted.

Observation. The AADC Module demonstrated value in supporting a geographically separate Area Air Defense Commander (12^{th} AF at Nellis AFB) and augmenting the planning capabilities of the Deputy Area Air Defense Commander (32^{nd} AAMDC at Nellis AFB).

Discussion. The planning capability supported extensive collaboration between the RADC/ADC and the Deputy AADC (32^{nd} Army Air and Missile Defense Command). Coverage diagrams, force laydowns and other information were routinely exchanged. The output from the module was routinely used to position ships though on at least one occasion PATRIOT batteries were shifted to increase coverage and reduce redundancy on the basis of a recommendation provided by the AADC module. The ability to model both Navy and Army Air Defense Artillery (THAAD and PATRIOT) systems was a unique capability as the Deputy AADC lacked the ability to either position or test (“wargame”) the effectiveness of force laydowns that employed Navy systems alone or in concert with ADA systems.

16.2.13Multi-TADIL Connectivity

Observations. Most participants noted that requirements for the addition of Link 16 and several noted that utilizing the module in support of a RADC/ADC would require access to the Global Command and Control System (GCCS) and Advanced Deep Operations Coordination System/Land Attack Warfare System (ADOCS/LAW).

Discussion. TADIL connectivity in the module is currently limited to Link 11. During the experiment an Air Defense System Integrator (ADSI) was added to allow access to Link 16/TADIL J tracks. This proved workable though the limited play of the operations component of the module prevented a full analysis.

During FBE J/MC02, GCCS and ADOCS/LAWS were used to maintain the common operational picture (COP). These were accessible through consoles in both the planning and execution side of the module and proved essential to the RADC/ADC's situational awareness. In an actual operation access to the information on these displays would have been essential. This experiment focused on planning vice execution and thus prevented more complete analyses of the necessity and impact of this capability.

16.2.14 Threat Library

Observations. The adversary force contained both air breathing threats (ABT) and ballistic missiles that were not included in the threat library.

Discussion. The AADC module performs its calculations of friendly force laydown and effectiveness based in part on the specific performance characteristics of the threat. The lack of complete coverage of ABT forced operators to use modeled systems whose performance was felt to be "close enough" to the threat or to adapt existing systems and extrapolate results. This was unsatisfactory and many participants noted the need for an immediate increase in the AADC module threat library particularly in the area of short-range (<300KM) ballistic missiles and Anti-Ship Cruise Missiles (ASCM).

16.2.15 User Defined Threats

Observations. The current module configuration does not include the ability for operators to manually enter threats.

Discussion. Several participants noted that the operators should have a contingency capability to manually enter threats based on a generic set of performance characteristics. This would allow on site entry of threats either not included in the original load or those who performance differed from pre-hostilities estimates. While this was acknowledged as backup, most participants felt that it was preferable to the ad hoc extrapolations that were used during the experiment.

16.2.16 Defensive Counterair (DCA)/Combat Air Patrol (CAP) Stationing Calculations

Observation. The ability of the module to support decisions in DCA/CAP stationing was extremely limited.

Discussion. Support for a RADC/ADC during the FBE J/MC02 required greater emphasis on stationing DCA/CAP than was normal during most previous AADC exercises. The ability of the module to support stationing decisions was extremely limited. The "CAP Attrit" feature, which is not strictly a stationing aid, was not used and DCA/CAP and Airborne Early Warning (AEW) stationing was conducted manually with little input from the module.

16.2.17 Emerging Friendly Capabilities

Observation. AADC module calculations did not appear to incorporate increases in sensor and weapons performance.

Discussion. Planned or programmed improvements to sensor performance or tracking ability were not incorporated in the current AADC configuration. The addition of Cooperative Engagement Capability (CEC) or E-2 Littoral Radar Modification Program (RMP) improvements were not reflected in increased probabilities of kill.

16.2.18 Manning and Training

Observation. Operations of a tactical commander (RADC/ADC) exposed the need for need for additional air defense training and experience in fleet air defense operations.

Discussion. During FBE J/MC02, the majority of the module staff consisted of Navy reserve officers with the remainder being drawn from an active duty CG (USS ANTIETAM). Using the module to support an RADC/ADC shifted the emphasis away from generation of alternative force lay downs or courses of action to more immediate near term planning involving on-going operations or emergent threats to friendly air and surface forces. In general, the reserve officers were well versed in the operation of the module and the capabilities of both ballistic missiles and ballistic missile defense systems. The active duty officers generally had less experience in fleet air defense operations and less training in the capabilities of hostile air breathing threats and air defense systems. Employing the module in support of a RADC/ADC will require reexamination of the training and experience requirements and the mix of active and reserve personnel.

16.2.19 Ability to Export Graphics

Observation. Collaboration between the ADC/RADC and the Deputy AADC was hindered by incompatibility of file formats and inability to automatically export graphic images.

Discussion. In order to exchange graphic displays with the Deputy AADC, the RADC/ADC staff was required to create a power point slide and send it via email. Neither AADC consoles nor those of the Deputy AADC had the ability to export graphics directly. Data from this slide was then manually extracted and re-entered into Army displays systems. This slowed the collaboration process and effectively eliminated the ability of individual planners at the nodes to exchange ideas and/or divide tasks. For example the AADC module has an unrivaled capability to evaluate alternative potential ECOA or in other words evaluate “what if” situations. This capability might have been of benefit to Army planners had the opportunity for closer operator collaboration existed.

16.2.20 Alternative Displays

Observation. Operations in support of a RADC/ADC require alternative display options.

Discussion. The AADC module uses a lifelike three-dimensional display in which aircraft appear as aircraft, missiles as missiles etc. While most participants appeared to feel this was valuable for an operational level commander such as a theater AADC, several noted it was less suited to a commander with a more tactical focus such as a RADC/ADC. Focusing on a small geographic area with numerous contacts presented a problem to operators trying to monitor or control tactical interactions. Operators expressed that the symbol size was too large and that it was difficult to determine aircraft course and speed. In such a situation, several participants noted that the display less informative than conventional Naval Tactical Data System (NTDS) symbology. There was no expressed desire to entirely replace the three dimensional display however, many felt that operators needed to be able to choose from alternative displays based on their requirements.

16.3 Key Observations and Conclusions

- **Navy TAMD/TBMD.** The inherent mobility and flexibility of Naval forces constituted a unique joint capability and a force multiplier during the experiment. Navy ships protected critical assets on the DAL, augmented PATRIOT units, provided the lower tier component for THAAD and projected missile defense over amphibious landings ashore. Ships provided a key compliment to Army Air Defense Artillery (ADA) surging to meet anticipated threats or to respond to other operational changes while THAAD and PATRIOT batteries focused on the defense of fixed critical assets.

- **AADC Module Tactical Operations.** The AADC Module successfully supported the Battle Force Air Defense Commander ("AW"), a geographically separate Area Air Defense Commander (12^{th} AF at Nellis AFB) and augmented the planning capabilities of the Deputy Area Air Defense Commander (32^{nd} AAMDC at Nellis AFB). The module routinely positioned ships though on at least one occasion PATRIOT batteries were shifted to increase coverage and reduce redundancy on the basis of a recommendation provided by the AADC module. Note: The operations function of the module was not extensively tested in the experiment.

- **Joint Command and Control.** Though a significant effort was made during MC02/FBE J, the ADC/RADC was never fully integrated into the Air Operations Center (AOC) battle rhythm and the organizational relationship between the JFACC/AADC and the ADC/RADC remained ambiguous. The absence of joint doctrine defining the role of a RADC and the lack of direct communication between the JFACC/AADC and the RADC most likely contributed to the difficulty. In contrast, a high degree of coordination and collaboration occurred between the RADC/ADC and Deputy AADC for missile defense. In the end a workable process evolved but the experiment highlighted the need for the development of common tactics, techniques and joint doctrine that defines roles, missions and responsibilities between functional component commanders and their subordinate commanders.

- **Navy Terminal Phase TBMD.** A robust terminal phase TBMD capability was critical to joint missile defense. Although extensive Army Air Defense Artillery (ADA) forces were in theater, Navy forces played a critical role defending designated critical assets either alone or in conjunction with Sea-Based Mid-Course (SMD), THAAD, and PATRIOT. In the experiment scenario in which the adversary was armed with large numbers of short range (range less than 300km), a terminal phase capability and extensive interceptor inventory proved invaluable. This was particularly true when forces were out of reach of ADA forces.

- **Sea-Based Mid-Course TBMD.** The contingency Sea-based Midcourse Defense (SMD) capability was critical to achieving the Joint Task Force Commander's desired probability of negation. Against longer-range threats, the extensive defended footprint provided an upper tier component of a two-tiered defense for a large number of critical assets. It was indicative of the importance of this mission that the primary mission of the single ship with this capability did not change throughout the experiment. Despite the ship's primary tasking however, the flexibility of multi-purpose surface combatants was demonstrated when the ship conducted Tomahawk Land Attack Missile (TLAM) strikes and sea control missions.

- **Enemy Course of Action (ECOA) Generation.** TAMD planning in general and the performance of the AADC module in particular are dependent on development of accurate assessment of potential Enemy Courses of Action (ECOA). During FBE J/MC02, a local Red Cell defined the worst and most likely case enemy courses of action at the tactical level of war. The ECOA was essential in developing counters to air and missile threats to specific friendly operations such as transits through critical straits or amphibious assaults. The input of this team was critical to the planning effort but highlighted the need for specific training and skills for the Red Team.

- **Intelligence Support.** Inadequate intelligence in FBE J/MC02 hindered planning but illuminated shortfalls in current intelligence support. In FBE J/MC02 there was sufficient information on enemy tactics and systems and little linkage between theater ISR operations and the RADC/ADC organization. In order to maximize the effectiveness of assigned forces an RADC/ADC requires improved situational awareness based on access to existing intelligence databases and the capability to blend historic information, and intelligence from national or strategic systems with intelligence gained from tactical or in-theater sensors.

- **Joint Doctrine and Firing Policy.** Attempts to develop coordinated engagement procedures in instances when both Army and Navy missile defense forces covered common critical assets, were unsuccessful. Doctrinal and technical differences between Army firing units and Navy ships formed a barrier and did allow coordination beyond spatial deconfliction ("engagement zones"). Without changes to existing doctrine, systems, and operational concepts, dynamic battlespace coordination including integrated engagements will not be possible.

- **Modeling.** Collaboration was hindered when weapons systems models in decision aids did not yield common solutions even when all entering data were identical. The AADC module consistently ascribed capabilities to the Theater High Altitude Air Defense (THAAD) that surpassed those developed by Army decision aids. Since the complexity of engagement calculations requires dependence on decision aids the result was a "stalemate." For distributed collaboration to be effective, all participants must have a common understanding of the capabilities and limitations of the individual systems, and decision aids should develop identical solutions when given identical inputs.

- **Short Range Ballistic Missile Threat.** Though it received less high-level attention than longer-range missiles, the threat posed by large numbers of relatively unsophisticated short-range missiles (<300km) and artillery rockets was a significant factor in operational planning and caught many planners by surprise. Coordination between the DAADC and the maritime ADC/RADC was hindered, as existing planning tools did not include models for these threats and the numbers present required intense considerations of interceptor inventory. The widespread distribution of these types of weapons warrants increased consideration in operational planning.

17.0 Sea-Based Joint Command and Control

17.1 Experiment Objectives

The goals of the sea-based joint C2 initiative were to refine C4ISR and to validate the manning support required for a sea-based Joint Force Commander. MC-02/FBE-J offered a unique analytic opportunity to assess sea-based joint C2 because the most modern US Navy command ship was participating and there was a unique mix of forward Joint and Component Commanders and JFMCC staff embarked.

The SBJC2 initiative was executed on USS CORONADO from 29 to 31 July 2002. The main Joint Force Headquarters (JFHQ-(M)) for MC02 (US Army III Corps) deployed a 37-person forward headquarters (JFHQ-(F)) to USS CORONADO. A three-man advance party preceded the JFHQ-F. The primary purpose of this initiative was to document the JFHQ staff perceptions of their capabilities as a JFHQ (i.e., sea-based within the context of the MC02 scenario and FBE-J/MC02 architecture).

The analytical objectives for this initiative were structured to take advantage of the existing experimental C2 construct, within the current design of MC 02/FBE-J, to provide insight into the reasonableness of the JCC (X) C4ISR requirements and manning, as stated in the Operational Requirements Document (ORD) and to Conduct C4ISR requirements studies.

The fundamental objectives for this experiment were:

- Provide insight into whether the requirements for sea-based C2 (as defined in JCC (X) ORD and studies) were sufficient. If not, where does the Navy need to do further study or experimentation? Determine what was learned from JFMCC afloat that could improve/validate JFMCC JP 3-32, in terms of manning and C4ISR requirements.
- Provide insights on the adequacy of the baseline in the above sub-initiative (relative to ORD, studies, and experimental results) in supporting staffs afloat in executing their mission and tasks, i.e., how well were they able to do their job given the BW, manning, C4ISR constraints.
- Doctrinal: Determine the considerations and advantages/disadvantages of sea-basing C2
- Organizational: Was the manning sufficient to perform tasks assigned? Determine the functions that were/were not adequately supported from the sea.
- Material: Analyze the software tools and communications structure (including required characteristics) that the staffs need to do their jobs. Was this sufficient? If not, what more would be needed?

17.2 Analytical Questions

- Did the JFHQ (Forward) at USS CORONADO have sufficient "reach-back capability" to the JFHQ (Main) at Suffolk VA to ensure information superiority?
- What insights can be derived from the manning, structure, and functional capabilities of the JFHQ?
- What are the CJTF staff perceptions of their capabilities as a CJTF that is sea-based within the context of the MC02 scenario and FBE-J/MC02 C4ISR architecture?

17.3 Baseline Model

The US Army III Corps (as the JFHQ) forward deployed the staff. Since this was the prototype deployment of this kind, there was little detailed, advance planning as to the specific organization or functioning of the forward staff. No baseline model for the organization was implemented.

17.4 Experiment Design

There was minimal input by NPS into the design of this experiment. During Spiral 3, the size, configuration, and functions of the JFHQ-F were determined by interviewing two members of the JFHQ-F advance party. Based on this information, the focus of the experiment was to collect data from the staff as they performed their functions during their approximately 36-hour presence on USS CORONADO. No assessment was conducted on the JFHQ-F capability to command and control while moving from Suffolk, VA to USS CORONADO.

There were two aspects of this experiment for which data collection and analyses could provide valuable insights. The first was the sufficiency of the MC02 communications architecture to provide the JFHQ-F a reach-back capability from USS CORONADO back to the JFHQ-M in Suffolk, VA. The bandwidth was instrumented to determine bandwidth suitability for the JFHQ-F to collaborate and share information with the JFHQ-M. The second aspect of this experiment was to determine if staff officers were able to perform their functional tasks with a significantly smaller staff while forward deployed. The supporting hypothesis was that because of sophisticated communications and collaborative tools; a relatively small, forward staff could obtain necessary information from its main headquarters to conduct operations in a satisfactory manner.

17.5 Sub-Initiative Observations

MC02 Communications Architecture Capability to Support Reach-back Operations

As part of Millennium Challenge 02, USS CORONADO was able to serve in a capacity not previously seen in prior Fleet Battle Experiments. The Joint Forces Maritime Command and Control (JFMCC) staff was forward deployed on board CORONADO, including two days at sea. The Ku-band satellite communications network setup for FBE-J was sufficient to handle the increased volume of data traffic necessitated by bringing the JFMCC on board.

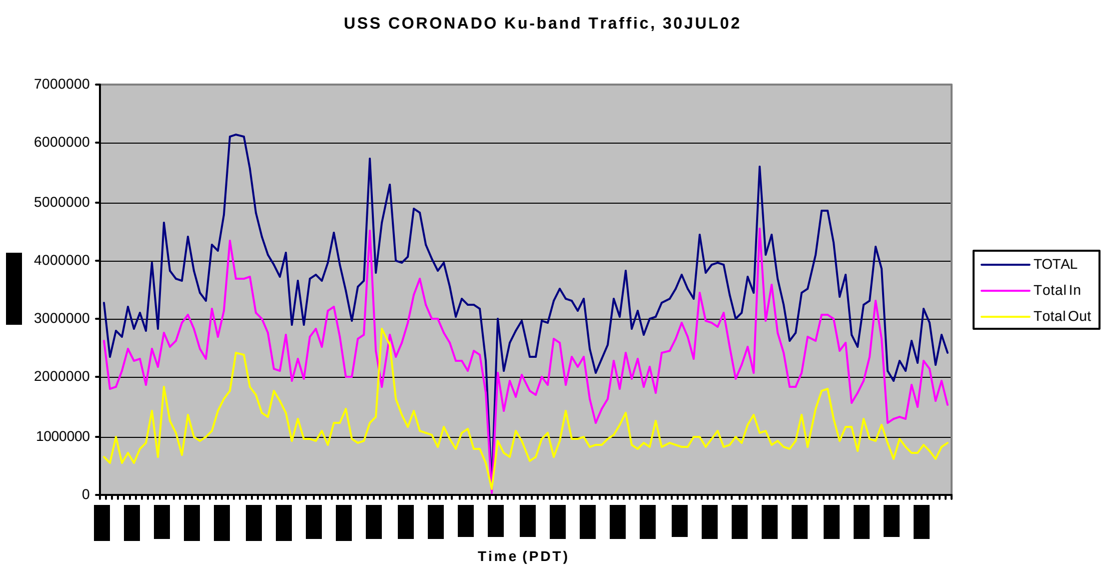

Figure 17-1a. USS CORONADO Ku-Band Input Traffic (30-31JUL02)

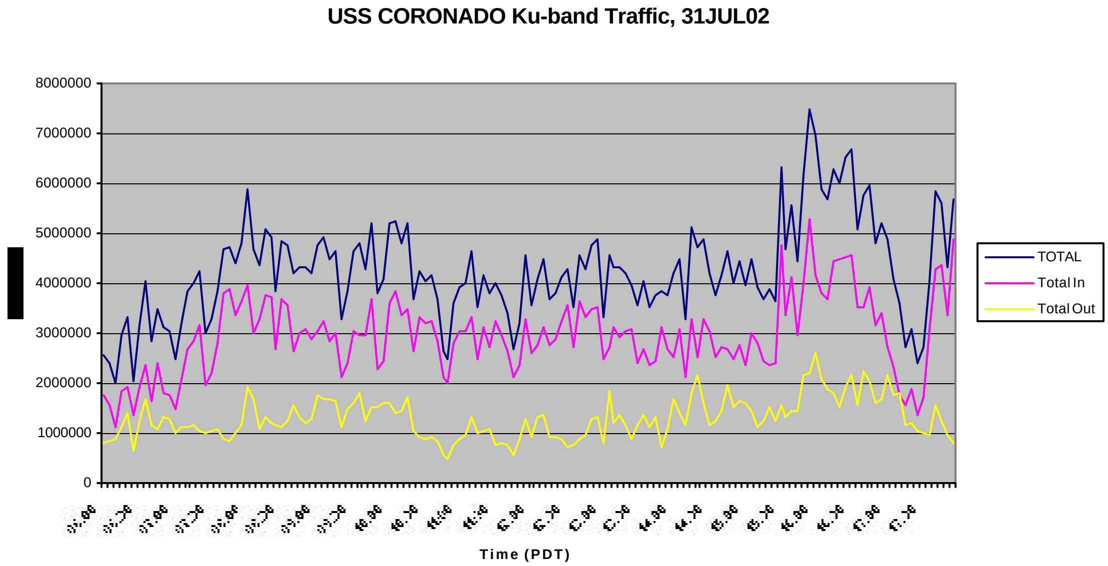

Figure 17-1b. USS CORONADO Ku-Band Output Traffic (30-31JUL02)

Figure 17-1(a and b) depict the total bandwidth used for the two underway days (July 30 and 31). The usage never exceeded 8 Mbps for five-minute averages, with inbound traffic exceeding outbound traffic. The only Ku-band outage experienced in the two day underway period was when the ship turned south as she was leaving port, causing a network outage of approximately five-minutes, from 11:40 to 11:44. However, this situation was anticipated due to the placement of the Ku-band antenna directly behind the mast.

The Ku-band network was also able to support much higher instantaneous throughput (figure 17-2).

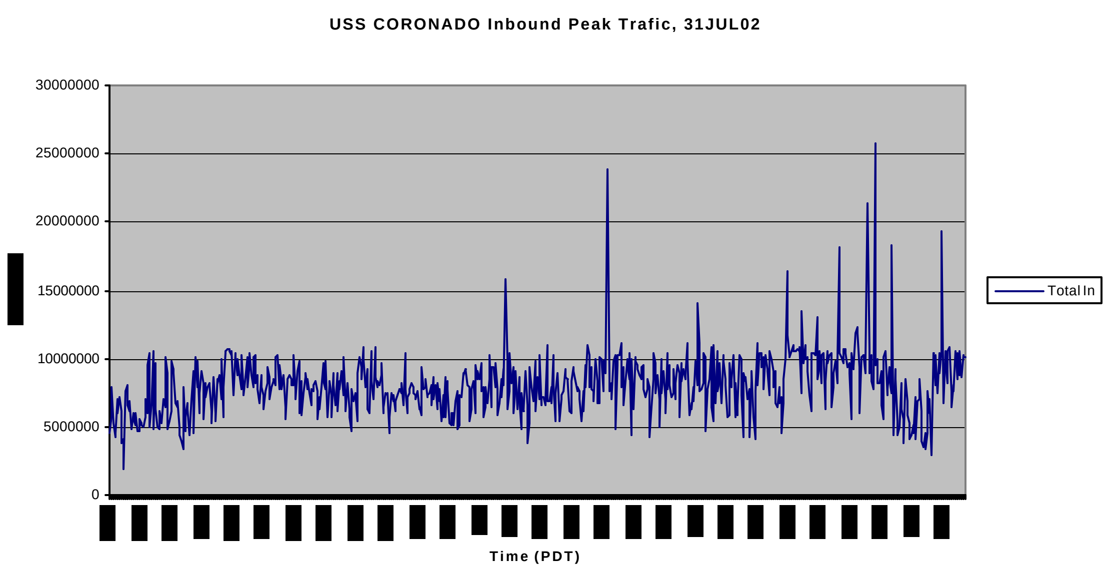

Figure 17-2. USS CORONADO Inbound Peak Traffic, 31JUL02

The peak communications loads generally topped off at around 1 Mbps, but on occasion rose to over 20 Mbps. From the diagram below, it becomes apparent what caused these extreme spikes. The MUSE U2 Simulation typically generated 5 Mbps bursts of streaming video.

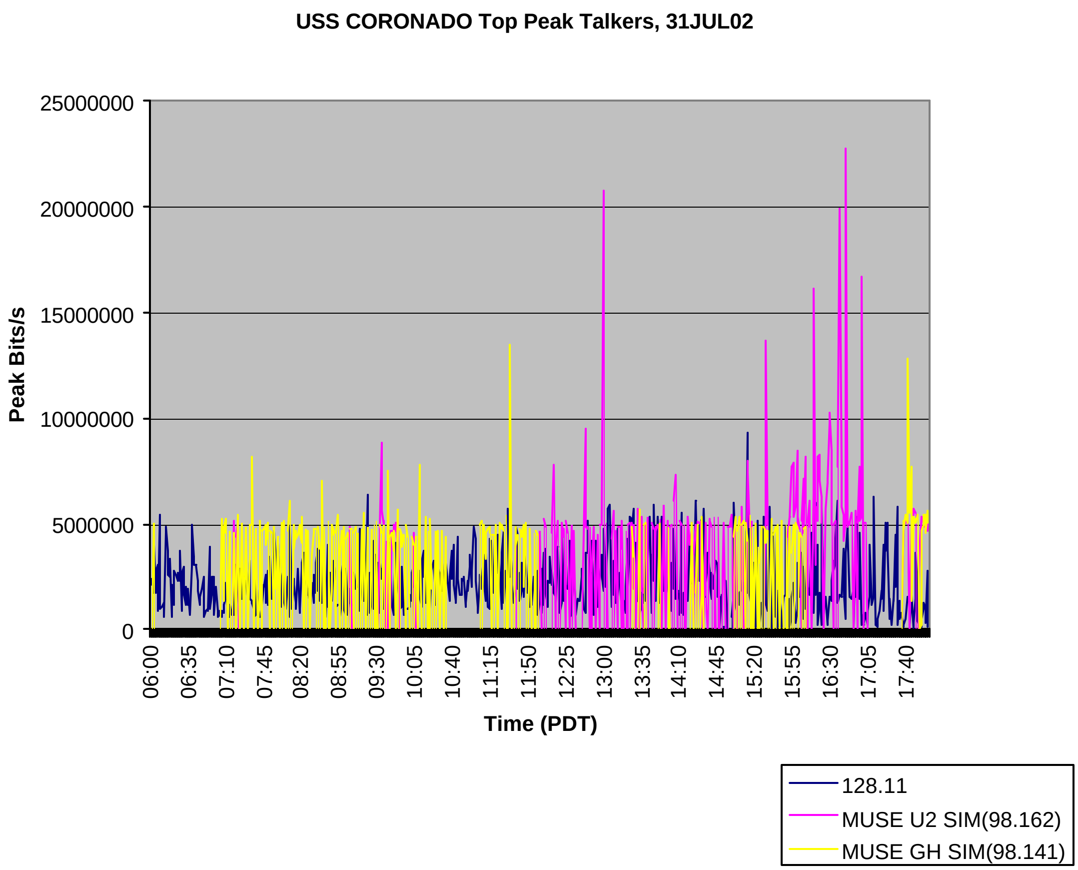

Figure 17-3. USS CORONADO Top Peak Talkers, 31JUL02

The simulation video transmitters were able to attain these high peak rates due to the connectionless nature of UDP and its capability to utilize available bandwidth.

Findings on the JFHQ-F Perceptions of Performing Functional Tasks while on USS CORONADO

The major functional tasks that were performed were in the areas of command and control, Fires, and maneuver. JFHQ-F staff officers were surveyed on their perceptions of operations while on USS CORONADO. The survey results indicate:

- All of the respondents agreed or strongly agreed that there was sufficient manning on USS CORONADO to perform their respective functional area tasks.
- All of the respondents agreed or strongly agreed that they had the capability to send information to and receive information from the JFHQ – Main.

- All of the respondents agreed that the configuration and space on USS CORONADO were sufficient to accomplish their respective functional tasks.

- All of the respondents agreed or strongly agreed that IWS collaborative tools on USS CORONADO allowed them to plan and execute effects based operations.

- Eighty-three percent of the respondents agreed or strongly agreed that the JFHQ-F had the same situational awareness as the JFHQ-M.

17.6 Key Observations Summary

- There were generally no interruptions of communications between the JFHQ-F and the JFHQ-M. This allowed the forward staff to conduct virtual planning and collaboration with the main staff. Additionally, the JFMCC staff continued to plan and operate without interruption. Thus, simultaneous operational- and tactical level operations were conducted during this period.

- Initially, the JFACC-F was to deploy to USS CORONADO simultaneously with the JFHQ-F. This event did not occur. Although additional traffic would be expected with the additional staff, estimate of the impact on communications would have been with three major commands on-board was not possible.

- With an arbitrary staff of approximately 37 people deployed on board, the JFHQ was able to conduct C4ISR, Fires, and maneuver functions while at sea. The forward staff was able to exchange information with both the main and component staffs.

- Configuration of USS CORONADO to support JFHQ-F operations was sufficient for MC02/FBE-J. However, further investigation would be needed to determine if the manning and configuration of USS CORONADO would be sufficient to support continuous, war tempo operations (2-3 shifts).

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Associated Analyses

18.0 METOC

18.1 METOC Observer's Notes

The following is the final report from the senior METOC observer. It differs from the major initiatives in that there were no specific goals, MOEs, or MOPs established for the METOC support in FBE-J. Rather, the community looked at its support to the various initiatives and offered comments and suggestions as to how the environmental support to the initiative could be improved.

18.2 General Communications and Connectivity

The Naval Pacific METOC Center San Diego (NPMOC-SD) was designated a reach back center in JFMCC METOC letter of instruction message[244]. Due to security restrictions, JFMCC could link to NPMOC-SD's SIPRNET FBE-J support web page, but NPMOC-SD had no visibility into the FBE-J/MC-02 WAN. Support personnel at NPMOC-SD noted that greater situational awareness of the scenario, gained by having access to the experiment WAN, would have improved METOC support at the reach back center. METOC support personnel who have an understanding of the current scenario and the warfighter's intentions are better able to anticipate the warfighter's METOC support requirements and fulfill them in a shorter time.

NPMOC-SD was able to collaborate with the USAF 25th Operational Weather Squadron, the USAF reachback center, via Net Meeting software. The CJTF METOC officer was able to participate in these discussions.

NPMOC-SD also achieved connectivity to JFMCC METOC via legacy communications through the COMTHIRDFLT METOC division office on USS CORONADO. Products could be delivered to the METOC division office and either viewed directly by the JFMCC METOC officer or manually transferred ("Sneakernet") to the FBE-J/MC-02 WAN.

NPMOC-SD was not normally included in experiment-related naval message traffic such as pre-exercise coordination messages, further degrading situational awareness. Decreased situational awareness leads to more generalized forecasts covering typical METOC parameters over the operating area, reducing the METOC support providers the ability to provide specific support to the warfighter's operations, thereby reducing customer satisfaction.

18.3 Product Creation and Dissemination

Figure 18-1 describes the general support and products that the METOC community provided to FBE-J forces.

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[244] COMCARGRU THREE message dated 181700Z JUL 02 PSN 984285M36

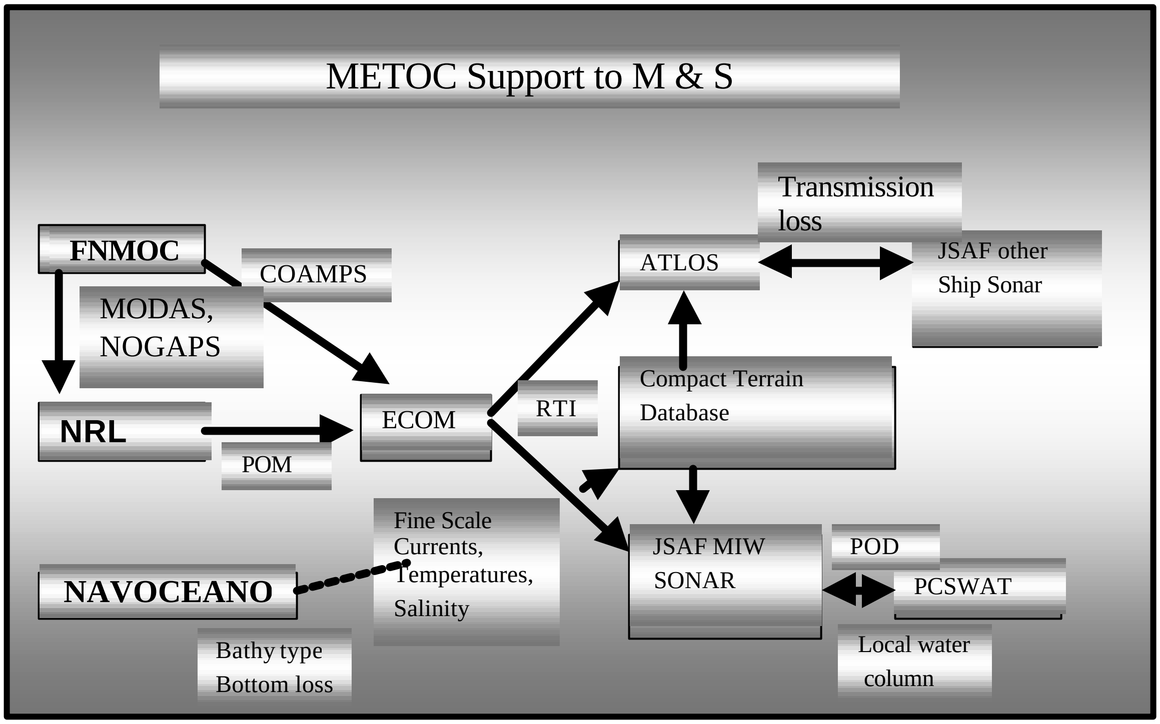

Figure 18-1: General METOC Support to Modeling and Simulation in FBE-J

18.3.1 Anti-submarine Warfare

The SCC was tasked via the METOC LOI to disseminate an XBT guard ship plan. Rather than simply task ships with launching XBT's every six hours, as is common practice, the ASW CUP team worked with SCC planners to develop an oceanographic data collection plan. Using the latest Modular Ocean Data Assimilation System (MODAS) field for the operating area, the CUP team noted areas of oceanographic spatial variability and homogeneity in the operating area. They recommended only one XBT in areas of limited variability, with more collection where the environment varied most. To address temporal variability, they recommended XBT drops at sunrise, sunset, and during the day. This process is an excellent use of environmental information to maximize resources. The approach used by the CUP team is a simple application of the more sophisticated numerically based adaptive observation work being performed at Naval Research Laboratory for the atmosphere and at Princeton and Harvard for the ocean.

The NPMOC-SD provided daily MODAS gridded data fields as well as full spectrum METOC support via web page.

The WECAN was used to effectively distribute ocean environmental data and information to decision-makers engaged in USW in a shared, collaborative, network-centric environment. The Common Undersea Picture (CUP) team provided sonar range prediction/analysis support to shore staffs and units afloat via WECAN. NPMOC-SD posted MODAS gridded temperature fields on WeCAN. USS Fitzgerald and USS Benfold posted bathythermograph data from their XBT drops on the WeCAN. The PC-IMAT operator at FCTCPAC SCC cell the used MODAS-Lite to incorporate XBT data to reanalyze the ocean temperature fields. Updated sound velocity profiles were then made available to all participants via the WECAN. PC-

IMAT and TCP were able to provide updated sonar range predictions to participants via WECAN. GRASP used the updated range prediction information to refine ASW search plans.

18.3.2 Mine Warfare

The Naval Oceanographic Office (NAVOCEANO) provided Special Tactical Oceanographic Information Charts (STOICS) for MIW planning, bathymetry database to support MEDAL, and a vast amount of oceanographic and bathymetric products via their web page. NAVOCEANO was designated a reach back center per JFMCC METOC Letter of instruction.[245] Due to security restrictions, JFMCC could link to NAVOCEANO's SIPRNET FBE-J support web page, but NAVOCEANO had no visibility into the FBE-J/MC-02 WAN.

MEDAL was primary environmental situational awareness tool for current MIW operations. The specialized nature of the mission, compounded by the fact that mine warfare demands very precise navigation, required a specialized environmental situational awareness tool. The MIWC's environmental scale was often tens to hundreds of yards.

STOICS were available electronically via the NAVOCEANO FBE- support web page; however, planners expressed a desire for large paper STOIC charts. The MIWC planners, as in other cells observed, preferred to use paper charts.

NAVOCEANO provided a detachment of two bathymetry experts to embark on the JOINT VENTURE to support the Mine Warfare Commander. The NAVOCEANO riders used gathered bathymetry data using two side-scan bathymetric sonars (Battlespace Planning and Undersea Vehicle (BPUAV) and a Klein). The data were then electronically transmitted from the JOINT VENTURE while underway to NAVOCEANO. NAVOCEANO compared the newly collected in-situ data with historical bathymetric databases. Changes in bathymetry were highlighted and transmitted electronically to the NAVOCEANO team on the JOINT VENTURE. The MIWC's staff could then view the results of the "change detection" via a standard web browser. This resulted in faster, more efficient mine searches; there is no need to check every bottom contact, only the new, unidentified ones.

18.3.3 JFMCC Maritime Planning Process

JFMCC METOC used the JFMCC web page as one way to disseminate METOC information among JFMCC elements (other JFMCC staff, Primary Warfare Commanders). Although it is a very rough metric, hit counters on the pages of the JFMCC web site may offer some insight to how broad an audience the JFMCC METOC products reached. The JFMCC home page registered 82,014 hits as of 1755Z 5 August. To reach the METOC page, one had to click on the "Warfighter" page (10,861 hits), then "METOC" (564 hits). Since there are no indications of where the METOC page is, potential customers must be told how to locate it. One of the first orders of business for METOC personnel in FBE-J was establishing awareness of their services. Face-to-face meetings usually accomplished this with prospective customers. A different web design that features a shortcut to the METOC page would ease this burden.

Although METOC hits were just 5.19 percent of total Warfighter hits, METOC compares favorably with Strike (778 hits), and had far more hits than AAWC (323), MIW (399), or AMWC (336). One must remember that the web page hit counters did not count unique users, or if the user actually read the page, only the number of times a page was accessed. A further confound is the fact that the METOC page as available through a link from the Master Maritime Attack Plan (MMAP) page in the plans section of the JFMCC web page. Although a more sophisticated analysis of web page utilization would yield further

[245] Ibid.

insights, it is worthy to note the METOC web page hits were above the median of all options in the warfighter section of the JFMCC page.

The JFMCC METOC Officer also provided METOC information via traditional briefings, whether in person or via Info Workspace collaboration tools.

18.3.4 Naval Fires Network

As follow-on to the efforts in FBE-I, NPMOC-SD provided METOC support to the NFN via the Tactical Exploitation System Navy (TES-N). NPMOC-SD created geospatially enabled METOC files (shapefiles) using XIS Viewpoint software. The shapefiles can be viewed in any geospatial information service viewer, in this case Arcview in TES-N. Shapefiles contain geolocation information - they "know" where they are on the globe, so they can be overlaid in a geographic display and match underlying maps, satellite images, etc. The power of this is the warfighter can visualize METOC information on his tactical display, regardless of what other datasets he may be viewing. Basic METOC parameters such as wind, or threshold-defined products, such as winds greater than 20 knots, can be displayed in TES-N. NPMOC-SD has made considerable progress in automating shapefile creation (from hours to minutes) so that it now can respond in a timely fashion to requests for information (RFI).

18.4 The Use of METOC Information by Decision Makers

Although data collection, analysis, product preparation and dissemination are all vital to supporting the warfighter, if the warfighter does not use the METOC products the result is effort wasted and sub-optimized tactical and operational plans. During FBE-J a major focus of the collection effort was how the warfighters used the information available to them. In many cases, the planners failed to take advantage of the information available until the environment adversely impacted operations.

18.4.1 JFMCC/MPP

Manning for the JFMCC included a METOC officer in the Current Plans Cell (CPC). The officer was familiar with the experimental Maritime Planning Process. Although assigned to the Current Plans Cell, the CPC was co-located with the Future Plans Cell (FPC) so on site METOC expertise was available in both the CPC and FPC. The JFMCC METOC officer provided mission impact assessments based on forecasts to FPC planners drafting the Maritime Operations Directive (MOD). Since the MOD addresses operations in the 72-96 hour timeframe, METOC guidance is focused on broad parameters at the operational level. The JFMCC METOC officer identified MOD development as a critical METOC inject point. Since the MOD initiates the planning cycle, incorporating METOC impacts into the MOD will have effects that ripple through the remainder of the MPP. Warfighter interest varied with the projected severity of weather impacts. When METOC impacts were assessed to be significant, the METOC officer was invited to brief the JFMCC during the afternoon MOD brief, and the late afternoon "fireside chat." That the JFMCC officer did brief on several occasions is evidence that the JFMCC staff was cognizant of METOC impacts on operational planning and aware of forecast METOC impacts.

The next step in the MPP cycle is development and submission of Maritime Support Requests (MARSUPREQs). MARSUPREQs were submitted by the Primary Warfare Commanders (PWCs) in response to tasking set out in the MOD. Due to experiment artificialities, the PWCs were in buildings, not ships that lacked organic METOC support. Typically the SCC, AMWC and AADC would be co-located with METOC support. During FBE-J their primary means of acquiring METOC information was either through briefs over IWS, or by going to the JFMCC METOC web page. Consequently, the PWCs were not poised to make best advantage of the environmental information available. Moreover, planners in the MIWC, AMWC, and SCC all used large paper charts and relocatable markers (yellow stickies) to visualize the battlespace when making their plans. This was not conducive to incorporating environmental information into PWC plans. Fortunately, if the MOD does include METOC impacts, the MARSUPREQs submitted to fulfill the MOD should implicitly incorporate METOC impacts to some extent.

The MMAPs served to prioritize tasks and allocate resources based on the MARSUPREQs submitted by the PWCs. Since the MMAP is focused on the 24-36 hour timeframe, the METOC forecast can be more focused and more certain. More specific guidance on tactical impacts is available. There is evidence that METOC was incorporated into some portions of the Master Maritime Attack Plans (MMAPs). Strike aircraft weapons load outs incorporated the cloud deck forecast when determining weapon selection (LGB vs. GPS). ISR planning, however, seemed not to acknowledge the forecast. Missions were repeatedly scheduled in areas of low cloud decks, even though the METOC impact charts were red for ISR, signifying severe impacts, and even though the maritime environment stayed relatively unchanged throughout the experiment.

18.4.2 Anti-Submarine Warfare

Combined with in-situ XBTs, MODAS fields were used by the operators of TCP, PC-IMAT and GRASP to produce sonar range prediction products. SCC planners used GRASP, which produces recommended search plans based on environmental inputs, to determine the number and types of assets required to conduct ASW searches. Although the CUP provided excellent near-real time awareness of both the blue force locations and the environment, the SCC did not use the CUP as the primary situational awareness or planning tools. Discussions with the CUP operators and SCC staff indicated that the CUP provided an excellent tactical depiction of a single mission area. However, the SCC staff required an operational level view of a multi-mission environment. The SCC was tasked with resource allocation among many mission areas, not monitoring a tactical level ASW prosecution.

Although products were available, there were no requests for non-acoustic ASW detection products by the SCC.

18.4.3 Mine Warfare

Awareness of the importance of the environment seemed to be uniformly high among the members of the MIWC staff. User survey results showed that the primary METOC product desired for MIW support was bathymetry. All respondents indicated bathymetry, or some variation thereof (e.g. bottom type) as their number one choice.

The MIW planning tools of choice were MEDAL and paper charts. Although bathymetry was critical to the MIW staff, MEDAL’s ability to render high-resolution bathymetry suffered in comparison to PC-IMAT or TCP. The displays MIW operators were using showed very linear contour lines that did not appear to capture the complexity of the littoral. A 3-D type display, capable of showing exaggerated relief, would greatly assist operators trying to visualize the near shore bathymetry on their tactical display. If MEDAL has this capability it was not in evidence.

Worse, the World Vector Shoreline database used to delineate the boundary between land and sea does not appear to have adequate resolution for use in mine warfare. Mine survey data, when plotted on the MEDAL display, carried over onto "land" when clearly it should have been plotted in the near shore. Discussions with the staff indicated this was a frequent problem with MEDAL. A high-resolution shoreline in the area of operations, in addition to high-resolution bathymetry, needs to be added to increase fidelity and enhance situational awareness.

Weather did not rank high on any MIW user surveys, in most cases it was not listed at all. This seems odd since sea state is known to reduce operator effectiveness, and the relatively small mine counter measures vessels are more prone to the effects of higher sea states.

18.4.4 Naval Fires Network

METOC shapefiles were available for display on TES-N. An interview with the JFMCC NFN METOC participant revealed that the TES-N operators under used them. The primary reason is TES-N operators are tasked with executing, not planning. The job of the TES-N operator is to precisely locate targets. Forecast METOC parameters are of little value. Obstructions to visibility will be apparent in the imagery being viewed; either he can see targets or he cannot. Further the Intelligence Specialists (ISs) at TES-N stations generally do not have the requisite knowledge to use METOC products. Recommend a METOC person be stationed with a TES-N. At the present, TES-N is being used as a very narrowly focused tactical workstation.

The METOC concept of operations to support time critical strike needs to be re-examined. It may be that the best way to address METOC impacts in time critical strike is not to provide overlays on a specialized workstation manned by an IS, but a more generalized situational awareness tool used by higher level decision makers. Fortunately, the shapefiles produced by NPMOC-SD can be viewed by virtually any geospatial visualization system; they are not limited to TES-N. Shapefiles were made available to Dominant Battlespace Command (DBC), a higher-level situational awareness tool available to the Battle Watch Captain in the Maritime Operations Center, but technical difficulties with the DBC interface rendered DBC unable to display METOC shapefiles.

18.5 The Use of METOC in Modeling and Simulation

A new Acoustic Transmission Loss Server (ATLoS) and a dynamic Synthetic Natural Environment (SNE) were brought to FBE-J by the Naval Research Laboratory (NRL), Advanced Information Technology (AIT). Anteon Corporation and Lockheed Martin (LMIS) also contributed to ATLoS. The principal simulation entities using ATLoS and this ocean representation were Joint Semi-Automated Forces (JSAF) ship’s sonars, developed by Northrop Grumman. The Acoustic Transmission Loss Server (ATLoS) supplied these ship’s sonars with acoustic transmission loss estimates due to the effects of the dynamic ocean as a propagation medium. ATLoS uses a fast gaussian ray beam model, called Fey Ray, to compute this. This allowed the sonar models to determine the “visibility” of ships and submarines using an ocean representation closely approximating the true ocean environment.

Geotranslation posed a number of challenges to effective environmental simulation. The bathymetry and water mass data in the JSAF simulation were based on Southern California. Real life water mass data, including oceanographic data collected by fleet units participating in FBE-J, were input to JSAF. The guiding principle was to ensure the live and simulation environments were the same to facilitate live force and simulation force integration. This was in concert with the JFCOM METOC officer's directive to use live weather throughout the experiment, as well as the desires of the NWDC Chief Engineer. However, the White Cell was adjudicating from the geotranslated positions, using other bathymetry. This was frustrating to ASW forces, which believed they made valid prosecutions of OPFOR submarines based on their tactical decision aid outputs and simulation outputs, only to have them disallowed by a White Cell working in a different environment.

Cloud decks were manually input into the MUSE UAV simulation. Cloud deck/ceiling forecast information was obtained from the Joint Oparea Forecast (JOAF) promulgated by the CJTF METOC officer each morning. The MUSE operators manually input the cloud deck/ceiling information. MUSE then displayed a textured cloud field that was a reasonable depiction of stratus cloud deck - quite similar to the cloud deck on live Predator video feed from the same area. MUSE has the clouds "follow" the UAV, so the different weather regimes present in different geographic areas could not be input. The workaround was to input cloud information into MUSE consoles supporting UAV missions in areas where clouds were forecast, but not for missions in areas clouds were not forecast. Seeing the cloud deck in the UAV simulation so similar to the live video feed from Pioneer enhanced the believability of the simulation and the weather forecast. Some simulation operators tried to work around the low cloud decks by flying below them, only to quickly learn that aircraft that fly low and slow get shot down.

18.6 METOC Impacts on Live Events

Table 18-1 details some of the impact that METOC conditions had on live events.

Date	Platform/Event	Weather impact
26-Jul	Pioneer from SCI	Cancelled due to weather
26-Jul	USV on SCORE range	Cancelled due to sea state > 3
29-Jul	Pioneer from SCI	Delayed 56 min due to weather. Flew for 45 minutes, returned to base due to weather. Afternoon flight cancelled due to low ceilings.
30-Jul	Pioneer from SCI	AM flight cancelled due to weather
31-Jul	Pioneer from SCI	AM flight cancelled due to weather
1-Aug	Pioneer from SCI	AM flight cancelled due to weather
1-Aug	SH-60	ASW ops cancelled due to low ceiling
2-Aug	SWARMEX	Cancelled due to weather - low visibility, high sea state
2-Aug	ATARS	No imagery due to solid cloud cover
2-Aug	P-3	Cancelled due to low visibility
3-Aug	UAV controlled by JV	Returned to base - low ceilings limited utility
3-Aug	P-3 Bear Trap Environmental Characterization (BTEC) Flight	Limited RF ranges - had to fly low to remain under cloud deck

Table 18-1: Impacts of the Environment on Operations During FBE-J

While many operators think of hurricanes, storms, and other types of severe weather when they think of weather impacts, the weather impacts in FBE-J were less dramatic, yet more long lasting, pervasive, and a hindrance to some operations, particularly UAV operations. Because there was little variation in the weather pattern throughout FBE-J, forecast verification was very good throughout the experiment - there were no weather "surprises." Furthermore, forecasters were able to shift their attention from the broad synoptic scale to forecasting finer mesoscale effects (e.g. exactly when the stratus deck will burn off over San Clemente Island). This is far more difficult, but the military forecasters gained valuable experience dealing with tactical level forecasts in tactical timescales in data sparse areas.

Low stratus cloud decks prevented visual surveillance of the maritime regions of the area of operations on a daily basis. Since most of the UAVs in FBE-J had visual sensors only, the clouds rendered them ineffective. Serious consideration should be given to equipping UAVs with additional sensors that operate outside of visual wavelengths (e.g. RADAR). Low ceilings and reduced visibility severely impacted Pioneer flights from San Clemente Island. Many mornings the Pioneer was unable to fly because ceiling and visibility were below NATOPS minima for safe flight. Nevertheless, the Pioneer was routinely scheduled for morning flights, even after a pattern of cancelled sorties had been well established.

Sea state also impacted operations on several occasions. Traditionally, METOC centers issues high seas warnings when seas are forecast to exceed 12-foot significant wave height. Although seas in the FBE-J areas of operations never came close to meeting this criterion (maximum observed 7 feet), they were sufficient to cancel USV operations (limited to seas 4 feet or less) and small boat SWARMEX (limited to seas 4 feet or less). It should be understood that significant wave heights of 5 feet and higher are not uncommon in many locations worldwide. USVs need to be designed to be effective in sea states higher that sea state 3. Joint Venture (HSV-X1) transits were not adversely impacted by sea state at any time during FBE-J.

Commodore Yoshihara (COMDESRON 9) noted that a possible tactic to deter small boat attack would be to route or position Navy ships in areas where seas would disrupt small boats, but not seriously degrade the larger Navy ships. This tactic, essentially validated during FBE-J, should be incorporated into the appropriate doctrinal publications.

18.7 Recommended METOC Manning in the JFMCC

During FBE-J, one METOC officer billet was assigned to the Current Plans Cell. He represented the JFMCC during Joint METOC collaboration meetings, supervised the production of the maritime portions of the Joint Forecast, tailored the Joint Forecast to address JFMCC operations and maritime environmental effects, ensured METOC impacts were considered in the Maritime Planning Process, and monitored current METOC conditions to assess their impacts on JFMCC forces and operations.

Two weather forecasters were assigned to the Current Plans Cell. They produced maritime METOC forecasts with the assistance of designated reach back METOC centers, assessed METOC impacts on JFMCC forces and operations, and monitored current METOC conditions to assess impacts on JFMCC forces and operations.

One NFN METOC support person was assigned to the JFMCC. This billet was intended to assist NFN operators with display and interpretation of METOC products on TES-N. Due to technical difficulties, almost all of this person's time was devoted to troubleshooting.

In an interview near the end of the experiment, the JFMCC METOC Officer indicated that in addition to the above manning, two additional billets are necessary to provide the required support to the JFMCC: a JFMCC OPS METOC billet and a JFMCC weather observer/technician.

The JFMCC OPS METOC billet should be an E-6, NEC 7412 with battle group experience. The JFMCC OPS METOC sailor would monitor Battle Watch coordination circuit and respond to short-term requests for METOC information effecting JFMCC forces - somebody to worry about the "now" while the JFMCC METOC officer concerns himself with tomorrow and the days following. The JFMCC OPS METOC sailor would also provide tactical METOC decision aid products to JFMCC forces.

The JFMCC weather observer technician billet should be an E-4.

19.0 Human Factors: Analysis of Sailor Fatigue and Sleep Patterns on the Joint Venture (HSV-X1)

19.1 Background

The high-speed vessel Joint Venture (HSV-X1) participated in the Navy's Fleet Battle Experiment – Juliet (FBE-J) and concurrently with the Joint Forces Command's Millennium Challenge 2002. The HSV was outfitted for a variety of roles (MIW, NSW, STOM, etc.) and spent a large portion of the experiment at sea attempting to assess the utility of the craft for such missions. As part of the assessment procedure, subject matter experts were embarked to determine if the vessel was capable of performing each assigned mission. The ship's crew consisted of a standard complement of 31 Navy personnel augmented by civilian mission specialists to run experimental or prototype systems. When staffs embarked, the Navy crew was increased to 42 plus civilian mission specialists. Navy personnel only accomplished the actual operation of the vessel. This was done to determine if such a vessel could operate below the manning levels typically associated with a naval vessel of this size, and particularly one with such non-traditional construction, speed, and maneuverability.

The Navy is attempting to determine if the reduced manning aboard such a vessel will allow for optimal crew and vessel performance. A reduction in personnel makes sense only if manning is a at a level that will not overwork the crew, degrade combat or mission effectiveness, increase injuries, or risk damage and/or loss of the vessel itself. The driving forces behind crew reductions are twofold. First, with the ongoing difficulty and expense of recruiting, training, and retaining qualified personnel, the ability to operate effectively on fewer crewmembers makes sense from a purely personnel perspective. And secondly, fewer personnel aboard a warship means that fewer people are required to "…go in harm's way" with the attendant risk of loss of life. Such reductions in personnel are already being designed into future combat platforms, with the DD (X) being designed from the keel up with reduced manpower and automated control, weapon systems, and damage-control capabilities.

19.2 Study Design

During FBE-J, the HSV-X1 was operated with most crewmembers (including officers) required to accomplish a wide variety of both technical and traditional shipboard jobs during a typical day. The XO reported that it was typical for each of his crew to be required to serve in 3 or 4, perhaps even more capacities, often doing jobs typically assigned only to specific ratings. For example, a MM1 might be required to perform traditional engine room duties, but to also help with line handling, mess deck duty, serving as a lookout, and perhaps assisting with navigation duties. Such cross-discipline job duties, however, are not atypical on smaller vessels. What is unusual, however, is that due to design and performance capabilities, the HSV does not require any tug assistance when docking/departing, and while at sea is capable of speeds in excess of 45 knots. Such speeds allow significantly less time for the crew to react to other shipping, obstructions, navigation hazards, etc.

Because fatigue and lack of sleep often result from an individual having to perform a wide variety of job functions, it was decided to outfit a small sub sample of the enlisted crewmembers with wrist activity monitors. These wristwatch-like devices, called Actigraphs, contain an accelerometer that records an individual's physical activity level. Actigraphy is a reasonably accurate representation of the sleep-wake cycle of the individual wearing the device. Four male Petty Officer volunteers were recruited to participate in the study and each wore an Actigraph for an average for 13 days. At the completion of this period, the devices were collected and the data were downloaded from each for statistical analysis.

19.3 Results

Average sleep per day as calculated through actigraphy data are reported for individual participants in Table 19-1 below. Plots of raw data for individual participant data are listed in Appendix 11.

Subject number	Average sleep in minutes per 24 hour period	Standard deviation
(1)	88	67.2
(2)	297	152.0
(3)	270	229.3
(4)	99	80.9

Table 19-1: Average Sleep in Minutes for 13-day FBE-J Exercise.

Over the course of this 13-day recording period, the average amount of sleep was disturbingly small, with individuals receiving only 182 minutes (or 3.02 hours) per night. The range was from 1.48 hours to 4.57 hours in length. Since humans require an average of 8 hours of sleep per night to function at an optimal level, it can be reasonably assumed that crew performance was impacted. Both laboratory and field studies have documented that reductions in the amount and quality of sleep are associated with predictable decrements in performance.[246]

The sleep quality of the participants was also significantly affected—indicating that individuals received very disrupted and disturbed sleep over the course of the exercise.

19.4 Overarching Finding

Individuals with sleep patterns such as those seen on the HSV have a greatly increased risk of mishaps due to lapses in attention and fatigue. From an operational risk management perspective, these results warrant further investigation since both safety and mission effectiveness are critical military issues.

The quantity and quality of sleep attained by these sailors is substantially less than the sleep observed in USN Recruits during boot camp and in USN sailors working nights during combat aboard USS STENNIS during Operation Enduring Freedom.[247,248]

19.5 Caveats

The following caveats should be considered when examining these results. The small sample size of the population under study may not be representative of the larger population of USN sailors. Another important consideration is whether motion artifact of the HSV could have corrupted the participants' activity patterns. At issue is the motion translated to crewmembers on the HSV as it moves through the

[246] Hursh, S. R., Redmond, D. P., Johnson, M. L., Thorne, D. R., Belenky, G., Balkin, T. J., Storm, W. F., Miller, J. C., and Eddy, D. R. (in press). Fatigue Models for Applied Research in War Fighting. Aviation, Space, and Environmental Medicine, 2002.

[247] Miller, N.L., Nguyen, J.L., Sanchez, S., and Miller, J.C. (May, 2003). Sleep Patterns and Fatigue Among U.S. Navy Sailors: Working the Night Shift During Combat Operations Aboard USS STENNIS During Operation Enduring Freedom. Accepted for presentation at the annual meeting of the Aerospace Medical Association.

[248] Nguyen, J. L. (2002). The Effects of Reversing Sleep-Wake Cycles on Sleep and Fatigue on the Crew of USS John C. Stennis. Unpublished master's thesis, Naval Postgraduate School, Monterey, California.

water. This motion may be important because actigraphy measurements could have been affected by the motion of the ship and therefore may not be an accurate assessment of the amount and quality of sleep received by the participants. Since actigraphy measures the activity levels of a human, the unusual waveform motions of the HSV may have interfered or added extraneous motion to this recording. This effect would be particularly problematic during sleep periods, when the absence of motion is used to assess whether an individual is asleep and to measure the quality of that sleep period. Future studies should ensure that any background noise due to ship motion is recorded and explained.

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Appendix 1: Master Scenario Event List
Final Report: Fleet Battle Experiment - Juliet

FBE-J Pre-Execution / Execution Overview

The FBE – J execution and pre-execution schedule was integrated within the construct of MC 02. The pre-execution phase involved installation and integration of equipment, technical testing, and operator training in a spiral development approach. The execution phase involved both live and simulated forces. All live play integrated with MC 02 was scenario driven.

Pre-Execution Phase (10 Jul-23 Jul 02)

Technical Integration and Testing Event*:* Technical testing included operational sequence diagram (OSD) testing 18-20 JUL 2002, which built upon testing completed in Spiral 3. Testing priorities in OSD testing included: HSV Joint Venture, USS Fitzgerald, USS Benfold, USS Salt Lake City, Sea SLICE. and China Lake Strike Warfare Commander Strike Cell. FCTCPAC JECG and technical support commenced 24-hour operations on 22 July.

Experimental installs and technical integration*:* Installations and integration were required on various platforms including: USS Benfold, USS Fitzgerald, USS Salt Lake City, JointVenture and Sea SLICE. In addition, additional workstations were installed at numerous FBEJ/MC 02 sites.

Functional training events*:* Training priorities were designed to: (a) train the JFMCC and PWC personnel who had no previous training or did not attend Spiral 3; (b) provide XC4I tools refresher training for operators; and (c) provide JECG and observer training for reservists. In addition, each JFMCC cell and PWC staff had refresher functional training specific to that cell.

Integrated training FBEJ / MC 02

Date of Event	Comments
10-21 JULY	End To End Connectivity / Communications Test (MC 02)
11 JUL	JTF Commander's VTC (1200-1330 EDT)
12 JUL	INTSUM Roll Up
15 JUL	FBE J Ops & Technical Team Deploys For San Diego
15-16 JUL	XC4I Tools Training JTASC
16 JUL	JECG Wargame (JTASC)
16-17 JUL	Technical Set-Up (FCTCPAC)
16-17 JUL	Live Fly & Pre-Sail Conference San Diego
17-18 JUL	XC4I Tools Training JTASC
17 JUL	U2 Collection For JFMCC
17 JUL	JFCOM Working VTC (13-1430 EDT)
17 JUL	All MC 02 Systems Fully Up
18 JUL	MC 02 Network Up For All USN Participants (Except BENFOLD, NP3D, HSV, and N24 VPU)
18-19 JUL	July JDN Conference (NELLIS)
18-20 JUL	Navy OSD Testing
18-21 JUL	JFI Testing
18 JUL	JTF Commander’s VTC (1200-1330 EDT)
19 JUL	COP VTC
19 JUL	U2 Collection for JFMCC
19 JUL	JECG In-processing JFCOM
20 JUL	BENFOLD, NP3D and HSV Enter MC02 Network

20-21 JUL JECG Training (via VTC for Remote Sites 09-1630 EDT)
21 JUL Reserves Report in
21 JUL Commence 24 Hour Technical Operations Support
21-23 JUL Training
22 JUL USN JIB Stands Up at NS Point Loma
22 JUL JTF In-Processing
22 JUL XC4I Tools Training JTASC (One Day Class)
22 JUL JFMCC-PWC Warfare Commander's Conference San Diego
22 -23 JUL In-Processing
22-23 JUL M&S Exercise Synchronization Drill (All Remote Sites and Response Cells
220900 PDT Commenced 24 Hour Ops For Navy JECG at FCTCPAC
23 JUL Sea Slice Underway - Live MIW Play Commences
23 JUL XC4I Tools Training JTASC (One Day Class)
23 JUL Form And Train
24 JUL N24 VPU MC 02 Network
241630 JUL EDT COMEX 24 Hour Ops and Battle Rhythm
25 JUL MIW DV Day (JOINT VENTURE)
01 AUG DV Day NAWC-WD CHINA LAKE
01 AUG Media Day San Diego
01 AUG ASUW Live-fire Rehearsal
02 AUG DV Day NAWC-WD PT MUGU
02 AUG ASUW Live-fire
05-06 AUG DV-VIP Days FBE J
05 AUG NFN TACMEMO Final Review Conference
10 AUG All Models Shut Down
10 AUG Senior Mentors Fly to JTASC
10 AUG JFMCC CDRS and Staff, and PWCS Conduct FBE AAR on site
11 AUG Component Commanders And Principal Staff Fly To Jtasc
11 AUG JFMCC Staff and PWCS Conduct FBE AAR on site
11 AUG Begin Redeployment (FBE (JTASC))
12 AUG Component Commander/Senior Mentor Cross Talk Groups (JTASC)
12 AUG Specific FBE Participants Finalize Review For FBE Related Doctrine & TACMEMO (JFMCC Chiefs Of Cells, NWDC Reps, PWC Reps, except AAWC and STWC)
13 AUG CIE/IKA Network Shutdown
13 AUG CINC In-Focus Session With Component Commanders (JTASC)
13 AUG Component Principal Staff Cross-Functional Working Groups (JTASC)
14 AUG Final After Action Review (FAAR)
15 AUG FBE-J Quicklook Released
15 AUG ENDEX
4 SEP MC 02 Quicklook

Appendix 2: Participants
Final Report: Fleet Battle Experiment – Juliet

Millennium Challenge 2002 and Fleet Battle Experiment – Juliet involved approximately 13,500 people spanning three time zones and 35,000 simulated platforms, tanks, aircraft and ships. Under the overall guidance of the Naval Warfare Development, FBE-J was the most sophisticated experiment to date.

UNIT DESIGNATION	UNIT LOCATION	COMMENTS
USCINCJFCOM	NORVA	
COMSECONDFLT	AFLOAT	JFMCC/USS CORONADO
	AFLOAT	DJFMCC/USS CORONADO
COMTHIRDFLT	AFLOAT	C3F STAFF, JFMCC PLANS STAFF
COMCARGRU EIGHT	NELLIS AFB	DJFACC, NELLIS AFB
COMCARGRU THREE	AFLOAT	CCG 3 STAFF, JFMCC OPS STAFF
USS CORONADO	AFLOAT	JFMCC, MIWC EMBARKED, SOCAL OPAREAS
USS Fitzgerald	AFLOAT	SOCAL OPAREAS
USS Benfold	AFLOAT	SOCAL OPAREAS
USS SALT LAKE CITY	AFLOAT	SOCAL OPAREAS, VIRTUAL SSGN
USS BOXER	AFLOAT	SUPPORT STOM, JSHIP, CPR 1 EMBARKED
JOINT VENTURE HSVX-1	AFLOAT	MIWC, NSWTG EMBARKED, SOCAL OPAREAS
SEA SLICE	AFLOAT	MIW, ASUW, SOF
OPFOR SUBMARINE	AFLOAT	SOCAL OPAREAS
CVW 11	CHINA LAKE	STRIKE WARFARE COMMANDER
CDS 9	FCTCPAC	SEA COMBAT COMMANDER
CPR 1	FCTCPAC	CATF/AMWC STAFF
	AFLOAT	CPR 1 EMBARKED BOXER
FIWC	NAB LITTLE CREEK	IO REAR
COMCMRON 3	AFLOAT HSV	MIWC
	FCTCPAC	AFTER DEBARK HSV
CTF 12	PEARL HARBOR	THEATER ASWC
CO ANTIETAM	GREENSBORO,N.C	AAWC/RADC, AT AADC MODULE
VIRTUAL SSGN	NUWC NEWPORT	
VIRTUAL COLLINS SSK	NUWC NEWPORT	FBE PLAY ONLY, NOT MC-02
VIRTUAL HMCS SHIP	HALIFAX, CA	DREA, ABOVE
VIRTUAL RN SHIP	PORTSDOWN,UK	NC3I, ABOVE
VIRTUAL DD-X	FCTCPAC	

NAWC SEA TEST RANGE	PT MUGU	
SAN NICOLAS ISLAND	SNI	UAV DOWNLINK SITE
TSC NORTH ISLAND	NASNI	ASW C2 SITE
SCORE-FACSFAC	NASNI	SURROGATE ADS
VC-6	SNI	VC-6 PIONEER UAV DET
PATRECON DET	NORTH IS	VP AND VPU DETATCHMENT
1 U2	BEALE AFB	9TH RS SQN
1 JSTARS	NELLIS AFB	93 ACW
1 VPU P-3	NASNI	VPU2
1 NP3D	PT MUGU	NRL
1 E2C	PT MUGU	VAW-116
1 F/A-18 (ATARS)	MCAS MIRAMAR	VMFA 242
1 AIP P-3	NASNI	VP 9, ASW MISSIONS
1 AIP P-3	NASNI	VP 46, ISR MISSIONS
2 PREDATOR (JOTBS)	CHINA LAKE	
2 F/A-18 (MIDS)	CHINA LAKE	VX 9
1 EA-6B	CHINA LAKE	VAQ 135
1 EA-6B	NELLIS	VAQ 132 USAF GSTF SUPPORT
SH-60	NASNI	HSL 43,45,47,49
S-3B	NAS LEMORE	VS 33
HS	NASNI	HS-2 NSW SUPPORT, HS-6 ASUW SUPPORT

Table A2 – 1. Units and Nodes that Participated in FBE-J

Acronyms	Naval Agencies Participating in FBE-J
ASN (RDA) CHENG	Assistant Secretary of the Navy (Research, Development, and Acquisition); Chief of Engineering
COMOPTEVFOR	Commander, Operational Test and Evaluation Force
DARPA	Defense Advance Research Projects Agency
FACSFAC San Diego	Fleet Air / Area Control and Surveillance Facility
FIWC	Fleet Information Warfare Center
NAVAIRSYSCOM	Naval Air Systems Command
NWC	Naval War College
NAVPACMETOCCEN	Naval Pacific METOC Center
NAVSEASYSCOM	Naval Sea Systems Command
NRL	Navy Research Laboratory
NWDC	Navy Warfare Development Command
NAWC-WD	Naval Air Warfare Center -Weapons Division
NDIA	National Defense Industrial Association
NRO-OSO	National Reconnaissance Office
NSAWC	Naval Strike Air Warfare Center
ONR	Office of Naval Research
SPAWARSYSCOM	Space and Naval Warfare Systems Command - System and Material Command
SSC-SD	SPAWAR Systems Center - San Diego
SWDG	Surface Warfare Development Systems Command

Table A2-2. Naval Agencies Participating in FBE-J

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Appendix 3: Data Collection
Final Report: Fleet Battle Experiment – Juliet

Success in Fleet Battle Experiments (as learned in previous FBE experience), in both data collection and analysis of complex and large-scale experiments such as the series of FBEs, depends upon a full understanding of underlying planning and execution requirements. In general, it is necessary to:

- Understand senior leadership experimentation goals.
- Define analytic objectives.
- Determine the operational details of each experiment or demonstration initiative.
- Define the experiment and supporting technical architecture.
- Support each warfighting finding with context.
- Actively engage in dialogue with the initiative leads and participants.
- Build flexibility into all of the above.

Great effort was taken to ensure that experiment data collection and analyses, within the confines of the experimental design, would support Fleet and senior leadership's intent and expectations. Analyses objectives for Fleet Battle Experiment Juliet were focused on six areas of high interest to senior Navy leadership:

- Service interoperability in the Joint environment.
- Reduction of the timeline for location and engagement of time sensitive targets (TSTs).
- Enhanced Situational Awareness (SA) for decision-making.
- DOTMPLF recommendations for Joint Forces Maritime Component Commander (JFMCC), Joint Fires Initiative (JFI), Navy Fires Network (NFN), ISR, and High Speed Vessel (HSV) initiatives
- Provide supporting data that contribute to systems acquisition decisions.
- Provide supporting data that contribute to defining requirements for advanced Joint and Navy communications and information architecture.

Fleet Battle Experiments do not follow standard practice for experiment design. A standard practice would begin with analysis objectives. Based on these objectives, an event would be designed to produce the data content and analysis necessary in order to produce the results that are being sought. Post experiment analysis would include an examination of the methodology and experiment design, as context for the results. An iteration of the entire chain would then be planned, as necessary in order to deepen an understanding of the operating hypothesis on which the analysis objective was based. This is essentially the scientific method. Fleet Battle Experiments to date have tended to invert this process, so that data collection planning and analysis are determined by the scope and development of initiatives that mature in-stride with operational planning for an event.

The above is not intended as critique (although there is an active ongoing discussion on this subject apart from FBE Juliet), but as an explanation to the trained methodologist as to the structure of the Data Collection Plan (DCP). This document is a description of the process that has emerged in Fleet Battle Experiments; it is not necessarily a set of best practices for experiment design.

Because of the complex planning required to produce an executable plan and near-continuous refinement of the operable initiatives, the FBE Juliet data collection plan was continuously modified until the start of the experiment. In general (as part of the FBE process), data planning often continues in real-time during experiment execution as conditions and systems are modified in-stride. Prior to execution, the data collection plan process builds from extensive interviews with initiative leads and experiment stakeholders that includes the Navy Warfare Development Command (NWDC) Maritime Battle Center, NWDC Concepts, NWDC Doctrine, and Fleet participants.

Data collection planning is dynamic and is required to be flexible enough to respond to changes in Concepts of Operations (CONOPS), architecture, and experiment scope. The Meyer Institute of Systems Engineering, Naval Postgraduate School (MISE) has been fully engaged with experimental initiative leads to improve the definition of appropriate analytic objectives and consequent data collection plans.

MISE was the lead to ensure FBE-J data collection efforts were coordinated between all agencies. To the extent other agencies are participating in FBE-J analyses, coordination will continue with JFCOM, the Naval Fires Network Virtual Program Office (NFN VPO), ForceNet, and the Army Space Program Office (ASPO).

Data Collection Plan Goals and Objectives

The Data Collection Plan ensured that data collection supported analysis and reporting requirements of the Fleet, NWDC and the stakeholder. In support of the DCP, the data management process ensured that collected data were appropriate and sufficient to analyze properly and support experimental initiatives.

The DCP formally documented the intended course of action for collection, distribution, analysis, reporting, and archiving of data products relevant to FBE-J initiatives. In addition, this plan defined experiment Measures of Performance (MOP) and Measures of Effectiveness (MOE) that provided guidance to plan and execute data collection and analysis of this experiment.

Objectives of the Data Collection Plan

- Manage all data collection planning and processes from a central organization (MISE).
- Ensure the collected data were adequate to provide analysis of initiatives and to meet NWDC and Fleet requirements.
- Ensure electronic data requirements were articulated early to systems managers so that adequate plans, software, and instrumentation were in place to collect required data.
- Ensure proper and timely collection, reduction, reproduction, and distribution of data.
- Minimize unnecessary collection, reproduction, and distribution of data.
- Minimize confusion in the data collection and distribution process.

The strategy for collecting sufficient electronic and manually recorded data for analysis was an extension of lessons learned from previous Fleet Battle Experiments (most recently, FBE India). This included an aggressive process to understand thoroughly the experiment technical architecture and Concept of Operations (CONOPS) during the experiment planning and architectures development phase. Also, data elements required to answer initiative MOEs and MOPs were identified. Thus, the data collection and analysis strategy were focused on providing a robust, comprehensive quantitative and qualitative database to address MOEs and MOPs. These questions were continually refined and targeted to specific experiment areas of interest and changes to the CONOPS.

There was strong emphasis and support to derive quantitative (generally analogous to digital) data. It was important that electronic data collection requirements were clearly defined to ensure systems managers could support analyses by providing sufficient, usable data. Data collection and analysis planning were conducted in parallel to the development of the architecture and CONOPS.

Data Requirements Definition

In general there were opportunities to collect four types of data in FBE-J:

- Time stamped data: As an example, reconstruction of time sensitive target (TST) events necessitated recording precise times at which significant events took place along the timeline from detection to attack and to mission success. A time stamp was recorded for every contact/target event as it passed through the TST process.

- Quantitative and contextual data: To meet the objectives of the Fires ISR and TST initiative, it was necessary to determine the number of contacts detected, cross-cued, nominated and engaged. In addition, each contact event needed to be tracked as it proceeded through the TST timeline in order to specify process impacts on the timeline.

- Technical performance data: Technical analysis was used to assess system reliability, connectivity, and/or interoperability. Data collection methodology included recording down times, malfunctions, file transfer rates, and times when connectivity was lost. Obtaining specific technical data were generally the responsibility of the system owner as the system participated in the FBE. In addition, trouble logs were collected and evaluated.

- Qualitative observations and measurement: Observations by participants, interviews and limited sample surveys were used to bring warfighting context to quantitative MOPs. Analysts with operational experience located at key decision-making nodes gathered data on C4I structure and processes.

As stated earlier, data collection planning occurred in parallel with the development of the architecture and CONOPS. Since the FBE-J Initial Planning Conference (IPC), a dialogue has continued with systems managers from all initiatives to define data requirements and determine system capabilities and function during the experiment. Data planners continued this discussion through SPIRAL 3 and further identified electronic and manual data to be collected during FBE-J. Data formats and data reduction capabilities of each system were also defined. MISE planners used this information to construct analysis tools for post experiment use on data collected during the experiment.

An electronic data capture "Operations Center" was created in the vicinity of the modeling and simulation center and experiment control locations at the Fleet Combat Training Center, Pacific. MISE personnel manned this center for data collection coordination, and for monitoring the day-to-day electronic data capture events and making adjustments to the data collection plan, as required. The data collection lead from each experiment node communicated with the operations center daily through an IWS chat channel or voice communication circuit to ensure that the data collection plan was functional.

Observation And Data Collection Guidance

Data collection is demanding and intellectual work. Data collectors must understand how to observe or collect what is important, defined through questions specified for each area, and also what might be important as the experiment unfolds. In other words, effective data collection includes the collection of required data and also those data from unintended and unplanned actions.

Each section of the data collection plan included questions that were defined as important to experimentation data collection within a specific area. Questionnaires, participant observations, data logs, electronic chat dialog, interview questions, and electronic data all contributed dimensions that together improved the quality and validity of answers to these core questions.

General Guidance Given to Data Collectors

- Define the context in which observations were made. For example, if there were delays in TST engagements, it is important to note the time delay, and the situation that may have contributed to the delay at the time of the observation (e.g., prosecution of pre-planned targets, shift in commander's intent, changes to the organization for TST, equipment/personnel problems etc.). This context is essential to analysis of complex interactions.

- Part of the context is ground truth. Note all positions (for example, ship's position, or target position) that would be necessary to understanding how a particular event evolved. Time is also an element to ground truth. You need to record time as a part of all observations. This is critical to tracking data in later analysis.

- Use data logs to assist in cataloguing observations. These will prove invaluable later as you reconstruct an event. Be very organized about this. Back of the envelope data collection is not useful later.

- Use a tape recorder as a means to help you fill in notes later. This technique works better for some than others. However, do not depend on a tape recorder as your principle collection means--transcription of taped notes is difficult, and interview notes are generally very reliable in reconstructing important respondent comments later, and can be verified by recordings. Also, quality recording on a ship is nearly impossible!

- Note exceptions to the "routine." As the flow of a problem becomes more and more routine, note those instances which are not routine, or which cause the system being observed to behave in a different way.

- Note changes in organization, CONOPS or other "baselines" that were the basis for the experiment at STARTEX. As well as you can, define reasons and consequences. This assumes that the data collector is well versed in what is considered the initial conditions for the experiment. It is essential that data collectors have this expertise, or changes to routines and to baselines will not be captured.

- Besides the basic set of questions and data sheets provided to you, adapt data collection to what you are observing. That is, if we aren't asking the right questions, what are the correct ones?

- Understand the system you are observing! Draw it out at the level you are observing it. Don't simply repeat the system from the EXPLAN, or operational sequence diagram (OSD) but try to construct it as a diagram based on what is actually happening (using the baseline architecture as a point of comparison).

- Be completely conversant with the overarching data goals for your portion of the experiment. Your expertise and depth of understanding will have a direct relation to what you notice, and the quality of those observations and notes.

- Do not interfere with operations and participants. However, "wallflowers" do not make good data collectors. If it is important to ask a participant a question, simply try to do this in a way that does not interfere, but in the end, it is the data that are most important. Post event interviews are an excellent way to obtain the "deck plate" view from participants, and there will be a structured set of interviews and focus groups that all data collectors will have an opportunity to work with.

Afterwards, it is critical that notes be immediately transcribed--the relevant information is generally perishable and will be difficult to reproduce in a few days.

- Preparation is required for each day's events. Data collectors must be familiar with the MSEL events anticipated in each day's operations (noting that much of the experiment is unscripted and variable). Think through the data collection opportunities inherent in each of the events, and plan accordingly. If there is a crossover to another initiative area, collaborate with the data collection lead in that area.

Electronic Data

Electronic data from systems comprising the FBE-J architecture were essential to quantitatively describe the TST engagement process and to document command and control decision-making processes. In addition, logs from collaborative tools (Info Workspace, IWS) provided qualitative experiment context and offered explanations that validated quantitative results. The systems and data element requirements required to support FBE-J analysis are highlighted below.

Electronic data (system logs) from ALL systems that are components of the targeting process (e.g. GISRC, TES-N, GCCS-M, ADOCS/LAWS, DTMS/PTW, RPM, RPTS, etc.) were required for FBE-J post experiment reconstruction analysis. Individual system managers were required to maintain electronic logs that define system performance and permit a timeline analysis, by event, of the operation of the system. These logs were an essential element of the data collection plan and overall test analysis effort and were submitted to MISE upon experiment completion. Details of initiative data elements required from electronic systems were identified within each initiative section in this data collection plan.

The general requirements for data from participating systems participating in FBE-JJ included:

- All systems were expected to record externally generated messages received by the system and the response sent from the system.
- Systems were to record the nature of any significant internal action performed by the system.
- All recorded data were to be time tagged.
- All time tags were to be time synched.
- All logged events and consequent actions (cause and effect) were to identify associated target or track number.

The format in which data were provided was to have been documented. The format was expected to be easily exportable to spreadsheets or databases (i.e., comma separated files).

Data were provided for daily analysis or immediately, post-experiment, depending on reporting requirements. Daily collection management and field analysis were discussed in the Data Collection Plan (Data Collection C2 and Battle-Rhythm). Post experiment data analysis was discussed in a separate Experiment Analysis Plan (EAP). Data were provided on floppy discs, zip discs, CDs, e-mailed or by FTP to NPS.

Data Collection Plan (DCP) Organization

For each of the initiatives in FBE Juliet the following elements were included in the DCP:

- An explanation of the relationship between the initiative and a warfighting challenge in 2007, as it was to be played within the FBE Juliet and MC02 scenario (scripted in the Master Scenario Events List (MSEL)), or as it emerged in unscripted free-play.

- A definition of the general theme of the initiative. Specifics with regard to background for an initiative could be examined in the Experiment Plan (EXPLAN).
- A Statement of Sub-Initiatives. Elements that contributed to sub-initiatives (sub-sub initiatives) were stated under each. A summary description of the contribution each of these elements made to the Sub-Initiative was also provided.
- Analysis Objectives were stated, which may have included objectives across sub-initiative areas
- Measures of Effectiveness and Measures of Performance, with associated requirements for data.
- Required data elements, which specified data needs for the initiative area.
- Synchronization between analysis objectives and MOPs and MOEs.
- Requirements for data collection instruments (questionnaires, surveys, interview questions, etc.) and log sheets.
- Data collection points, nodes, or positions.
- Lead data collection responsibility (by name).
- Coordinating instructions, including requirements for daily data summaries, media collection, and data collection, C2 etc…

Measures of Effectiveness (MOEs) and Measures of Performance (MOPs) were identified as a means to characterize or compare systems and processes to a structured requirement that contributed to full understanding of the observed system.

- MOE is defined as a measure that expressed the extent to which a system accomplished or supported a mission or task (in other words, a capability).

- A MOP is purposely more quantitative, and is a measure of a system's capabilities or specific performance.

While it would be convenient to succinctly capture performance/effectiveness in a single number, MOPs/MOEs alone do not generally provide the context needed to express the interrelations between a cause and an effect. For this reason, MOPs/MOEs are best used when coupled with contributing context.

Examples

- A JFMCC MOE: "Sufficient manning to perform functions outlined in MPP CONOPS. “Sufficient” is the condition in which the processes required in the MPP are not delayed as a result of lack of personnel resources alone."

- A JFMCC MOP: "Percent of orders synchronized prior to being issued to a warfare commanders."

- Contributing context would include: “Although adequate personnel were sitting at workstations, they were not conversant in JFMCC MPP process details. The result was a constrained process.” Or, “The percentage of orders synchronized was time dependent; i.e., that there were gaps between required actions to conduct synchronizations, so that they tended to pile up all at once.”

Data Collection Command and Control (C2), and Battle Rhythm

Lead Data Collector. A lead data collector was assigned for each principle node and for each initiative area. These roles were specified in a matrix of manning attached as an appendix to the DCP. In each initiative area, this individual was responsible for (including, but not an all encompassing list):

- Data collection requirements.
- Data collection media.
- Data collection instruments.
- Coordination of data collection events (e.g., MSEL or other scheduled events).
- Collaboration with other data collection leads for cross-cueing of data requirements of events crossing initiative areas.
- Training of respondents to become active participants in the data collection process.
- Status of electronic data in their initiative area.
- Collection, retrieval, or archiving of electronic and respondent data.
- Forwarding of principle daily results to the analysis lead.
- Forwarding any issues with respect to data collection that impacts ability to collect, retrieve, archive, or forward data.
- Recommendations with respect to improvements to data collection requirements, collection, or C2.
- Participating in all operational, planning, and data collection events.
- Uploading of instruments in the Joint Data Collection and Analysis Tool (JDCAT) in collaboration with the data instrument lead.
- Providing all coordination means possible in order to ensure collaboration between data collection areas and data management (e.g., establishing contact through e-mail and IWC or IRC chat accounts).
- Downloading of essential IWC or IRC chat in chat rooms used in the course of operations in your initiative area.

There were daily chat sessions in either IWC or IRC between the Analysis Lead and all Lead Data Collectors. These sessions typically occurred in the morning, just after the Experiment Director had met with the experiment leads.

A Principal Results Review took place each evening at 1700. In order to prepare, it was essential that inputs be provided to the Analysis Lead by 1600 of each experiment day. These times could be adjusted according to the operational battle rhythm.

Data Collection Instruments

Surveys, questionnaires, interview sheets, event logs were all included as data collection instruments. All were focused to meet the data collection requirement that supported an analysis objective. In general, surveys, questionnaires, interviews, and focus groups were used to elicit responses from participants that deepened and provided context to data in logs, chat files, and in electronic data files. Quality indicators (e.g., how a participant felt about a particular process that was indicated in a set of scales) did provide some information about how something was valued, but it did not provide insight into why. All FBE instruments therefore leaned toward understanding context and relationships (the why part), vice quality, as an experimentation issue.

Both participants and observers filled in logs. The value of logs was their utility in helping to reconstruct context in post experiment analysis. From past experience, it was very difficult to ask participants and observers to do this in any detail after the experiment has been completed. If done electronically, these logs became an invaluable source for immediate analysis. Data leads for each initiative were responsible for cultivating the filling in of log sheets, and for retrieval of the sheets for submittal.

A process for implementing the use of instruments across all of the data initiatives includes the following:

- Construction of the instrument by the data collection lead.

- Submission of the instrument to the instrument lead for review.
- Validated instruments were sent to KM for inclusion in the database.
- A validated instrument could be loaded in the Joint Data Collection Analysis Tool (JDCAT). This required that the instrument be physically uploaded or typed into the JDCAT interface as part of the bank of surveys and questionnaires to be accessed via the SharePoint Portal Server (SPPS) and the JFMCC web site during the experiment.
- During the experiment, data leads asked for their instrument to be activated/deactivated in JDCAT. This meant that the instrument would be available for respondents to answer when activated, and would not be accessible when deactivated.
- Emergent requirements for new instruments followed the same procedure as above, but data leads were expected to discuss them directly with the instrument lead.
- Results and statistics for each survey were held in a folder specifically for that instrument, and were available for download at FCTCPAC or on USS CORONADO for immediate review.
- If paper copies of the instruments were required for distribution, data leads were responsible for the publication, distribution, retrieval, data reduction and requests for analysis based on that particular instrument. Employment of the electronic means at hand greatly increased the utility of these instruments.
- At experiment end, data leads were responsible for ensuring that data from instruments in their area were collected and archived safely for further analysis.

The resulting JDCAT database has been incorporated into the MISE KM system for further analyses.

Appendix 4: Initiatives, Data, and Analysis
Final Report: Fleet Battle Experiment – Juliet

Initiatives are not all of the same type. An initiative may have very definite objectives, from which definitive data and events to obtain the data are derived. Or an initiative may be more of an exploration, perhaps even to get an initial determination of what needs to be learned. Differing types of planning, data collection, and analyses will be used for different initiative types.

This Appendix describes three highly interdependent aspects that control results obtained from an experiment:

- Initiative type, and how each is conducted.
- The types of data available.
- Methods used to analyze the data.

Initiative Categorizations

Initiatives are segmented into two categories:

- **Experimentation** (which is then further subdivided into either)
    - **Exploration**
    - **Developmental**
- **Demonstration**, which can be of a system or process

These categorizations have implications for data collection and results. For example, a demonstration implies a lessened set of requirements for data, analysis, and reporting, when compared to an experiment.

Experimentation implies that the initiative:

- Must have some potential for replication. It may not be possible to run exactly the same test many times and obtain statistical data, but it is possible to conduct the same category of event for the same data collection and analysis purpose.
- Must have a clear analytic –objective; one, that leads to data requirements and connected analysis methods.
- Must have some form of "baseline." A baseline, in this case, can be a process model, proposed performance, CONOP, Operation Sequence Diagram, or architecture. There must be a proposed way in which a system or component is to perform in the experiment.
- Must have a well-defined experiment protocol.

These criteria do not rule out experimentation that will yield largely subjective information.

Exploration refers to including something new in FBEs that has not been done before, and hence there is some risk. Failure or discoveries are acceptable options. Experimental conditions will be set up but it is expected that deviations will occur; unanticipated lessons will be learned, in the course of the experiment.

Developmental refers to initiatives that are being furthered from previous FBE work; require additional work to mature them before results are finalized. The conditions for which one wishes to undertake additional development are well known. Control is more rigorous and discovery is not expected.

For a **demonstration**, one installs a system or process then observes it to see if it works. Subjective opinions can be gathered as to whether it did or did not, but little analysis is expected to determine why.

Data Types

Fleet Battle Experiments always produce a diverse collection of data and information. This diversity has several aspects:

- Data/Information - from objective data to opinions.
- Opinion quality - from well-located, qualified observers to those with preformed opinions.
- Appropriateness - from a well-designed event to a happening not connected to an objective or from a system operating within appropriate physical context to physical conditions not appropriate to an objective.
- Context - is a class of data that provides background or situation understanding for other data and information.

As noted above, a demonstration may require only data that are operator opinions about whether the system or process being demonstrated works. If one is doing detailed Test and Evaluation (T&E) of a system, there will be a full plan, objective data, and MOPs.

Developmental Experimentation will also have planned events to produce objective data and quantitative analysis. Exploration Experiments will be a mix; because of the exploratory nature, some subjective information will be obtained through discovery.

Analysis

Analyses are designed to deal appropriately with this diversity. This is largely an art, however, more than it is a well-defined set of procedures (e.g., in some cases it was most appropriate to throw away suspect information, whereas in others it was appropriate to combine it with other information to produce a useful result, with caveats). In all cases, an analysis result must be accompanied by context; this gives it meaning. Combining results with Context provides limits of validity and can produce cause-and-effect relationships.

Analysis Limitations

Analysis results could not be blindly accepted as "truth". If they were to be used for some purpose, the results were examined carefully to determine their meaning and validity with respect to the intended purpose. Process and system performance measures, with humans-in-the-loop, during operations, were the desired results from FBE-J. Brief explanations of limitations follow:

- **Context**. Results have meaning only if they are accompanied by context. Regardless of the analysis technique used, if the conditions under which a result was obtained are not available, the result is of little use. Interpreting context/conditions and the impact on results was one of the most challenging aspects of analysis, yet context subtleties could be easily overlooked. With all operational experimentation, results obtained applied only to circumstances that existed during that operation. The subsequent extrapolation to other conditions is not necessarily valid. Thus, reconstruction of an event stream provided important context for analysis.

- **Subjective Information**. Most of the information obtained from FBEs is subjective, and Juliet was no exception. A full range of human impacts influences subjective opinions: misinterpretation, prejudice, and overloading; but they can also provide correct, perceptive insight gained from personal expertise and experience in similar situations. Regardless of limitations, there were many reasons for developing results from these opinions. They might have been all that were available. Also, when trying to determine the performance of systems, processes, and included human operators, the opinions obtained may have provided the best understanding of how these human-included systems will perform in an operational environment. However, caution must be used when attempting to develop too-rigorous analyses from subjective information.

- **Range of Validity.** Results were valid only for the conditions for which they were determined. Conditions were not a constant throughout the experiment. Reconstruction and careful observations or data collection at critical nodes provided the specific conditions under which a particular result was obtained, yielding the range of validity. Although FBEs do not have process models available so that one can only assume the results are valid for the conditions that existed, some extensions are possible in certain circumstances, i.e., the ability to maintain a somewhat slower rate of actions successfully demonstrated.

- **Anecdotes**. This is a problem that occurs for all experimental results for which there is not control and replication. If the system under analysis was unstable, then every result becomes an anecdote. One has no means for generalizing the result to other circumstances.

Analysis Methods

Analysis methods are grouped into four general classes:

- Objective Results
- Context and Subjective Results
- Comparisons
- Reconstruction

This grouping is useful, but the methods do not belong exclusively to one class. A particular result can use methods from more than one class.

To delineate the method used in each analysis, a code was provided for each of the methods. These codes are included with the various results to indicate the method(s) used for their production.

Objective Results

This class of results comes from objective data, i.e., data that have a specific quantification, such as an elapsed time, a number of objects, or a number of occurrences. The analysis methods are analytically rigorous. For FBEs, objective data are almost completely event occurrence times within various electronic systems. Context was still needed to give these results meaning.

- **SP - System Performance**. Process execution within systems was logged, often electronically. These data were used to determine analytic performance parameters for that system. This method is appropriate to Test and Evaluation and was used only occasionally within FBE-J.

- **SA - Statistical Analysis**. SA requires that data from a sufficient numbers of similar events be collected so that statistical parameters have precision. This was the case only for the components of Fires events timelines.

- **SC - Statistical Comparisons.** Means and variances were compared for situations where the situations/contexts are known and different, allowing rough cause-and-effect to be established.

- **CS - Case Studies**. Unique results can sometimes be associated with context, providing a case study. Derived distributions, however, often have outliers; a type of unique result, and examination of outliers can provide more significant information than stating the distribution mean and variance. Case studies are a good method for uncovering cause-and-effect. A difficulty is that a unique event may be only an anecdote, and may not replicate even under the same, or thought to be the same, conditions.

- **MBA - Model-Based Analysis**. A model can be used to predict behavior or process results. Experiment execution determined what occurred, either what was predicted or something else. MBA is a comparison of predicted and actual results, with a goal of parameterizing or modifying the model. The model could be as simple as a set of expected task completion times for the detect-to-engage cycle. It could also be a complex model underlying a simulation, and simulation runs provided the prediction.

Subjective Results

In the context of these experiments, there should be no implication that either objective or subjective results are of greater validity or value. Both have meaning only when accompanied by appropriate context and getting accurate context is difficult because of the human-in-the-loop and operational (fog of war) nature of the experiments. There are subtleties of context that are difficult to determine.

- **PO - Process Observations**. Subject matter experts logged process behavior observations. The event logs included observation times, observed incidents/conditions, and opinions. The information in the logs was correlated with other data, such as detect-to-engage timeline data, to build a complete sequential picture of the operation. This provided both context and results. The results were opinions about performance. The context was observations, such as a person is overloaded, fatigued, or lacks understanding.

- **SO - System Observations**. The method was the same as for Process Observations.

- **Text**. Analysis of the texts of Chat, e-mail, for relationships and communication processes. Besides revealing processes actually used, the texts provided additional context.

- **SUB - Subjective Opinions**. Operators were queried about their judgment of process or system with regard to its meeting needs or requirements. These opinions are appropriate to a segment or the whole of the experiment rather than an individual event (SO or PO). Judgments are provided from different perspectives, and they can conflict.

Subjective analysis consisted of correlating judgments with situations. An attempt was made to generalize the result by correlating judgments from different perspectives. Context was used to determine cause-and-effect. Additional analyses attempted to determine if results provided implications about the relative success of various configurations of systems and processes, such as distributed versus centralized.

Comparisons

- **ComS - Compare to Standard**. Standards exist for process performance. This was a comparison of the performance achieved to the standard.

- **ComE - Compare to Expectation**. Processes and systems were expected/planned to operate in a particular way. This was a comparison of expectation and what was done in the experiment. This is the simplest type of MBA, presented separately because no actual model was used.

- **FID – Fidelity**. This refers specifically to whether or not information was correct, or whether different instances of what was supposed to be the same information were the same. (The human factors concern of whether different individuals have the same perception when viewing information was not pursued in this experiment.)

Reconstruction

- **Rec – Reconstruction** was essentially zero order analysis. It provided what actually occurred, down to the level of detail needed for subsequent analyses. It provided the basic context within which results were cast. Reconstruction was assumed as part of all analysis methods; when this code appears it meant that only reconstruction would be done.

- **RecT**. Reconstruction of engagement timelines from system electronic data and participant communications.

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Appendix 5: Collaborative Tools
Final Report: Fleet Battle Experiment – Juliet

SharePoint Portal Server (SPPS)

SharePoint Portal Server (SPPS) was the chosen system for a web based document collaboration and portal tool. As a new Microsoft product, SPPS ran very smoothly, and will improve over time. During FBE-J, only a subset of SPPS's features were used, but one of the most import aspects of SPPS was that warfighters could take ownership of their portal. The following will briefly discuss the JFMCC use of SPPS in *Site Navigation, PWC Ownership, Security Settings, Search Engine, Publishing Process, Subscriptions, Personal Dashboards, and Unused Features.*

Site Navigation

The site was divided into five major sections: JFMCC Home, Warfighting, Applications, and Document Library, and Help. "JFMCC Home" was similar to a Yahoo front page. It contained a status for each of the FBE-J nodes, along with all the most current and admin information. "Warfighting" was split up into warfighting area sub portals. Each area then received ownership of their portal. They were given a generic template for their portal and then given the necessary training and rights to modify it as they saw fit.

All web-based applications were located in the portal "Applications." Applications such as the MOD, MARSUPREQS, and the MMAP were located here. Although all applications were placed in this portal, they were not fully integrated into the portal and the planning processes. More cross-references were necessary. One way to solve this problem would be to create an applications web-part containing links to all the applications a warfighting area would use. The warfighter would determine which application is useful and should be visible in the part. This web-part is an example of passing ownership to the warfighting area and distributing the web infrastructure control.

At the start of the experiment, the major complaint about the portal was lack of content. As more users became familiar with posting methods, content increased. However, with this increase came a new complaint; how do you find the information? The information was placed into sections although it might have best resided elsewhere. The poorly placed information possibly created a direct correlation to the steady increase in use of the search function. The web structure was roughly modeled after the K-Web application, used by CCG3. Once it was implemented, it became difficult to change the layout. If the K-Web structure is not the best solution, then some research and development needs to take place, to design a more efficient portal architecture for experimentation.

Information on any site, including SPPS, needs to be user-friendly and easily navigable. JFCOM's SPPS was a good example of a user-unfriendly web site. On the JFCOM site, users were presented with many inadequately labeled links, as well as multiple clicks to reach specific information. During one review of the JCFOM site, it took 8 clicks in order to reach specific information. Unfortunately, this was not a unique circumstance.

Primary Warfare Commander (PWC) Ownership

Although there were some growing pains in Spiral 3 with training and using Office 2000 instead of Office XP, the PWC took ownership over their portals. This was the first FBE where the operators were given control over their own web sites. They maintained them and configured them to their liking.

Office XP is tightly integrated with SPPS. Once XP was installed, users could easily add and modify documents. Users had the ability to click on a document, modify it, and then save it. Office XP automated the upload and replacement process, and made the entire process seamless to the user. In Spiral 3, users they had to download the document to their local computer, modify it, and then re-upload it to the SPPS, with Office 2000. This was a time consuming process, which left most users frustrated and annoyed. During execution there were no issues with users posting to SPPS, with XP. The cells took complete ownership and had little difficulties doing it.

Security Settings

CORONADO SPPS was setup with open security settings policies. The open security policy was set up for two reasons. First, there were difficulties setting the access rights for CORONADO SPPS. Second, there were a lack of identified file posters and site administrators. To solve these problems, everybody was given coordinator rights. Thus, anyone who entered the site had the ability to modify its structure all the way down to the web part level. Users, in general, were responsible administrators. Some documents were accidentally deleted, but were able to be recovered. SPPS does have a document recovery tool, which was not used, but and needs to be examined more closely for the future. An interesting outcome from this experiment is was USS CORONADO SPPS wide-open security policies led to relatively little harm. There were some accidental deletions and some web site style edits, but overall nothing major. This open architecture should be avoided in the future though, because too many unrecoverable modifications can occur. Next time SPPS is used, security groups in Active Directory should be created for each area of the site. Users can then be added to they appropriate groups which then will give them the proper access rights. JFCOM set up their SPPS's user permissions in this manner.

The JFCOM share point was set up using a structured permission scheme. JFCOM maintained tight control on the accounts that were able to view, change, and post to the JFCOM SPPS site. Often the users on the JFMCC site needed access and were locked out due to the permissions policy. Gaining access to the section was difficult. It required contacting the JFCOM help desk, which would then try to track down the SPPS administrators, who were often gone. Once an administrator was contacted, an explanation was needed as to why access was necessary. JFCOM did not publish their permission schema. This would have enabled restoration of the access rights when the permissions were deleted or reset. Restoration of access rights was a "wait and see who complains" process. This greatly affected the logistics, targeting, and JECG cells, and affected all others to a lesser extent.

Search Engine

SPPS has a powerful indexing engine included. Not only does it index itself, it can index other folders systems such as a share drive, another IIS server, public folders, or other http web sites. The MC02 SPPS used some of its inherent indexing capabilities. The SPPS/SJFHQ had a global index of all the SPPSs in the MC02 architecture. This provided a global search catalogue for all the components. Each component's SPPS did not have a global search because of the necessary resources and bandwidth required to execute the indexing engine. Further testing is necessary to see if other SIPRNET sites could be indexed to make an even more powerful search engine for an experiment.

Publishing Process

A feature that was not truly used on the JFMCC SPPS was the publishing process, which has a built-in authoring, approval, and publishing process. The publishing process is part of the enhanced folder option in SPPS. Much of the JFMCC site had the enhanced folder option turned off. This allowed documents to be visible to all as soon as they were posted to the SPPS. and made the posting process less confusing for the operators. A three-step process was reduced to a one-step process. In the future, the publishing process should be implemented to see how much more overhead is necessary by the operators, or if they find it reduces the document approval timeline.

Subscriptions

Subscriptions allow users to get email updates of new content in a designated folder or document. They were not used during execution as well. Anonymous access was granted for all users which made subscriptions disabled. Subscriptions could have played a large role for the local KMO. The KMO could have dispersed key folders and documents that would be useful subscriptions to the warfighters. This list could have been tailored to warfighting areas and cells. For future use subscriptions can play an important part in Knowledge Management vs. Information Management.

Personal Dashboards

Personal dashboards were enabled for FBE-J, but were not used. Several users created dashboards but did little with them. One reason why they did little with them was there was not an active web-part gallery. Unless a user knew how to create a custom web-part, they were unable to do any customization to their web-part. With extensive and robust galleries, personal dashboards are possible and may become a vital information source.

Unused Features

Many of the unused features such as Enhanced Folders, Subscriptions, Publishing Process, Categories, and Personal Dashboards can all add significant functionality to a website. It is difficult in during a short exercise to use all the available features. For feature experimentation it would be useful to identify a cell and train them on the full SPPS functionality. This would give us a better bearing on what is too difficult and what are not usable features.

Web Applications

Questionnaire System

Joint Data Collection and Analysis Tool (JDCAT) was used by JFCOM and NWDC. There were two servers one at JFCOM and one on CORONADO. The JFCOM server was used for MC02 questionnaires and CORONADO server was used for FBE-J questionnaires. There was some confusion on who should respond to which questionnaire system. Constructing an instructions page and pointing users to the desired questionnaire system alleviated some of the confusion. The questionnaires were only responded to if the operators went to the website and submitted their questionnaires. More management is necessary for the system to be more effective and to collect the desired inputs. One way to improve the system would be to push the surveys to the users via email. This would bring the surveys to the operators and make them aware their inputs are needed.

JDCATS is not the optimal solution for Fleet Battle experiments. It has a poor database design and is not easily scalable. NWDC should find or create a suitable questionnaire system, which can be used for all of NWDC's experimentation.

Info Workspace (IWS)

Info Workspace was the chosen collaboration tool for MC02. JFCOM sent servers to each of the components and had five servers located at JFCOM. The JFCOM servers were in a federated environment. This means users could browse to any server in the federation. The component servers were not in a federation, so logging directly into them was the only way to access them. See Figure A5-1. IWS Federation Architecture. IWS user accounts were integrated with LDAP. Each IWS server was pointed to a LDAP and synchronized its users with the LDAP users. The following will cover how IWS was used and how well it performed.

Warfighter Use

The warfighter used mainly three features: voice over IP, text chat, and file cabinets. Features that went mostly unused were discussion groups, room events, whiteboard, text tool, shared view, and voting. With more time and more training users may discover some of the other useful features IWS has to offer. But when it comes down to it people revert to what they know: voice, chat, and email. Voice was abandoned in many cases because of poor voice quality caused by network overload or poor quality of microphone. Users resorted to text based chat, which is freely available as IRC. So if all the features are used then IWS has promise, but if users resort to chat then there are more effective and robust chat programs available.

Reliability

IWS reliability was suspect for many users. Many issues caused its unreliability, which makes it difficult to say what the largest contributor was. There were problems with Multicast routes, poor microphones, ADF cards, and over loading the IWS servers. Multicast routes weren't fixed until a week into the experiment. There was a large reduction in traffic as seen in the InfoWorkSpace/Placeware Multicast and bandwidth usage. The poor quality of microphones was also an issue. Some peoples' voices were so faint you could hardly hear them; while others were so loud they were distorted. ADF cards presented another issue, which most users did not understand. ADF cards pushed network policies to the NIC card on a client machine. Many of the policies applied did not take in consideration the Audio requirements for IWS. There were several mornings when all ADF client machines did not have audio, printing, or map drive capabilities. Finally, in some cases the IWS server could not handle the user load and would disconnect users on a regular basis. IWS was relatively stable once the network and the ADF policies were fixed

Federated Environment

During Spiral 3, all the IWS servers were federated. This allowed users from anywhere in the MC02 forest to access any IWS server. IWS was not designed for a federation of nine servers and thus could not handle it. Several days into Spiral 3, JFCOM broke the federation and set up the architecture pictured in Figure A5-1. IWS Federation Architecture. The five JFCOM IWS servers remained federated, but the component servers were separated. In order to let the components communicate at the JFCOM level, JFCOM pointed a server in their federation to each of the components LDAP. This worked for communicating at the JFCOM level, but not at the cross-component level. A more ideal solution would be to have an IWS server point to multiple LDAPs. This would have avoided an IWS server for each domain.

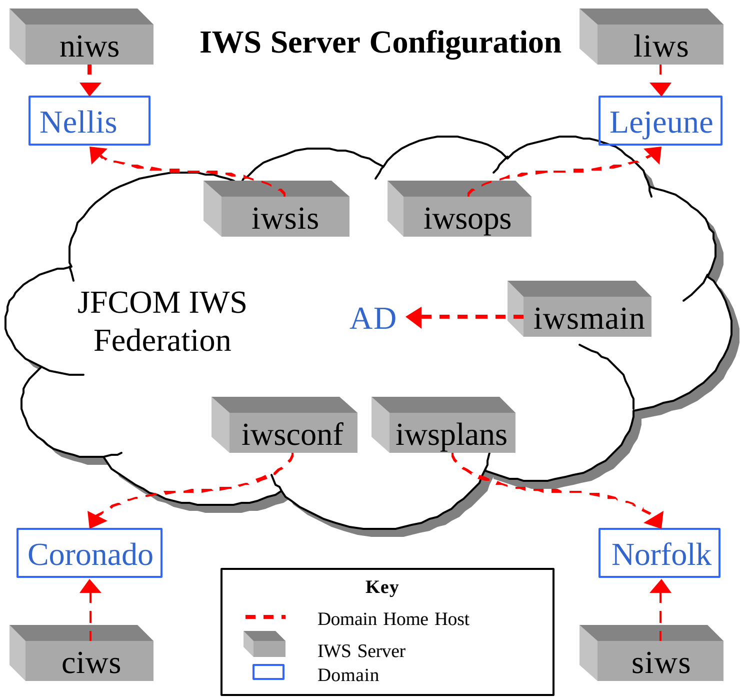


Figure A5-1. IWS Federation Architecture.

Cross Component Collaboration

Cross component collaboration became very difficult after the federation was broken during Spiral 3. If two components wanted to communicate they had to both log into the JFCOM federation. This meant having multiple instances of IWS running on a client machine. Another draw back was that it was very difficult for users to listen to collaboration sessions on another component's server. These issues were resolved by creating duplicate and generic accounts without email boxes on the other component's domain controllers. This was more of a brute force method, but for a short period of time it worked.

Throughput needs

IWS uses multicast, which makes it difficult to calculate exactly what its throughput needs are. Multicast is a more efficient way to transmit audio to many people without broadcasting the same audio transmission to everyone. What can be calculated is what one typical audio transmission uses. Once you know this, then you can calculate how many different concurrent conversation can occur given the current bandwidth constraints. For detailed network analysis see the section on IWS Multicast within the LAN.

Multiple LDAPs

One of IWS's shortfalls was its inability to use multiple domains for authentication. IWS used a complicated replication scheme with an Oracle database. This federation became difficult if not possible to maintain with 8 IWS servers. IWS needed to do the replication for its federation because an IWS server can only point to one domain. If IWS was able to point to multiple domains then it would make the federation possible. It is important when choosing a collaboration tool, for such a large architecture, for it to be scaleable and IWS's current version was not scalable enough.

Impact on FBE-J

IWS had a tremendous impact on FBE-J and MC02. As with any new tool, there is a learning curve. Once the players and operators became familiar and comfortable with the tool, there were few problems. The most difficult aspect of IWS for the user was logging into the servers. The complicated scheme devised after the federation was broken in Spiral 3 left users confused about how to get to specific rooms. Going to another component's server was even more confusing because their user name and passwords did not exist there. (See Figure A5-1. IWS Federation Architecture) Once these difficulties were overcome, cross PWC and component collaboration became a real time activity. Although all the features were not used, with time and training more functionality would have been used. The time period for an experiment is not long enough for such collaboration tools to be used to its full extent.

PlaceWare Conferencing

Placeware is a separate program purchased by IWS and integrated into their collaboration suite. Placeware was used as the conferencing server for MC02. It was set up much like a real life auditorium. There were presenters and audience members. Presenters could give interactive briefs and audience members could interact via questions and chatting with fellow audience members. Placeware was heavily used and was an essential part of the experiment. There was a misconception that Placeware was IWS, but it was actually a program that operates normally without IWS and was incorporated into IWS.

Warfighter Use

The Warfighters used Placeware primarily for JFCOM briefings and Fire Side Chat. As they became more comfortable with the system they JFMC began using auditorium 112 for more briefings. There were some frustrations by the warfighter because of Audio problems. This was not necessarily a problem with the software though. There were the ADF cards which were blocking Multi-cast audio and there were the network multicast issues. Once all the problems were resolved it worked well, besides the occasional bad microphone. A feature not used was the meeting room. This was a smaller room where people could have held group sessions. These meeting rooms had many of the features IWS contains and some others such as application sharing.

Throughput needs

Placeware advertises that a 56k modem will work. Since the audio is the same as IWS, Section InfoWorkSpace/Placeware Multicast and bandwidth usage will contain the audio network results. When multi-cast was working there were relatively few problems with the conference server.

FBE-J Impact

The high utility of the system leads to the need for something similar for future experiments. As experiments become more and more dispersed, something more than just a teleconference is needed. Even expensive videoconference systems do not have some of the capabilities Placeware provided. With further research it was discovered Placeware could be integrated with outlook for scheduling and invitation lists. If Placeware is not the answer for the future then some research needs to be done to find a suitable system, which contains many of the features of Placeware.

Domains and Exchange Systems

MC02 used the Windows 2000 Advanced server forest and trees architecture. There were a total of 7 domains in the forest. The AD domain was the parent and all others were located below it. (See Figure

A5-2. Active Directory Domain Architecture) FCTCPAC and CORONADO were the JFMC based domains. FCTCPAC was for ashore users and CORONADO was for afloat users.

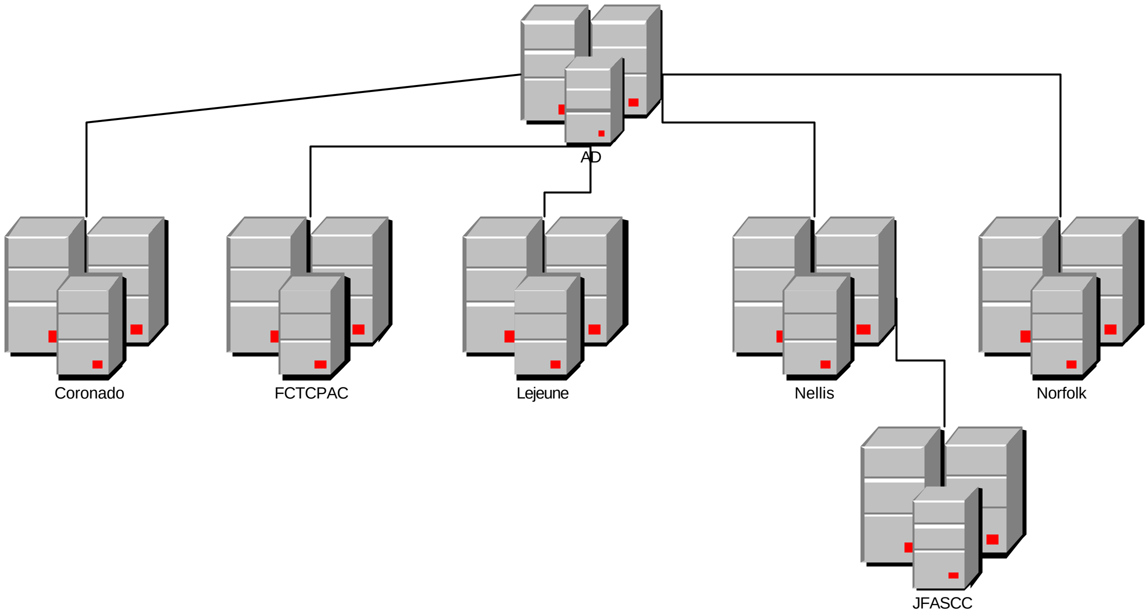


Figure A5-2. Active Directory Domain Architecture.

Active Directory

Windows 2000 Active Directory was used during FBE-J/MC02. This provided many well used features. The most used feature was an accurate Global Address List (GAL). The GAL provides a full listing of all users in Outlook for all domains in the forest. The second most used feature was the ability to logon anywhere in the Active Directory (AD) domain. This is accomplished by using site connectors to replicate accounts to the AD servers. Accounts are then pushed down to the component's servers using the same site connectors. Doing this gives each child domain a complete global address book.

Figure A5-3. Active Directory server Locations and Figure A5-4. Active Directory Replication Streams (M = Minutes, H = Hours) display the Domain Controllers and their locations. The later displays the replication interaction between AD, FCTCPAC, and CORONADO.

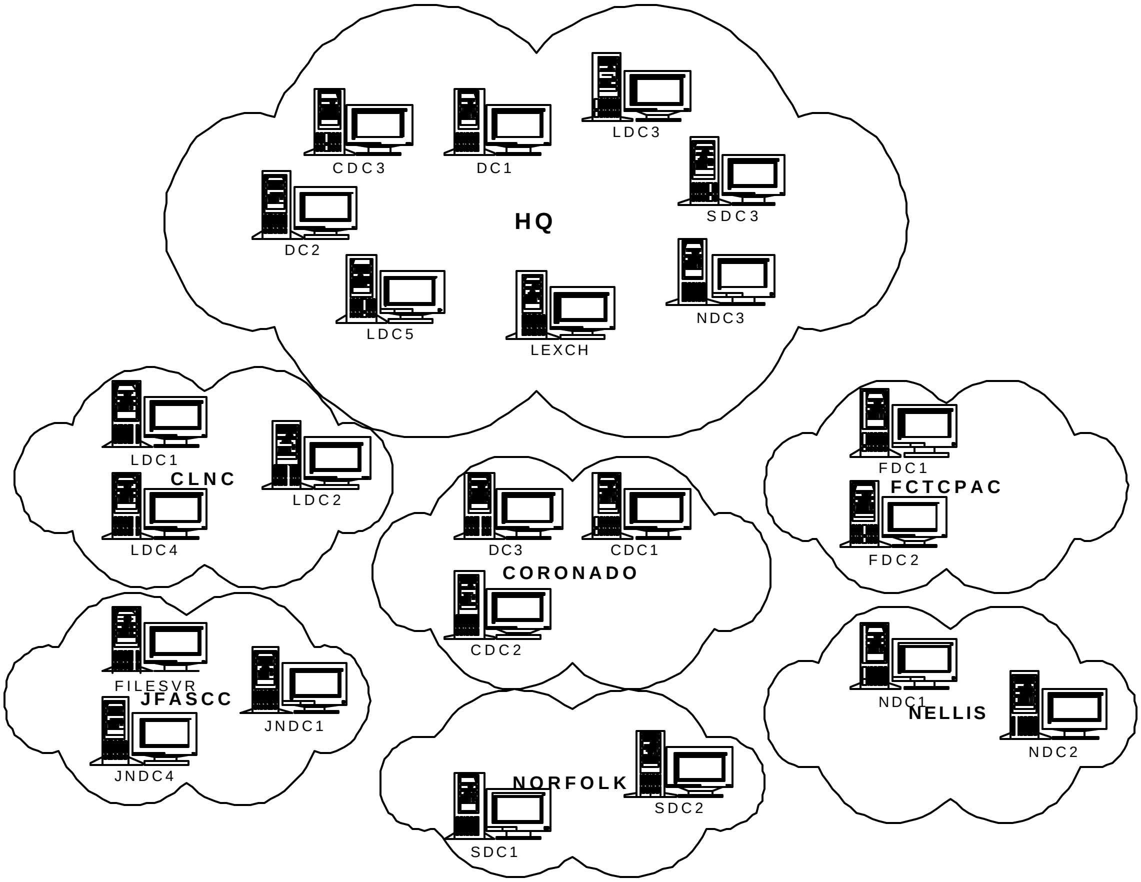


Figure A5-3. Active Directory server Locations.

Active directory replication scheme was not efficiently design, causing redundant replicated over the WAN links. In Figure A5-4. Active Directory Replication Streams (M = Minutes, H = Hours), you can see replication of DC1 going to both CDC1 and CDC2, with CDC1 and CDC2 replicating between each other. The ideal architecture would be to have a primary domain controller or otherwise know as a bridgehead server for each domain. The bridgehead servers replicate the Active directory information between domains and then the bridgehead replicates those changes to all the domain controllers in its domain.

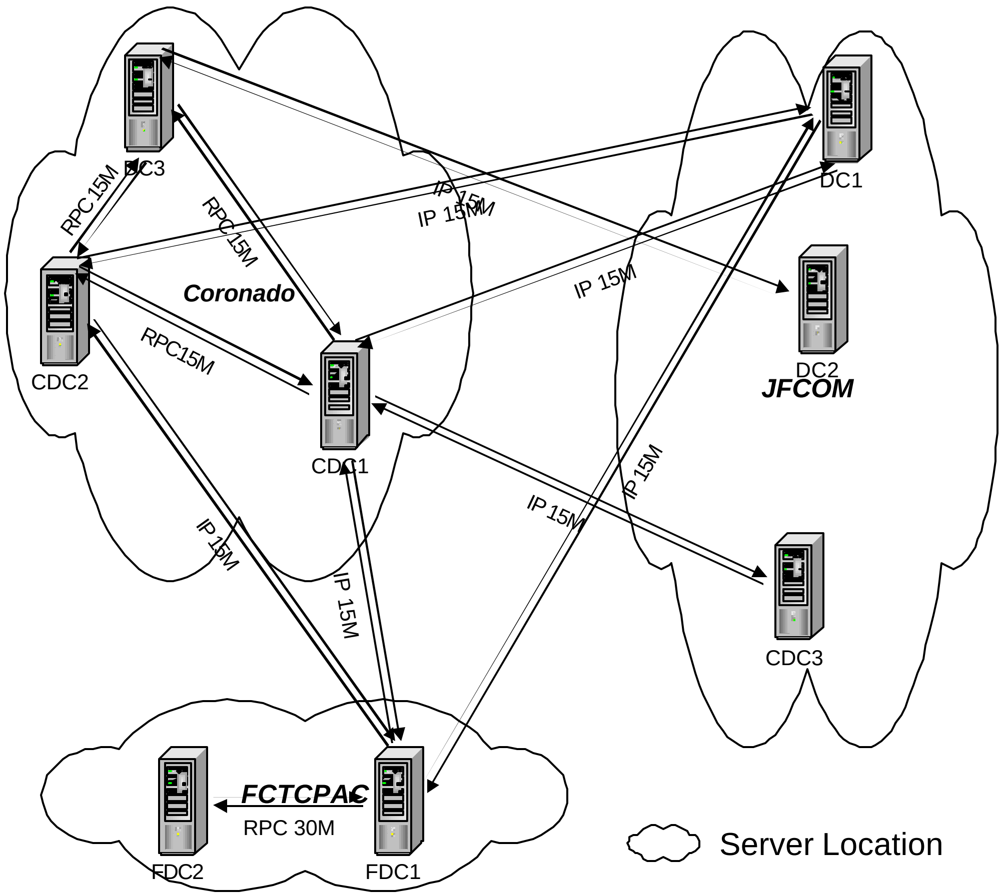


Figure A5-4. Active Directory Replication Streams (M = Minutes, H = Hours).

When installing and configuring a Windows 2000 Active Directory forest, transitive parent-child trusts are automatically created. Trusts have the following benefits:

- Shared user information (Combined Global Address List).
- Pass validation requests to trusted domain (Authenticated to any of the trusted domains).
- Manage accounts and groups across trusts (System administrators can create accounts on any trusted domain.).
- Security Management across trusts (Groups can span domains, thus users from both domains can access public folders.).
- Access to resources (files, folders, virtual containers) in trusted domain subject to trusted domain.

Explicit trusts are created from parent to child, but not child-to-child. Since the trusts are transitive then there is an inherent trust between children via the parent. During FBE-J, users were able to log into any of the children domain in the AD forest. For example, a FCTCPAC client is capable of having a user authenticate to CORONADO domain. The authentication process was lengthy, because of the KU connection and the child to child transitive trust. User validation would be passed to the AD and then to CORONADO. This adds an extra hop in the authentication process, which could have added a significant amount of time. Another option would have been to add an explicit trust between FCTCPAC and CORONADO domains, this would have eliminated the extra hop and sped up the authentication process (See Figure A5-5. Domain Trusts).

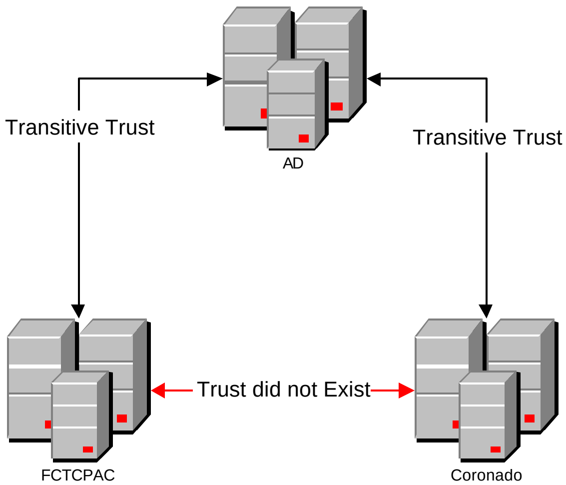


Figure A5-5. Domain Trusts.

During Spiral 3, JFCOM stood up a domain controller on CORONADO for the AD domain. This is not a normal practice and added extra KU traffic to CORONADO. This extra traffic can be viewed in Figure A5-6. LDAP traffic flow between 114.84 and 128.90. There was a steady stream of traffic all day and it had a max of 9000 bytes. The domain controller DC3 (114.84) was added to increase the login speed for AD users such as the JTF Commander. JFCOM made several adjustments to make the JTF Commanders visit seamless in his eyes. A detailed account of how mailboxes and profiles were moved is located in the section
Joint Task Force Visit and Bandwidth Usage below.

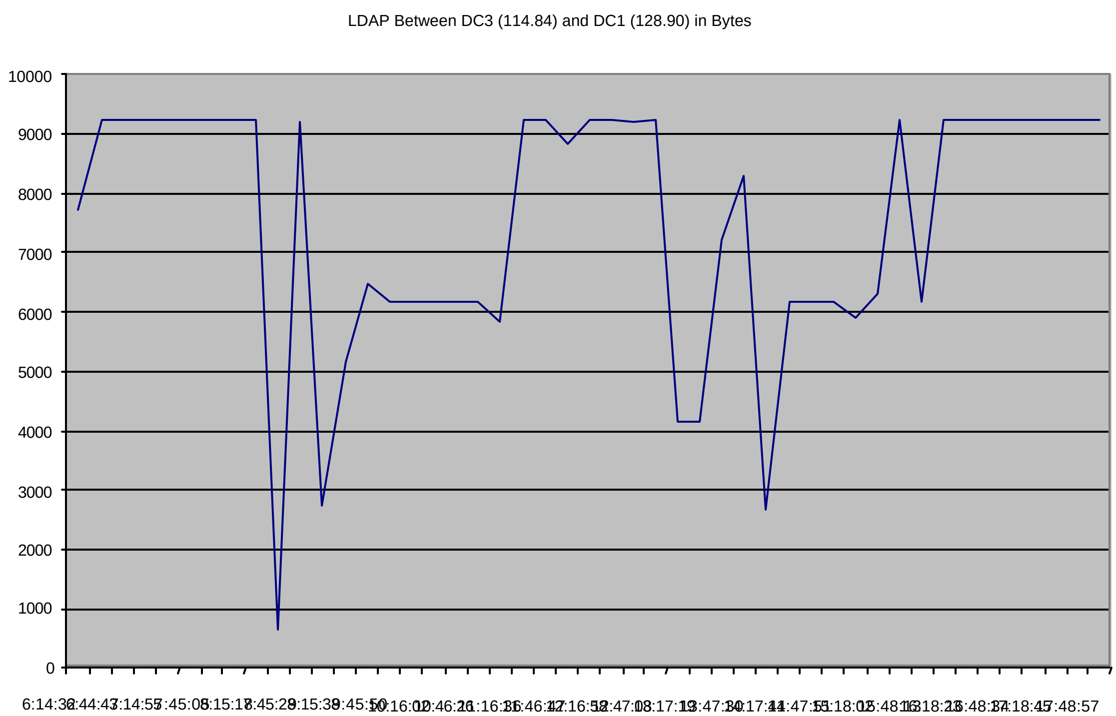


Figure A5-6. LDAP traffic flow between 114.84 and 128.90. Intra-site replication versus Inter-site replication.

An Intra-site connection is for reliable high-speed connections where an Inter-site connection is over low-bandwidth unreliable connections. When designing an Active Directory replication architecture

Table A5-1. Active Directory Replication Types must be taken into consideration.

Intra-site replication	Inter-site replication
Replication traffic is not compressed to save processor time.	Replication traffic is compressed to save bandwidth.
Replication partners notify each other when changes need to be replicated, to reduce replication latency.	Replication partners do not notify each other when changes need to be replicated, to save bandwidth.
Replication partners poll each other for changes on a periodic basis.	Replication partners poll each other for changes on a specified polling interval, during scheduled periods only.
Replication uses the remote procedure call (RPC) transport.	Replication uses the TCP/IP or SMTP transport.
Replication connections can be created between any two domain controllers located in the same site.	Replication connections are only created between bridgehead servers. One domain controller from each domain in a site is designated by the KCC as a bridgehead server. The bridgehead server handles all inter-site replication for that domain.
The KCC creates connections with multiple domain controllers to reduce replication latency.	The KCC creates connections between bridgehead servers using the lowest cost route, according to site link cost. The KCC will only create connections over a higher cost route if all of the domain controllers in lower cost routes are unreachable.

Table A5-1. Active Directory Replication Types.

Future Active Directory Architecture Considerations

Other domain architecture options may be options as well. The following are two other options, which should be investigated for feasibility and functionality.

1. **One large domain:** The large domain would have many Domain Controllers and Exchange servers. The primary would be at the central site and the remote sites would have secondary Domain Controllers with Exchange. This will still allow users to logon at any location and provides an accurate GAL.

2. **Separate Domains:** The architecture would consist of separate domains and exchange servers at each site. Domains would be trusted and an x.400 connector would be built between exchange servers. Users would only be able to logon to their local domain, and have an accurate GAL.

Profiles

Profiles contain user specific settings for Microsoft applications and users documents. Roaming profiles are stored on the server and download with logon and then uploaded when the user logs off. Local Profiles remain on the machine and changes are not populated from machine to machine. The downfall with this is that the user does not have access to files located in their profile and has to reset up all their applications with each machine During FBE-J/MC02 we used a mixture of Roaming profiles and Local Profiles. Roaming profiles allow users to move from machine to machine and retain all their application settings and files saved within the profile. Roaming profiles were used mostly for CORONADO participants. We did not use roaming profiles for users located on remote sites due to the size that a profile can reach (20+ MEG). One option would be to provide a profile server at each location and have the user accounts point to the local profile server. This would enable local downloads for profiles and expedite the Windows 2000 authentication process.

Exchange

Exchange 2000 was used as the backend email server with Outlook XP as the client. The only issue experienced with Exchange was a corrupted GAL on CORONADO exchange server, causing undeliverable mail to FCTCPAC recipients. Public folders were not used at the JFMCC level, but were used at the Standing Joint Forces Headquarters (SJFHQ). The public folders were accessible by both Share Point Portal Server and Outlook. Public folders provided replication and document storage. With SPPS you can display public folders in a web format giving the users an alternate way of accessing information. We did not use the exchange conferencing and chat server, along with any of the advanced features.

During Spiral 3 the JFCOM server on CORONADO used the display name only to populate the exchange attributes. FCTCPAC servers had all possible exchange attributes entered. Doing this forced CORONADO participants to be looked up using only billet description. During execution we used display name as billet then populated first name, last name, and IP phone giving the users information to ensure they were sending their email to the correct person.

Video Conferences (Vigo)

ViGO by VCON was used for desktop Video Teleconferencing. ViGO companied the camera, speaker, microphone and headset into a small desktop unit requiring only one cable to be plugged into the USB port on the computer. This made installation very simple. ViGO was a stand-alone VTC system using VCON MXM as a locator and dialer service.

Cisco IP Phone

Cisco IP phones (IP Telephony) was used for point-to-point and multipoint-to-multipoint voice communications. IP phones provide very clear and reliable communications both LAN and WAN based. IP phones were set for the 80 Kilobyte; when not in a call the phones sent a 60 byte keep a live packet to the Call Manager every minute. Quality of Service was established with the routers to guarantee 5 percent of the bandwidth to IP phones and 1 percent for the JFMC Commander’s phone. When the IP phones are not in use the guaranteed bandwidth is released for use by other applications.

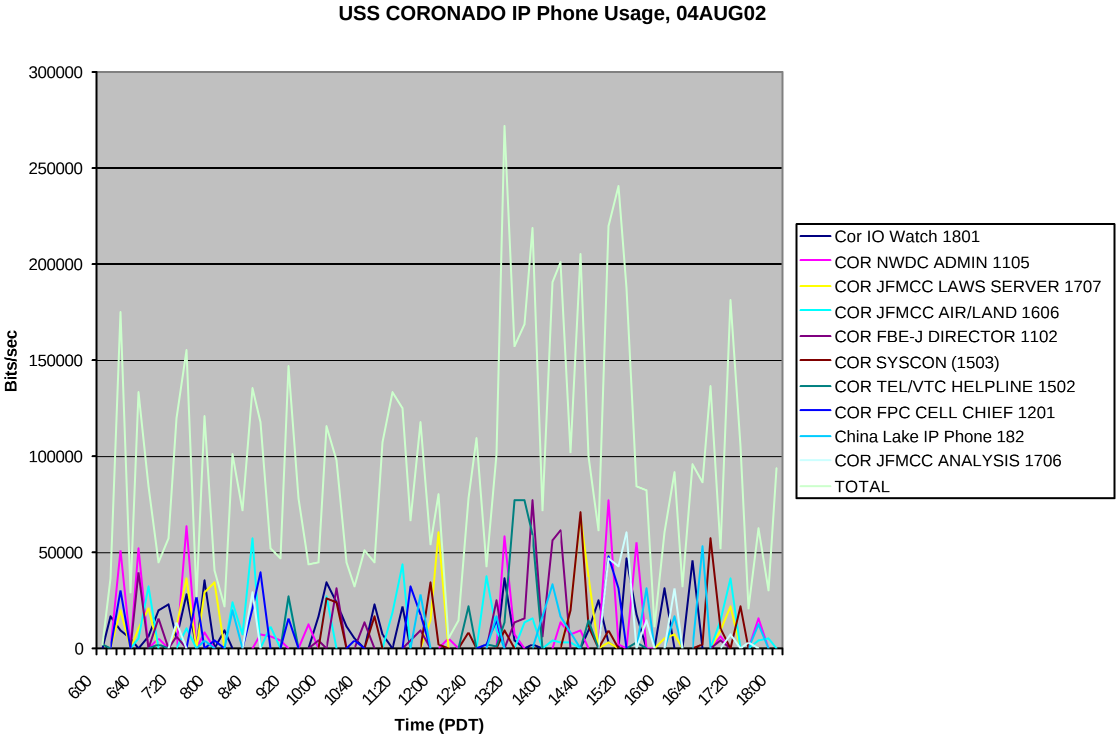


Figure A5-7. IP Phone Traffic

Joint Task Force Visit and Bandwidth Usage

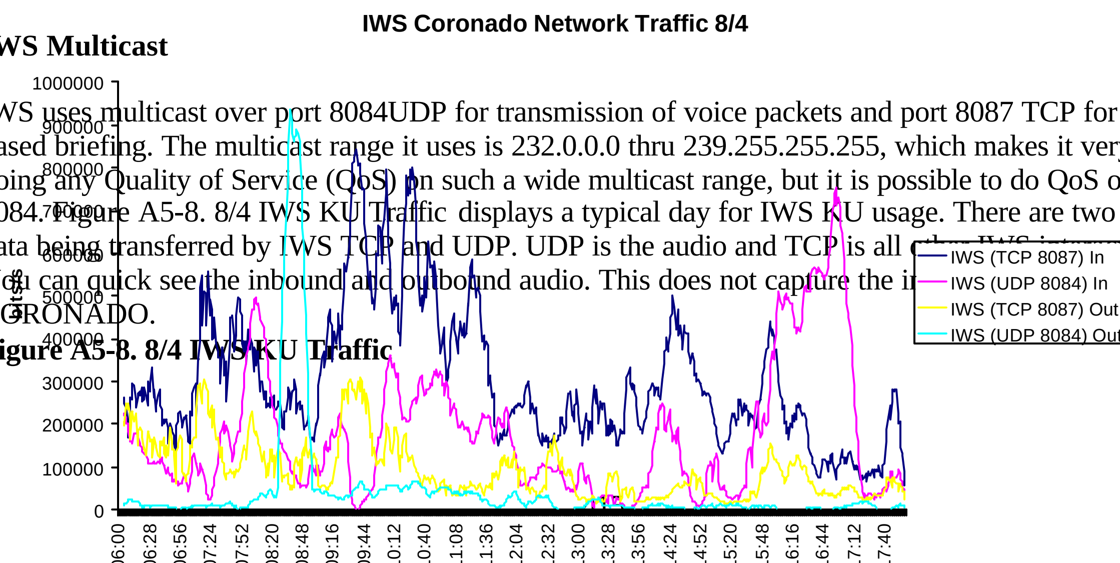
One of the advantages of Active Directory architecture is the ability for an individual to login from any location in the forest. This was demonstrated when the JTF visited CORONADO. The only problem though was the throughput constraints to CORONADO. JFCOM systems administration circumvented this by moving profiles and mailboxes and standing up a new domain controller on CORONADO. The new domain controller was named DC3 and was for the AD domain.
Spiral 3 DC3
Mobility of Accounts
Transfer costs (Time and Bandwidth)

InfoWorkSpace/Placeware Multicast and bandwidth usage

IWS Multicast

IWS uses multicast over port 8084UDP for transmission of voice packets and port 8087 TCP for Web based briefing. The multicast range it uses is 232.0.0.0 thru 239.255.255.255, which makes it very hard to doing any Quality of Service (QoS) on such a wide multicast range, but it is possible to do QoS on port 8084. Figure A5-8. 8/4 IWS KU Traffic displays a typical day for IWS KU usage. There are two types of data being transferred by IWS TCP and UDP. UDP is the audio and TCP is all [illegible]ions. You can quick see the inbound and outbound audio. This does not capture the i[illegible] on CORONADO.

Figure A5-8. 8/4 IWS KU Traffic



IWS Multicast within the LAN

Cisco Group Management Protocol (CGMP) is a Cisco propriety protocol that runs between the layer 2 switch and router or Route Switch Module (RSM) passing what ports on the switch to send the Multicast packet vice flooding it out every port. CGMP becomes very important when more than one multicast stream is being subscribed to within the LAN. During Spiral 3 the participants complained of choppy audio within the LAN when multiple IWS conference was being attended. The source of this problem was traced back to CGMP running on the switches. Upon further troubleshooting it was found that CGMP messages were not transmitting from the Router to the Switch. It was determined that the Mentat Skyx Gateway (PEPs) did not pass the messages. To solve this problem a Local Area Network router was place before the PEP.

IWS LDAP connection

CIWS (114.92) and IWSCONF (128.96) used LDAP port 389 connections to CDC1 (114.90) to import accounts and passwords. CIWS was not part of the federation during the last part of Spiral 3 and all of Execution, causing the need for the two LDAP connections. The LDAP connection between CIWS and CDC1 was not over the KU satellite. The LDAP connection between IWSCONF and CDC1 was over the KU band with peaks of close to 3 Mbps. CDC3 (128.100) was located at JFCOM on the same LAN as IWSCONF and would have taken no bandwidth across the KU when IWSCONF pulled the accounts. CDC3 had a complete list of all accounts on CORONADO domain that was replicated every 15 minutes. It was also noticed that a consistent LDAP stream from IWSCONF to CIWS average less than 1Kbps with some short peaks of 50Kbps.

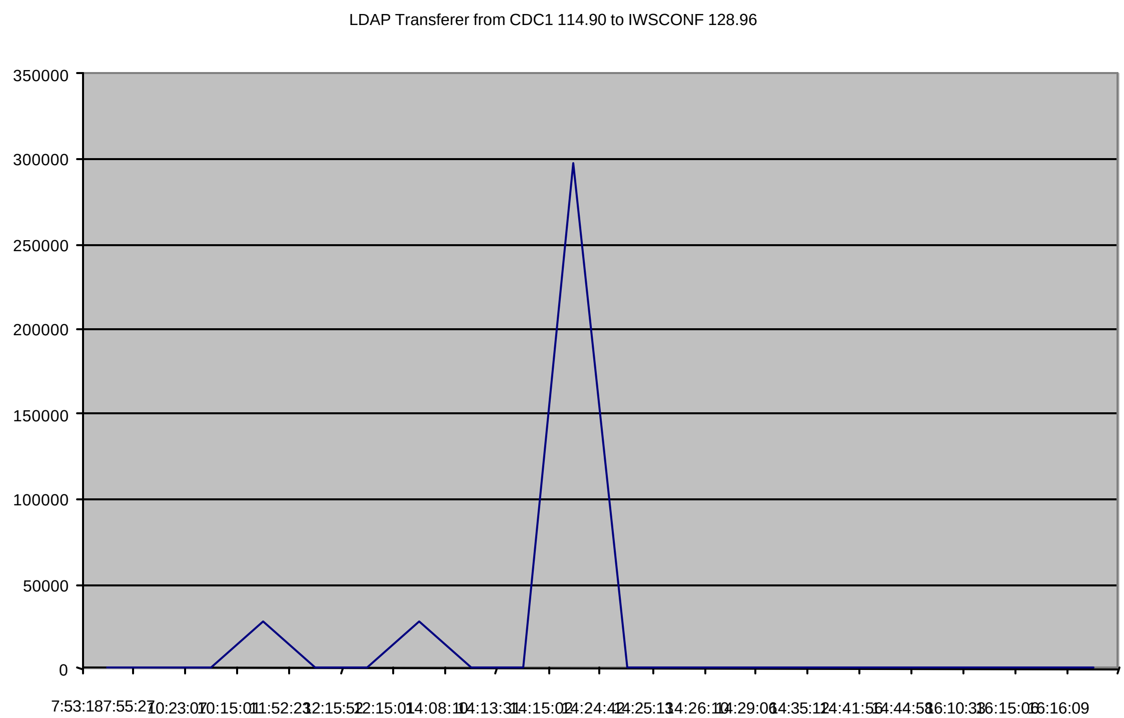


Figure A5-9. LDAP traffic flow between IWSCONF and CDC1

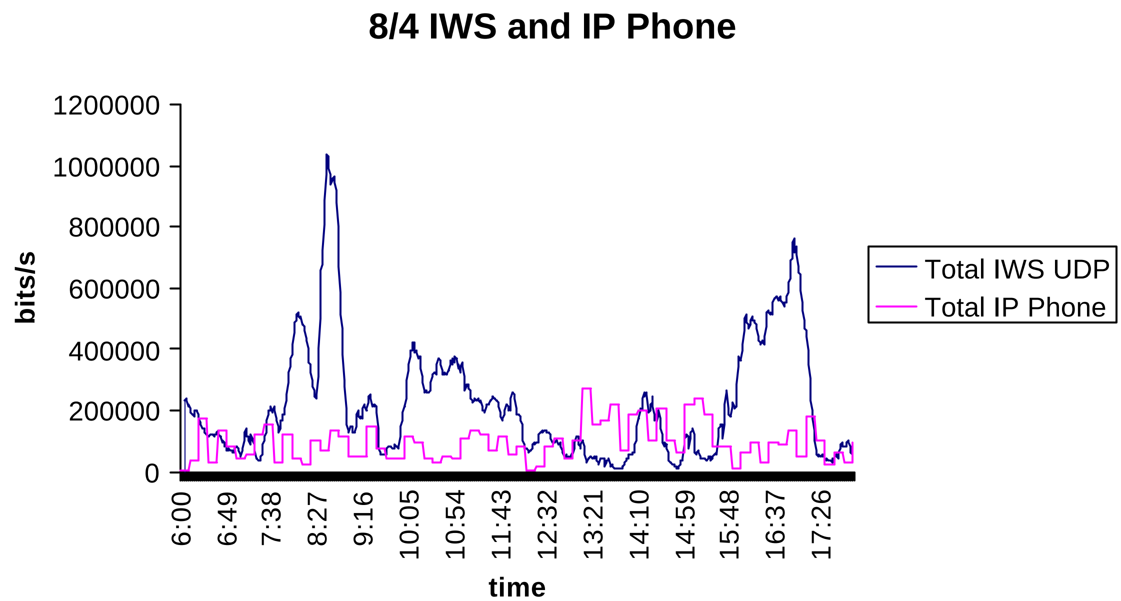


Figure A5-10. 8/4 IWS and IP Phones Total

SharePoint Portal Usage and Search Indexing

HTTP Port 80 request over KU

Network analysis equipment was not set up to track bytes being pulled from the SPPS but it was set up to capture traffic across the KU. The following figures display the outbound and inbound HTTP port 80 traffic.

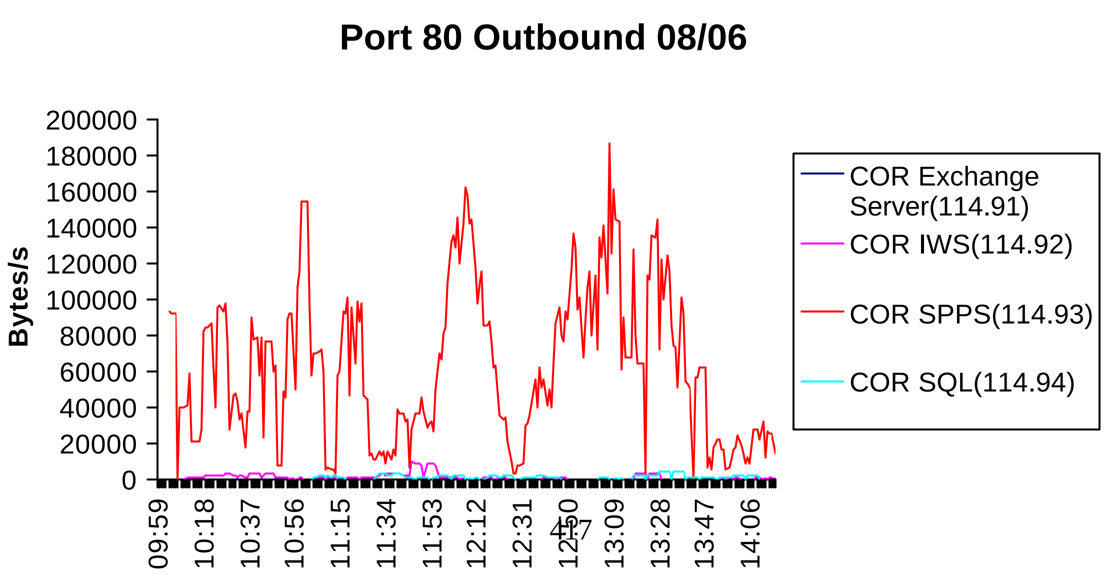


Figure A5-11. Port 80 Outbound 08/06

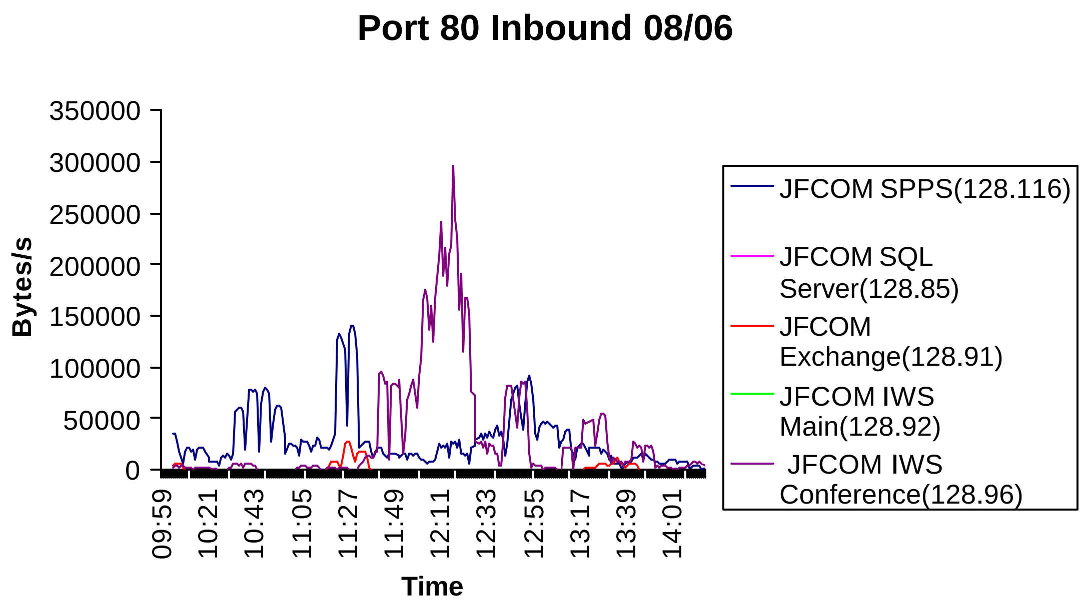


Figure A5-12. Port 80 Inbound

Information/Process Systems and Initiatives

Automated Distributed Firewall Network Interface Cards (ADF NIC)

The Automated Distributed Firewall Network Interface Card uses a 3COM 3CR990 NIC installed in the PC. A 3COM Embedded Firewall Policy Server controls the ADF NICs. This allows for a central managing of policies on the ADF NICs. The main problem we encounter was when a new policy was pushed out we would have portions of applications not work due to either an IP address, multicast address, or a port being closed. Using a firewall within the LAN becomes difficult due to the amount of ports being used, Dynamic IP assignments, and applications using random port numbers. The ADF NICs did not offer content inspection on the IP packets. Opening the wide range of ports required for LAN based application to run leaves the machines vulnerable to a lot of attacks. It is still required to have a Firewall at the Point of Presence to protect the LAN from WAN based attacks that the ADF NICs would not be able to stop due to the port being opened to support a LAN based application. The ADF NICs would be better used for machines setting in either the DMZ or outside the firewall.

Maritime Planning Support System (MPSS) by KnowledgeKinetics (K^2)

The MPSS integrates emerging technologies for distributed and collaborative decision support in a J2EE framework, by providing warfighters with web-based tools and information to help manage the complexity of planning Effects based operations in Rapid Decisive Operations. It has the potential to reduce decision timelines, mitigate information overload, and standardize procedural, doctrinal and training issues. (Taken from K^2 Quad chart) The true value of K^2 is the J2EE backbone it is built on. K2 has many pre-built Java based process objects for drag and drop development. One can easily build an interactive process model in a matter of hours. One possible use for K2 in experimentation would be to visually represent a process as it is being developed. For instance if particular section of the JFMCC process is not working and it is modified the process model could then be modified as well and be able to visually show the new process to the warfighters. The rest of the K^2 suite is a set of collaboration tools and a knowledge portal. The K^2 portal has many of the same features of SPPS and the collaboration tools are very much like those that come with Microsoft Netmeeting. The main difference between the K^2 suite and the Microsoft products is K^2 is built on J2EE architecture.

JFMCC process Integration

K^2 was integrated with the JFMCC process at the highest level. It was designed to mimic Brad Poelter's JFMCC process flow diagram in Figure A5-13. Maritime Planning Process. In order to track the process the K^2 team created a set of tags, which would interact with the Cold Fusion JFMCC process web applications. These tags notified the K^2 process flow for MOD, MARSUPREQ, and MMAP changes. The interaction was highly successful and worked well with the Cold Fusion applications. The integrated event tags only covered Future plans and Current Plans in the process flow. MTO production and execution Event tags were not part of the process flow. There were some hard coded interactions but it was used sparsely if used at all. For future builds there must be event tags developed with TBMCS for MTO production, BDA, and MTO execution. Once the execution piece is added the process loop is complete and will show how the process feeds back into itself. There are many JFMCC sub process. After FBE-J the sub process will become more defined, and then they can be added to the MPSS process flow and add significant enhancements to the process flow. Other warfare areas would then be able to view the current needs and status for each PWC. The process flow would contain more useful information and would be more reflective of the process instead of the current top-level view.

Highlights

K2 was successfully integrated with the Cold Fusion JFMCC process applications. A series of custom Cold Fusion tags were created to send events to the K2 object model. It captured events for MOD Section status, MOD complete, MARSUPREQ submitted, MARSUPREQ completed, MMAP item added, and MMAP completed. This enable the MPSS to represent the state of the JFMCC process in a real time manner. The background K2 process object model is also easily modified. During execution the process model was significantly modified. All user notifications were removed and the MARSUPREQ to MMAP was change from a serial process to a parallel process.

Improvements

As the JFMCC process becomes more defined so will the usefulness of the MPSS. The current high level process flow does not show anything a typical warfighter does not already know. As the process becomes more detail so will the complexity of information, and thus the need for a process flow model to help the warfighter gain better insight into the process state. More automation is needed. If things have to be entered in manually there are greater chances the process flow will not be up to date. So as the process is defined system events need to be identified which will help facilitate the automation of the process flow.

Frequency of Use

The product was not used to the degree desired. There were thee main reasons for its lack of use.

1. **Training.** During Spiral 3 there were several attempts to train the JFMCC cell on MPPS and K2. Due to the hectic nature of Spiral 3 the proper time was not allotted for the K2 representatives' time on CORONADO. If the MPPS is to be an integral part of the JFMCC process then it must be fully integrated into the JFMCC training package.

2. **JFMCC process definition.** The K2 system is designed to create interactive process flows. If the process it is not well defined then the interactive flow diagrams will not meet the users needs. Post FBE-J analysis should bring more definition to the JFMCC process at the lower levels. These inputs will significantly improve the process flow for the warfighter with more in-depth information and more interactive flows.

3. **Lack of Time and Resources**. To make a truly integrated product more time and resources would be necessary. System integration is not an easy task when there are many systems, technologies, and groups to work with.

Domain Security Settings

Domain policy manager was used to control security settings on client machines. This made controlling the machine policies very simple and setting only had to be set at one place. It was also used to preset users' homepage and Internet Explore security settings. Domain policy manager can also be used to control application settings, but we did not use it for that. The domain policy manager needs to be used more. We spent countless hours configuring client machines. If application and security settings can be set from the domain level then this needs to be done to save time and money.

Remote Administration

Virtual Networking Client (VNC) was installed on the ADOCS/IKA workstations and was used for remote administration and trouble shooting. VNC was invaluable for helping the remote sites were technicians were not readily available. VNC was all used to provide training, as we could talk users through the steps as we watched their screen. VNC is a free program, but it lacks the ability to do file transfers. Programs such as VNC need to become part of the FBE standard load. It is not only valuable for remote sites but it also saves time for locations within one site. The help desk was located on the 6th deck and there was a cell located on the O4 deck. With VNC a trouble call could be solved instantaneously as apposed to having someone go to the O4 deck to just ascertain the problem.

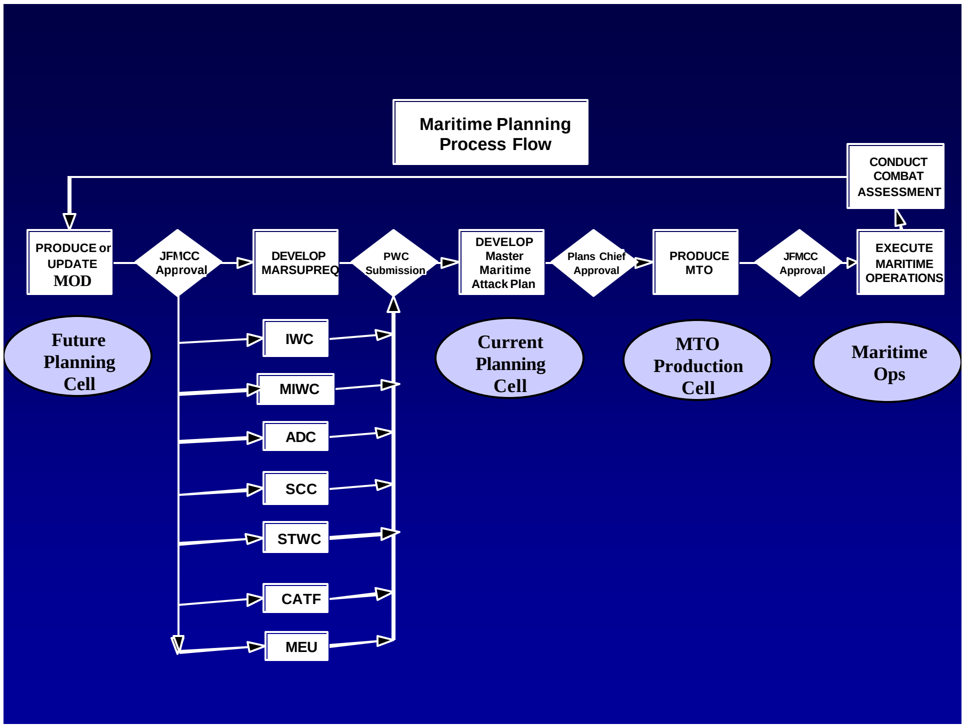


Figure A5-13. Maritime Planning Process

Additional Analyses

A. IWS Network Data

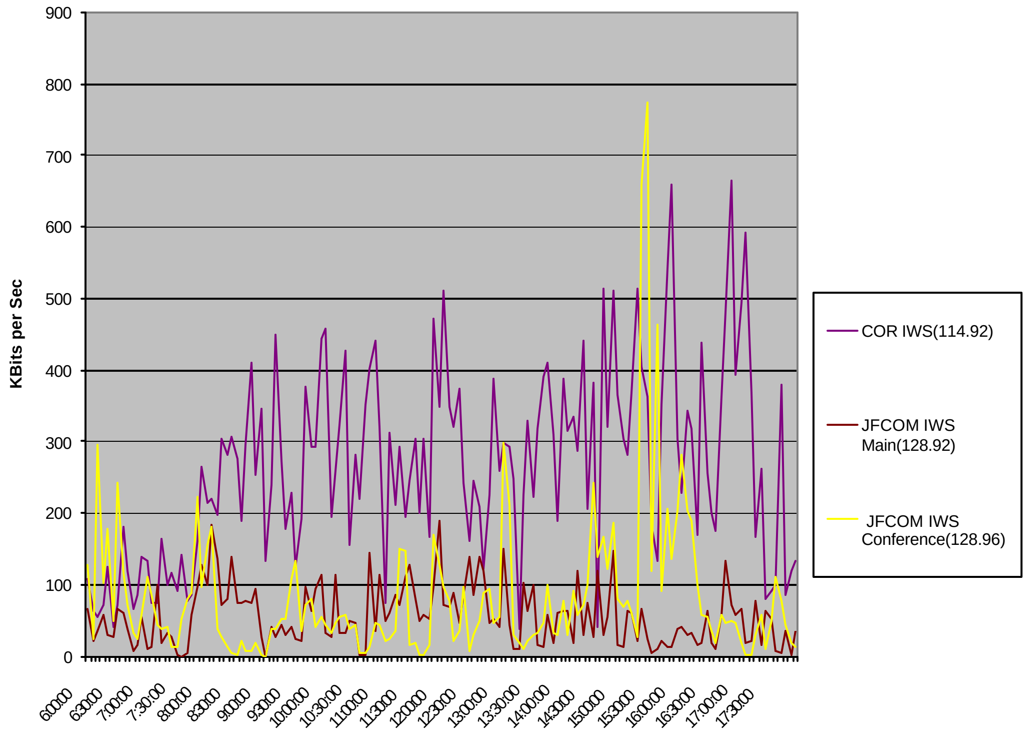


Figure A5- 14. IWS Data to & from COR 27 JUL 02

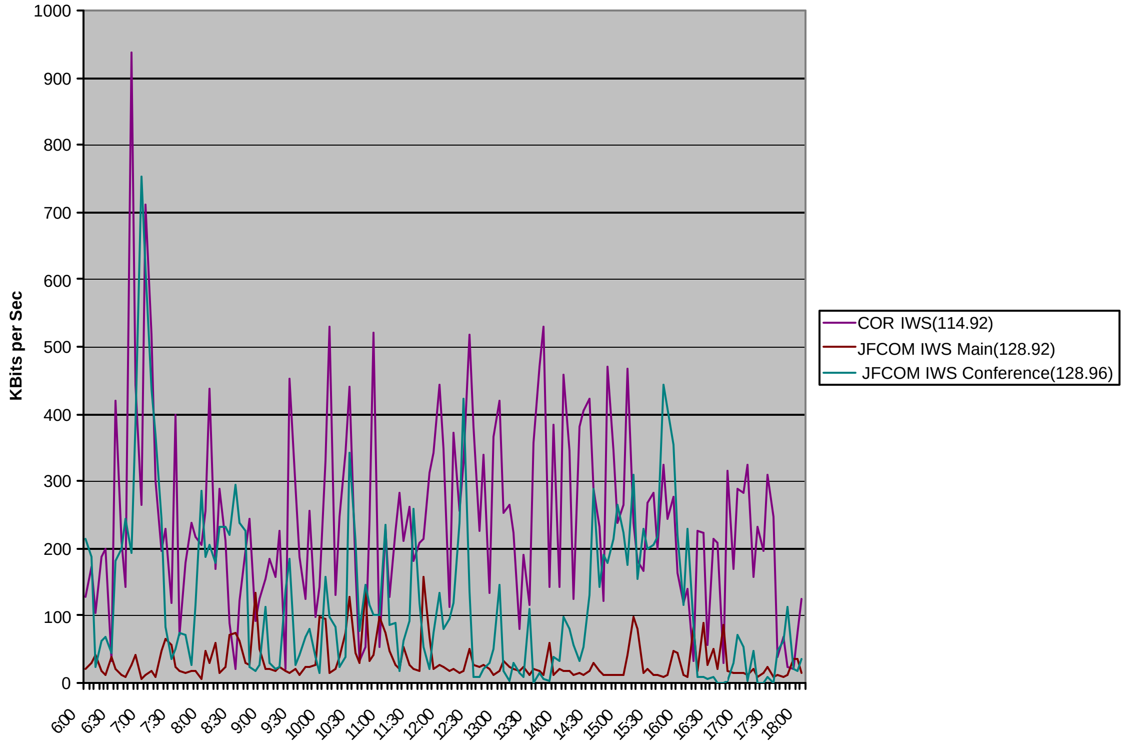


Figure A5-15. IWS Data to & from COR 28 JUL 02

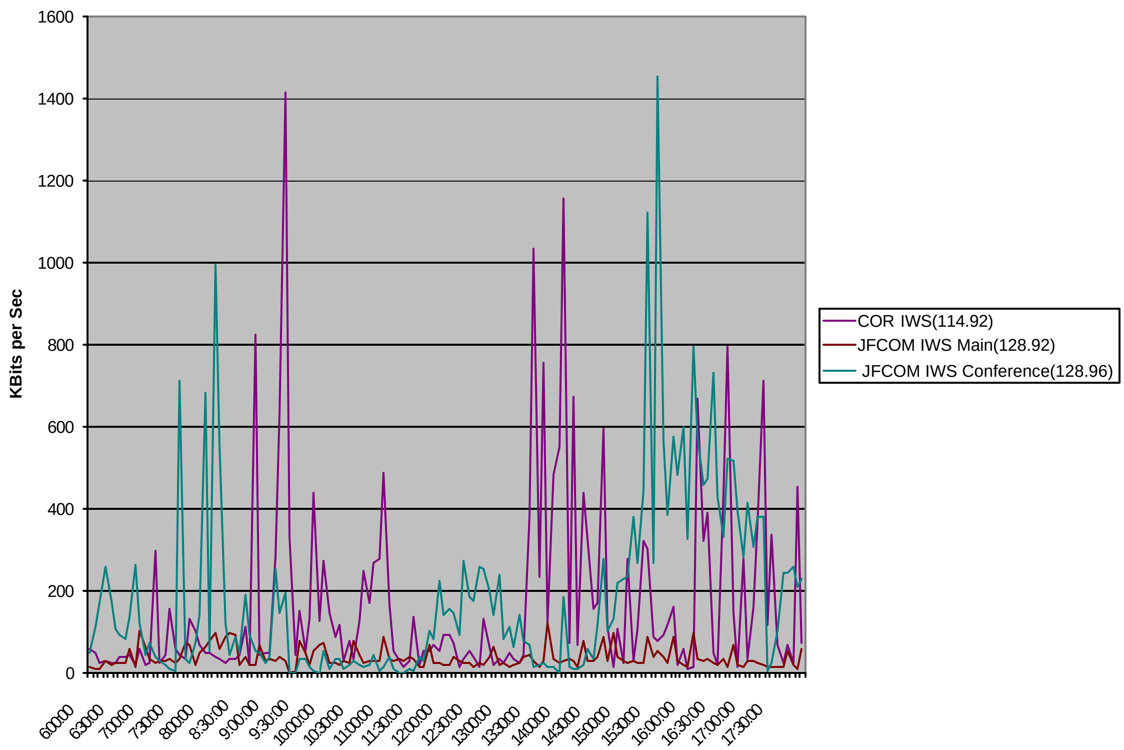


Figure A5-16. IWS Data to & from COR 29 JUL 02

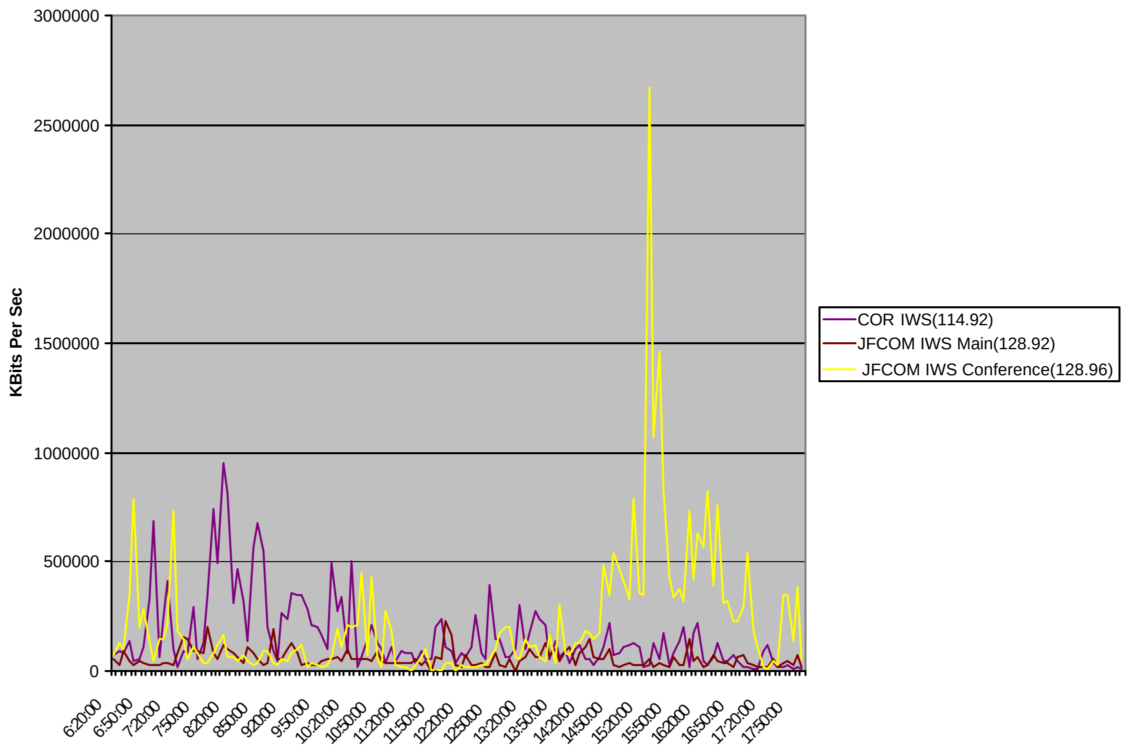


Figure A5-17. IWS Data to & from COR 30 JUL 02

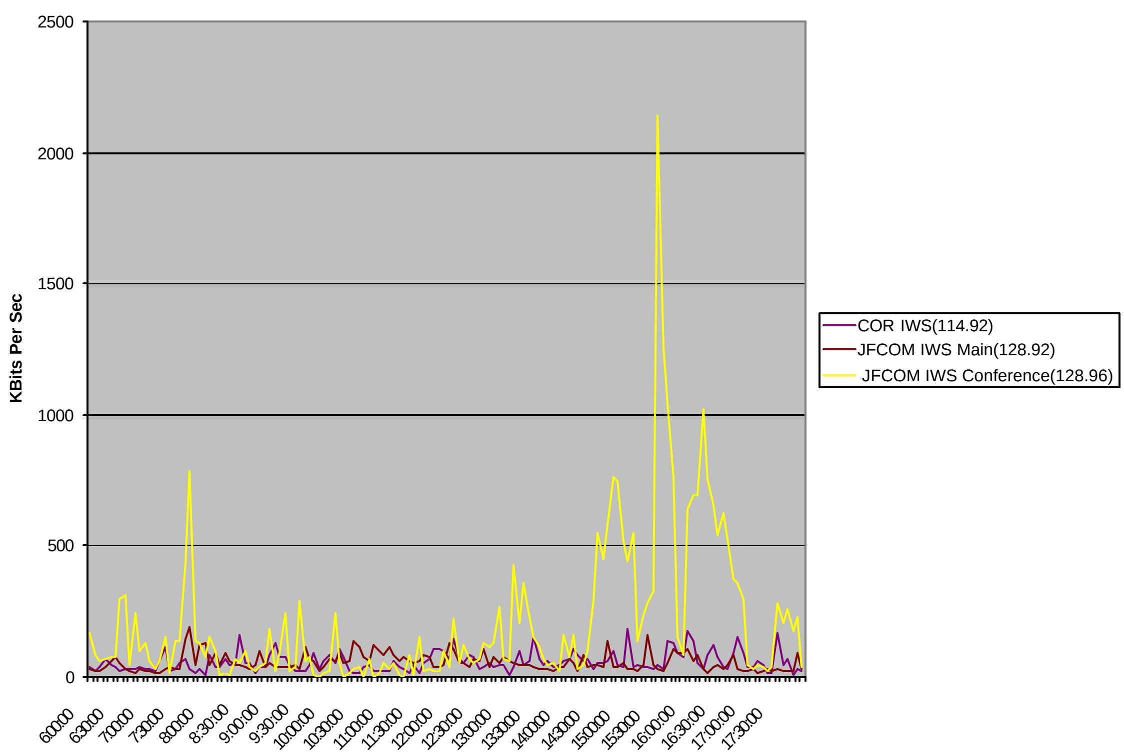


Figure A5-18. IWS Data to & from COR 31 JUL 02

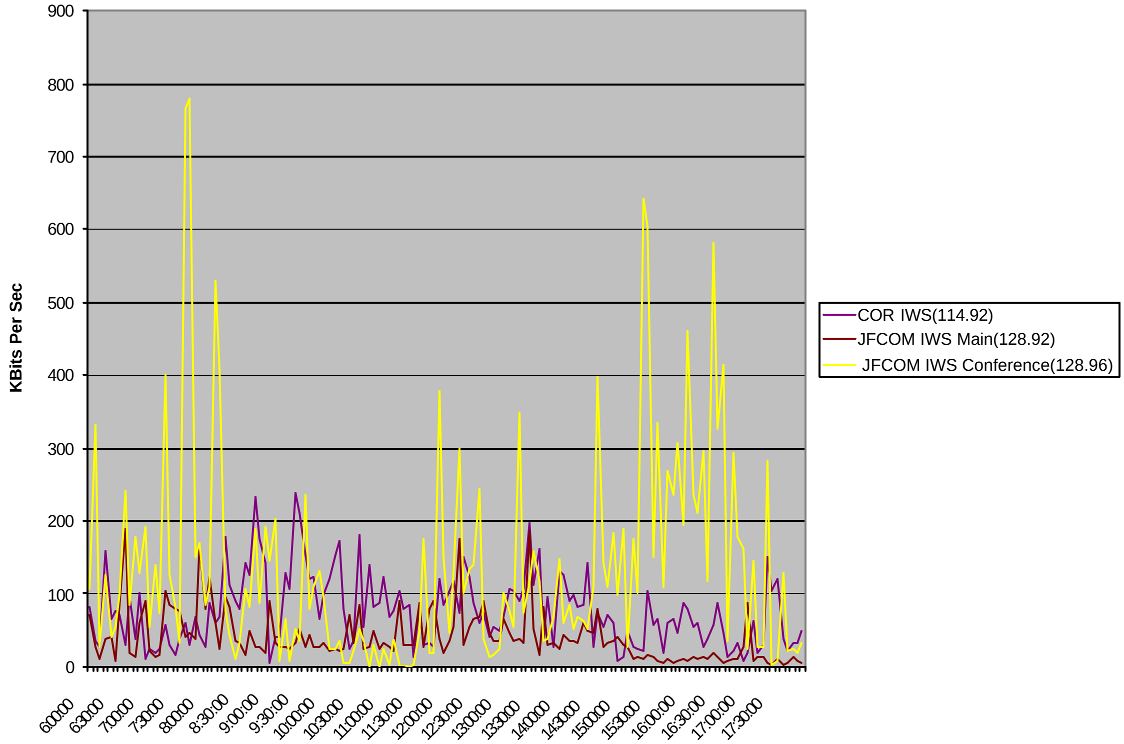


Figure A5-19. IWS Data to & from COR 1 AUG 02

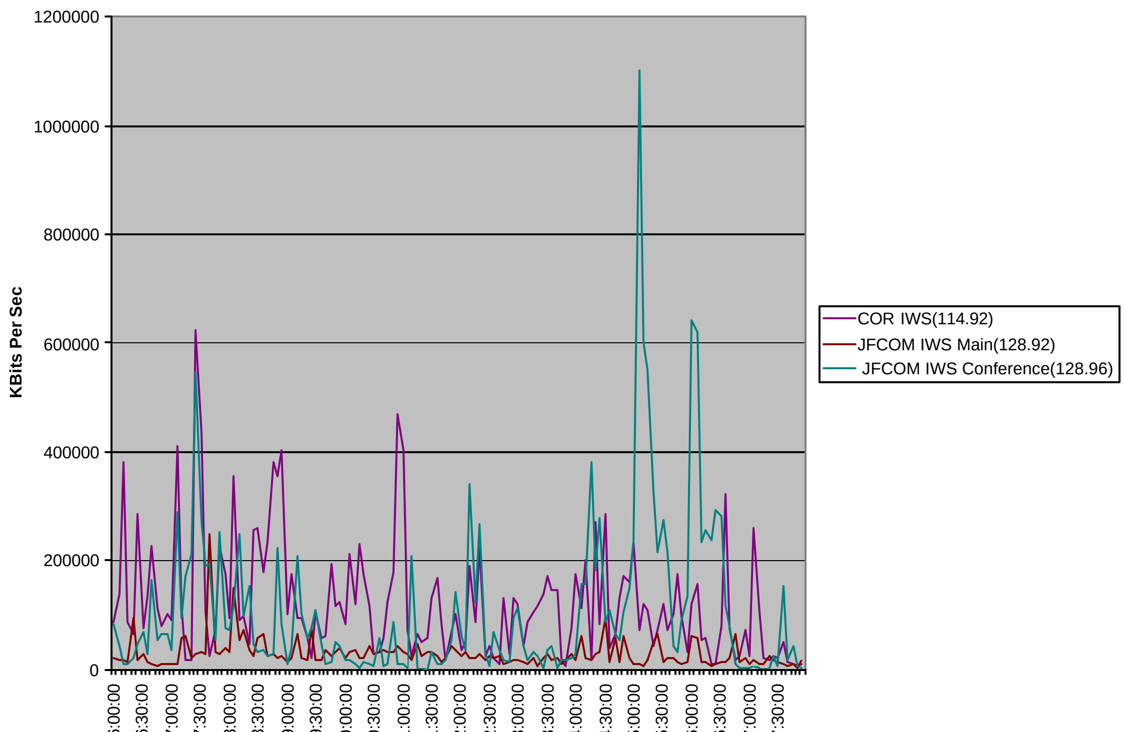


Figure A5-20. IWS Data to & from COR 2 AUG 02

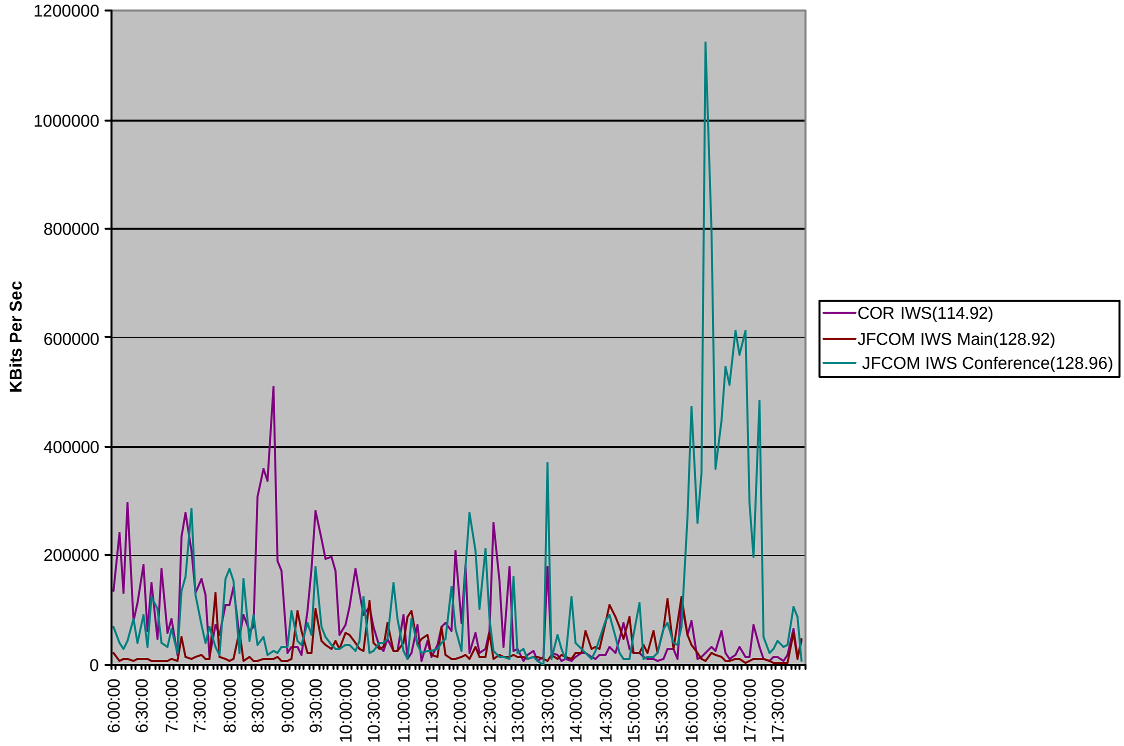


Figure A5-21. IWS Data to & from COR 4 AUG 02

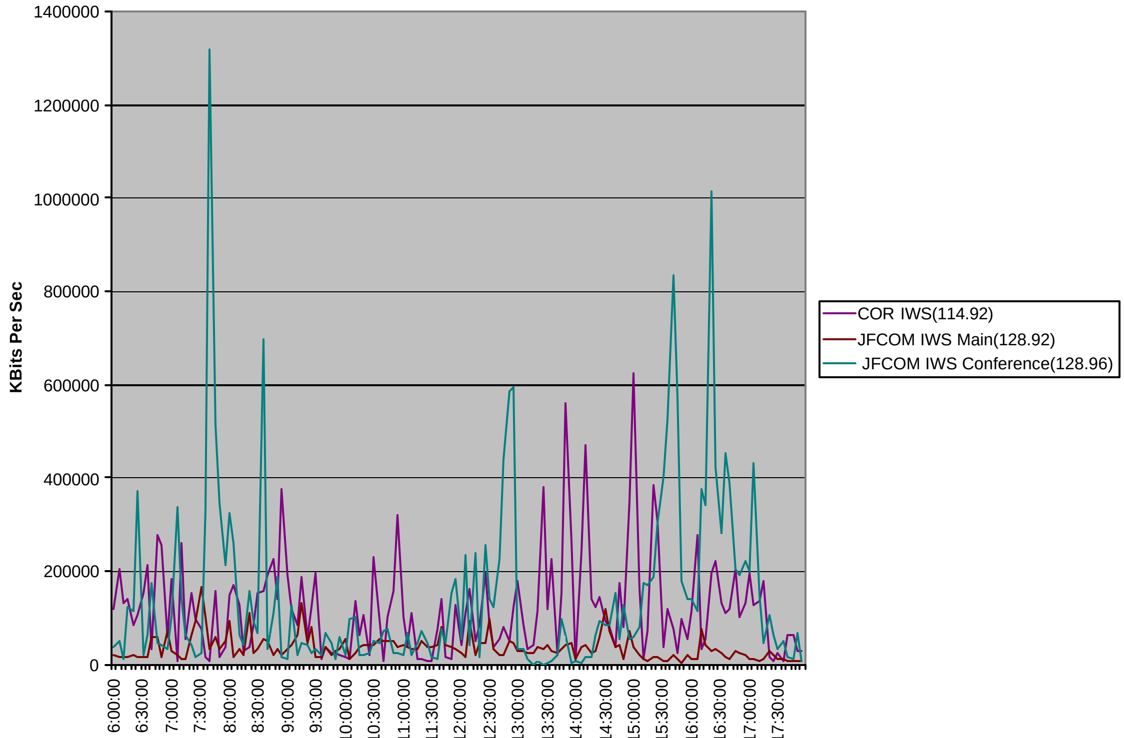


Figure A5-22. IWS Data to & from COR 5 AUG 02

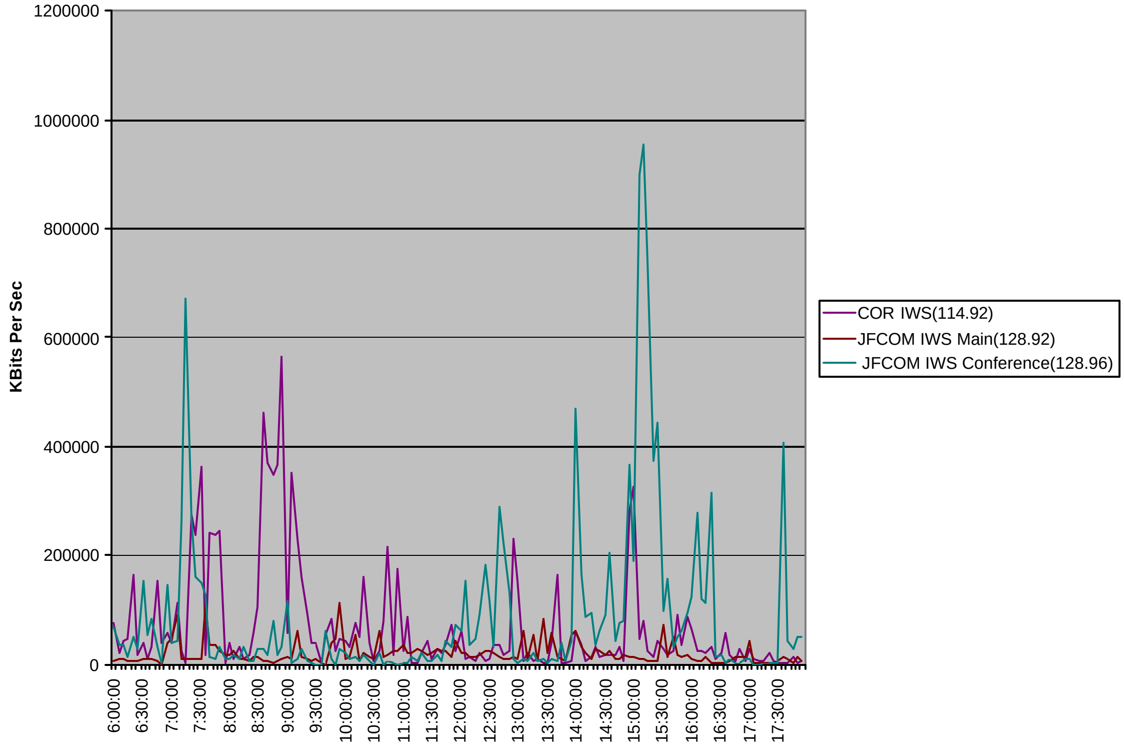


Figure A5-23. IWS Data to & from COR 7 AUG 02

B. Vigo VTC Data

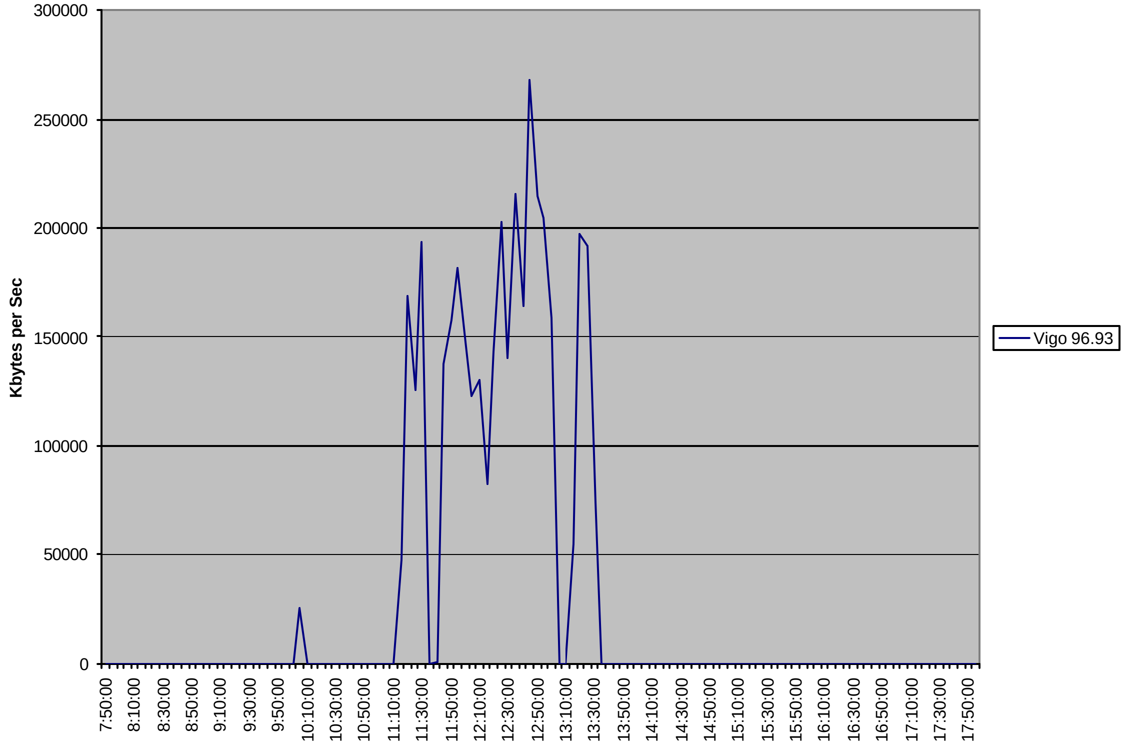


Figure A5-24. Vigo VTC data 26 JUL 02

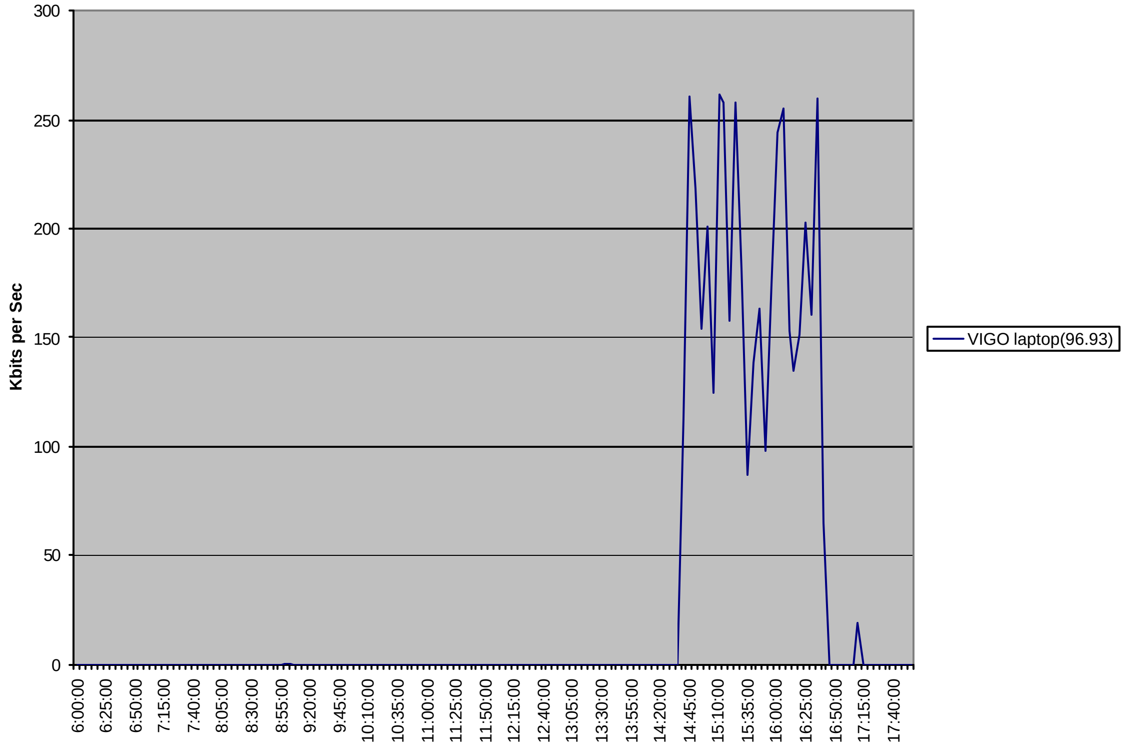


Figure A5-25. Vigo VTC data 27 JUL 02

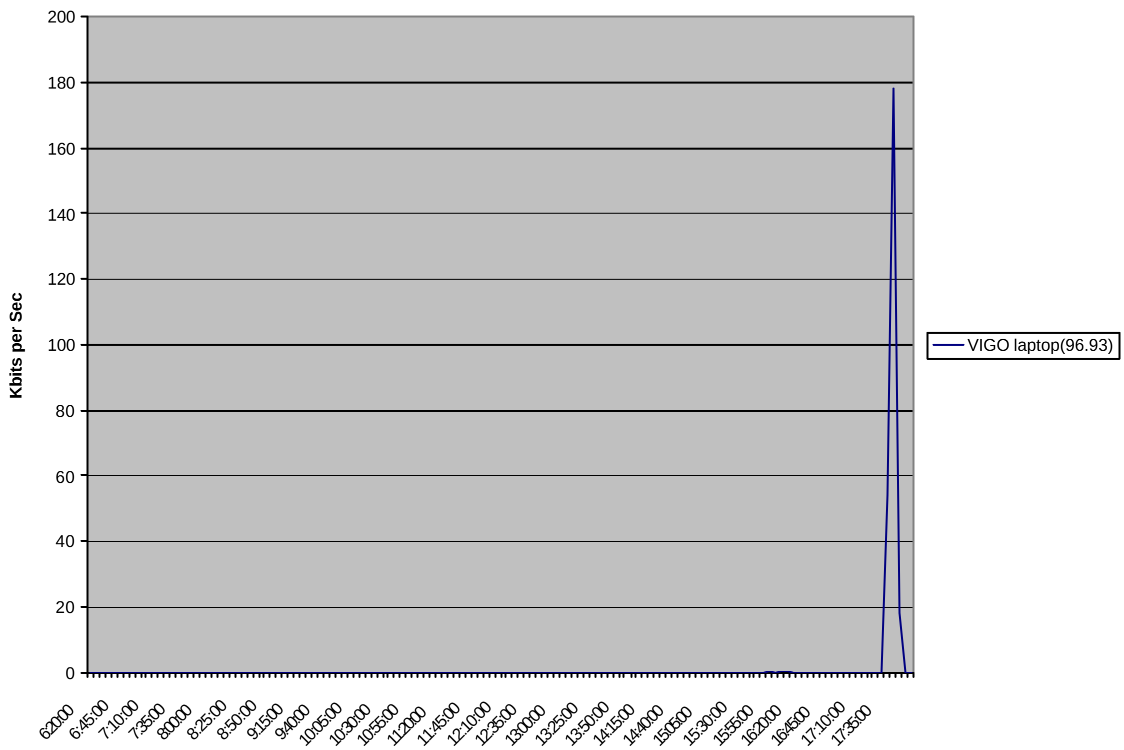


Figure A5-26. Vigo VTC Data 30 JUL 02

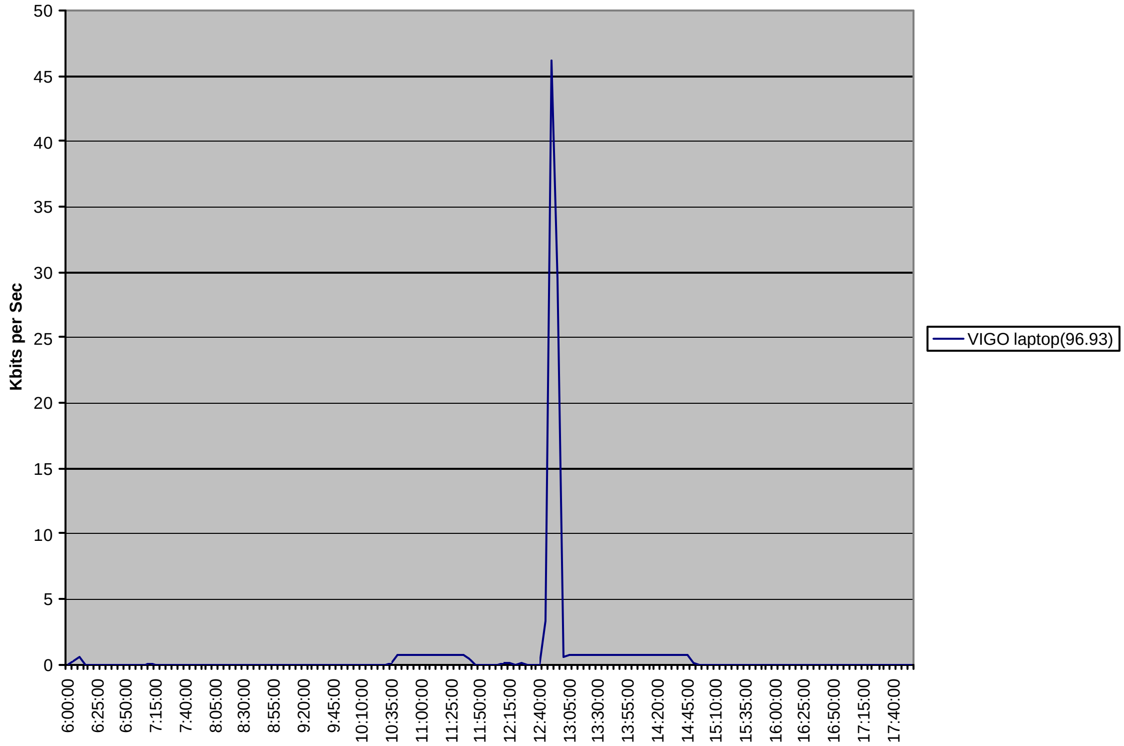


Figure A5-27. Vigo VTC Data 01 AUG 02

C. Port 80 Data

Active Directory Replication Data

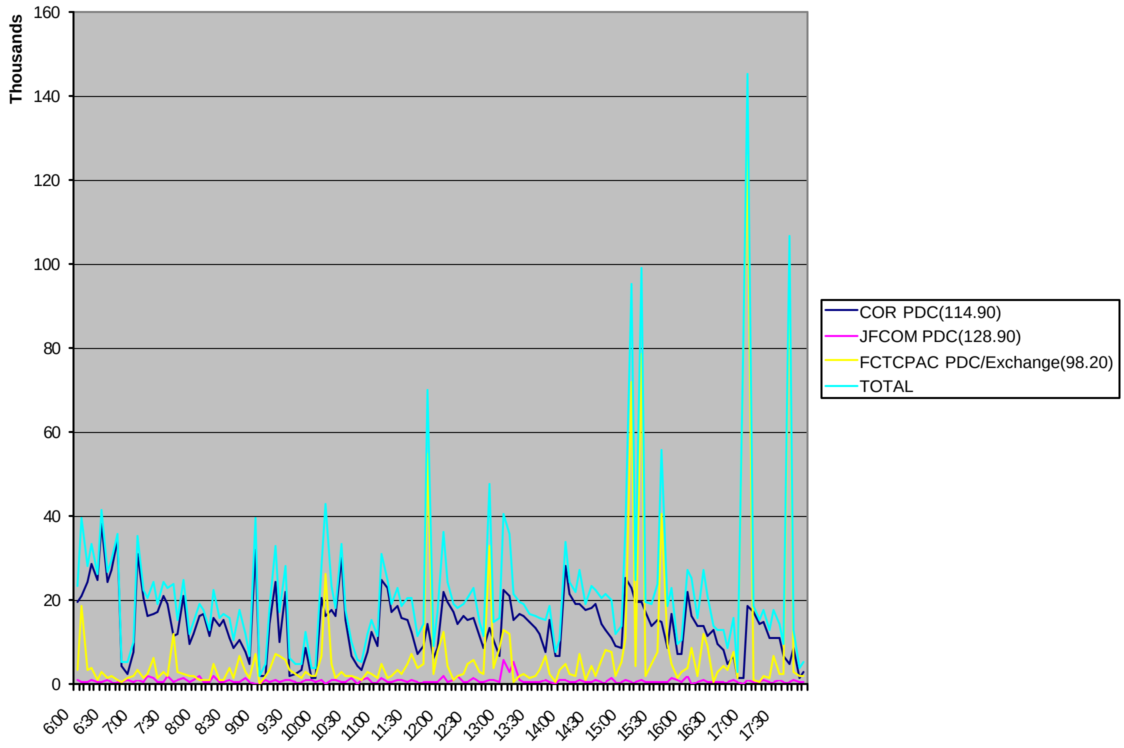


Figure A5-28. Active Directory Replication 27 JUL 02

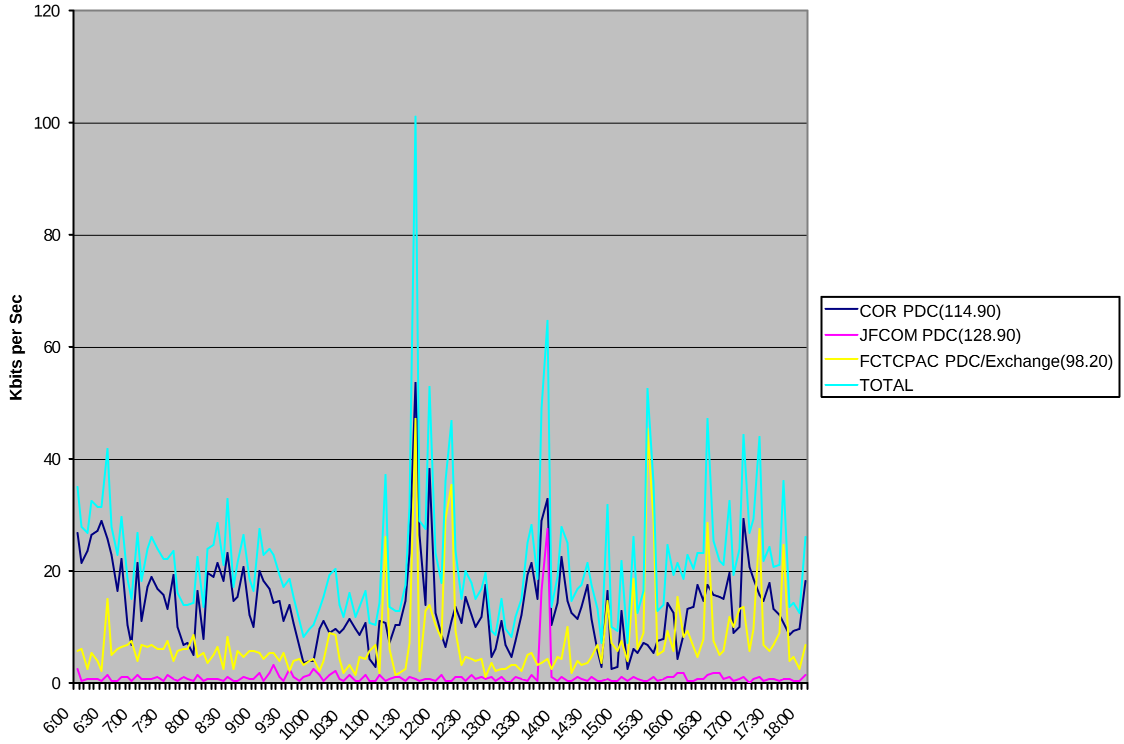


Figure A5-29. Active Directory Replication 28 JUL 02

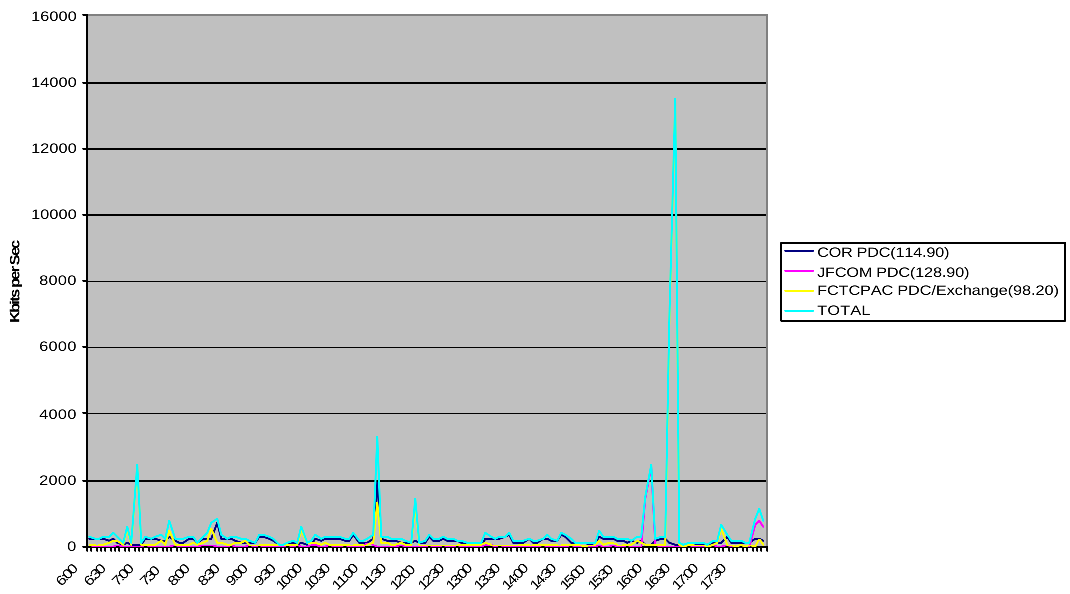


Figure A5-30. Active Directory Replication 29 JUL 02

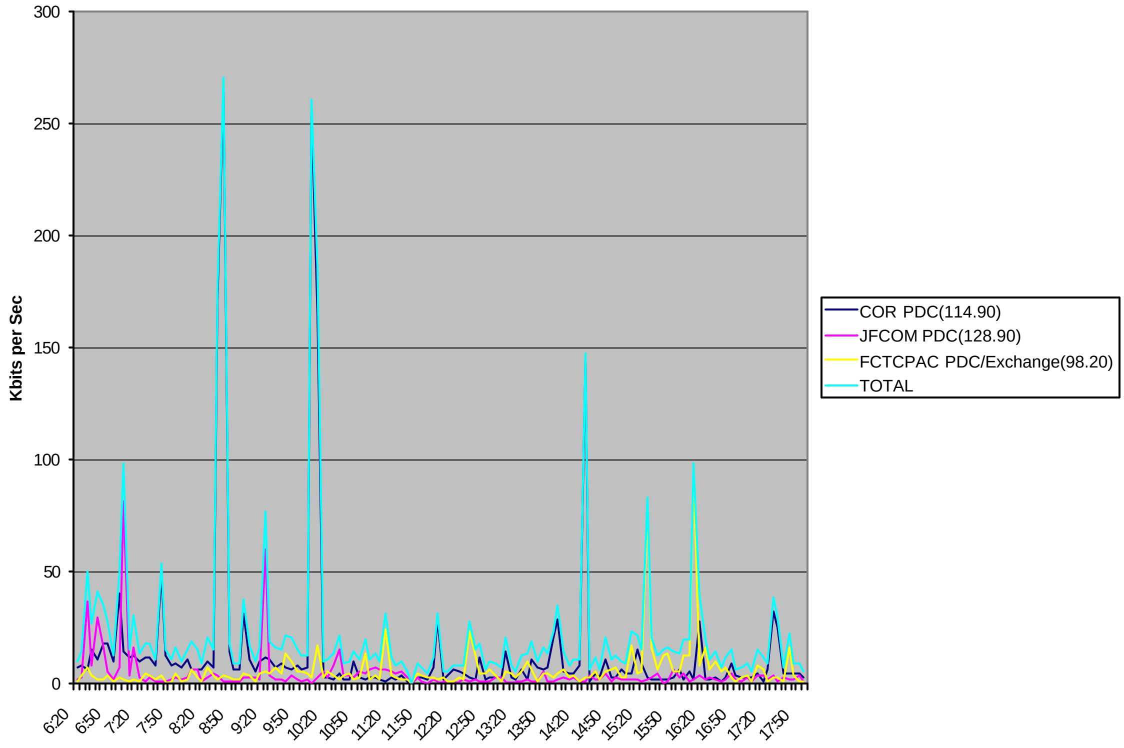


Figure A5-31. Active Directory Replication 30 JUL 02

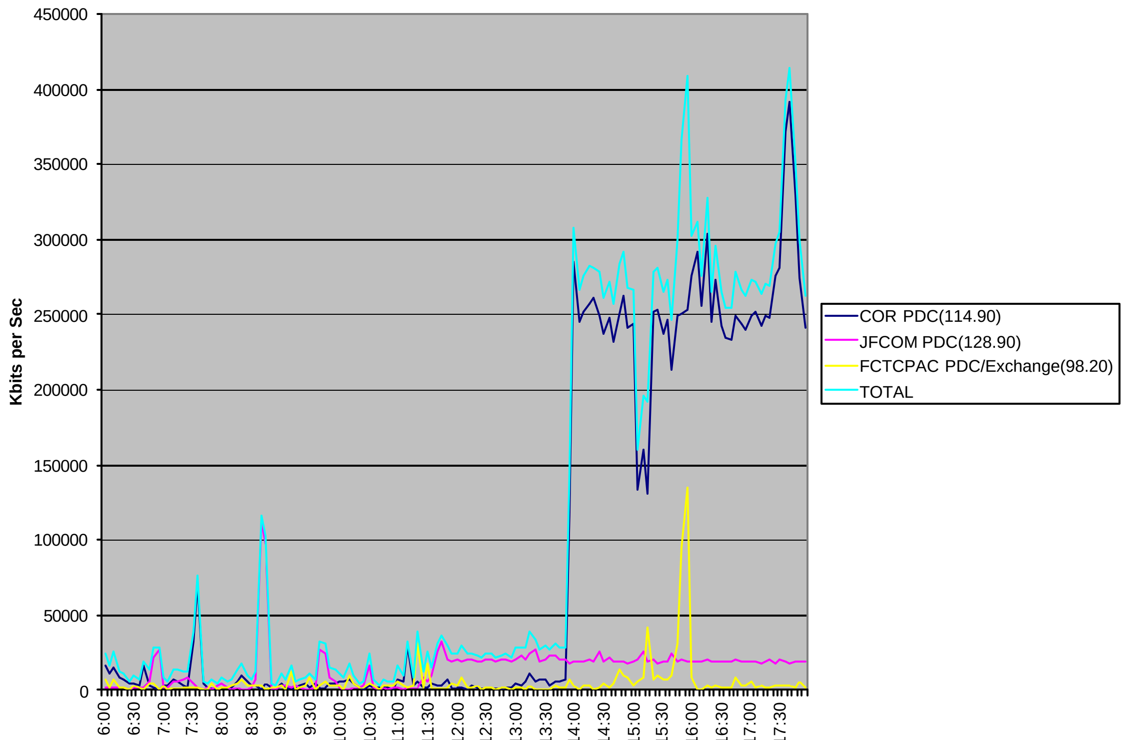


Figure A5-32. Active Directory Replication 31 JUL 02

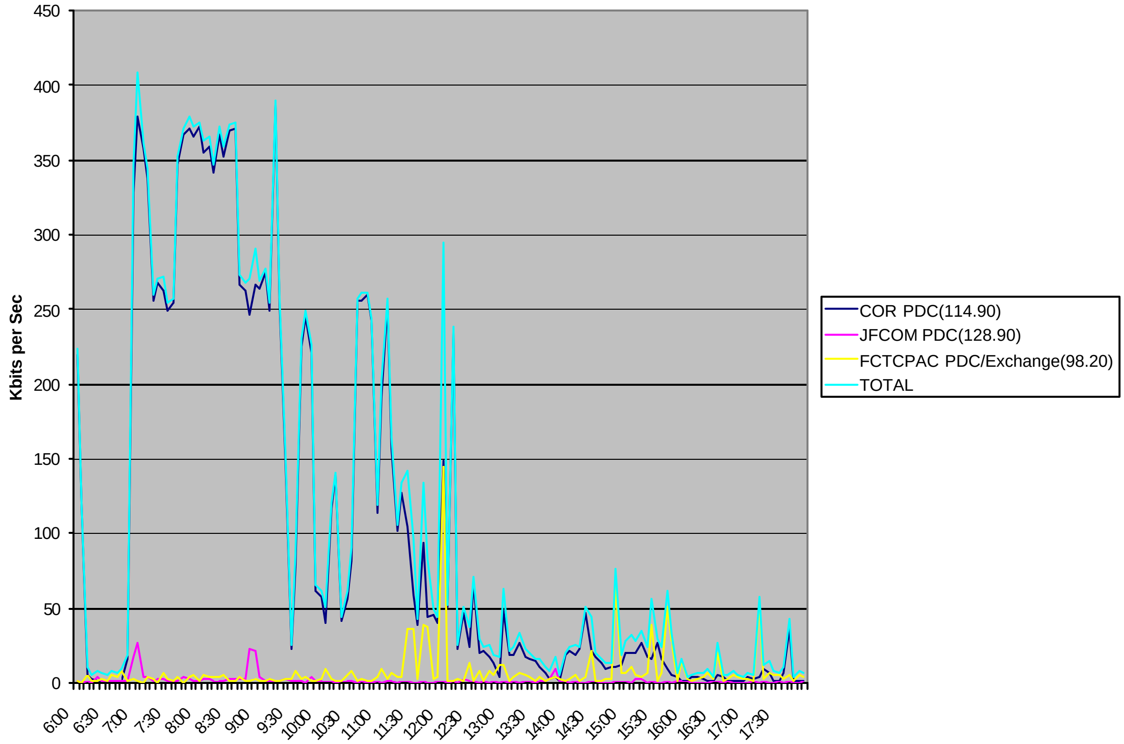


Figure A5-33. Active Directory Replication 01 AUG 02

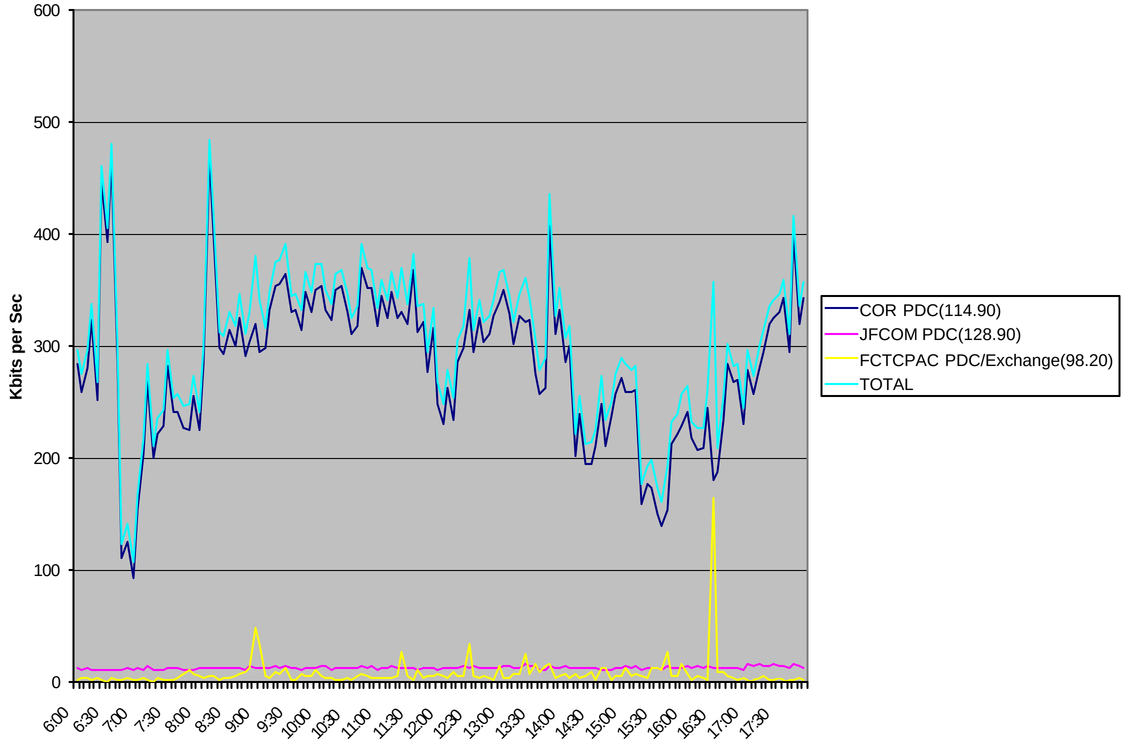


Figure A5-34. Active Directory Replication 02 AUG 02

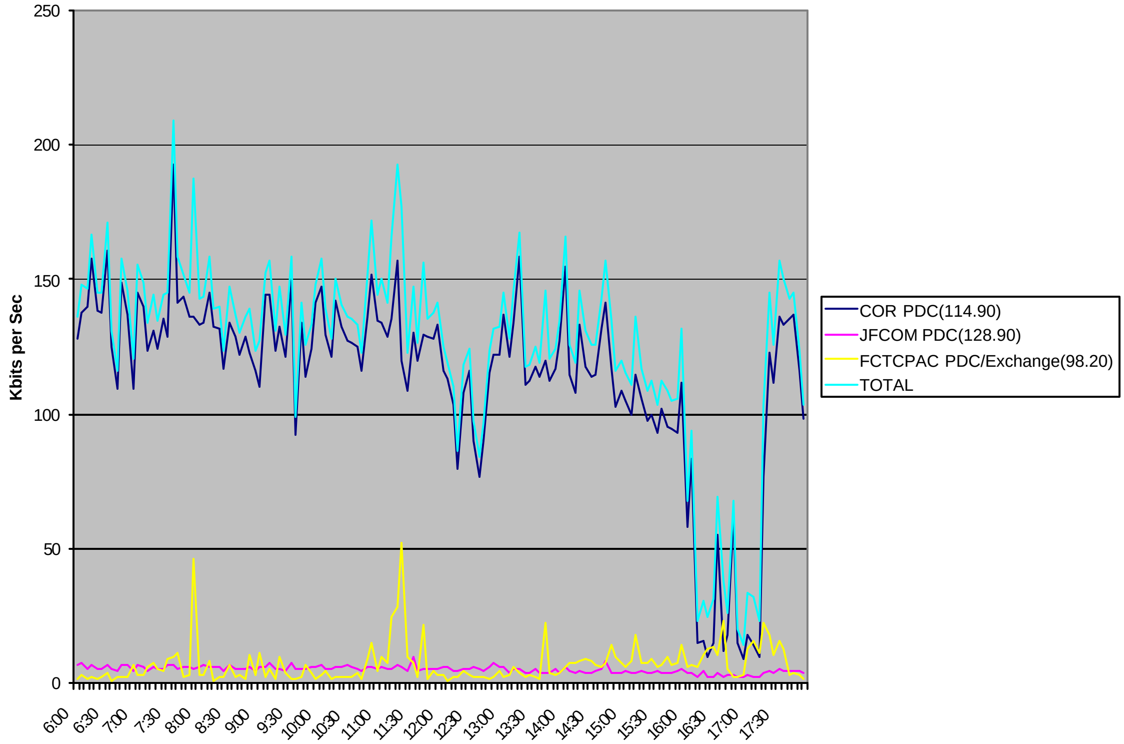


Figure A5-35. Active Directory Replication 04 AUG 02.

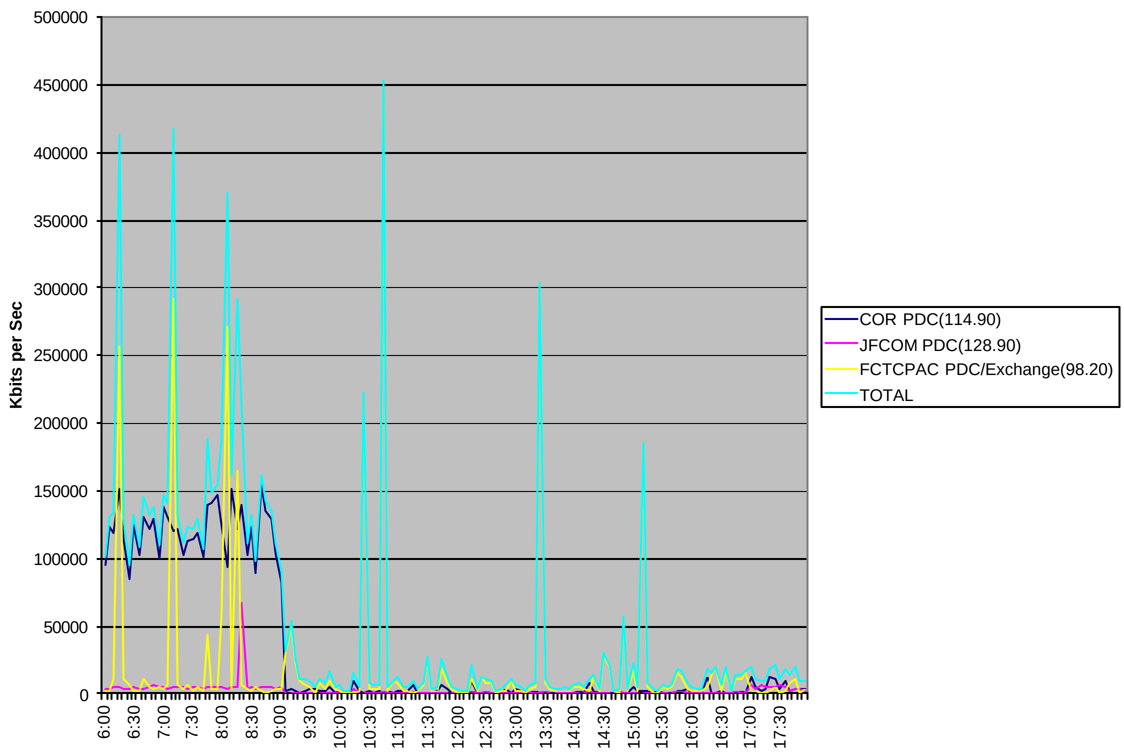


Figure A5-36. Active Directory Replication 05 AUG 02

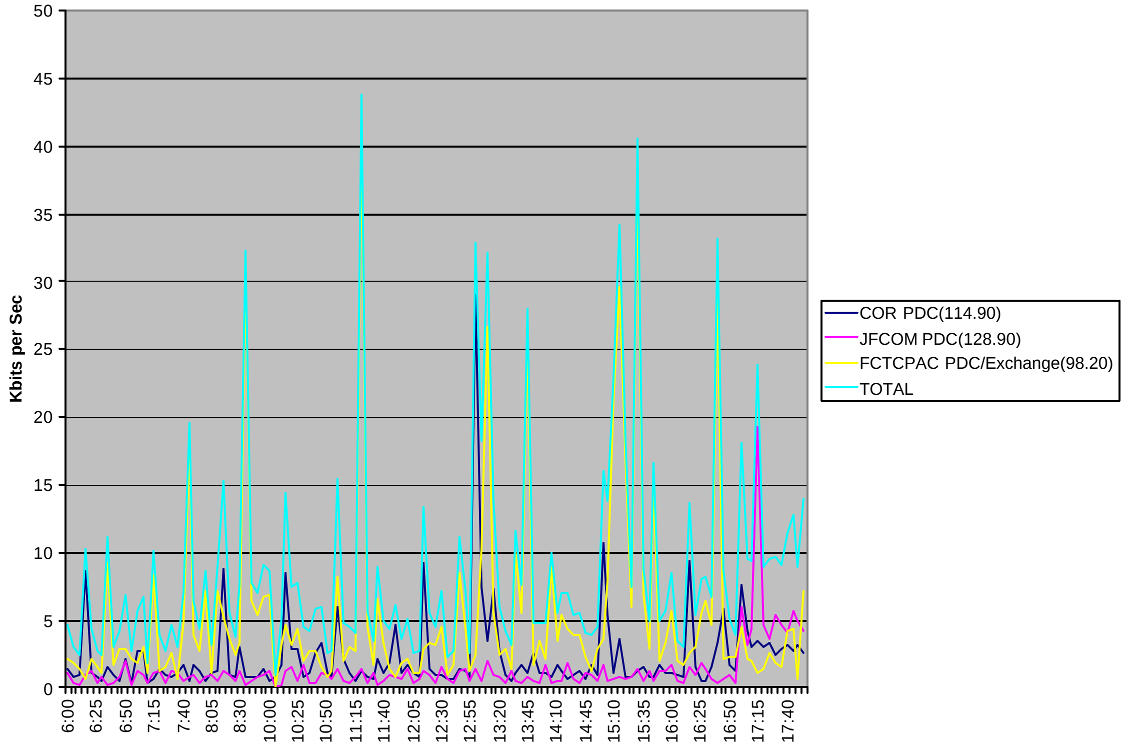


Figure A5-37. Active Directory Replication 06 AUG 02

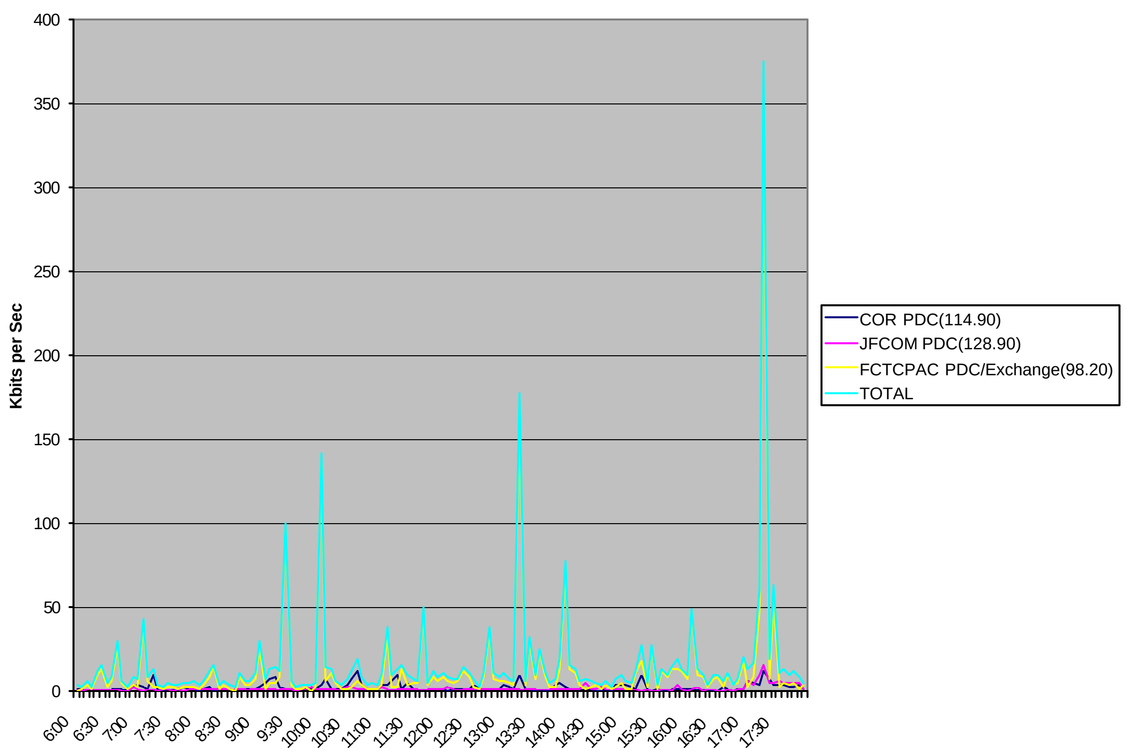


Figure A5-38. Active Directory Replication 07 AUG 02

D. Multicast Network Data

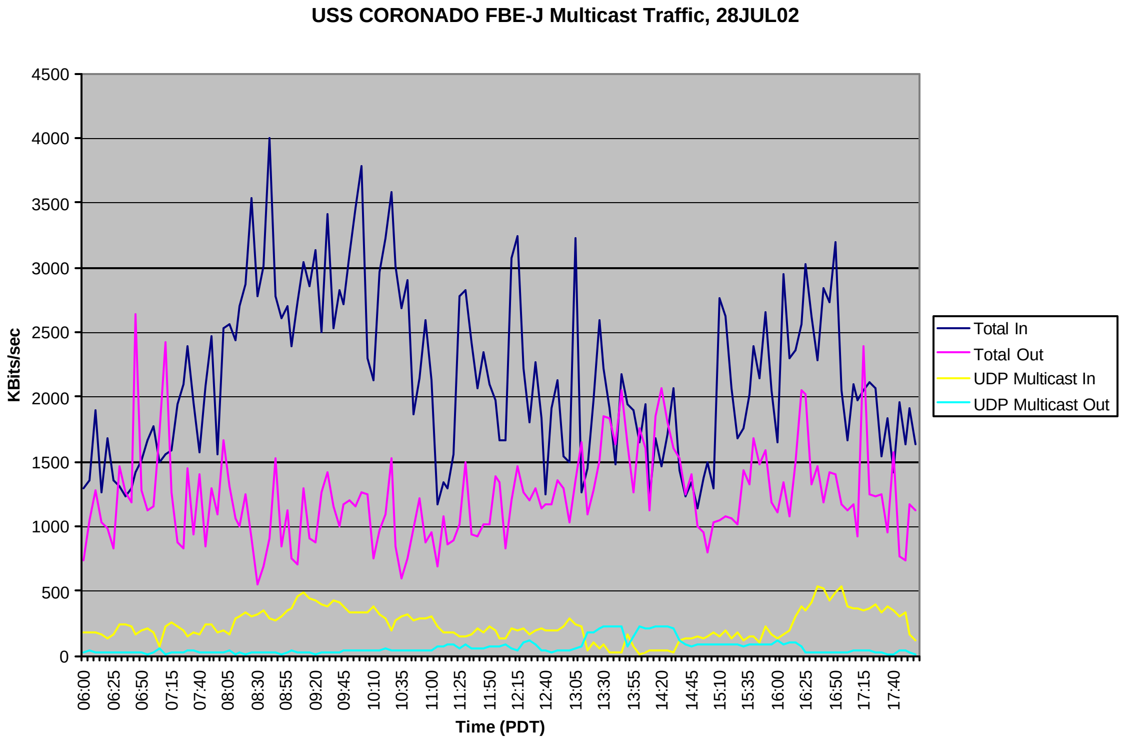


Figure A5-39. Multicast Traffic 28 JUL 02

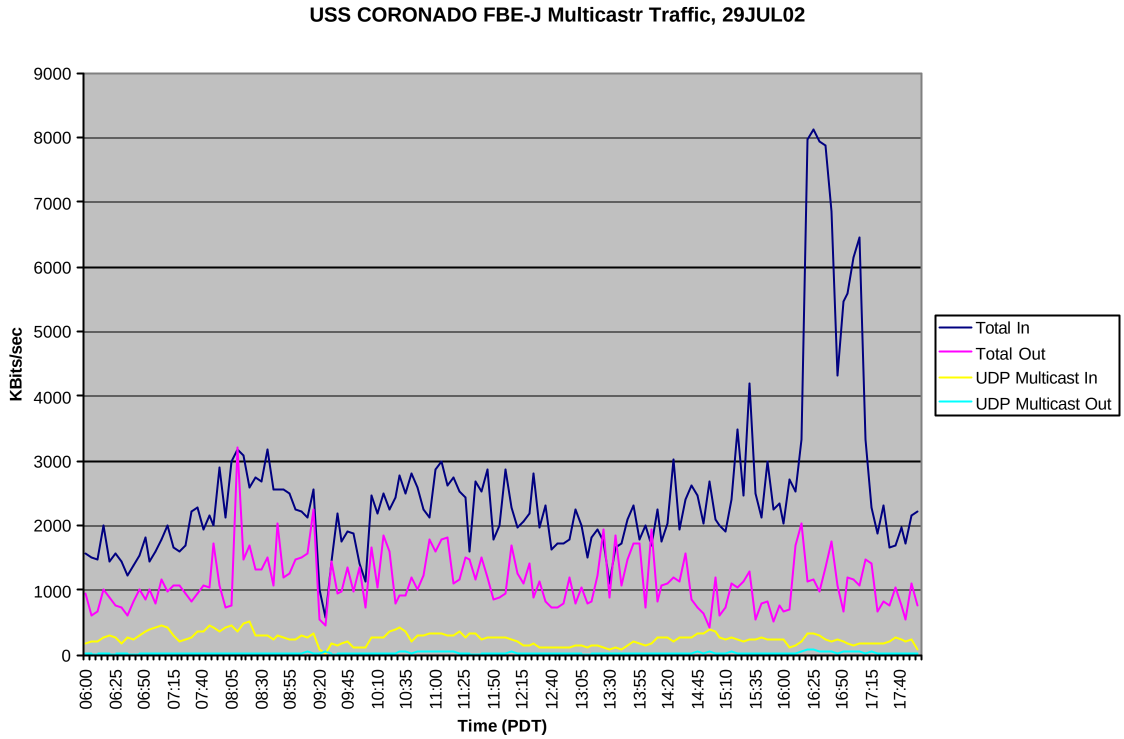


Figure A5-40. Multicast Traffic 29 JUL 02

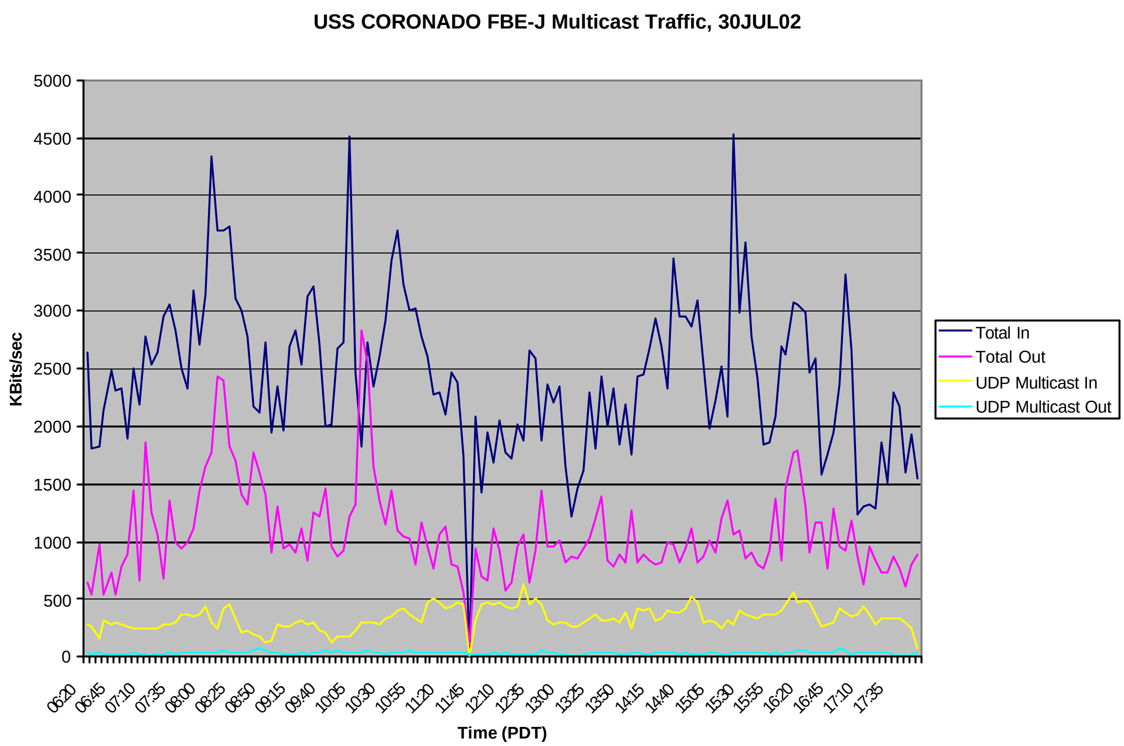


Figure A5-41. Multicast Traffic 30 JUL 02

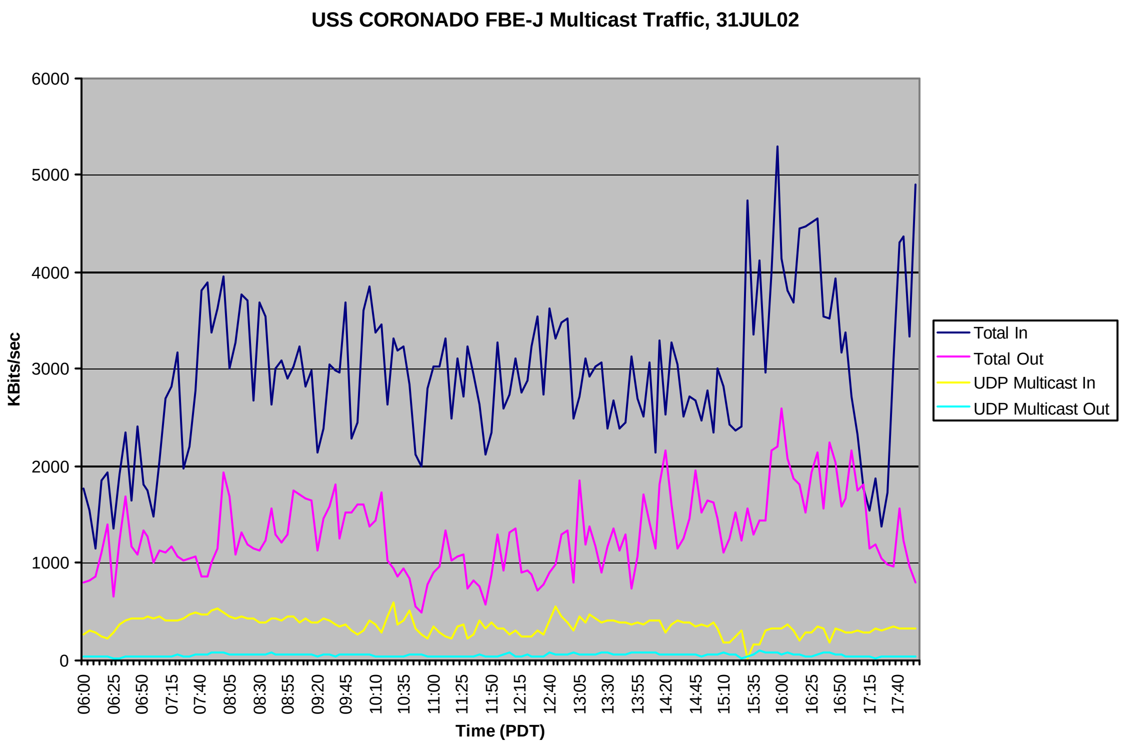


Figure A5-42. Multicast Traffic 31 JUL 02

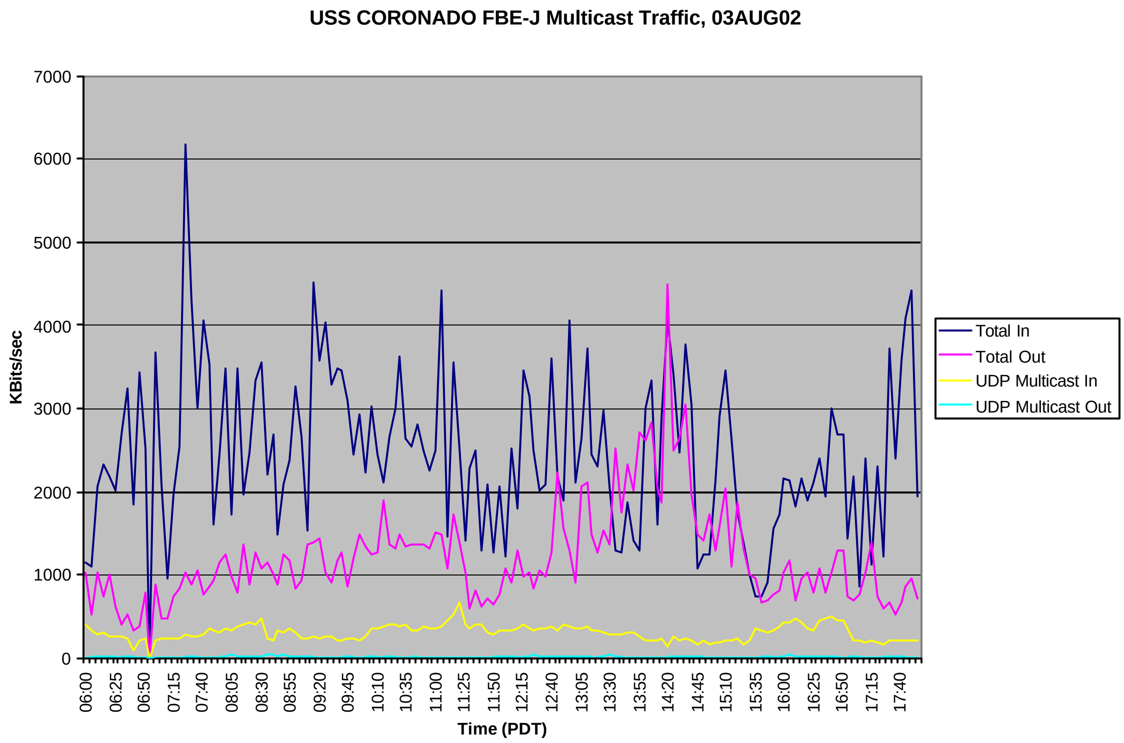


Figure A5-43. Multicast Traffic 3 AUG 02

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Knowledge Management Supported Analysis

The Netted Force Section earlier in this report deals with KM for operational decision-making. In this Appendix we briefly discuss KM for analysis, with illustrations from analyses that were done for FBE-J. Operational use requires that information be displayed so that real-time situational understanding can be developed whereas analysis use focuses on correlating information from many situations so that cause-and-effect can be developed. In both cases, information is used for decision-making, decisions leading to physical action in the first case and program-like decisions in the second.

Structure

Common structure definition is to delineate data, information, and knowledge. The Netted Force Section shows that also needed is an Understanding level for real-time, military decision-making. For long-term, military analysis, it is necessary to segment both information and data into sub-categories. This is illustrated in Figure A6-1.

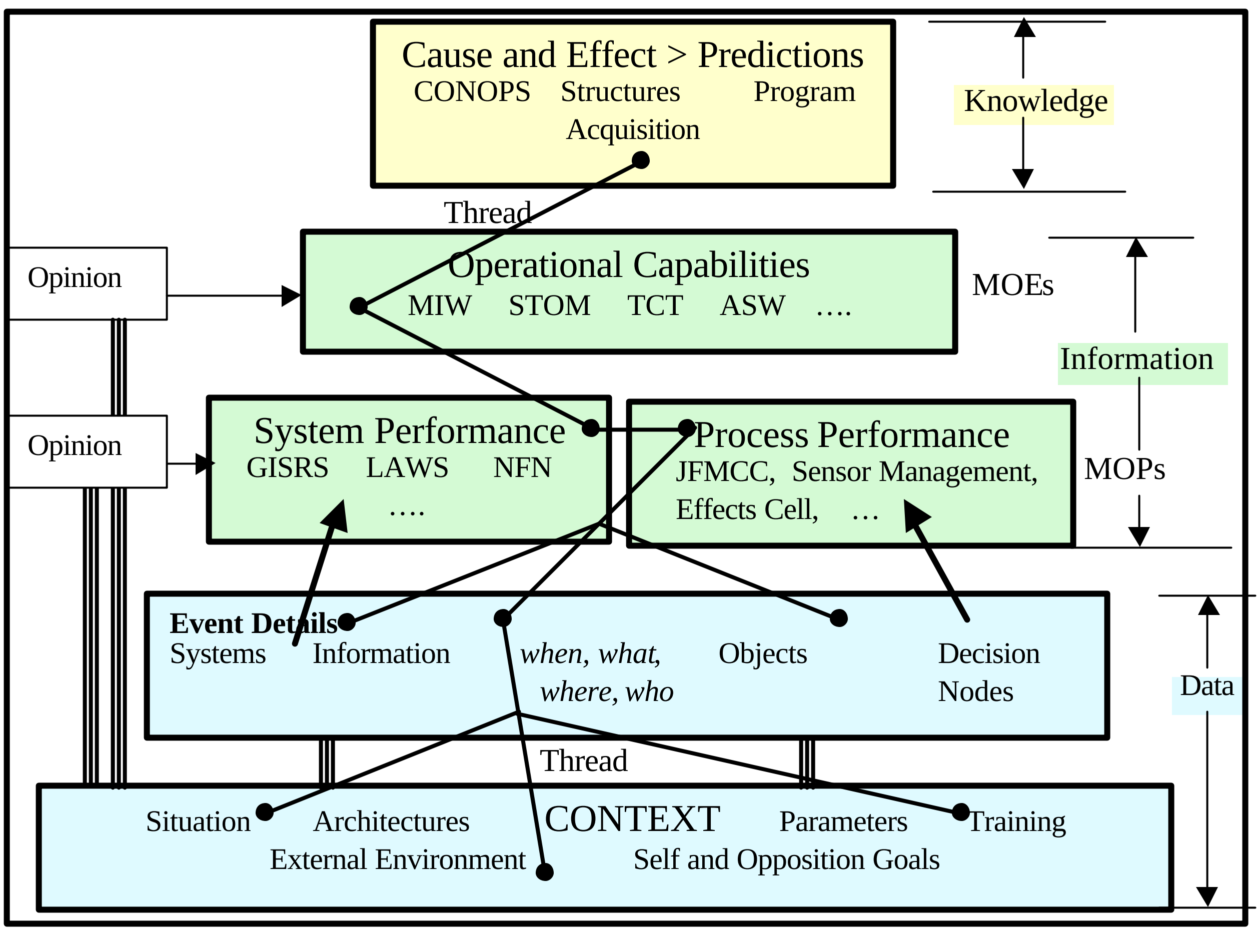

Figure A6-1. The transformation of data to information to knowledge

This structure is best discussed from the inside out. At the core is information about system performance, performance of processes within which systems operate, and operational capabilities provided by these systems and processes. Figure A6-1 shows just a few examples of the many systems and processes being investigated with FBEs. Performance includes many factors, often expressed in terms of Measures of Performance (MOPs). These Measures express desired and realized performance. Systems operate within processes, thus there are MOPs associated with system/process combinations, probably the most important Measures.

Examples

- JFMCC MOP: Percent of orders synchronized prior to being issued to warfare commanders.

- MIW MOE related to JFMCC: Ratio of the number of days required to clear mines in a defined zone to the number of days specified by JFC for the operation, with JFMCC as the managing authority.

- Context for this MOE: a) There was no competition for assets needed by MIWC for the mine clearing operation. b) The area to be cleared was 5 x 1 miles and the mine density was 1 per 500 yards square. c) There were no shore batteries or other Red capabilities to threaten the operation.

Systems and processes can cover wide or narrow ranges. TCT is a process within which there are many sub-processes, e.g. mensuration, and sub-systems, e.g., LAWS. MOPs can, and should, be defined for individual sub-systems and processes and for agglomerates.

Development of improved operational capabilities is a principal goal of FBEs. Measures of Effectiveness (MOEs) are determined for defined areas of interest, e.g. MIW, ASW. STOM is a broad area, encompassing several other operational areas. An MOE is a measure of how well an operation can be prosecuted compared to set goals - essentially, a measure of success. Parameters such as how rapidly an operation is concluded; the fraction of targets destroyed; how many friendly forces were lost; etc. measure success.

The data level contains two distinct types, events and context. Events are things that occur at a specific time. Description of an event requires what is happening, when, where, and who is involved. Events are associated with entities, noted as Systems, Information, Objects, and Decision Nodes. They occur at the inputs to, outputs from, and within systems. They occur at physical objects, such as a UAV moving to a location or erecting a TEL. A near continuous stream of decision-events is occurring at decision nodes such as the Battle Watch Captain.

Information is shown as a separate Event class. A sensor detecting a target is an information event. We class the detection with the sensor. Sending the detection information from the sensor to another location is an information event. It is useful to track information as packets that move through systems and processes.

Context provides the framework within which events occur. Situation and external environment are straightforward. Architecture has broad meaning. It applies to the mapping of system interconnections, organization structures, information flow, decision authorities, etc. The complete architecture provides the structure within which processes operate, and also includes definition of the processes, (rules or TTPs). A process model can be built from the complete architecture and run as a simulation. This requires having quantified parameters that define specifics of systems and processes operation.

The functioning of military processes depends significantly on the level of personnel training and experience. A measure of training levels provides an indication of the competence of those who are operating systems and making decisions and is important context. Correlations between results and prior training provide information on training needs.

Goals that have been established for an operation dictate the actions that will occur. Goals are communicated and passed down through the chain-of-command through various directives, such as Effects and Air Tasking Orders. These directives have a strong influence on how systems and processes will be operated. Goals and directives are important context.

Not all performance and capabilities information comes from data. Personnel involved in an operation will have opinions, which are valid and important sources of information. This information is included, with clear indication that it is subjective.

The triple solid lines in the figure indicate that all data and information must have associated context. An important factor, often overlooked, is that results from an experiment are only known for those situations that were examined. Context provides the range of validity for results. If one can determine cause-and-effect from an experiment it may be possible to extend results to situations other than those examined. Doing this is an important aspect of analysis and is within the Knowledge realm.

What has been defined as the Knowledge level has two distinct components:

- Cause-and-effect
- Decisions

Cause-and-effect is determined by correlating performance or capabilities results with systems and processes that were responsible for those results. Systems and/or processes are changed and the results before and after the change are determined. Unequivocal cause-and-effect can be determined if a single factor is varied (ignoring correlation between factors). Unfortunately, this is seldom possible with FBEs, several factors vary simultaneously, and one must sort influences to determine approximate cause-and-effect. The KM system allows this to be done efficiently.

The purpose of most analyses is to provide information for decision-making. As was noted above, real-time operational analysis provides information such as target tracks, using a display designed for situational awareness (COP), and an appropriate authority makes decisions and commands action. Analysis of FBE results also provides decision-enabling information, which involves predictions of operational success resulting from new systems, processes, structures, etc. These predictions lead to decisions about how to conduct future operations, including acquisition of new equipment and modification of processes.

Direct and Threaded Information and Knowledge Extraction

As with all Knowledge Management System uses, military analysis processes consist of accessing appropriate data, using it to develop information, followed by developing knowledge to be used for specific purposes. The Figure A6-1 shows two ways this is done, solid arrows indicating direct information extraction and the multi-branch line Thread analysis.

Direct extraction is used to determine the performance of specific systems or processes from data that was captured specifically for that purpose. An example is construction of detect-to-engage timelines for systems and processes within NFN. Another is tracking construction of the MTO within the JFMCC process. Having results from such analyses available as information in the KM system makes subsequent analysis of operational capabilities more efficient.

A distinct class of information is opinion. Opinions are distinct because they address performance and capabilities directly rather than being extracted from data.

All information must be associated with Context if it is to be of use (shown by triple lines in Figure A6-1). Context provides the situation that existed when data and information were obtained. It will allow one to determine limits to results validity, their range of applicability. Changes in context, with associated changes in results, are what one uses to extract cause-and-effect. Note that opinions must also be associated with Context. We have not shown Knowledge associated with Context. It may or may not be necessary to do so. An acquisition decision can stand alone, or Context may be desired because more than one acquisition may be needed to cover more than one operational Context.

Thread construction is the process used for most analyses (even the direct extraction noted above). There are two types:

- Extraction of all data and information related a topic of interest.
- Extraction of all data and information related to an event.

For both cases tools are needed to identify and extract appropriate information. Events are the easiest to reconstruct because most of the data needed can be extracted using time of occurrence. Context may not have the same time stamp because it will normally apply to a broader time range, but time association still applies.

Extraction of data related to a topic requires more extensive tools. Keyword searches are used extensively. Keywords can refer to systems, processes, and functions. If TCT is the topic of interest, keywords such as LAWS, Tomahawk, sensor management, mensuration, etc., would all apply. Each of these keywords alone would provide too broad a range of information; focus is needed. Construction of combinations of keywords and use of advanced search techniques to produce the needed focus is an analysis function.

Figure A6-1 shows thread analysis beginning at the knowledge level and working back down the hierarchy, but it can begin at any level. If performance of a system is the topic of interest, the Thread begins at that level and reaches to lower levels to acquire needed data. Military analysis is often to determine operational capabilities, for which the thread would begin at that level. It may be that appropriate MOPs are already available, if not they will be determined in the course of the analysis. MOPs will be agglomerated into operational capabilities, by calculating appropriate MOEs.

Thread analysis can be very extensive when major decisions are to be the end result, e.g. CONOP changes or acquisition. Threads begin at the knowledge level with a clear understanding of needed cause-and-effect relationships. E.g., one may be considering acquiring a particular system. The proposed operational use of the system will be known, the structures within which it will operate will be known or hypothesized, and from these types of information Threads can be constructed. A significant amount of information will be needed from all levels of the knowledge system to make the acquisition decision.

Threads can be constructed in the reverse direction. The purpose of FBEs is to evaluate operational capabilities. These results can lead to change or acquisition recommendations, by design or through a process of discovery. In this case, a thread starts at the operational capabilities level, includes data and information at lower levels, and extends upward to the knowledge level. It will often be the case that recommendations will not involve a single aspect, but be multi-factored, e.g. if a particular system is to be acquired, it will be necessary to change CONOPS in order to use it effectively. The KM system supports developing such correlations.

KM Analysis Examples

The NPS KM system provides efficient means to do the above analyses through various information extraction tools. The existing NPS system has been used extensively for FBE-J analysis, with attendant timesavings and increased results validity. The following are two examples of such analyses, including brief descriptions of methods and tools used.

Example 1: In the course of the analysis, the question arose as to the number of times that the authority for time sensitive target engagement was transferred between major commanders. The KM system was used as follows:

- All documents (1642) were searched for those that reported experimental data (1017).
- The data-related documents were searched for "TST" and "Authority".
- The KM system then displayed the context for either or both of the searched words in the relevant documents—typically documents which related to observations, reports, logs, etc. from the FBE-J experiment.
- The transfers of authority, including principals, dates, and times were quickly identified.

The total time required accomplishing this process – approximately twenty minutes.

Example 2. During the course of the analysis, it became obvious that the chat logs contained potentially significant information, but the value would typically be lost because the majority of the issues would never be reflected in formal reports. To improve the overall analysis, the chat logs were examined within the KM system. It was noted that, in general, chat logs reflect a series of "vignettes" which characterize various actions associated with the experiment. Many of these vignettes provided unusual insight into successes, frustrations, inefficiencies, and even failures within the experiment. Thus, the chat log vignettes, provided by the KM system, brought a new dimension to the formal analysis.

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Appendix 7: JFMCC SharePoint Portal Server
Final Report: Fleet Battle Experiment – Juliet

I. Observations

Objectives

The objective of web-based displays is to improve the distribution of knowledge through development of a Common Relevant Operational Picture (CROP). This includes improved situation awareness, perception of data patterns, alerting & attention management, memory augmentation for dynamic events, and situation-based data fusion.

Developing knowledge depends on dynamic, synchronous and asynchronous collaboration that changes over time. It requires adaptive information flow and team structure. In other words it depends on people, and their ability to recognize and communicate patterns. This adaptability requires a flexible interface that can be modified over time to adjust to circumstances.

The continual flow of information and the updates to situational awareness eliminate the need for traditional briefs. Current information is continually being updated, and reviews of the situation can be tied to specific alerts or trends. Providing continuous information access implies an increase in speed of command.

Each user group has different needs. This implies that web tools and concepts must be significantly scalable. The provider of information must understand his audience. But the provider cannot cover all situations or formats. So the users of information need the ability to customize on the fly, to pick and choose.

Results Summary

A web portal or content management system is at the top of the information pyramid. At the bottom lie sensors, raw data and communication networks. Next come applications that collect the data to present information. And finally comes the synthesis of information into knowledge. The top cannot exist without the bottom. When MC02 started, the entire pyramid was in place, but not functioning. It took time for the communication issues at the bottom to resolve themselves and enable the development of knowledge at the top. This is a long way of saying that SPPS reflected the knowledge within the organization during the MC02 experiment. As communication problems were resolved and people learned how to use the tools, knowledge increased and was reflected on SPPS.

SharePoint Portal Server (SPPS) was a valuable tool for knowledge management. The right data got to the right user at the right time. Specifically, the data could be found (search capabilities), the data were current (no other versions), and the data were authoritative (could be trusted). It provided users with a customizable web portal that was a single source of data for storage and retrieval. SPPS was the one collaborative tool where Warfare Commanders and others could publish their data for JFMCC-wide use. SPPS enabled the dispersed and estranged JFMCC organization to coalesce rapidly, and engage the enemy.

Hit counter data shows that in the first few days of the experiment, each major page was viewed 250 to 1000 times per day as users explored the portals content. Then there was a steady decline to about 100 hits per page. Pending further analysis, early indications are that users were figuring out where to find the data they needed and were spending less time “surfing”. During this same time there was an increasing use of the Search page starting at about 500 hits per day and increasing to over 1000 hits per day. It appears that as the volume of data increased, users became more familiar with the Search functionality and found it faster than "surfing". This ability to successfully search the web site is at the heart of a web portal's value. Subscriptions would have further improved users abilities to get timely data had we had more time to implement this function (more discussion on this later).

An important note about the JFMCC Portal is that it was not real-time. Its data often lagged the battlefield by hours, unlike IWS, ADOCS, and GCCS where the war was being fought. SPPS contained analysis and "knowledge" that reflected long-term trends and the direction of the JFMCC. Many of the web pages could be automated to make the information near-real time.

Each component commander (JFACC, JFMCC, JFLCC, etc.) had a different implementation of SPPS that varied by organization, content and functionality. The JFMCC implementation was adapted from the Knowledge Web (KWeb) and used in Operation Enduring Freedom by CARGRU 3. This design, first developed and tested by SPAWAR during Global 2000, organizes the portal by warfare areas and major activities. Each page includes functionality for communicating status through the use of stoplights. These stoplights are linked to a composite page that shows the overall health of the JFMCC. Comments from the other components indicate that users found this organization easiest to use.

For the Navy, SPPS may have had the added advantage of demonstrating a bridge between Collaboration at Sea (CAS) and KWeb. It merges the document storage and retrieval functionality of CAS, with the user interface of KWeb. (Since SPPS is customizable, interfaces other than KWeb could have been designed).

This is the first version of SPPS. While sporting lots of features, its simplicity and easy customization made it an ideal choice for demonstrating the power of web portals. It also showed the potential of Content Management software. A good overview of CM software is located at http://www.cmswatch.com. This site lists many of the large enterprise and upper tier packages. The following list is provided to show the breadth of software available:

Enterprise platforms. Large-scale packages that are meant to scale across an enterprise. These run over quarter of a million dollars.

- Vignette - V/6 Content Management Suite*
- Documentum - 4I WCM Edition*
- Broadvision - One-To-One Publishing
- Divine - (OpenMarket) Content Server*
- Interwoven - TeamSite*

Upper Tier. These packages target large departments and corporations; expect base licensing of less than $200k for most implementations.

- Stellent - Stellent Content Management Suite*
- Percussion - Rhythmyx 4.0*
- Microsoft - Content Management Server*
- FatWire - UpdateEngine6*
- FileNET - eGrail (now FileNET)*
- Gauss - Interprise VIP Enterprise Content Management Platform
- Enigma - Insight*
- Day - Communiqué*
- Tridion – DialogServer

These products have more features for improved reliability, security, accessibility, functionality, etc. that are necessary for large-scale implementations of critical data.

Due to the limited duration of FBE-J, SPPS lacked some production features that would be required for real-world implementations. The first was configuration control. The functionality demonstrated on the JFMCC site required the modification of several core SPPS files. The modification of these files was uncontrolled and irreversible (without saving copies of the original) due to temporary value of the code. Large-scale implementations would require strategies and utilities to make each web part self contained. Given more time and resources, an extensive web part gallery similar to JFCOMs could have been developed.

The other weakness in the FBE-J implementation was the lack of standard tools for managing security. Managing security is labor intensive and leads to its disuse. Each page must be checked individually. In addition, there is no easy way to audit and document security settings, or to track any changes.

It is also important to note that some of the functionality on the JFMCC site was developed using Cold Fusion, SQL Server, and VB Script. This is noteworthy because SPPS achieves its simplicity by providing a web template with limited functionality. As users began to demand greater sophistication, developers began to break out of the SPPS template. Once this begins to happen, more powerful tools, such as InterDev or Dream Weaver, should be used for efficient page design and development.

Findings and Recommendations

- SPPS worked well for storing and retrieving data. Basic functions worked well and were easy to learn and use.
- As a web based tool, it can be accessed from anywhere and easily modified.
- SPPS was under-utilized! Due to several problems, many SPPS features were not used, including subscriptions and enhanced folders (versions and publishing). FBE-J did not test the full potential of SPPS.
    - The first problem was that we were learning the software along with the users. We were not able to field a robust implementation ahead of users. They were encountering problems as fast as we were fielding features. In the future, an administrator billet should be assigned to each group that is responsible for training and administering SPPS. This person can set up privileges and help with the daily administration of the software.
    - The second problem was a lack of sophisticated documentation. Most of the available documentation was simplistic and obvious. One week prior to Execution, we finally found the book "Microsoft SharePoint Portal Server", by Kevin Laahs, Emer McKenna, and Don Vickers, published in 2002 by Digital Press. It documents the guts of SPPS and is essential to achieving its full potential. This book is essential and should come with the software!
    - Third, users were under a non-stop time crunch to execute the game scenario (no breaks). In this environment users were reluctant to innovate or try something new.
- SPPS was not integrated with other collaborative tools. Users were either working in IWS or working on SPPS, never both. The difficulty in linking these applications stems from the proprietary nature of IWS. If IWS authentication was integrated with Windows NT authentication, integration would be simpler. Some ideas include:
    - An icon displayed in SPPS next to a document being discussed in IWS. Click on the icon to enter the discussion.
    - Link SPPS documents through IWS. The file cabinet in IWS would be replaced with the Document Library in SPPS.
    - IWS Chat rooms could be integral to SPPS pages. Go to the Strike web page and view the IWS chat in progress.
- SPPS competed for attention. There were too many applications trying to get users attention and not enough screen real estate to show them all. SPPS was often competing with

ADOCS, IWS, SPPS, email, Chat, and IP Phones. Data needs to be coming through a common medium. SPPS is the most flexible application available and provides the best platform for integration through the use of web parts.

- There were many flows of information including asynchronous & synchronous, push & pull. The experiment did not run long enough to determine which systems were best in different circumstances. For instance, could the IWS/SPPS combination eliminate the need for phones/email. During FBE-J users initially struggled with IWS/SPPS, then settled back into the familiar use of email and phones.
- Too many documents published multiple times. It was not until Execution that Office XP was installed. This made it simpler to use a link rather than simply copying the document again. After Spiral 3, an inventory of the contents revealed a lot of duplication. During Execution, the situation improved dramatically.
- SPPS is sensitive to browser and server configurations. SPPS runs best on Internet Explorer 5.5. It will not work well with Netscape Navigator due to the lack of ActiveX Controls. The browser settings for proxy, and local network are critical to performance. IIS settings for Anonymous User, Proxy, etc must be right. Installing Office XP adds the ActiveX controls required for browser integration with the other Office Applications (like the Outlook Calendar) and is a must!
- Extensive reliance on ActiveX controls. The use of ActiveX controls is generally considered a security hole because it enables the web page to modify files and registry settings on the user's computer. The Browser is no longer a read-only application. But this is what enables the integration of SPPS with the Windows environment and Office applications.

II. Design Guidelines

- Web pages were arranged by organization. People, especially in the military, know who owns what data. This is a natural organization and reinforces command and control. It also aids authors in the early days to know where they can put data. (Users are hesitant to publish data on pages they don't own).
- All pages display a focal's name with email link if possible. This enables users to quickly correct problems and ask questions for data. While not universally implemented, this is one of those things that improve over time as PWCs take ownership of their pages.
- The Help link at the top of each page was tied to a help Section rather than the MS boilerplate pages.
- Standard web parts were put on each page to demonstrate the capabilities of SPPS to users.
- Status – stop light to provide status.
- Document library list – showing the contents of the folder for the same page.
- Image – to provide a visual depiction of status, if appropriate.
- Banner – to alert users to significant situations or events.
- Web Links – to give users a simple place to collect links.
- Link to Group Folder – linked to the folder for the same page.
- All the data in the document library was accessible on a web page. This prevents data from getting lost and accumulating in forgotten folders.
- Page size was limited to a single screen size of 1024 x 768. It is tempting to put more data on a page, but many studies have shown that most users do not scroll down. Since SPPS web parts can have an expanded or collapsed state, page size can be reduced and usability can be improved by choosing a "collapsed" default.
- Load time was limited to 5-7 seconds. This was not scientific, but a general rule. Pages that take too long to load are termed "heavy". One strategy to reduce the weight of a page is to build a link to the data (like the calendar) and have it pop up in its own window. This reduces load time and allows users to choose whether they want to see this data.

- Use of links to reduce duplication of data. This was difficult to enforce. Users need to get used to building links to data they find useful, not copying it. Linking to the original data ensures the data are always current. More importantly it avoids duplication of the data in the Portal. Duplication is a problem because the Search function returns multiple documents, and the user has no way of knowing which one is the original that will be maintained.
- Folder Hierarchy matched web pages and matched organizations. Folders need clear owners or the data rapidly multiplies without accountability. There needs to be a long term way to archive data. The best way is to have clear owners that can clean out their folders.

III. Review of JFMCC Web Pages

- Pages were changed several times throughout the experiment as users asked for additional data, or as it became clear that certain areas were not being used. Screen shots are available if requested. Screen shots of the pages are available.
- JFMCC Home. This page contained information critical to all JFMCC users. It included the FBE-J Status, links to the Outlook Calendar and Personal Dashboards, links to other component commanders, MC02 news updates, Phone lists and General Administration.
- Warfighting. The Warfighting page was modeled after KWeb and was a composite status of all the PWCs and several other critical areas of concern. This page automatically updated periodically and is one reason it had so many hits. The following is a list of sub-pages (tabs): AAWC, AMWC, JFMCC, IWC, MIWC, SCC, STWC, Plans, Coalition, Intel, KM-CIE, Logistics, Metoc, ROE-JAG, and Targets.
- Applications. The applications tab was the gateway for all the Maritime Planning Process tools as well as other JFMCC applications. This provided a one-stop shop to find all the applications users needed. If we could have figured it out, we would have added ADOCS and IWS so we didn't need to find them on the desktop. Applications included ONA, TAP-VSS, ETO, MOD, MARSUPREQ, MMAP, MTO, JATF, Intel Queries, UAV, JTF RFI Database, MPSS, FitRep, WNN and NSS. UAV really belonged in the Warfighting area but was too hard to move.
- Calendar. This was a Public Outlook calendar that had many of the MC02 scheduled events. In general users were unaware of how to update this calendar and it lacked critical data.
- Help. This was a number of tabs designed to help users. It included a Trouble Log for entering and reviewing problems (written in Cold Fusion). It also included an automatic network status matrix using What'sUp Gold. Given more time, it would have been interesting to try a discussion group and FAQ Section. This could have been facilitated by the Help group and been used to reduce phone traffic, as well as resolve and record more complex problems. This would have been especially useful if there had been lots of administrators distributed to the PWCs and groups
- Personal Dashboards were enabled but not used. Mainly because there were not needed. Most people were suffering from information overload and didn't want to create another view of the data. The button was out there and it was only clicked 5 times. A robust Web Part Gallery could have provided more incentive and functionality.

IV. Configuration & Features

SPPS Service Pack 1. Service Pack 1 provides significant performance enhancements. Specifically its ability to render pages based on cached data accelerates page rendering ten-fold. During Spiral 3, Service Pack 1 was overwritten during the restore process. It turns out that moving a Workspace from one server to another copies the Service Pack level. We built the initial workspace on a non-SP1 server. When the workspace was transferred to CORONADO, the process converted that server to a non-SP1 configuration. This problem was not recognized until preparations for Execution. SP1 was reinstalled and the performance (and user satisfaction) was noticeably better. Many of the problems associated with lack of bandwidth disappeared.

Office XP Installed. Office XP was installed on half the PCs during Spiral 3 (the JFCOM laptops) and all the PCs during Execution. Office XP installs all the Active X controls needed to make SPPS perform at its best. Specifically it enables the integration of other Office applications, and the Windows 2000 OS. For example, users can view an Outlook Calendar or Inbox. (Some Office 2000 installs come with the Outlook viewer ActiveX control as well). Without it, the user has to launch the application separately. Another example is the updating of files. With Office XP the process is streamlined through the integration of Windows Explorer folders and browse functions**.**

Internet Explorer 5.5. SPPS is advertised to work with IE 4.5 or greater and Netscape Navigator. However this is only for Readers. For full functionality as an Author or Coordinator, SPPS requires IE 5.5. Netscape Navigator will not work because it does not recognize ActiveX controls. This also means it will not display pages built with integrated Office Applications like Outlook Calendars**.**

Coordinator Permissions – Everyone Group. Initially users were allowed maximum freedom to use SPPS in the FBE experimental setting. Then midway through Spiral 3, as focals were identified and user accounts stabilized, we began trying to limit user's privileges. Several problems immediately surfaced. The biggest was an error in the server setup (caused by the way we restored SPPS) that treated all users (including administrators) as Readers. Suddenly nobody could modify their data and we were forced to reset and relax all privileges. (Errors on our configuration may have been the problem. JFCOM was able to successfully configure its security policies).

SPPS lacks powerful admin tools to manage permissions. So when we encountered permission problems, the only available solution was to use inheritance and push the privileges from the top folder. In solving the problem just mentioned, this wiped out 2 days worth of work. Using User Groups would have helped, but initially JFCOM controlled the server and was unwilling to create groups or add users to existing groups. There was also a lack of visibility as to the current permission settings. A person with admin privileges had to check the settings Page by Page. Admins should be able to print the permissions as a record at a given point in time that can be restored independently of the data. Also, the admin tools need an audit feature that shows the current privileges, recent changes, and who made them.

The other nuisance was that the security screen for each page took several minutes to load. With about 30 pages and 30 folders, it took several hours to update permissions. User Groups would have made this simpler, but assumes the pages have similar permission schemes.

The open access policy avoided all these headaches, plus had the added advantage of allowing users to innovate. The only downside was the potential for inadvertent deletion of data or the untraceable manipulation of pages. Surprisingly, this rarely occurred during the experiment. (In a real-world deployment, this would be a major concern).

The ideal solution would have been to identify an admin for each group able to provide privileges locally.

<u>Enhanced Folders</u> – OFF, Auto Publishing, No versions

The Enhanced Folders feature was turned off due to its added complexity, its lack of value (in this environment) and increased load on the network. The JFMCC and PWCs ran on a 24-hour battle rhythm, and the majority of documents were updated on a daily basis. During Spiral 3 it was noted that the status of most documents always showed “checked out”. This was because the documents were continually being updated. As soon as a document was published, it was checked out again within hours to begin the next revision cycle. The problem was that many users needed to see the last published document, not the interim update.

Users saw the interim documents because the default privilege was set to Coordinator. SPPS hides the revisions for a user that is a Reader. To make this work properly, the default user should have been a Reader, with Author and Coordinator User Groups created for each organization (PWCs, Initiatives, etc.). With about 10 groups, this would have required about 20 User Groups. In addition it was difficult to determine who the Approvers would be as accounts and people kept changing. This is another layer of complexity that points to the need for local admins that can set up the permissions tailored to meet local conditions (user expertise, security requirements, update rates, local procedures, etc.).

For this experiment, document versioning and approval lacked value. Users knew who was publishing the documents because the pages were arranged organizationally. Documents published by mistake were rapidly detected by the page owners and deleted. And because the simulation moved forward so rapidly, older versions were seldom needed, and consumed lots of memory.

The version also burdened the network. Once a document is Checked Out for revision, an open connection is maintained with the user. During Spiral 3, the sporadic reliability of the network created problems with users losing data. SPPS interpreted a loss of connection as the user logging off. The document is then reset to the last published version. The user must know to save his data to his desktop, recheck the document, and then replace the checked document with the desktop version. Most people found this recovery procedure confusing and lost their data. (With Office XP, the procedure was more straightforward).

In reviewing other SPPS web sites (JTF, JFLCC, etc.), there were only a handful of cases that used versioning.

<u>Subscriptions</u> – OFF
Subscriptions were on during part of Spiral 3, and disabled throughout Execution. This was an unintended consequence of enabling “Anonymous User” on the web server (IIS). During Spiral 3, many users had account and access problems. They were continually confronted with login screens, and their NT ID required frequent authentication by IIS and Active Directory. This was an added burden on the network and often required the user to wait while authentication was delayed. This was solved by adding jfcom.smil.mil as an intranet “sit” in the domain policies.
Enabling Anonymous Users initially solved this problem. The downside was it disabled subscriptions. The reason was that an NT ID is required by SPPS to store subscription data, and Anonymous users do not have a name SPPS can use. The trade-off was considered acceptable since few people were using subscriptions and everyone was complaining about the frequent login screens. A later change to the Internet Explorer browser solved the problem without the Anonymous User, but by then the experiment was too far along for another configuration change.

<u>Personal Dashboards</u> – ON
The idea was to allow users to make the greatest possible use of the data available. Personal Dashboards enable users to display data important to them by importing Web Parts. When users find useful data on other pages, they export the Web Part to their Desktop, and then import it to their Personal Dashboard.

An alternative is to create a Web Part Catalog for users. The web parts are collected on a "Personal Dashboard" that is referenced in the SPPS code. This is not obvious to set up, but should be tried next time. One problem in allowing reuse of web parts is that many require more coding for generalized use. As it was, many of the Web Parts required changes in variable names for use elsewhere.

Creating Personal Dashboards requires time for users to test, review, and customize for their own use. Most users were not inclined to spend their free time experimenting with the tool. Only five people tried this feature.

Categories – NOT USED
This feature was the biggest disappointment. We could easily create Categories, but could not develop Web Parts to use them. Most of the lists on the SPPS web pages were simply the contents of a folder. Categories held the potential to build lists based on subjects. Potentially, users could add a Category to a document and it would automatically show up on a web page. A simple example would have been the Phone Lists. Each group could have created a local phone directory and tagged it with the Phone Directory category. Then the home page could have listed all the documents with category Phone Directory. This scheme could have been used for the Fireside Chat, Conops, etc.

Document Discussions - Enabled
This feature enables users to add comments to documents. Unfortunately, there is no indication of the comments being made. This was intended as a collaborative tool. Users could pass the document along with comments for the author to incorporate. With all the other collaborative tools available, this feature was rarely used.

Backup and Restore

When a backup is performed, the entire workspace is captured. There are no other options, such as incremental or differential backup. The backup routine is very quick. The file size with no data in the workspace is about 400 KB. The final JFMCC workspace was on the order of 2 GB.
The backup includes all the SPPS settings and application files.

The restore option is limited to restoring the entire workspace. There is no way to restore an individual piece of data. The strategy used for recovery of data was to restore the workspace on another server, and then transfer the restored data back to the original server. Because the backup file was so large it was difficult to transfer. The typical method was to load it on a laptop hard drive and carry the laptop.

The only replication strategy is to restore SPPS to a new location. This strategy is only helpful when the information is not time sensitive and all the users are Readers. The data on the server is only as fresh as the last backup and restore procedure. Any data changed on the "replicated" server will be lost when the next restore operation is performed.

Integrated Applications

Cold Fusion and SQL Server were used to provide some additional functionality. Specifically they were used for page Hit Counters, Status of Nodes and Sites, and for the Trouble Desk Problem Entry and Reporting.

What'sUp Gold was used to show the status of various network nodes

Appendix 8: Observations, Comments, and Suggestions
Final Report: Fleet Battle Experiment – Juliet

The pages in this appendix represent a selection of observations, comments, and suggestions by participants. They have been extracted from various reports and logs. They are unedited and without context. That is:

- An expert or a journeyman may have made the comment.
- The comment may have been made before or after training.
- The comment may have been made early in the experiment before operations were smooth; later after the team gained experience; or even in a report following; etc.

When a comment appeared to have applicability to another area, it was also inserted into that area for easy reference.

The value of these insights is that a decision maker can quickly review a particular area for relevant comments from within FBE-J without needing to pour over the entire volume of logs, reports and other potential sources, and without reading the reports from all initiatives on the chance that something might apply to his/her area of interest. However, if in reading a Section something isn't of interest, it can be easily ignored, although someone else reading the same subject area may have great interest in the issue.

Where two or more comments conflict, additional consideration and study by the decision maker may be required in order to determine the most accurate course of action to resolve a problem. There is value, however, in identifying the issue as a potential problem and bringing possibly worthwhile suggestions to light.

Finally, this appendix represents only a small portion of the potential total number of observations, comments, and suggestions that are contained within the various documents associated with FBE-J. A highly experienced Naval Officer and scientist subjectively compiled it as a demonstration, based on his belief that this type of information has value to program managers, sponsors, and others who are responsible for structuring comprehensive programs and fixing extant problems.

Initi-ative	Applica-bility	Observations/Comments	Recommendations	Reference Report
Army	General	1-227 AVN was not issued the proper ALSE to conduct overwater shipboard helicopter operations. The Army unit had to borrow all their ALSE, including SV-2 survival vests, Helicopter Air Breathing Devices (HABD), anti-exposure drysuits, shipboard saltwater-activated float coats, cranials, and goggles, from JSHIP and the Marine Corps for the SWARMEX.	Recommend Army provide ALSE equipment for unit's shipboard overwater use. Additionally, recommend the Army create an ALSE Military Occupational Specialty (MOS) to maintain and distribute this equipment.	JSHIP, JT&E Report
ASW	General	ASW CUP team worked with SCC planners to optimize oceanographic data collection. Using the latest MODAS field for the operating area, the CUP team noted areas of oceanographic spatial variability and homogeneity in the operating area. They recommended only one XBT in areas of limited variability, with more collection where the environment varied most. To address temporal variability, they recommended XBT drops at sunrise, sunset, and during the day.		Baker Report
ASW	General	The WeCAN was used to effectively distribute ocean environmental data and information to decision-makers engaged in USW in a shared, collaborative, network-centric environment. The Common Undersea Picture (CUP) team provided sonar range prediction/analyses; NPMOC-SD posted MODAS gridded temperature fields; USS Fitzgerald and USS Benfold posted bathythermograph data from their XBT drops; the PC-IMAT operator at FCTCPAC SCC cell used MODAS-lite to incorporate XBT data to reanalyze the ocean temperature fields for updated sound velocity profiles and range predictions.		Baker Report
ASW	SCC	Although products were available, there were no requests for non-acoustic ASW detection products by the SCC.		Baker Report
ASW	METOC	Geotranslation posed a number of challenges to effective environmental simulation. The bathymetry and water mass data in the JSAF simulation were based on Southern California. Real life water mass data, including oceanographic data collected by fleet units participating in FBE-J, were input to JSAF. The White Cell was adjudicating from the geotranslated positions, using other bathymetry. This was frustrating to ASW forces, which believed they made valid prosecutions of OPFOR submarines based on their tactical decision aid outputs and simulation outputs, only to have them disallowed by a White Cell working in a different environment.		Baker Report

ASW	METOC	Sea state also impacted operations on several occasions. Seas were sufficient to cancel USV operations and small boat SWARMEX , both limited to seas 4 feet or less.	USVs need to be designed to be effective in sea states higher than sea state 3	Baker Report
ASW	General		Implement enhancements to MEDAL to provide easier multiple asset planning capability. Embed capabilities of NMWS into MEDAL or Common undersea picture (CUP) to provide a USW COA development tool for MIW and ASW.	MIW Quicklook Rpt
ASW	USV	The experiment was not successful in gaining contact or tracking of the target submarine due to technical problems relating to the modification of the DICASS sonobuoy sensor packages onto the USV's. USV DICASS sensors were either inoperative (no ping) or could not replicate the acoustic performance of an unmodified DICASS sonobuoy and gain contact. The problem related to the modification of the DICASS transducer for the USV. There was inadequate power and acoustic output due to 200-400 foot cable losses and impedance issues.	If a DICASS sonobuoy package is used, a re-engineering of the power source to transducer cable will be necessary to provide adequate power and acoustic output.	Bergeron-Haig Memo
ASW	USV	Another factor in not gaining contact was transducer damage due to transit and towing. Several transducers experienced damage due to high tow speeds, up to 30 knots, which they were not designed to withstand.	Lower USV repositioning speeds to limit DICASS transducer damage.	Bergeron-Haig Memo
ASW	X-CUP	The most significant limitation is the connectivity between submarines and the rest of the force. It appears that this is partly a policy issue and partly a technology issue - with current technology, submarines tradeoff continuous high bandwidth communications for stealth and freedom to operate deep.	Significant bandwidth and reliable connectivity must be assured to achieve improved ASW through the benefits of network-centricity.	ASW QL
ASW	X-CUP	The network connectivity to aircraft is a limitation. This appears to be primarily a design issue. Some tactical data links exist with ASW aircraft, but the existing communications architecture isn't designed to work with the current technology of network-centric ASW tools. Man-in-the-loop work-arounds were needed.		ASW QL

ASW	X-CUP	Chat connectivity permitted continuous and rapid information flow between all participants. There were two significant difficulties observed with Chat. First, Chat requires channel discipline to avoid transmission of bad information and to ensure uniformity of data transmission. The second difficulty concerns manning. In many cases, Chat required almost full-time attention from an operator monitoring and participating in from one to three Chat sessions (rooms) simultaneously.	Policies (i.e., doctrine or tactics, techniques, and procedures) are needed for the use of Chat tactically and for operational level C2.	ASW QL
ASW	Remote Unmanned Sensors	The size and design of the USV is critical to its ability to contribute consistently to warfighting due to seaworthiness and recoverability issues. The durability of the sensor and control systems is an issue due to their intended high operating speeds and impact of sea state that takes a toll on small boats operating remotely. Availability and maintainability issues are critical if USVs are needed in more than just the most benign sea states.		ASW QL
ASW	Extending NFN to USW	In the case of submarines, it was seen that the C2 functionality of NFNX-LAWS did add value, but that the value added would be greater if the functionality were incorporated into existing submarine weapons control systems. In the case of surface ships, including aircraft carriers (the notional location of the Sea Combat Commander), it was seen that some features of the NFNX-LAWS functionality could add value if incorporated into existing ASW tactical data systems and/or a Common Undersea Picture system.		ASW QL
ASW	Extending NFN to USW	LAWS demonstrated latency of several minutes on occasion that made it currently unacceptable for this application (compared to some existing ASW tactical command and control systems that are quicker). With training and better system understanding the operators were able to reduce the latency to an acceptable level. With improvements in bandwidth and system design the latency problem could be overcome entirely.		ASW QL
ASW	TASWC	The quality of the connectivity between the TASWC and the rest of the force was key and must have redundancy and high bandwidth.		ASW QL

ASW	Dynamic Network Mngmt	The experimental network provided the coalition force with reliable communications and enhanced bandwidth contributing to an overall improvement in battlespace awareness. At one point the DREN connection between FCTCPAC and NUWC was lost due to operator actions, and when restored, the agent-based computing environment dynamically reconfigured and automatically restored the "grid" COP for all registered users within 15 seconds. The back-up COP took 15 minutes to recognize loss of updates and manually restore.	Coalition C2 QL
ASW	Dynamic Network Mngmt	Agent-based computing is possible across secure WANS to a network-centric naval force, but requires some management of bandwidth traffic priority to ensure bottlenecks do not occur.	Coalition C2 QL
ASW	Dynamic Network Mngmt	The value of collaboration and shared awareness with other elements of the coalition ASW force encouraged tactics that maximized time connected to the grid.	Coalition C2 QL
ASW	Doctrine	The capability of near-continuous communications and fault-tolerant, dynamically reconfigurable networks in 2007 shows that there may be potential for more doctrinal flexibility in waterspace management (WSM), and a more responsive approach to manned and autonomous unmanned undersea vehicle battlespace management. The concept of a moving NOTACK area, supported by a robust and current multi-national COP, may have merit for improved ASW prosecution timelines while maintaining safety of U.S. and coalition subs.	Coalition C2 QL
ASW	Dynamic Network Mngmt	An expeditionary sensor grid with pervasive sensing needs to have a reporting scheme with a C2 node, which can package and possibly prioritize numerous contact reports (perhaps once per minute, at least for the undersea battlespace), rather than have each sensor report individually handled and routed.	Coalition C2 QL

ASW	Dynamic Network Mngmt	It is critical for all nodes of a network-centric force to not only know when connectivity is established or regained, but equally important to know when it is lost. Although agents have been able to quickly recognize and restore a network grid for data exchange, they have not been configured to support recognizing loss of connectivity. The health and status of the network-centric environment is particularly important for the employment of autonomous sensors, as well as for coalition forces, which lack the same level of grid/agent administrative support.	Coalition C2 QL
ASW	Secure Info Sharing	FBE-J architecture for agent-based coalition chat was designed to experimentally operate in a secret high coalition environment, in parallel with a U.S. chat capability, for information security reasons. Field implementation of the agent-facilitated chat capability would not be effective unless the architecture for a multi-national chat capability existed as a single integrated system, with a means to designate a user's chat stream as being U.S. only, or releasable to multi-national force, perhaps by prefacing the chat stream with a flag (/c) to indicate the text is meant for all coalition. Implementation of a dual system, air-gapped on U.S. platforms would be ineffective. C2 with coalition needs to rely on the content of the information exchange, not on the platform or system being used. Secure information sharing needs to be managed and tagged at the data level with users. U.S. enclaves on foreign ships, and foreign liaison officers are not the answer to managing information.	Coalition C2 QL
ASW	Netted Force	Significant bandwidth and reliable connectivity must be provided if we are to achieve improved ASW through the benefits of network-centricity.	ASW QL
ASW	Netted Force	Chat connectivity at several levels was utilized and created an environment of continuous and rapid information flow between all assets that markedly improved individual capability. It requires channel discipline to avoid transmission of misinformation and to ensure uniformity of data transmission.	ASW QL

ASW	Netted Force	Collaborative planning tools are a powerful way to focus the ASW assets for methodical and optimized search. Additionally, they have the potential to rapidly re-direct the force as conditions change. A large investment is needed to fully develop these tools to achieve their full potential.		ASW QL
ASW	USV	The size and design of the USV is critical to its ability to contribute consistently to war fighting due to sea worthiness and recoverability issues. The durability of the sensor and control systems is an issue due to their high operating speeds and impact of sea state, which take a toll on small boats and their remote operations that make maintenance difficult.		ASW QL
ASW	JFMCC	The laws system demonstrated latency of several minutes on occasion that made it currently unacceptable for this application. With training and better system understanding the operators were able to reduce the latency to an acceptable level.	With improvements in bandwidth and system design the latency problem could be overcome entirely.	ASW QL
ASW	Netted Force	The concept of using an engagement system like LAWS has potential for ASW. These C2 systems could be incorporated into the common undersea picture and be fully integrated for simplicity of operations.		ASW QL
ASW	Netted Force	The TASWC was used exclusively in the role of planner and operational analyst to the SCC at a remote site in Pearl Harbor. It was not investigated whether CTF-12 would have been capable of serving as the ASWC and controlling local forces if the SCC had not been on station at the outset of the experiment.	This capability requires additional analysis and experimentation.	ASW QL
ASW	Netted Force	The quality of the connectivity between the TASWC and the rest of the force was key and must have redundancy and high bandwidth.		ASW QL
ASW	Netted Force	The same tools that are available at the SCC/ASWC must be available at the TASWC. During the experiment CTF12 was able to provide significant direct support for planning and operations to CDS 9/SCC that was used extensively in the ASW campaign. The recommendations were immediately understood and useable because of the commonality of the tools. Because SCC was fully familiar with the products, he knew what to request and expect.		ASW QL

ASW	General	FBE J simulation architecture was fully integrated with MC 02 architecture that federated over 50 different models from all services. As a result, there were discontinuities in the COP and simulation interactions, which precluded fighting Naval Forces at the tactical level.		ASW QL
ASW	General	MC 02 utilized a fully interactive OPFOR in a two-sided game. The simulation and COP limitations for both RED and BLUE did not support realistic interactions solely based on modeled outcomes and as a result, extensive adjudication by a WHITE cell was required.		ASW QL
ASW	General	The experimental network provided the joint task force with reliable communications and enhanced bandwidth, contributing to an overall improvement in Battlespace awareness. The warfighter's ability to monitor and dynamically change the network bandwidth allocation proved significant.		ASW QL
ASW	General	The virtual SSGN effectively demonstrated both large volume sub-surface Fires and time-critical strike capability from a submerged, relatively stealthy platform.		ASW QL
ASW	HSV	The C4I suite is adequate.	Circuits should be fully operational for NSW operations: 4 SATCOM channels are optimal, 2 channels are the minimum; 6 UHF/VHF channels are optimal with 3 minimum. All circuits should be thoroughly tested to ensure minimal interference with other ships' electronics and optimum placement.	HSV STOM MIW Summary
ASW	HSV	HSV method of launching and recovering small boats (RHIBs and SDV) is unsatisfactory. HSV method of using the hydraulic crane for the launching and recovery of small boats is inefficient, slow, and not optimally safe.	A combination of a stern ramp and a deck cradle system would enhance all aspects of small boat operations.	HSV STOM MIW Summary
ASW	HSV		A two spot helicopter deck to accommodate the launching and recovery of 2 HH-60 helicopters is needed. Additionally a helicopter maintenance bay is recommended to allow continuous operations at sea.	HSV STOM MIW Summary
ASW	General	The degree to which a collaborative or situational awareness tool is valuable depends on the consistency, accuracy and timeliness of the information it displays.		JFI Analysis

ASW	Exercises	One of the SWARMEX objectives was to complete a successful joint helicopter live-fire exercise. Had JSHIP not pursued use of live ordnance, only inert ordnance would have been allowed, due to the Navy ordnance community's resistance to using live USA/USAF ordnance on ships, degrading a major test event. In addition, the USMC test to validate their hot loading checklist was restricted to inert ordnance only. This test was permeated with an attitude that is typical of all services toward inert ordnance, and is incompatible with live ordnance operations. Hence, observations confirmed that valid procedural tests require live ordnance for meaningful application of the data to live ordnance operations. Additionally, "live-fire" exercises like the MC 02 SWARMEX require live ordnance.	Recommend that live ordnance be used to validate loading procedures whenever possible. Based on over three years of joint ordnance testing, JSHIP has seen a marked difference in testing of live and inert ordnance — live ordnance adds an element of realism, and added command presence and attention that is difficult to simulate or garner with inert ordnance.	JSHIP, JT&E Report
ASW	SLD	The ASW Commander may prefer to have SLDs report less frequently to conserve limited number of devices.	It would be useful to command prompt SLD reports rather than only have reports at predetermined intervals.	Pilnick ASW report
ASW	SLD	ASW Commander may prefer to have SLDs report at greater frequency in order to have less time-late for a subsequent prosecution, or timely information that a particular area is free of enemy submarines.	Specific procedures need to be developed for SLD reporting responsibilities and methods.	Pilnick ASW report
ASW	SLD	Most SLD reports did not result in command actions, other than recording the positions reported. SCC staff considered periodic reports from the SLD as sufficient information on those enemy submarine locations, and chose to assign their blue ASW assets to search for unlocated or unreported enemy submarines.	Specific procedures need to be developed for SLD reporting responsibilities and methods.	Pilnick ASW report
ASW	SLD	If a Blue force asset is assigned to respond to every SLD signal, there is a concern that this may compromise the intelligence.	It may be possible to use SLD reports in conjunction with other ASW contact information to give a better situational awareness picture.	Pilnick ASW report
ASW	SLD		A P-3C is the preferred asset to have in the air on-station for SLD transmissions due to its long range and long on-station capability. It is not advisable to have a helo launched in anticipation of SLD reports due to the short on-station time of a helo.	Pilnick ASW report
ASW	ADS		Procedures should exist for the ASW Commander to request ADS field deployment via the JFMCC.	Pilnick ASW report
ASW	USV		SCC should pass TACON of the USVs to a surface ship for control like Maritime Patrol Aircraft or ASW helicopters.	Pilnick ASW report

ASW	USV	The Roboski-sized USV could not effectively be used in sea states greater than 3. The Spartan-sized USV was successfully operated up to sea state 4	USVs need to be capable of operations in sea states higher than sea state 3	Pilnick ASW report
ASW	USV	USV DICASS sensors were inoperative or could not replicate the acoustic performance of an unmodified DICASS buoy. These comparisons were made on a daily basis with aircraft dropped sonobuoys. The difficulties encountered related to the engineering of the DICASS transducer, with its power source located aboard the USV. While an unmodified DICASS transducer is a one-piece assembly with a lithium battery in close proximity to the transducer, the USV power source involved a 200' or 400' cable between the battery and transducer. As such, inadequate power and acoustic output resulted due to impedance issues.	Should the DICASS package be used in future FBEs, a re-engineering of the power source to transducer assembly will be required, and this modification tested against the performance of an unmodified DICASS buoy	Pilnick ASW report
ASW	USV	The transducers also experienced damage during transit and towing, due to high tow speeds, up to 30 knots, which they were not designed to withstand.	USV transit and towing speeds must be lowered to limit DICASS transducer damage. Operationally however, high-speed capability is needed for the missions envisioned for USVs. The possibility exists that an alternate sensor package needs to be considered.	Pilnick ASW report
ASW	USV	It was necessary to physically modify the cable lengths for the USV sensors because of acoustic propagation conditions.	There is a need for selective transducer depth for USV sensors.	Pilnick ASW report
ASW	USV	The unmanned surface vessel (USV), remote autonomous sensor, concept has merit to work in areas where air ASW assets cannot fly due to the anti-air threat level encountered and where water may be too shallow for deep water combatants to effectively maneuver.		Pilnick ASW report
ASW	USV	The USV keeps manned units out of range of threat ASW contacts.		Pilnick ASW report
ASW	General		Innovative connectivity via UAVs, lighter-than-air vehicles, satellites, etc. should be considered.	Pilnick ASW report
ASW	USV		USV CONOPS should be developed for wide area ASW search.	Pilnick ASW report
ASW	CUP	Parts of the undersea picture resided in several different systems that weren't integrated. Not all of the participants had the proper systems.		Pilnick ASW report
ASW	C2	Chat functions at several levels can improve data and information flow, but chat discipline is necessary to avoid misinformation flow.		Pilnick ASW report

ASW	C2		Inclusion of attack C2 functionalities (similar to some contained in LAWS) would be a valuable addition to ASW CUP tool set.	Pilnick ASW report
ASW	METOC	The Sonar Performance Prediction (SPP) Tools gave some awareness of the environment. The AMAT search coverage diagrams conveyed how effective the coverage could be and the Cumulative Detection Probability (CDP) curves gave the planners the ability to perform asset allocation and time trade-offs.		Pilnick ASW report
ASW	METOC	AMAT was used to determine the placement of assets, the number of assets required and the duration of the search. They indicated that the information was very important to the planning process and to the actual operations (to a lesser extent).	It needs to be installed on ships and SCC modules and personnel trained to use it.	Pilnick ASW report
ASW	C2	The length of time it took the computer to generate a search plans was too long.		Pilnick ASW report
ASW	CUP	At the operational level the X-CUP tools were of limited use because of the artificial tactical picture set-up of the exercise. The exercise forced a non-integrated GCCS-M picture and WeCAN to be used rather than an integrated Link 11/16 based picture. As a result the tools designed for real-time situational awareness really had nothing to work on		Pilnick ASW report
ASW	General	The GCCS-M track feed was the least useful capability in AMAT; this data could not be effectively transferred between units and obfuscated rather than clarified the situation. Lack of a track manager hindered SCC operations.		Pilnick ASW report
ASW	METOC	AMAT plan is linked to a specific unit. Given that ships can be re-assigned, this linkage is too strong.	AMAT planning tools need to be more flexible.	Pilnick ASW report
ASW	CUP	In the chat rooms, data are available from multiple sources and there was no clear sense of the overall picture of what was going on with enemy submarines.	SCC Watch Officer needs a clear battlespace picture available to him at his console. Primary and secondary lines of communication for battlespace awareness need to be delineated.	Pilnick ASW report
ASW	C2	The SCC large display (DBC system) did not match the MIWC large display. The DBC large screen displays did not display information useful to the SCC watch. It was used more for projecting PowerPoint briefings than for tactical or operational display.		Pilnick ASW report

ASW		WeCAN (Web-Centric ASW Network) is normally a distributed server but was restricted to a single site for FBE-J. This connection failed occasionally and all connectivity was lost.	Backup systems need to be identified.	Pilnick ASW report
ASW	General	Firewalls were also a problem.	Backup systems need to be identified.	Pilnick ASW report
ASW	C2	Engagement direction was interrupted in more than one instance by WeCAN failure.	Backup systems need to be identified.	Pilnick ASW report
ASW	C2	The loss of SATCOM (K band) resulted in the net going down; this was observed in a non-hostile EW environment.	System vulnerabilities need to be explored in hostile EW environments.	Pilnick ASW report
ASW	C2	Bandwidth limitations underway using EHF medium data rate through a 5.5 inch antenna precluded access to SPPS. Result was degraded crew situational awareness.		Pilnick ASW report
ASW	CUP	MIW Q-routes were not displayed on AMAT or other X-CUP displays.		Pilnick ASW report
ASW	General	TSC feedback from the TSC WO, ASW Analysis LPO and TACCOs indicated that the information provided by PC-IMAT and SIIP was used and useful. AMAT provided another way to communicate planning information like aircraft schedule, status, call signs, and buoy load-outs.		Pilnick ASW report
ASW	CUP		Waterspace Management (WSM) tools and procedures need to be incorporated into an automated system within the Common Undersea Picture, as well as into USW target engagement command and control architectures.	Pilnick ASW report
ASW	C2	The need for submarine communications at speed and depth has been emphasized for purposes of Waterspace Management. Being able to locate any blue sub instantaneously will pay huge benefits.		Pilnick ASW report
ASW	C2	CTF-12 did not have access to the entire network systems shared by local participants such as Info Workspace and the SharePointPortalServer due to network connection problems.		Pilnick ASW report
ASW	C2		All ASW platforms need fully integrated sensor-weapons control-tactical data systems, capable of high-data-rate, network communications that are fully interoperable with common operational picture systems at all levels of the chain of command. The functionality of NFN (X)/LAWS needs to be integrated with their existing systems. NFN (X)/LAWS itself isn’t the answer.	Pilnick ASW report

ASW	C2		LAWS must be seamlessly integrated with the SSGN Attack Weapons System.	Pilnick ASW report
ASW	C2		If the remote sensors cannot provide attack criteria, then incorporating them into the NFN is a mistake.	Pilnick ASW report
ASW	C2		Inclusion of attack C2 functionalities (similar to some contained in LAWS) would be a valuable addition to ASW CUP tool set.	Pilnick ASW report
ASW	C2		The distinctions between the ASW process of cueing-to-prosecution, and the Fires process of sensor-to-shooter need more thought.	Pilnick ASW report
ASW	C2	For the blue submarine, communications connectivity for NFN (X)/LAWS is inadequate. This could be due to signal propagation and bandwidth issues.	Blue Submarine units also need to be better integrated. This is both a bandwidth and combat system integration issue.	Pilnick ASW report
ASW	C2	The time required to get data entered into LAWS and then receive an engagement order resulted in a loss of attack criteria whether or not the unit in contact was ship or air.		Pilnick ASW report
ASW	C2	Common tools, networked to common sources of data, did indeed support distributed collaborative planning and a shared common understanding of the undersea acoustic environment. Tools also permitted planning of optimal search patterns and monitoring of the search plan execution.		Pilnick ASW report
ASW	C2	Realization of the full potential of network-centricity is limited by some fundamental technology/design/policy restrictions. The most significant limitation is the connectivity between submarines and the rest of the force. This is partly a policy issue and partly a technology issue – with current technology, submarines tradeoff continuous high bandwidth communications for stealth and freedom to operate deep.	Significant bandwidth and reliable connectivity must be assured to achieve improved ASW through the benefits of network-centricity.	Pilnick ASW report
ASW	C2	Chat connectivity at several levels was utilized and created an environment of continuous and rapid information flow between all participants.	Chat requires channel discipline to avoid transmission of bad information and to ensure uniformity of data transmission. Some policies (i.e., doctrine or tactics, techniques, and procedures) are needed for the use of Chat tactically and for operational level C2. Chat required almost full-time attention from an operator monitoring and participating in from one to three Chat sessions (rooms) simultaneously.	Pilnick ASW report
ASW	C2	The ability to identify a critical location in an expected choke point and install a sensor field unknown to the enemy submarine force contributed to the successful use of the ADS field.		Pilnick ASW report

ASW	C2	The ability to coordinate USVs with surface and air ASW platforms was demonstrated, but USVs and their sensors did not function as designed due to a combination of prototype equipment limitations and acoustic environmental conditions. The size and design of the USV is critical to its ability to contribute consistently to warfighting due to seaworthiness and recoverability issues. The durability of the sensor and control systems is an issue due to their intended high operating speeds and impact of sea state that takes a toll on small boats operating remotely.		Pilnick ASW report
ASW	C2	LAWS demonstrated latency of several minutes on occasion that made it currently unacceptable for this application.		Pilnick ASW report
ASW	C2	The TASWC provided significant direct support for ASW planning from a rear Headquarters in Hawaii. TASWC was fully connected to the SCC with the Experimental Common Undersea Picture tool set. TASWC recommendations were immediately understood and useable.		Pilnick ASW report
C3	HSV	The JV HSV C4I space is not currently the "heartbeat" of the ship.	SPECWAR TOC (Tactical Operations Center) and C4I should be together for SA.	HSV STOM MIW Summary
C3	HSV	The video feed of the P3 FLIR camera was invaluable in the planning and the execution of the series of VBSS (Visit, Board, Search and Seizure) Operations; the feed was displayed in the C4I suite on one of the Large Screen Displays and provided a large degree of SA.		HSV STOM MIW Summary
C3	HSV	The communication between the ship's bridge and the C4I suite is cumbersome at best. The information is currently relayed via a hand held radio.	Provide the location data that the P3 is providing, into GCCS.	HSV STOM MIW Summary
C3	HSV	Information from the C4I space to the bridge is unsecured. Communication from bridge to C4I space has to be reevaluated both in terms of space design, location, and architecture.		HSV STOM MIW Summary
C3	HSV	The transition from MIW operations to NSW operations was virtually seamless and transparent. The same JV HSV C4I space can be and was utilized by both commanders.		HSV STOM MIW Summary

C3	General	During initial planning, JSHIP had to request a waiver for the UH-60L in order to conduct class III flight deck and hangar operations onboard USS BOXER. NAVAIR Aircraft Launch and Recovery Equipment program (PMA 251) has approved UH-60A, MH-60K, and more recently the MH-60S aircraft for this level of operations. All three of these helicopters are very similar to the UH-60L.	Recommend NAVAIR Aircraft Launch and Recovery Equipment program (PMA 251) approve UH-60L aircraft for class III flight deck and hangar operations aboard LHD class ships.	JSHIP, JT&E Report
C3		No process is in place to inform embarked units or ships of reclassification of ammunition. A Notice of Ammunition Reclassification (NAR) is issued when the class (serviceable, not serviceable, etc.) of specific lots of ordnance has changed. Current NARs must be received by units and ammunition storage facilities to ensure proper disposition of the affected lots. When a NAR is issued against a USA/USAF lot, it is sent from the Ammunition Supply Point (ASP) to the receiving unit. If the unit and the ammunition are embarked, there is no process to ensure the NAR also goes to the ship or has in fact been received by the unit. It is imperative the ship receive the NAR as it is the storage facility for the ammunition and is responsible for its proper disposition until it is received by the unit on the flight deck. For MC 02, an ad hoc arrangement was made where a JSHIP rep ashore would check daily with the ASP for NARs on the lots of embarked ammunition. If a NAR was issued, the JSHIP rep would then notify SURFPAC to forward this info to the ship. This worked for the exercise, but a permanent solution is required.	Recommend the Joint Ordnance Commander's Group (JOCG) assess this problem and work to establish a standard process for shipboard notification of joint ammunition reclassifications.	JSHIP, JT&E Report
C3	Exercises	One of the SWARMEX objectives was to complete a successful joint helicopter live-fire exercise. Had JSHIP not pursued use of live ordnance, only inert ordnance would have been allowed, due to the Navy ordnance community's resistance to using live USA/USAF ordnance on ships, degrading a major test event. In addition, the USMC test to validate their hot loading checklist was restricted to inert ordnance only. This test was permeated with an attitude that is typical of all services toward inert ordnance, and is incompatible with live ordnance operations. Hence, observations confirmed that valid procedural tests require live ordnance for meaningful application of the data to live ordnance operations. Additionally, "live-fire" exercises like the MC 02 SWARMEX require live ordnance.	Recommend that live ordnance be used to validate loading procedures whenever possible. Based on over three years of joint ordnance testing, JSHIP has seen a marked difference in testing of live and inert ordnance — live ordnance adds an element of realism, and added command presence and attention that is difficult to simulate or garner with inert ordnance.	JSHIP, JT&E Report

Coalition C2	General		SCC should pass TACON of the USVs to a surface ship for control like Maritime Patrol Aircraft or ASW helicopters.	Pilnick ASW report
Coalition C2	ASW	The unmanned surface vessel (USV), remote autonomous sensor, concept has merit to work in areas where air ASW assets cannot fly due to the anti-air threat level encountered and where water may be too shallow for deep water combatants to effectively maneuver.		Pilnick ASW report
Coalition C2	ASW	The USV keeps manned units out of range of threat ASW contacts.		Pilnick ASW report
Coalition C2	General		Innovative connectivity via UAVs, lighter-than-air vehicles, satellites, etc. should be considered.	Pilnick ASW report
Coalition C2	General		USV CONOPS should be developed for wide area ASW search.	Pilnick ASW report
Coalition C2	General	Parts of the undersea picture resided in several different systems that weren't integrated. Not all of the participants had the proper systems.		Pilnick ASW report
Coalition C2	METOC	AMAT was used to determine the placement of assets, the number of assets required and the duration of the search. They indicated that the information was very important to the planning process and to the actual operations (to a lesser extent).	It needs to be installed on ships and SCC modules and personnel trained to use it.	Pilnick ASW report
Coalition C2	ASW	The length of time it took the computer to generate a search plans was too long.		Pilnick ASW report
Coalition C2	ASW	At the operational level the X-CUP tools were of limited use because of the artificial tactical picture set-up of the exercise. The exercise forced a non-integrated GCCS-M picture and WeCAN to be used rather than an integrated Link 11/16 based picture. As a result the tools designed for real-time situational awareness really had nothing to work on		Pilnick ASW report
Coalition C2	General	Firewalls were also a problem.	Backup systems need to be identified.	Pilnick ASW report
Coalition C2	C2	Engagement direction was interrupted in more than one instance by WeCAN failure.	Backup systems need to be identified.	Pilnick ASW report
Coalition C2	C2	The loss of SATCOM (K band) resulted in the net going down; this was observed in a non-hostile EW environment.	System vulnerabilities need to be explored in hostile EW environments.	Pilnick ASW report
Coalition C2	CUP	MIW Q-routes were not displayed on AMAT or other X-CUP displays.		Pilnick ASW report

Coalition C2	CUP		For the SCC to coordinate waterspace assignments for blue Subs, all MARSUPREQs must be chopped by SCC planners before approval by JFMCC. SCC must work closely with JFMCC during MTO development to ensure the WSM plan supports the final product.	Pilnick ASW report
Coalition C2	C2	The need for submarine communications at speed and depth has been emphasized for purposes of Waterspace Management. Being able to locate any blue sub instantaneously will pay huge benefits.		Pilnick ASW report
Coalition C2	C2	CTF-12 did not have access to the entire network systems shared by local participants such as Info Workspace and the SharePointPortalServer due to network connection problems.		Pilnick ASW report
Coalition C2	C2	Common tools, networked to common sources of data, did indeed support distributed collaborative planning and a shared common understanding of the undersea acoustic environment. Tools also permitted planning of optimal search patterns and monitoring of the search plan execution.		Pilnick ASW report
Coalition C3	Interoper. C2 Syst	Agents were extremely effective in restoring c2 functionality after connectivity losses.		Coalition C2 QL
Coalition C3	Interoper. C2 Syst	Operations and planning on separate siprnet and coalition wan environments still presents obstacles for highly effective integration of coalition forces, particularly if the jfmcc planning process used in fbe-j is adopted.		Coalition C2 QL
Coalition C3	Interoper. C2 Syst	Foreign disclosure and multi-level security issues were not adequately addressed by smart agents, although agents can provide limited protection from inadvertent disclosure in a collaborative chat environment.		Coalition C2 QL
Coalition C3	Interoper. C2 Syst	The current internet protocol-based system handles tracks as first-in/first-out, which is particularly inefficient for speed of command, especially for reports from disadvantaged communications nodes such as submarines, UUVs, and other autonomous/remote sensors.		Coalition C2 QL

Coalition C3	Interoper. C2 Syst	Users believe that based on demonstrated agent capabilities, the application of agent technology into the U.S.C2 system (GCCS-M) could reduce manning for FOTC management by about 2 watchstanders. Agents could execute most optask FOTC functions automatically, and present some (red track management) functions to an operator for execution approval.		Coalition C2 QL
Coalition C3	Interoper. C2 Syst	Agents should support the decision-maker in providing information to the COP, but should not be delegated the authority for weapons employment based on information submitted to the COP. Chat collaboration on designated tracks of interest, with a man-in-the-loop C2 decision, was a vital procedural step in using agents in the end-to-end engagement cycle, to avoid possible fratricide from mislabeled COP tracks.		Coalition C2 QL
Coalition C3	Interoper. C2 Syst	The SCC GCCS-M operator was coordinating the entry of multi-sensor, multi-platform reports on a suspect hostile SSK, including reports from coalition forces. Rather than merging correlated contact reports or coordinating the management of these reports, all but the most recent report was deleted at the TOPCOP level without consulting the SCC. This resulted in loss of the richness in coordinating localization of the submarine and effective prosecution.	PWC cells should retain FOTC-like authority to manage classes of threat reports associated with their warfare mission.	Coalition C2 QL
Coalition C3	Interoper. C2 Syst	The situational awareness provided by the COABS/CAST grid was most effective in confirming the TMA generated by the submarine combat system, and supporting optimized TMA tactical maneuvers, but not replacing the need to conduct TMA. The COP generated from agent-based computing improved the confidence level of submarine commanding officer in his own tactical picture, and provided cueing for correlation and rapid assessment of contacts that were beyond organic sensor range, until they were sensed		Coalition C2 QL
Coalition C3	Interoper. C2 Syst	Agent-based computing environment is a management tool to support the decision making, it should not be the sole discriminator on employment of weapons.		Coalition C2 QL

Coalition C3	Interoper. C2 Syst	The simulated Australian rapidly deployable system (RDS), a prototype FY2007 tactical autonomous array, was highly effective for chokepoint sea control, particularly for queueing against a surface threat in support of indications & warning missions or maritime interdiction operations.	Recommend continued investigation of autonomous sensor conops and ttp in future experiments. Particular emphasis should be placed on the network interface for automating queuing from autonomous sensor fields, and undersea connectivity to all manned and unmanned undersea vehicles, including coalition submarines.	Coalition C2 QL
Coalition C3	Interoper. C2 Syst	CAST agents provided an immediate warfighter benefit by reliably delivering and exchanging track data, and improving battlespace awareness for cross-platform cueing of threats. Further experimentation with CAST is warranted to extend agent-based computing to managing sensor level data.		Coalition C2 QL
Coalition C3	Dynamic Network	The experimental network provided the coalition force with reliable communications and enhanced bandwidth contributing to an overall improvement in battlespace awareness. At one point the DREN connection between FCTCPAC and NUWC was lost due to operator actions, and when restored, the agent-based computing environment dynamically reconfigured and automatically restored the "grid" COP for all registered users within 15 seconds. The back-up COP took 15 minutes to recognize loss of updates and manually restore.		Coalition C2 QL
Coalition C3	Dynamic Network Mngmt	Agent-based computing is possible across secure WANS to a network-centric naval force, but requires some management of bandwidth traffic priority to ensure bottlenecks do not occur.		Coalition C2 QL
Coalition C3	Dynamic Network Mngmt	The value of collaboration and shared awareness with other elements of the coalition ASW force encouraged tactics that maximized time connected to the grid.		Coalition C2 QL
Coalition C3	Dynamic Network Mngmt	The capability of near-continuous communications and fault-tolerant, dynamically reconfigurable networks in 2007 shows that there may be potential for more doctrinal flexibility in waterspace management (WSM), and a more responsive approach to manned and autonomous unmanned undersea vehicle battlespace management. The concept of a moving NOTACK area, supported by a robust and current multi-national COP, may have merit for improved ASW prosecution timelines while maintaining safety of U.S. and coalition subs.		Coalition C2 QL

Coalition C3	Dynamic Network Mngmt	An expeditionary sensor grid with pervasive sensing needs to have a reporting scheme with a C2 node, which can package and possibly prioritize numerous contact reports (perhaps once per minute, at least for the undersea battlespace), rather than have each sensor report individually handled and routed.	Coalition C2 QL
Coalition C3	Dynamic Network Mngmt	It is critical for all nodes of a network-centric force to not only know when connectivity is established or regained, but equally important to know when it is lost. Although agents have been able to quickly recognize and restore a network grid for data exchange, they have not been configured to support recognizing loss of connectivity. The health and status of the network-centric environment is particularly important for the employment of autonomous sensors, as well as for coalition forces, which lack the same level of grid/agent administrative support.	Coalition C2 QL
Coalition C3	Secure Info Sharing	FBE-J architecture for agent-based coalition chat was designed to experimentally operate in a secret high coalition environment, in parallel with a U.S. chat capability, for information security reasons. Field implementation of the agent-facilitated chat capability would not be effective unless the architecture for a multi-national chat capability existed as a single integrated system, with a means to designate a user's chat stream as being U.S. only, or releasable to multi-national force, perhaps by prefacing the chat stream with a flag (/c) to indicate the text is meant for all coalition. Implementation of a dual system, air-gapped on U.S. platforms would be ineffective. C2 with coalition needs to rely on the content of the information exchange, not on the platform or system being used. Secure information sharing needs to be managed and tagged at the data level with users. U.S. enclaves on foreign ships, and foreign liaison officers are not the answer to managing information.	Coalition C2 QL

Coalition C3	MPP	The use of coalition forces as core (dedicated) assets under TACOM and TACON to the SCC, highlights the need for any JFMCC/MTO process to incorporate the concept of "sorties held in reserve" rather than give up all assets to the JFMCC as a default for allocation. There should be some assets that can assure continuity of effort, readiness, mission execution proficiency, and effective planning, that SCC retains as core. Due to the mobile nature of multi-mission maritime assets in the JFMCC apportionment, there are C2 challenges that are unique to this maritime environment. They need to be assigned as part of the core capability upon which PWCs such as SCC can rely for planning and execution. Having coalition forces in this category facilitated planning for ASW and for branch plans such as MER ship or ARG escort duties. Such assets might still have MSR inputs with SCC as a non-negotiable PWC assignment, to allow for inclusion in the MMAP and MTO for overall visibility.		Coalition C2 QL
Coalition C3	MPP	The maritime tasking order (MTO) process does not provide sufficient flexibility to the dynamic maritime tasking environment to warrant the additional time commitment and SCC planning overhead. The ability to task coalition forces for merchant "safe haven" management and escort or prize ships, those missions with lower priority than TCT re-roll, more effectively supported SCC execution of sea control mission, because it was offline from MTO process.		Coalition C2 QL
Coalition C3	General	The degree to which a collaborative or situational awareness tool is valuable depends on the consistency, accuracy and timeliness of the information it displays.		JFI Analysis
Coalition C3	General	While classified communication is not impossible, it remains a significant challenge that must be addressed when conducting Joint shipboard helicopter operations. A variety of solutions exist; recommend the units involved in a particular scenario proactively explore the best option based upon their available resources for classified communications. Classified communication will continue to be important to successful Joint operations.	Army tactical units do not have easy access to either official message traffic Plain Language Address (PLA), nor classified Secure Internet Routing Protocol Network (SIRPNET). The Navy, on the other hand, almost exclusively uses these systems to communicate with other units/levels. USS BOXER had difficulty in transmitting classified information to the Army unit—this impacted various aspects of the operation, including required overhead times for helicopters, radio frequencies used for inbound flight operations, and ordnance logistics.	JSHIP, JT&E Report

Coalition General C3	Secure voice communications and IFF Mode IV were not planned for in support of the SWARMEX because participants believed they were too hard to coordinate, even though it was a requirement for all other MC 02 participating fixed-wing aircraft. JSHIP has previously evaluated Mode IV/secure voice aboard ships with Army helicopters with success.	In order to test in a realistic scenario, recommend exercising the tools required for actual missions and use secure communications and MODE IV IFF.	JSHIP, JT&E Report
Coalition General C3	US Navy air-capable ships are equipped with Tactical Aid to Navigation (TACAN) and an Ultra-High Frequency (UHF) Non-Directional Beacon (NDB) for use as aircraft aids to navigation. Most conventional Army helicopters are not equipped to use these systems, and therefore lack the means to independently navigate to a ship. USS BOXER transmitted a signal (50 watts at 2199 KHz) to assist the AH-64D aircraft flying inbound to the ship. However, due to miscommunication, the AH-64D pilots did not have the frequency (see Inter-Service Unit-Level Classified Communication Issue), so they were vectored in by radar, radio voice and visual contact. Although not required in this case because of the close proximity of USS BOXER to shore, conventional joint helicopter operations will normally require radio navigation aids while inbound to ships.	Recommend using HF homing for all future Army helicopter inbound flight operations with Navy ships. JSHIP has successfully tested a procedure that will work with both models of Army ADF receivers and all Navy HF transmitters. Emission Control (EMCON) permitting, the ship transmits a continuous wave HF frequency signal between the frequency range of 2000-2199 KHz at a power level of approximately 50 watts. The transmitter must be set to "CW" modulation. This signal can then be received by the aircraft's ADF receiver and will provide a directional needle pointing to the ship. Distance information will not be available using this method.	JSHIP, JT&E Report
Coalition General C3	The SWARMEX was representative of a Joint Task Force (JTF) assembled for a short-term contingency, involving dissimilar helicopter and fixed-wing units and several amphibious task force ships. The 1-227 AVN unit was unfamiliar with the personnel requirements for mission planning and the process for coordinating with the Tactical Air Control Squadron (TACRON) or the ship’s Air Operations department for scheduling and planning shipboard flight operations and ordnance load plans. This created difficulty at times, especially when a passenger transfer between USS BOXER and USS Benfold was required on short notice. Furthermore, no dedicated staff or ship liaisons were provided to the 1-227 AVN unit once they embarked. Consequently, JSHIP personnel performed the initial shipboard flight operations planning and scheduling support for the 1-227 AVN and provided most of the liaison between the staff, the ship, and the embarking unit required for the Air Plan. Effective coordination between embarking aviation units and the appropriate ship personnel is critical to proper planning and successful mission execution.	This issue is well documented by JSHIP and has been a recurring problem associated with Army and Air Force units embarking Navy ships when liaisons between services were not exchanged. It further demonstrates the need for a prebriefed command element/liaison, familiar with naval shipboard flight operations, to embark with these units. If such a joint command element/liaision cannot be embarked, recommend USN/USMC units and ship’s company provide this dedicated liaision support, especially for scheduling and planning shipboard flight operations and ordnance loads. Also, JSHIP recommends embarked units bring additional personnel dedicated to the planning process.	JSHIP, JT&E Report

Coalition C3	General	During initial planning, JSHIP had to request a waiver for the UH-60L in order to conduct class III flight deck and hangar operations onboard USS BOXER. NAVAIR Aircraft Launch and Recovery Equipment program (PMA 251) has approved UH-60A, MH-60K, and more recently the MH-60S aircraft for this level of operations. All three of these helicopters are very similar to the UH-60L.	Recommend NAVAIR Aircraft Launch and Recovery Equipment program (PMA 251) approve UH-60L aircraft for class III flight deck and hangar operations aboard LHD class ships.	JSHIP, JT&E Report
Coalition C3	General	The effects of the ship's radar and communication transmitters on USA/USAF aircraft flight control and avionics systems continues to be an unfamiliar issue for the Navy. The Navy/Marine Corps aircraft have fewer EMV problems since they are designed to operate in the shipboard electromagnetic environment. The Army and Air Force helicopters are not designed for the shipboard environment and certain shipboard transmitters must be turned off or operated at reduced power to prevent Electromagnetic Interference (EMI) to the Army and Air Force helicopters. JSHIP engineers have developed an EMV database for all USA/USAF helicopters. In preparation for MC 02, USS BOXER was given transmitter guidance by JSHIP engineers through use of this database to ensure safe joint helicopter operations. EMV was not a problem for the SWARMEX because JSHIP planning and intervention insured safe operations. Because Army and Air Force helicopters are not EMV hardened by design, EMV will remain an area that must be addressed to prevent aircraft damage or mishaps.	Recommend future joint exercises use the JSHIP-developed EMV database and place emphasis on EMV protection. This function should be incorporated into Joint Force planning process, and is best suited for integration with the Joint Spectrum Center's (JSC) E3 Engineering Support Program. Second, recommend future USA/USAF rotorcraft acquisition programs incorporate shielding and protective methods for aircraft electrical and avionics systems to reduce their EMV in the shipboard environment.	JSHIP, JT&E Report
Coalition C3	General	HERO classification of Army ordnance also continues to be an issue since these items are usually not contained in the Navy's HERO publication, OP 3565. Each time non-Navy ordnance comes aboard a Navy ship, a special HERO assessment to determine the HERO classification must be performed by Naval Surface Warfare Center, Dahlgren Division (NSWCDD). For MC 02, a special assessment was performed by NSWCDD that resulted in severe and unnecessary restrictions to USS BOXER transmitters. JSHIP engineers and officers reviewed existing HERO test data and contacted the helicopter program managers to gather data so NSWCDD could reevaluate the HERO shipboard transmitter restrictions. Due to their efforts, the special HERO assessment was modified by NSWCDD, ultimately resulting in a workable solution and a less restrictive environment.	Recommend NSWCDD develop a procedure to ensure that all relevant information is considered prior to establishing HERO conditions.	JSHIP, JT&E Report

Coalition General C3	No accepted joint processes are in place for USA/USAF ordnance handling, movement, and storage aboard Navy ships. In addition, the process for transferring USA/USAF ordnance from its parent service to a Navy site ashore is not defined. Over the course of two years, JSHIP has worked to develop a standardized process which Joint helicopter units may use to employ their aviation ordnance safely and effectively aboard ships. Problems that were previously addressed and resolved through this process resurfaced during this MC 02 test period. This indicated that decisions to allow specific ordnance onboard a ship can be personality driven, rather than procedurally based. Navy Ordnance Pamphlet 4's (OP4) use of the words, "authorized containers" was construed to mean "prohibited" for Army 2.75" rocket storage, because the storage containers were authorized by the Army rather than the Navy. Although OP4 and various ship Naval Aviation Training and Operating Procedures Standardization (NATOPS) manuals address naval ordnance procedures, USA/USAF ordnance and procedures are not included. Naval ordnance policies are designed to support operations in close quarters and in a high electromagnetic transmission environment. Naval ordnance procedures are, by requirement, applied restrictively; e.g., if not expressly permitted, the procedure is not allowed without an approved waiver. USA/USAF ordnance procedures have not been developed for the close quarters and high electromagnetic environment encountered aboard ship. For these reasons, USA/USAF units operate outside the Naval ordnance system and therefore require waivers to conduct operations. Knowing how to generate the request for waivers, determining addressees and using the correct format should not be tasks expected of the embarking unit. Further, JSHIP experience has shown that a request for a wavier may elicit completely different responses from different commands based on personal interpretations. For MC 02, the BOXER, with the assistance of Naval Surface Force, U.S. Pacific Fleet (SURFPAC), should have requested the waiver, as the ship was tasked by higher headquarters to support the live-fire exercise. Only because JSHIP is an OSD organization specifically chartered to investigate Joint interoperability, and with considerable effort and OPNAV-level intervention, were Army 2.75" aerial rockets with inert warheads and loaded in FASTPACKS allowed onboard the ship. Clearly, tactical units forced to use the Naval ordnance procedures currently in place have insurmountable obstacles to overcome to conduct Joint exercises with aviation ordnance aboard ships.	The services should develop and implement a process using JSHIP products and recommendations that defines the logistics steps required for joint use of aviation ordnance (Navy certified or non-certified) aboard ships.	JSHIP, JT&E Report

Coalition C3	General	No process is in place to inform embarked units or ships of reclassification of ammunition. A Notice of Ammunition Reclassification (NAR) is issued when the class (serviceable, not serviceable, etc.) of specific lots of ordnance has changed. Current NARs must be received by units and ammunition storage facilities to ensure proper disposition of the affected lots. When a NAR is issued against a USA/USAF lot, it is sent from the Ammunition Supply Point (ASP) to the receiving unit. If the unit and the ammunition are embarked, there is no process to ensure the NAR also goes to the ship or has in fact been received by the unit. It is imperative the ship receive the NAR as it is the storage facility for the ammunition and is responsible for its proper disposition until it is received by the unit on the flight deck. For MC 02, an ad hoc arrangement was made where a JSHIP rep ashore would check daily with the ASP for NARs on the lots of embarked ammunition. If a NAR was issued, the JSHIP rep would then notify SURFPAC to forward this info to the ship. This worked for the exercise, but a permanent solution is required.	Recommend the Joint Ordnance Commander's Group (JOCG) assess this problem and work to establish a standard process for shipboard notification of joint ammunition reclassifications.	JSHIP, JT&E Report
Coalition C3	General	BOXER's Ship Safety/Orientation Brief shown on closed-circuit television (CCTV) was inadequate for Army personnel unfamiliar with shipboard safety. Joint units have a natural tendency to assume that routine operations on land can be easily conducted aboard ship. Because the briefing was presented on CCTV, it lacked dynamic interaction and the option to ask impromptu questions.	Recommend that ship's companies provide an officer or senior NCO to conduct an in-person safety/orientation brief for embarking Army units. Although the brief presented over CCTV contained all essential information, an in-person briefing would help enforce the inherent safety issues encountered on Navy ships.	JSHIP, JT&E Report

Coalition C3	General	BOXER supply personnel were not aware that Navy and Army pay systems were incompatible. The issue was identified when the Assistant Supply Officer (ASUPPO) was told by JSHIP that they would not be able to deduct from the 1-227 AVN enlisted personnel Basic Allowance for Subsistence (BAS) pay while embarked aboard BOXER, precluding meal deductions from their pay. The issue is even more evident when Joint embarking units pay for fuel taken by their helicopters. No standard method exists for Army/Air Force units to pay for these supply items; several options have been tried without success. Navy ships are not equipped to accept standard Army fuel credit cards, and most USA/USAF helicopter units are not familiar with the DD-1348 payment form, routinely used by Navy and Marine Corps units for transactions.	Recommend payment for supply items such as food and fuel be addressed at the service level. Even though all services have competent systems in place to handle their own needs (MIPR, credit cards, DD-1348), a standard should be established to handle joint operations when one service provides goods/services to another.	JSHIP, JT&E Report
HSS	HSV	Major physical modifications would be needed to ensure proper casualty handling and decontamination.	Passageways need to be at least 50 inches in width (hospitals require 8 feet for passage ways) to easily move patients in litters. There must be direct access from helicopter deck. A ramping system, as a back up for elevators, to move litter patients throughout the vessel is necessary (Most commercial ships incorporate this due to needing to be wheel chair accessible). Higher ceilings are necessary on vehicle deck (for buses). Elevator should be able to accommodate the length of a litter plus a minimum of 2 litter bearers--approx 8 ft in length per litter. Increase sizes of passageways and midship rooms where care and transportation is much easier in higher sea states. Access from flight deck should be straight and direct and wider.	Marks Trip Report
HSS	HSV		Skid proof flooring for when it is wet.	Marks Trip Report
HSV	C2	The JFMCC retains OPCON of all assets and provides them to tasked PWCs to accomplish their assigned missions. The MTO does not indicate reporting processes for reconfigurable or multiuse platforms. The assumption that OPTASKs (which are developed in advance of operations) are an adequate means to convey C2 relationships is risky.	The relationship between OPTASKs and the MTO needs to be evaluated.	Lumsden Information Report
HSV	Medical	The noise levels in the aft Section vehicle bay and at midship precluded hearing (with a stethoscope) manual blood pressure and lung sounds.	Noise attenuation at lower frequencies, especially in the vehicle deck and engineering spaces, is greatly needed. There is the possibility of using hand signals, but this develops a concern about visual cues and resulting mistakes. Should consider using headsets for communication.	Marks Trip Report

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HSV	Medical	Sea spray is constant on vehicle deck.		Marks Trip Report
HSV	Medical	Could be reconfigured for rapidly identifying casualties; tracking patients; connecting with TRAC2ES; reporting blood requirements; communicating patient requirements; researching drug reaction book, etc…		Marks Trip Report
HSV	C2	Could be reconfigured for rapidly identifying casualties; tracking patients; connecting with TRAC2ES; reporting blood requirements; communicating patient requirements; researching drug reaction book, etc…		Marks Trip Report
HSV	Medical	Sea spray is constant on vehicle deck.		Marks Trip Report
HSV	USMC	Sea spray is constant on vehicle deck.		Marks Trip Report
HSV	Medical	In calmer seas, it may be possible to perform minor procedures, i.e. IV starts. These procedures need to be performed in the most stable part of the vessel (e.g., the Vehicle Deck). There can only be limited care of seriously ill patients due to rough seas, and thus lack of stability for the caregivers.		Marks Trip Report
HSV	Medical	HSV is more suitable for transportation vehicle, not treatment.		Marks Trip Report
HSV	Medical	The Vehicle Deck is stable enough for simple procedures (e.g., lung sounds and blood pressure).		Marks Trip Report
HSV	Medical	The Upper Level and Passenger Levels are not good areas for patient procedures and treatment due to sea state. The caregivers spend too much time stabilizing themselves.		Marks Trip Report
HSV	Medical	Better lighting is needed at all levels to perform medical procedures.		Marks Trip Report
HSV	Medical	Concerns still exist concerning the containment and disposal of the contaminated waste aboard such a small vessel.		Marks Trip Report
HSV	Medical	For basic safety, isolation modular units are required for chemical and biological casualties.	Opened lower vehicle deck could be isolated for chem, bio casualties.	Marks Trip Report
HSV	Medical	HSV could be used as a decontamination ship.		Marks Trip Report
HSV	Medical	There is a general concerns with noise, diesel fumes, and sea spray.		Marks Trip Report

HSV	Medical	Diesel smell made people nauseous.	Exhaust system redesign is necessary to minimize re-circulating diesel exhaust into vehicle deck. Routing exhaust stacks vertically would reduce exhaust infiltration.	Marks Trip Report
HSV	HSS	HSV is good for movement of deployable medical platforms and / or personnel. The movement of personnel would be for short distances -even the HSV crew said that in high seas seasickness, fatigue, and anorexia are a problem.		Marks Trip Report
HSV	Medical	It would me most useful for high speed transit to and from area, limited use en route.		Marks Trip Report
HSV	Medical	Vessel can support HSS as en-route care/evac vessel and as delivery platform for medical assets or systems. HSV would be a good medical logistics and re-supply ship.		Marks Trip Report
HSV	Medical	It should only be used as a last resort for transport of patients.	It might be useful as a shuttle for patient care in homeland defense.	Marks Trip Report
HSV	Medical		Think transportation, not treatment. Underway patient care is possible in mild to moderate sea states.	Marks Trip Report
HSV	Medical	Major physical modifications would be needed to ensure proper casualty handling and decontamination.	Passageways need to be at least 50 inches in width (hospitals require 8 feet for passage ways) to easily move patients in litters. There must be direct access from helicopter deck. A ramping system, as a back up for elevators, to move litter patients throughout the vessel is necessary (Most commercial ships incorporate this due to needing to be wheel chair accessible). Higher ceilings are necessary on vehicle deck (for buses). Elevator should be able to accommodate the length of a litter plus a minimum of 2 litter bearers--approx 8 ft in length per litter. Increase sizes of passageways and midship rooms where care and transportation is much easier in higher sea states. Access from flight deck should be straight and direct and wider.	Marks Trip Report
HSV	Medical		Stop the rocking. Develop stabilization system for when at sea.	Marks Trip Report
HSV	Medical		Skid proof flooring for when it is wet.	Marks Trip Report
HSV	Medical		Task organized packages can be designed to be modularized and made operational quickly. Configuration can be adjusted based on mission requirement. Modules could be slid into rails.	Marks Trip Report
HSV	Medical		Develop spring loaded side doors, need a lock or hook to hold them opened.	Marks Trip Report

HSV	HSS		Reconstruct head facilities, laundry facilities, and dirty linen holding area.	Marks Trip Report
HSV	CONOPS		Define and formalize CONOPS for HSV usage across multiple mission areas. Provide greater fidelity in HSV modeling for use in continuing concept exploration and feasibility studies.	QL Exec Summary
HSV	General		Continue to use the HSV as a near-term interim replacement for the Inchon and as an experimentation platform.	QL Exec Summary
HSV			Define the relationship between the capabilities resident in HSVs with other capabilities and programs such as LPD-17, MPF, DD(X), and ISC(X).	QL Exec Summary
HSV	General		Conduct vulnerability assessments in order to determine HSV's ability to operate in contested littoral environments.	QL Exec Summary
HSV	General	The C4I suite is adequate.	Circuits should be fully operational for NSW operations: 4 SATCOM channels are optimal, 2 channels are the minimum; 6 UHF/VHF channels are optimal with 3 minimum. All circuits should be thoroughly tested to ensure minimal interference with other ships' electronics and optimum placement.	HSV STOM MIW Summary
HSV	General	The JV HSV C4I space is not currently the "heartbeat" of the ship.	SPECWAR TOC (Tactical Operations Center) and C4I should be together for SA.	HSV STOM MIW Summary
HSV	SA	The JV HSV C4I space is not currently the "heartbeat" of the ship.	SPECWAR TOC (Tactical Operations Center) and C4I should be together for SA.	HSV STOM MIW Summary
HSV	MIW		Extend the C4I space to accommodate a plotting and map table.	HSV STOM MIW Summary
HSV	General		Extend the C4I space to accommodate a plotting and map table.	HSV STOM MIW Summary
HSV	C2	The video feed of the P3 FLIR camera was invaluable in the planning and the execution of the series of VBSS (Visit, Board, Search and Seizure) Operations; the feed was displayed in the C4I suite on one of the Large Screen Displays and provided a large degree of SA.		HSV STOM MIW Summary
HSV	SA	The video feed of the P3 FLIR camera was invaluable in the planning and the execution of the series of VBSS (Visit, Board, Search and Seizure) Operations; the feed was displayed in the C4I suite on one of the Large Screen Displays and provided a large degree of SA.		HSV STOM MIW Summary
HSV	C2	The communication between the ship's bridge and the C4I suite is cumbersome at best. The information is currently relayed via a hand held radio.	Provide the location data that the P3 is providing, into GCCS.	HSV STOM MIW Summary

HSV	C2	Information from the C4I space to the bridge is unsecured. Communication from bridge to C4I space has to be reevaluated both in terms of space design, location, and architecture.		HSV STOM MIW Summary
HSV	General	Information from the C4I space to the bridge is unsecured. Communication from bridge to C4I space has to be reevaluated both in terms of space design, location, and architecture.		HSV STOM MIW Summary
HSV	General	All heads, galley, and billeting areas are too small to adequately support an entire Seal Team.		HSV STOM MIW Summary
HSV	General	MOGAS supply and storage is not capable of handling long duration mission requirements for NSW small boats.		HSV STOM MIW Summary
HSV	General	HSV method of launching and recovering small boats (RHIBs and SDV) is unsatisfactory. HSV method of using the hydraulic crane for the launching and recovery of small boats is inefficient, slow, and not optimally safe.	A combination of a stern ramp and a deck cradle system would enhance all aspects of small boat operations.	HSV STOM MIW Summary
HSV	MIW		A two spot helicopter deck to accommodate the launching and recovery of 2 HH-60 helicopters is needed. Additionally a helicopter maintenance bay is recommended to allow continuous operations at sea.	HSV STOM MIW Summary
HSV	MIW	The communication between small boat operators and the ship's crew was accomplished by shouting, hand and arm signals, and chemical light signals.	There needs to be an efficient and reliable communications system in place, for the small boat operators to coordinate with the JV HSV deck crew. The system needs to be hands free and wireless.	HSV STOM MIW Summary
HSV	General	The communication between small boat operators and the ship's crew was accomplished by shouting, hand and arm signals, and chemical light signals.	There needs to be an efficient and reliable communications system in place, for the small boat operators to coordinate with the JV HSV deck crew. The system needs to be hands free and wireless.	HSV STOM MIW Summary

Appendix 9: Network Analysis for Joint Sea-based Command and Control; Netted Force; Bandwidth Utilization; and Naval Fires Network, Experimental (NFN (X))
Final Report Fleet Battle Experiment – Juliet

One of the key efforts in Fleet Battle Experiment, Juliet (FBE-J) was to demonstrate the capability of a deployed Naval force to engage in network-centric warfare, where planning, execution, command and control can be conducted using a common data network. FBE-J saw the participation of four ships (USS CORONADO, acting as the Command and Control ship, as well as USS Benfold, USS Fitzgerald and the High-Speed Vessel (HSV-X1)). The ships were linked together with high-speed Ku-band satellite communications, providing up to 15 Mbps bandwidth for CORONADO and 1 Mbps for the other ships.

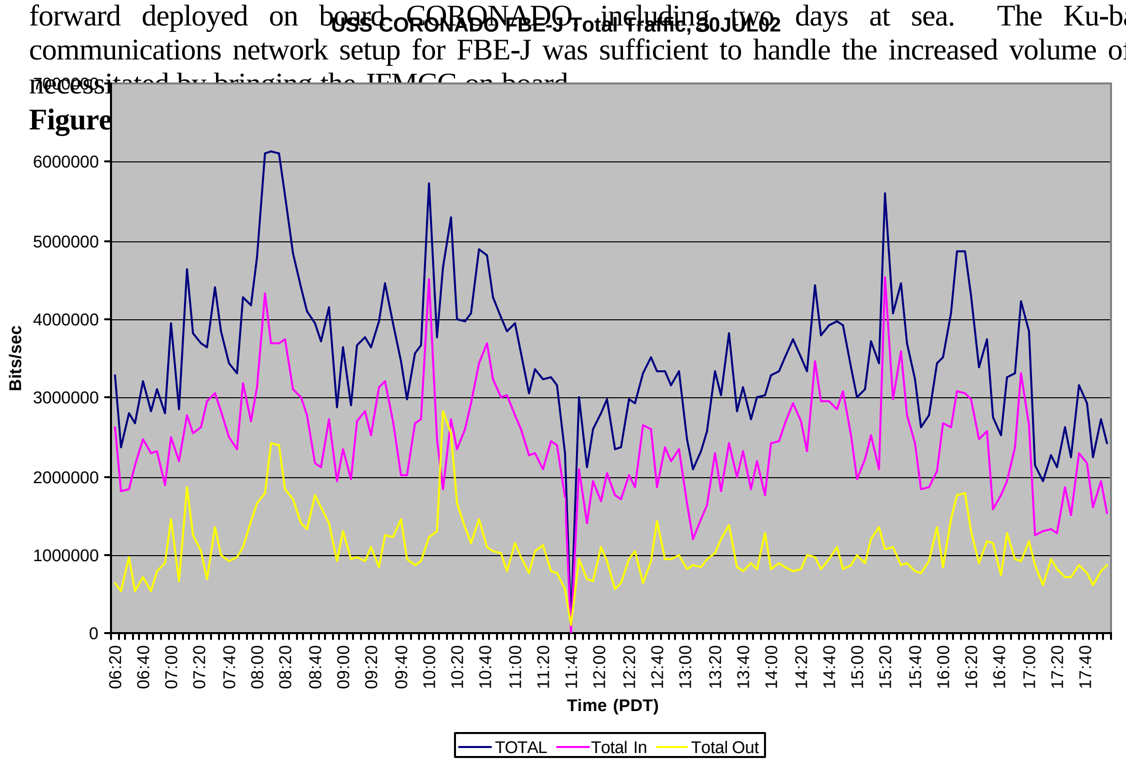
To measure network utilization and data flows, laptops were placed at six key positions (the wide-area-network (WAN) choke points for CORONADO, BENFOLD, FITZGERALD and HSV-X1 satellite links, as well as the choke points inside the Defense Research and Engineering Network (DREN) at Fleet Combat Training Center, Pacific (FCTCPAC) in San Diego, and the FBE-J local area network at Naval Air Warfare Center, China Lake, California. Each laptop used Network Associates' Sniffer Basic packet capture software, with the exception of BENFOLD, which used Windump, a Windows-based, open-source packet capture program. Data capture generally began at 0600 local (Pacific Daylight Time) and ended at 1800 local. Due to the considerable volume of data collected, packet capture was limited to the fist 128 bytes of each packet, and external hard disk drives of 80 to 160 gigabytes capacity were attached to the laptops. Data was reduced using Perl scripts developed at Naval Surface Warfare Center, Corona, into comma-separated variable (CSV) files for importation into Microsoft Excel.

This report uses that data to gain insight on four initiatives important to FBE-J: Joint Sea-based Command and Control; Netted Force; the Naval Fires Network, Experimental; and Bandwidth Utilization.

Initiative: Joint Sea-Based Command and Control

As part of Millennium Challenge 02, USS CORONADO was able to serve in a capacity unseen in previous Fleet Battle Experiments. The Joint Forces Maritime Component Commander (JFMCC) was forward deployed on board CORONADO, including two days at sea. The Ku-band satellite communications network setup for FBE-J was sufficient to handle the increased volume of data traffic necessitated by bringing the JFMCC on board.

Figure



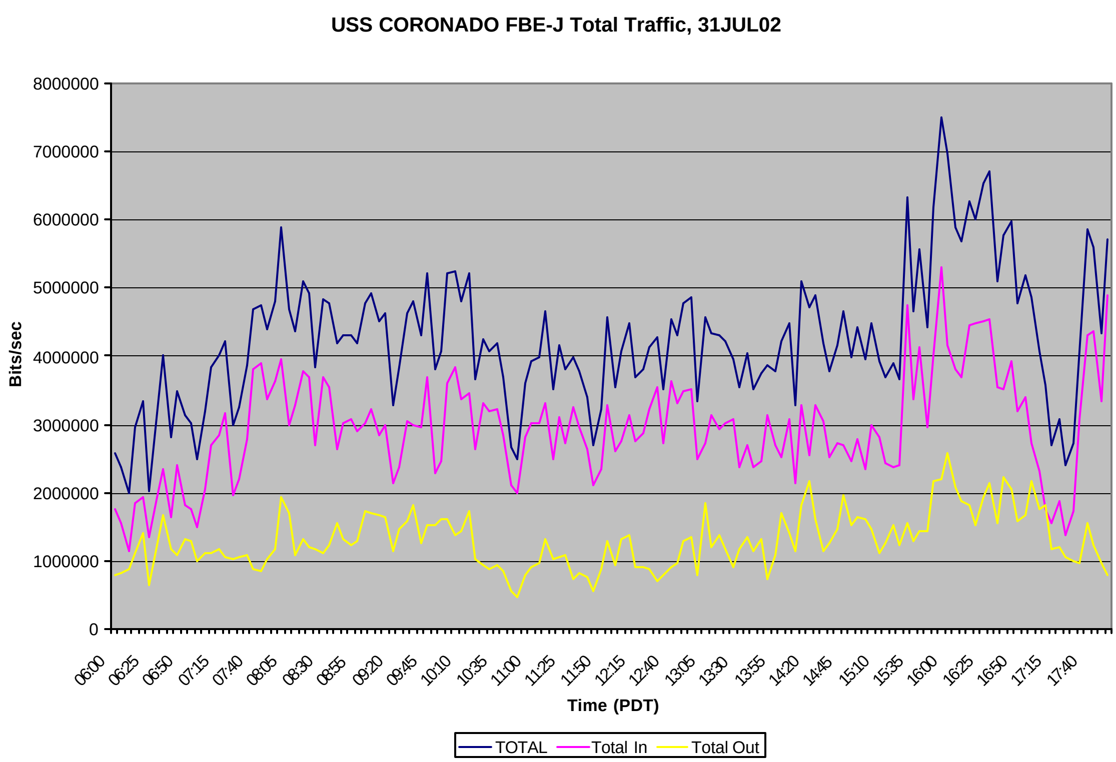


Figure A9-2. USS Coronado Ku-Band Traffic, 31July 02

As seen in figures A9-1 and A9-2, the total bandwidth used for the two underway days (July 30 and 31), never exceeded 8 Mbps for 5-minute averages, with inbound traffic exceeding outbound traffic. The only Ku-band outage experienced in the 2-day underway period was when the ship turned south as she was leaving port, causing a network outage of approximately 5 minutes, from 11:40 to 11:44 on July 30. This was anticipated and was due to the placement of the Ku-band antenna directly behind the mast.

The Ku-band network was also able to support much higher instantaneous throughput, as seen in the following diagram (showing top 1-second peaks for each 1-minute interval)

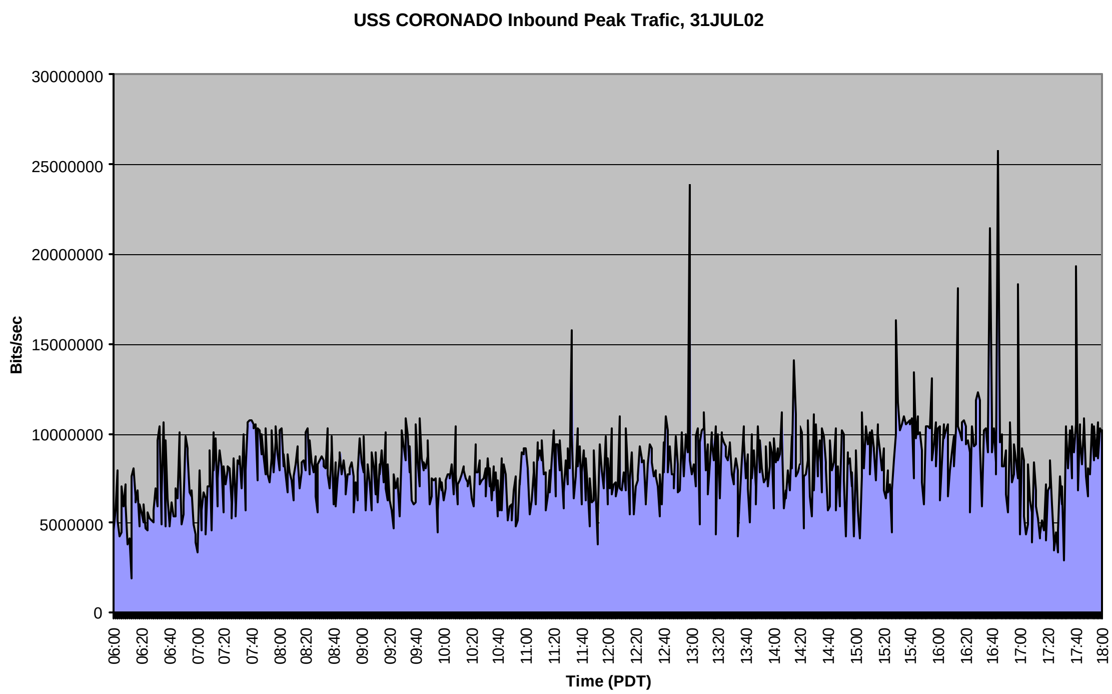


Figure A9-3. USS Coronado Inbound Peak Traffic, 31JUL02

Notice that the peaks generally topped off at around 10 Mbps, but on occasion rose to over 20 Mbps. From the diagram below, it becomes apparent what caused these extreme spikes. The MUSE U2 simulation typically generated 5 Mbps bursts of streaming video, with the occasional burst of over 20 Mbps.

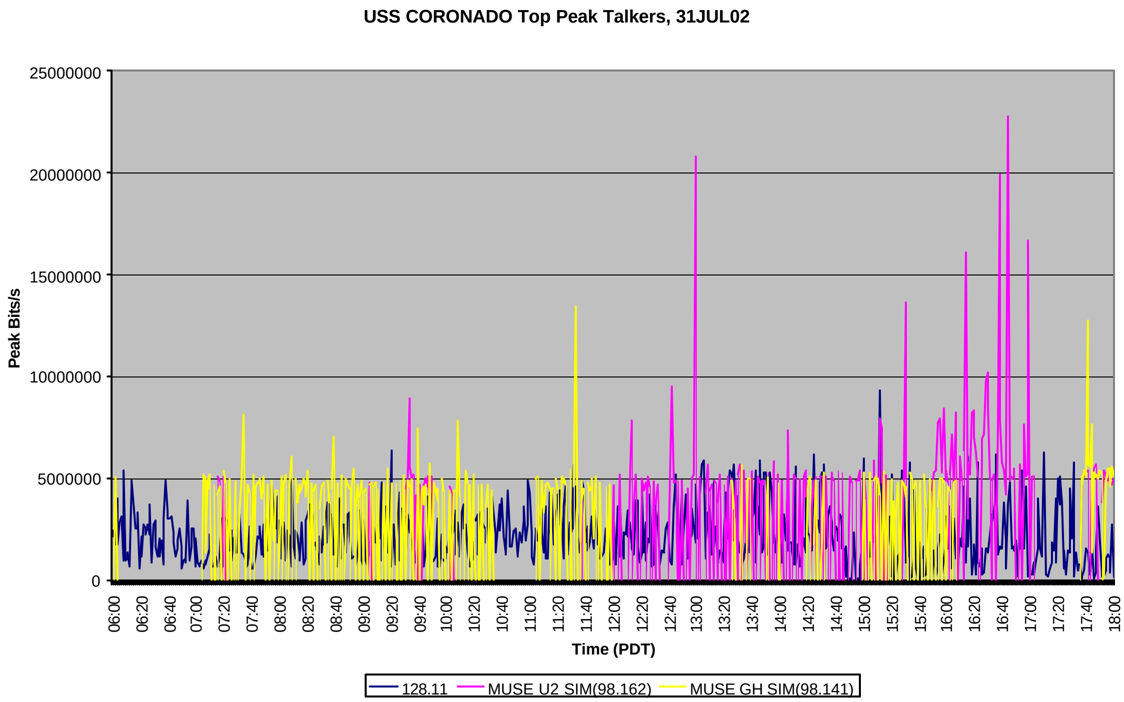


Figure A9-4. USS Coronado Top Peak Talkers, 31JUL02

The simulation video transmitters were able to attain these high peak rates due to the connectionless nature of UDP and its capability to utilize available bandwidth. The above chart shows peak rates transmitted from one simulation video server at JFCOM and two at FCTCPAC, across the Ku-band link, and inbound on CORONADO.

Initiative: Netted Force

A major goal of FBE-J was to demonstrate the interoperability of warfighting systems and components over a single, unified data network. The FBE-J network backbone was built using commercial off-the-shelf (COTS) IP routers (similar to those used on the Internet backbone), and information was shared using the same protocols as found on the Internet today (FTP, HTTP, and SMTP were among the protocols with the highest bandwidth utilization in FBE-J.)

Several commercial off-the-shelf (COTS) products were used to disseminate information over the FBE-J network. InfoWorkSpace (IWS) was used as a portal for accessing files as well as audio chat among participants. Microsoft Exchange (in conjunction with Active Directory) was used for electronic mail. The SharePoint Portal Server served as a Web-based portal.

Protocol-Enhancing Proxies

Most host-to-host traffic used the transmission control protocol (TCP), a connection-oriented protocol with built-in end-to-end error checking and flow control. The flow control uses a windowing mechanism, which allows the receiving host to notify the sending host when it needs to "slow down" the flow of data so the receiver can keep up. This windowing mechanism has a limitation over high-latency satellite links caused by the fact that the sender must wait for an acknowledgement from the remote end before it can continue sending data according to the updated maximum allowed window size sent back from the receiver. The *bandwidth-delay product* is the calculation used to compute the ideal window size, and is simply the maximum bandwidth of the connection times the round-trip time in seconds. For CORONADO, this is approximately (15000000 bits/sec) * (0.6 sec), or 9 Mbits (approximately 1.1 Mbyte). Default window sizes are typically set to 32 Kbytes or less, leading to large inefficiencies for TCP-oriented data transfers. In previous Fleet Battle Experiments, this limited the throughput of individual TCP sessions to just over 100K bits per second.

FBE-J was the first Fleet Battle Experiment to employ protocol-enhancing proxies (PEPs), which circumvent the bandwidth-delay limitation by breaking a TCP session into three sessions in series: a "spoofed" TCP session between the initiating host and its local PEP; an eXpress Transport Protocol (XTP) session between two PEPs (on each end of the satellite link), and another TCP session between the responding host and its local PEP. The PEPs appear as two-port ethernet bridges to non-TCP traffic, but process TCP traffic by converting it to XTP packets. The PEPs easily overcame the previous limitations in TCP throughput, as demonstrated by the following tables:

START	SOURCE HOST	DESTINATION HOST	TCP PORT	BYTES	SECS	BPS
11:48:06.366	HSV VTC PC(104.246)	xxx.xxx.127.203	HTTP (80)	576912	29.453	156700
11:48:06.366	HSV VTC PC(104.246)	xxx.xxx.127.203	HTTP (80)	576912	29.453	156700
11:23:22.498	HSV VTC PC(104.246)	xxx.xxx.127.203	HTTP (80)	429960	25.53	134730
11:23:22.498	HSV VTC PC(104.246)	xxx.xxx.127.203	HTTP (80)	429960	25.53	134730
15:41:16.917	104.53	JFCOM COR SPPS(114.93)	HTTP (80)	7125378	464.784	122644
06:05:46.380	99.165	HSV Video Remote(104.126)	1503	580415	76.923	60363
11:21:34.397	HSV VTC PC(104.246)	xxx.xxx.127.203	HTTP (80)	89552	13.105	54667
11:21:34.397	HSV VTC PC(104.246)	xxx.xxx.127.203	HTTP (80)	89552	13.105	54667
11:18:38.016	HSV VTC PC(104.246)	xxx.xxx.127.203	HTTP (80)	29730	4.548	52295
07:55:39.297	HSV VTC PC(104.246)	xxx.xxx.138.23	HTTP (80)	84471	13.321	50729
11:56:24.447	HSV VTC PC(104.246)	xxx.xxx.114.8	HTTP (80)	31684	5.803	43679
11:56:24.447	HSV VTC PC(104.246)	xxx.xxx.114.8	HTTP (80)	31684	5.803	43679
10:57:40.157	HSV VTC PC(104.246)	xxx.xxx.222.35	HTTP (80)	29881	5.54	43149
07:23:38.432	HSV VTC PC(104.246)	xxx.xxx.97.6	HTTP (80)	1241888	231.272	42958
07:50:14.454	HSV VTC PC(104.246)	xxx.xxx.138.23	HTTP (80)	42695	8.296	41171
07:55:39.301	HSV VTC PC(104.246)	xxx.xxx.138.23	HTTP (80)	54659	11.015	39697
11:53:13.068	HSV VTC PC(104.246)	xxx.xxx.125.20	HTTPS (443)	31260	6.338	39457
11:53:13.068	HSV VTC PC(104.246)	xxx.xxx.125.20	HTTPS (443)	31260	6.338	39457
09:55:56.254	HSV VTC PC(104.246)	xxx.xxx.179.43	HTTP (80)	111183	24.221	36722
08:27:33.789	HSV VTC PC(104.246)	xxx.xxx.179.43	HTTP (80)	281479	61.725	36481
09:28:12.254	HSV VTC PC(104.246)	xxx.xxx.179.43	HTTP (80)	90923	20.002	36365

Table A9-1. Joint Venture (HSV-X1) Top TCP Flows by Bits per Second, 04AUG02

The HSV had no protocol-enhancing proxies over its satellite link, so top TCP throughput was limited to around 150 Kbps per TCP session. In contrast, UDP traffic flowed at much higher peak rates as shown in the following chart:

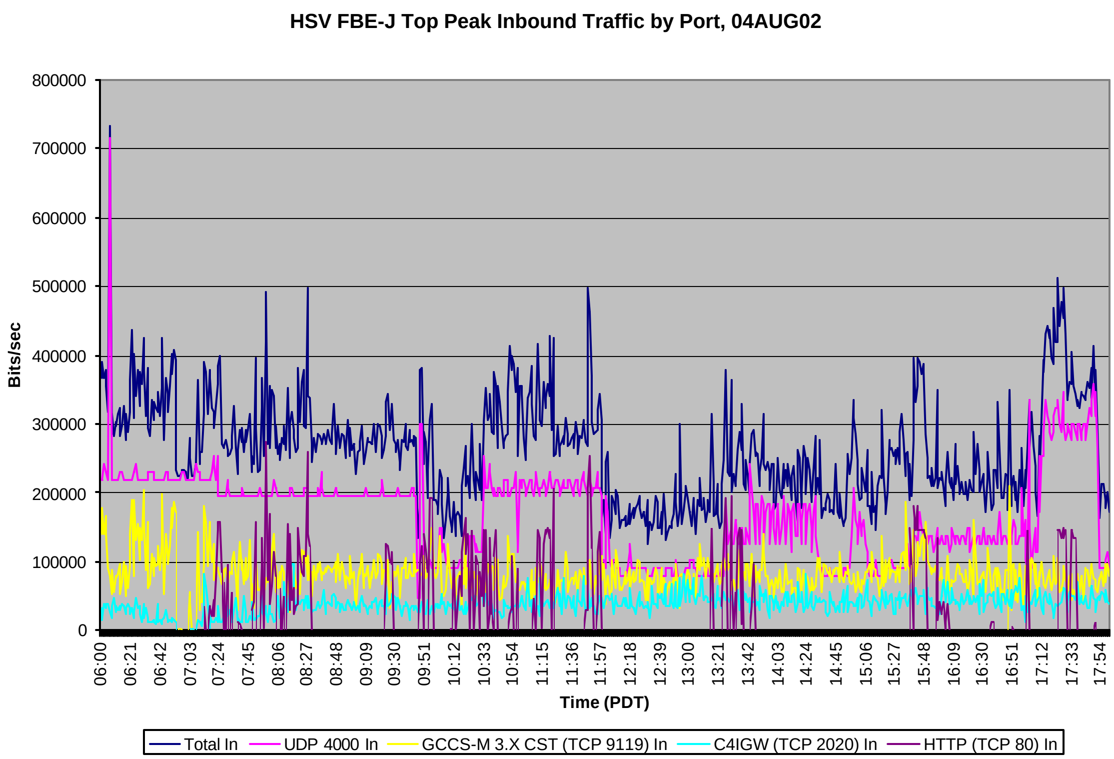


Figure A9-5. Joint Venture (HSV-X1) Top Peak Inbound Traffic by Port, 04 Aug02

On the ships outfitted with PEPs, throughput of individual TCP sessions was much better, as shown in the following tables for CORONADO, BENFOLD and FITZGERALD:

START	SOURCE HOST	DEST HOST	DEST PORT	BYTES	DURATION	BPS
10:05:14.385	105.48	JFCOM COR SPPS(114.93)	HTTP (80)	221859	0.065	27305723
06:50:48.708	99.82	JFCOM COR SPPS(114.93)	HTTP (80)	262927	0.089	23633887
09:12:32.029	114.201	JFCOM SPPS(128.116)	HTTP (80)	2823	0.001	22584000
06:01:53.855	China Lake ADOCS 12(105.12)	JFCOM COR SPPS(114.93)	HTTP (80)	249525	0.109	18313761
09:56:57.643	DC2_FCTC Sharepoint(98.23)	JFCOM COR SQL(114.94)	HTTP (80)	4281	0.002	17123999
09:55:22.561	99.9	JFCOM COR SQL(114.94)	HTTP (80)	4260	0.002	17039999
09:50:38.426	99.89	JFCOM COR SQL(114.94)	HTTP (80)	4244	0.002	16975999
09:31:00.763	105.48	JFCOM COR SPPS(114.93)	HTTP (80)	222127	0.118	15059457
08:46:48.762	117.228	JFCOM COR SPPS(114.93)	HTTP (80)	468969	0.255	14712752
07:34:56.151	128.203	JFCOM COR SPPS(114.93)	HTTP (80)	530175	0.289	14676124
08:30:23.113	117.205	JFCOM COR SPPS(114.93)	HTTP (80)	390959	0.222	14088612
07:16:41.099	105.66	JFCOM COR SPPS(114.93)	HTTP (80)	280545	0.163	13769079
09:49:55.603	105.48	JFCOM COR SPPS(114.93)	HTTP (80)	1019361	0.597	13659778
08:21:51.294	117.204	JFCOM COR SPPS(114.93)	HTTP (80)	334951	0.197	13602071
08:35:15.402	117.212	JFCOM COR SPPS(114.93)	HTTP (80)	519615	0.314	13238598
08:59:26.286	117.24	JFCOM COR SPPS(114.93)	HTTP (80)	527537	0.321	13147339
07:54:26.475	99.82	JFCOM COR SPPS(114.93)	HTTP (80)	147162	0.09	13081066
10:04:39.482	97.103	JFCOM SQL Replication(128.94)	HTTP (80)	3248	0.002	12992000
09:10:52.875	115.17	JFCOM COR SPPS(114.93)	HTTP (80)	887453	0.558	12723340

Table A9-2. USS Coronado Top TCP Flows by Bits per Second, 29JUL02

START	SOURCE HOST	DEST HOST	DEST PORT	BYTES	DURATION	BPS
13:25:26.813	FITZ AMAT MP(101.177)	xxx.xxx.140.31	HTTP (80)	2072	0.004	4143999
08:40:41.741	NFN JSC(96.155)	FITZ RTC(101.151)	1134	243775	1.572	1240585
14:35:25.699	FITZ RTC(101.151)	NFN JSC(96.155)	HTTP (80)	1111725	19.978	445179
06:03:13.446	FITZ CIC ADOCS(101.54)	JFCOM COR SPPS(114.93)	HTTP (80)	2975722	54.849	434023
11:44:02.899	FITZ RTC(101.151)	NFN JSC(96.155)	HTTP (80)	1112534	20.752	428887
09:17:01.825	FITZ RTC(101.151)	NFN JSC(96.155)	HTTP (80)	1112685	20.776	428450
11:31:19.086	FITZ RTC(101.151)	NFN JSC(96.155)	HTTP (80)	1112156	20.767	428432
11:32:58.924	FITZ RTC(101.151)	NFN JSC(96.155)	HTTP (80)	1112363	20.772	428408
11:43:16.709	FITZ RTC(101.151)	NFN JSC(96.155)	HTTP (80)	1112870	20.811	427800
11:30:32.722	FITZ RTC(101.151)	NFN JSC(96.155)	HTTP (80)	1112028	20.827	427148
10:07:54.985	FITZ AMAT MP(101.177)	xxx.xxx.140.31	HTTP (80)	2188	0.041	426926
09:16:01.122	FITZ RTC(101.151)	NFN JSC(96.155)	HTTP (80)	1112945	20.95	424990
11:35:58.440	FITZ RTC(101.151)	NFN JSC(96.155)	HTTP (80)	1112813	21.017	423585
14:34:17.137	FITZ RTC(101.151)	NFN JSC(96.155)	HTTP (80)	1112525	21.384	416208
10:42:56.871	GCCS-M 3.x TDBM Master(98.101)	FITZ CST Master(101.101)	C4IGW (2020)	5664	0.11	411927
11:40:59.523	FITZ RTC(101.151)	NFN JSC(96.155)	HTTP (80)	1112420	21.773	408733
07:51:27.750	TDBM Master(96.101)	FITZ CST Master(101.101)	GCCS-M 3.X CST (9119)	306	0.006	407999
16:25:50.511	FITZ RTC(101.151)	NFN JSC(96.155)	HTTP (80)	1113357	22.201	401191

Table A9-3. USS Fitzgerald Top TCP Flows by Bits per Second, 29JUL02

START	SOURCE HOST	DEST HOST	DEST PORT	BYTES	DURATION	BPS
10:20:31.565	BEN CIC PCIMAT(102.132)	xxx.xxx.140.31	HTTP (80)	1131	0.007	1292571
11:14:41.490	BEN ADOCS Laptop 51(102.51)	JFCOM COR SQL(114.94)	HTTP (80)	1227	0.008	1226999
10:47:21.678	BEN CIC PCIMAT(102.132)	xxx.xxx.140.31	HTTP (80)	1131	0.011	822545
17:07:53.371	BEN CIC PCIMAT(102.132)	xxx.xxx.140.31	HTTP (80)	1131	0.011	822545
17:07:43.358	BEN CIC PCIMAT(102.132)	xxx.xxx.140.31	HTTP (80)	1131	0.016	565499
10:10:16.444	BEN Sonar Ctl PCIMAT(102.131)	xxx.xxx.140.31	HTTP (80)	1041	0.015	555200
11:13:23.338	BEN RTC(102.151)	NFN JSC(96.155)	HTTP (80)	3231023	46.737	553056
11:12:10.259	BEN ADOCS Laptop 52(102.52)	xxx.xxx.82.248	HTTP (80)	682361	9.934	549515
11:01:22.603	BEN ADOCS Laptop 52(102.52)	xxx.xxx.82.248	HTTP (80)	562829	8.283	543599
11:06:31.962	BEN ADOCS Laptop 52(102.52)	xxx.xxx.82.248	HTTP (80)	799373	11.874	538570
16:27:12.564	BEN Sonar Ctl PCIMAT(102.131)	xxx.xxx.140.31	HTTP (80)	1138	0.017	535529
11:36:31.922	BEN CIC PCIMAT(102.132)	xxx.xxx.140.31	HTTP (80)	1131	0.017	532235
11:14:44.295	BEN ADOCS Laptop 52(102.52)	xxx.xxx.82.248	HTTP (80)	778561	12.69	490818

Table A9-4. USS Benfold Top TCP Flows by Bits per Second, 29JUL02

The following table shows the TCP sessions with the highest byte count for 27 July, illustrating the capability of the PEPs to sustain a high transfer rate for relatively large data transfer sizes. The duration ("SECS") is the time difference between the receipt of the sync-acknowledge (SYN-ACK) packet from the destination host by the packet capture program, and the receipt of the finish-acknowledge (FIN-ACK) packet on the same packet capture machine. The PEPs enable up to over 1000 packets per second for a single TCP session over a satellite link, enabling file transfers to take place at speeds previously seen only on local-area networks (over 10 Mbps).

START	SOURCE HOST	DEST HOST	DEST PORT	PACKETS	BYTES	SECS	BPS
12:13:10.866	LAWS DDX(98.56)	JFCOM COR SPPS(114.93)	HTTP (80)	10342	11868547	8.8	10789588
12:15:43.084	LAWS DDX(98.56)	JFCOM COR SPPS(114.93)	HTTP (80)	8851	9379599	67.885	1105351
14:12:48.869	LAWS DDX(98.56)	JFCOM COR SPPS(114.93)	HTTP (80)	7875	8672643	5.691	12191380
15:09:17.854	FITZ TSCSI ADOCS 52(101.52)	JFCOM COR SPPS(114.93)	HTTP (80)	6645	7504943	164.725	364483
08:19:58.673	China Lake ADOCS 12(105.12)	JFCOM COR SPPS(114.93)	HTTP (80)	4354	5103674	86.594	471503
08:47:59.881	China Lake ADOCS 12(105.12)	JFCOM COR SPPS(114.93)	HTTP (80)	4285	4960643	16.54	2399343
12:21:11.309	LAWS DDX(98.56)	JFCOM COR SPPS(114.93)	HTTP (80)	4219	4638080	64.201	577944
14:38:49.124	RRF Server MOC(96.121)	MUSE GH SIM(98.141)	37622	4457	4444433	4.777	7443052
11:30:23.723	RRF Server MOC(96.121)	MUSE GH SIM(98.141)	36388	4455	4444337	4.567	7785131
12:29:32.187	RRF Server MOC(96.121)	MUSE GH SIM(98.141)	36736	4455	4444331	6.939	5123886

Table A9-5. TCP Sessions with the Highest Byte Count, 27 July 02.

Cisco IP Phones

FBE-J also saw the widespread deployment of Cisco IP phones, which connect directly to an Ethernet cable and access a Cisco Call Manager, which redirects calls to a destination IP phone. Over 120 phones were used, and voice communications were greatly improved over previous Fleet Battle Experiments. The phones used standard 64-Kbps Pulse-Coded Modulation (PCM) to deliver toll-quality audio, with a 600-millisecond latency typical of satellite connections.

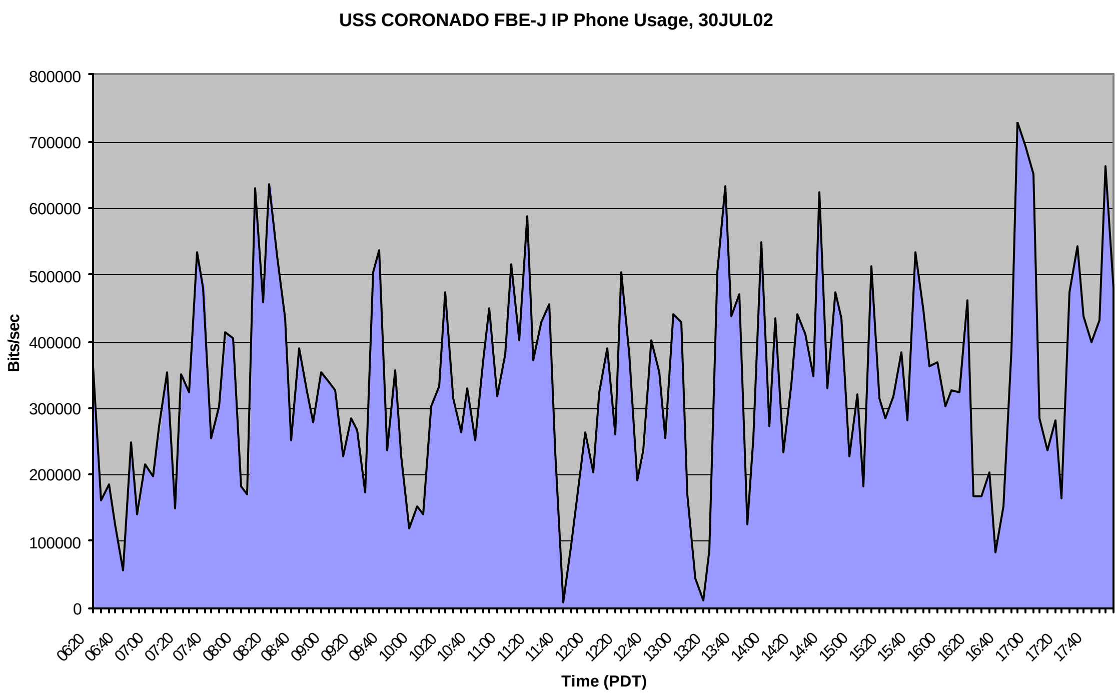
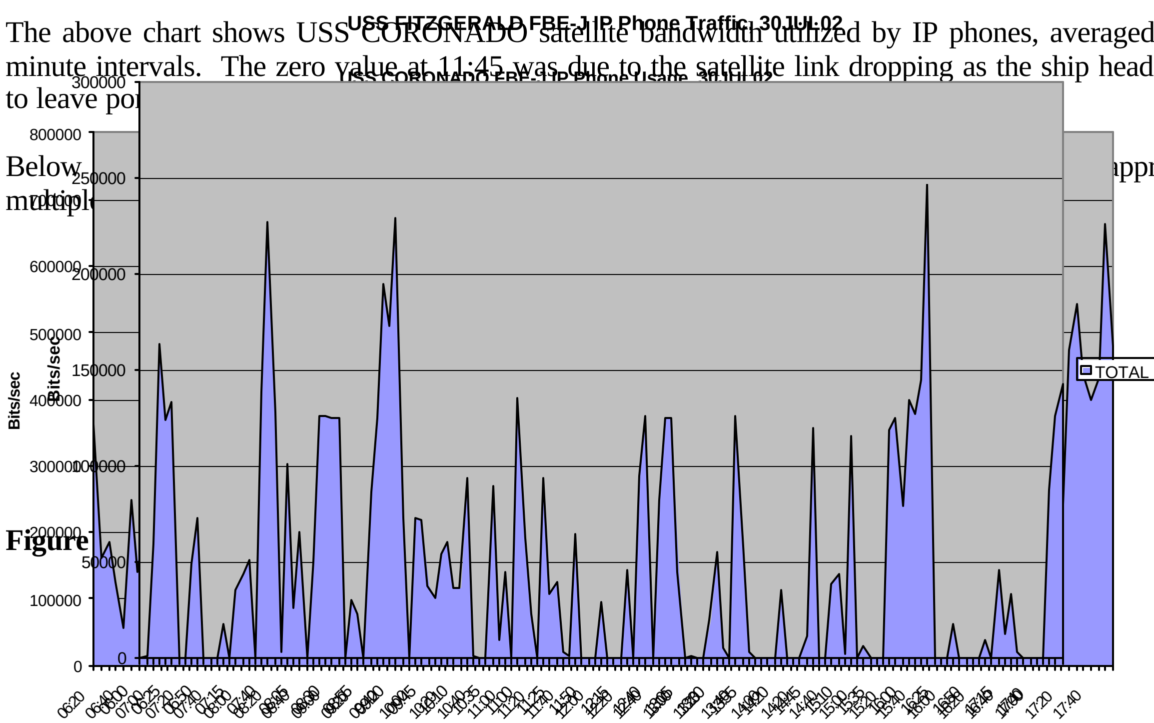


Figure A9-6. USS Coronado IP Phone Bandwidth, 30JUL02

The above chart shows USS CORONADO satellite bandwidth utilized by IP phones, averaged over 5-minute intervals. The zero value at 11:45 was due to the satellite link dropping as the ship headed south to leave po

Below approximate multipl



Figure

Figure A9-8. USS Fitzgerald IP Phone Traffic, 30 July, 02

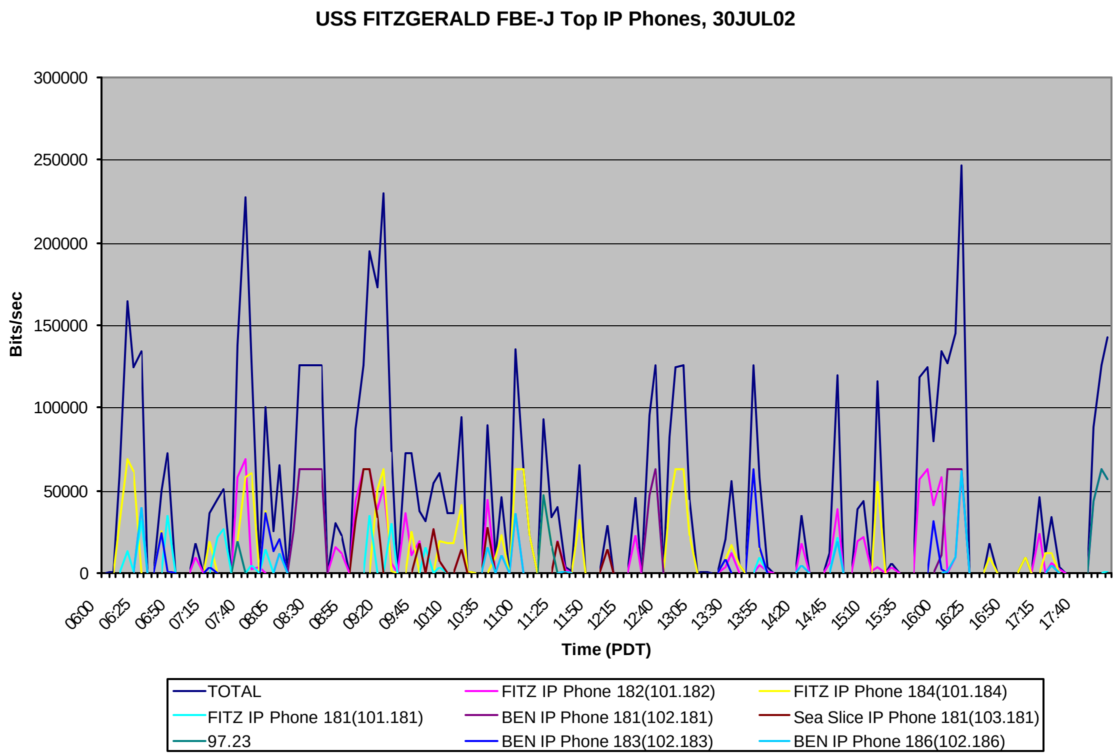


Figure A9-9. USS Fitzgerald Top IP Phones, 30 July, 02

In the above figure, notice how several of the peaks are flattened out, indicating an upper bound on throughput of around 65 Kbps. This indicates that the voice data is uncompressed and not optimized. The inbound and outbound voice traffic is split almost evenly, each being roughly half the total shown. The peaks of 256 Kbps are due to two simultaneous IP phone calls over the entire 5-minute interval period. More simultaneous phone calls would impact the flow of data over the satellite link. Future voice-over-IP deployments could use enhancements such as audio compression, header compression and voice-activity detection to conserve bandwidth without sacrificing voice quality.

The best indicator of voice quality is audio jitter measurement. Audio jitter is defined as the variability in latency between the packets sent and the packets received.[249]

The interarrival jitter J is defined to be the mean deviation (smoothed absolute value) of the difference D in packet spacing at the receiver compared to the sender for a pair of packets. As shown in the equation below, this is equivalent to the difference in the "relative transit time" for the two packets. The relative transit time is the difference between a packet's RTP timestamp and the receiver's clock at the time of arrival, measured in the same units.

[249] As defined by RFC1889

If Si is the RTP timestamp from packet i, and Ri is the time of arrival in RTP timestamp units for packet i, then for two packets i and j, D may be expressed as:

$$D(i,j)=(Rj-Ri)-(Sj-Si)=(Rj-Sj)-(Ri-Si)$$

The interarrival jitter is calculated continuously as each data packet i is received from source SSRC_n, using this difference D for that packet and the previous packet i-1 in order of arrival (not necessarily in sequence), according to the formula:

$$J=J+(|D(i-1,i)|-J)/16$$”

The following charts display the average jitter over 1-minute intervals. A value of over 20 milliseconds is considered detrimental to voice quality. Cisco digital signal processors use an adaptive jitter buffer of between 20 and 50 milliseconds to mitigate the effects of jitter. If a packet's instantaneous jitter is greater than 10 milliseconds over the current setting for jitter buffer size, the packet is dropped (but the buffer size is adjusted accordingly).

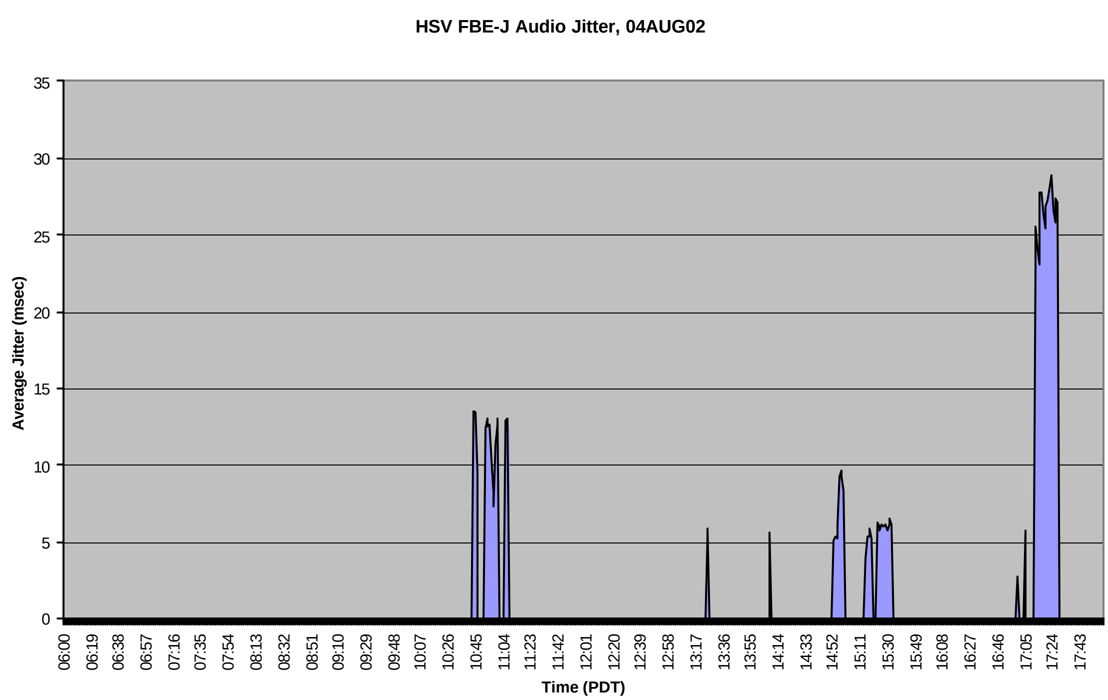


Figure A9-10. Joint Venture (HSV-X1) Audio Jitter, 04AUG02

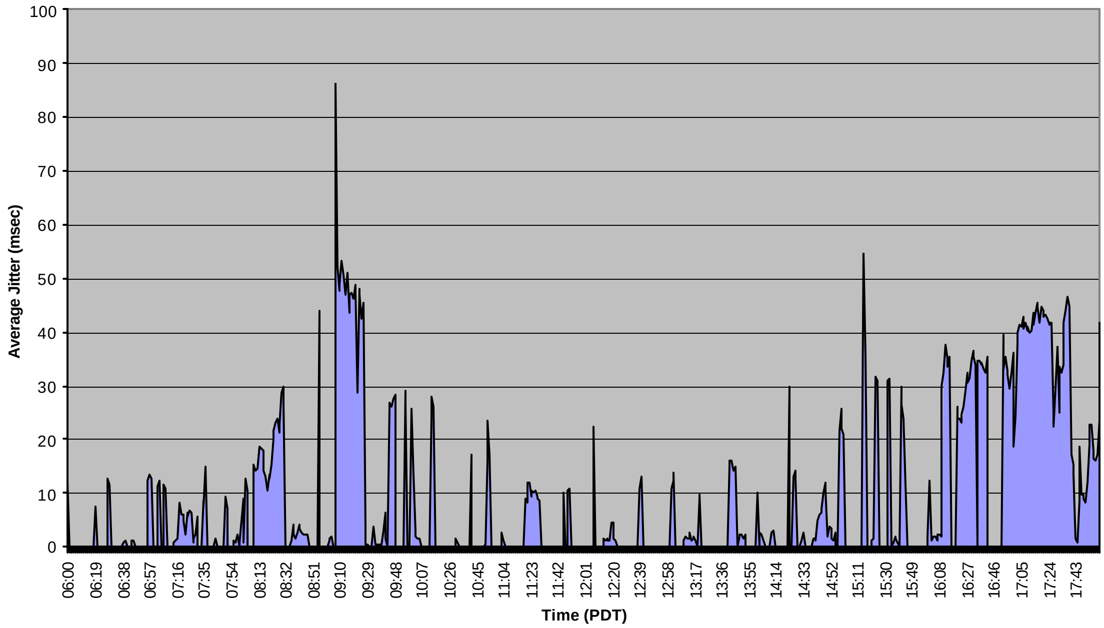


Figure A9-11. USS Benfold Audio Jitter, 31JUL02

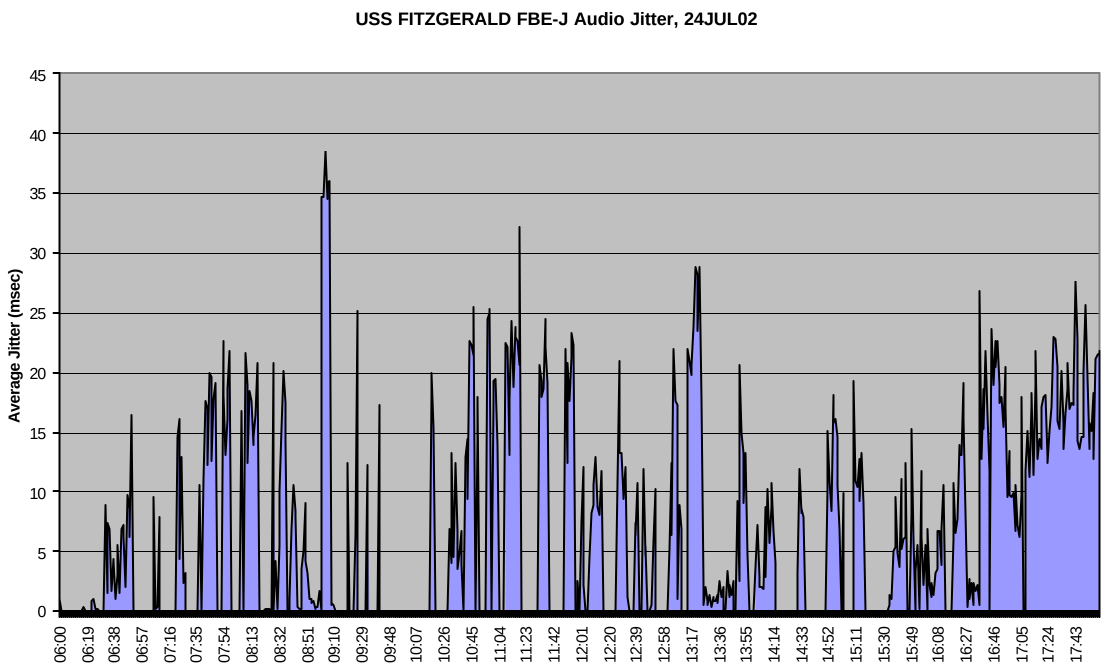


Figure A9-12. USS Fitzgerald Audio Jitter, 24JUL02

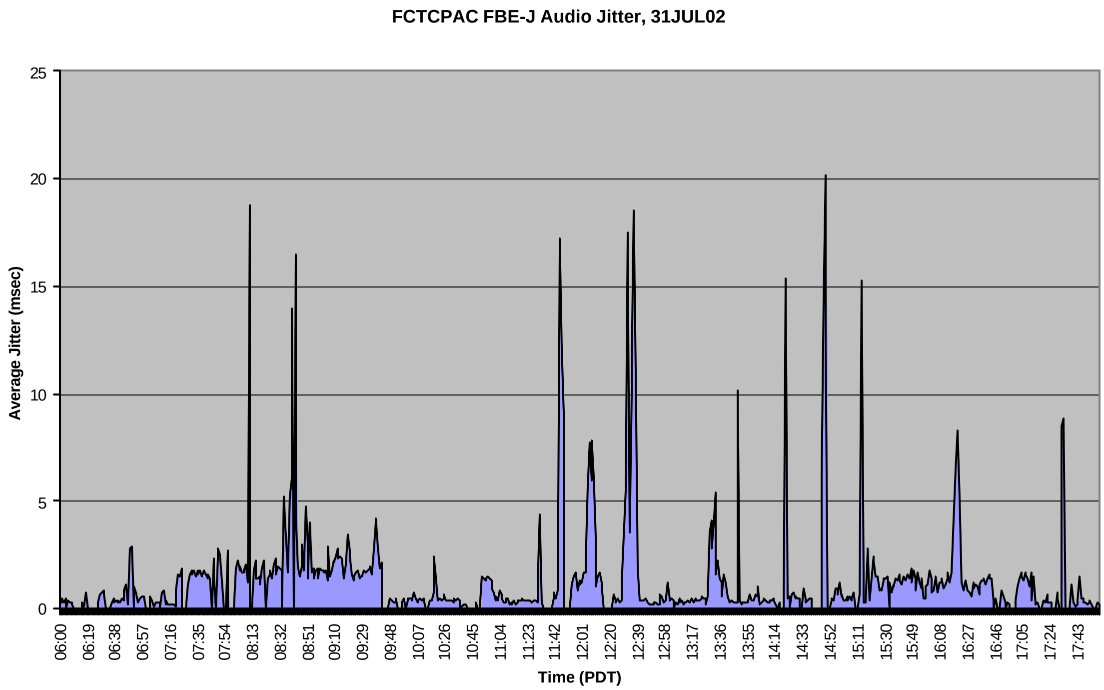


Figure A9-13. FCTCPAC Audio Jitter, 31JUL02

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InfoWorkSpace (IWS)

InfoWorkSpace was used in FBE-J as a collaboration and conferencing tool. Users were able to share files and conduct both text-based and audio-based chat. IWS was installed as a separate application on FBE workstations, and used the real-time protocol (RTP) to send audio data over the IP network. The IWS server on CORONADO functioned as a conferencing bridge by setting up point-to-point Voice-over-IP (VoIP) sessions on-demand from voice-activated microphones, and rebroadcasting the audio to all chat participants using multicast RTP.

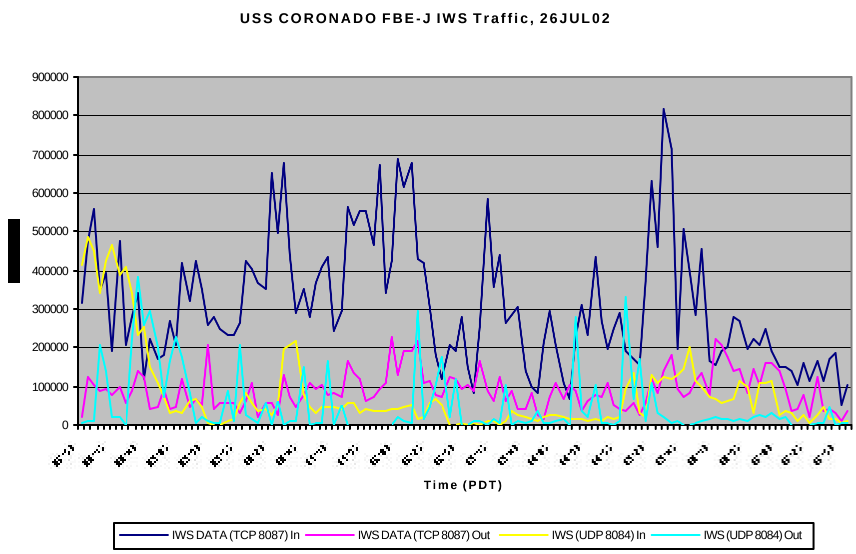

Figure A9-14. USS Coronado IWS Traffic, 24 July, 02

An interesting observation is observed by sorting all IWS-related TCP flows on CORONADO by average round-trip time, as shown in the figure below. Of the sessions with the highest latencies, most were from the HSV. This is due to the two factors: that the path between CORONADO and the HSV was over two satellite hops, and the lack of Protocol-Enhancing Proxies on the HSV satellite connection.

START	SOURCE HOST	DEST HOST	DEST PORT	BYTES	SECS	RTT (ms)
13:37:27.830	100.24	JFCOM COR IWS Server(114.92)	JAVA RMI (1099)	7139	547.222	3824.84
12:32:22.328	104.55	JFCOM COR IWS Server(114.92)	JAVA RMI (1099)	6243	53.659	3725.32
08:00:42.219	HSV LAWS(104.41)	JFCOM COR IWS Server(114.92)	JAVA RMI (1099)	7056	27.885	2622.17
11:29:15.947	99.91	JFCOM COR IWS Server(114.92)	JAVA RMI (1099)	1397	16.665	2616.97
15:51:23.292	104.55	JFCOM COR IWS Server(114.92)	JAVA RMI (1099)	2808	16.723	1798.86
06:56:02.558	104.55	JFCOM COR IWS Server(114.92)	JAVA RMI (1099)	6780	117.13	1579.6
12:36:19.273	HSV ADOCS(104.53)	JFCOM COR IWS Server(114.92)	HTTP (80)	14845	14.344	1187.69
16:09:50.568	HSV ADOCS(104.53)	JFCOM COR IWS Server(114.92)	JAVA RMI (1099)	3334	13.15	1143.44
07:51:10.324	104.55	JFCOM COR IWS Server(114.92)	HTTP (80)	31574	13.246	1098.51
10:28:30.160	HSV LAWS(104.41)	JFCOM COR IWS Server(114.92)	HTTP (80)	31773	16.721	1041.17
12:33:39.963	HSV ADOCS(104.53)	JFCOM COR IWS Server(114.92)	HTTP (80)	31646	13.604	1037.7
15:35:49.615	104.55	JFCOM COR IWS Server(114.92)	JAVA RMI (1099)	1888	7.849	982.15
08:49:28.495	99.54	JFCOM COR IWS Server(114.92)	JAVA RMI (1099)	16069	31.254	946.18
07:16:30.937	104.55	JFCOM COR IWS Server(114.92)	JAVA RMI (1099)	15967	18.973	910.34
15:45:59.258	104.55	JFCOM COR IWS Server(114.92)	JAVA RMI (1099)	1583	6.613	878.45

Table A9-6. IWS TCP Flows on USS Coronado

Another notable feature of IWS is its push capability, where it updates the connected clients all at once, as shown in the following table. Within 34 milliseconds, 40 simultaneous TCP sessions to the JFCOM conference server were initiated, with each session comprising over 200 Kbytes. This "push" scenario occurred several times each day, contributing to a higher overall bandwidth usage than what would be observed in a multicast data transfer. Overall bandwidth utilization in this time frame was low (just over 2 Mbps inbound), yet the throughput of each individual session was less than 7 Kbps, indicating an internal flow control mechanism.

START	SOURCE HOST	DESTINATION HOST	DEST PORT	PACKETS	BYTES	SECS	BPS
16:05:12.760	114.203	JFCOM Conference Server(128.96)	HTTP (80)	253	229962	283.057	6499
16:05:12.761	114.254	JFCOM Conference Server(128.96)	HTTP (80)	256	229774	285.096	6447
16:05:12.762	114.241	JFCOM Conference Server(128.96)	HTTP (80)	255	229722	283.975	6471
16:05:12.765	114.204	JFCOM Conference Server(128.96)	HTTP (80)	253	229962	284.011	6477
16:05:12.765	114.206	JFCOM Conference Server(128.96)	HTTP (80)	252	229510	287.567	6384
16:05:12.765	114.187	JFCOM Conference Server(128.96)	HTTP (80)	251	229442	290.99	6307
16:05:12.766	Plasma Display PC(96.127)	JFCOM Conference Server(128.96)	HTTP (80)	463	241306	297.475	6489
16:05:12.766	114.215	JFCOM Conference Server(128.96)	HTTP (80)	254	231072	284.495	6497
16:05:12.766	114.157	JFCOM Conference Server(128.96)	HTTP (80)	253	229570	284.037	6465
16:05:12.767	114.208	JFCOM Conference Server(128.96)	HTTP (80)	258	230262	283.68	6493
16:05:12.767	114.178	JFCOM Conference Server(128.96)	HTTP (80)	251	229834	283.986	6474
16:05:12.768	114.181	JFCOM Conference Server(128.96)	HTTP (80)	258	232766	282.664	6587
16:05:12.768	114.244	JFCOM Conference Server(128.96)	HTTP (80)	250	231609	289.467	6400
16:05:12.768	114.171	JFCOM Conference Server(128.96)	HTTP (80)	253	229570	285.462	6433
16:05:12.769	97.143	JFCOM Conference Server(128.96)	HTTP (80)	256	230662	284.917	6476
16:05:12.769	97.134	JFCOM Conference Server(128.96)	HTTP (80)	252	229510	289.717	6337
16:05:12.770	97.67	JFCOM Conference Server(128.96)	HTTP (80)	250	229390	297.465	6169
16:05:12.771	97.98	JFCOM Conference Server(128.96)	HTTP (80)	98	87870	87.835	8003
16:05:12.772	97.85	JFCOM Conference Server(128.96)	HTTP (80)	317	288583	283.933	8131
16:05:12.773	97.83	JFCOM Conference Server(128.96)	HTTP (80)	291	256524	288.255	7119
16:05:12.776	97.62	JFCOM Conference Server(128.96)	HTTP (80)	272	247142	285.535	6924
16:05:12.776	97.144	JFCOM Conference Server(128.96)	HTTP (80)	254	229646	282.653	6499
16:05:12.777	97.71	JFCOM Conference Server(128.96)	HTTP (80)	252	230022	289.211	6362
16:05:12.777	97.253	JFCOM Conference Server(128.96)	HTTP (80)	166	144195	219.545	5254
16:05:12.778	MOC LAWS(96.49)	JFCOM Conference Server(128.96)	HTTP (80)	114	103511	95.313	8688
16:05:12.779	97.86	JFCOM Conference Server(128.96)	HTTP (80)	84	71884	55.831	10300
16:05:12.780	97.66	JFCOM Conference Server(128.96)	HTTP (80)	257	234192	284.033	6596
16:05:12.780	114.201	JFCOM Conference Server(128.96)	HTTP (80)	250	229398	284.095	6459
16:05:12.782	97.61	JFCOM Conference Server(128.96)	HTTP (80)	258	234234	284.055	6596
16:05:12.782	114.211	JFCOM Conference Server(128.96)	HTTP (80)	252	229518	284.994	6442
16:05:12.782	114.219	JFCOM Conference Server(128.96)	HTTP (80)	250	229510	285.693	6426
16:05:12.783	97.69	JFCOM Conference Server(128.96)	HTTP (80)	257	231296	285.378	6483
16:05:12.783	114.212	JFCOM Conference Server(128.96)	HTTP (80)	253	229570	287.233	6393
16:05:12.784	MOC-SCIF LAWS(96.50)	JFCOM Conference Server(128.96)	HTTP (80)	252	230952	285.035	6482
16:05:12.784	97.123	JFCOM Conference Server(128.96)	HTTP (80)	256	230378	286.305	6437
16:05:12.784	114.218	JFCOM Conference Server(128.96)	HTTP (80)	67	54930	55.921	7858
16:05:12.785	97.79	JFCOM Conference Server(128.96)	HTTP (80)	256	231192	288.285	6415
16:05:12.786	114.185	JFCOM Conference Server(128.96)	HTTP (80)	254	229638	291.047	6312
16:05:12.787	114.21	JFCOM Conference Server(128.96)	HTTP (80)	254	229975	283.668	6485
16:05:12.790	97.97	JFCOM Conference Server(128.96)	HTTP (80)	318	282895	289.756	7810
16:05:12.790	MOC LAWS(96.48)	JFCOM Conference Server(128.96)	HTTP (80)	256	229750	297.632	6175
16:05:12.794	97.53	JFCOM Conference Server(128.96)	HTTP (80)	247	229210	287.039	6388

Table A9-7. IWS Push Capability to JFCOM

Initiative: Naval Fires Network, Experimental (NFN (X))

FBE-J provided a unique opportunity for demonstrating the Naval Fires Network capabilities. FCTCPAC provided the simulation cell site where video and tracking data were multicast throughout the FBE-J network. The Global Command and Control System (GCCS) presented a picture of the battlespace based on its track database updated by the GCCS-M ISR Capability (GISRC) from the streaming video and sensor data it receives. The Land Attack Warfare System (LAWS, based on the Automated Deep Operations Coordination System (ADOCS)) receives track data and is used to nominate targets based on information from the GCCS-M track database and geo-refinement from DTMS. LAWS workstations communicate amongst themselves over the FBE-J network, form a weapons-target pairing (WTP), and generate an engagement message to the selected shooter.

The JAOC Annex LAWS workstation served as a LAWS "hub", as seen in the following TCP flow table for USS CORONADO on July 30. Notice how the JAOC LAWS sends out LAWS and SMTP messages until it receives an SMTP message, then it stops and listens for remote connections from other LAWS machines. Note the fact that it took 34 seconds to receive a message of less than 2K bytes (starting at 07:45:37).

START	SOURCE HOST	DEST HOST	DEST PORT	SECS	BPS
07:45:08.717	JAOC Annex LAWS(96.43)	HSV ADOCS(104.51)	LAWS (2814)	1.072	1402
07:45:21.781	JAOC Annex LAWS(96.43)	CDC3_FCTC 20(98.20)	SMTP (25)	4.008	4768
07:45:21.783	JAOC Annex LAWS(96.43)	China Lake TPG(105.28)	SMTP (25)	5.298	3737
07:45:31.841	JAOC Annex LAWS(96.43)	HSV ADOCS(104.51)	LAWS (2814)	1.071	1404
07:45:35.075	JAOC Annex LAWS(96.43)	HSV ADOCS(104.51)	LAWS (2814)	1.017	1478
07:45:37.870	CDC3_FCTC 20(98.20)	JAOC Annex LAWS(96.43)	SMTP (25)	34.592	58
07:46:05.170	BEN TSCSI LAWS(102.41)	JAOC Annex LAWS(96.43)	LAWS (2806)	7.291	408
07:46:05.364	NUWC LAWS_MCC(107.34)	JAOC Annex LAWS(96.43)	LAWS (2812)	7.097	419
07:46:06.246	laws-asw1(98.41)	JAOC Annex LAWS(96.43)	LAWS (2810)	6.215	478
07:46:06.264	laws-asw3(98.43)	JAOC Annex LAWS(96.43)	LAWS (2805)	6.197	480
07:46:06.280	laws-catf(98.44)	JAOC Annex LAWS(96.43)	LAWS (2807)	6.181	481
07:46:07.181	laws-sim1(98.48)	JAOC Annex LAWS(96.43)	LAWS (2809)	5.28	563
07:46:07.366	FITZ LAWS 41(101.41)	JAOC Annex LAWS(96.43)	LAWS (2800)	5.094	584
07:46:09.164	China Lake LAWS 13(105.13)	JAOC Annex LAWS(96.43)	LAWS (2804)	3.296	902

Table A9-8. Typical JAOC LAWS Workstation Interaction

At other times, the JAOC LAWS workstation refuses incoming LAWS connections, often for several minutes (while at the same time accepting SMTP connections). This pattern is noted throughout FBE-J, and seems to have magnified as the experiment progressed. The following is an example from Aug 2 on CORONADO:

START	SOURCE HOST	DEST HOST	DEST PORT	SECS	BPS
16:49:42.365	HSV ADOCS(104.51)	JAOC Annex LAWS(96.43)	LAWS (2814)	101.137	308
16:52:43.435	laws-asw1(98.41)	JAOC Annex LAWS(96.43)	LAWS (2810)	35.461	354
16:56:05.212	HSV ADOCS(104.51)	JAOC Annex LAWS(96.43)	LAWS (2814)	6.145	551
16:58:00.437	CDC3_FCTC 20(98.20)	JAOC Annex LAWS(96.43)	SMTP (25)	0.382	6994
16:58:03.923	CDC3_FCTC 20(98.20)	JAOC Annex LAWS(96.43)	SMTP (25)	0.614	6684
16:58:09.419	CDC3_FCTC 20(98.20)	JAOC Annex LAWS(96.43)	SMTP (25)	0.053	41358
16:59:12.505	CDC3_FCTC 20(98.20)	JAOC Annex LAWS(96.43)	SMTP (25)	0.18	14844
16:59:45.060	laws-asw1(98.41)	JAOC Annex LAWS(96.43)	LAWS (2810)	0.001	1007999
16:59:45.061	laws-sim1(98.48)	JAOC Annex LAWS(96.43)	LAWS (2809)	0	0
16:59:45.062	laws-miw(98.47)	JAOC Annex LAWS(96.43)	LAWS (2801)	0	0
16:59:45.062	laws-asw3(98.43)	JAOC Annex LAWS(96.43)	LAWS (2805)	0	0
16:59:45.063	laws-catf(98.44)	JAOC Annex LAWS(96.43)	LAWS (2807)	0	0
16:59:45.063	laws-jecg(98.46)	JAOC Annex LAWS(96.43)	LAWS (2808)	0.001	1008000
16:59:45.083	98.6	JAOC Annex LAWS(96.43)	LAWS (2803)	0	0
16:59:45.111	China Lake LAWS 13(105.13)	JAOC Annex LAWS(96.43)	LAWS (2804)	0	0
16:59:45.167	NUWC LAWS_MCC(107.34)	JAOC Annex LAWS(96.43)	LAWS (2812)	0	0
16:59:45.225	xxx.xxx.155.76	JAOC Annex LAWS(96.43)	LAWS (2816)	0	0
16:59:45.407	BEN TSCSI LAWS(102.41)	JAOC Annex LAWS(96.43)	LAWS (2806)	0	0
16:59:45.619	HSV ADOCS(104.51)	JAOC Annex LAWS(96.43)	LAWS (2814)	0	0
16:59:45.984	laws-sim1(98.48)	JAOC Annex LAWS(96.43)	LAWS (2809)	0.001	1007999

Table A9-9. Refusals by LAWS on USS Coronado, 02 Aug 02

The apparently high bit rates observed in the lower entries are calculated from two TCP packets (SYN and RST) that indicated a "Connection refused by server" condition and are recorded by the packet sniffer within 1 millisecond apart from each other.

The following figure shows the activity for the JAOC LAWS workstation (96.43) on July 30, at one-minute intervals. Notice the drops in activity, typically of 1-3 minutes' duration. Also notice that the transmit and receive throughputs were generally equivalent.

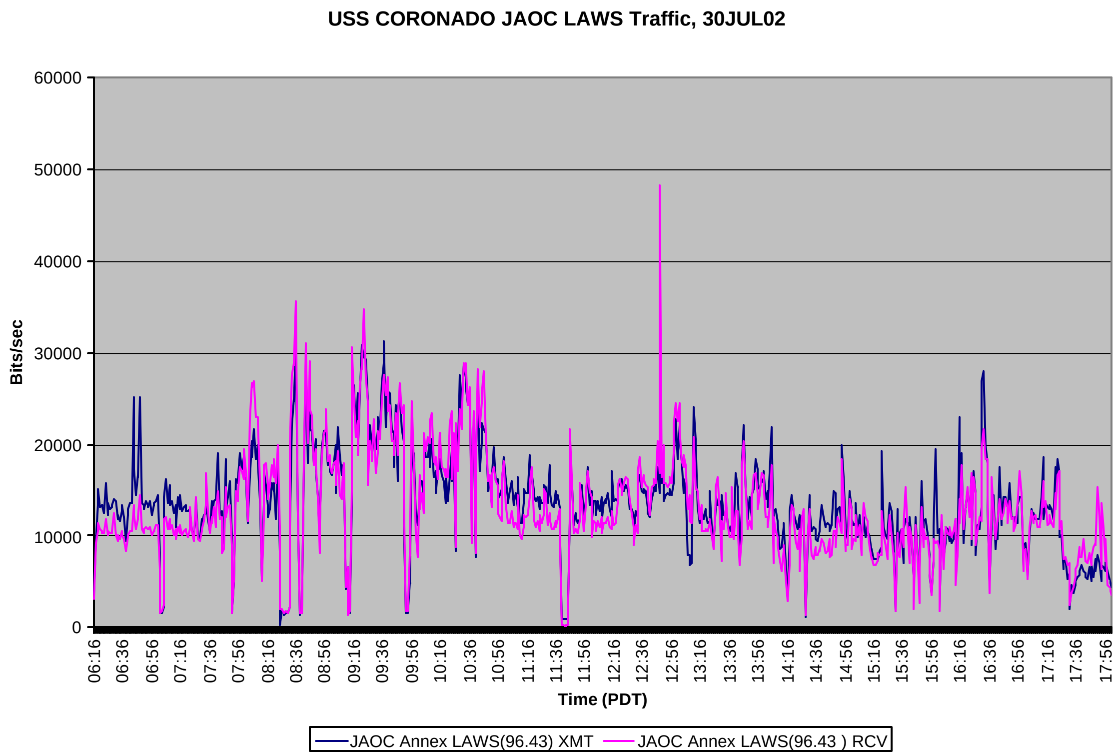

Figure A9-15. USS Coronado JAOC LAWS Workstation Traffic, 30 July 02

The following table indicates a potential network problem between FCTCPAC and China Lake. Of the top 25 TCP sessions in duration between FCTCPAC and other shore sites, 15 of them originated from China Lake, despite China Lake comprising only 36% of originating addresses for TCP sessions that day. (This occurred throughout FBE-J, not just on 1 August.) All these were over 2 hours (7200 seconds) in duration, and were successfully terminated with a TCP "FIN-ACK" (finish-acknowledgement) packet, implying a connection timeout rather than a client abort. Ten of the remaining 11 longest sessions were to AADC Greensboro, which was connected via dial-up ISDN, where less reliability was expected.

START	SOURCE HOST	DEST HOST	DEST PORT	BYTES	SECS
07:01:05.739	108.122	CDC3_FCTC 20(98.20)	1409	6144	18009.614
07:01:04.854	108.122	CDC3_FCTC 20(98.20)	1026	1956	14405.098
11:17:48.867	108.125	CDC3_FCTC 20(98.20)	1026	2734	14403.143
11:17:50.026	108.125	CDC3_FCTC 20(98.20)	1409	3550	14254.408
13:14:07.872	China Lake ADOCS 11(105.11)	CDC3_FCTC 20(98.20)	1026	3066	14253.915
10:30:49.321	China Lake IP Phone 182(105.182)	Call Manager(96.242)	GCCS-M 4.X TMS (2000)	2880	13417.283
10:31:19.350	China Lake IP Phone 182(105.182)	Call Manager(96.242)	GCCS-M 4.X TMS (2000)	2640	12793.5
14:12:18.306	105.43	CDC3_FCTC 20(98.20)	1026	5588	12383.498
13:44:41.721	AADC plan9pc(108.83)	CDC3_FCTC 20(98.20)	1026	6340	12095.783
13:26:40.727	105.49	CDC3_FCTC 20(98.20)	1026	40722	11864.706
12:15:01.177	108.125	CDC3_FCTC 20(98.20)	1409	9252	10822.843
09:48:58.795	China Lake IP Phone 182(105.182)	Call Manager(96.242)	GCCS-M 4.X TMS (2000)	2280	10413.534
14:20:19.722	108.122	CDC3_FCTC 20(98.20)	1026	1924	10324.534
14:19:52.766	108.122	CDC3_FCTC 20(98.20)	1026	155514	10302.433
08:30:20.347	105.65	CDC3_FCTC 20(98.20)	1026	3562	8344.411
07:57:24.042	105.54	CDC3_FCTC 20(98.20)	1026	3558	8182.404
06:10:55.791	105.66	CDC3_FCTC 20(98.20)	1026	10246	8181.212
07:54:22.324	China Lake LAWS 14(105.14)	CDC3_FCTC 20(98.20)	1026	3934	8167.013
06:13:04.996	China Lake IP Phone 185(105.185)	Call Manager(96.242)	GCCS-M 4.X TMS (2000)	1860	7934.639
10:41:55.187	108.124	CDC3_FCTC 20(98.20)	1409	46385	7781.059
15:52:31.794	105.66	JFCOM IWS Main(128.92)	HTTP (80)	16808	7662.454
06:06:39.168	NUWC IWS-1(107.2)	CDC3_FCTC 20(98.20)	1409	30272	7500.08
15:55:17.405	105.66	JFCOM COR IWS Server(114.92)	JAVA RMI (1099)	2034	7475.094
06:13:13.776	China Lake IP Phone 186(105.186)	Call Manager(96.242)	GCCS-M 4.X TMS (2000)	1620	7312.098

Table A9-10. FCTCPAC - DREN TCP Sessions Sorted by Duration, 1 August 2002

INITIATIVE: BANDWIDTH UTILIZATION

FBE-J saw a large increase in traffic over previous Fleet Battle Experiments, due to the integration with Millennium Challenge '02 and the increased capacity of the satellite communication links. During FBE-India, both inbound and outbound traffic on CORONADO typically averaged around 500 Kbps, while for Juliet the overall average for CORONADO was approximately 3.26 Mbits/sec inbound and 1.39 Mbits/sec outbound (for the 12-hour period from 0600 to 1800 local, for each day starting on July 26 and ending on August 7). The following charts show the day-to-day traffic for the top application ports.

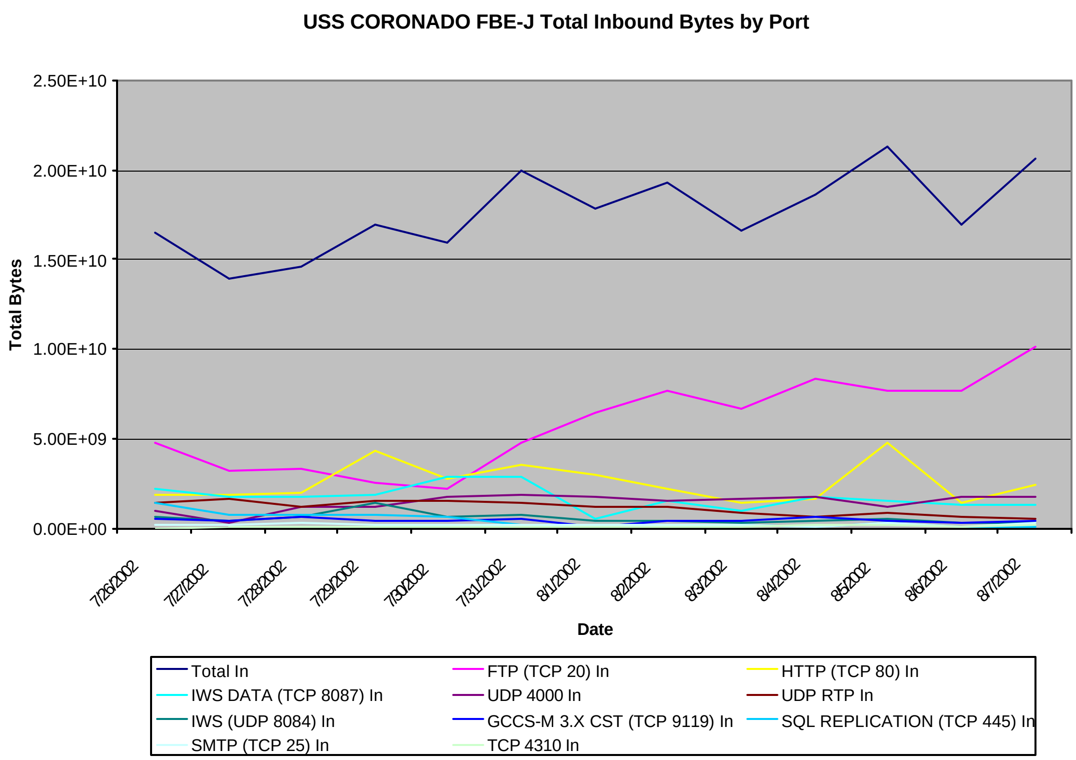

Figure A9-16. USS Coronado Total Inbound Bytes by Port

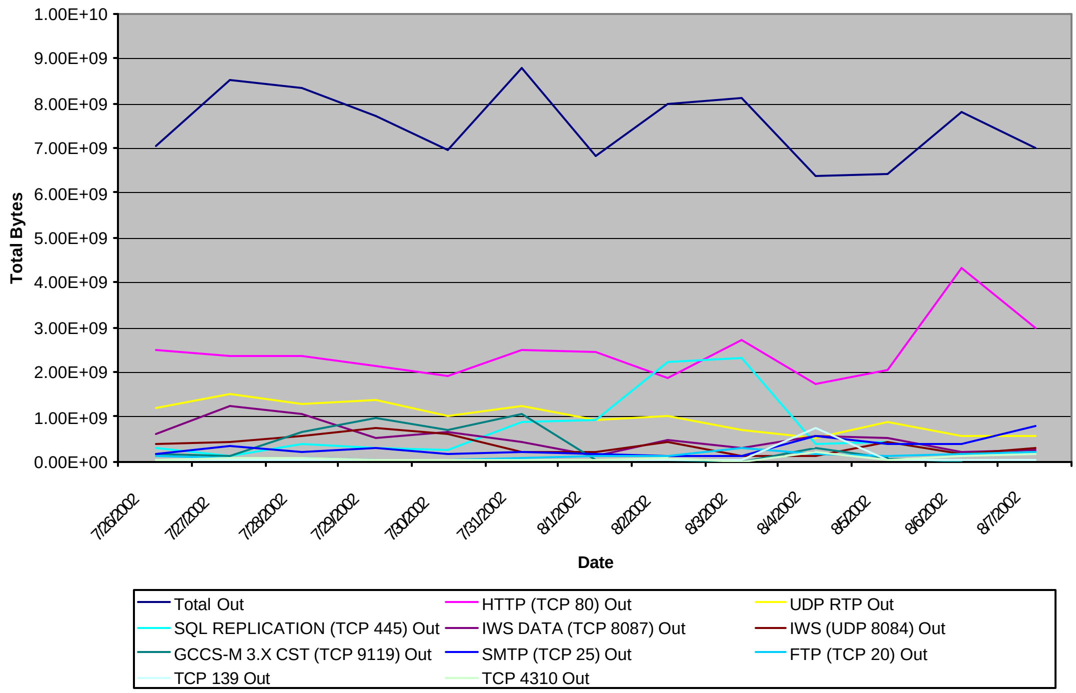

Figure A9-17. USS Coronado Total Outbound Bytes by Port

Notice that there was a slight overall trend in increasing traffic, with the overall traffic peaking out on July 31 (the second and last day CORONADO was underway during FBE-J). The total input traffic exhibited a slight upward trend, also reflected in the total FTP traffic. The following table shows numerical totals for daily traffic, broken into two intervals for readability.

DESTINATION PORT	26-Jul	27-Jul	28-Jul	29-Jul	30-Jul	31-Jul
TOTAL	24526283332	23222658315	22993727077	24764900460	22986344122	28778175262
Total In	16453227517	13939230337	14560566435	16931531040	15977403682	19929930697
TCP Total In	12593393482	10593042187	11088318690	12210517312	11333115315	14865835575
Total Out	7033629524	8518810897	8332822957	7720428367	6975412132	8776864125
FTP (TCP 20) In	4785209737	3181069500	3322900882	2531716357	2246510895	4771363545
TCP Total Out	4459409264	5287622767	5726870662	4941633825	4457980132	6020606047
UDP Total In	3793641779	3264949537	3397622880	4688527297	4596304987	4983228075
HTTP (TCP 80) In	1853700622	1905972360	1972141267	4305468142	2821858087	3514537245
HTTP (TCP 80) Out	2488702649	2363831737	2340072097	2135215432	1895825340	2474035530
UDP Total Out	2507617912	3149082225	2526630555	2746710907	2463056302	2716985190
UDP Multicast In	1358768354	684860910	1595692402	1668821542	2192409690	2375114812
IWS DATA (TCP 8087) In	2198016270	1798104960	1723041465	1839807990	2916391035	2927057475
UDP 4000 In	1007354730	346551810	1186512997	1232091277	1788759772	1873080480
UDP RTP In	1415745397	1630130107	1248096300	1554268305	1530328455	1457879790
UDP RTP Out	1211703022	1507962997	1283341065	1363276492	1032369165	1257485932
SQL REPLICATION (TCP 445) Out	305944687	125717805	415046190	316717132	261975607	880962157
IWS (UDP 8084) In	671382420	457212367	646662922	1435701615	706924800	796394437
IWS DATA (TCP 8087) Out	602333009	1239222360	1054483597	522314475	678828292	454135635
GCCS-M 3.X CST (TCP 9119) In	575275034	415992427	710226540	414388035	433704165	552742177
SQL REPLICATION (TCP 445) In	1387892842	758438347	737309595	728902612	717618765	224620740
IWS (UDP 8084) Out	376740772	462086445	579771577	773058390	605606437	219578512
GCCS-M 3.X CST (TCP 9119) Out	167495580	146960167	681821122	994277497	708582817	1071265650
SMTP (TCP 25) Out	173490255	348970965	204089040	323158717	156976012	229294935
UDP Multicast Out	357891532	446638732	436226490	200699917	221000872	335004532
SMTP (TCP 25) In	224510707	188578207	280678162	210011250	182831775	261399570

Table A9-11. USS Coronado Daily Traffic by Top Ports, 26-31 July 2002

DESTINATION PORT	1-Aug	2-Aug	3-Aug	4-Aug	5-Aug	6-Aug	7-Aug
TOTAL	24725813437	27320497200	24787129785	24971844787	27770747317	24914470387	27752742187
Total In	17858041312	19264960222	16617541657	18574615597	21302477775	16984214887	20690010015
TCP Total In	14333059102	15416671162	12509614965	14978571165	17813956650	13535291909	17420761222
Total Out	6832162387	7975538700	8129183047	6375898882	6433488030	7807817692	7026700035
FTP (TCP 20) In	6438694290	7661494807	6667851142	8311721062	7659824490	7707821301	10130108025
TCP Total Out	5251067167	5693045182	6440616682	5034104955	4372738920	6418664782	5546797515
UDP Total In	3481478902	3797003190	4073696295	3561047812	3447585525	3436857660	3249071910
HTTP (TCP 80) In	3032847210	2226411810	1437336795	1643129190	4791952320	1480565189	2444627107
HTTP (TCP 80) Out	2459109945	1851017820	2728563510	1740084052	2041673565	4335835386	2982118222
UDP Total Out	1536896880	2231073097	1650654195	1300303950	2014266952	1376818724	1460315445
UDP Multicast In	2237211780	1950388275	2035312597	2183655367	1619056867	2119367722	2043566235
IWS DATA (TCP 8087) In	506896140	1546147860	1047061687	1793292127	1558474642	1349474114	1384140795
UDP 4000 In	1758059287	1532928667	1666150710	1789027702	1263508275	1791421671	1733729970
UDP RTP In	1187306730	1216465357	930840510	685644720	856880242	656844636	506027407
UDP RTP Out	917193630	1040298337	706023030	535199235	872648962	556280444	591930922
SQL REPLICATION (TCP 445) Out	927779010	2219970007	2324634112	381184650	453386467	154499422	223238925
IWS (UDP 8084) In	392010652	389496750	301016092	479175202	532835385	365538726	374494650
IWS DATA (TCP 8087) Out	117249960	505400115	288160747	556654065	536107785	218411204	274368007
GCCS-M 3.X CST (TCP 9119) In	40590570	424230795	411785587	640857022	453823972	292725682	405065010
SQL REPLICATION (TCP 445) In	205885785	193322745	161751712	102947242	295409242	77677049	125109450
IWS (UDP 8084) Out	217966455	423943597	126179932	119065275	443409210	196852124	327450667
GCCS-M 3.X CST (TCP 9119) Out	42919485	50619885	12916147	305156835	97627552	7671727	8315002
SMTP (TCP 25) Out	189486030	137190345	132900367	567074107	409001677	418257246	811154092
UDP Multicast Out	279494407	220670805	105576435	119794192	114237225	77565914	105927195
SMTP (TCP 25) In	201181725	177816322	187110210	140216490	295929007	119474631	289268332

Table A9-12. USS Coronado Daily Traffic by Top Ports, 1-7 August 2002

The day-by-day breakdown of FBE-J traffic to and from CORONADO is shown in the following figures:

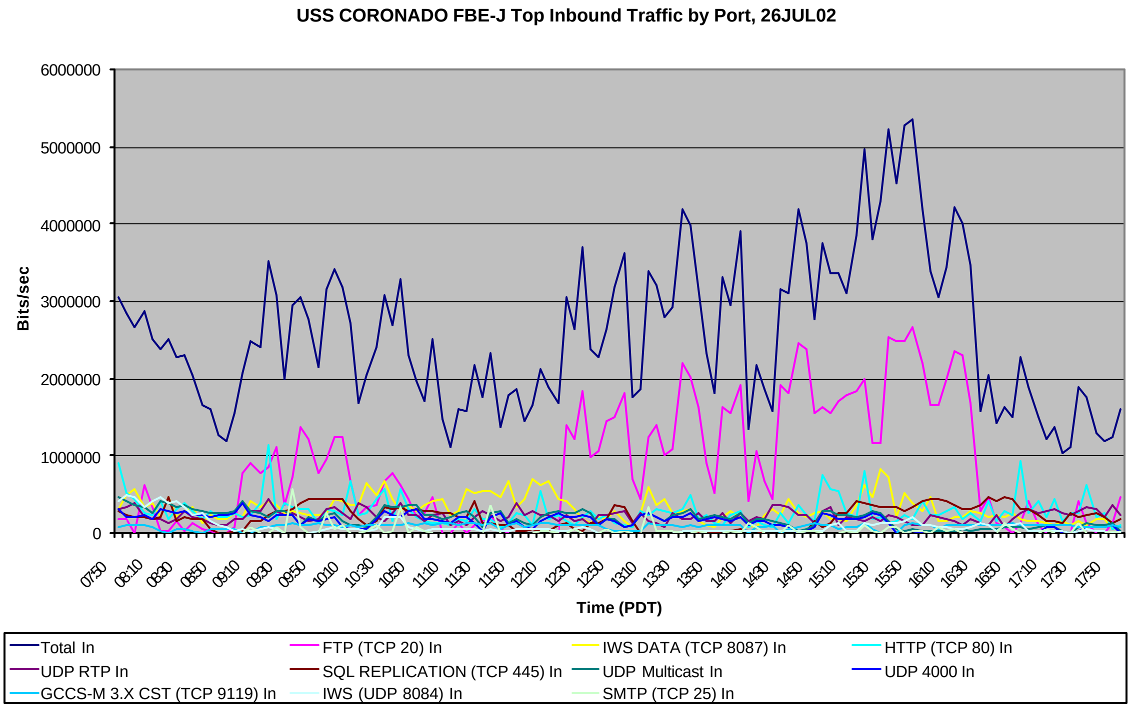

Figure A9-18. USS Coronado Top Inbound Traffic by Port, 26 July 02

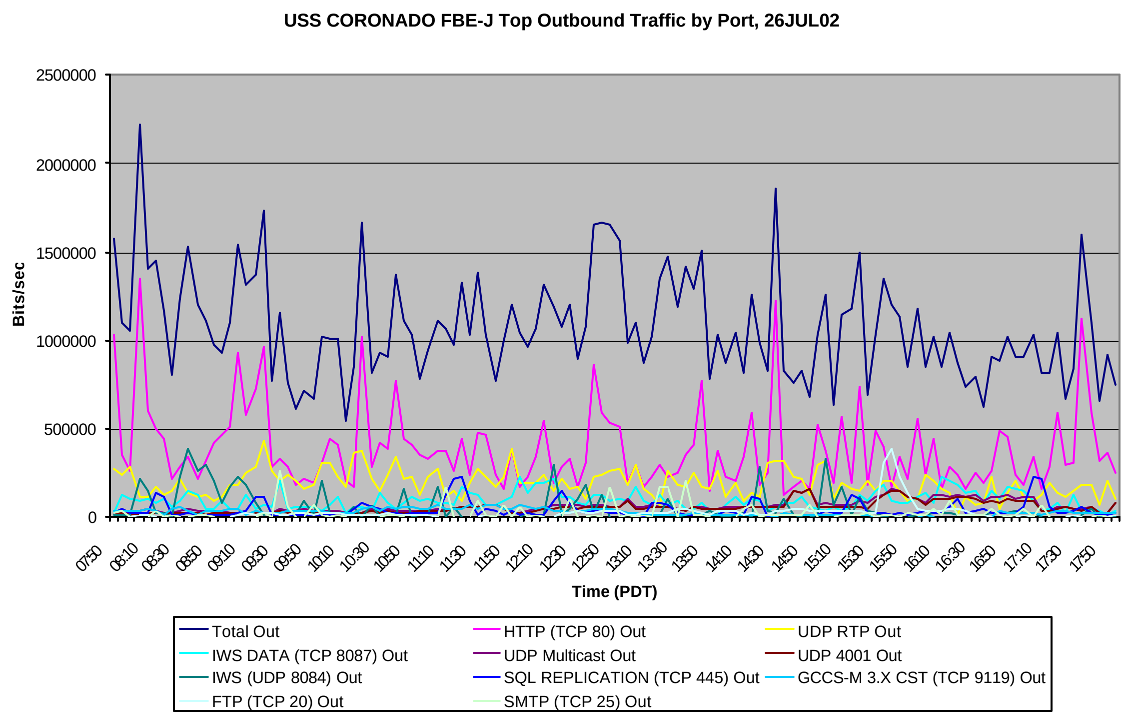

Figure A9-19. USS Coronado Top Outbound Traffic by Port, 26 July 02

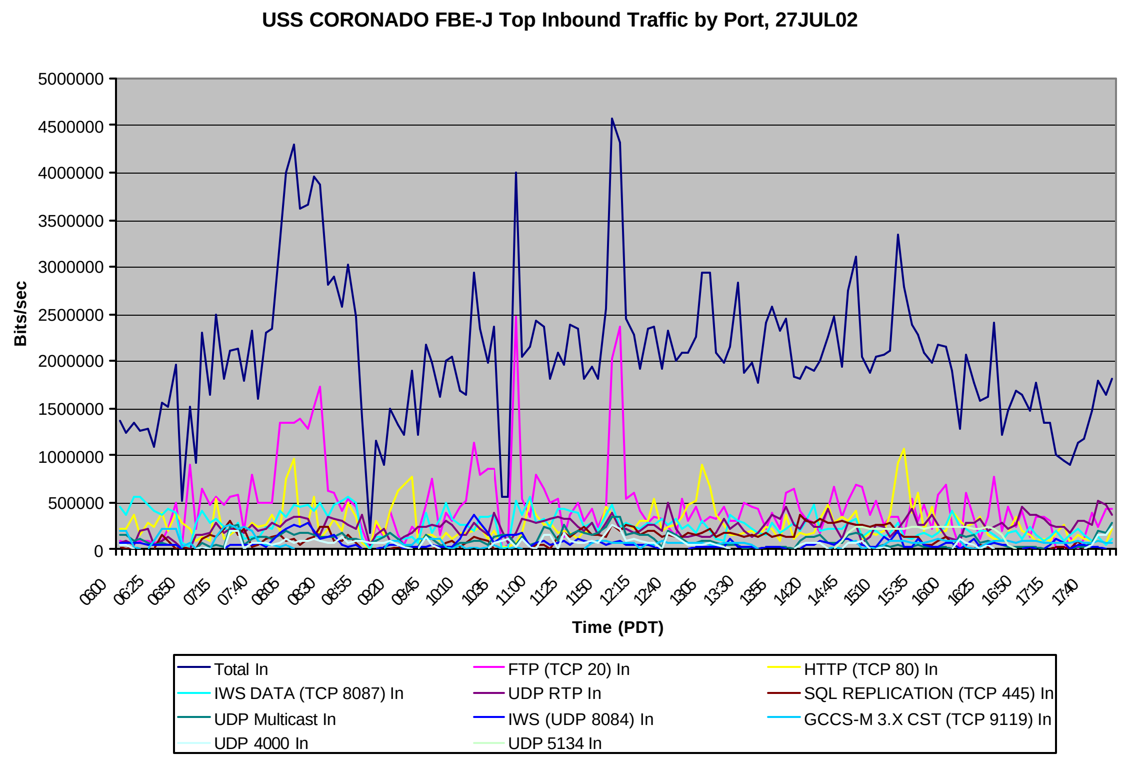

Figure A9-20. USS Coronado Top Inbound Traffic by Port, 27 July 02

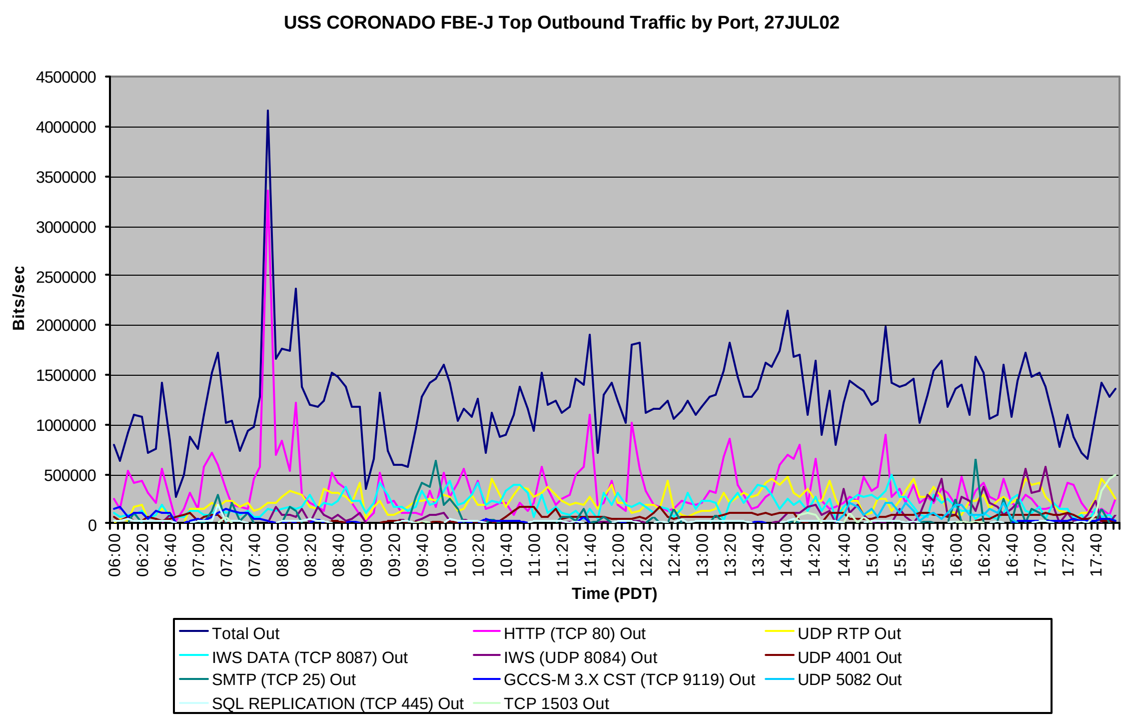

Figure A9-21. USS Coronado Top Outbound Traffic by Port, 27 July 02

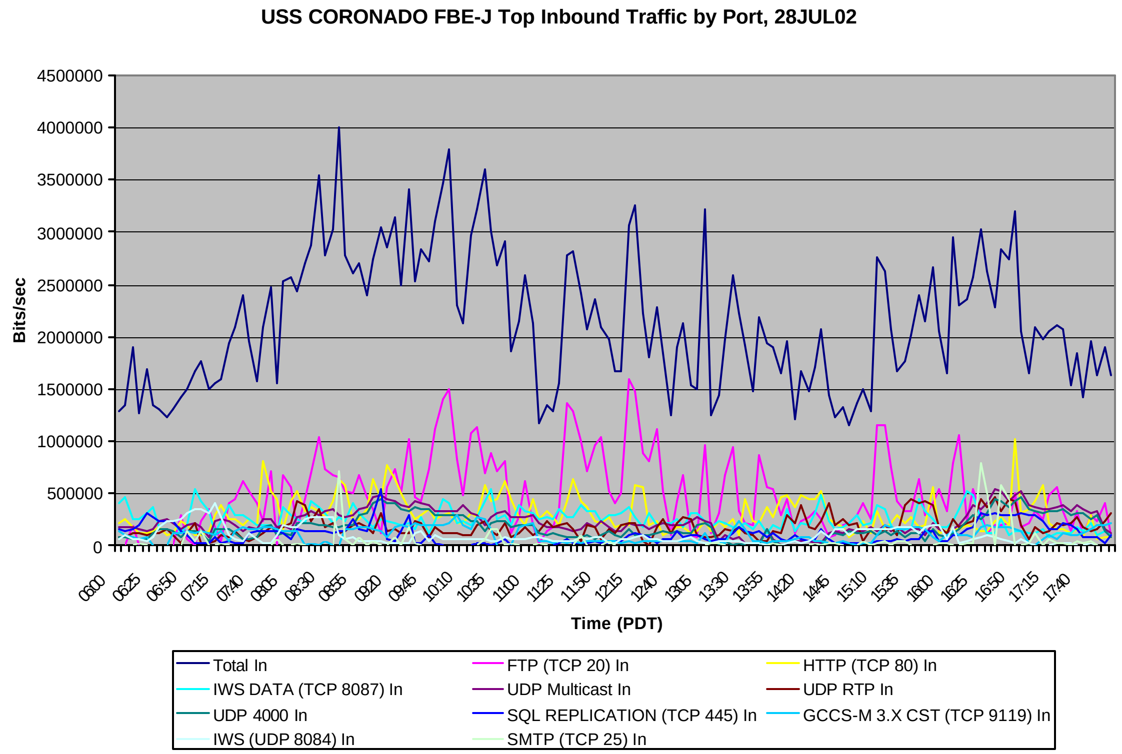

Figure A9-22. USS Coronado Top Inbound Traffic by Port, 28 July 02

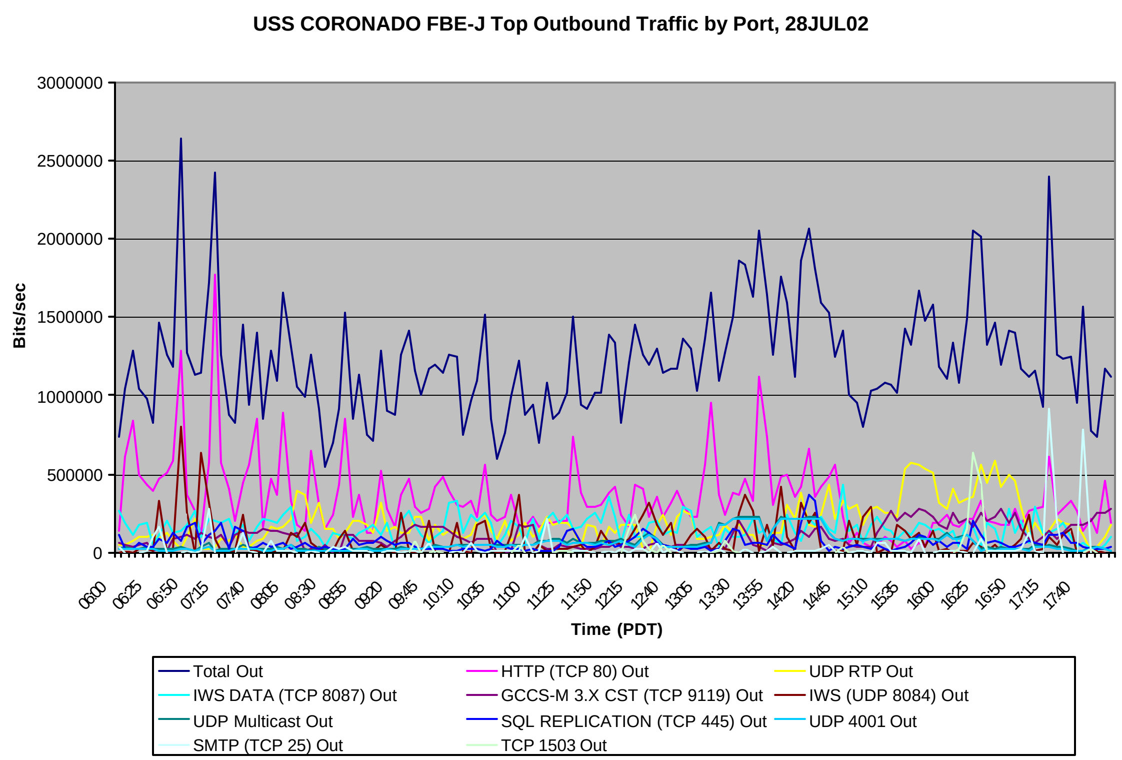

Figure A9-23. USS Coronado Top Outbound Traffic by Port, 28 July 02

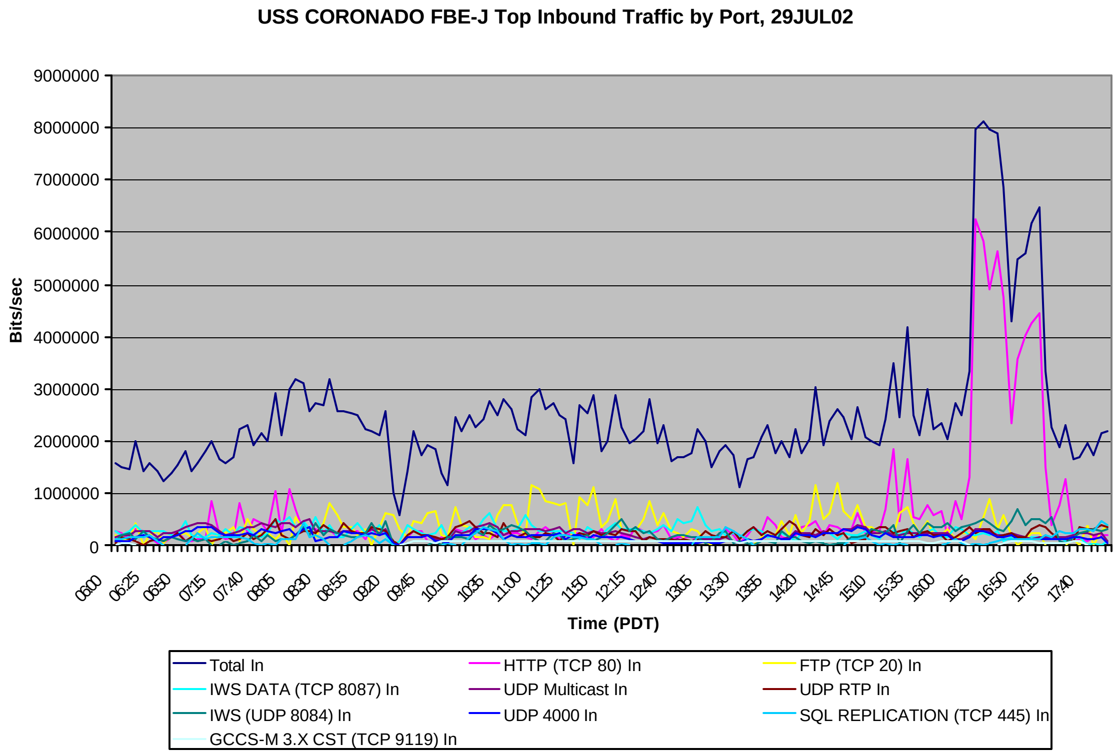

Figure A9-24. USS Coronado Top Inbound Traffic by Port, 29 July 02

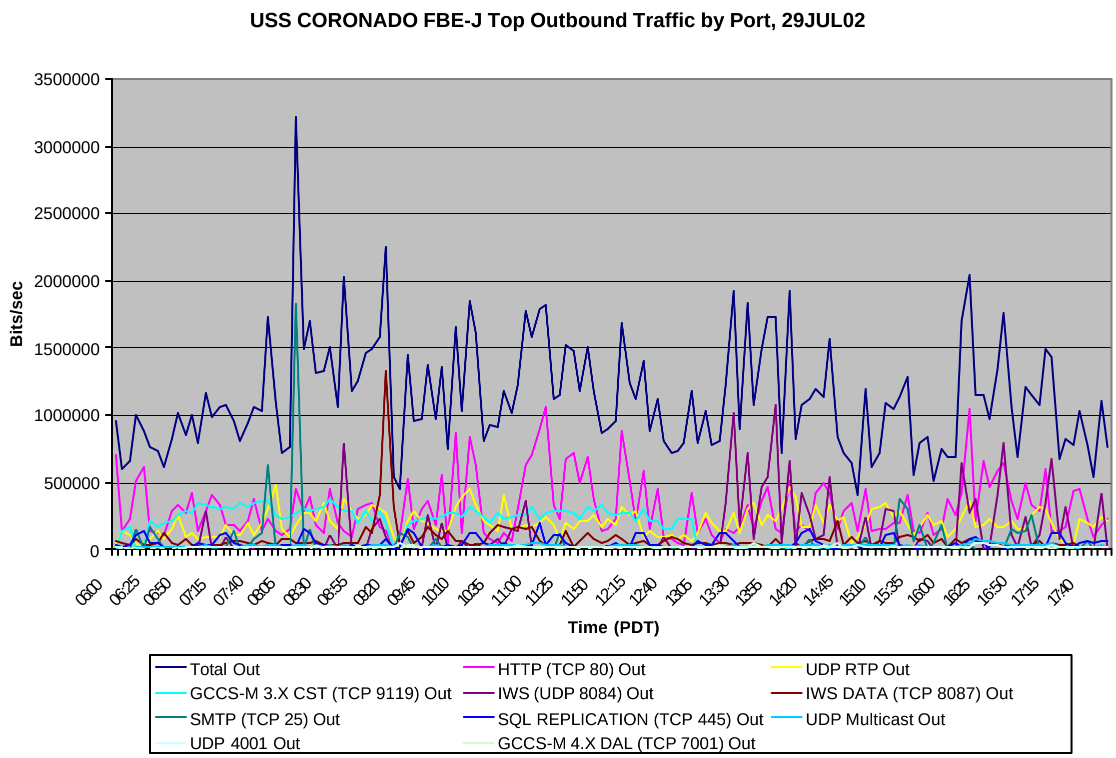

Figure A9-25. USS Coronado Top Outbound Traffic by Port, 29 July 02

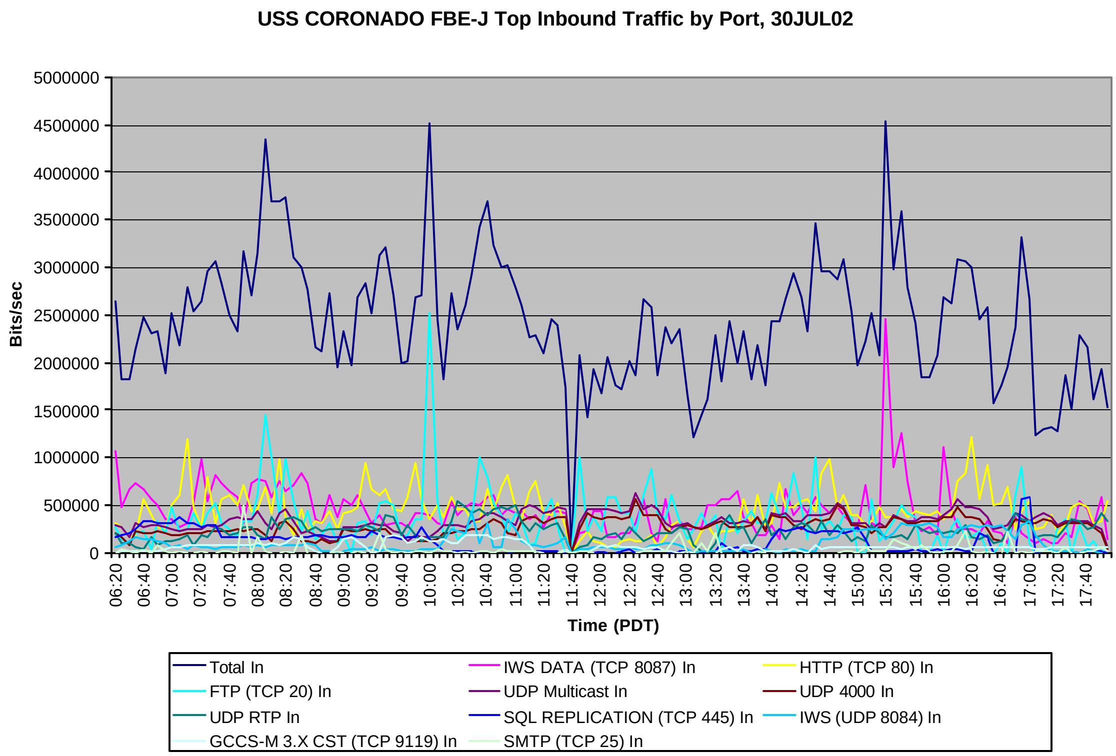

Figure A9-26. USS Coronado Top Inbound Traffic by Port, 30 July 02

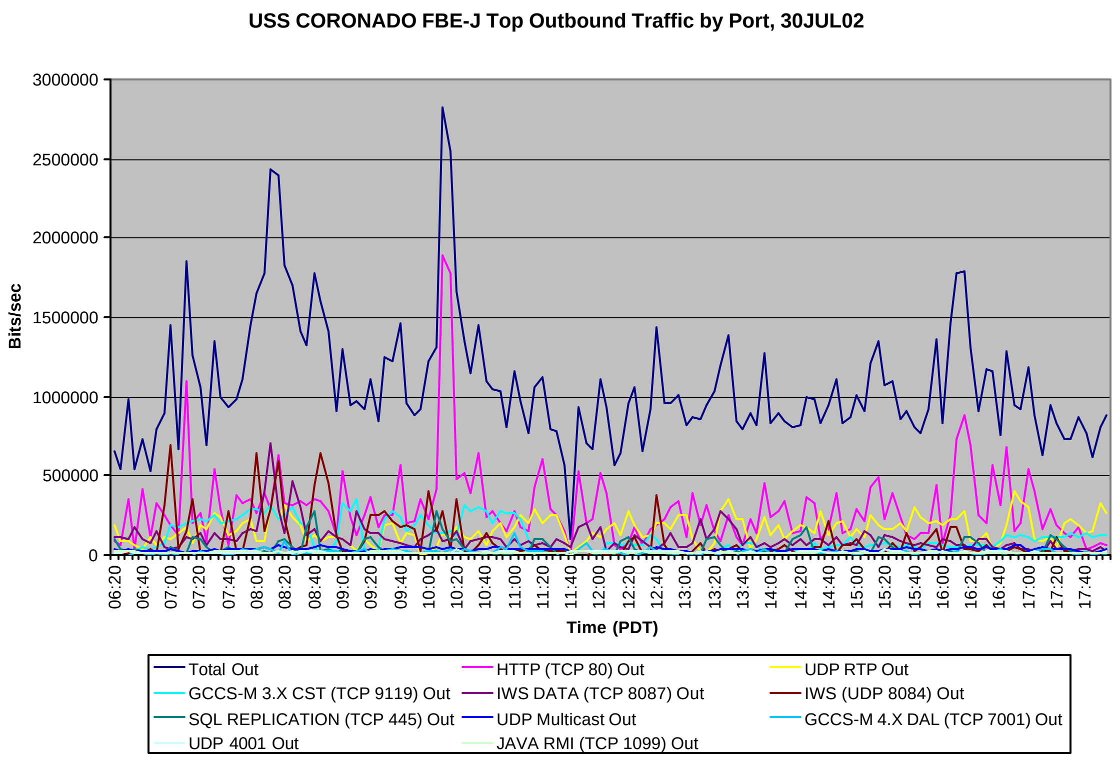

Figure A9-27. USS Coronado Top Outbound Traffic by Port, 30 July 02

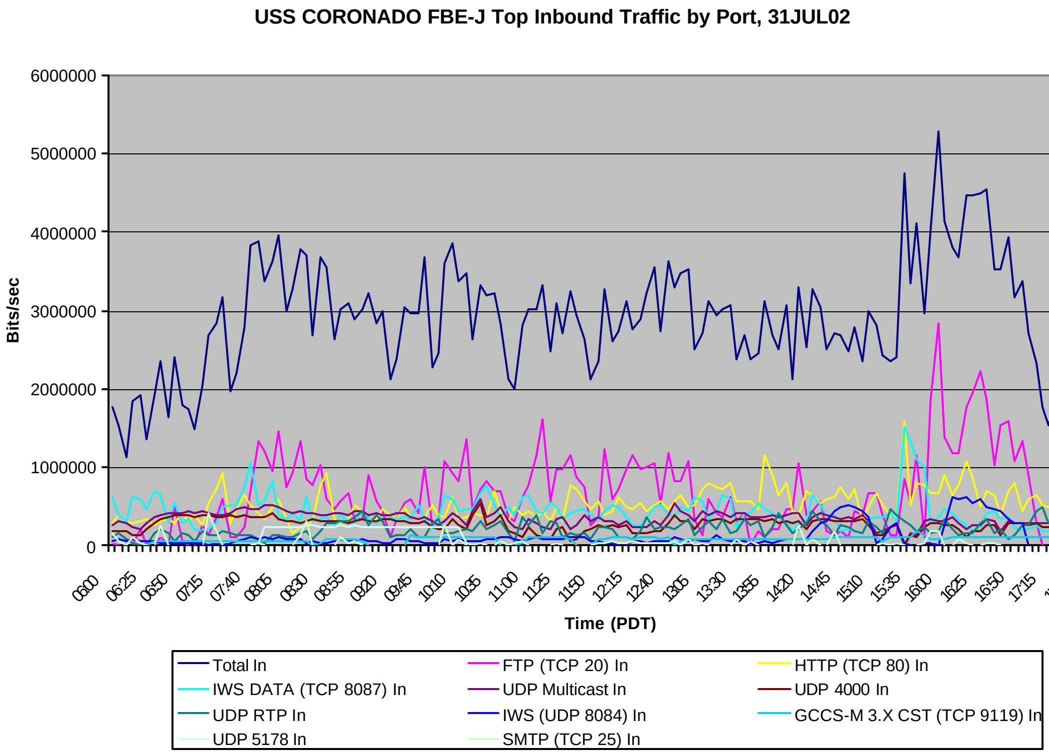

Figure A9-28. USS Coronado Top Inbound Traffic by Port, 31 July 02

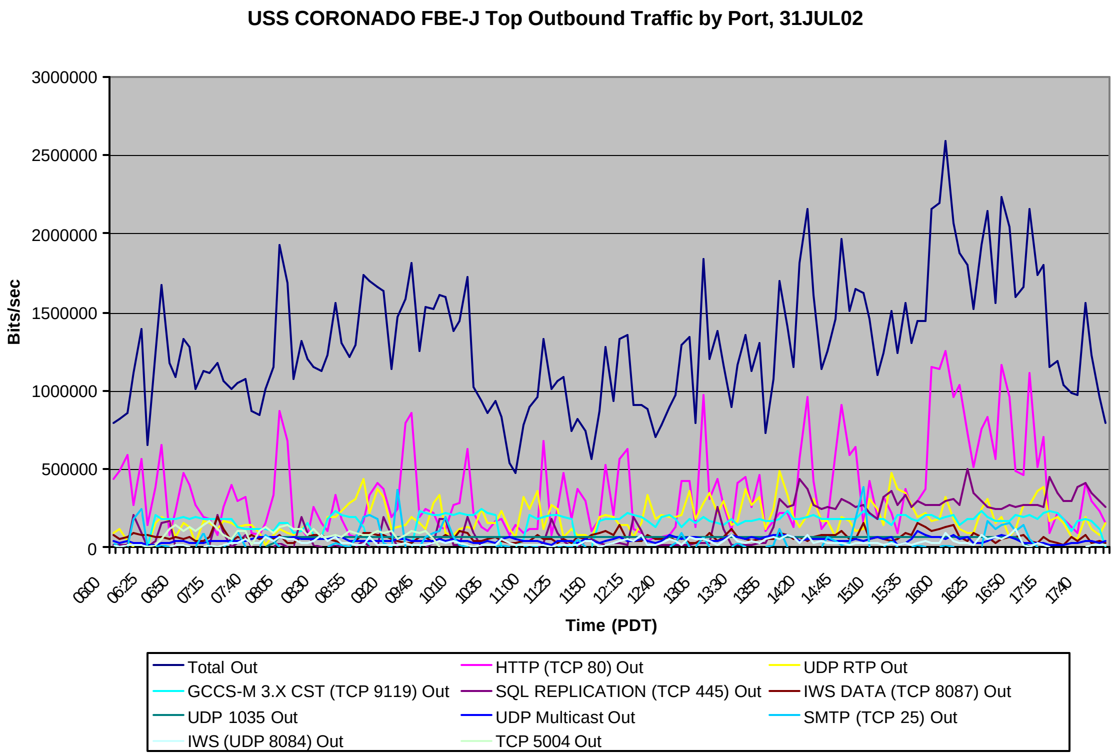

Figure A9-29. USS Coronado Top Outbound Traffic by Port, 31 July 02

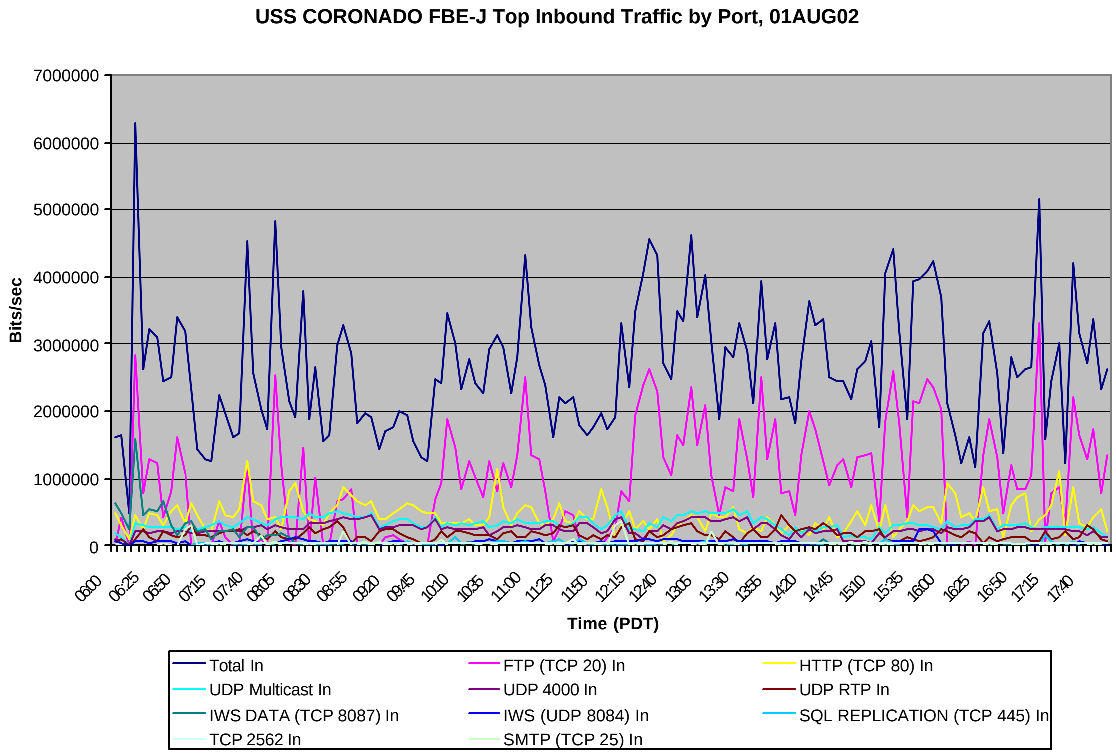

Figure A9-30. USS Coronado Top Inbound Traffic by Port, 01 August 02

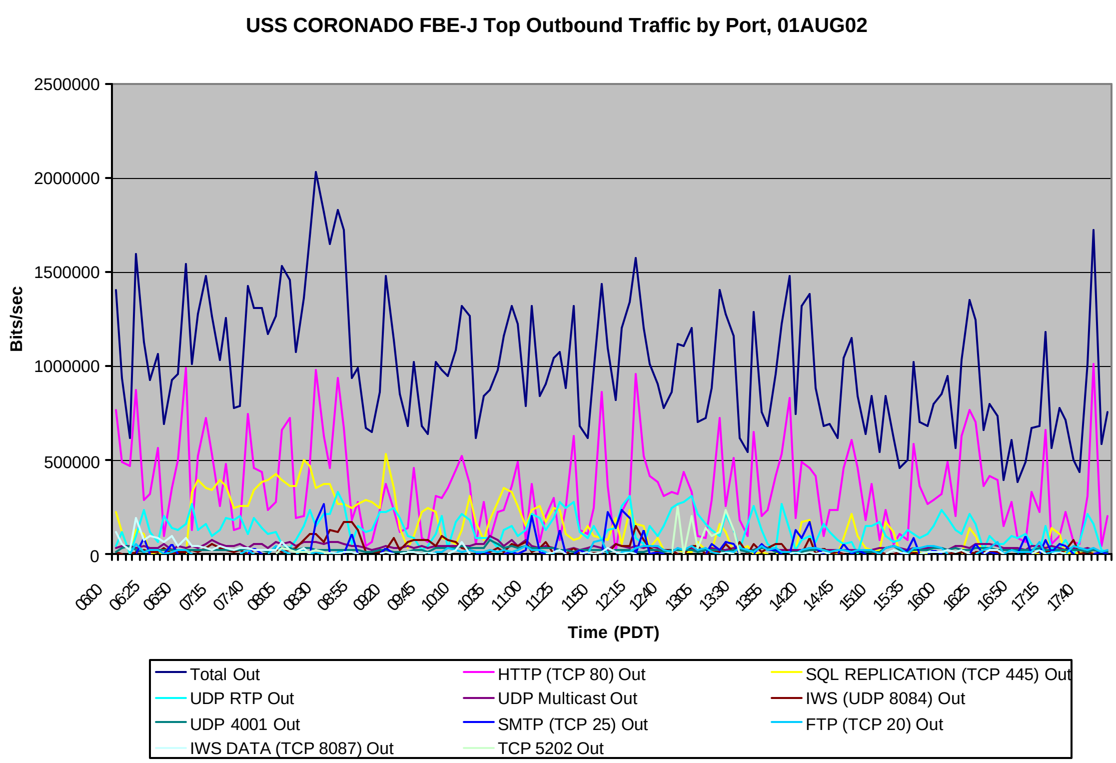

Figure A9-31. USS Coronado Top Outbound Traffic by Port, 01 August 02

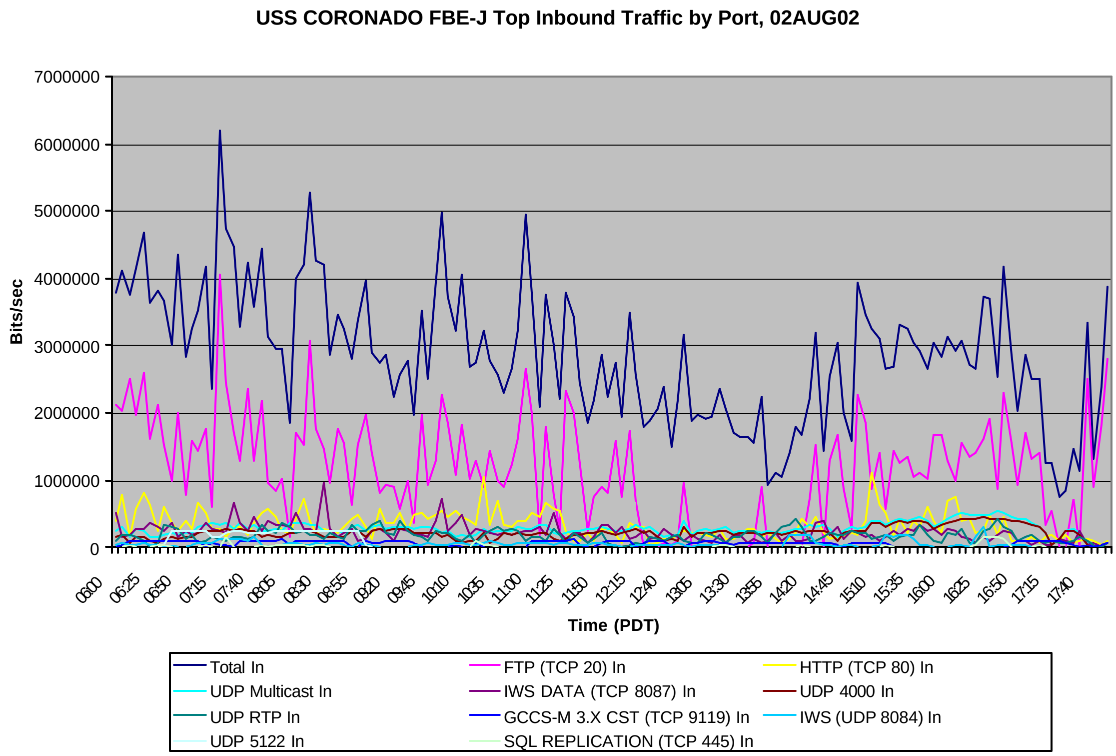

Figure A9-32. USS Coronado Top Inbound Traffic by Port, 02 August 02

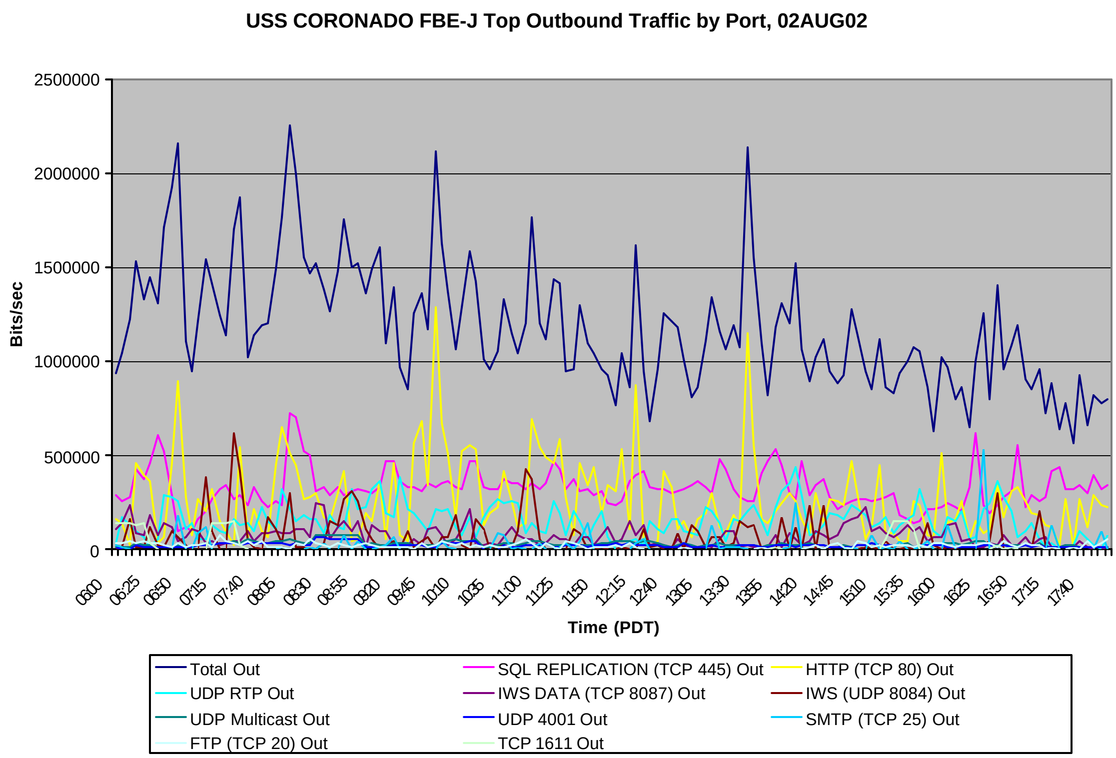

Figure A9-33. USS Coronado Top Outbound Traffic by Port, 02 August 02

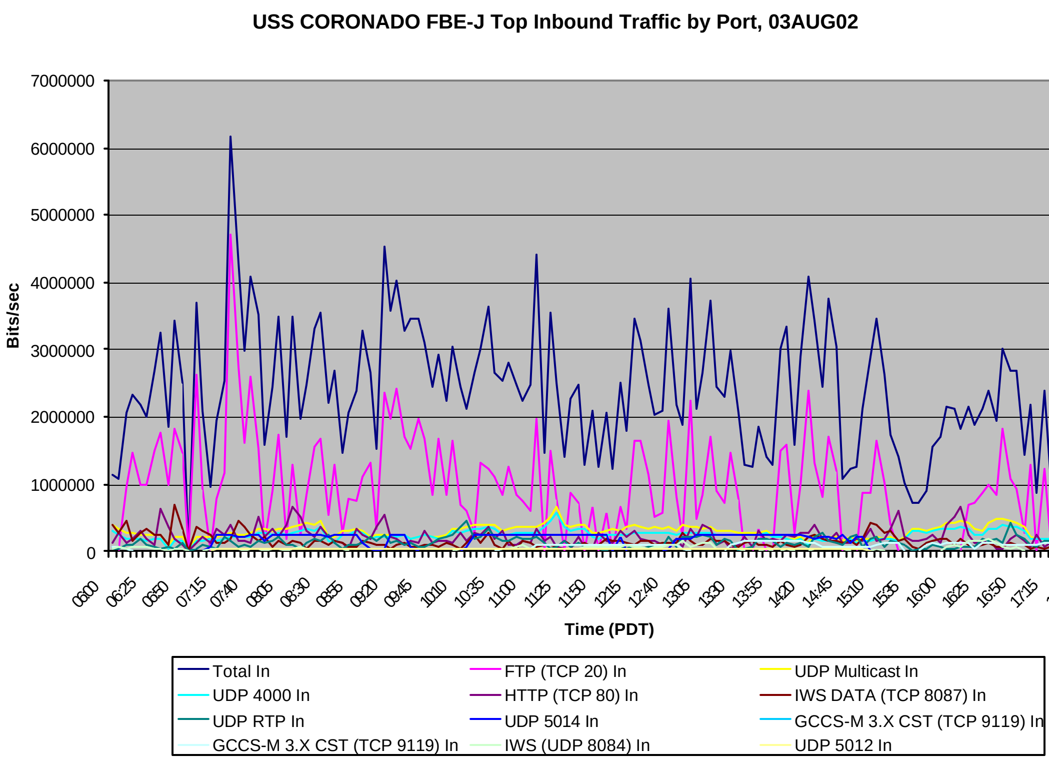

Figure A9-34. USS Coronado Top Inbound Traffic by Port, 03 August 02

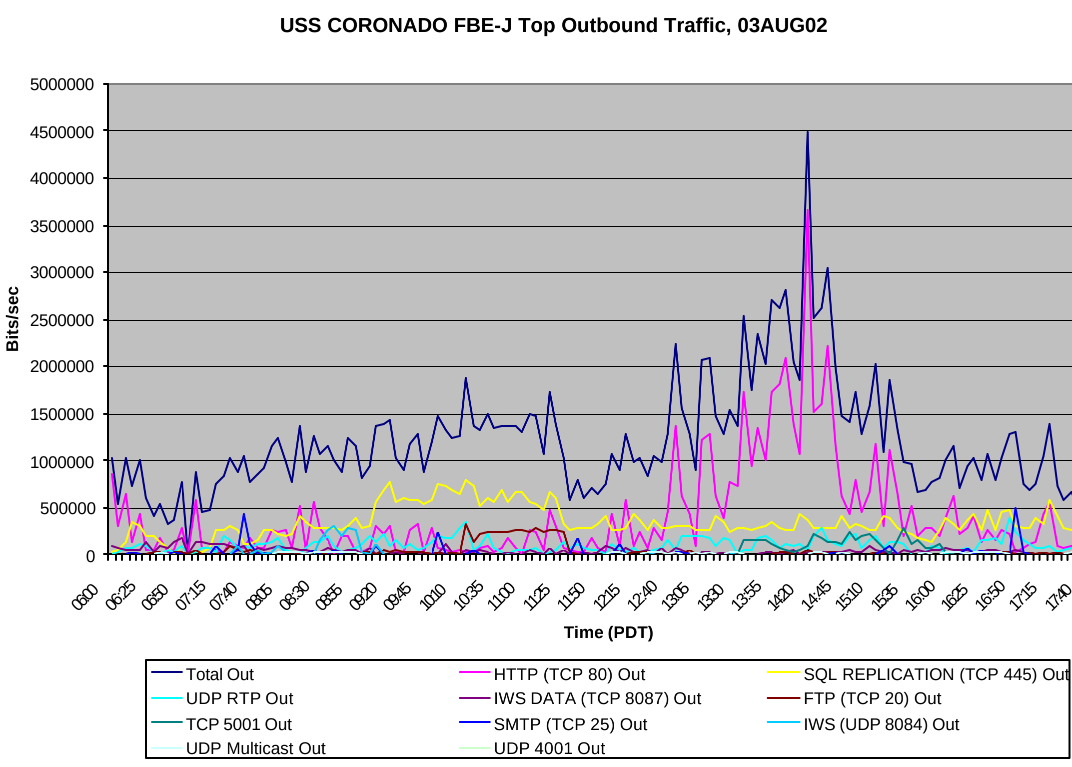

Figure A9-35. USS Coronado Top Outbound Traffic by Port, 03 August 02

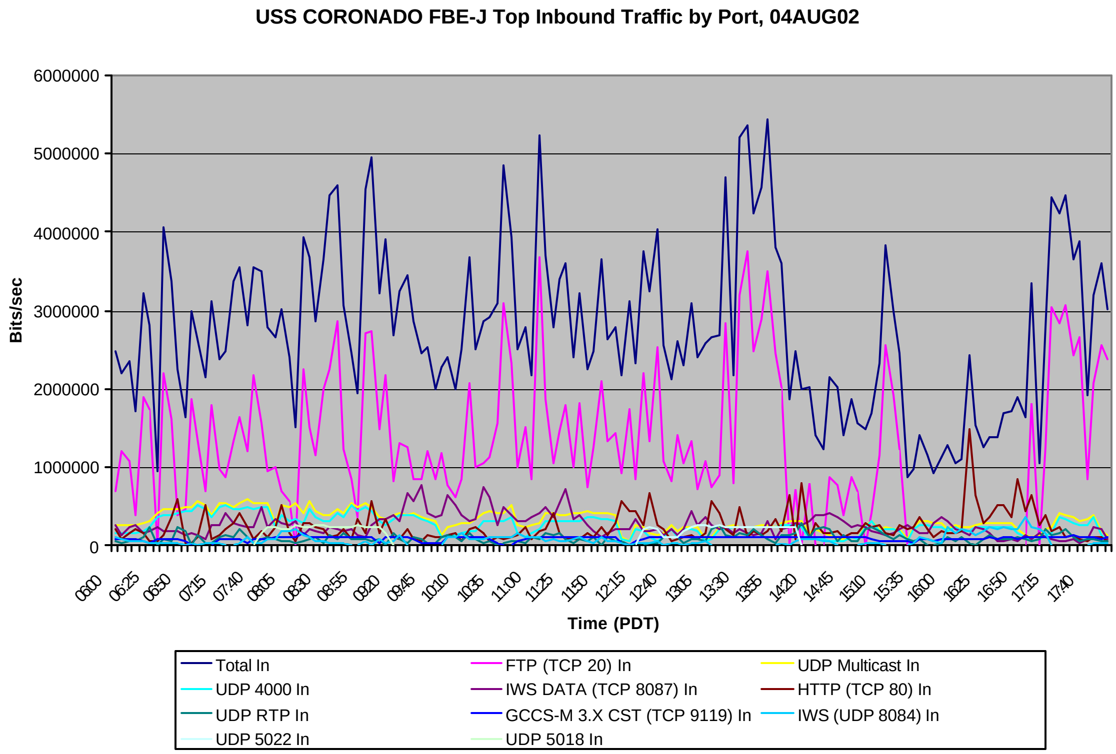

Figure A9-36. USS Coronado Top Inbound Traffic by Port, 04 August 02

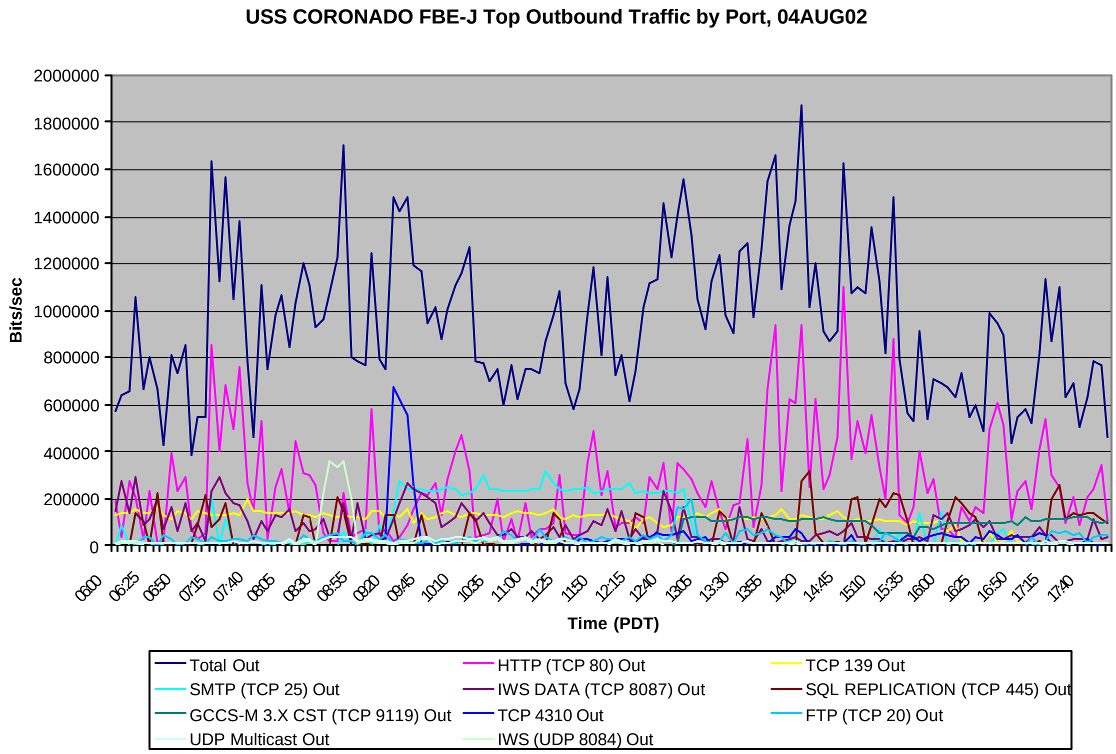

Figure A9-37. USS Coronado Top Outbound Traffic by Port, 04 August 02

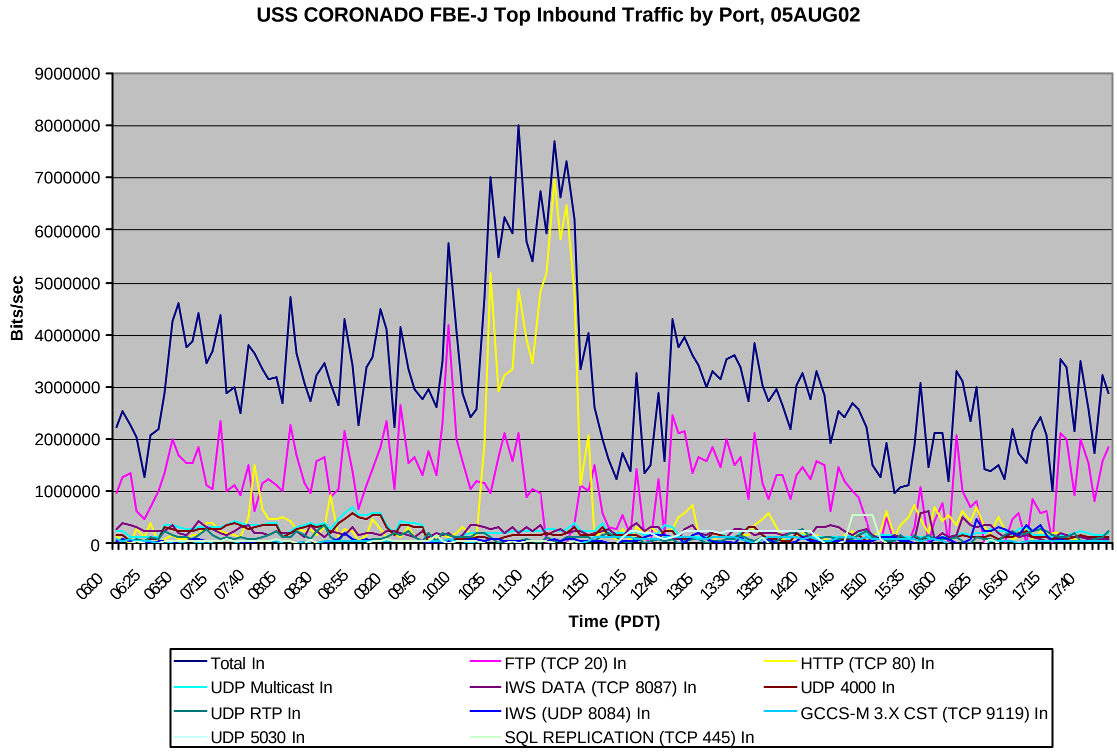

Figure A9-38. USS Coronado Top Inbound Traffic by Port, 05 August 02

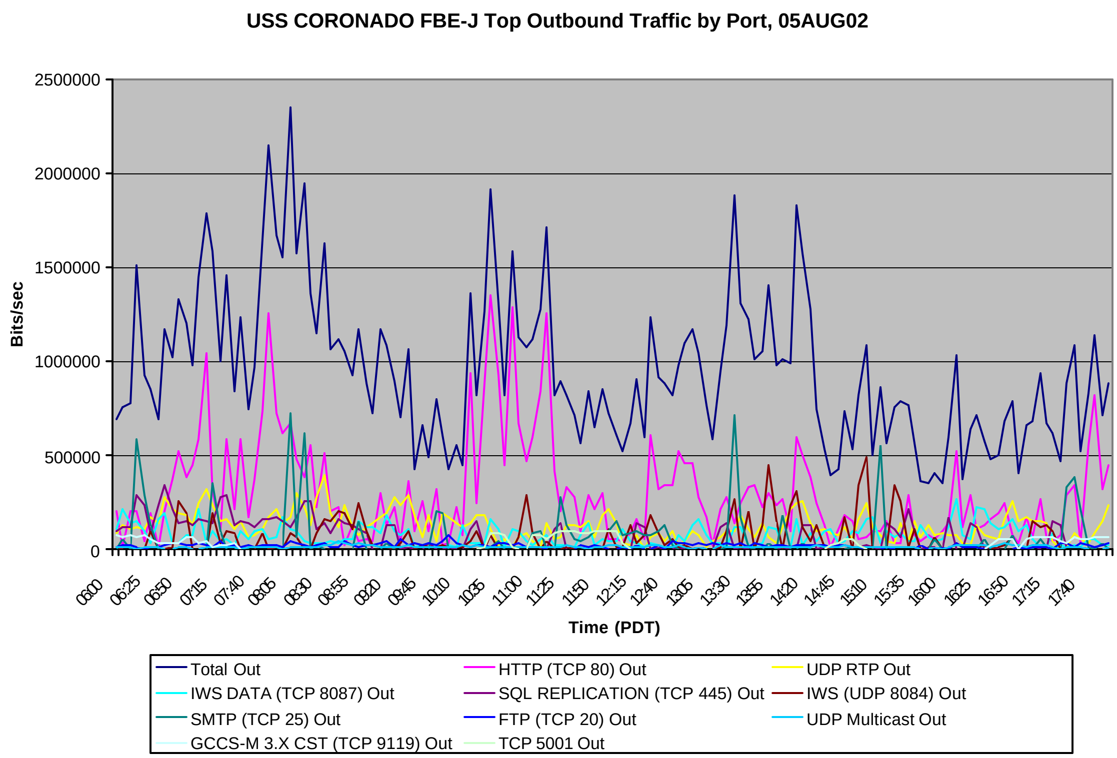

Figure A9-39. USS Coronado Top Outbound Traffic by Port, 05 August 02

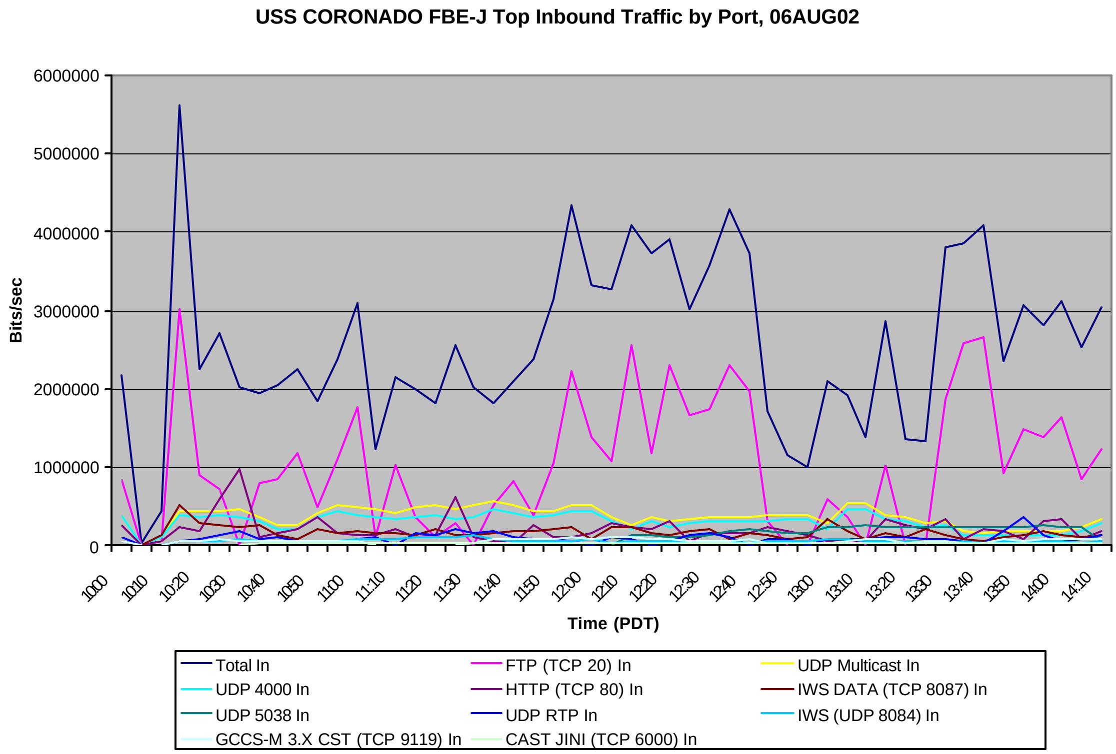

Figure A9-40. USS Coronado Top Inbound Traffic by Port, 06 August 02

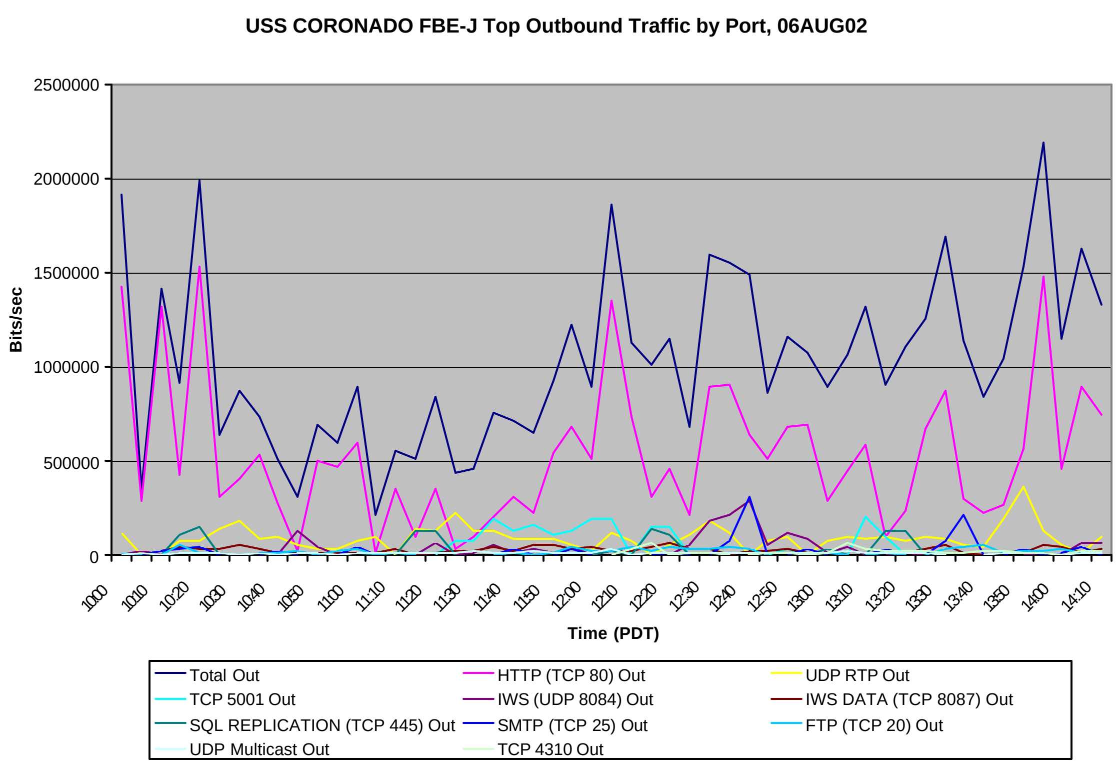

Figure A9-41. USS Coronado Top Outbound Traffic by Port, 06 August 02

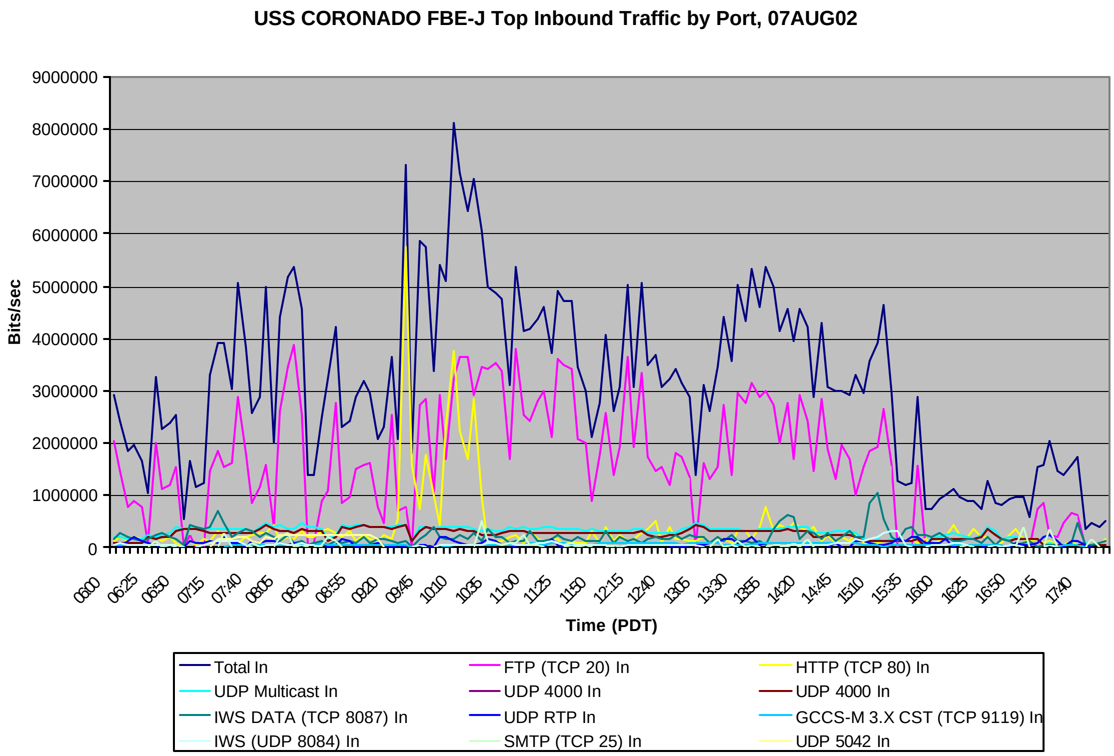

Figure A9-42. USS Coronado Top Inbound Traffic by Port, 07 August 02

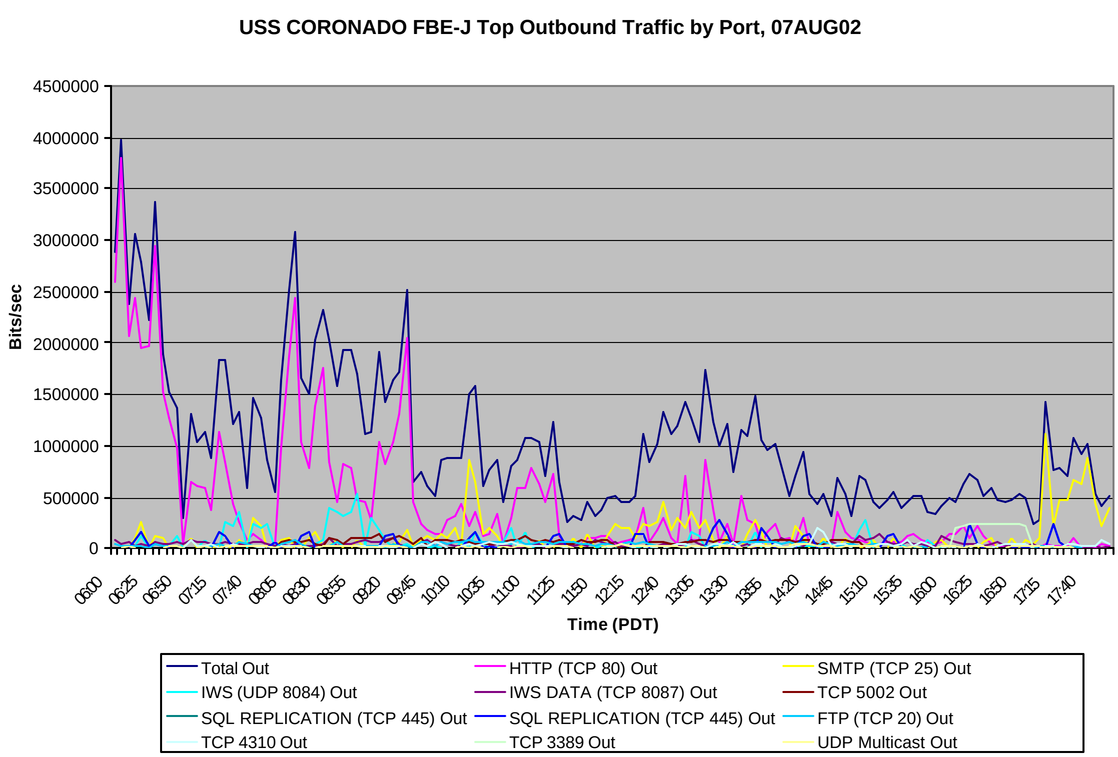

Figure A9-43. USS Coronado Top Outbound Traffic by Port, 07 August 02

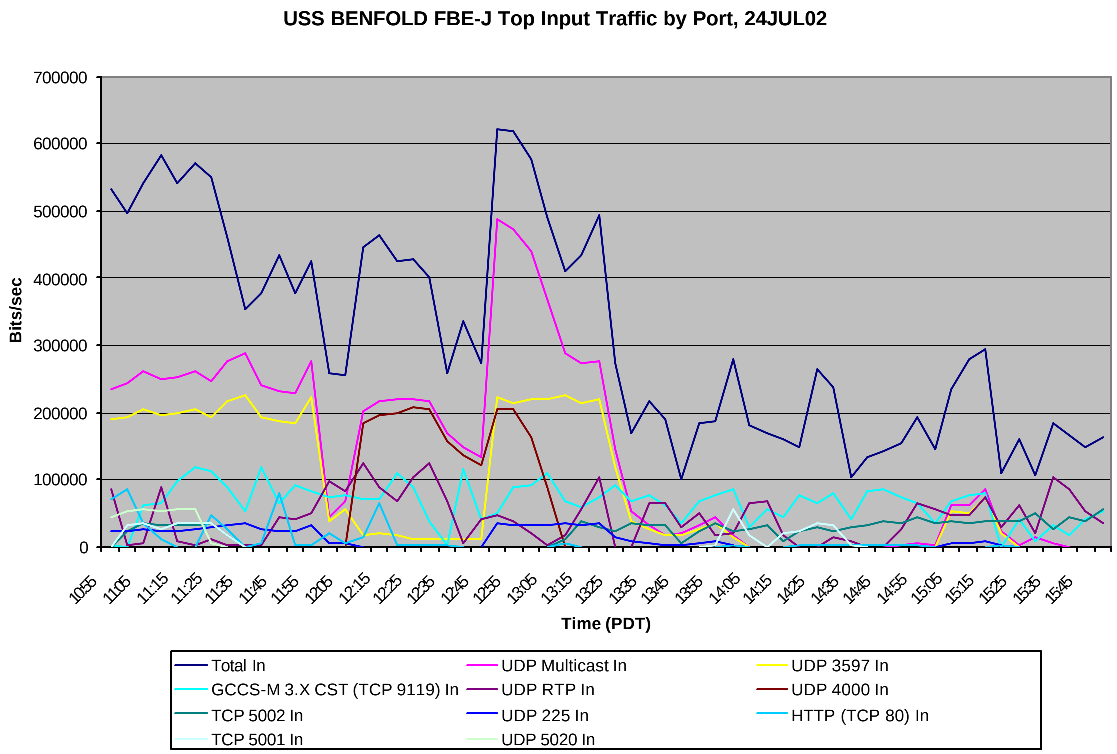

Figure A9-44. USS Benfold Top Inbound Traffic by Port, 24 July 02

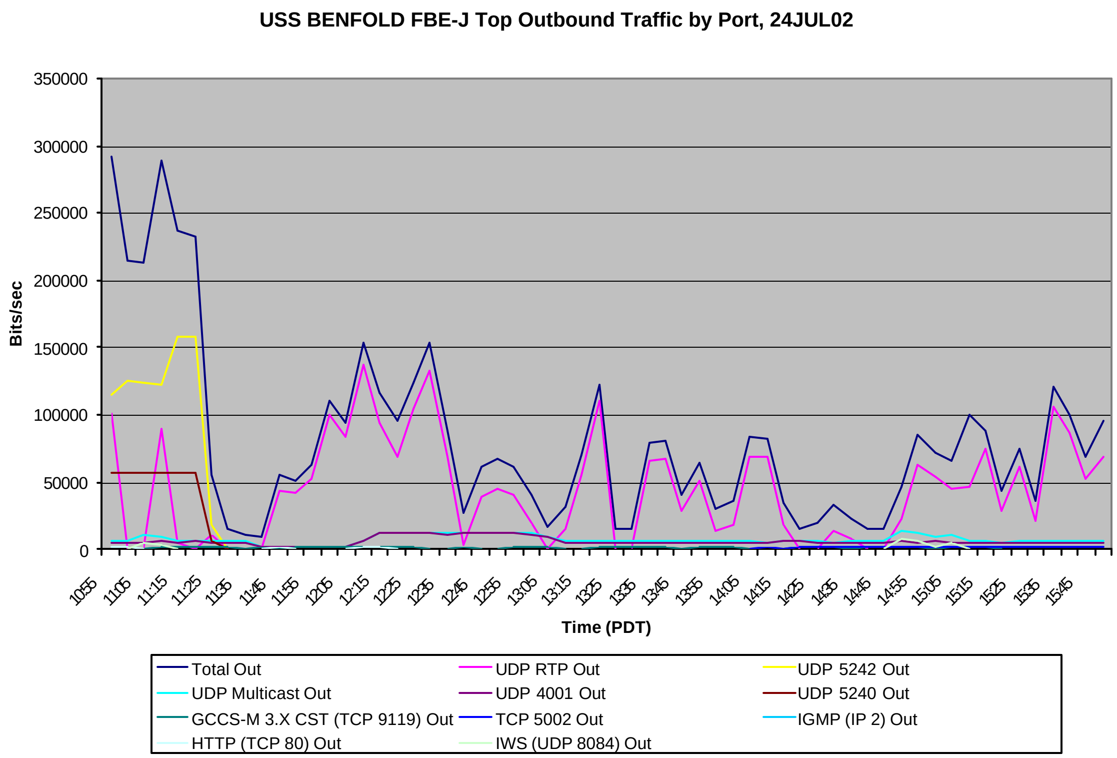

Figure A9-45. USS Benfold Top Outbound Traffic by Port, 24 July 02

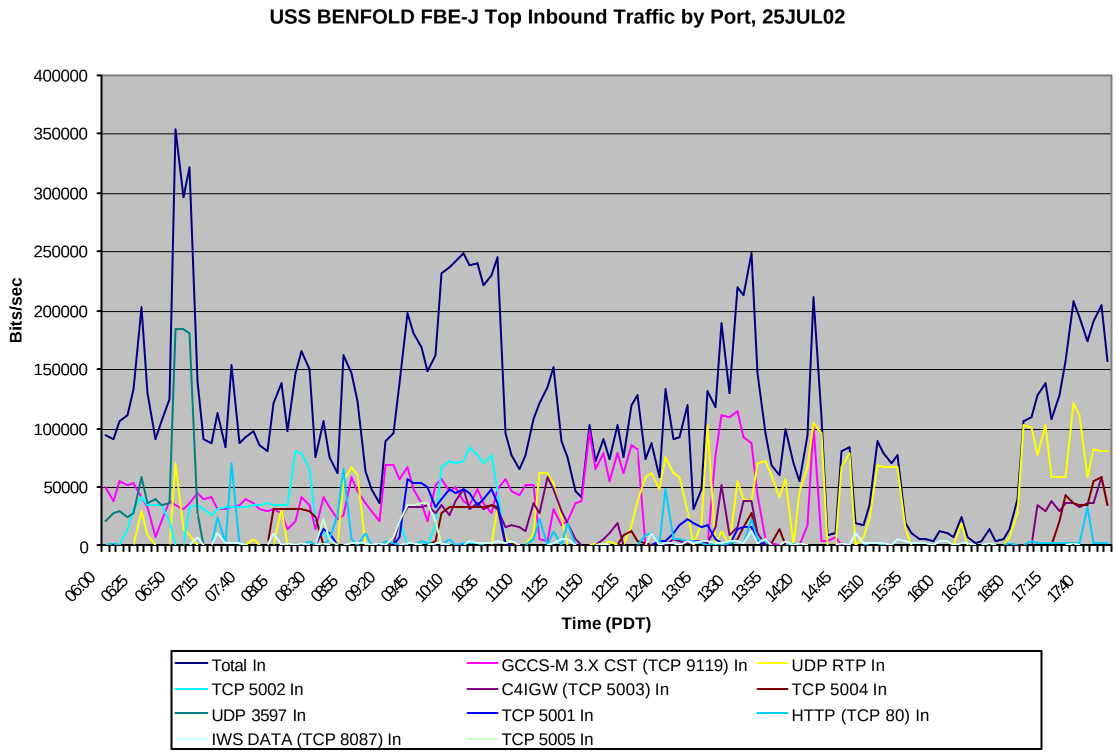

Figure A9-44. USS Benfold Top Inbound Traffic by Port, 25 July 02

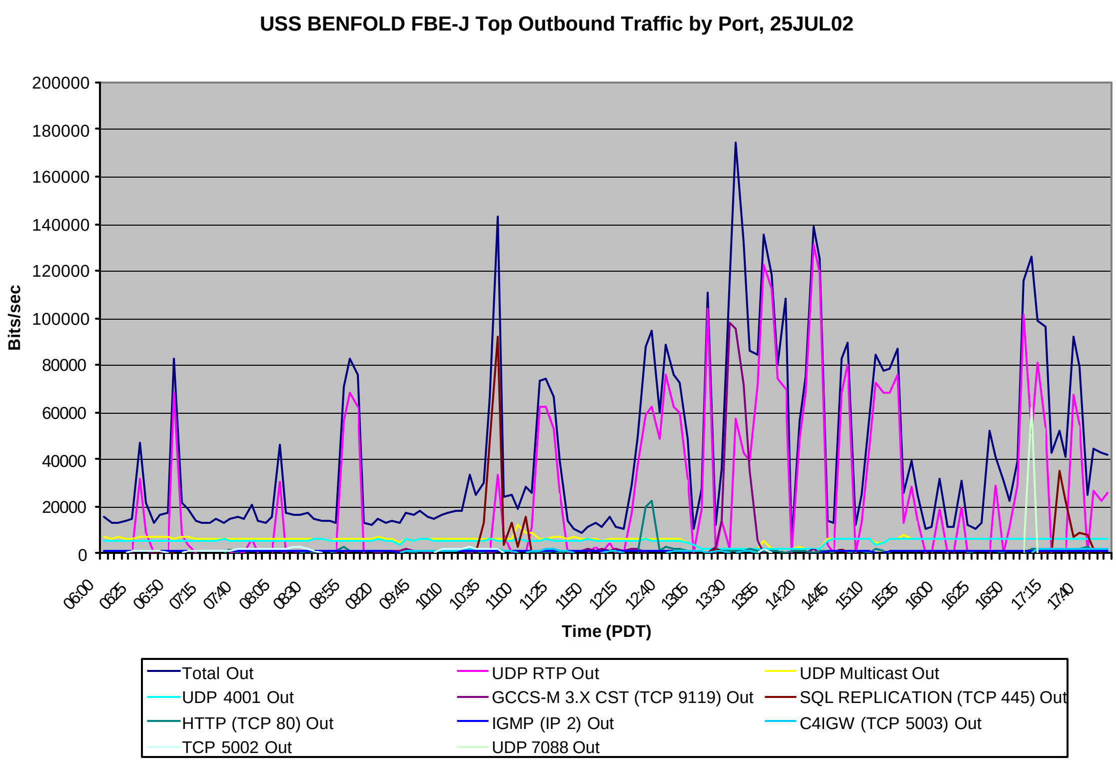

Figure A9-45. USS Benfold Top Outbound Traffic by Port, 25 July 02

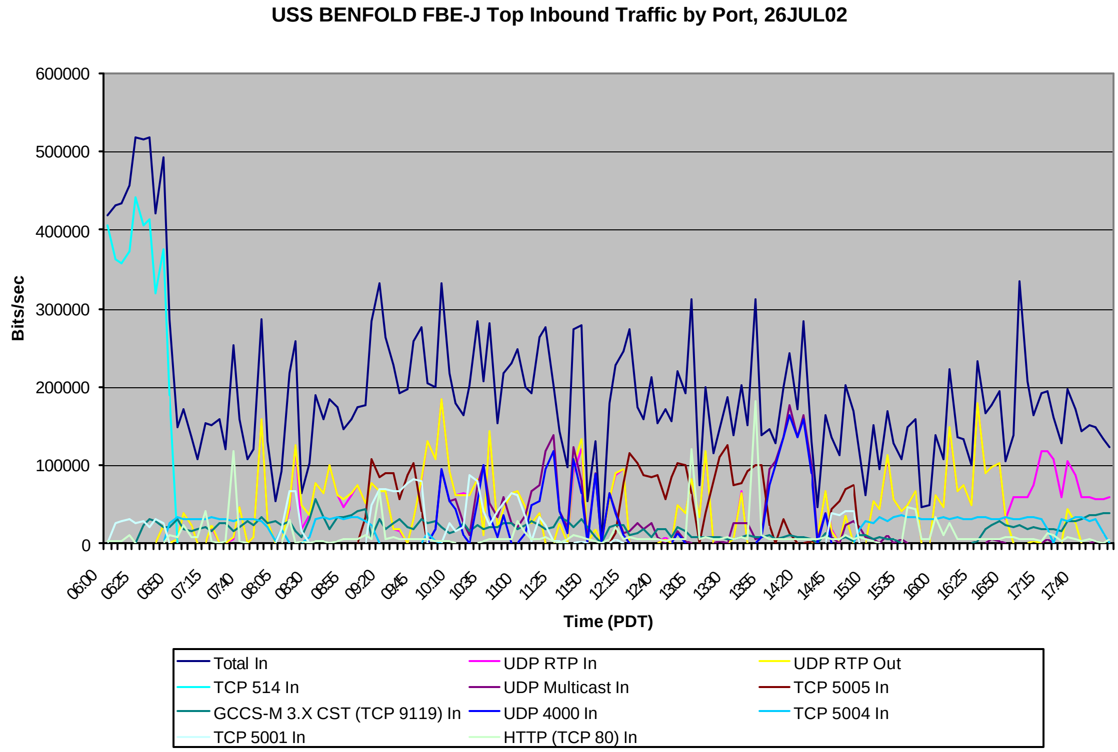

Figure A9-46. USS Benfold Top Inbound Traffic by Port, 26 July 02

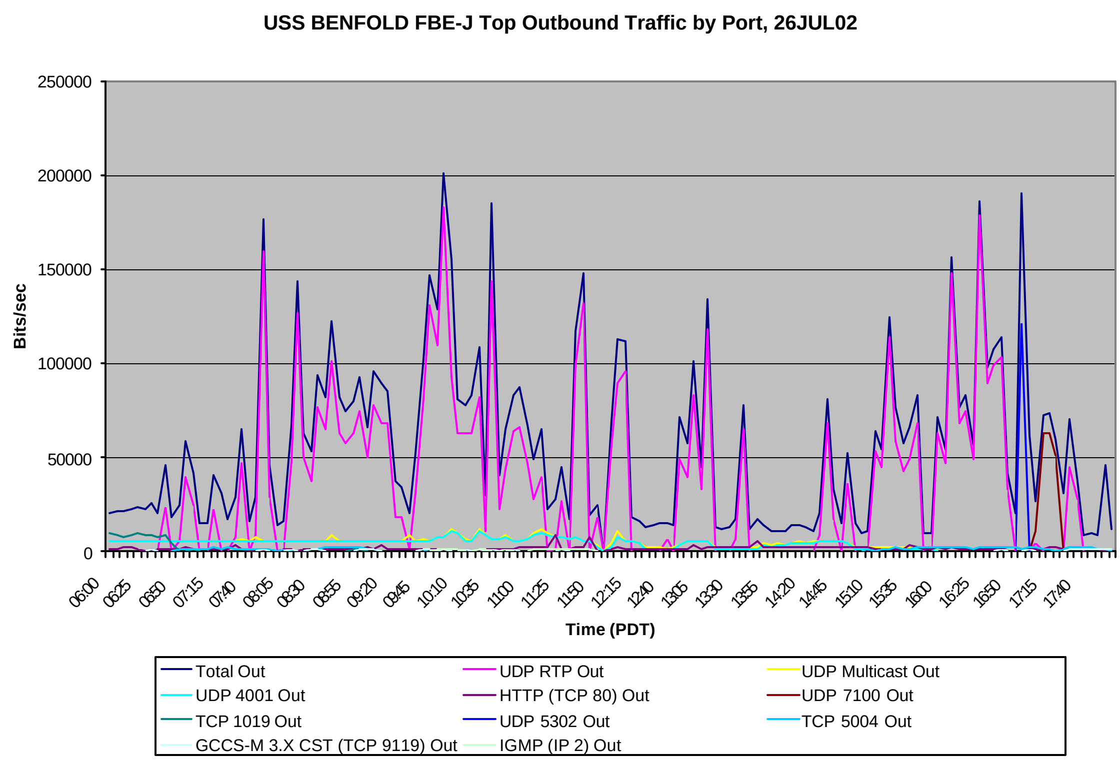

Figure A9-47. USS Benfold Top Outbound Traffic by Port, 26 July 02

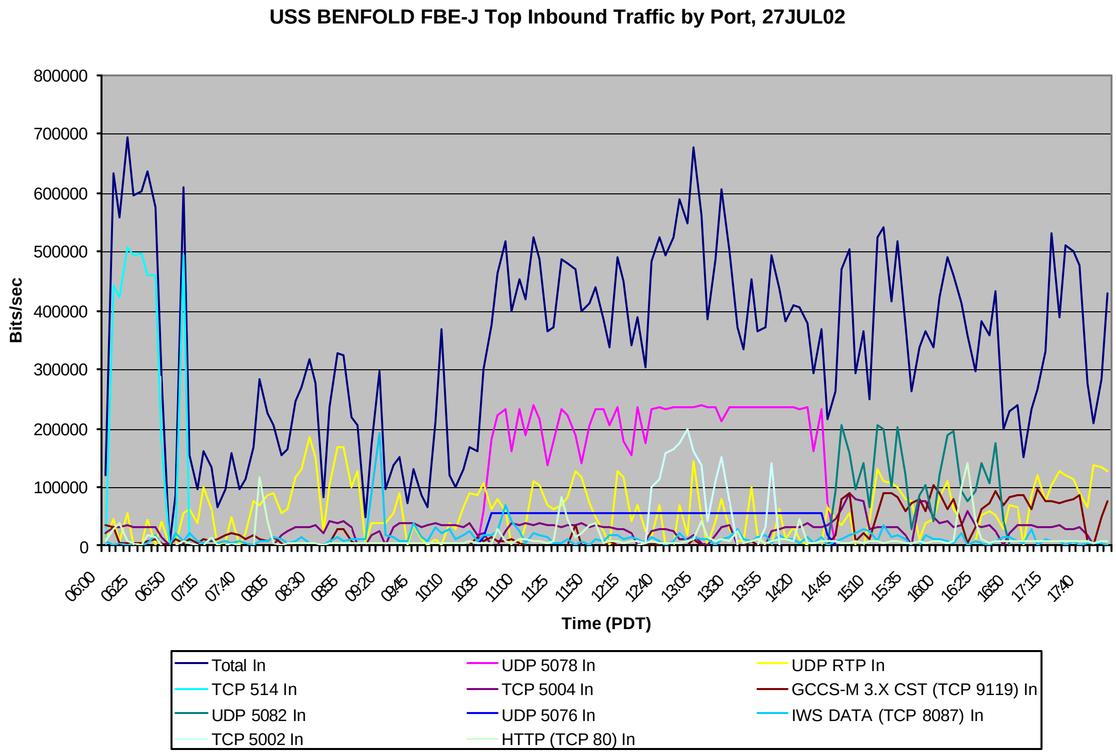

Figure A9-48. USS Benfold Top Inbound Traffic by Port, 27 July 02

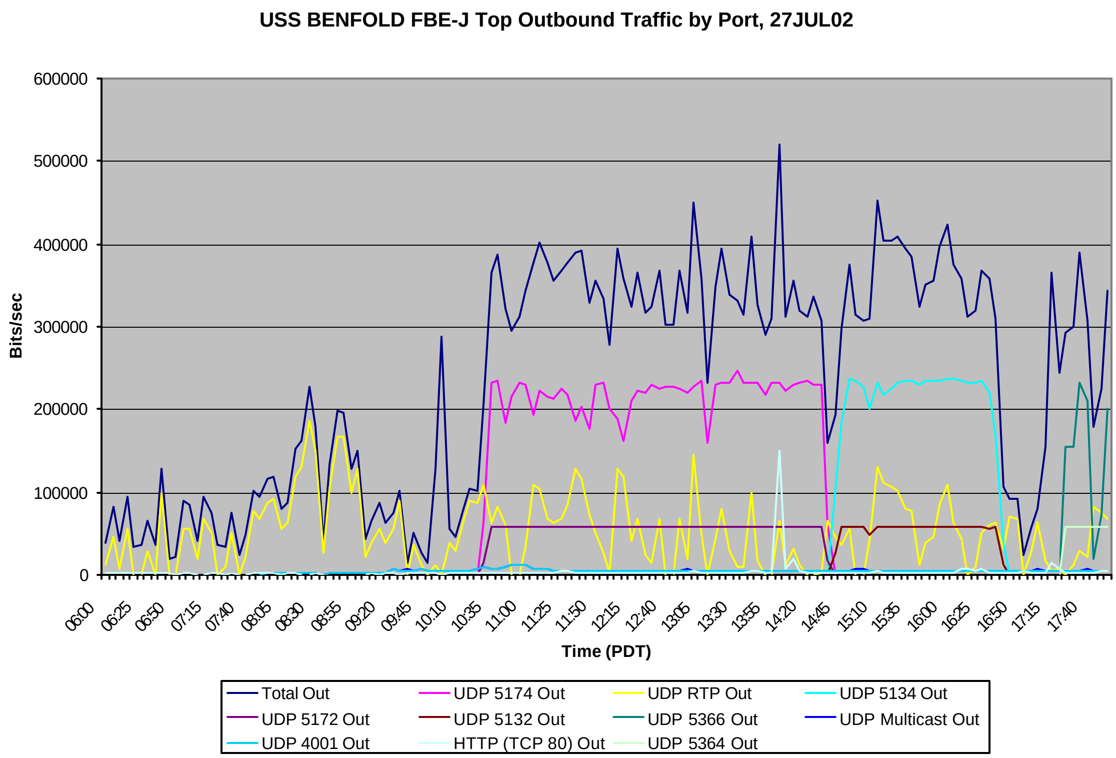

Figure A9-49. USS Benfold Top Outbound Traffic by Port, 27 July 02

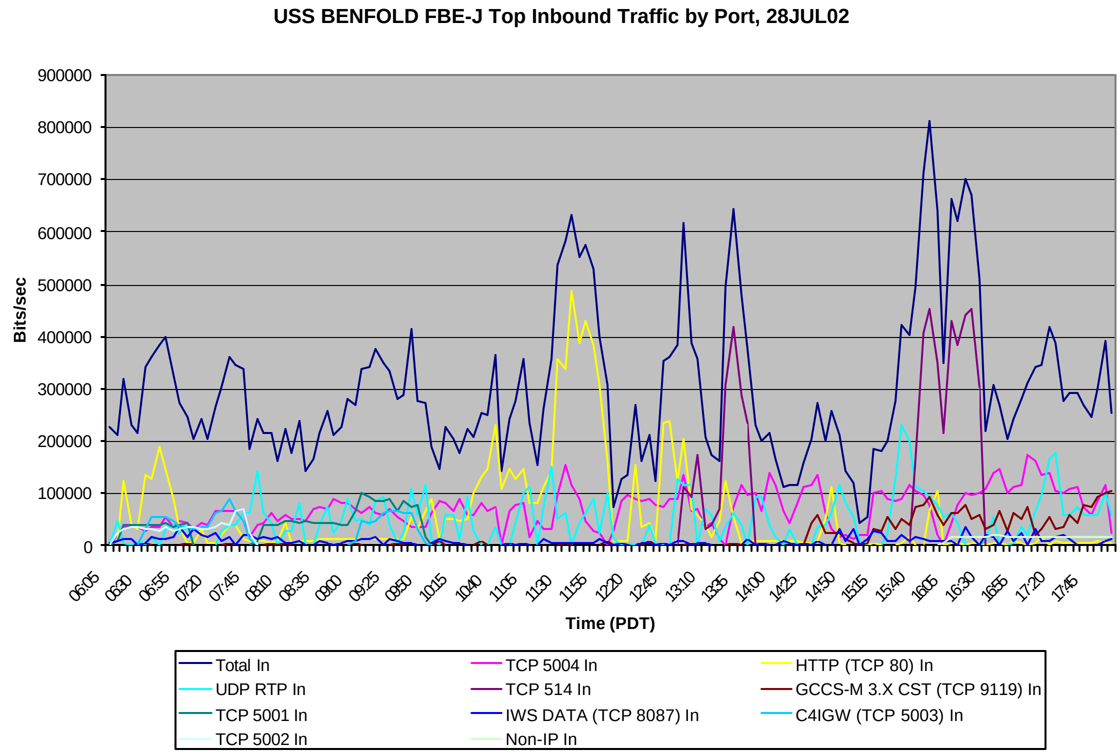

Figure A9-50. USS Benfold Top Inbound Traffic by Port, 28 July 02

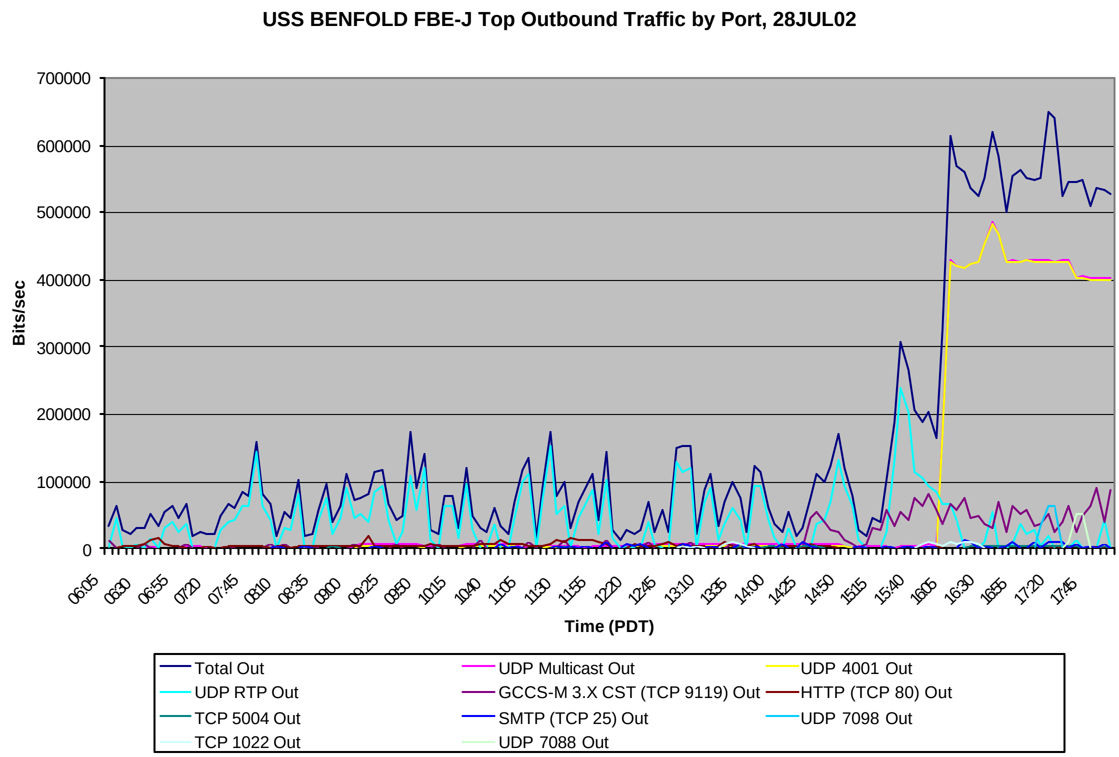

Figure A9-51. USS Benfold Top Outbound Traffic by Port, 28 July 02

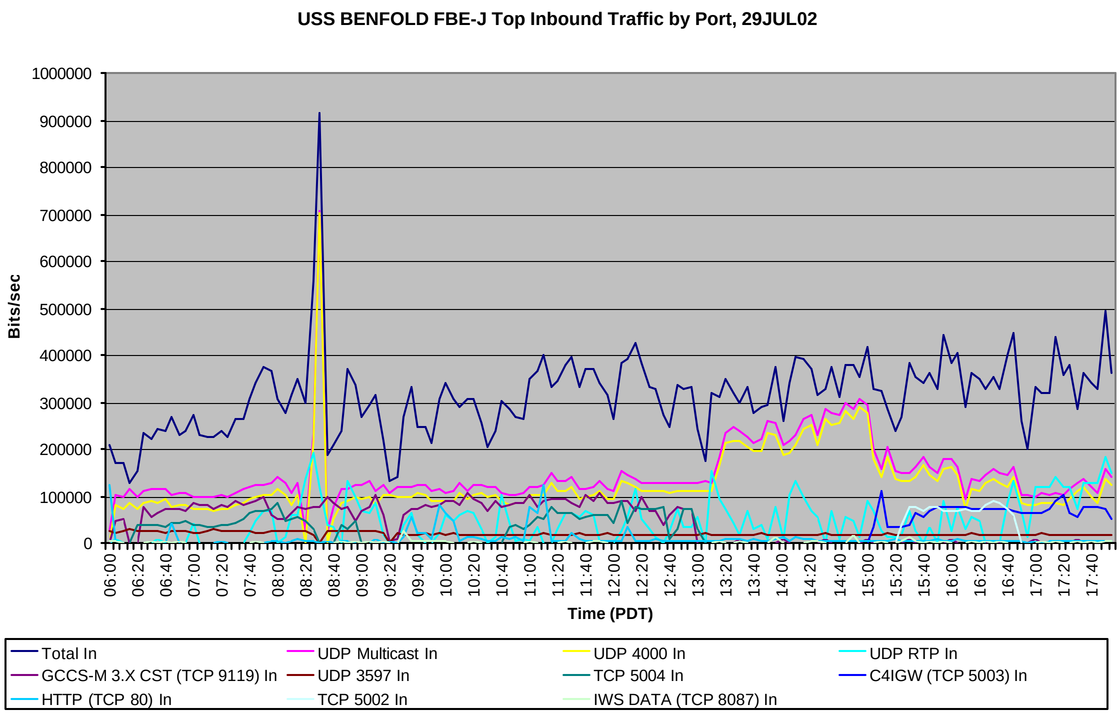

Figure A9-52. USS Benfold Top Inbound Traffic by Port, 29 July 02

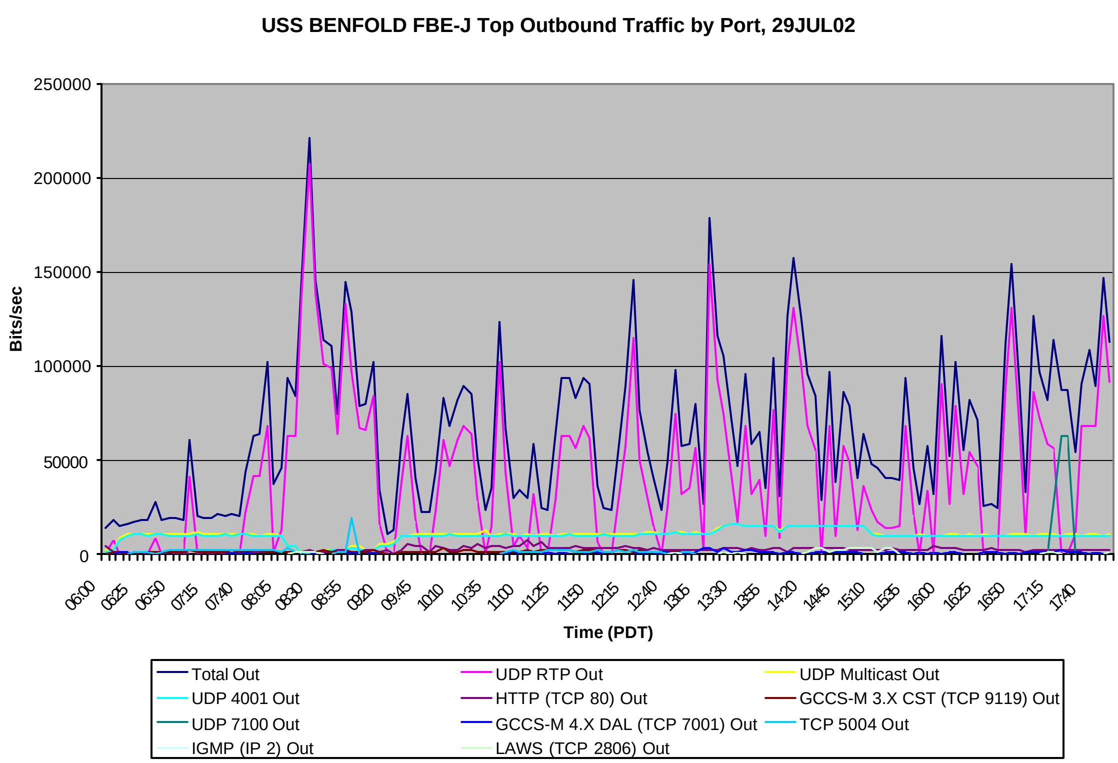

Figure A9-53. USS Benfold Top Outbound Traffic by Port, 29 July 02

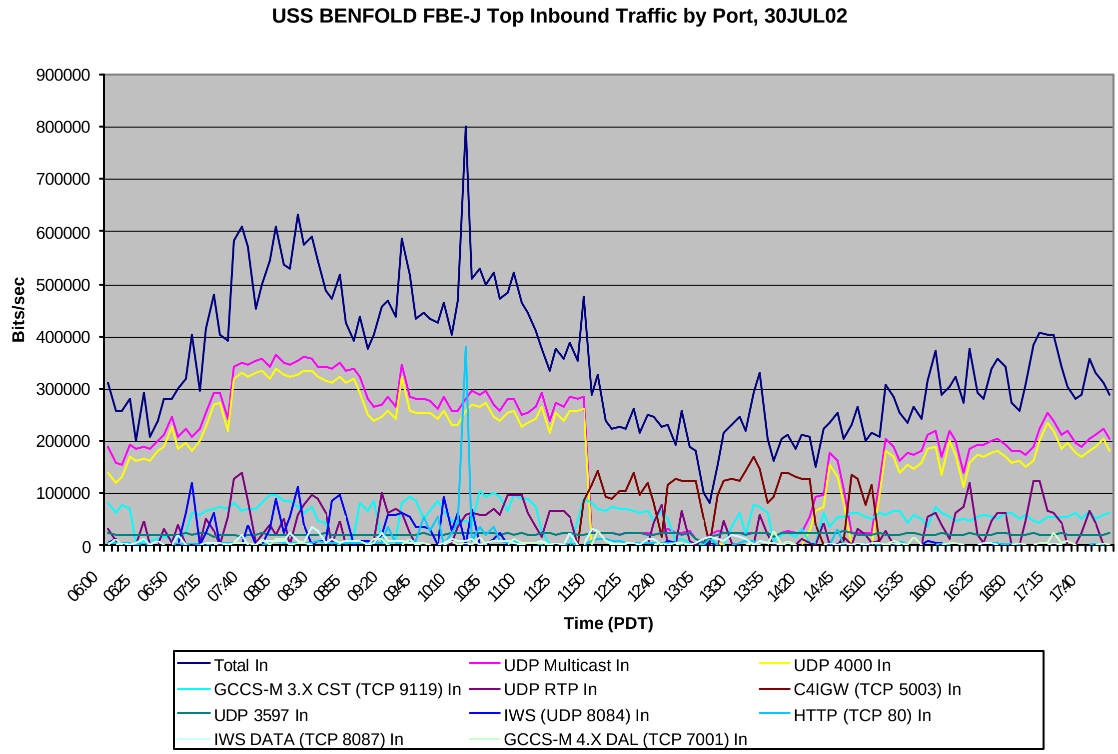

Figure A9-54. USS Benfold Top Inbound Traffic by Port, 30 July 02

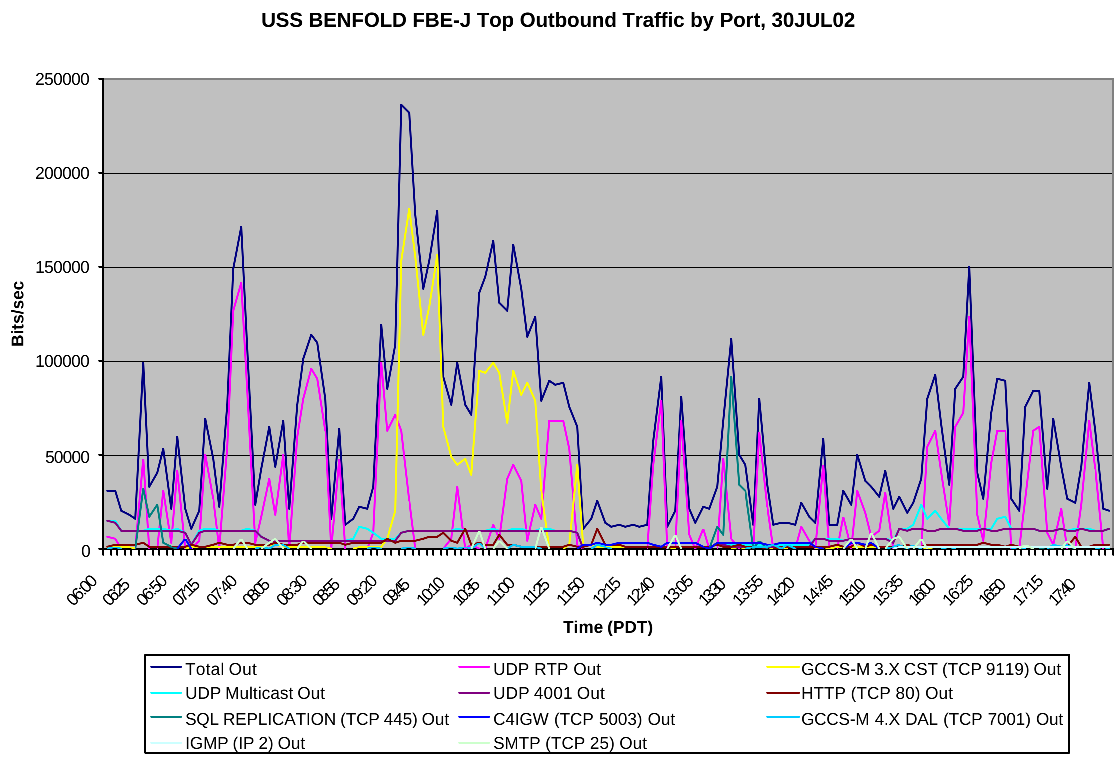

Figure A9-55. USS Benfold Top Outbound Traffic by Port, 30 July 02

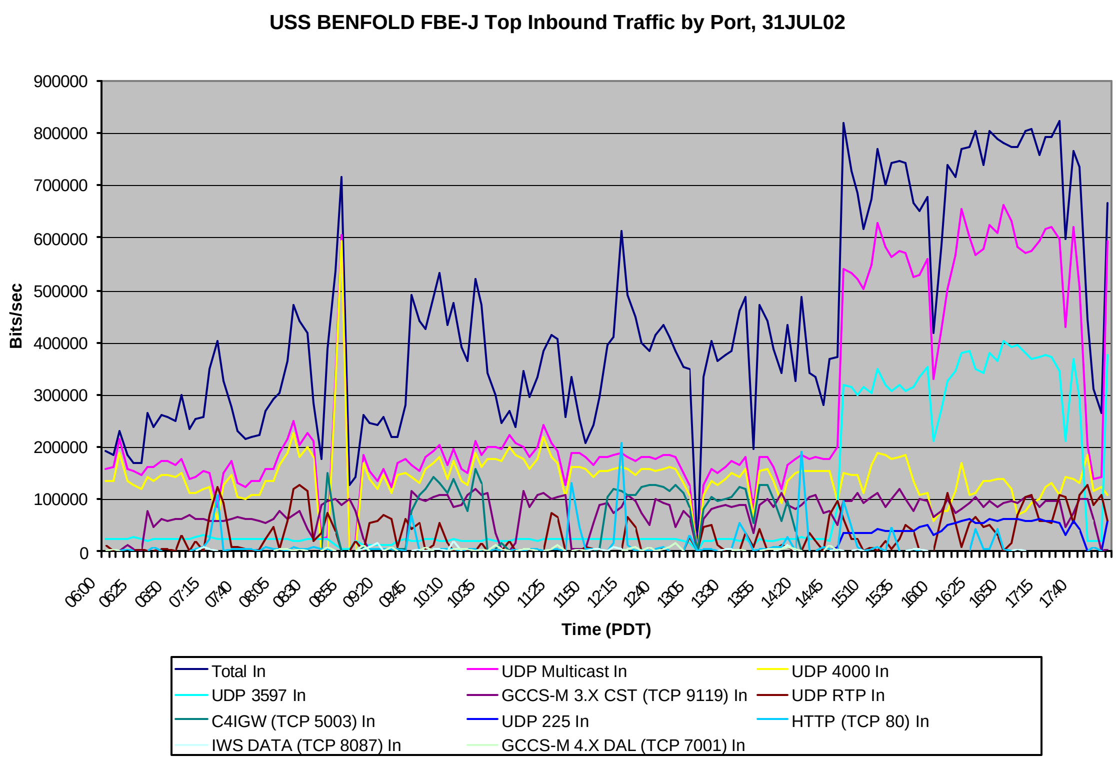

Figure A9-56. USS Benfold Top Inbound Traffic by Port, 31 July 02

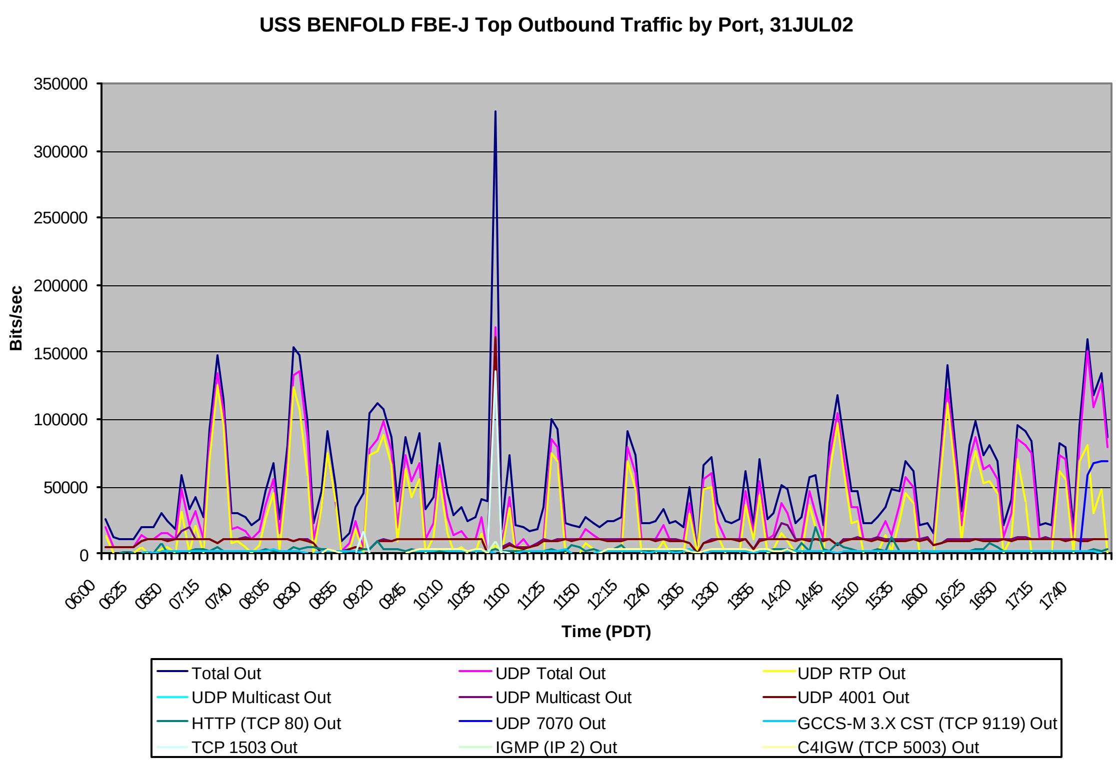

Figure A9-57. USS Benfold Top Outbound Traffic by Port, 31 July 02

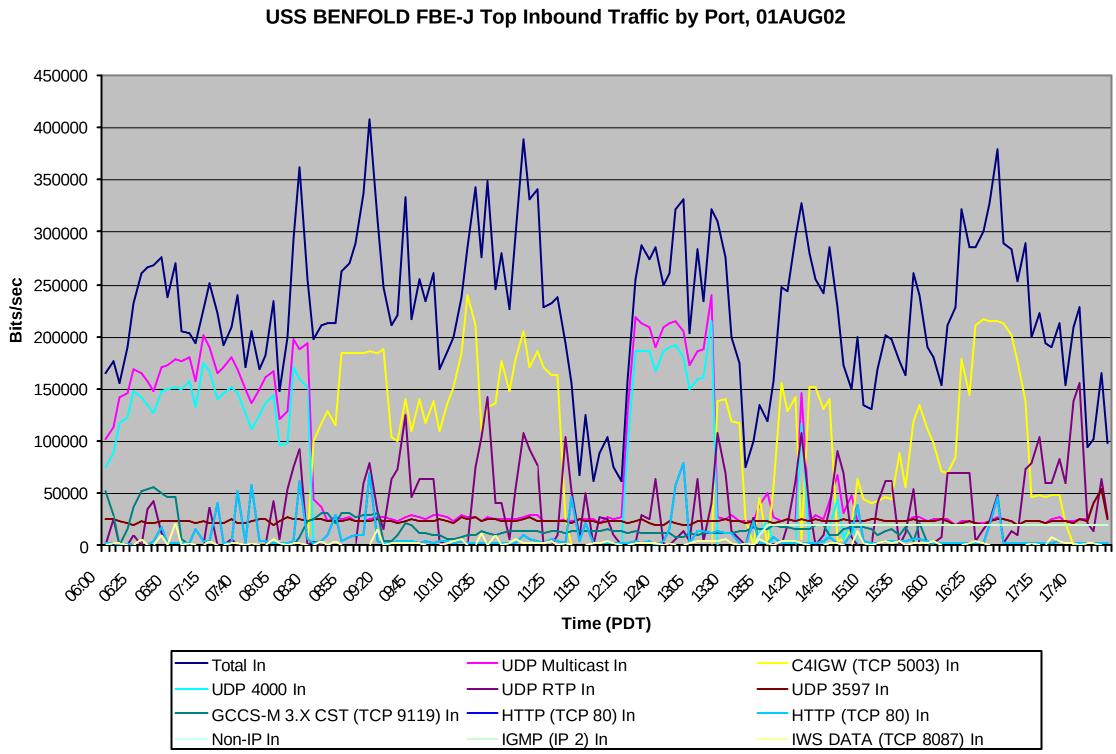

Figure A9-58. USS Benfold Top Inbound Traffic by Port, 01 August 02

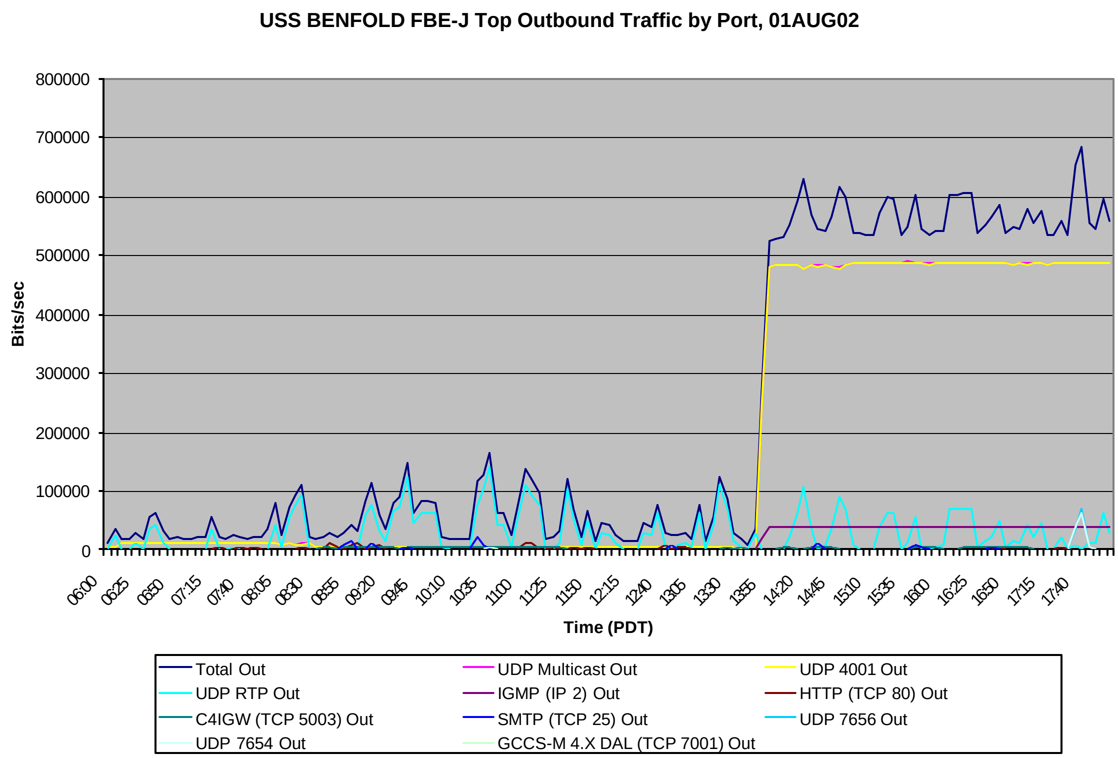

Figure A9-59. USS Benfold Top Outbound Traffic by Port, 01 August 02

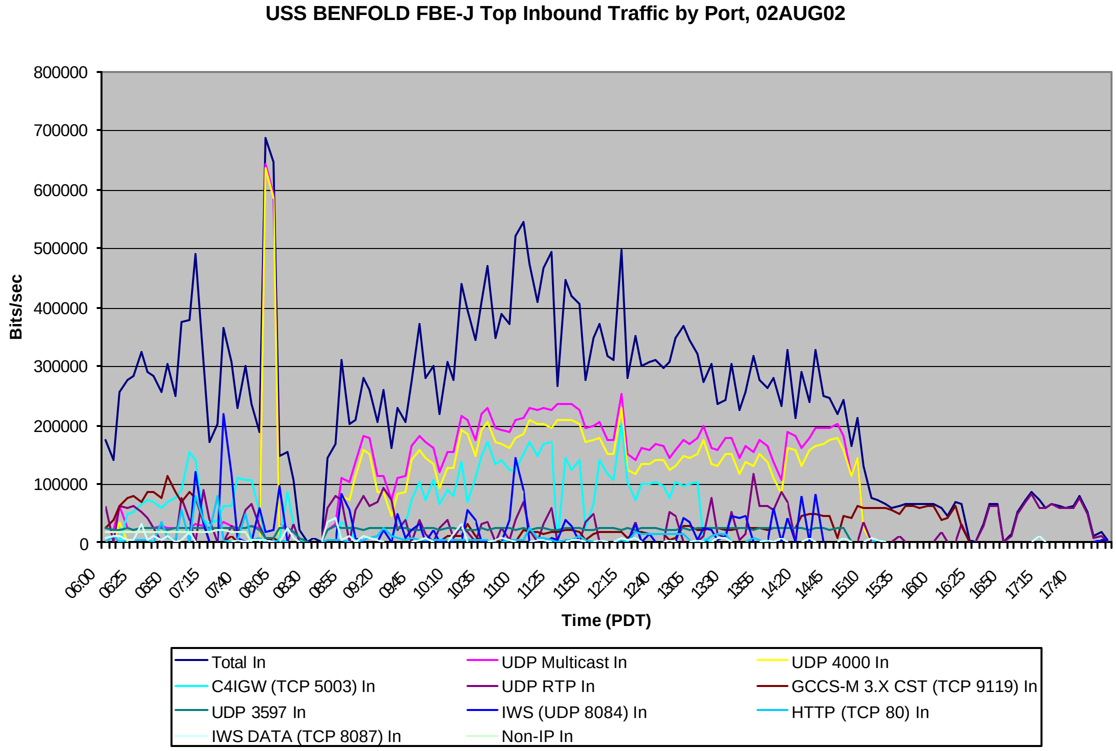

Figure A9-60. USS Benfold Top Inbound Traffic by Port, 02 August 02

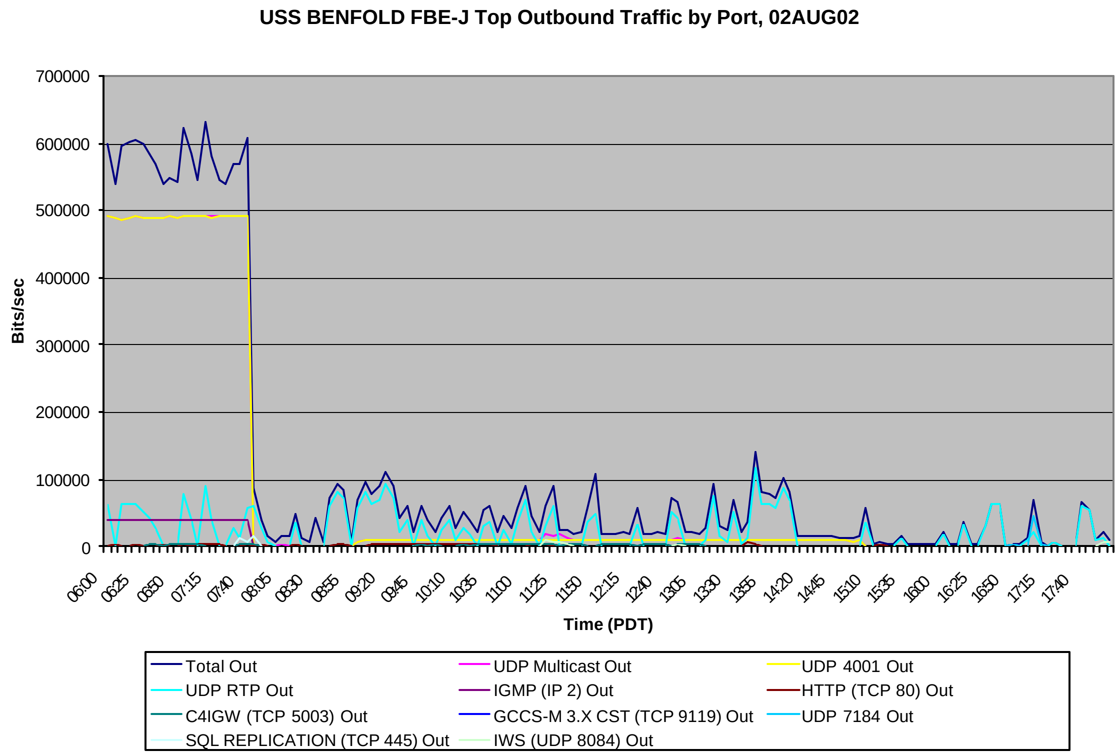

Figure A9-61. USS Benfold Top Outbound Traffic by Port, 02 August 02

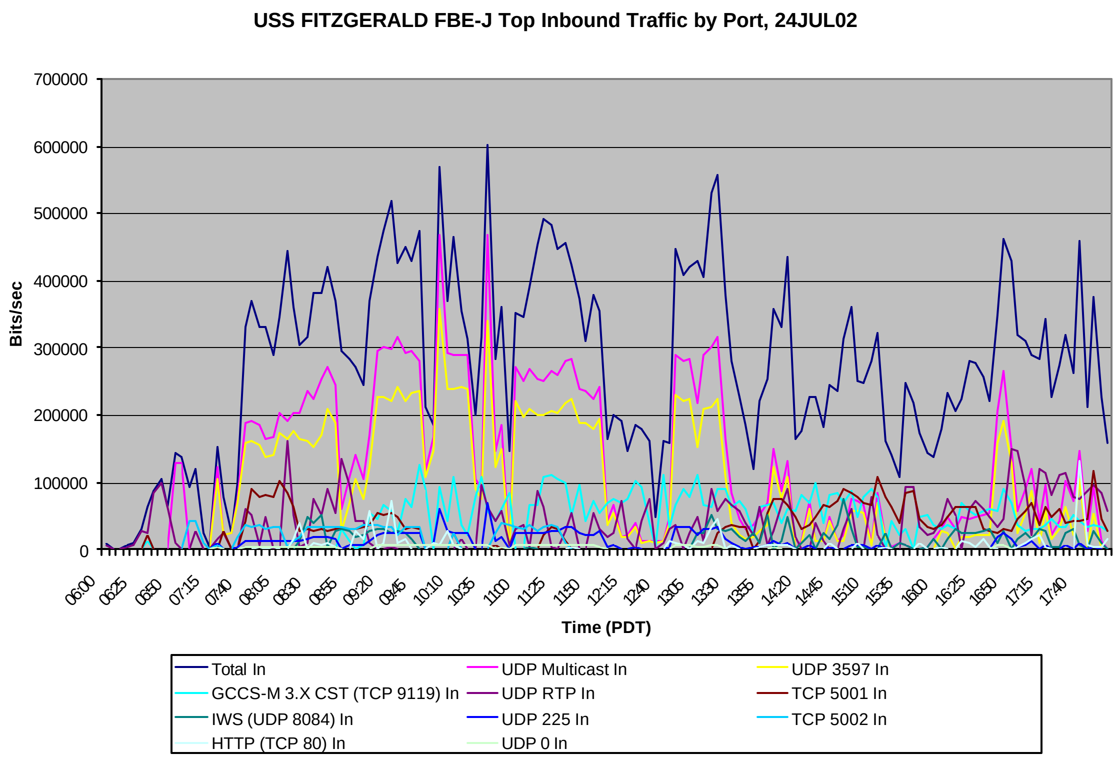

Figure A9-62. USS Fitzgerald Top Inbound Traffic by Port, 24 July 02

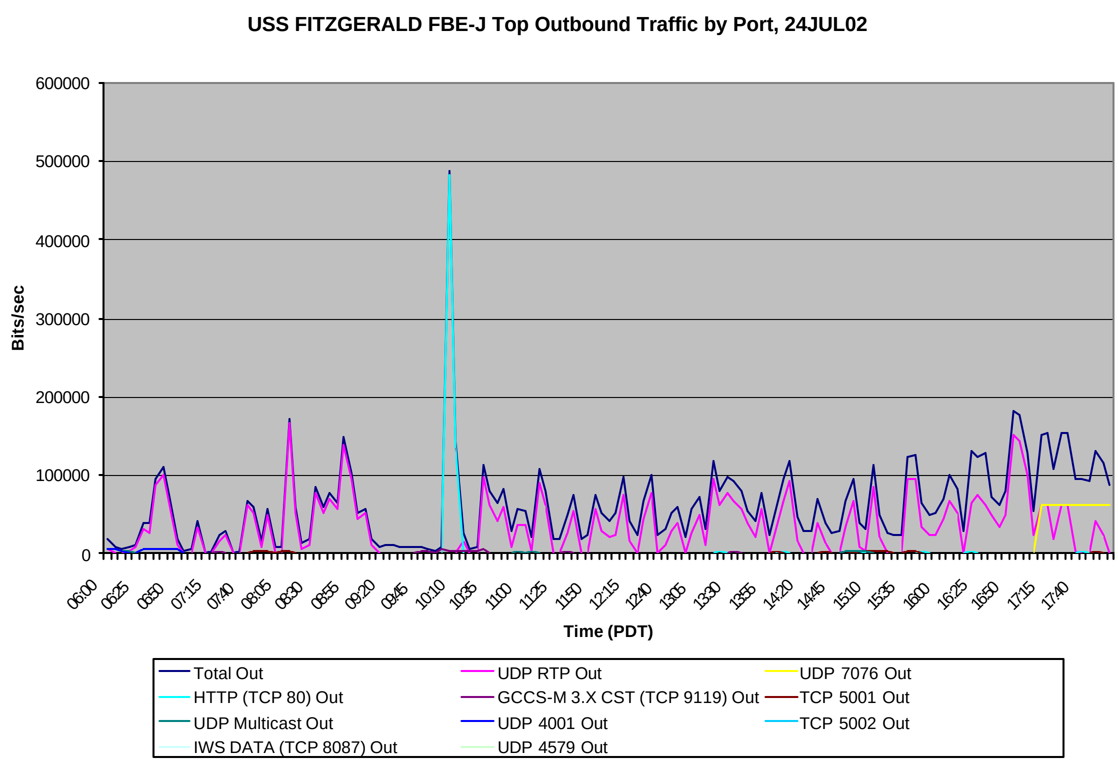

Figure A9-63. USS Fitzgerald Top Outbound Traffic by Port, 24 July 02

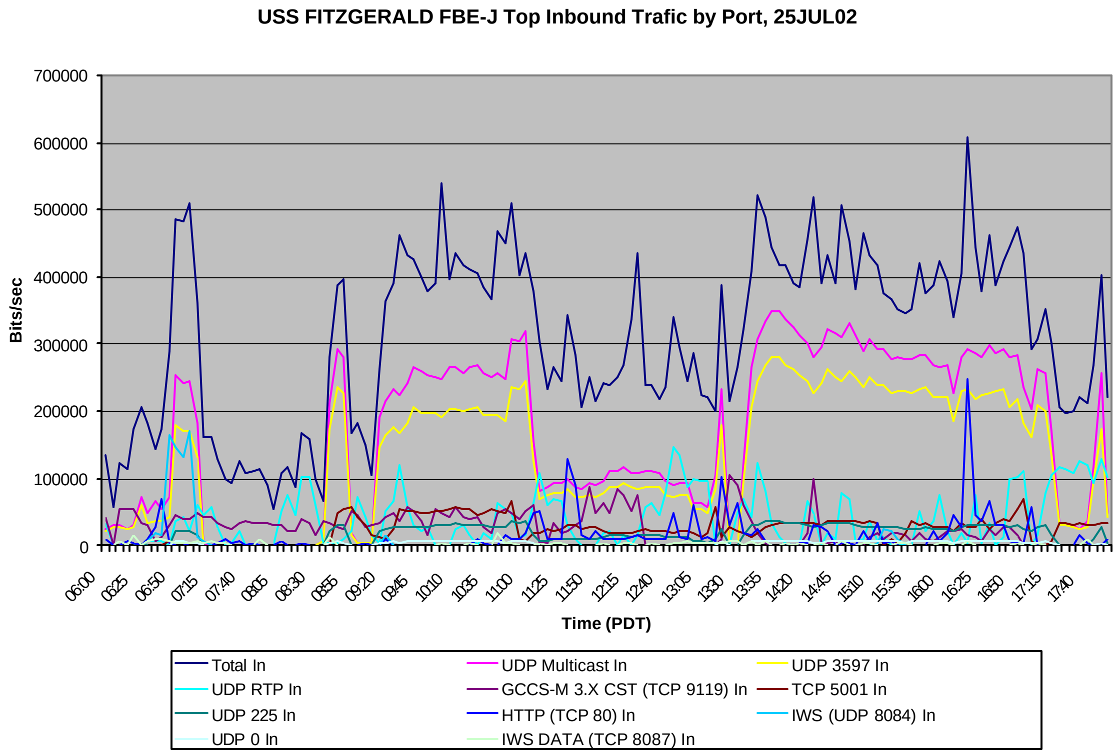

Figure A9-64. USS Fitzgerald Top Inbound Traffic by Port, 25 July 02

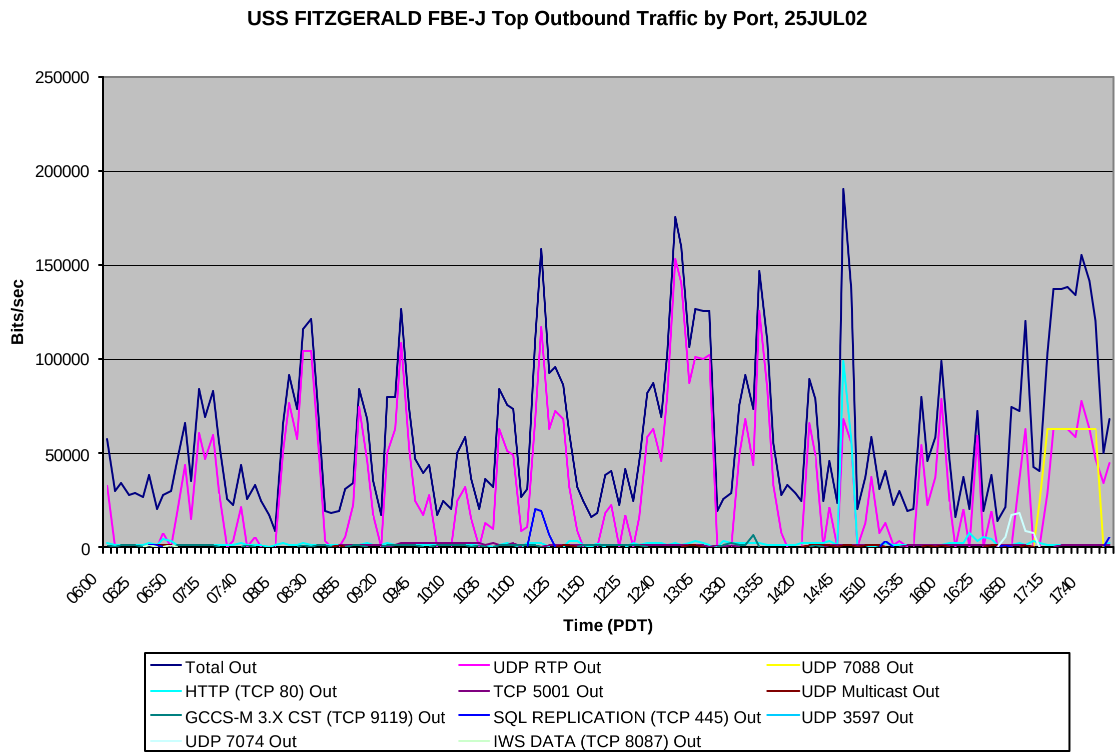

Figure A9-65. USS Fitzgerald Top Outbound Traffic by Port, 25 July 02

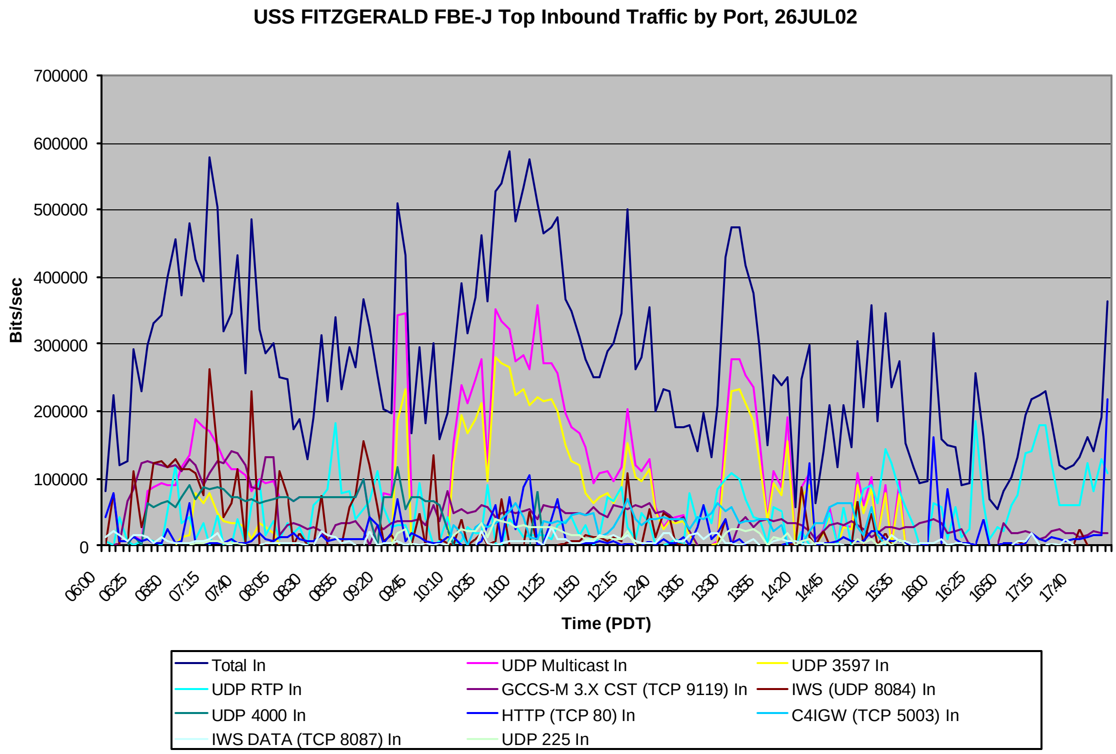

Figure A9-66. USS Fitzgerald Top Inbound Traffic by Port, 26 July 02

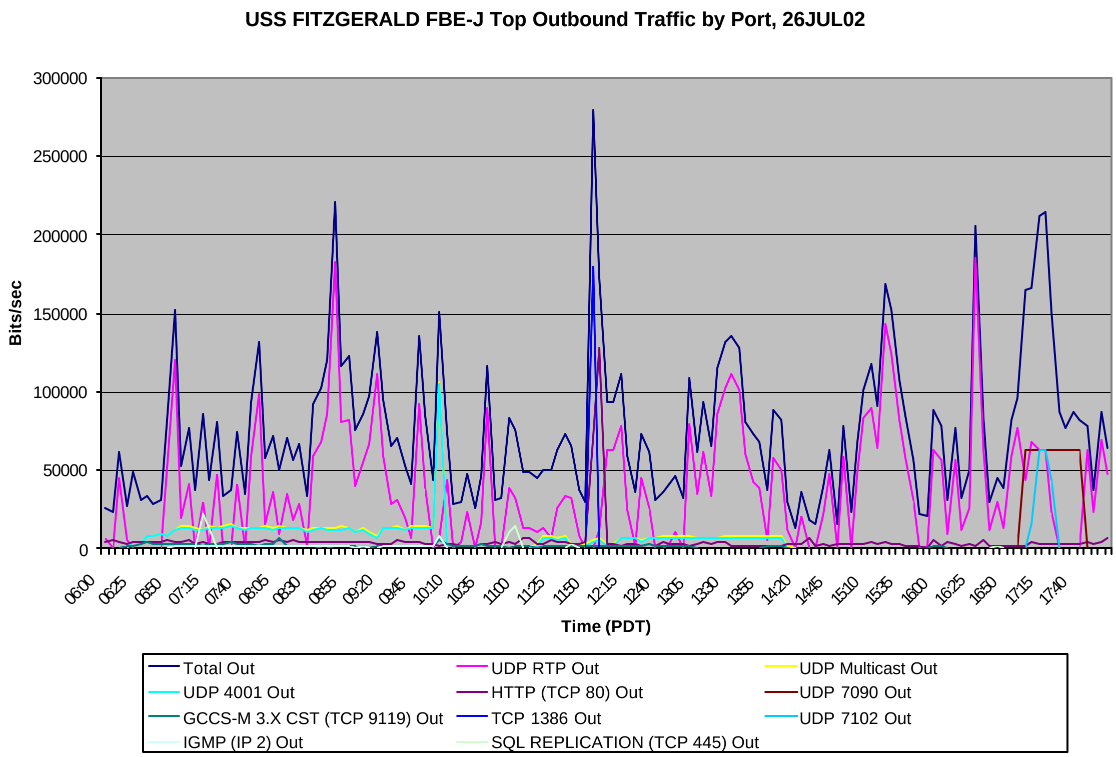

Figure A9-67. USS Fitzgerald Top Outbound Traffic by Port, 26 July 02

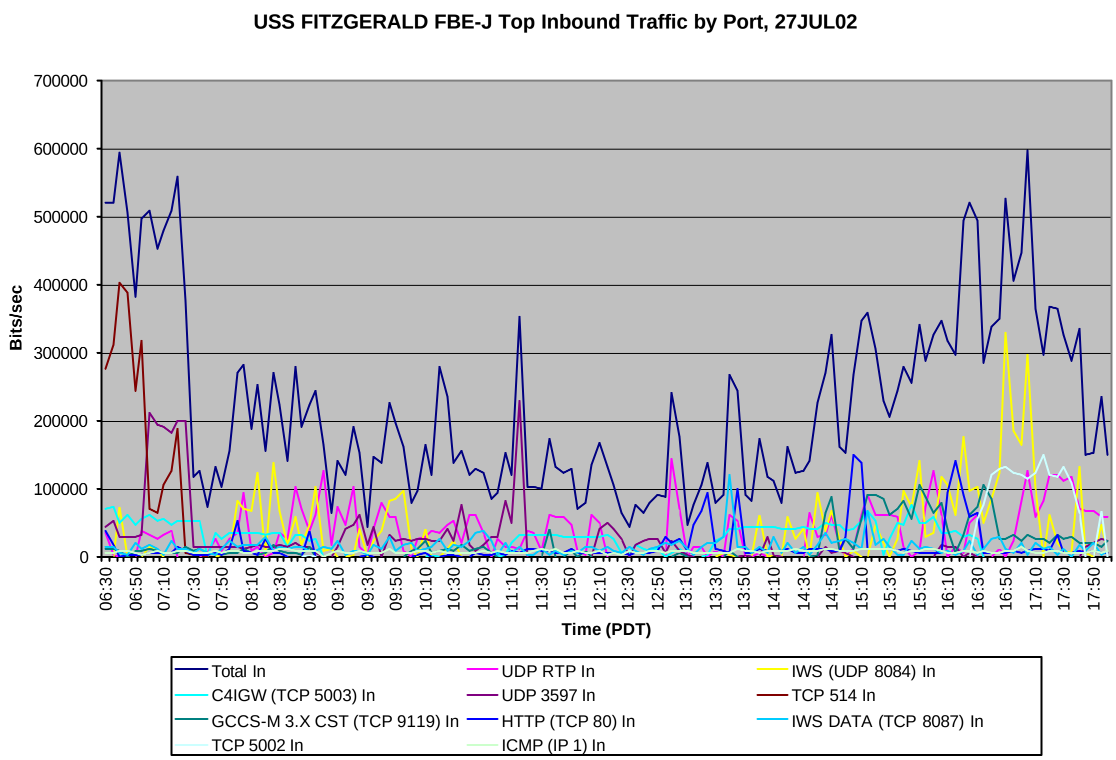

Figure A9-68. USS Fitzgerald Top Inbound Traffic by Port, 27 July 02

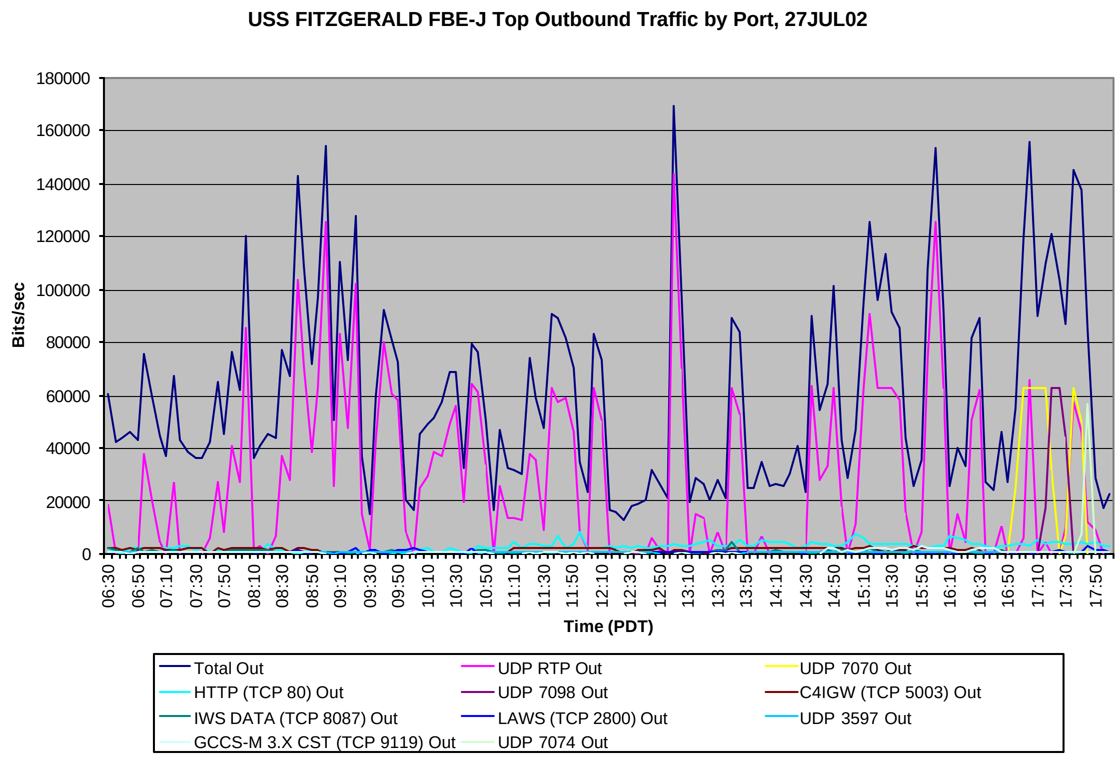

Figure A9-69. USS Fitzgerald Top Outbound Traffic by Port, 27 July 02

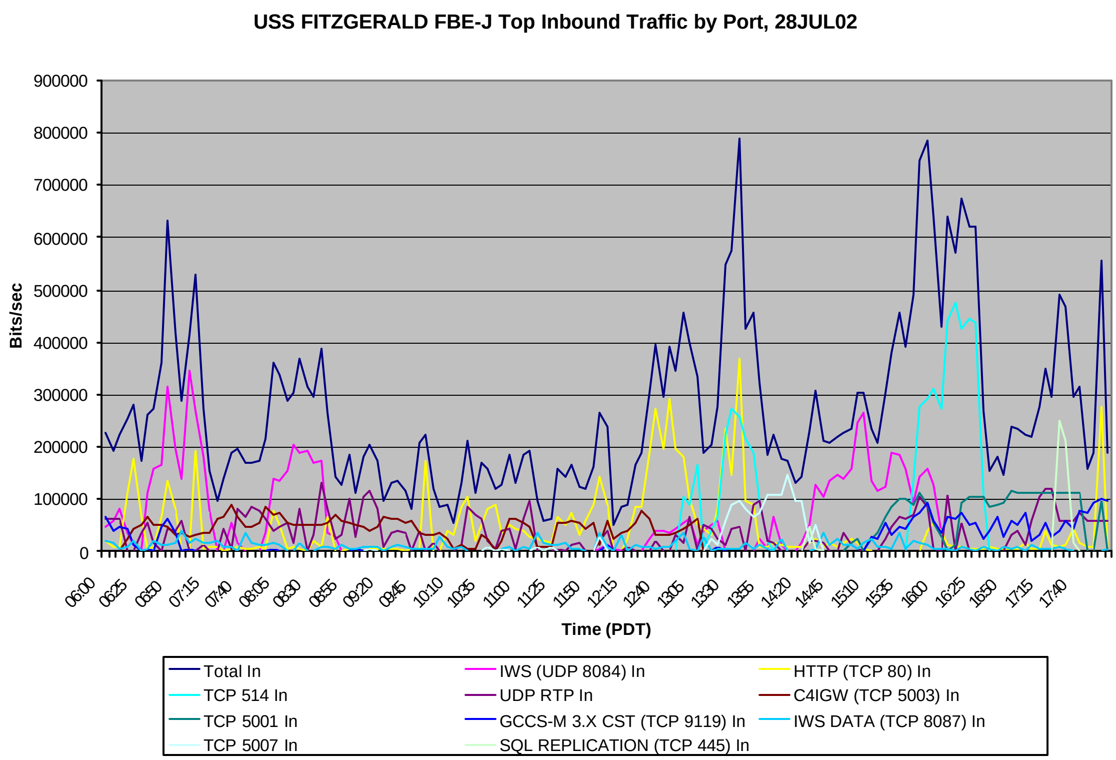

Figure A9-70. USS Fitzgerald Top Inbound Traffic by Port, 28 July 02

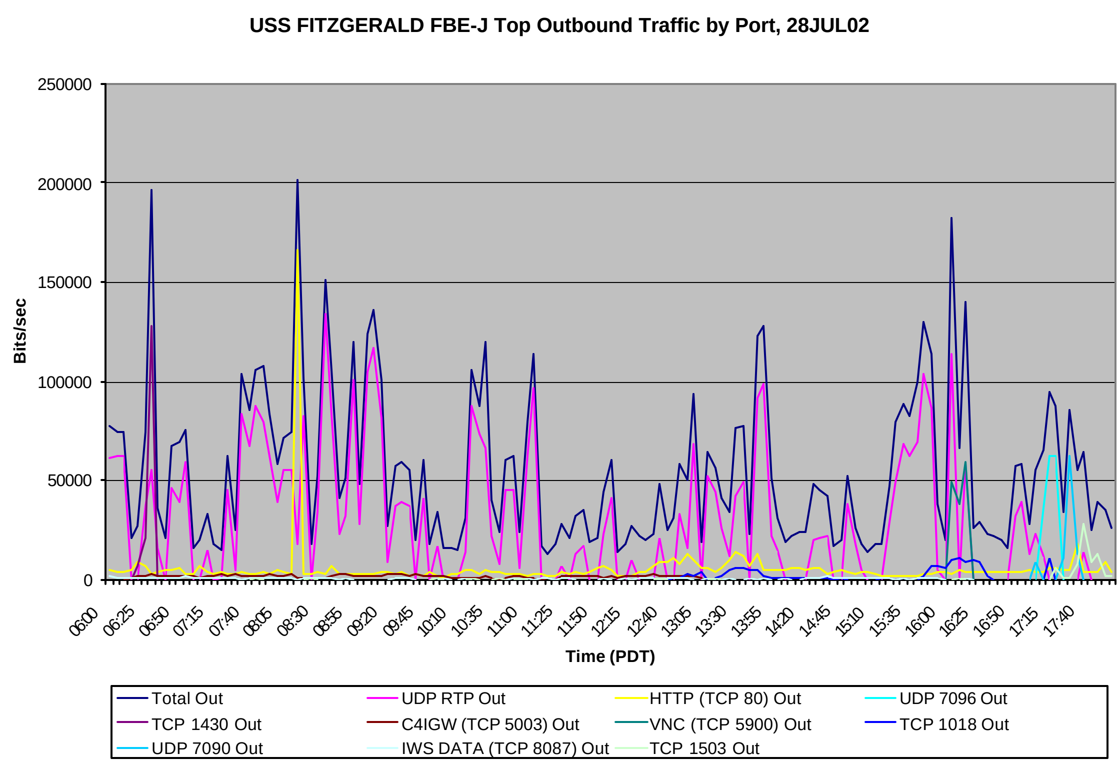

Figure A9-71. USS Fitzgerald Top Outbound Traffic by Port, 28 July 02

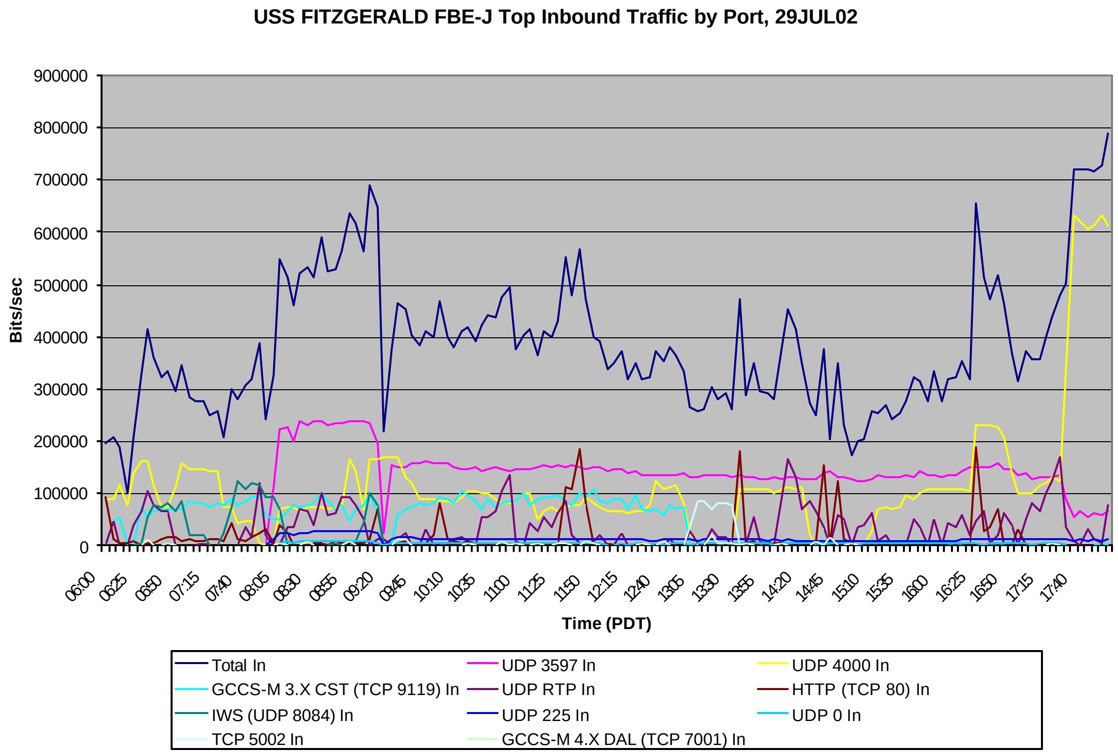

Figure A9-72. USS Fitzgerald Top Inbound Traffic by Port, 29 July 02

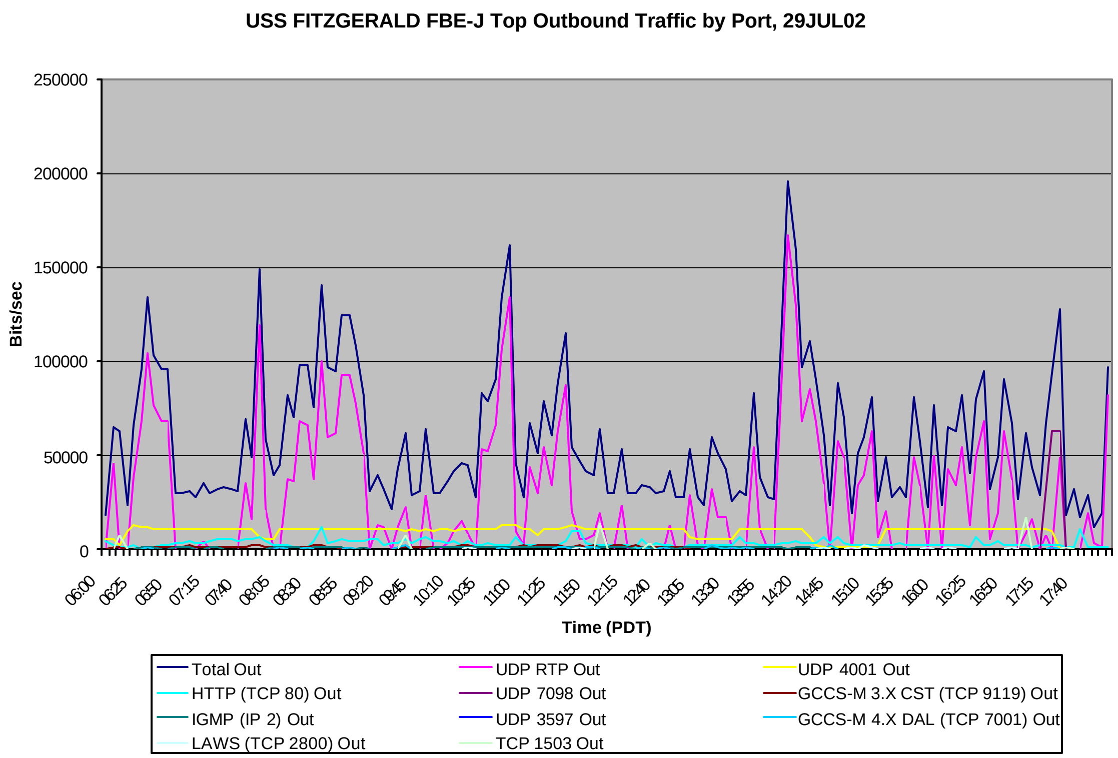

Figure A9-73. USS Fitzgerald Top Outbound Traffic by Port, 29 July 02

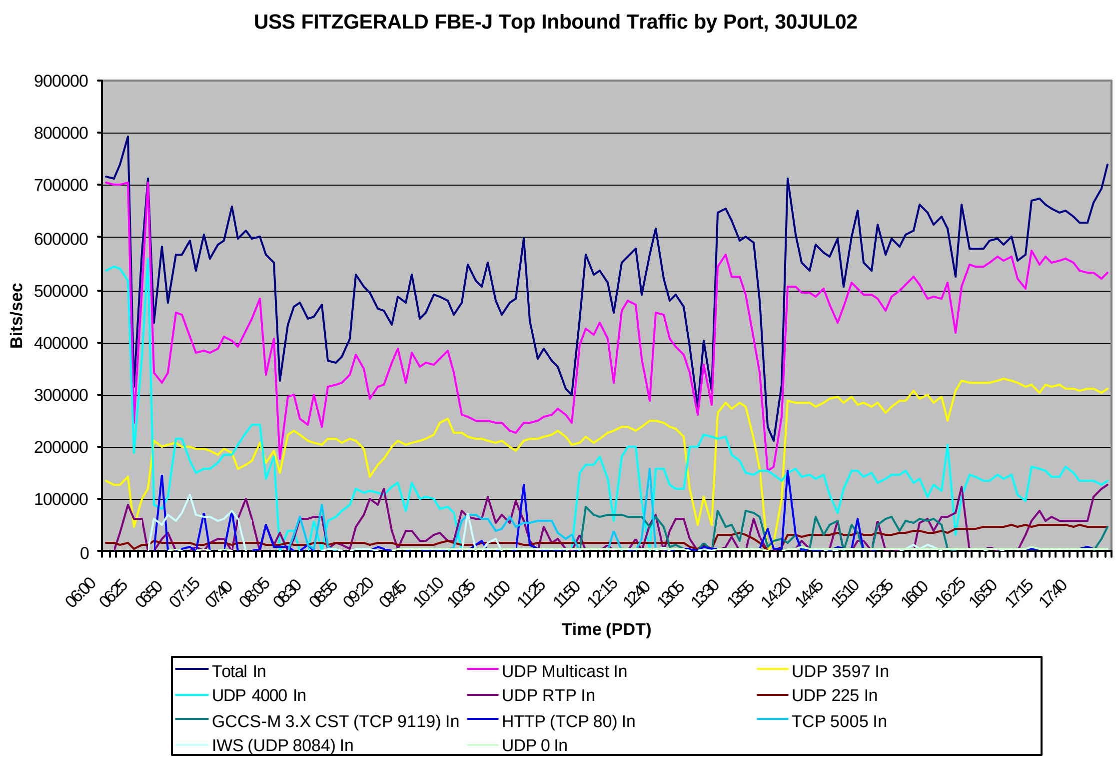

Figure A9-74. USS Fitzgerald Top Inbound Traffic by Port, 30 July 02

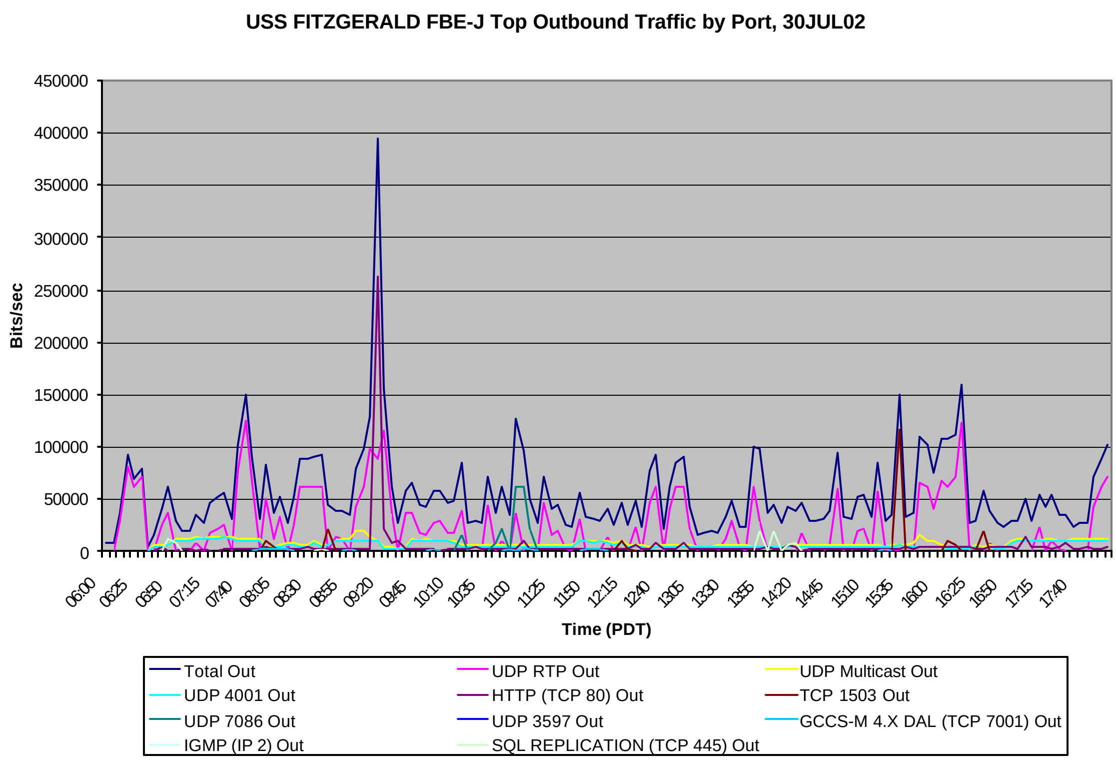

Figure A9-75. USS Fitzgerald Top Outbound Traffic by Port, 30 July 02

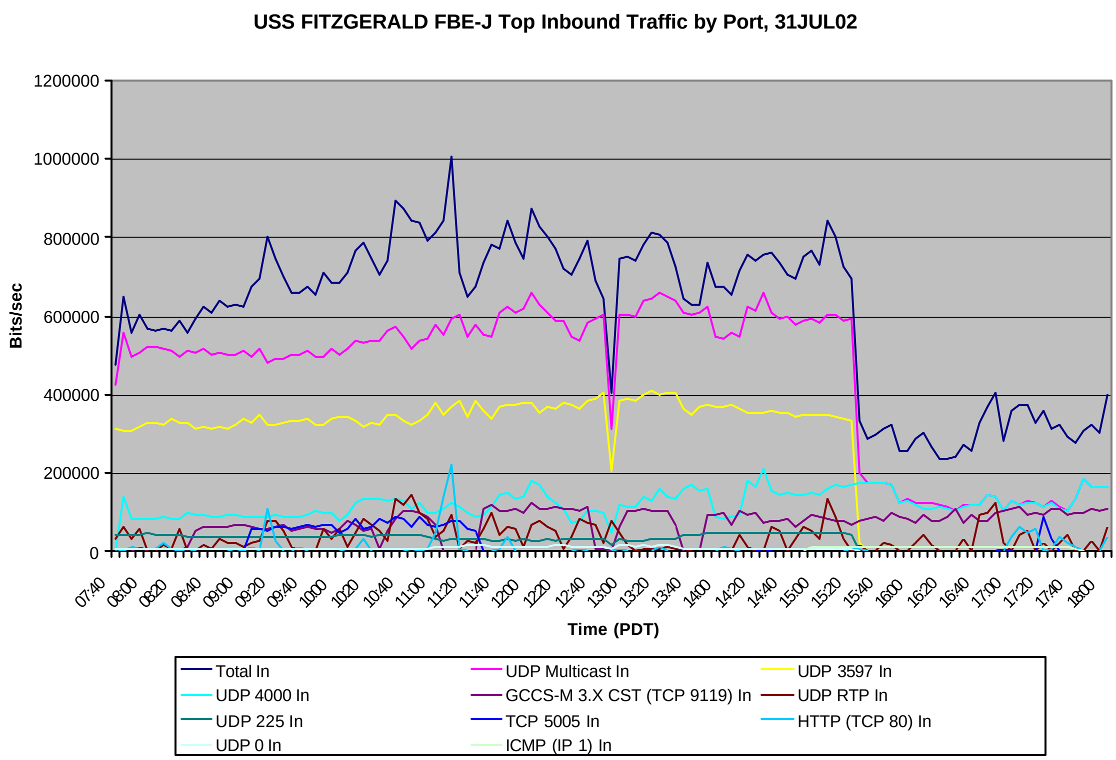

Figure A9-76. USS Fitzgerald Top Inbound Traffic by Port, 31 July 02

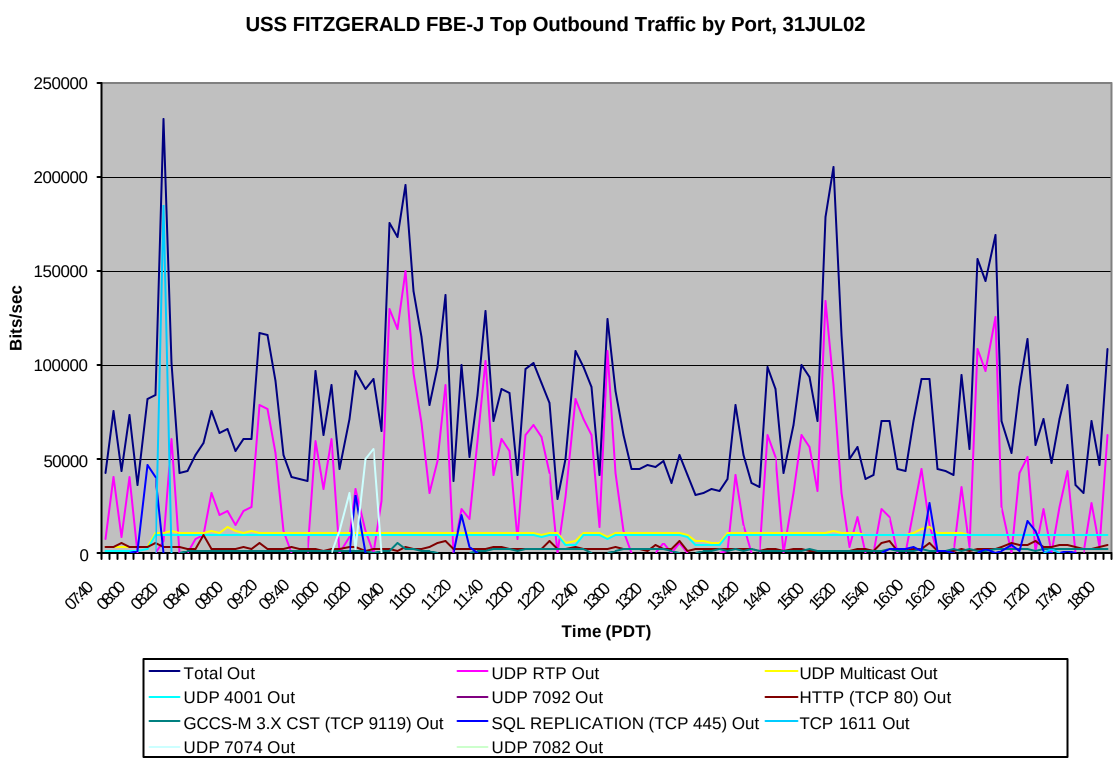

Figure A9-77. USS Fitzgerald Top Outbound Traffic by Port, 31 July 02

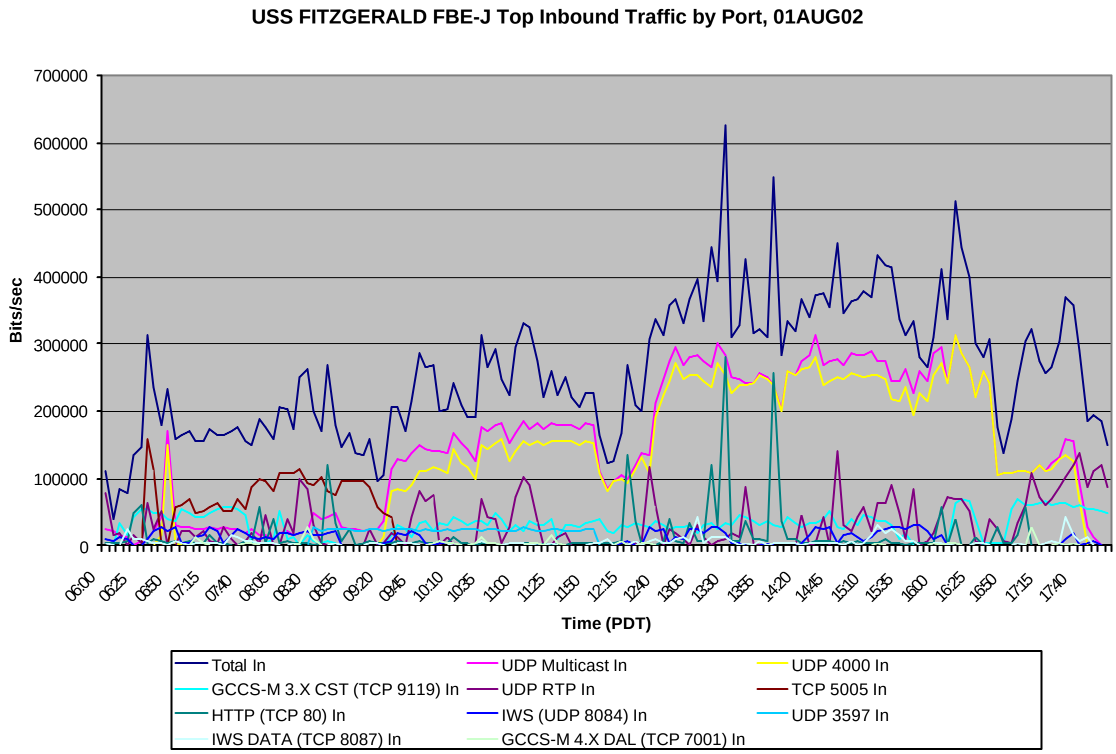

Figure A9-78. USS Fitzgerald Top Inbound Traffic by Port, 01 August 02

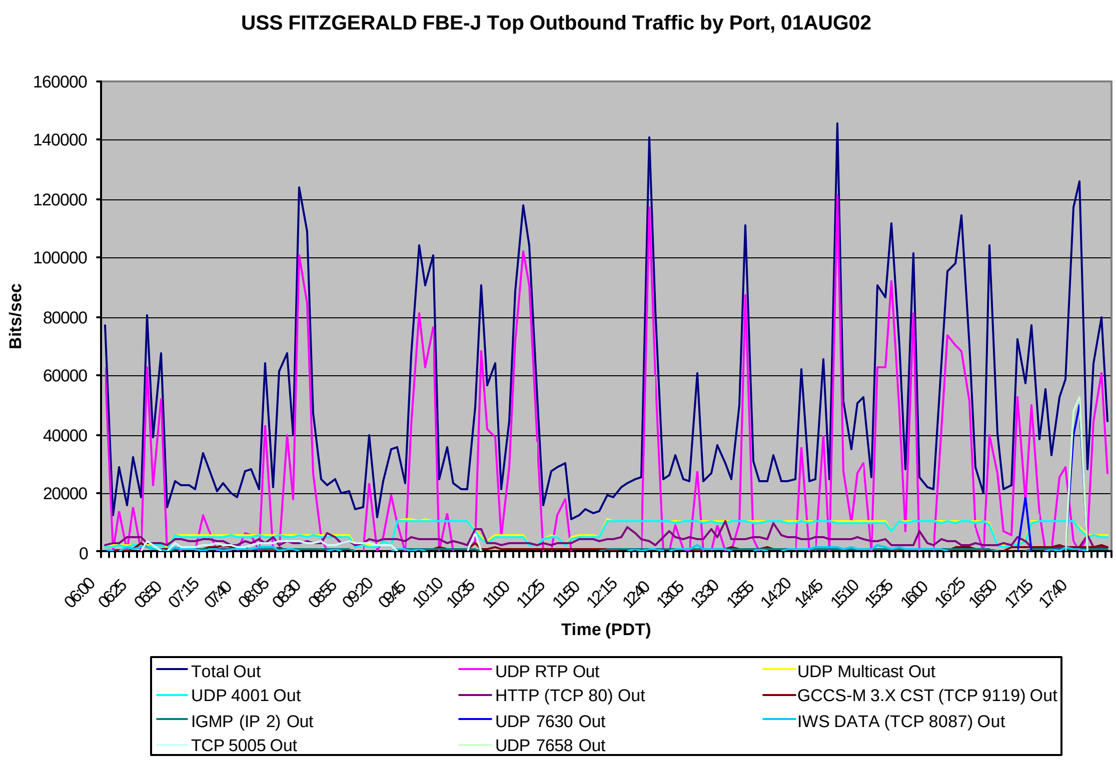

Figure A9-79. USS Fitzgerald Top Outbound Traffic by Port, 01 August 02

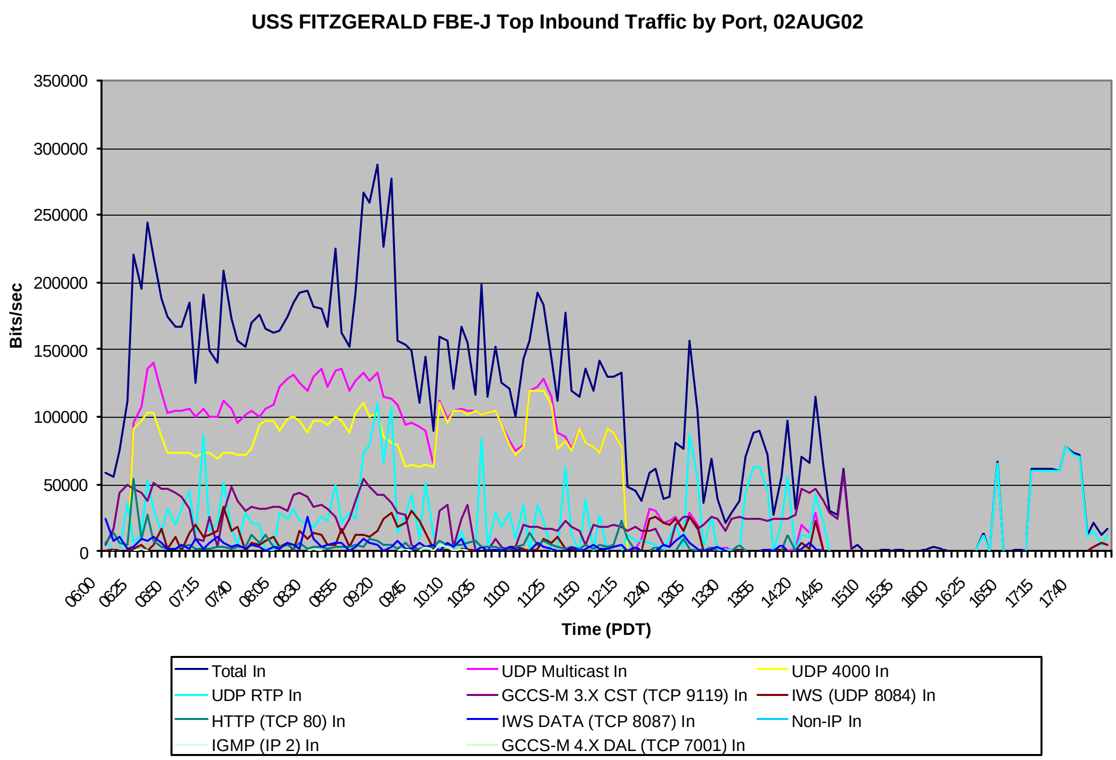

Figure A9-80. USS Fitzgerald Top Inbound Traffic by Port, 02 August 02

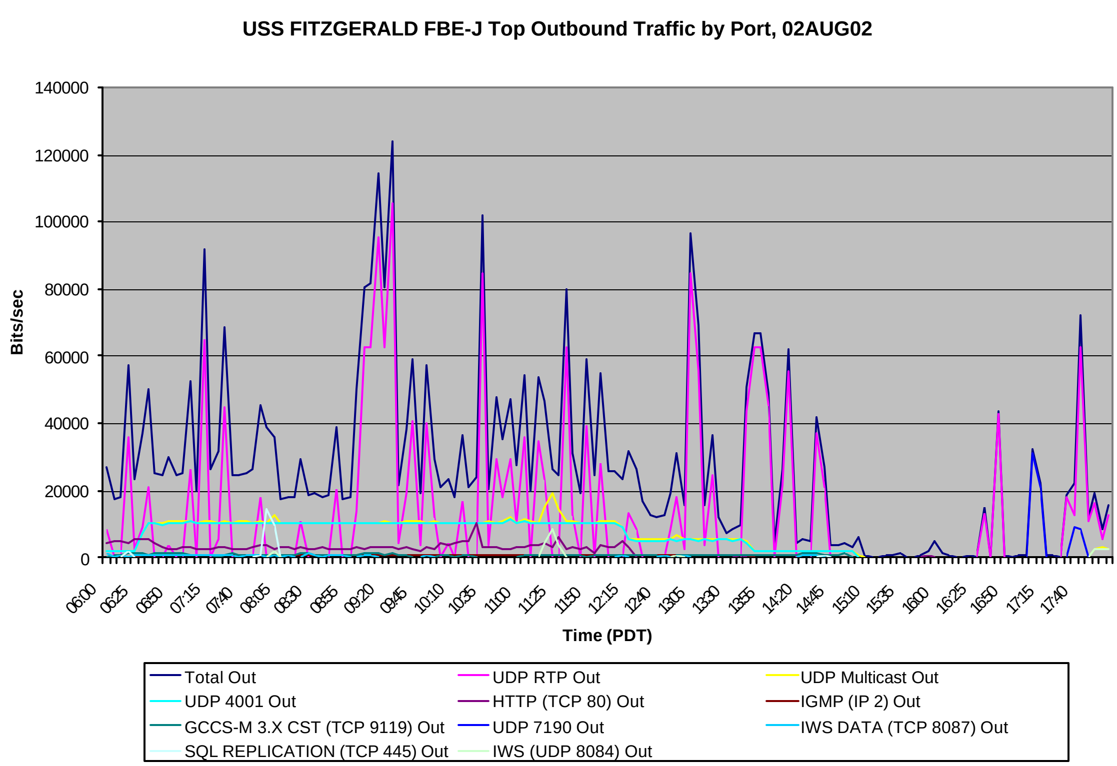

Figure A9-81. USS Fitzgerald Top Outbound Traffic by Port, 02 August 02

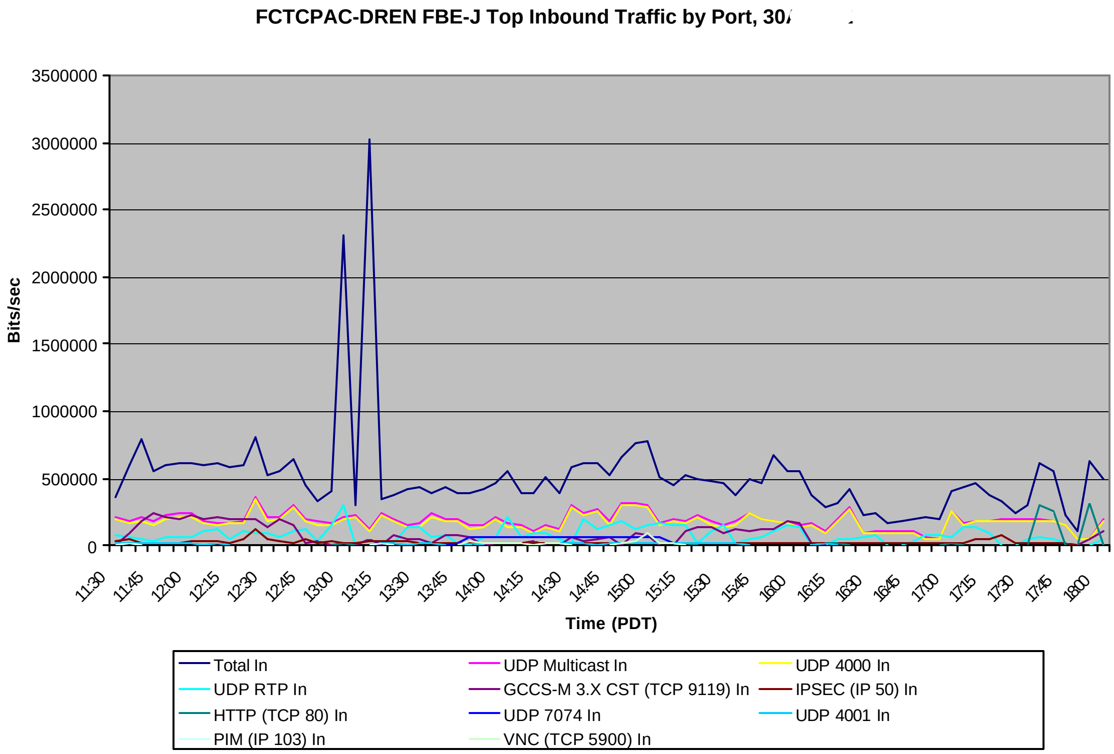

Figure A9-82. FCTCPAC-DREN Top Inbound Traffic by Port, 30 July 02

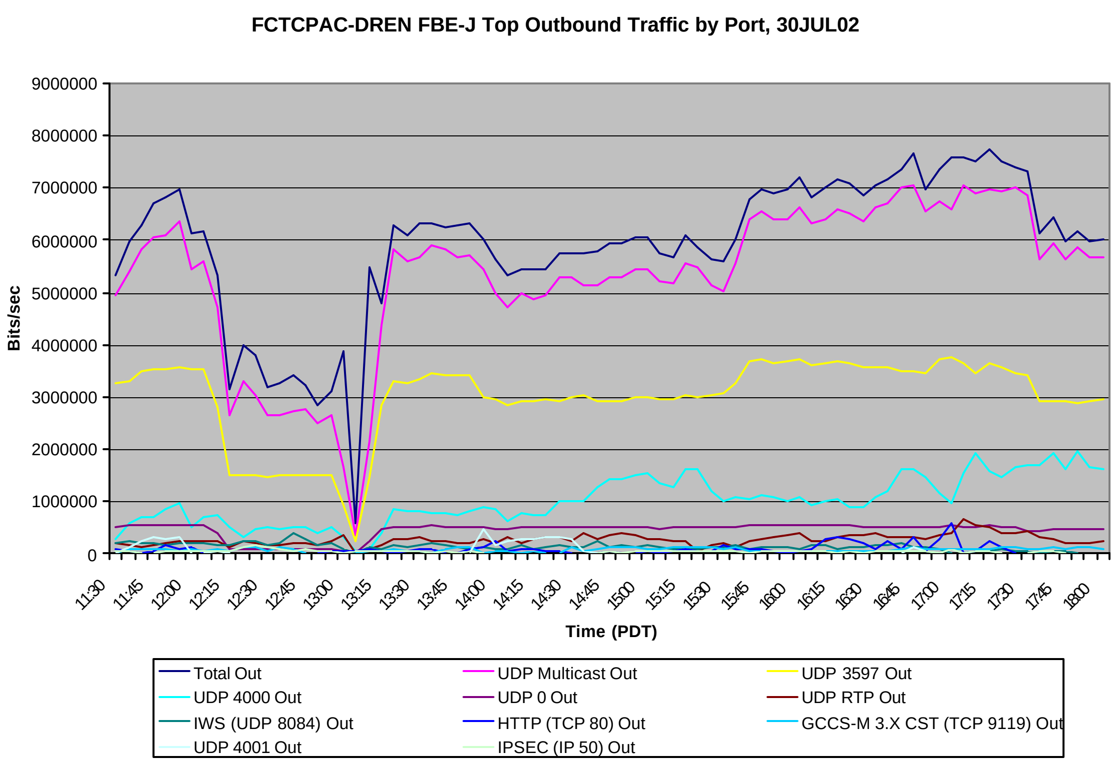

Figure A9-83. FCTCPAC-DREN Top Outbound Traffic by Port, 30 July 02

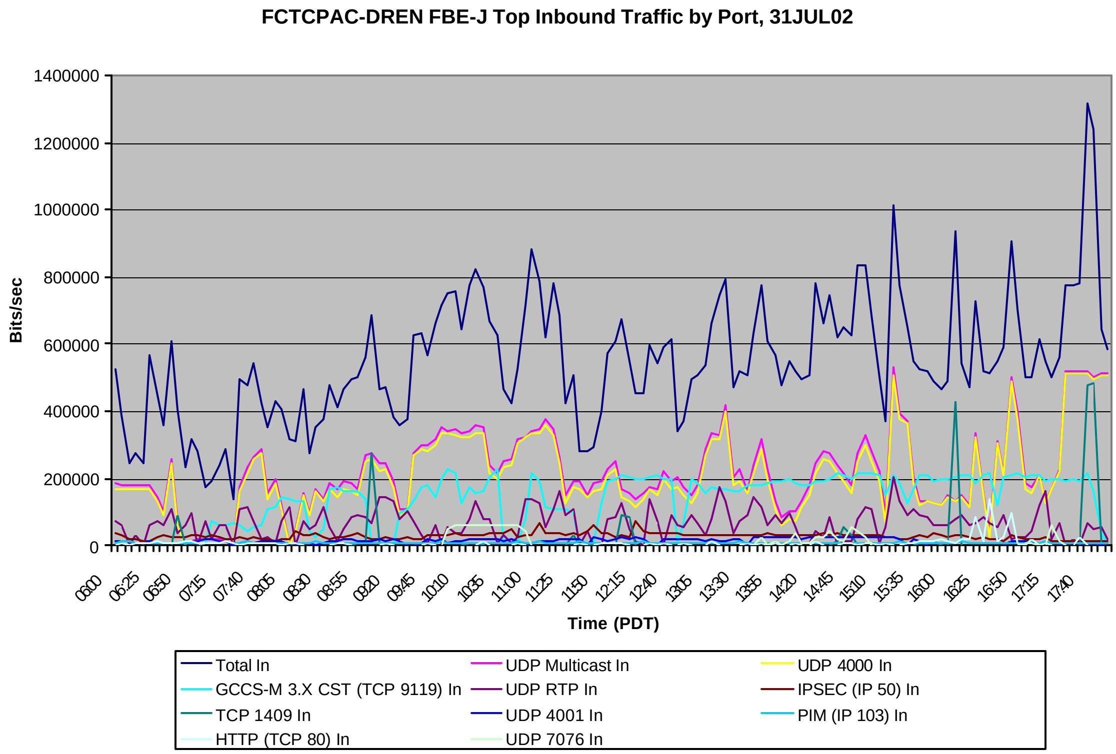

Figure A9-84. FCTCPAC-DREN Top Inbound Traffic by Port, 31 July 02

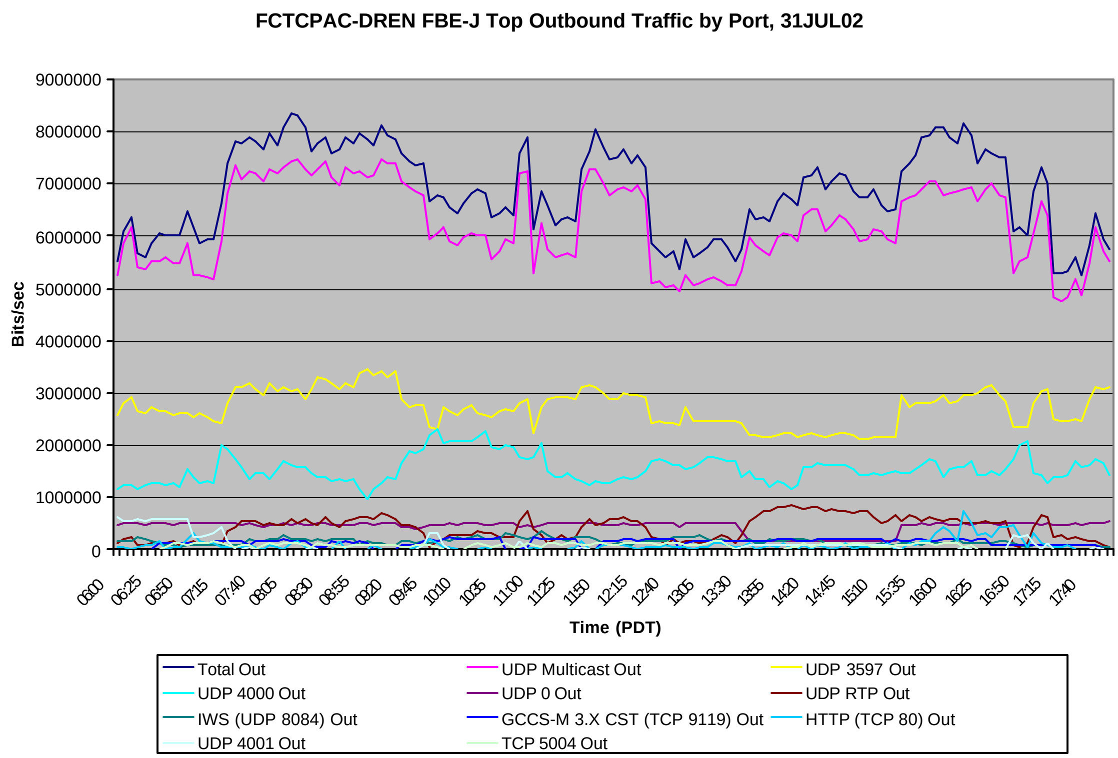

Figure A9-85. FCTCPAC-DREN Top Outbound Traffic by Port, 31 July 02

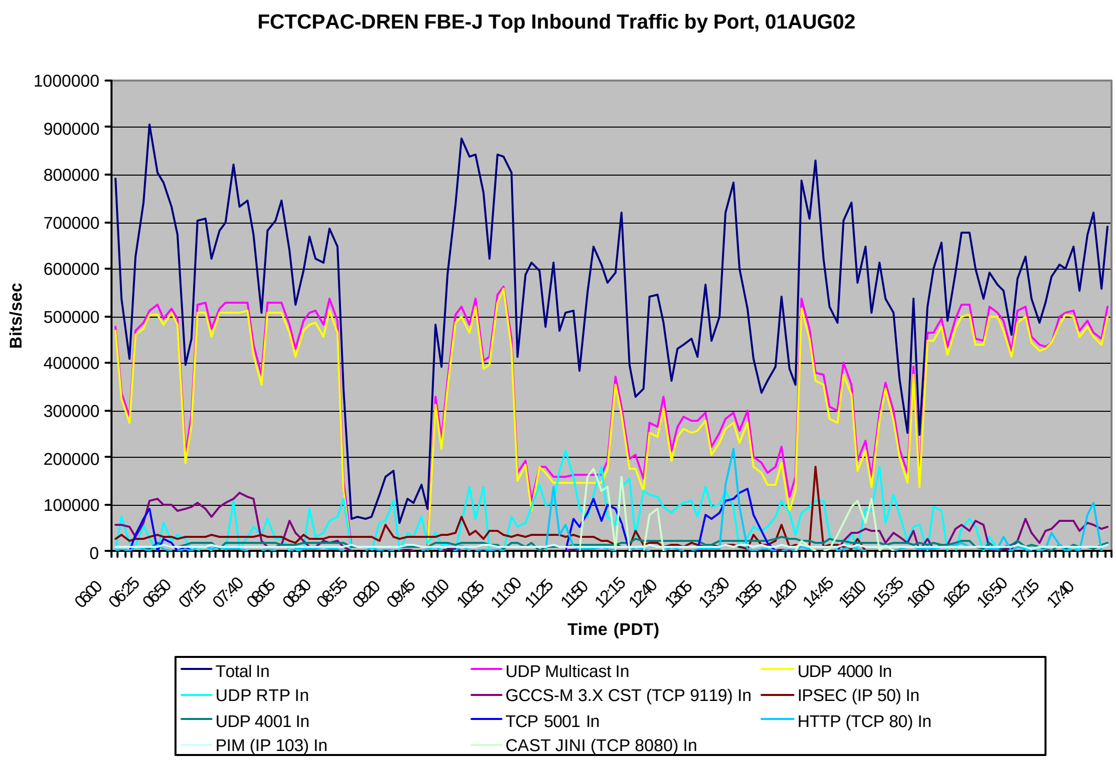

Figure A9-86. FCTCPAC-DREN Top Inbound Traffic by Port, 01 August 02

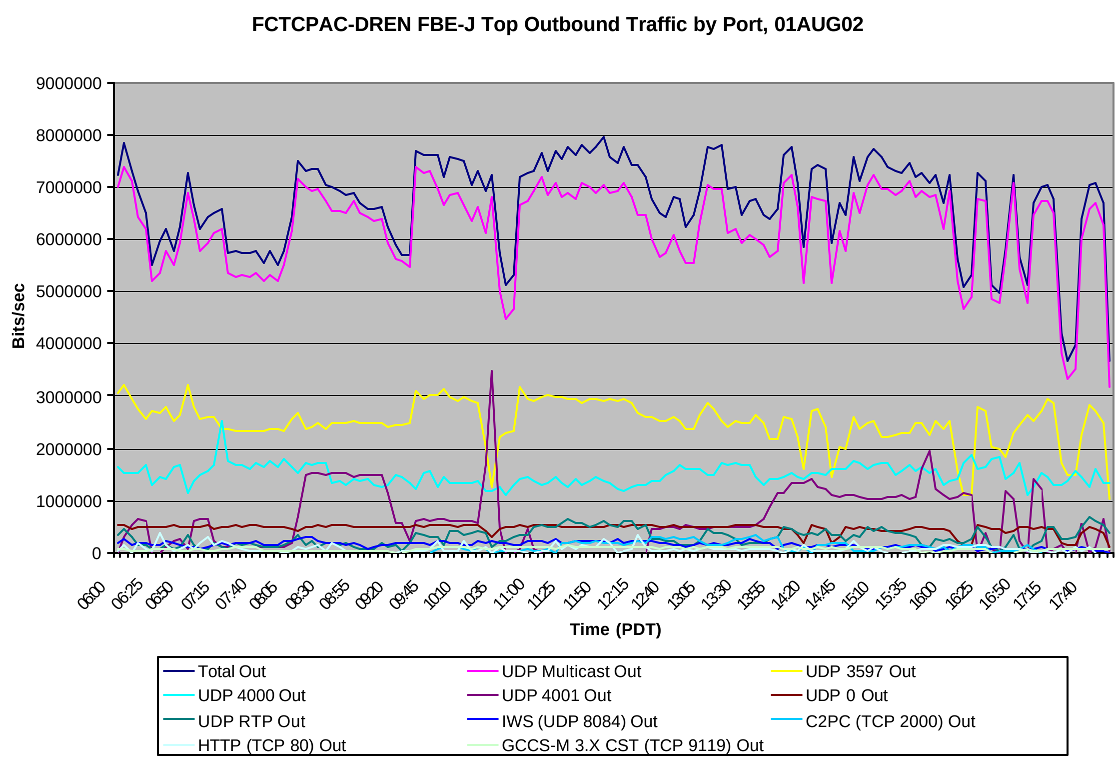

Figure A9-87. FCTCPAC-DREN Top Outbound Traffic by Port, 01 August 02

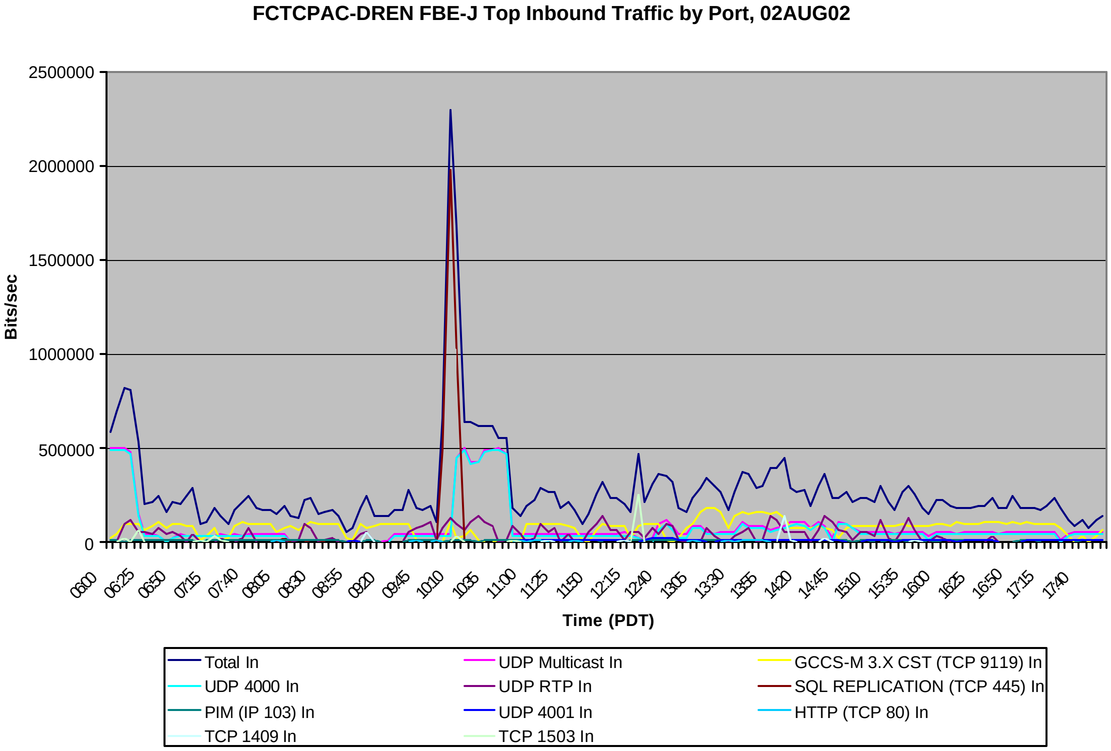

Figure A9-87. FCTCPAC-DREN Top Inbound Traffic by Port, 02 August 02

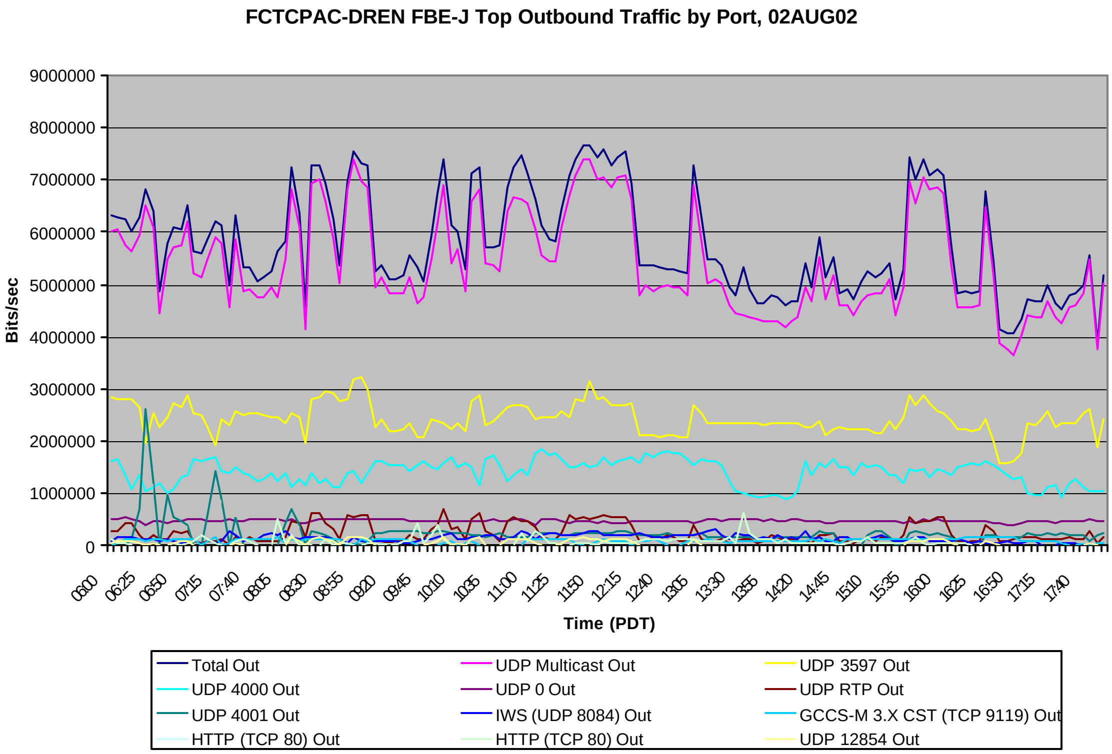

Figure A9-88. FCTCPAC-DREN Top Outbound Traffic by Port, 02 August 02

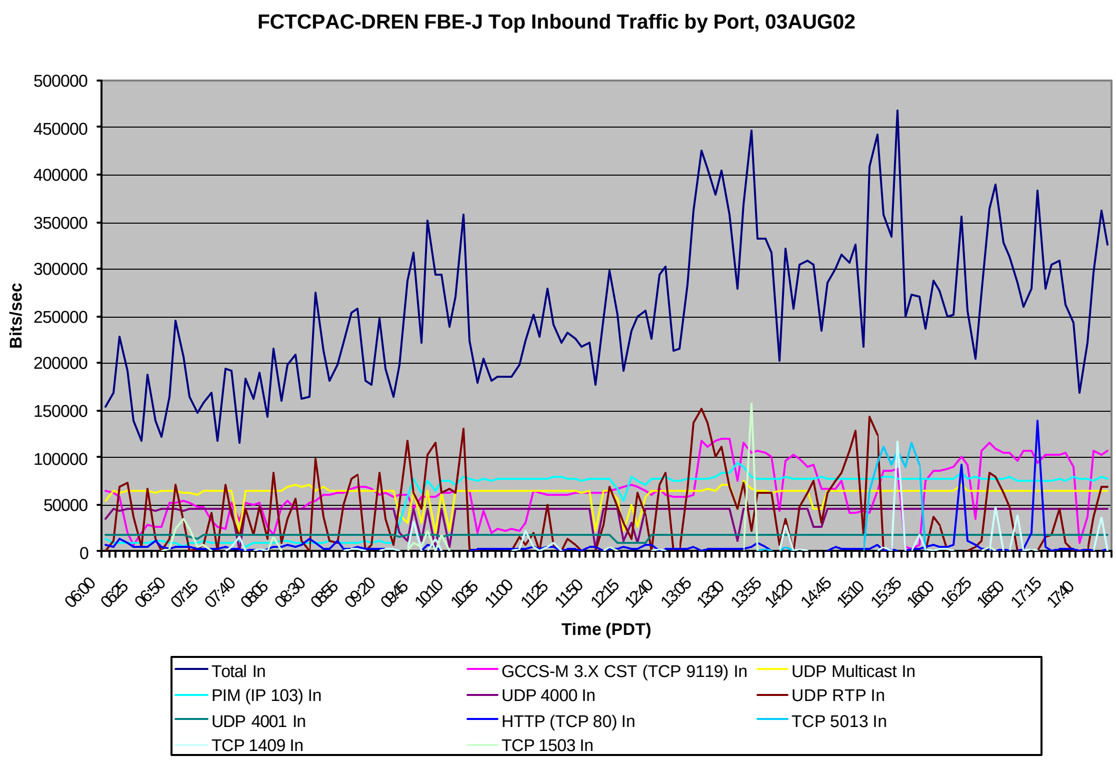

Figure A9-89. FCTCPAC-DREN Top Inbound Traffic by Port, 03 August 02

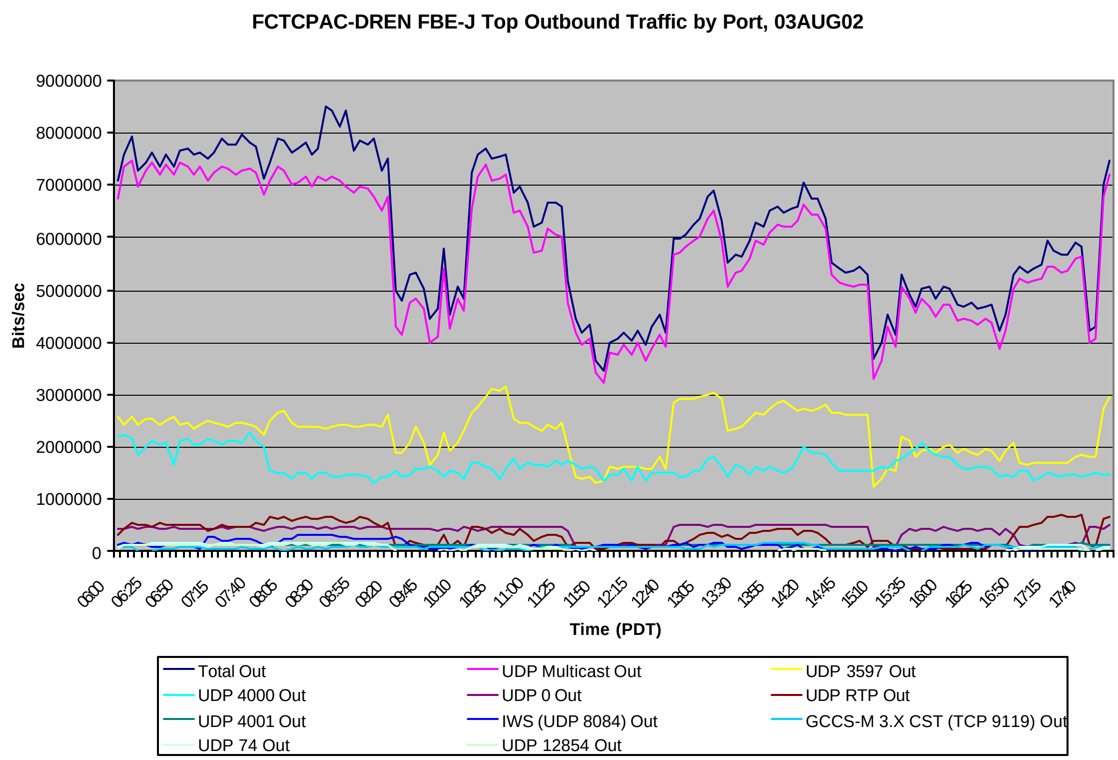

Figure A9-90. FCTCPAC-DREN Top Outbound Traffic by Port, 03 August 02

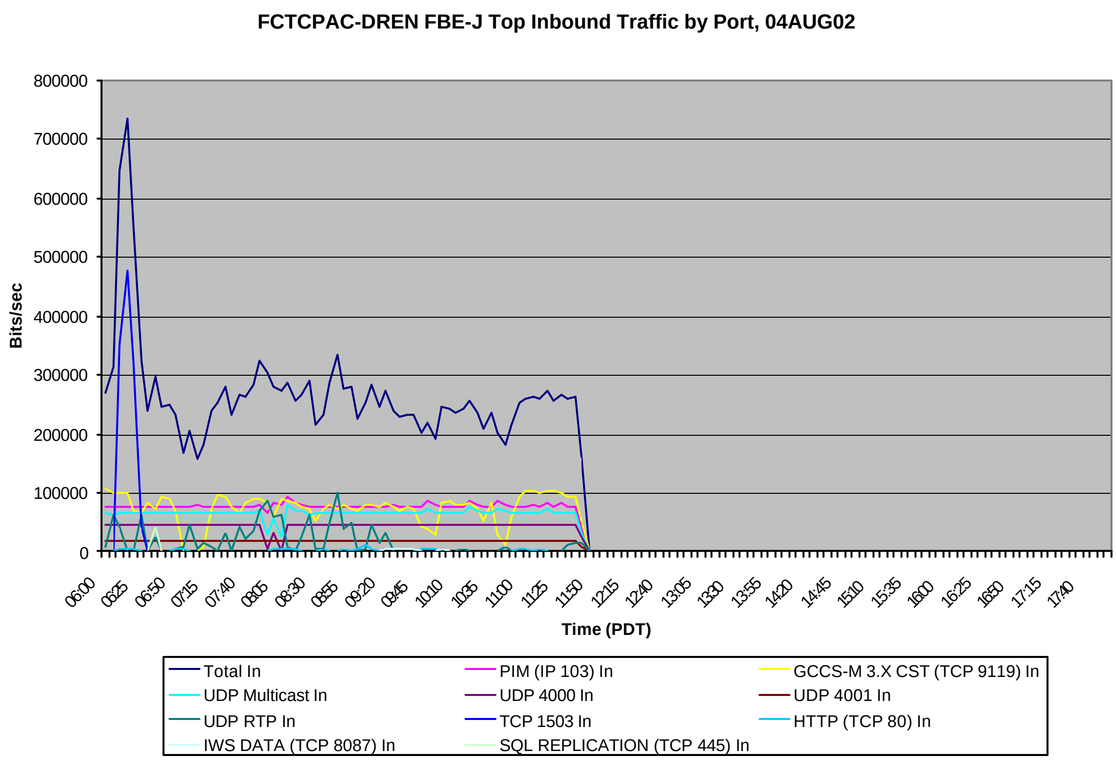

Figure A9-91. FCTCPAC-DREN Top Inbound Traffic by Port, 04 August 02

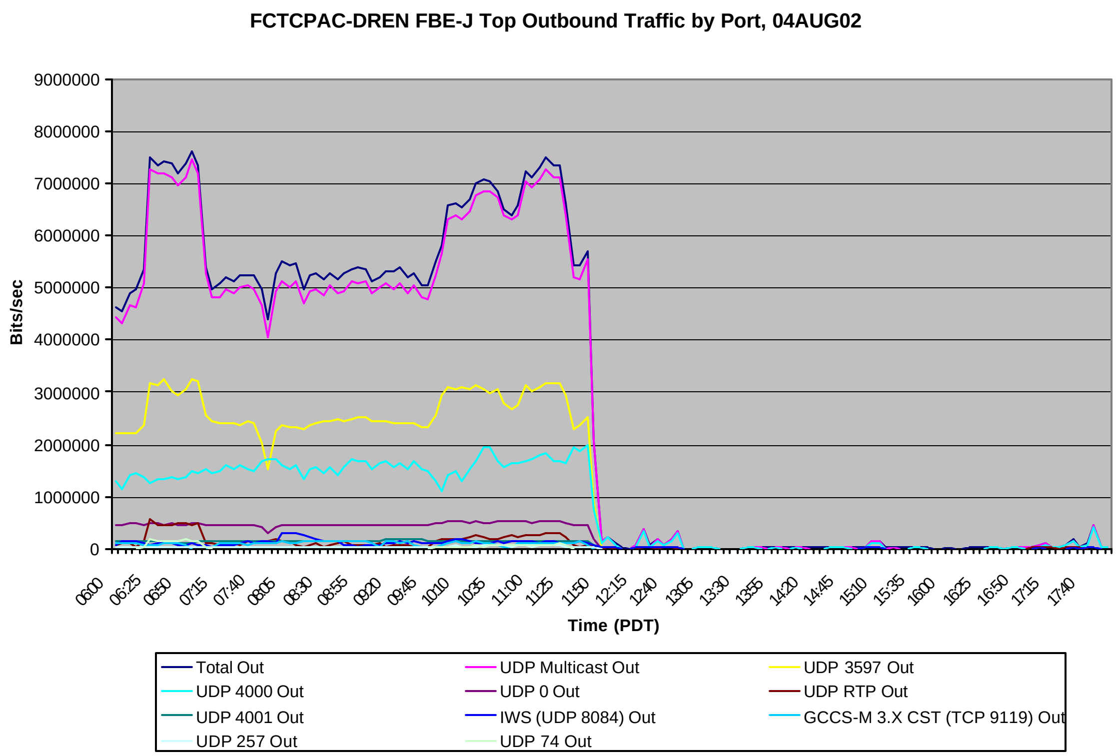

Figure A9-92. FCTCPAC-DREN Top Outbound Traffic by Port, 04 August 02

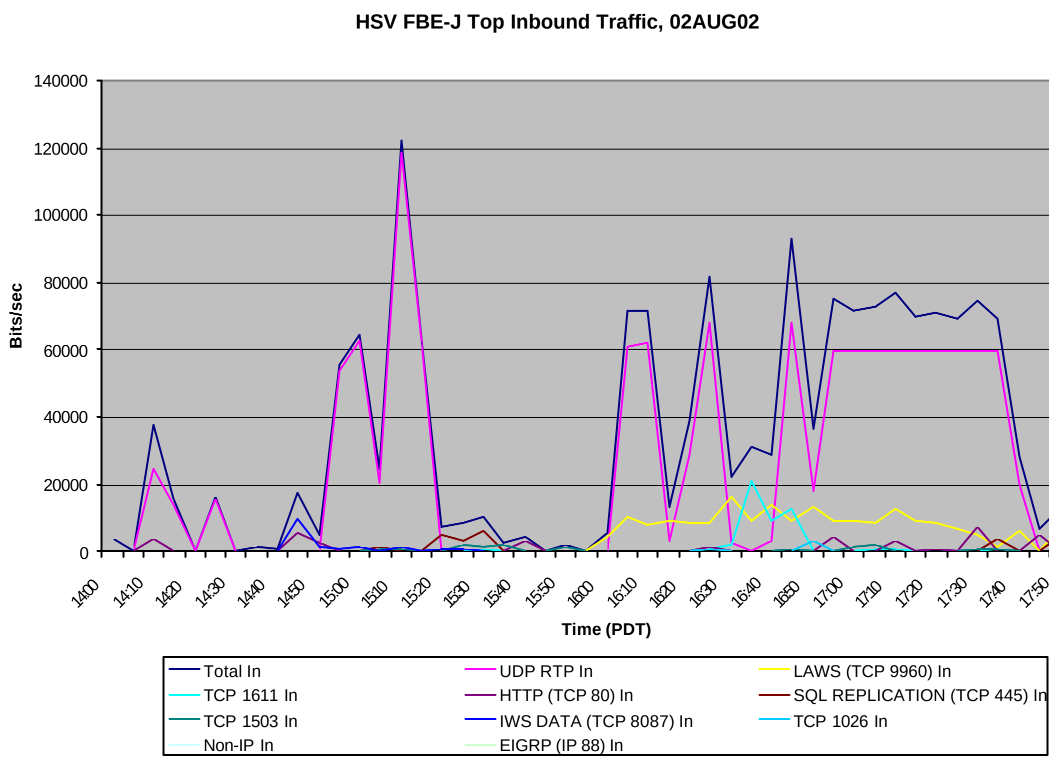

Figure A9-93. Joint Venture (HSV-X1) Top Inbound Traffic by Port, 02 August 02

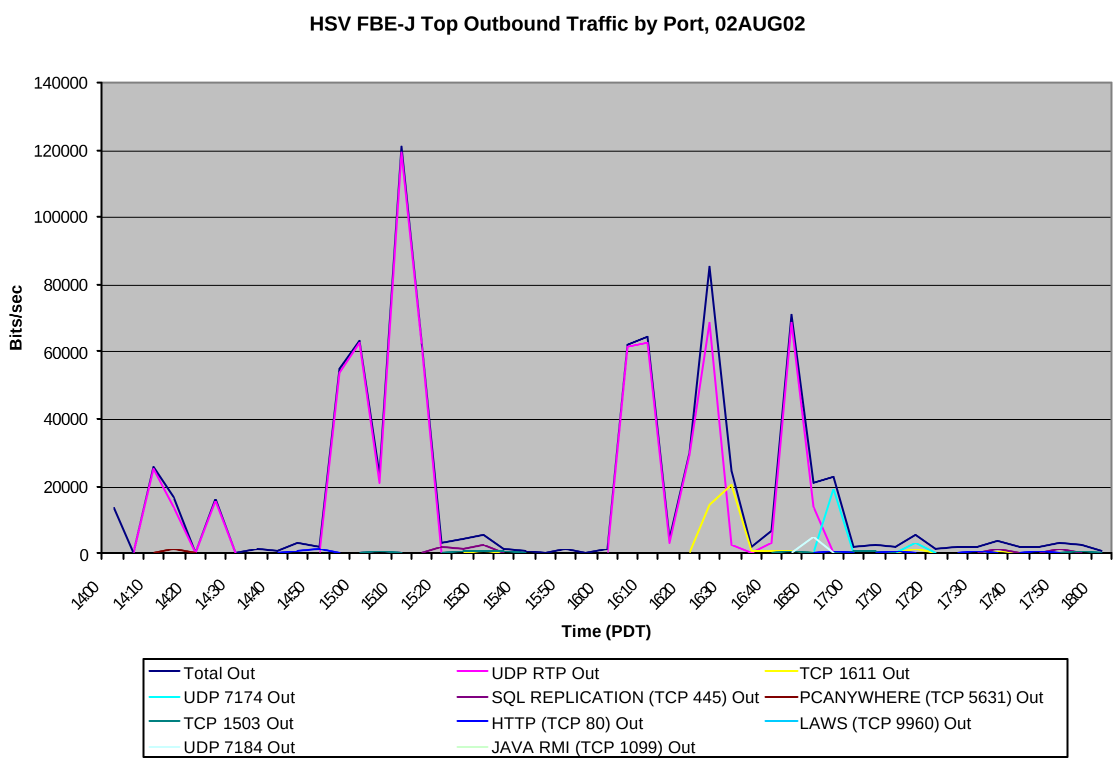

Figure A9-94. Joint Venture (HSV-X1) Top Outbound Traffic by Port, 02 August 02

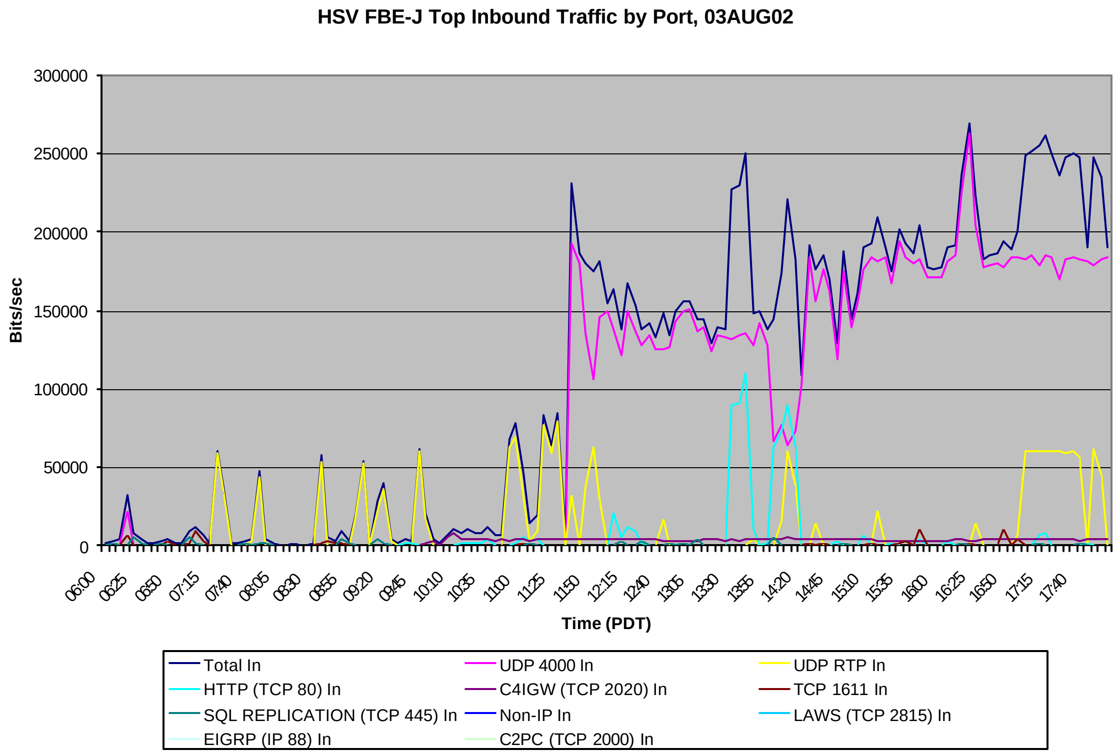

Figure A9-95. Joint Venture (HSV-X1) Top Inbound Traffic by Port, 03 August 02

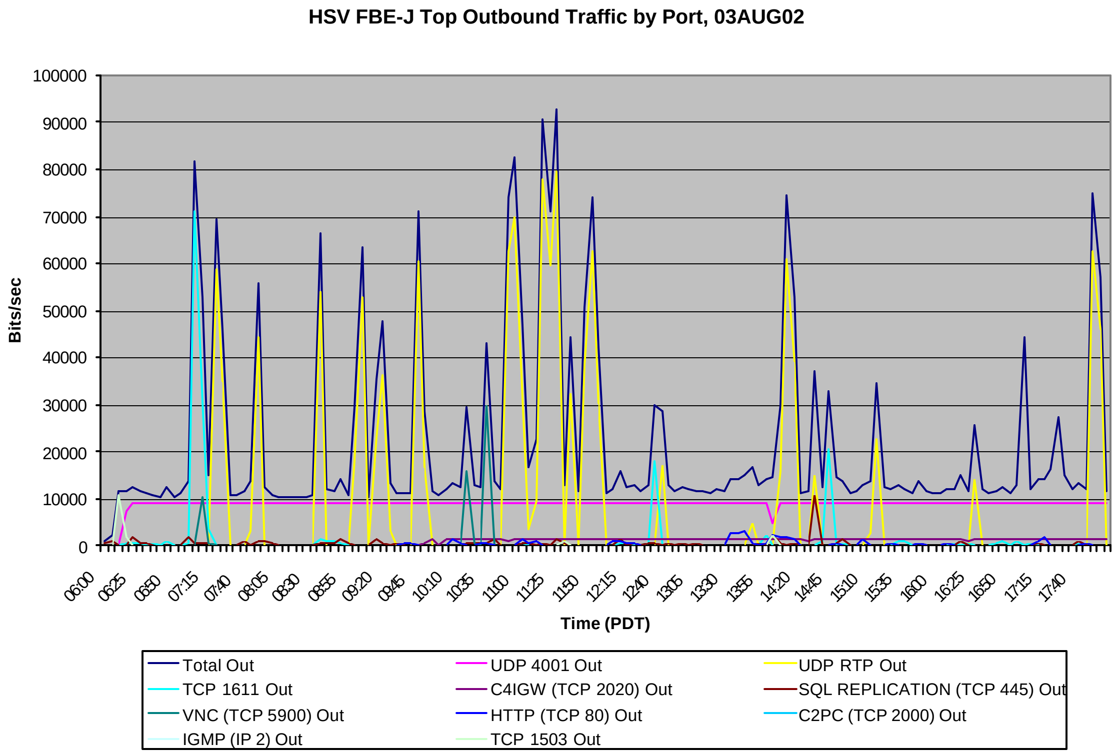

Figure A9-96. Joint Venture (HSV-X1) Top Outbound Traffic by Port, 03 August 02

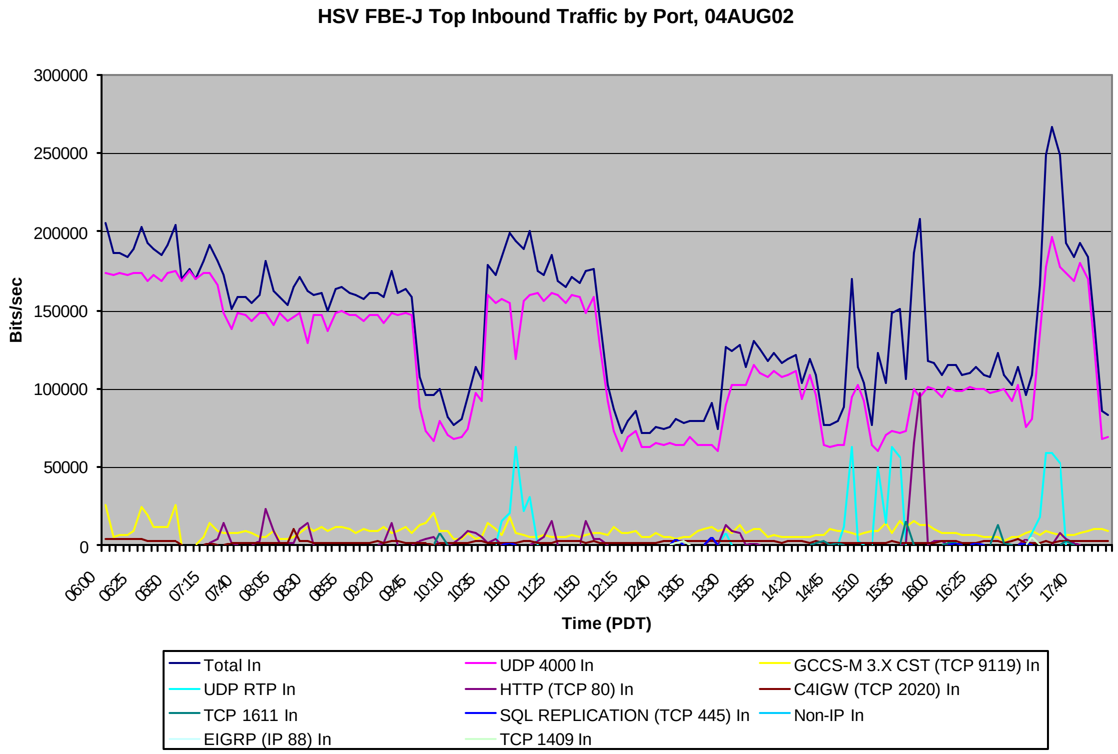

Figure A9-97. Joint Venture (HSV-X1) Top Inbound Traffic by Port, 04 August 02

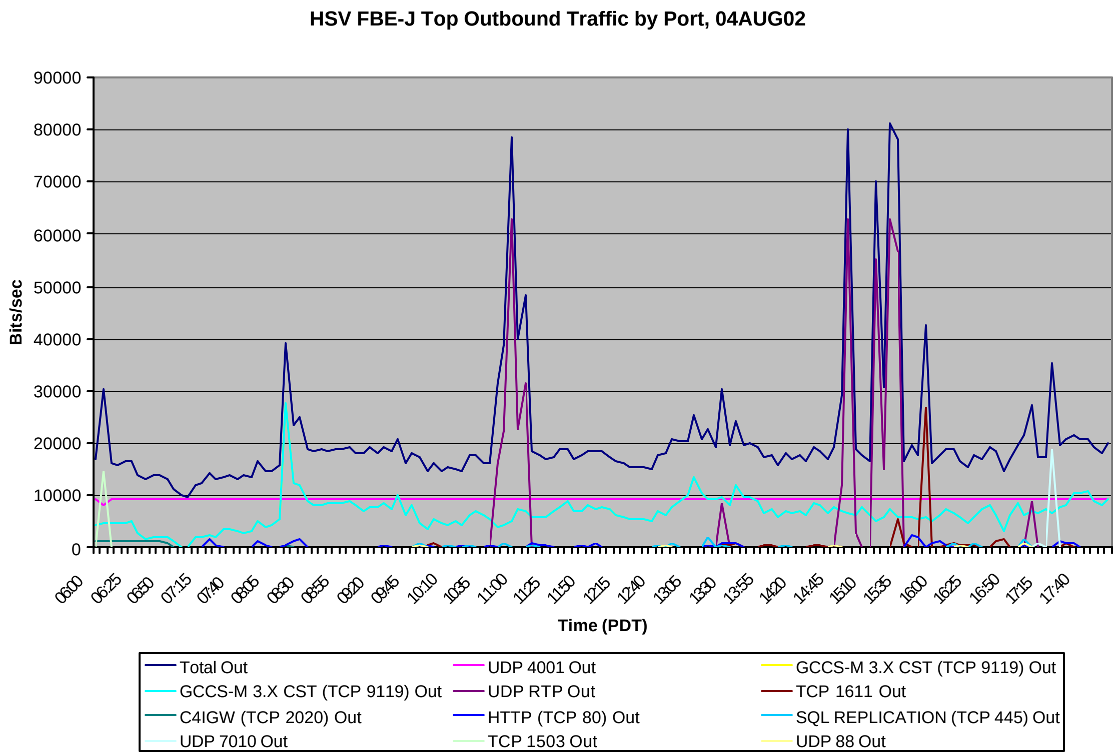

Figure A9-98. Joint Venture (HSV-X1) Top Outbound Traffic by Port, 04 August 02

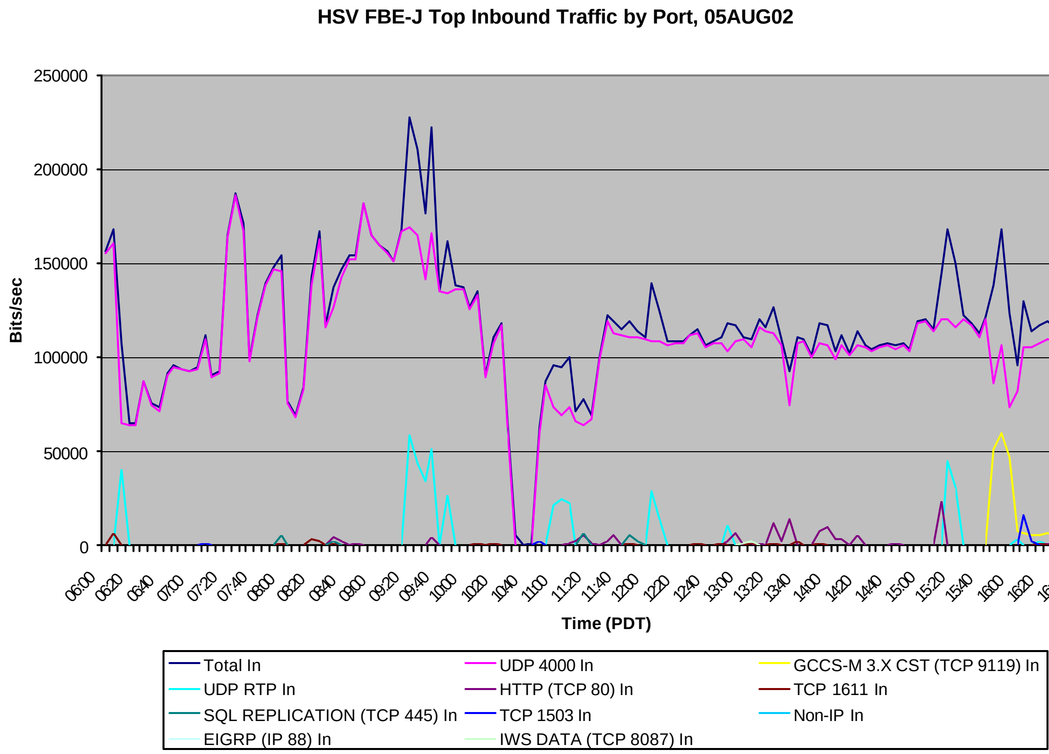

Figure A9-99. Joint Venture (HSV-X1) Top Inbound Traffic by Port, 05 August 02

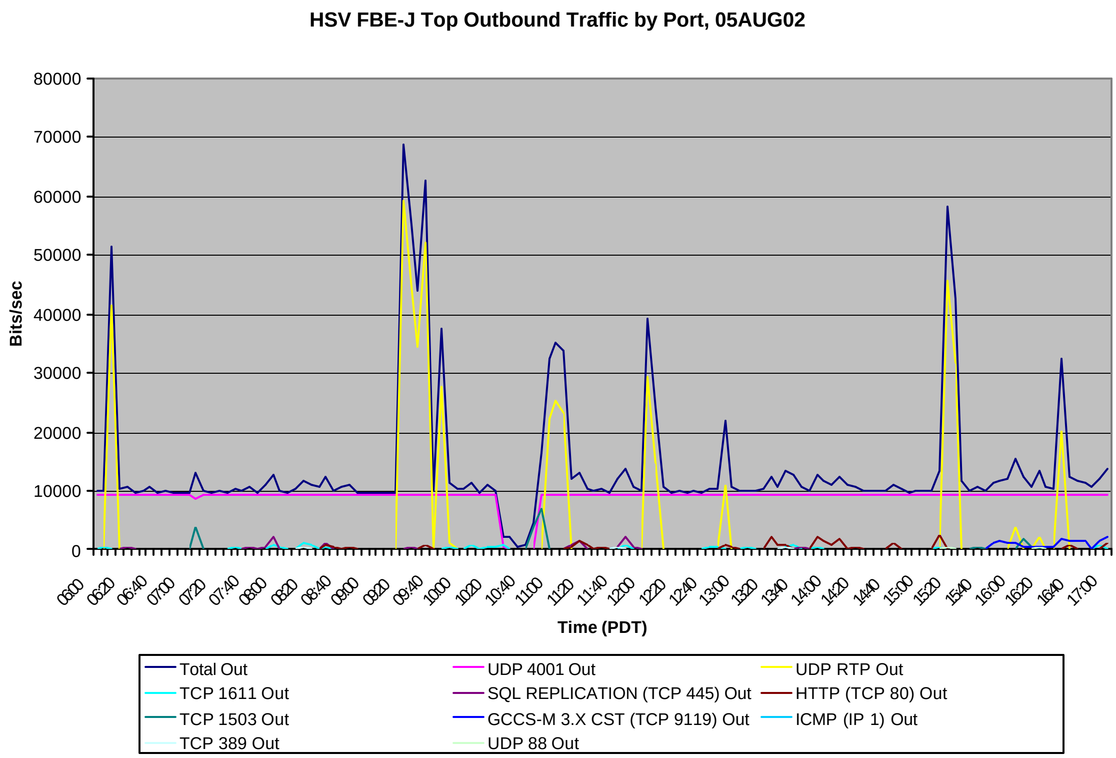

Figure A9-100. Joint Venture (HSV-X1) Top Outbound Traffic by Port, 05 August 02

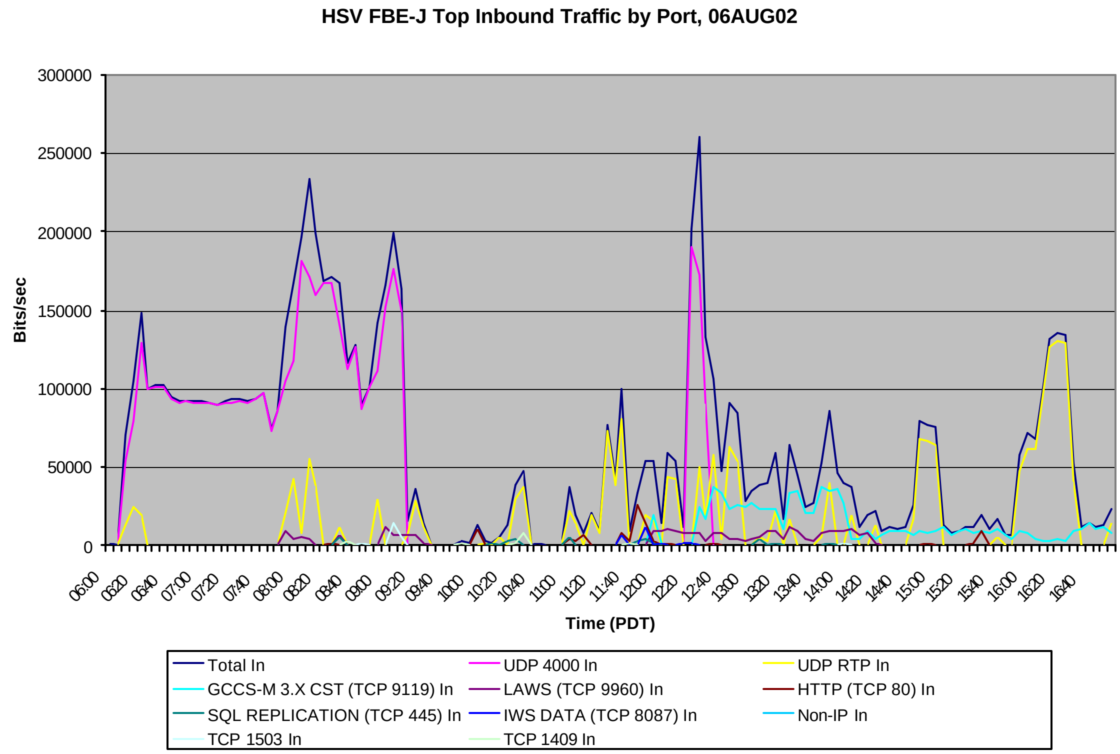

Figure A9-101. Joint Venture (HSV-X1) Top Inbound Traffic by Port, 06 August 02

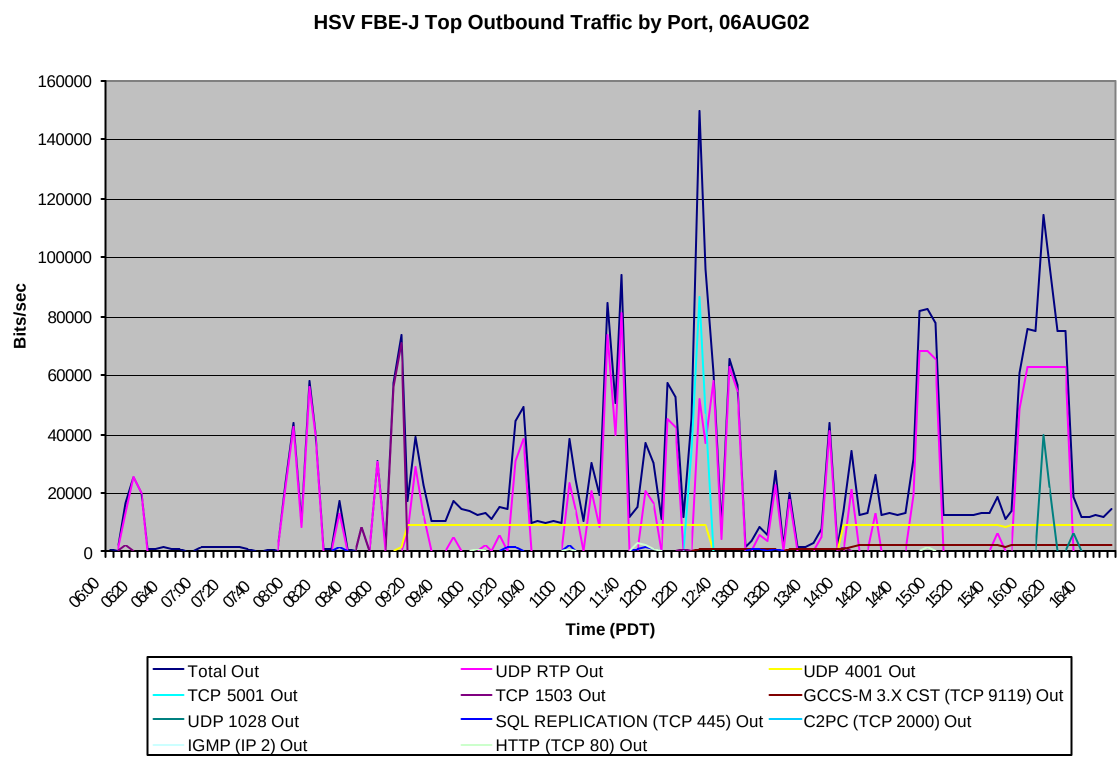

Figure A9-102. Joint Venture (HSV-X1) Top Outbound Traffic by Port, 06 August 02

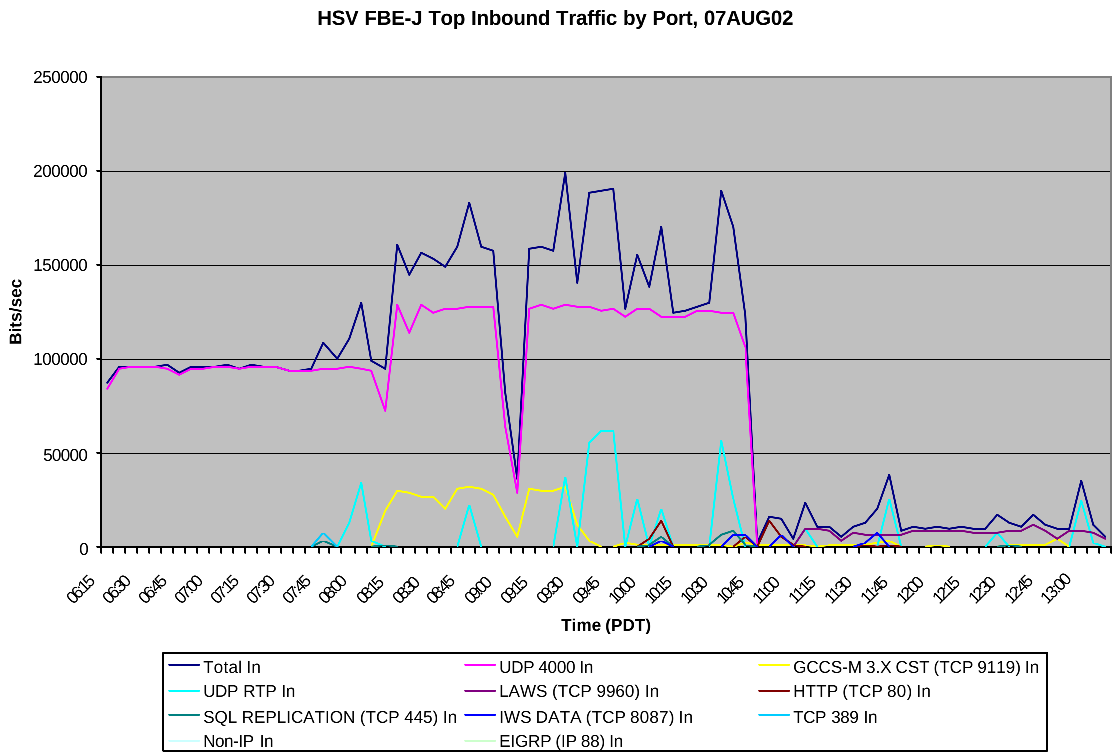

Figure A9-103. Joint Venture (HSV-X1) Top Inbound Traffic by Port, 07 August 02

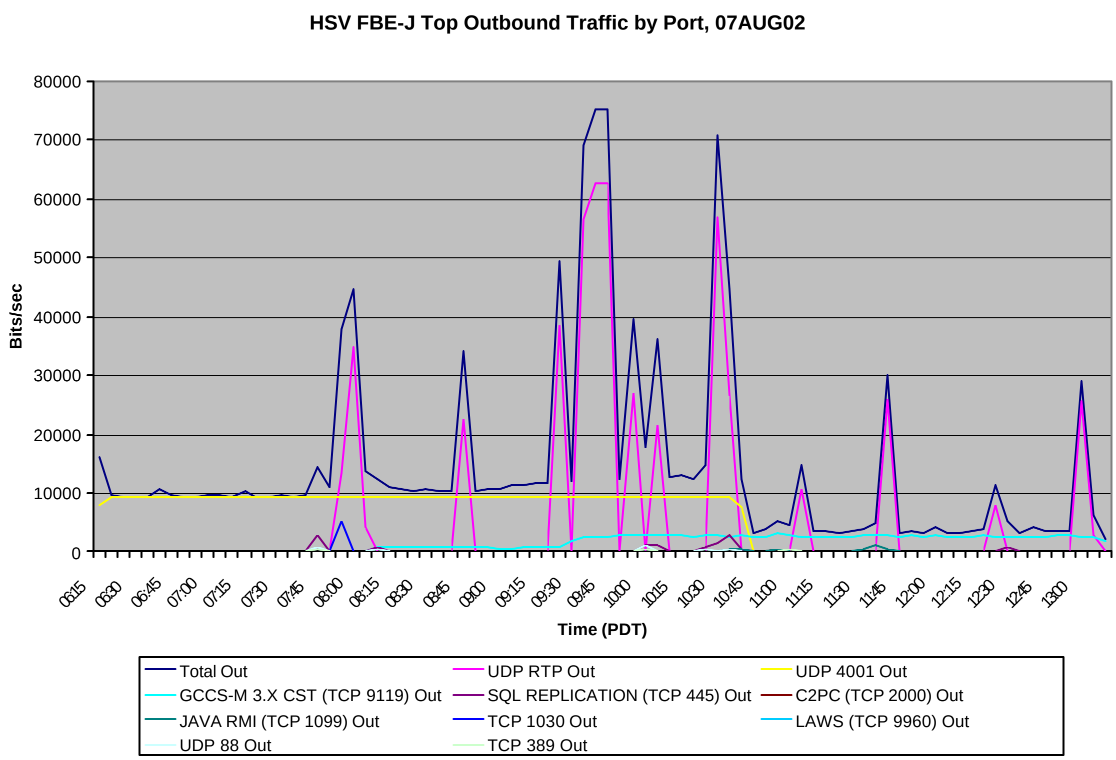

Figure A9-104. Joint Venture (HSV-X1) Top Outbound Traffic by Port, 07 August 02

The following chart shows the daily byte counts of the top 10 remote hosts transmitting over the Ku-band link on CORONADO. What stands out is the increase in data transmitted from the MUSE U2 simulator starting on August 1, and the steady decline of traffic from the JFCOM host 128.105 between July 26 and 29, with no traffic after that. The 222.82 host at Nellis Air Force Base also exhibited anomalous behavior, showing a general increase in traffic the first week, peaking on July 31 (the second day CORONADO was underway), and then dropping off substantially for the next two days, and shutting off altogether starting on August 3.

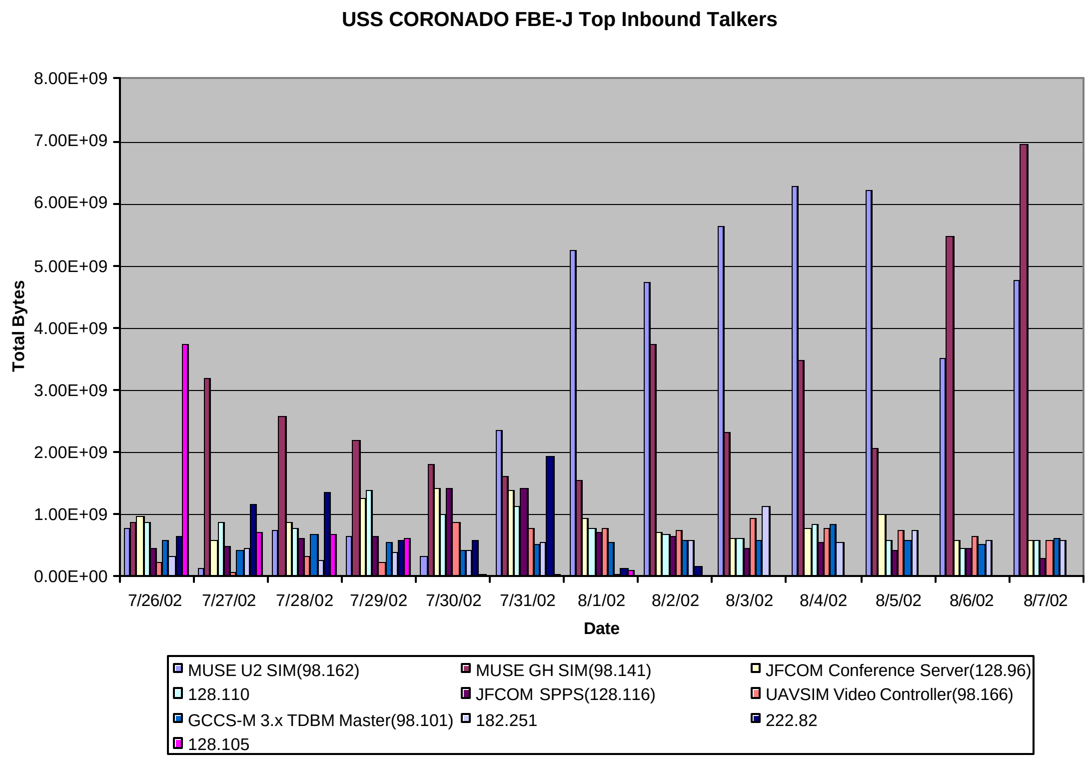

Figure A9-105. USS CORONADO Top Inbound Talkers

The corresponding chart for outbound traffic is notable in that 5 of the top 8 hosts transmitting data off CORONADO were JFCOM "Netted Force" servers (SharePoint Portal Server, InfoWorkSpace server, and Microsoft's Active Directory, Exchange and SQL servers).

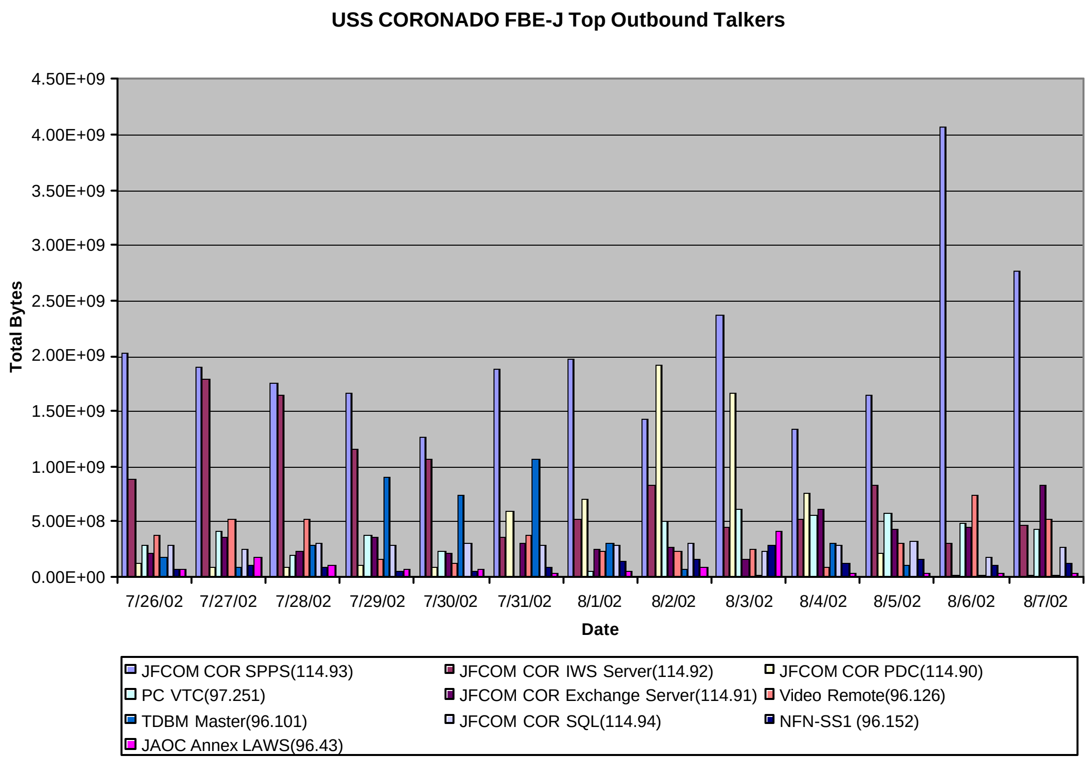

Figure A9-106. USS CORONADO Top Outbound Talkers

Data Collection, Reduction and Analysis

In the 15 days of FBE-J data collection, over 330 gigabytes of packet header data were collected at the 6 sites (CORONADO, FITZGERALD, BENFOLD, HSV, FCTCPAC and China Lake). The data were stored locally on external hard disk drives (with the exception of the HSV) and reduced nightly on CORONADO, BENFOLD and FITZGERALD. The main reduction script ("snifcap.pl") reduced output from either a series of Sniffer capture files (ending in ".cap") or a Windump capture file (ending in ".dmp"). The reduction process typically reduced about 3 gigabytes of data per hour. The reduced data were in the form of comma-separated files showing inbound and outbound per-minute average and one-second peak rates of each minute for all TCP and UDP port numbers, IP type numbers; average and peak rates transmitted from and received by all IP addresses; and data for each TCP session, consisting of start and stop times, source and destination IP addresses, source and destination TCP ports, packet and byte counts, average bits per second, total retransmissions for each session, and average round-trip time per packet in milliseconds. Other scripts were used to extend the interval from 1 to 5 minutes, to save and sort the top 250 ports or IP addresses (to get around the 255-column limitation of Microsoft Excel), and to select user-specified IP address or ports from these files.

The IP addresses were sanitized by substituting "nnn.nnn" for the FBE-J network portion of the address, and "xxx.xxx" for the network portion of non-FBE network addresses. Due to SIPRNET connectivity, the packet capture files remain classified, and the reduced text data were run through a rigorous 11-step sanitization procedure (detailed at the Navy information security Web site at https://infosec.navy.mil/sectips.html) before further reduction on the unclassified side.

In addition to bit rates, RTP audio and video jitter as well as RTP dropped packets and total packet counts were logged for each minute. Other data produced in the reduction process (Web server usage and UDP flow data) remain on the classified side. Entire SMTP packets on CORONADO and at FCTCPAC were captured using the "windump" open-source packet capture program, and message traffic was reconstructed from these captures using a Perl script developed at NSWC Corona. These data also remain on the classified side.

Several problems occurred in the data collection effort, most notably those related to the switched nature of the local area networks. The analysis laptop placement at FCTCPAC originally allowed for packet capture over the Ku-band and DREN connections simultaneously, but ended up being shut down for 3 days (July 26-29) due to potential impact on the LAN switch it was connected to. From July 29 onward, the laptop captured only the packets between FCTCPAC and the DREN connection. Future implementations of network analysis laptops at the shore-based satellite site should include two separate packet capture programs and interfaces (one for the satellite link and the other for the link to the other shore sites). Also, China Lake encountered a problem with switch performance when port-mirroring the DREN data onto the network analysis port. Network engineers at China Lake were able to work around this problem by making the mirrored port receive-only, which still allowed for packet capture but made remote administration impossible. Reliable data collection for China Lake was limited to 5 days (July 28 – August 1, when most of the action on the ground was taking place).

The HSV encountered many issues relating to network analysis data collection. This was the only site where a laptop was not used (due to space limitations). A rack-mounted PC was put to use, and controlled through a keyboard-video-mouse (KVM) matrix switch as well as remotely using pcAnywhere. This led to some user contention problems as personnel aboard the HSV easily accessed the PC. The screen-saver password was changed first to alleviate this problem, but then the network analysis PC was rebooted in an apparent attempt to get around the password change. The packet capture was stopped several times between July 25 and August 2, limiting the amount of good data collected.

In addition, the LAN switch port did not appear to mirror all the packets entering and leaving the HSV via the Ku-band satellite link. From July 25-29, very little TCP data was captured other than that to and from the network analysis PC itself. The following table shows all the TCP flow data from July 26. All the LAWS sessions shown below represent only one (inbound) packet for each session.

START	STOP	SOURCE HOST	DEST HOST	DEST PORT	BYTES
09:13:04.766	09:13:52.108	99.25	HSV Net Analysis(104.243)	PCANYWHERE (5631)	54137
14:58:33.567	14:58:34.894	Network Analysis(96.135)	HSV Net Analysis(104.243)	PCANYWHERE (5631)	252
14:58:39.575	14:58:39.575	Network Analysis(96.135)	HSV Net Analysis(104.243)	PCANYWHERE (5631)	126
14:58:41.658	14:58:45.940	Network Analysis(96.135)	HSV Net Analysis(104.243)	PCANYWHERE (5631)	258
18:36:59.000	05:28:50.396	Network Analysis(96.135)	HSV Net Analysis(104.243)	PCANYWHERE (5631)	192
09:04:14.000	05:28:50.396	JAOC Annex LAWS(96.43)	HSV LAWS(104.41)	LAWS (2811)	66
10:27:47.000	05:28:50.396	JAOC Annex LAWS(96.43)	HSV LAWS(104.41)	LAWS (2811)	66
09:37:22.000	05:28:50.396	JAOC Annex LAWS(96.43)	HSV LAWS(104.41)	LAWS (2811)	66
18:36:38.000	05:28:50.396	Network Analysis(96.135)	HSV Net Analysis(104.243)	PCANYWHERE (5631)	126
21:22:43.000	05:28:50.396	JAOC Annex LAWS(96.43)	HSV ADOCS(104.51)	LAWS (2814)	66
08:10:20.000	05:28:50.396	JAOC Annex LAWS(96.43)	HSV LAWS(104.41)	SQL REPLICATION (445)	66
09:16:23.000	05:28:50.396	JAOC Annex LAWS(96.43)	HSV LAWS(104.41)	LAWS (2811)	66
11:48:57.000	05:28:50.396	JAOC Annex LAWS(96.43)	HSV LAWS(104.41)	LAWS (2811)	66
08:10:43.000	05:28:50.396	JAOC Annex LAWS(96.43)	HSV LAWS(104.41)	135	66
09:13:06.000	05:28:50.396	JAOC Annex LAWS(96.43)	HSV LAWS(104.41)	LAWS (2811)	66
09:11:04.000	05:28:50.396	JAOC Annex LAWS(96.43)	HSV LAWS(104.41)	LAWS (2811)	66

Table A9-13. Joint Venture (HSV-X1) TCP Data Flow, 26 July 02

The port-mirroring problem was resolved on July 30, but due to other reboots and outages, the only full days where good data was collected on the HSV were August 2-6. Although running a dedicated laptop on the HSV for network analysis data collection was not an option, future data collection efforts need to restrict access to the packet capture machine by removing it from the KVM matrix switch menu.

On CORONADO, analysis laptop placement also presented a problem. The laptop was plugged into a hub, which also shared a switched port with the sea-based JFCOM servers, and data collection for the first two days was 3 times what it should have been. Starting on July 26, complex filters were set up on the Sniffer Basic program to filter out local packets being captured (those that never left the ship), and packet capture data was reduced from 24 gigabytes to 8 gigabytes per 12-hour period.

On BENFOLD, the Sniffer Basic software quit recognizing the network interface card on the Network Analysis laptop at approximately 1530 on the first day of capture (July 24), and subsequently failed to work even after removing and re-installing the software. Windump was installed in its place and worked flawlessly from that point on. Windump, while possessing no graphical user interface (GUI) and lacking some of the drill-down features of the costly ($1600 GSA price) Sniffer Basic, outperformed Sniffer in packet capture. While Windump (based on the very popular “tcpdump” open-source packet capture software for Unix) sends raw packets to standard output or a file, Sniffer buffers the data in memory and writes to file only when the allocated memory (maximum of 40 megabytes) is filled. While doing so, new packets coming in are discarded (up to 50 milliseconds’ worth), which may not have a noticeable impact on bandwidth utilization and benchmarking, but can create gaps in reconstructing data flows. Network Associates (as of May 2002) had no solution for this problem in Sniffer Basic.

For the SMTP entire-packet captures on CORONADO and at FCTCPAC, windump ran concurrently with Sniffer Basic on the same machine without any problem. In fact, multiple instances of Windump can run on the same interface on a machine (Sniffer Basic requires multiple interfaces for this to work). During FBE-J, the network engineering team expressed a desire to obtain some of the usage statistics in near real time for troubleshooting. This may be possible using a Unix/Linux machine and tcpdump by piping the standard output to a data reduction script, which would output usage data to a file or database, which could be queried using a Web browser. At the same time, the reduction software could be modified to split the output into smaller, more manageable files similar to what Sniffer Basic does (without the packet drop). One advantage of Sniffer Basic is its superior assistance in troubleshooting, but on several occasions, while filtering captured data at the same time as running packet capture, the application hung the server, forcing a reboot (and losing minutes' worth of captured packets).

The reduction scripts were written to provide usage statistics similar to those provided by the PacketShapers during FBE-India. Since the packet capture laptops had only a "passive tap" capture using one interface, the layer-2 Media Access Control (MAC) address of the upstream router or PEP (toward the wide-area network) needed to be input to the reduction script to determine inbound vs. outbound traffic. The "duration" statistic produced in the TCP flow data corresponded to the "network delay" data from the PacketShaper. Additional features provided were the capability to generate voice quality statistics, show average round-trip time of TCP packets, and break the TCP flow data down into individual sessions. NWDC network engineers using Cisco Policy Manager instead of PacketShapers effectively accomplished traffic shaping for FBE-J.

Time synchronization was accomplished using the "Automachron" time-synchronization software (as mandated for FBE-J). Every morning before starting data collection, and every evening at the conclusion of data collection, Automachron was invoked manually to synchronize with the local JOTS1 server.

The following table shows the clock slips over 12 hours on the local network analysis PCs based on the "delta" values (in milliseconds) given by the Automachron program at the end of daily data collection. Clock slips were generally in the hundreds of milliseconds over a 12-hour period. The positive values indicate the PC clock gaining milliseconds ("forward slippage"),and the negative entries indicate the clock losing milliseconds ("backward slippage").

Date	USS CORONADO	USS Benfold	USS Fitzgerald	HSV	FCTCPAC	China Lake
27-Jul	70	136	-357	-17		-1347
28-Jul	2509	774	4394			
29-Jul	395	1834	-7228			
30-Jul	330	392	71	887	-32	
31-Jul	415	-162	245	190	827	
1-Aug	399	774	258	183	688	
2-Aug	396	7765	1209	500	782	
3-Aug	1880			232	792	
4-Aug	590			342	-76	
5-Aug	409		5787	-395	708	
6-Aug	-294				705	
7-Aug	438					

Table A9-14. Daily Network Analysis PC Clock Slippage (msec), 0600-1800 PDT

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Appendix 10: Simulation Within FBE-J
Final Report: Fleet Battle Experiment - Juliet

Simulation is used extensively as a substitute for live play during FBEs. Physical actions are determined by simulation computation and results used to stimulate the systems being used in the experiment. There has been some misunderstanding of what can and cannot be determined from simulation-stimulated experimentation. This appendix provides a brief discussion of the topic, using examples from TCT.

Simulation Use Constraints

It is often assumed that more results can be obtained from simulation experiments than is possible. As an example, suggestions have been made to use them to determine Pk. This either can or cannot be done depending on the definition of Pk. If Pk means kill probability taking into account weapon fly out and weapon effects, it cannot be done. If Pk means kill probability taking into account the full detect-to-engage process, it can partially be done. This is explained immediately below.

Simulations are based on an underlying mathematical model of physical reality. Simulation is performed by a time-stepped succession of model calculations. Its greatest use is representing object-object interactions, for which it contains parameters, such as the lethality for a specific weapon against a specific target. Thus, weapon-target interaction is programmed into the model and the only pk that can be determined is what is already there, etc. for contributions from delivery vehicle flight dynamics and aim point errors. One might suggest that successive simulation runs can be run where the parameters are not deterministic but represented by probability distributions. This can be done, but the output effects distribution is determined by the distributions used in the model. Again, one is not doing an experiment but determining what is programmed into the model. The point is that <u>you cannot use a simulation to independently determine information that is already programmed into it</u>.

However, we noted that Pk can be determined when the physics of the situation is modeled if it is for the full detect-to-engage cycle. Then, one has human processes in the loop external to the simulation stimulated by simulation output. One can determine any number of MOPs for the full process, including Pk, by repeated stimulation-based experiments. Pk is then an experiment result providing information about the effectiveness of information and human-in-the-loop processes, with pk a deterministic value that contributes to it.

Sensor Planning Effectiveness, a Simulation Use Example

Consider an experiment goal to evaluate sensor management planning effectiveness. We assume that intelligence preparation of the battlespace (IPB) information is available and the plan is based on it. For ease of discussion, graphical illustrations of IPB, planning, and results are shown in Figure A10-1.

IPB

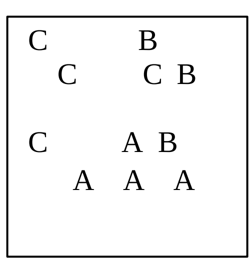

Figure A10-1. Graphical Illustrations of Intelligence Preparation of the Battlespace (IPB).

Figure A10-1shows targets within a search area. A, B, and C are target types, shown in their <u>suspected</u> locations. Terrain for the area is known, including an understanding of how one would hide target types in various terrains. From this information the sensor plan is developed for three sensor types. The plan is responsive to both suspected locations and hiding places.

Plan

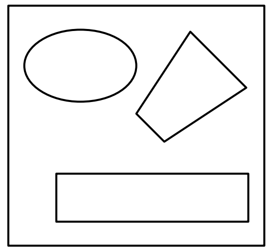

Figure A10-2. Planned Footprints for the Three Sensors.

Figure A10-2 shows the planned footprints for the three sensors. The footprints are covered over a period of time, not all at once. One may have the targets be present and available for detection for the full time period of the experiment or pop up for short periods.

The purpose of the experiment is to evaluate sensor plans by determining fraction of targets detected. Details of interactions between target type, terrain type, and sensor determine detection probability of detection and this information is included in the simulation model. Assuming the information is programmed correctly, determining sensor plan effectiveness with either live or simulated play produces equally valid results.

Results are shown with detections in bold and non-detection as plain letters. These results are due to the following sensor detection capabilities:

Rectangle	A and B
Trapezoid	A and B
Oval	A and C

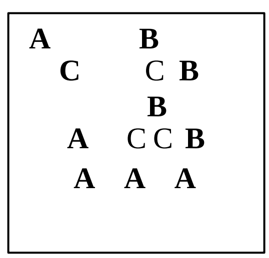

Figure A10-3. Detections in Bold and Non-Detection as Plain Letters.

Note that some targets were not the same as in the IPB. The search plan needed to be able to search for unknown targets, perhaps based on terrain knowledge.

One can examine actual target locations and detections, shown in the third figure, and decide whether the search plan was "good", and evaluate an MOP. The important point is that use of the simulation to perform this experiment is perfectly valid, can produce results every bit as good as doing a live experiment. But, this experiment has a very specific and restricted goal: to determine the quality of sensor management planning. There is nothing here that allows one to evaluate other properties of target detection, such as the ability to detect targets in some type of terrain. That information is pre-programmed into the simulation model.

One important factor with respect to this example is that results will depend on the physics programmed into the simulation model, e.g., if sensor detection probabilities are incorrect, results will be skewed. It is necessary to understand a simulation's underlying model when interpreting experimentation results—a point that will be important in the following discussion.

Simulation in FBEs, TCT Example, Data Capture Requirements

This sub-Section illustrates types of information needed at the interfaces with, and within a simulation in order to have sufficient data for analysis. The notional TCT process used is not meant to be complete; rather to illustrate some processes to discuss simulation-stimulated experimentation. Not included are a myriad of processes that would only complicate the discussion. We assume a common information backbone, labeled "Info Backbone", rather than discuss realities of how various types of information are exchanged. The only live play is people involved in the human detect-to-engage processes. Thus, this example is much like the one above, our interest being in how well humans perform their tasks and how well they are supported by software systems designed to be part of the process.

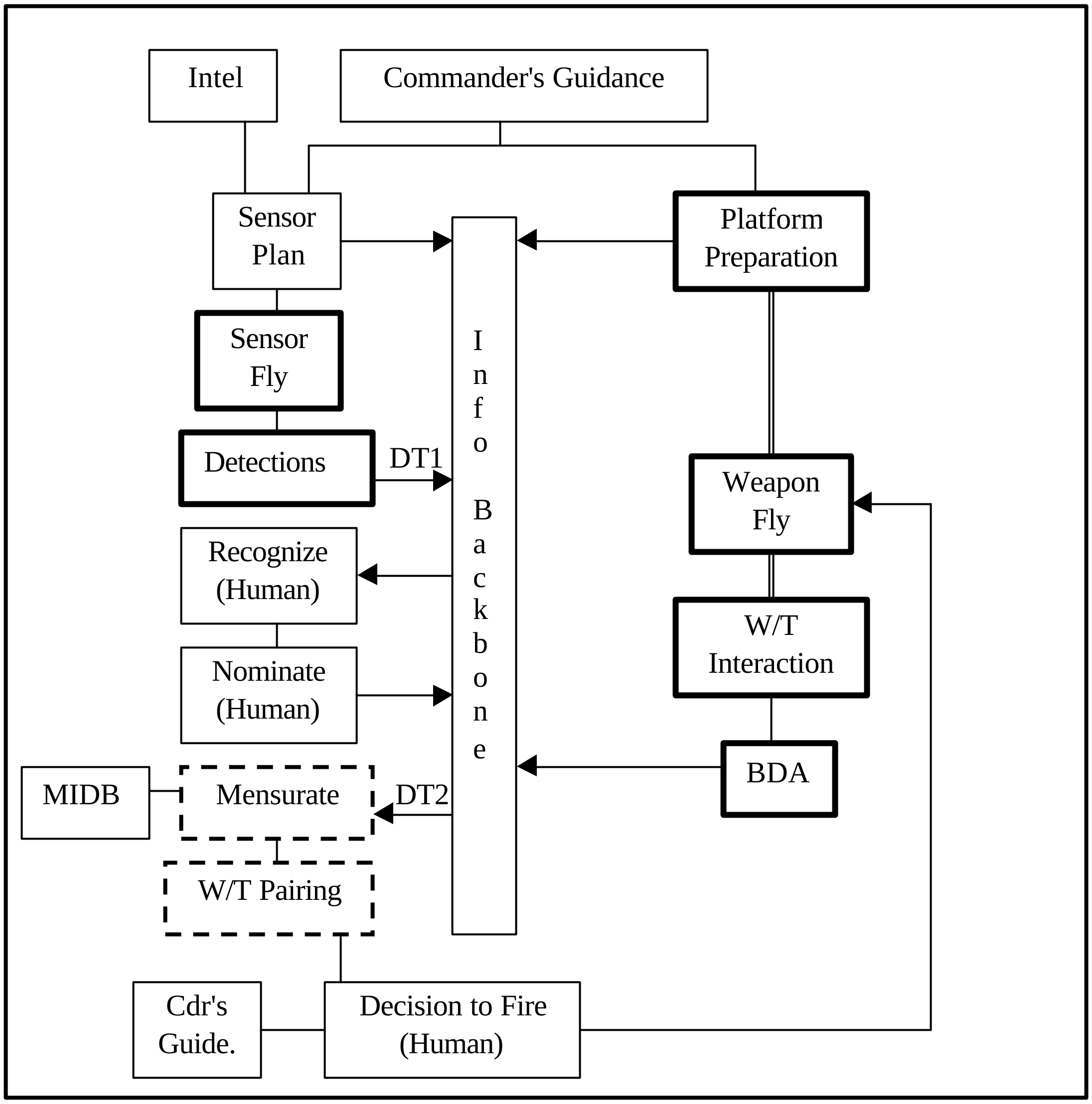

Figure A10-4. Essentials of the TCT simulation, information, and decision processes.

In the Figure A10-4:

- Solid bold boxes are processes totally within the simulation.
- Dashed boxes are processes performed by a human with computer aid.
- (Human) shows processes performed totally by a human.

We assume that the reader is familiar with the TCT process so we will not describe the processes shown in the figure. Rather, we will discuss data that must be captured within and outside the simulation in order to analyze TCT process capabilities. The two double lines are present for specific reference in the discussion that follows.

Analysis of this process requires knowing the time of occurrence and details of all events, inside and outside the simulation. For example, the figure shows detection information being placed on the information backbone by the simulation. It shows a human recognition of that information, with a time lapse of DT1. Also shown is DT2, which represents the amount of time between nomination and completion of mensuration. These elapsed times must be known.

Determining DT1 requires capturing first the time of simulation information output. This requires an automatic data capture process wither within the simulation or the information backbone. The second time to capture is when the human recognizes the information is available. This may seem a peculiar thing to determine, but it bears on quality of the display system and on human training and capabilities in this type of situation. Capturing this time can be done either by a separate observer or by the person logging the event.

DT2 is the time between target nomination and the completion of mensuration. Deciding to nominate is a purely human decision. Its occurrence can be logged or captured on the information backbone when the human enters the nomination. A human with software performs mensuration and the time of completion of the process can be captured either within that software or on the information backbone. There are times within the mensuration process that will also be needed for complete evaluation of the TCT process.

To summarize to this point, determining DT1 and DT2 (and other associated times not discussed) requires logging event times:

- Within the simulation.
- On the information backbone.
- Within software/hardware systems .
- At human decision nodes.

This may seem, and is, fairly obvious, but obtaining these times has been a challenge.

It is not possible to evaluate the TCT process without a determination of the quality of information available for making various decisions. Poor imagery or incorrect target locations will lead to poor targeting decisions and results. The simulation provides this information. Thus, analysis requires detailed knowledge of:

- Sensor parameterization within the simulation model.
- Target parameterization within the simulation model.
- How sensors are flown by the simulation.
- How terrain is represented within the simulation, etc…

Commander's guidance will prompt many actions, including moving platforms to be in position to perform assigned tasks. The two double lines are between platforms, weapon fly out, and weapon/target interaction. They are there to indicate interdependences between these actions. Ship location will influence whether it can engage a particular target and how long it takes a weapon to be on target once fired. Weapon/target interaction depends on impact location, which depends on weapon fly out. All these factors affect TCT results and all are within the simulation.

Summary

The purpose of TCT analysis as described here is to determine the effectiveness of human-included processes. These processes include:

- Information flow
- Decision structures
- Support systems
- Human capabilities

These processes are stimulated by simulation output and depend on details of provided information. In live operations operators have an understanding of physical effects, such as how long it takes for a weapon to reach a target and whether a particular weapon is effective against a given hard target. This influences their decisions. In order for a simulation-based experiment to produce sensible results, there must be a correspondence between operator understanding of physical effects and what is occurring within the simulation. Analysis must be able to verify that this correspondence is present or, if not, have an understanding of the differences.

In order for the operators in an experiment to make sensible decisions, they must be trained to understand how the supporting simulation behaves or the simulation must provide an accurate representation of reality. Analysis of experiment results will only produce accurate results if these details are known. Again, this requires capture of events within and at simulation interfaces with TCT processes and detailed understanding of the underlying physics used to calculate the effects.

HSV: USS JOINT VENTURE

Data were collected from
4 sailors during FBE-J

Figure A11-1.

Circadian Rhythms Effects

Physiological cycles with predictable peaks and troughs over the course of about a day, examples are:

- **-- Temperature**
- **-- Blood Pressure**
- **-- Heart Rate**

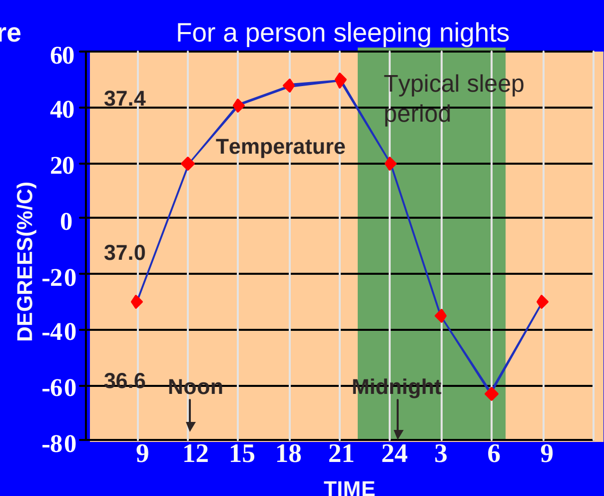

Figure A11-2.

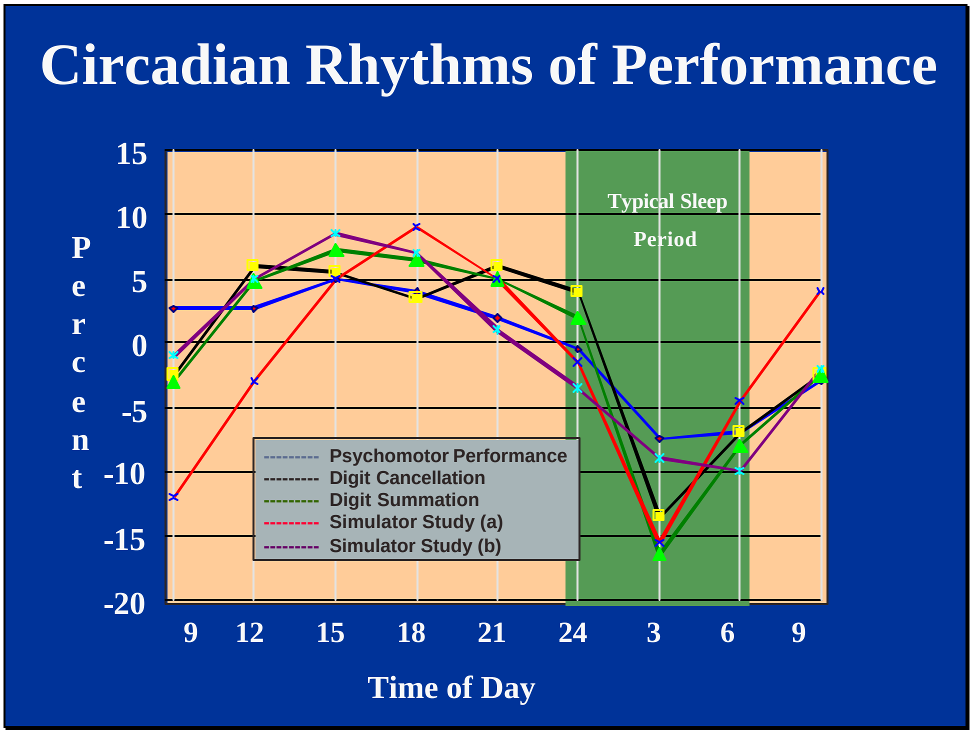

Figure A11-3.

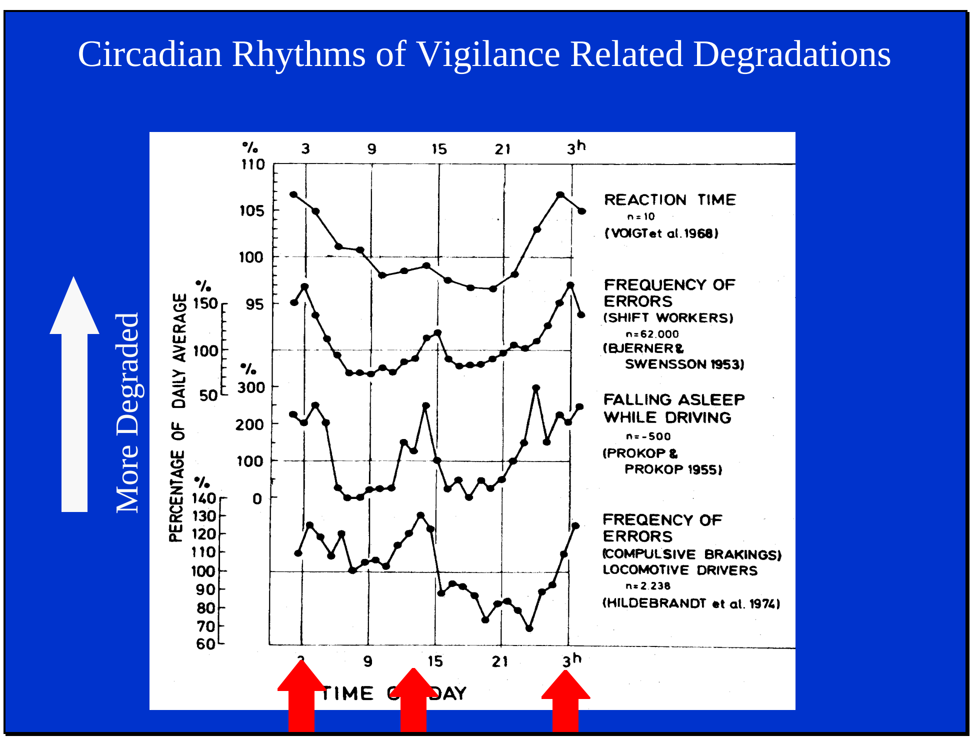

Figure A11-4.

Tools to Measure Sleep and Fatigue in the Field

- Activity Logs, Subjective Ratings, Surveys and Questionnaires
- Wrist activity monitors (WAMs), Thermometers, Tests of Human Performance (reaction time, memory, vigilance), Salivary Melatonin
- Computerized scoring and modeling
  (Action-W, ACT Millennium Edition, FAST Fatigue Avoidance Scheduling Tool)

Figure A11-5.

Wrist Activity Monitor (Actigraph)

This wristwatch-like device has an accelerometer that measures motion and is used to determine activity levels. Data are stored internally and later downloaded for analysis. Data can be collected continuously for up to a year.

Figure A11-6.

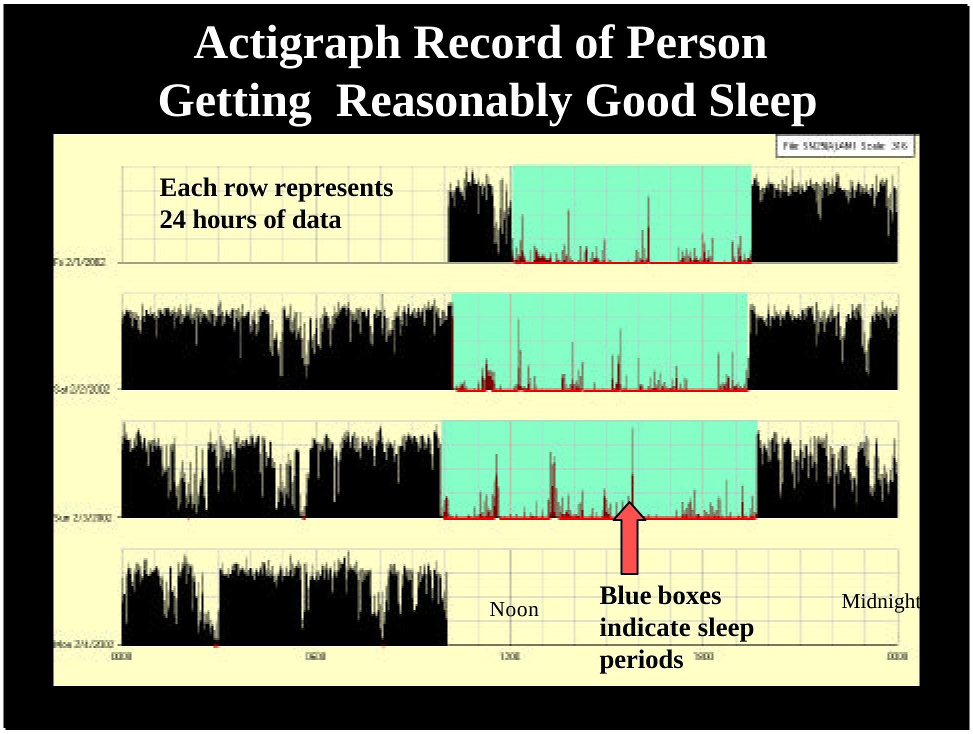

Figure A11-7.

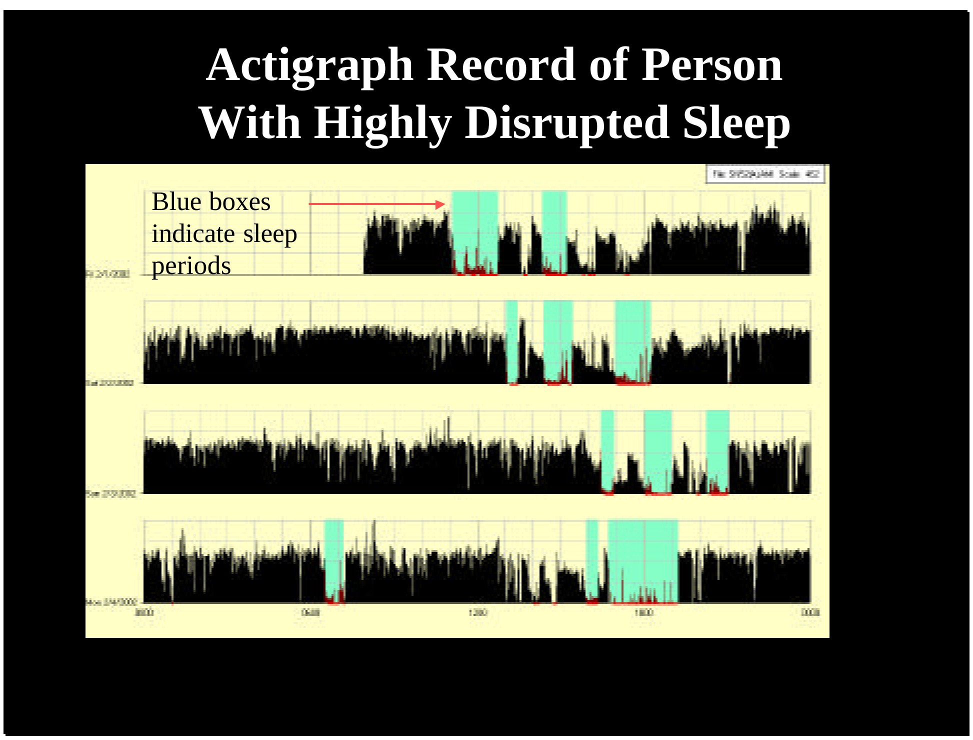

Figure A11-8.

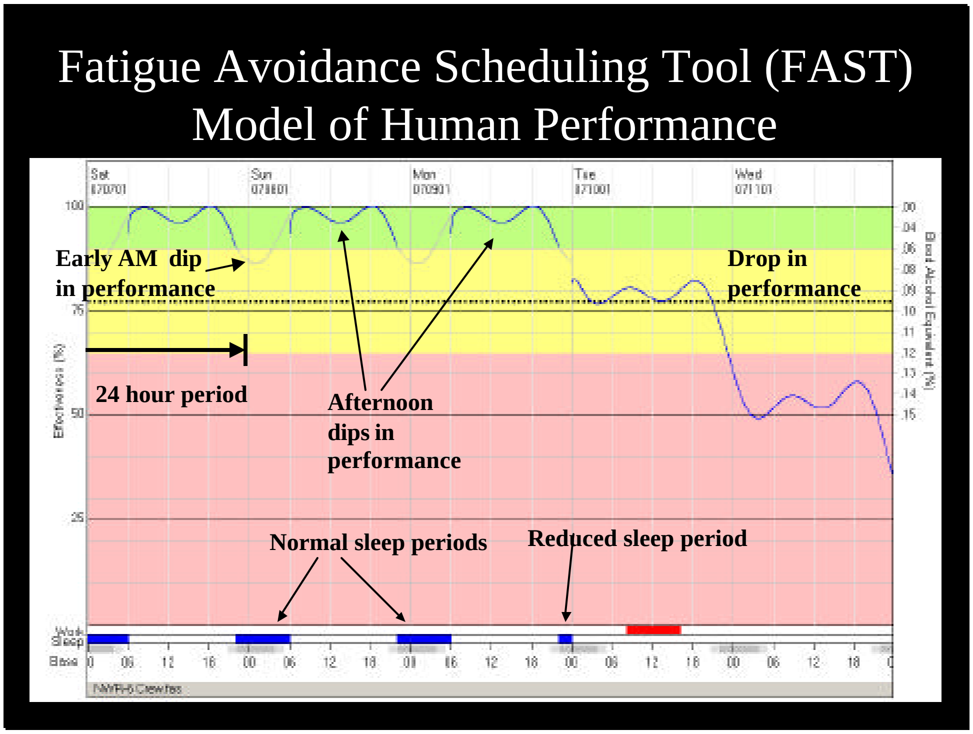

Figure A11-9.

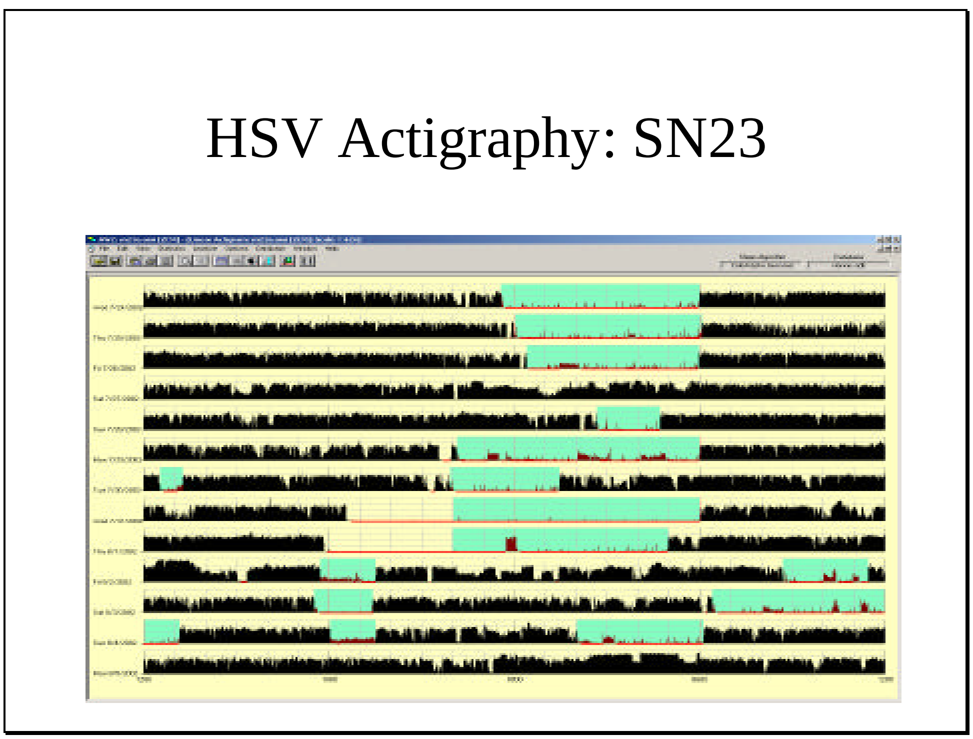

Figure A11-10.

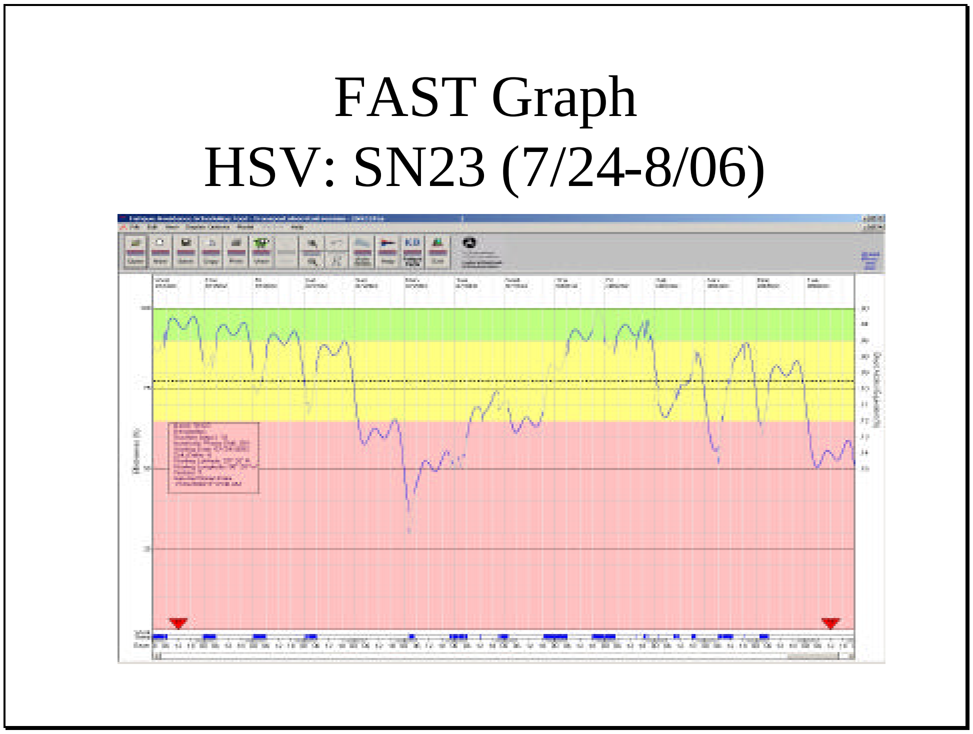

Figure A11-11.

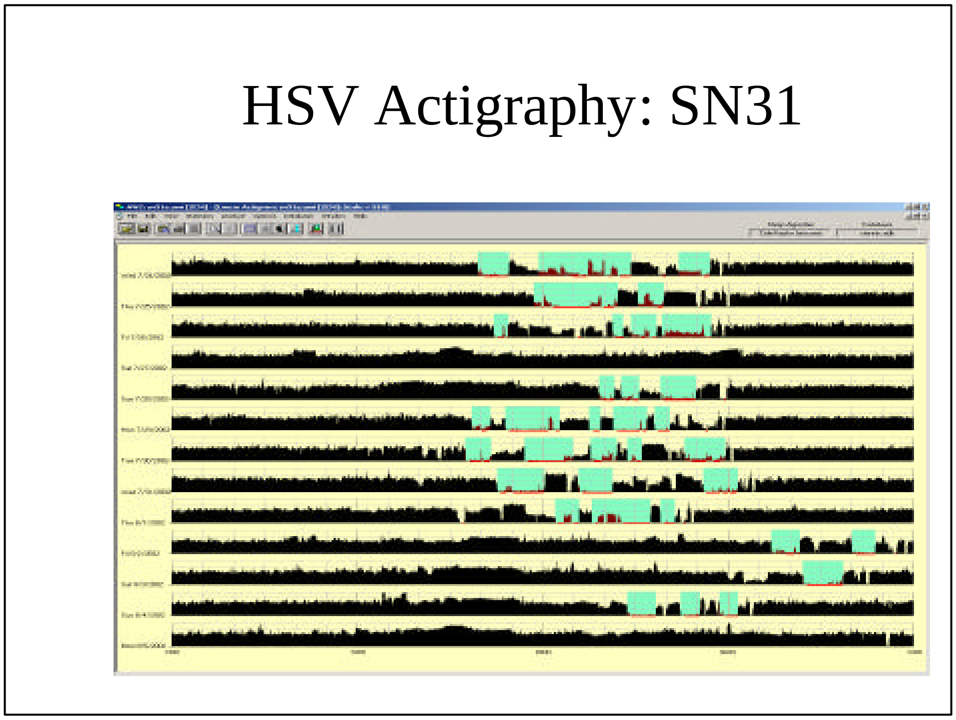

Figure A11-12.

FAST Graph
HSV: SN31 (7/24-8/06)

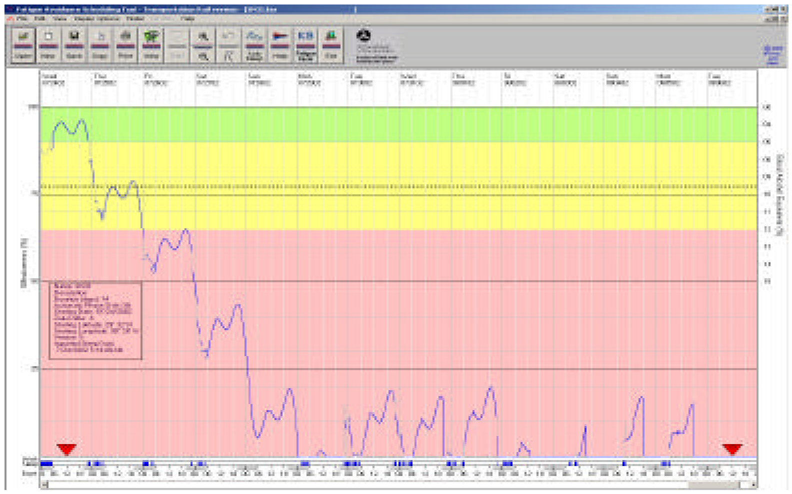

Figure A11-13.

HSV Actigraphy: SN65

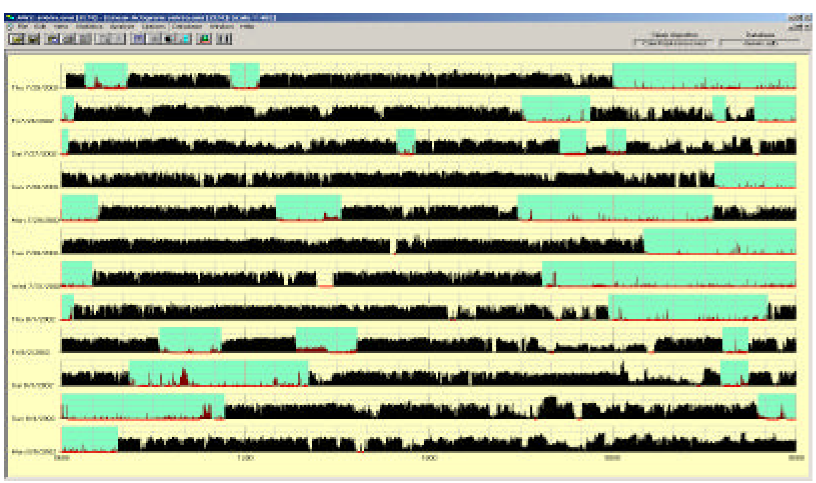

Figure A11-14.

FAST Graph
HSV: SN65 (7/24-8/06)

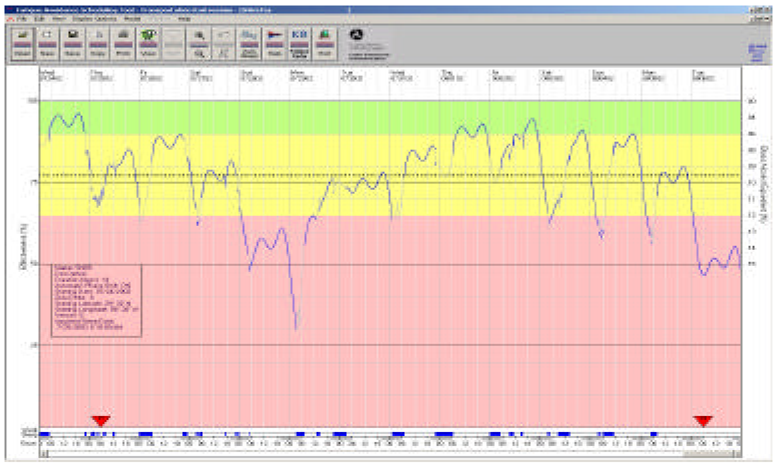

Figure A11-15.

HSV Actigraphy: SN70

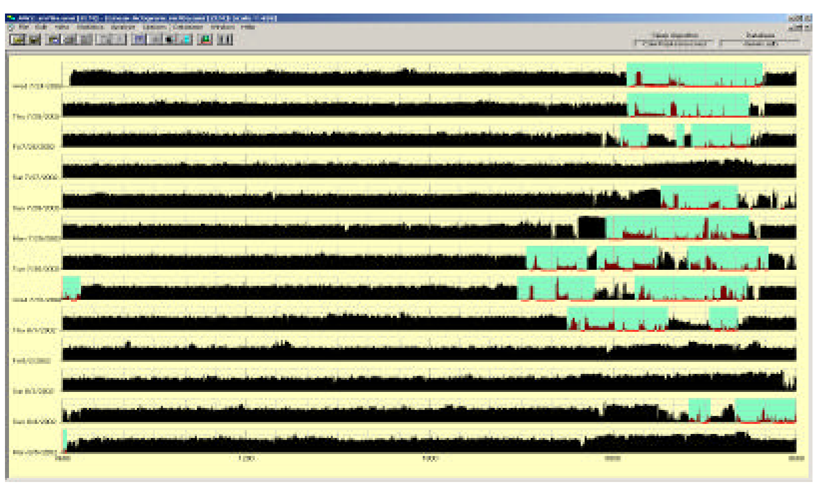

Figure A11-16.

FAST Graph
HSV: SN70 (7/24-8/06)

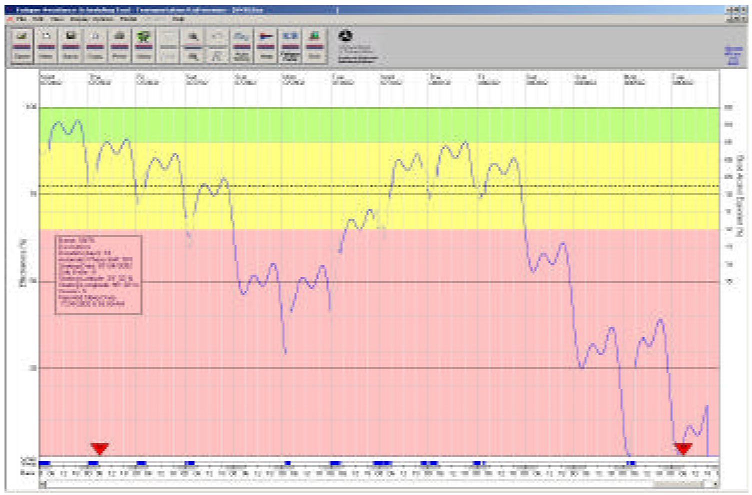

Figure A11-17.

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Appendix 12: Operational Sequence Diagrams
Fleet Battle Experiment – Juliet

This list provides a quick reference to the operational sequence diagrams that follow.

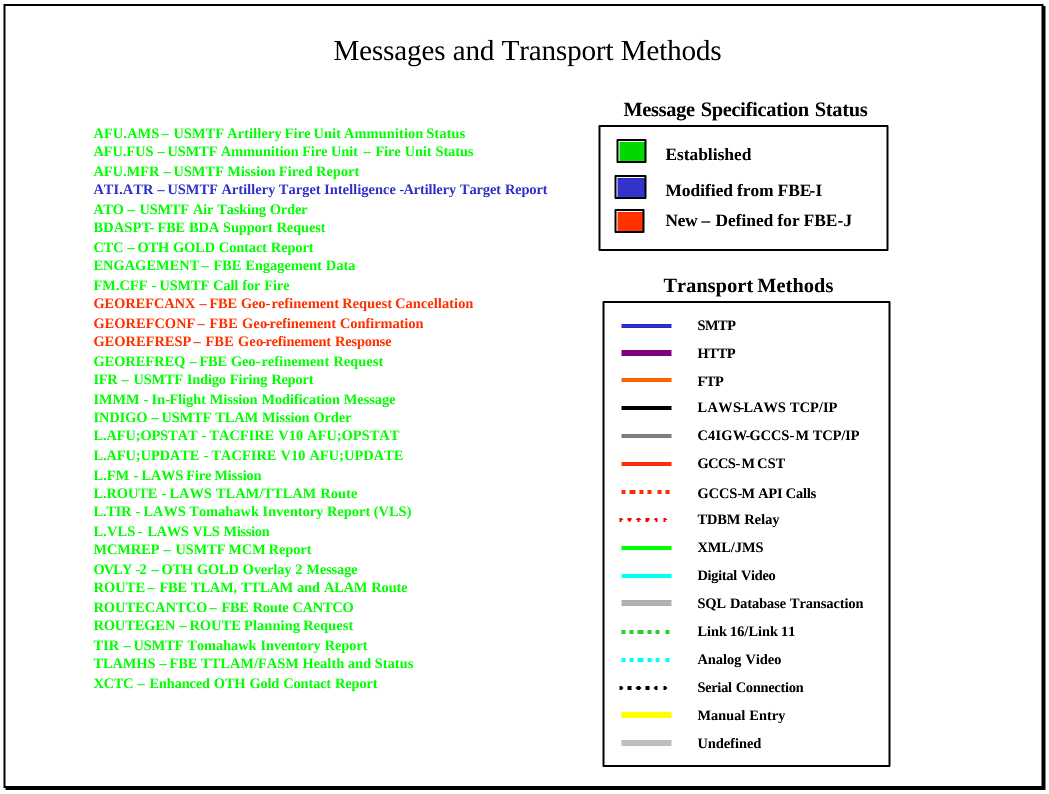


Figure A12-1. Messages and Transport Methods.

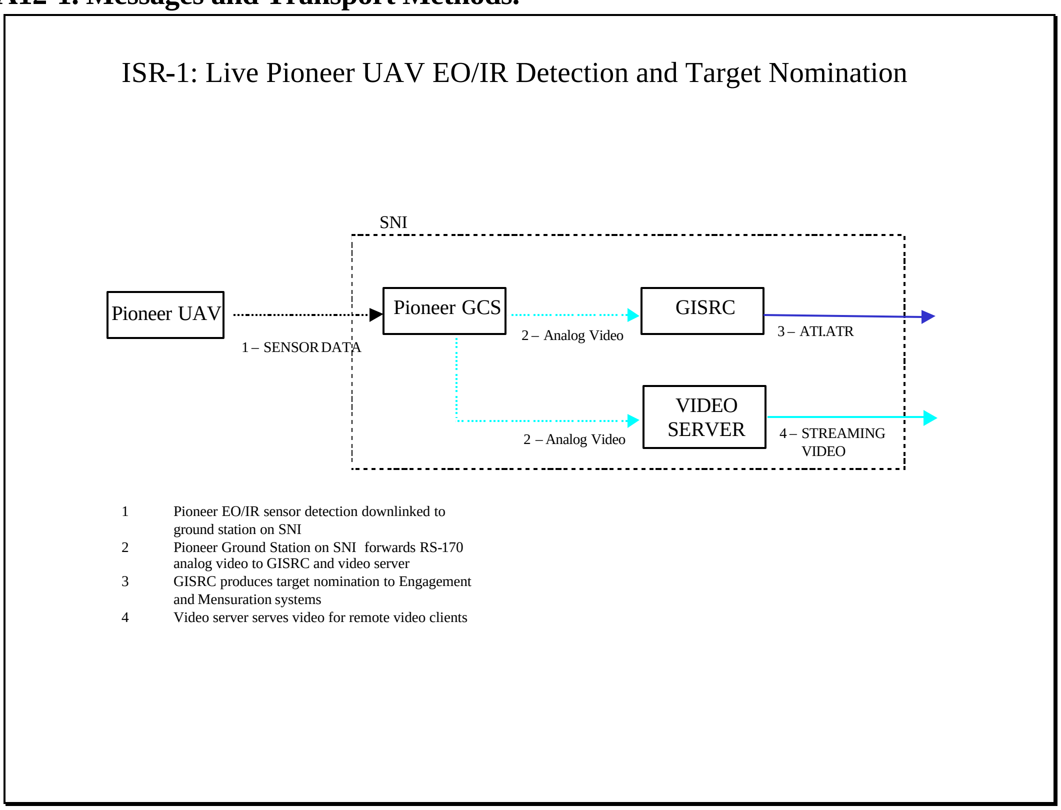


Figure A12-2. ISR-1: Live Pioneer UAV EO/IR Detection and Target Nomination.

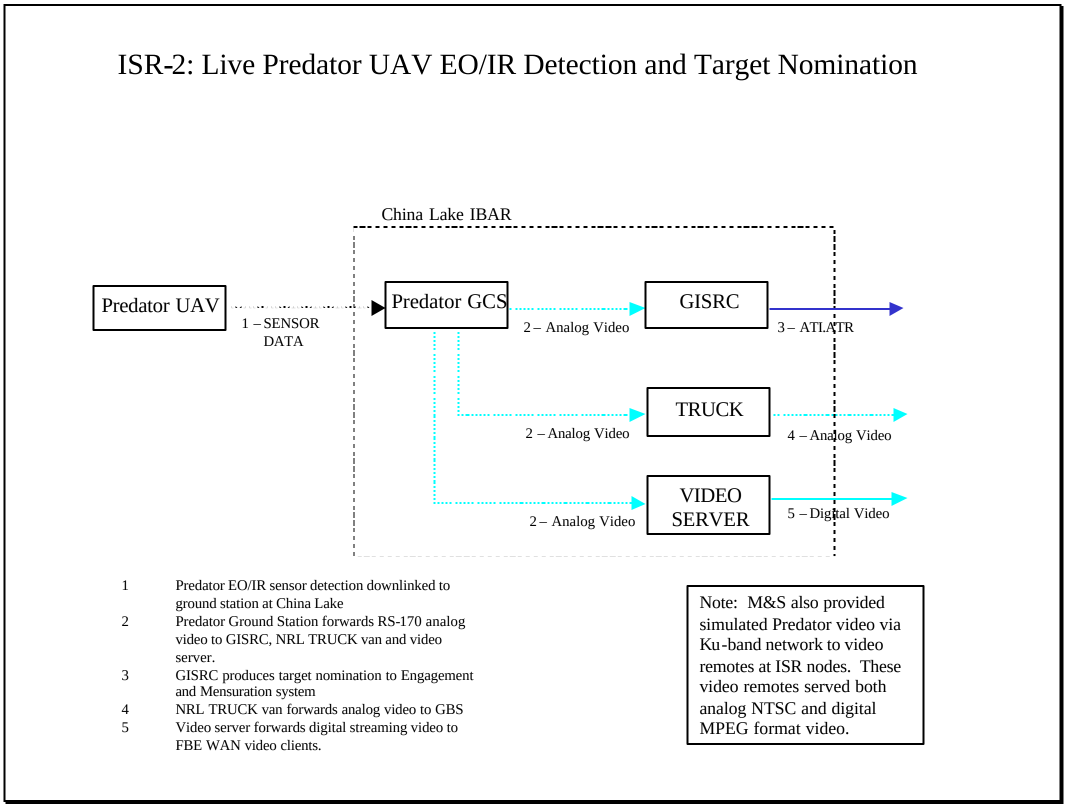


Figure A12-3. ISR-2: Live Predator UAV EO/IR Detection and Target Nomination.

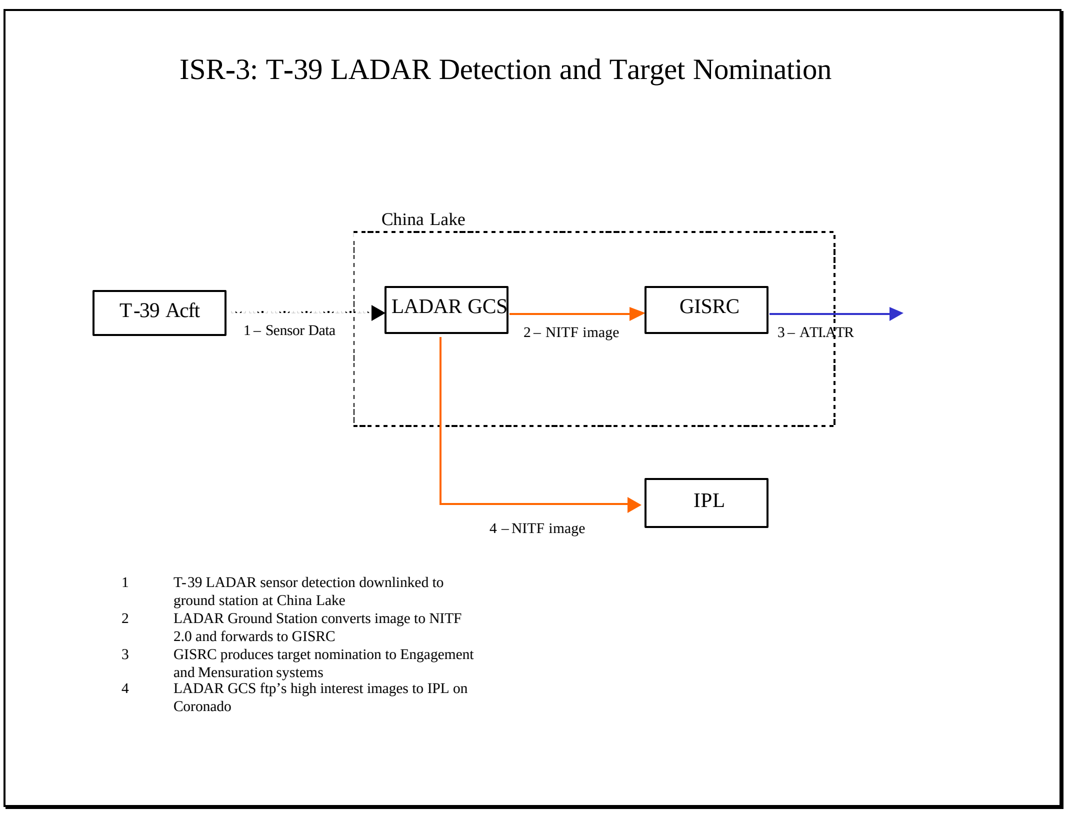


Figure A12-4. ISR-3: T-39 LADAR Detection and Target Nomination.

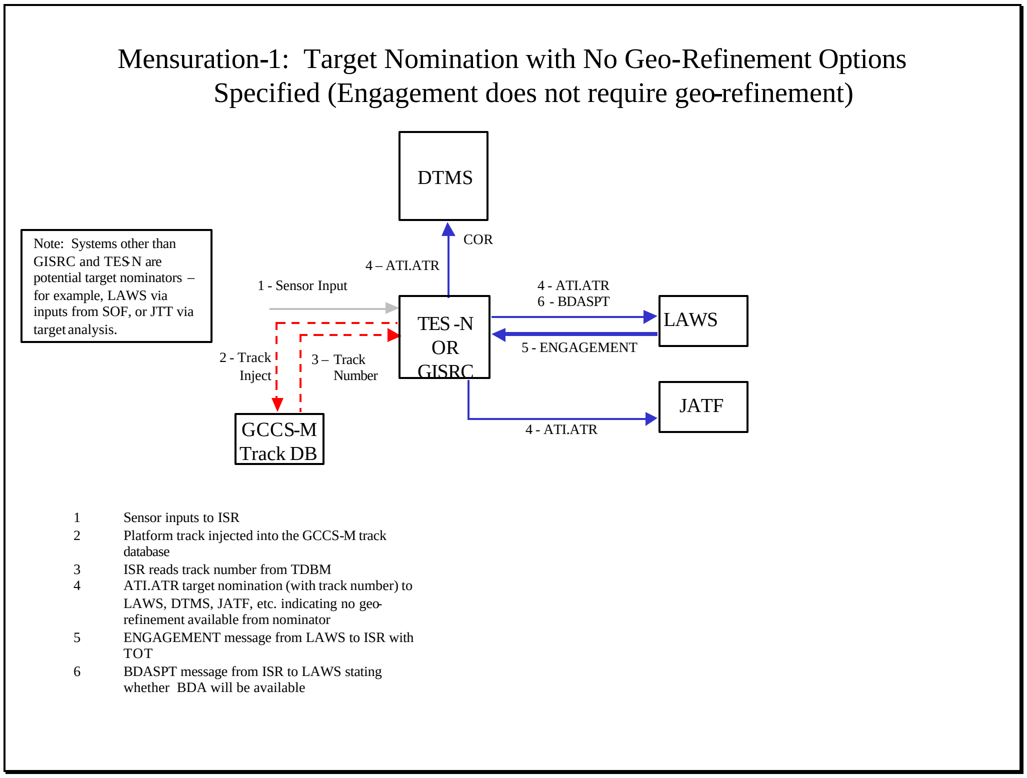


Figure A12-5. Mensuration-1. Target Nomination with No Georefinement Options Specified (Engagement does not require georefinement).

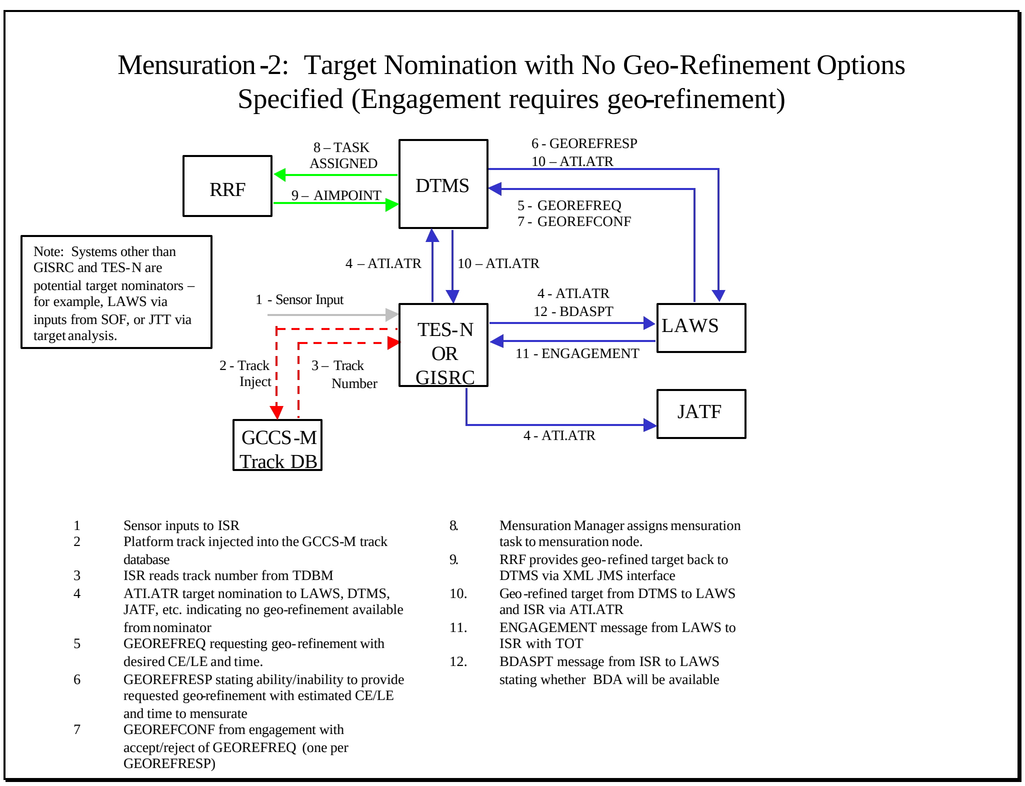


Figure A12-6. Mensuration-2. Target Nomination with No Georefinement Options Specified (Engagement requires georefinement).

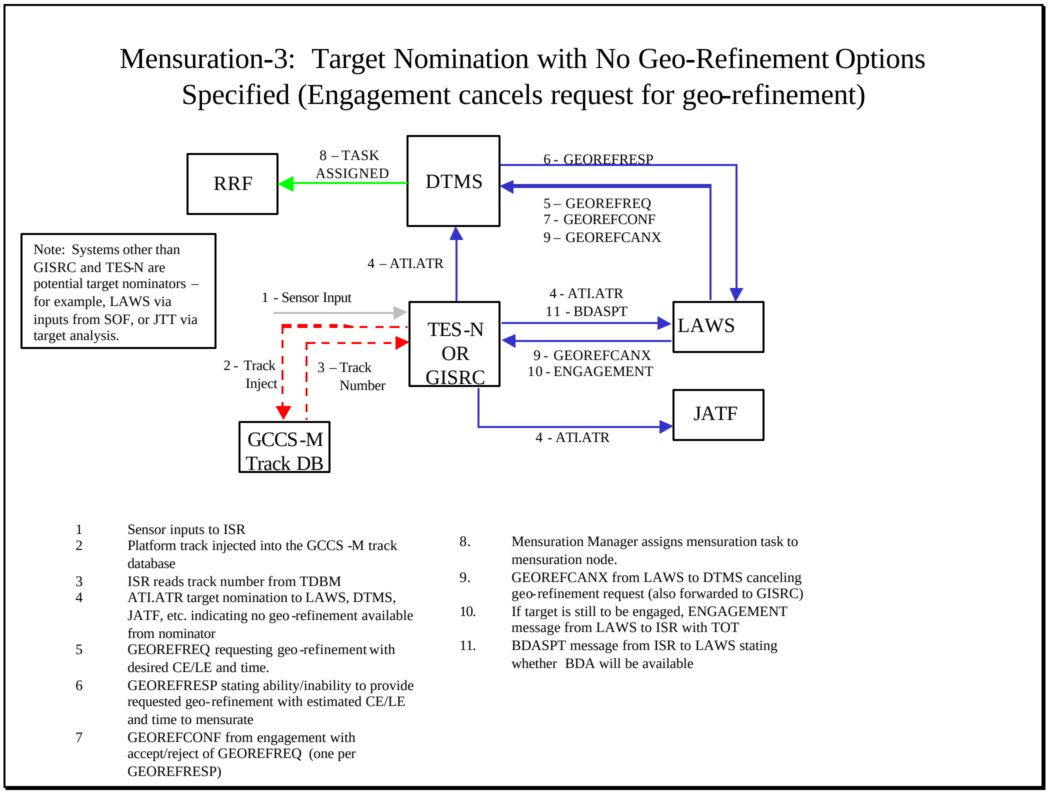


Figure A12-7. Mensuration-3: Target Nomination with No Georefinement Options Specified (Engagement cancels request for georefinement).

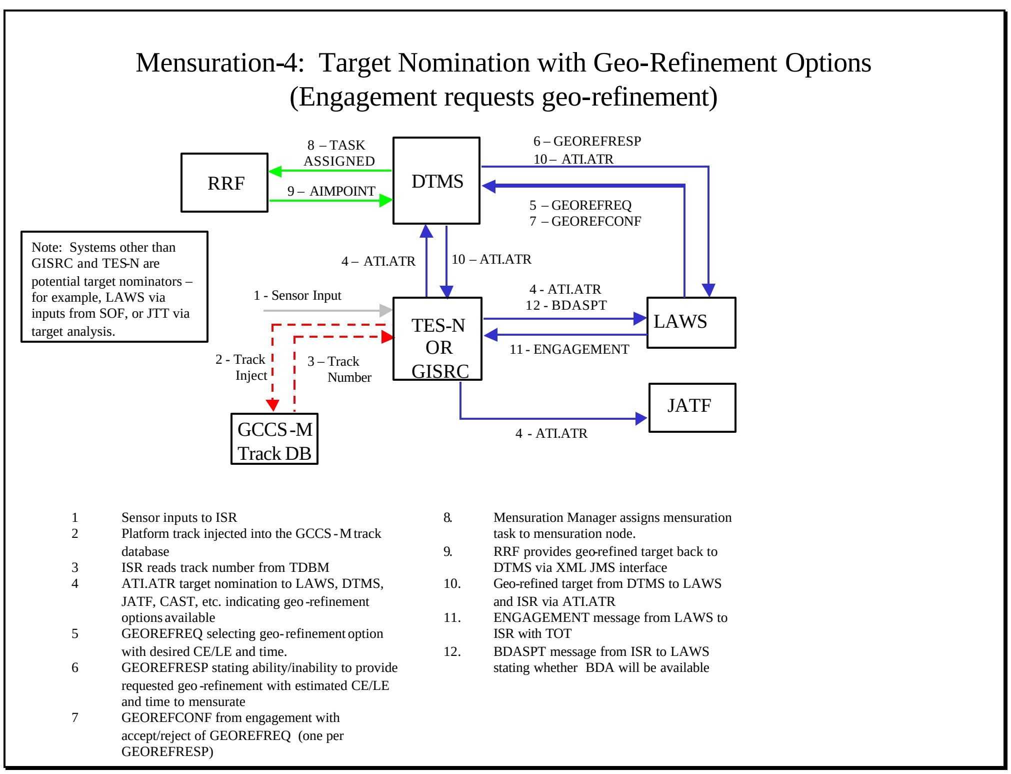
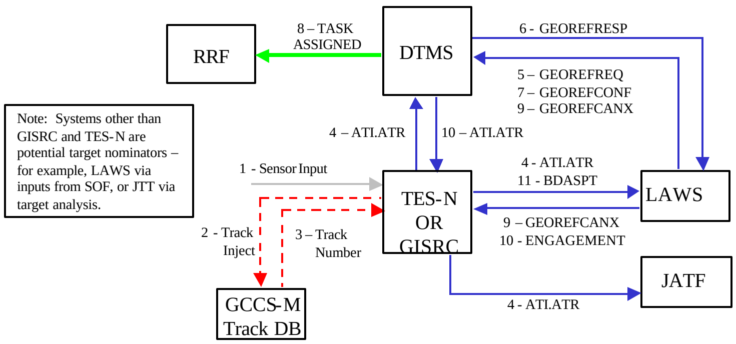


Figure A12-8: Mensuration-4. Target Nomination with Georefinement Options (Engagement requests georefinement).

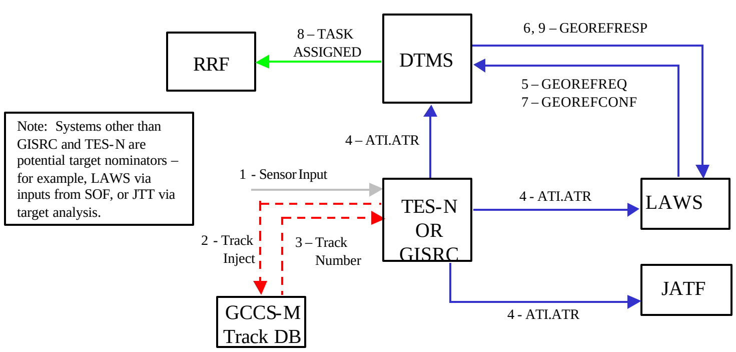
Mensuration-5: Target Nomination with Geo-Refinement Options
(Engagement cancels request for geo-refinement)



1 Sensor inputs to ISR
2 Platform track injected into the GCCS-M track database
3 ISR reads track number from TDBM
4 ATI.ATR target nomination to LAWS, DTMS, JATF, etc. indicating geo-refinement options available
5 GEOREFREQ selecting geo-refinement option with desired CE/LE and time.
6 GEOREFRESP stating ability/inability to provide requested geo-refinement with estimated CE/LE and time to mensurate
7 GEOREFCONF from engagement with accept/reject of GEOREFREQ (one per GEOREFRESP)
8. Mensuration Manager assigns mensuration task to mensuration node.
9. GEOREFCANX from LAWS to DTMS canceling geo-refinement request
10. If target is still to be engaged, ENGAGEMENT message from LAWS to ISR with TOT
11. BDASPT message from ISR to LAWS stating whether BDA will be available

Figure A12-9. Mensuration-5: Target Nomination with Georefinement Options (Engagement cancels request for georefinement).

Mensuration-6: Target Nomination with Geo-Refinement Options
(Engagement requests geo-refinement; Mensuration CANTCO)



1 Sensor inputs to ISR
2 Platform track injected into the GCCS-M track database
3 ISR reads track number from TDBM
4 ATI.ATR target nomination to LAWS, DTMS, JATF, etc. indicating geo-refinement options available
5 GEOREFREQ selecting geo-refinement option with desired CE/LE and time.
6 GEOREFRESP stating ability/inability to provide requested geo-refinement with estimated CE/LE and time to mensurate.
7 GEOREFCONF from engagement with accept/reject of GEOREFREQ (one per GEOREFRESP)
8. Mensuration Manager assigns mensuration task to mensuration node.
9. Mensuration Manager cannot provide mensuration; updated GEOREFRESP returned to LAWS stating unable to provide.

Figure A12-10. Mensuration-6: Target Nomination with Georefinement Options (Engagement requests georefinement; Mensuration CANTCO).

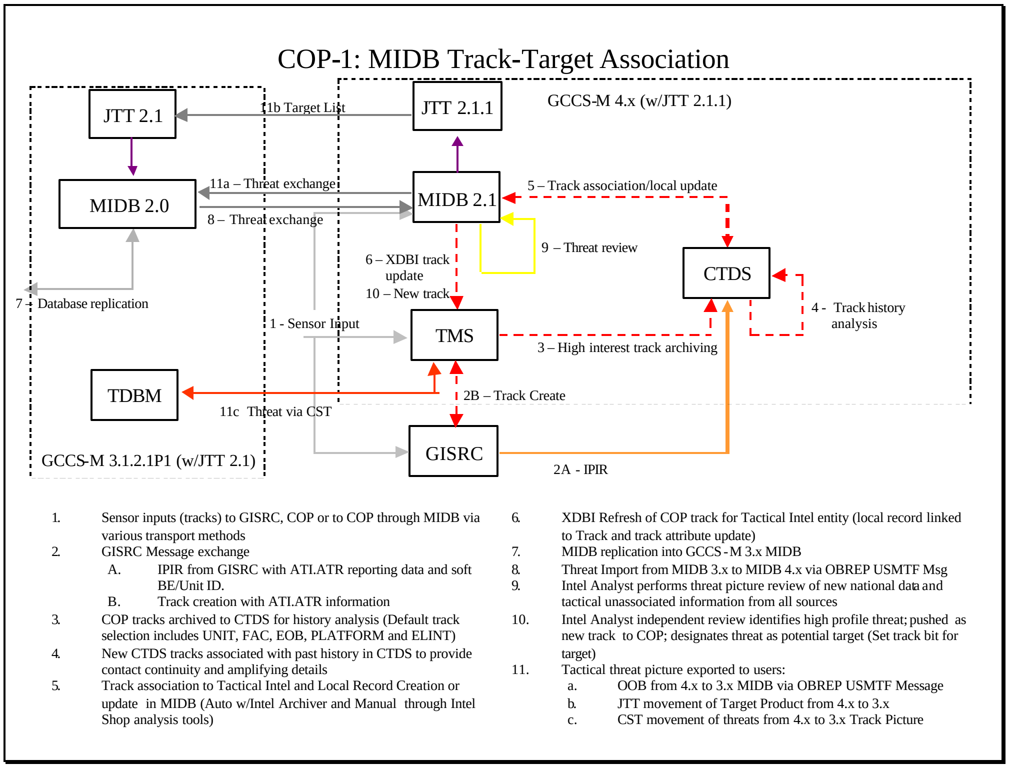


Figure A12-11. COP-1: MIDB Track-Target Association.

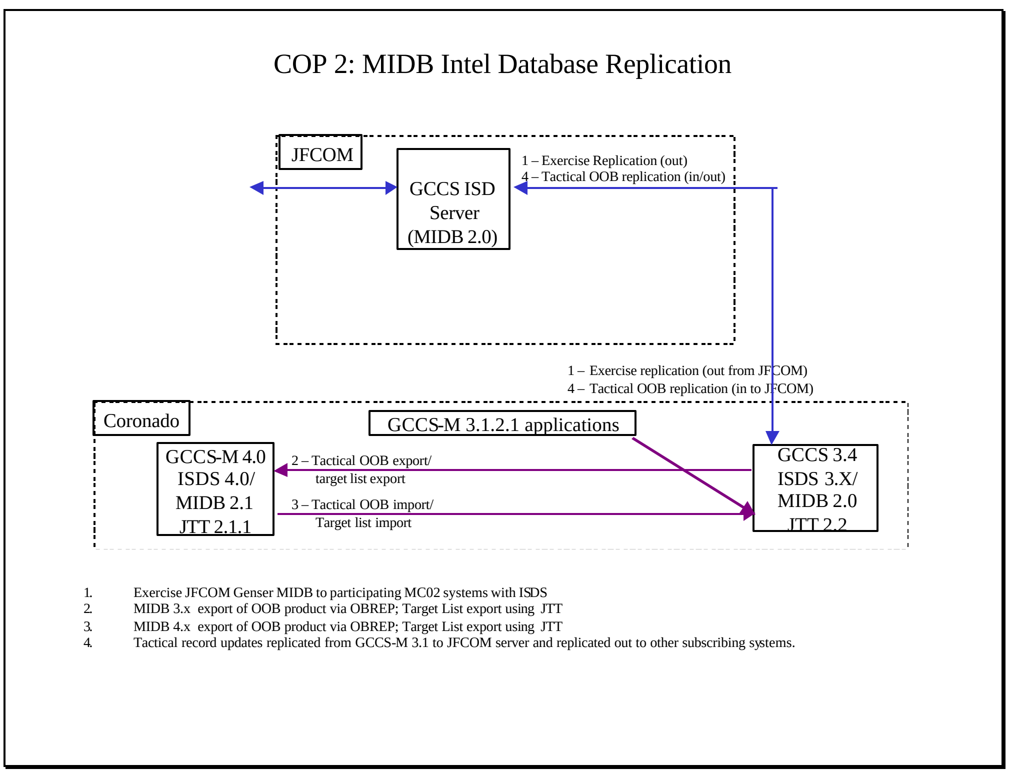
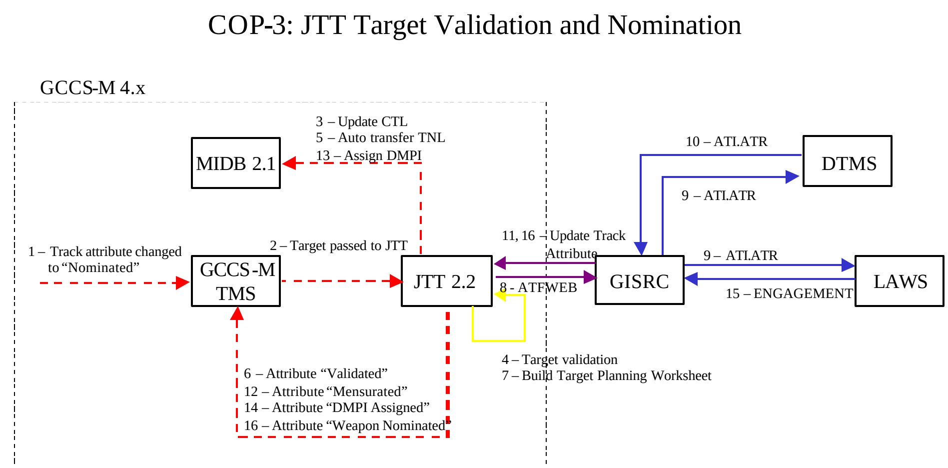
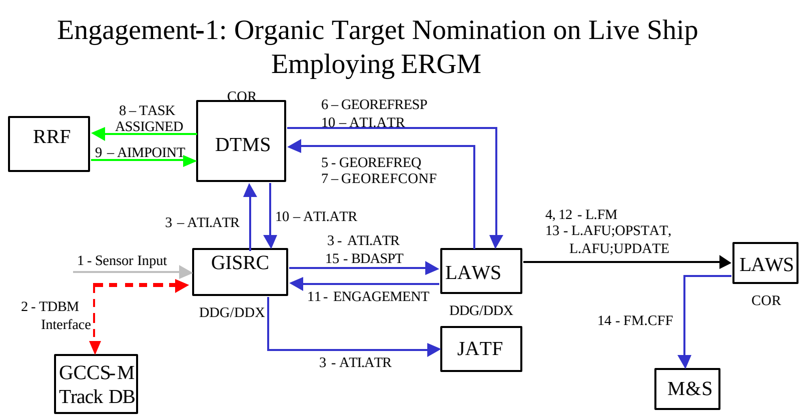


Figure A12-12. COP 2: MIDB Intel Database Replication.



1. Intel Analyst/COP tools nominate track/threat as potential target (update Track Attribute to "Nominated").
2. JTT received potential target (popup on dedicated COP display)
3. Candidate Target List auto updated (within ISDS GMI).
4. Target Validation Process (JTT algorithm; based on Commander's Guidance, ROE, Restricted Fire Areas, Collateral damage constraints, existing Candidate Target List, and No-Strike List.)
5. Auto Transfer from Candidate Target List to Target Nomination List (within ISDS GMI).
6. Update Track Attribute (Target "Validated")
7. Manual build of Target Planning Worksheet associated with TNL targets (Hyperlinked to track; in lieu of ATI.ATR)
8. Operator view of target folder status via web page (JTT 2.2 or 2.1.1)
9. Generate ATI.ATR to DTMS and LAWS
10. DTMS returns mensurated points;
11. Add mensurated points through JTT application from GISRC; JTT receives, reviews and updates target
12. Update Track Attribute (Target "Mensurated") if appropriate
13. DMPI/DPI assigned and added to target
14. Update Track Attribute ("DMPI Assigned")
15. ENGAGEMENT message from LAWS with TOT and weapon assigned
16. Update Track Attribute ("Weapon Nominated")

Figure A12-13. COP-3: JTT Target Validation and Nomination.



1 Sensor inputs to ISR
2 Platform track injected into GCCS-M track database; track number read back
3 ATI.ATR target nomination to LAWS, DTMS, JATF, etc. indicating geo-refinement options available
4 Copy of mission to other LAWS nodes
5 GEOREFREQ selecting geo-refinement option with desired CE/LE and time.
6 GEOREFRESP stating ability/inability to provide requested geo-refinement with estimated CE/LE and time to mensurate (repeated 1-N times)
7 GEOREFCONF from engagement with accept/reject of GEOREFREQ (one per GEOREFRESP) or GEOREFCANX canceling mensuration request.
8. Mensuration Watch Officer assigns mensuration task to remote node.
9. RRF provides geo-refined target back to DTMS via XML JMS interface
10. Geo-refined target from DTMS to LAWS via ATI.ATR
11. ENGAGEMENT message from LAWS to ISR with TOT
12. LAWS fire mission update to COR
13. AFU;UPDATE and AFU;OPSTAT weapon status update generated
14. FM.CFF from LAWS to M&S
15. BDASPT message from ISR to LAWS stating whether BDA will be available

Figure A12-14. Engagement-1: Organic Target Nomination on Live Ship Employing ERGM.

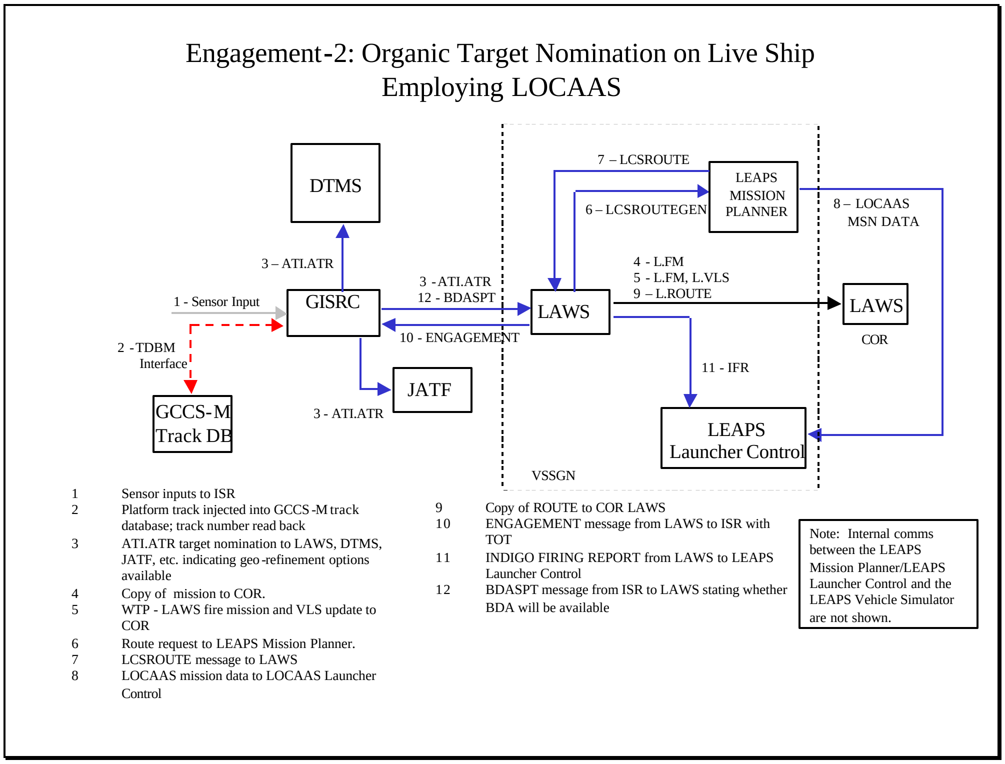


Figure A12-15. Engagement-2: Organic Target Nomination on Live Ship Employing LOCAAS.

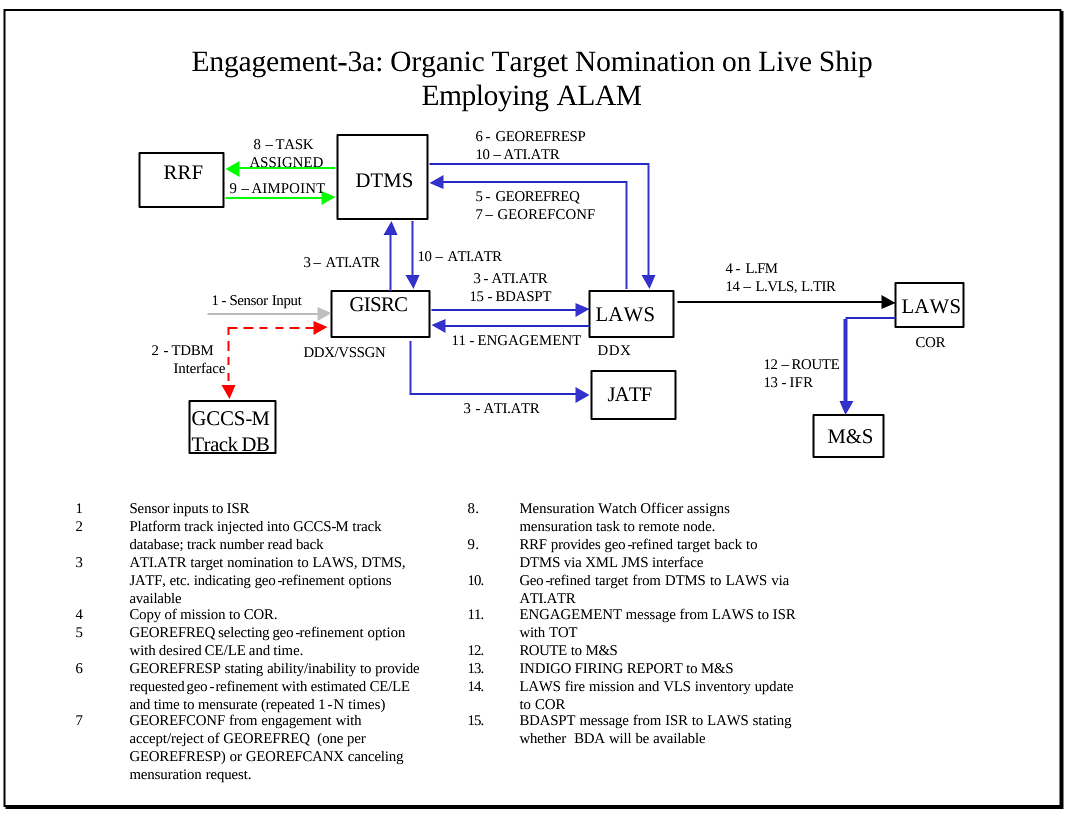


Figure A12-16. Engagement-3a: Organic Target Nomination on Live Ship Employing ALAM.

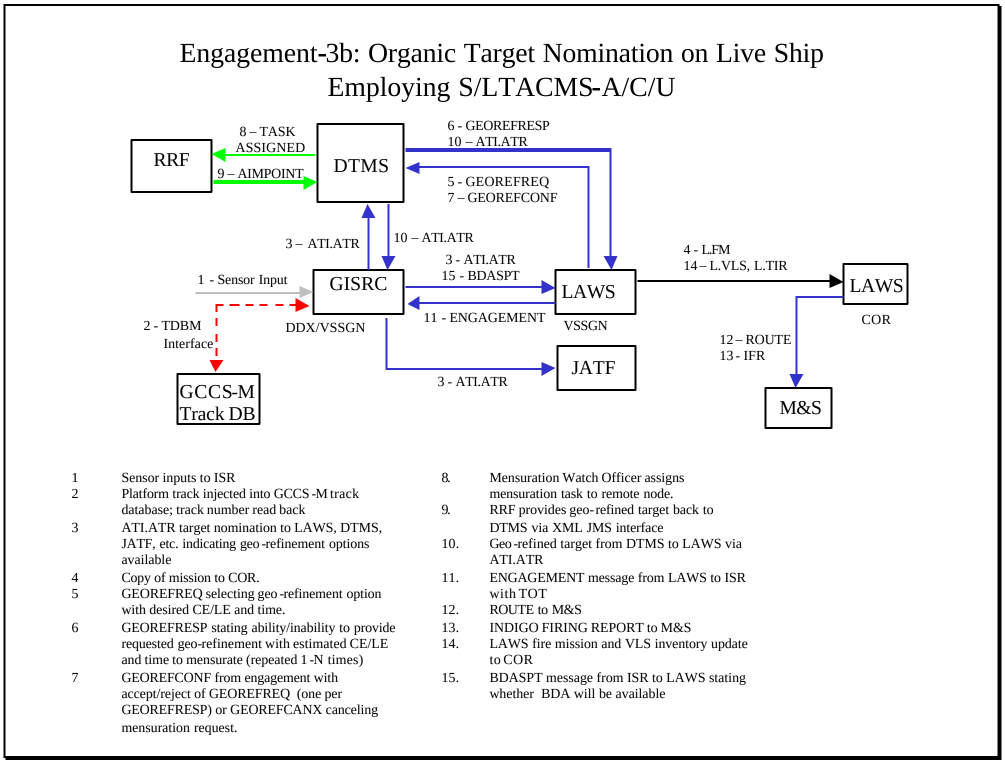


Figure A12-17. Engagement-3b: Organic Target Nomination on Live Ship Employing S/LTACMS-A/C/U.

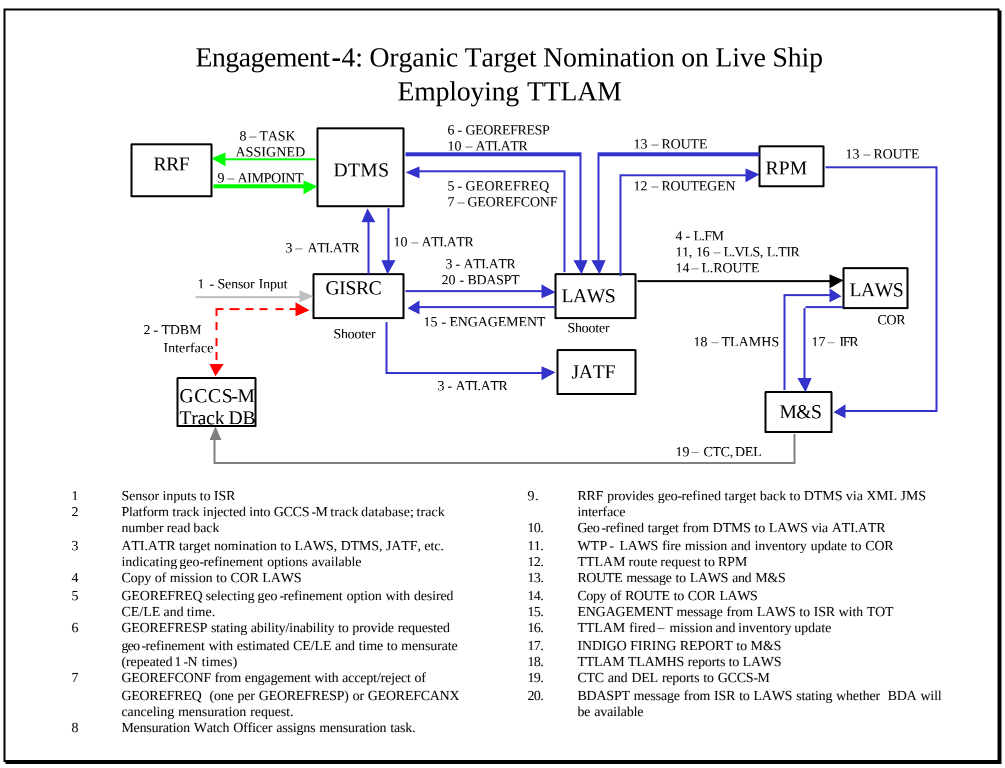


Figure A12-18. Engagement-4: Organic Target Nomination on Live Ship Employing TTLAM.

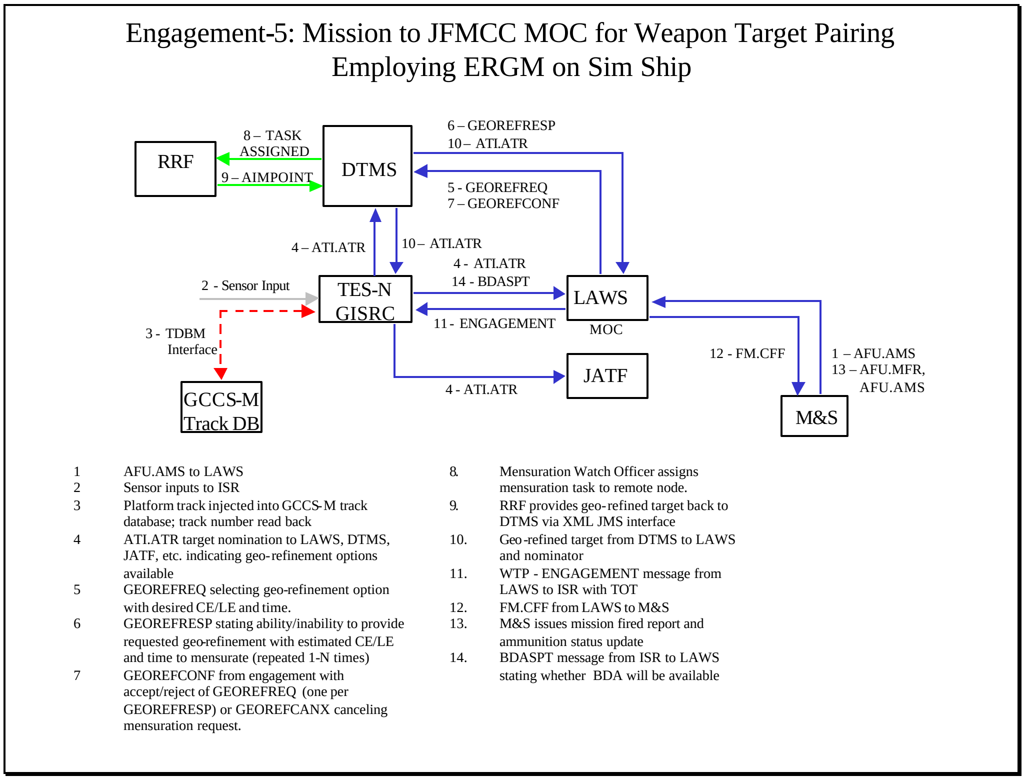


Figure A12-19. Engagement-5: Mission to JFMCC MOC for Weapon Target Pairing Employing ERGM on Sim Ship.

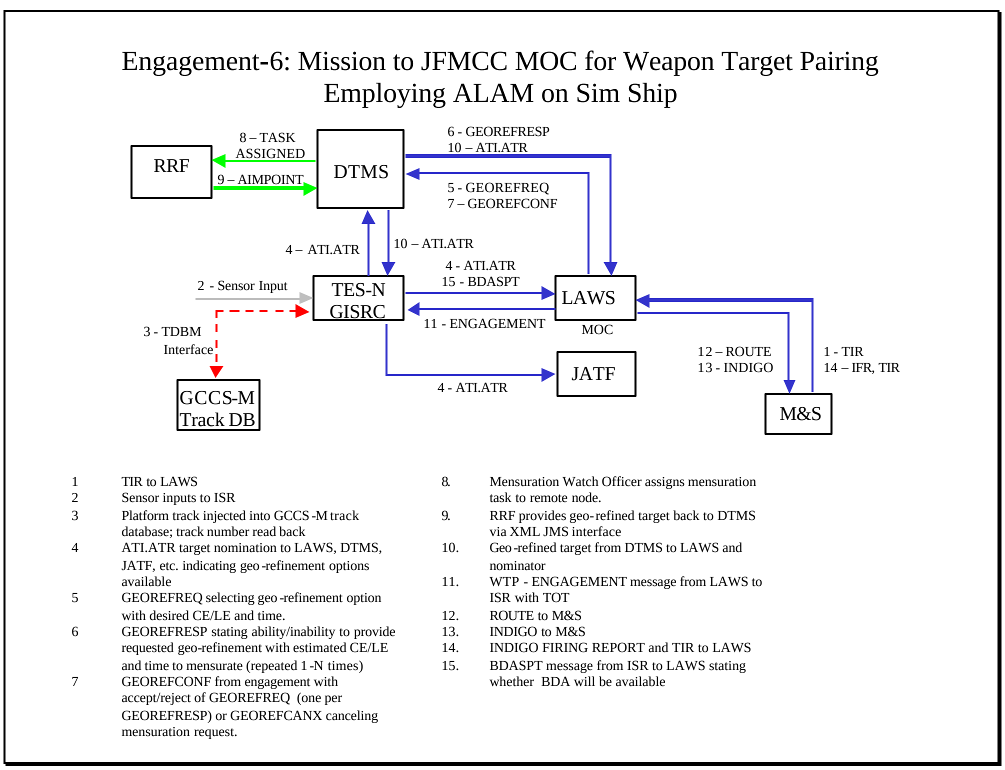
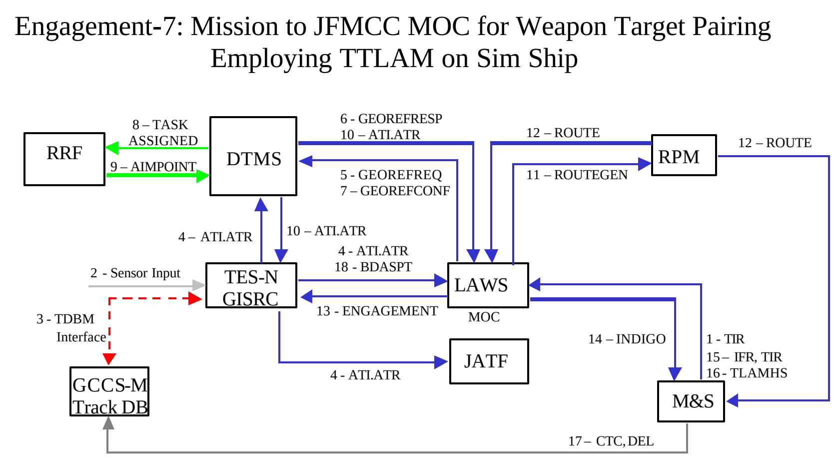
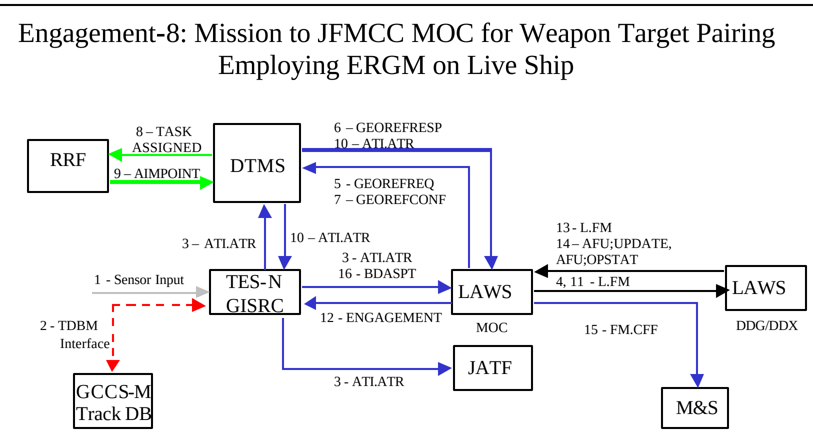


Figure A12-20. Engagement-6: Mission to JFMCC MOC for Weapon Target Pairing Employing ALAM on Sim Ship.



1. TIR to LAWS
2. Sensor inputs to ISR
3. Platform track injected into GCCS-M track database; track number read back
4. ATI.ATR target nomination to LAWS, DTMS, JATF, etc. indicating geo-refinement options available
5. GEOREFREQ selecting geo-refinement option with desired CE/LE and time.
6. GEOREFRESP stating ability/inability to provide requested geo-refinement with estimated CE/LE and time to mensurate (repeated 1-N times)
7. GEOREFCONF from engagement with accept/reject of GEOREFREQ (one per GEOREFRESP) or GEOREFCANX canceling mensuration request.
8. Mensuration Lead assigns mensuration task to remote node.
9. RRF provides geo-refined target back to DTMS
10. Geo-refined target from DTMS to LAWS and nominator
11. TTLAM route request to RPM
12. ROUTE message to LAWS and M&S
13. ENGAGEMENT message from LAWS to ISR with TOT
14. INDIGO to M&S
15. INDIGO FIRING REPORT, TIR to LAWS
16. TTLAM TLAMHS reports to LAWS
17. CTC and DEL reports to GCCS-M
18. BDASPT message from ISR to LAWS stating whether BDA will be available

Figure A12-21. Engagement-7: Mission to JFMCC MOC for Weapon Target Pairing Employing TTLAM on Sim Ship.



1. Sensor inputs to ISR
2. Platform track injected into GCCS-M track database; track number read back
3. ATI.ATR target nomination to LAWS, DTMS, JATF, etc. indicating geo-refinement options available
4. Copy of mission to shooter
5. GEOREFREQ selecting geo-refinement option with desired CE/LE and time.
6. GEOREFRESP stating ability/inability to provide requested geo-refinement with estimated CE/LE and time to mensurate (repeated 1-N times)
7. GEOREFCONF from engagement with accept/reject of GEOREFREQ (one per GEOREFRESP) or GEOREFCANX canceling mensuration request.
8. Mensuration Watch Officer assigns mensuration task to remote node.
9. RRF provides geo-refined target back to DTMS via XML JMS interface
10. Geo-refined target from DTMS to LAWS
11. WTP – Fires mission to shooter
12. ENGAGEMENT message from LAWS to ISR with TOT
13. Shooter "fires" mission, updated fire mission to MOC
14. AFU;UPDATE and AFU;OPSTAT from "shooter" to MOC LAWS
15. FM.CFF from LAWS to M&S
16. BDASPT message from ISR to LAWS stating whether BDA will be available

Figure A12-22. Engagement-8: Mission to JFMCC MOC for Weapon Target Pairing Employing ERGM on Live Ship.

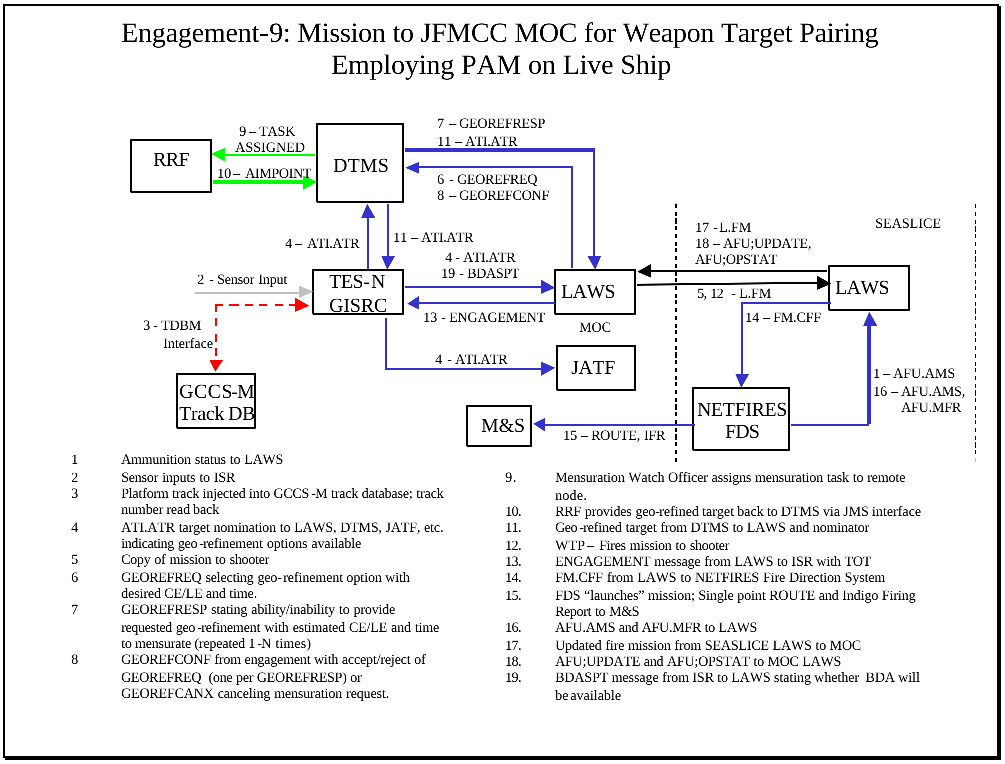


Figure A12-23. Engagement-9: Mission to JFMCC MOC for Weapon Target Pairing Employing PAM on Live Ship.

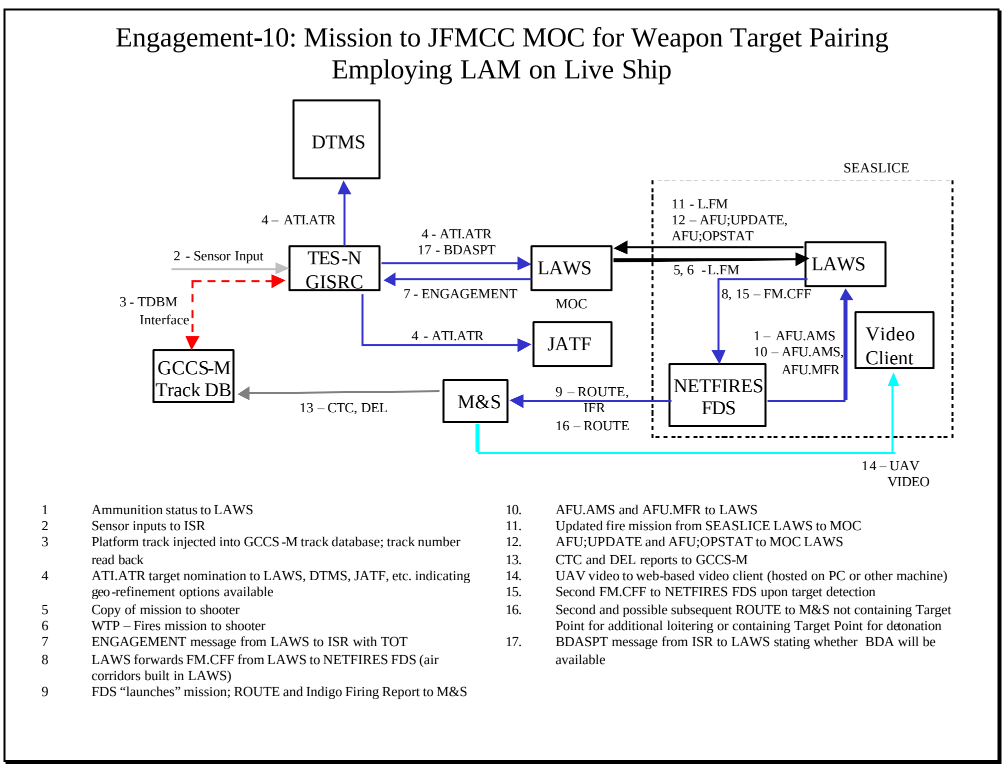


Figure A12-24. Engagement-10: Mission to JFMCC MOC for Weapon Target Pairing Employing LAM on Live Ship.

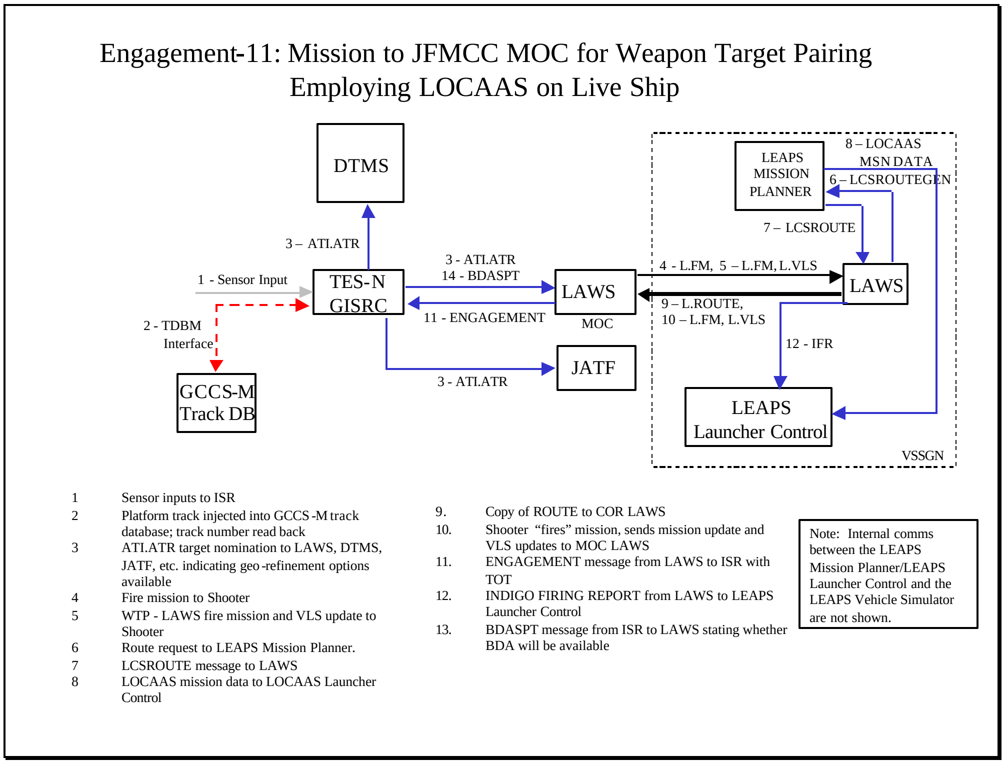


Figure A12-25. Engagement-11: Mission to JFMCC MOC for Weapon Target Pairing Employing LOCAAS on Live Ship.

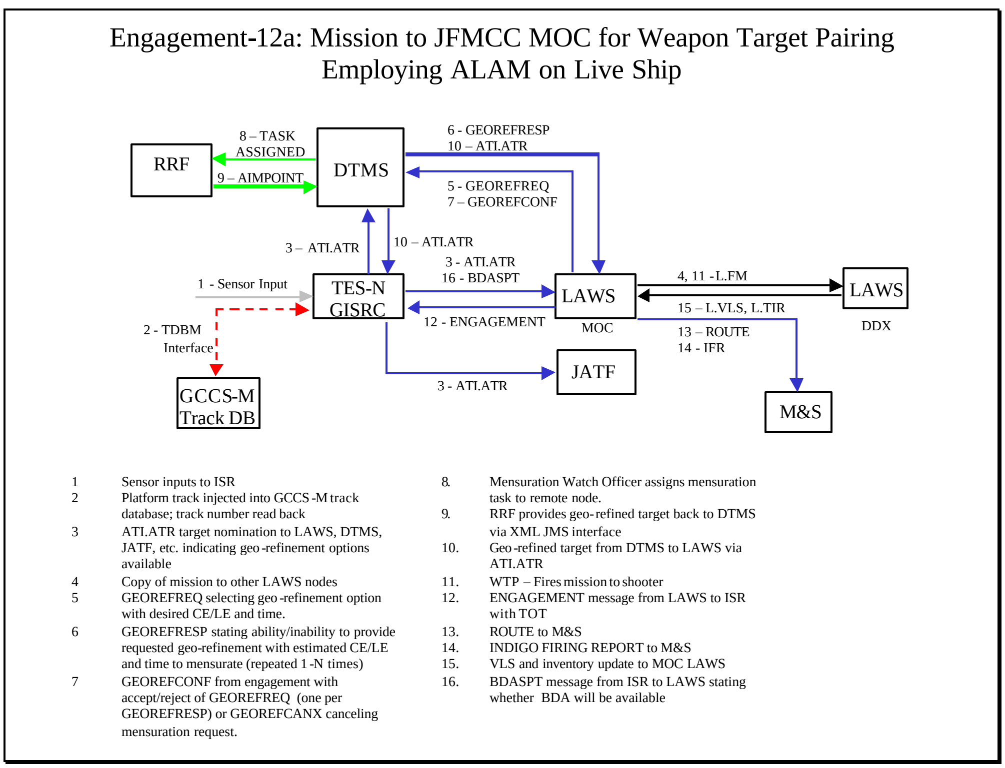
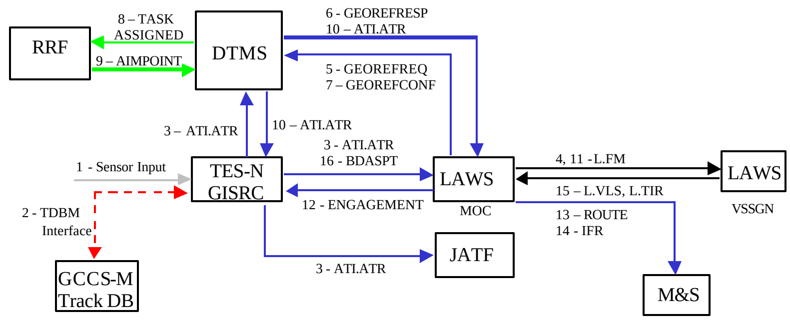


Figure A12-26. Engagement-12a: Mission to JFMCC MOC for Weapon Target Pairing Employing ALAM on Live Ship.

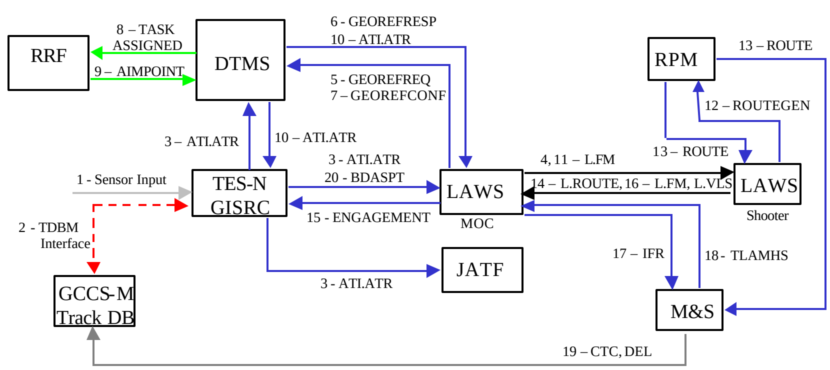
Engagement-12b: Mission to JFMCC MOC for Weapon Target Pairing
Employing S/LTACMS-A/C/U on Live Ship



1 Sensor inputs to ISR
2 Platform track injected into GCCS-M track database; track number read back
3 ATI.ATR target nomination to LAWS, DTMS, JATF, etc. indicating geo-refinement options available
4 Copy of mission to other LAWS nodes
5 GEOREFREQ selecting geo-refinement option with desired CE/LE and time.
6 GEOREFRESP stating ability/inability to provide requested geo-refinement with estimated CE/LE and time to mensurate (repeated 1-N times)
7 GEOREFCONF from engagement with accept/reject of GEOREFREQ (one per GEOREFRESP) or GEOREFCANX canceling mensuration request.
8. Mensuration Watch Officer assigns mensuration task to remote node.
9. RRF provides geo-refined target back to DTMS via XML JMS interface
10. Geo-refined target from DTMS to LAWS via ATI.ATR
11. WTP – Fires mission to shooter
12. ENGAGEMENT message from LAWS to ISR with TOT
13. ROUTE to M&S
14. INDIGO FIRING REPORT to M&S
15. VLS and inventory update to MOC LAWS
16. BDASPT message from ISR to LAWS stating whether BDA will be available

Figure A12-27. Engagement-12b: Mission to JFMCC MOC for Weapon Target Pairing Employing S/LTACMS-A/C/U on Live Ship.

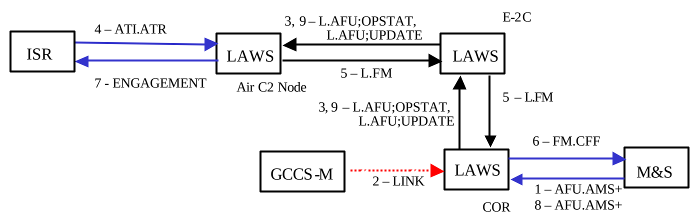
Engagement-13: Mission to JFMCC MOC for Weapon Target Pairing
Employing TTLAM on Live Ship



1 Sensor inputs to ISR
2 Platform track injected into GCCS-M track database; track number read back
3 ATI.ATR target nomination to LAWS, DTMS, JATF, etc. indicating geo-refinement options available
4 Copy of mission to shooter
5 GEOREFREQ selecting geo-refinement option with desired CE/LE and time.
6 GEOREFRESP stating ability/inability to provide requested geo-refinement with estimated CE/LE and time to mensurate (repeated 1-N times)
7 GEOREFCONF from engagement with accept/reject of GEOREFREQ (one per GEOREFRESP) or GEOREFCANX canceling mensuration request.
8 Mensuration Watch Officer assigns mensuration task to remote node.
9 RRF provides geo-refined target back to DTMS
10 Geo-refined target from DTMS to LAWS via ATI.ATR
11 Fire mission to "shooter"
12 TTLAM route request to RPM
13 ROUTE message to LAWS and M&S
14 Copy of ROUTE to MOC LAWS node
15 ENGAGEMENT message from LAWS to ISR with TOT
16 Shooter "fires" mission, sends mission update and VLS updates to MOC LAWS
17 INDIGO FIRING REPORT to M&S
18 TTLAM TLAMHS reports to LAWS
19 CTC and DEL reports to GCCS-M
20 BDASPT message from ISR to LAWS stating whether BDA will be available

Figure A12-28. Engagement-13: Mission to JFMCC MOC for Weapon Target Pairing Employing TTLAM on Live Ship.

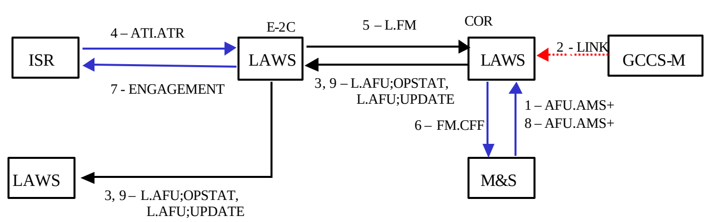
Engagement-14: Mission to Air C2 Node for Weapon Target Pairing
Employing Stand-Off Weapon with Sim Aircraft



1. M&S sends AFU.AMS+ containing mission #, weapons, and ready flag
2. Location of aircraft updated through TDBM relay
3. LAWS firing platform updates to other LAWS nodes
4. ATI.ATR target nomination to LAWS
5. Copy of fire mission to COR LAWS
6. FM.CFF to M&S
7. ENGAGEMENT message to ISR
8. M&S sends updated AFU.AMS+ on CAP, when tasked, weapons free, and off cap.
9. LAWS firing platform updates to other LAWS nodes

Figure A12-29. Engagement-14: Mission to Air C2 Node for Weapon Target Pairing Employing Stand-Off Weapon with Sim Aircraft.

Engagement-15: Mission to E-2C for Weapon Target Pairing
Employing Stand-Off Weapon with Sim Aircraft



1. M&S sends AFU.AMS+ containing misson #, weapons, and ready flag
2. Location of aircraft updated through TDBM relay
3. LAWS firing platform updates to other LAWS nodes
4. ATI.ATR target nomination to LAWS
5. Copy of fire mission to COR LAWS
6. FM.CFF to M&S
7. ENGAGEMENT message to ISR
8. M&S sends updated AFU.AMS+ on CAP, when tasked, weapons free, and off cap.
9. LAWS firing platform updates to other LAWS nodes

Figure A12-30. Engagement-15: Mission to E-2C for Weapon Target Pairing Employing Stand-Off Weapon with Sim Aircraft.

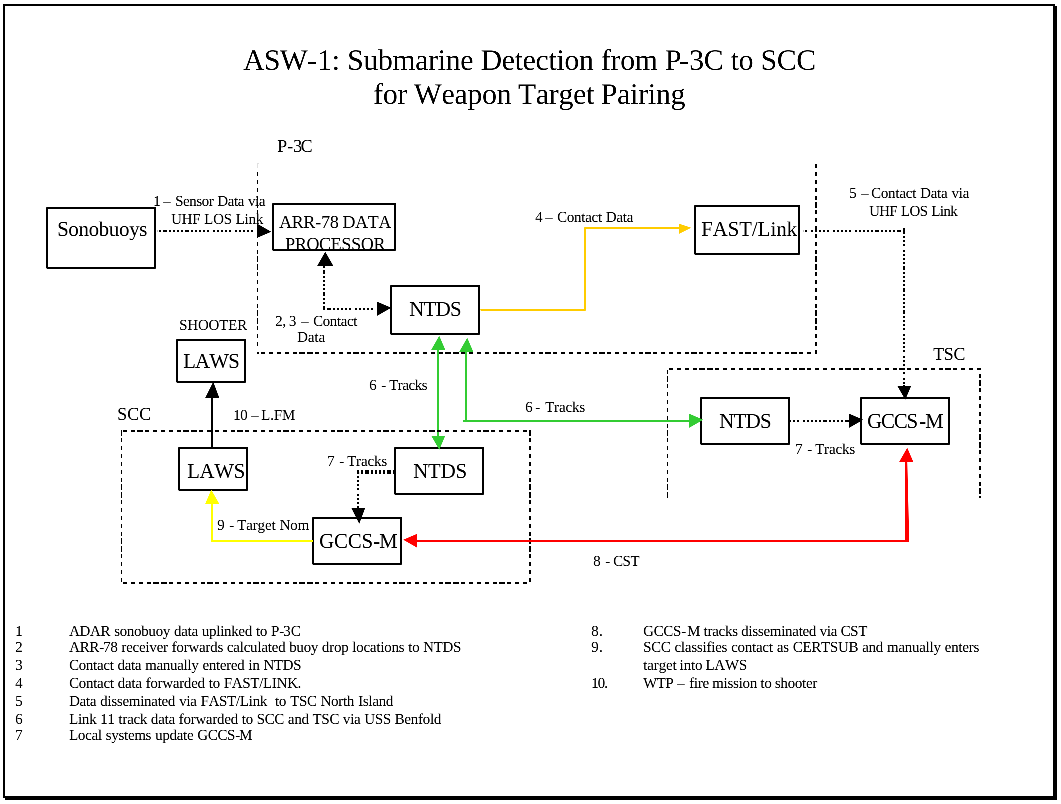


Figure A12-31. ASW-1: Submarine Detection from P-3C to SCC for Weapon Target Pairing.

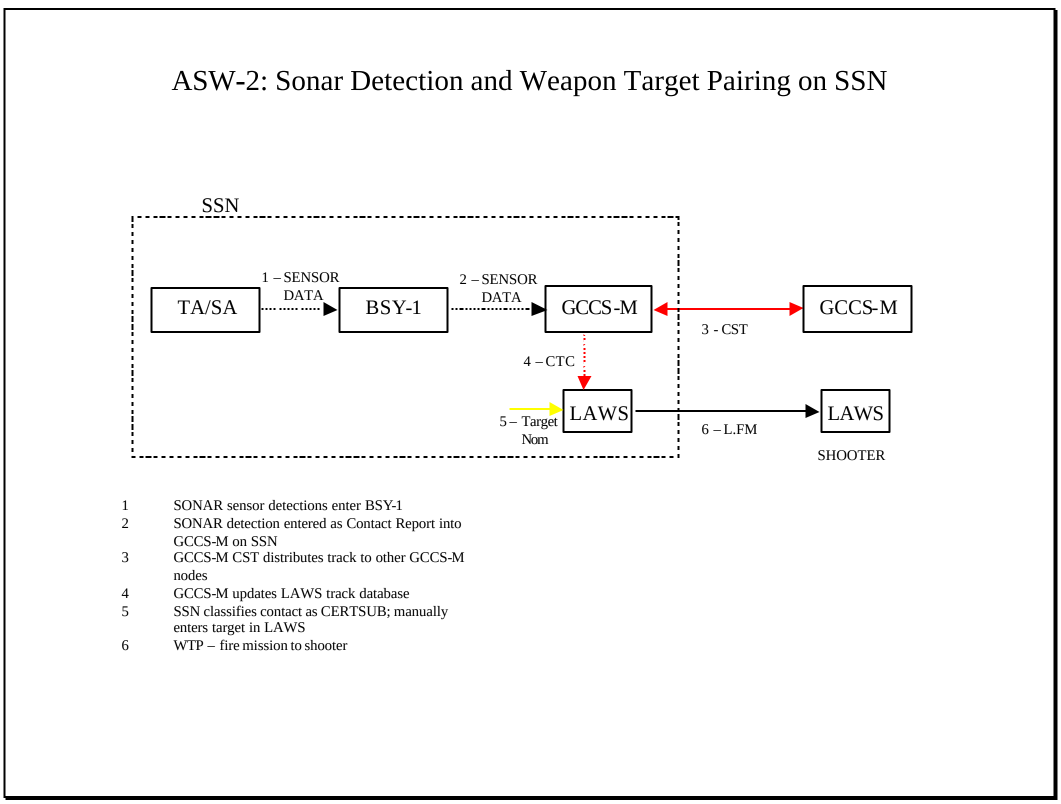


Figure A12-32. ASW-2: Sonar Detection and Weapon Target Pairing on SSN.

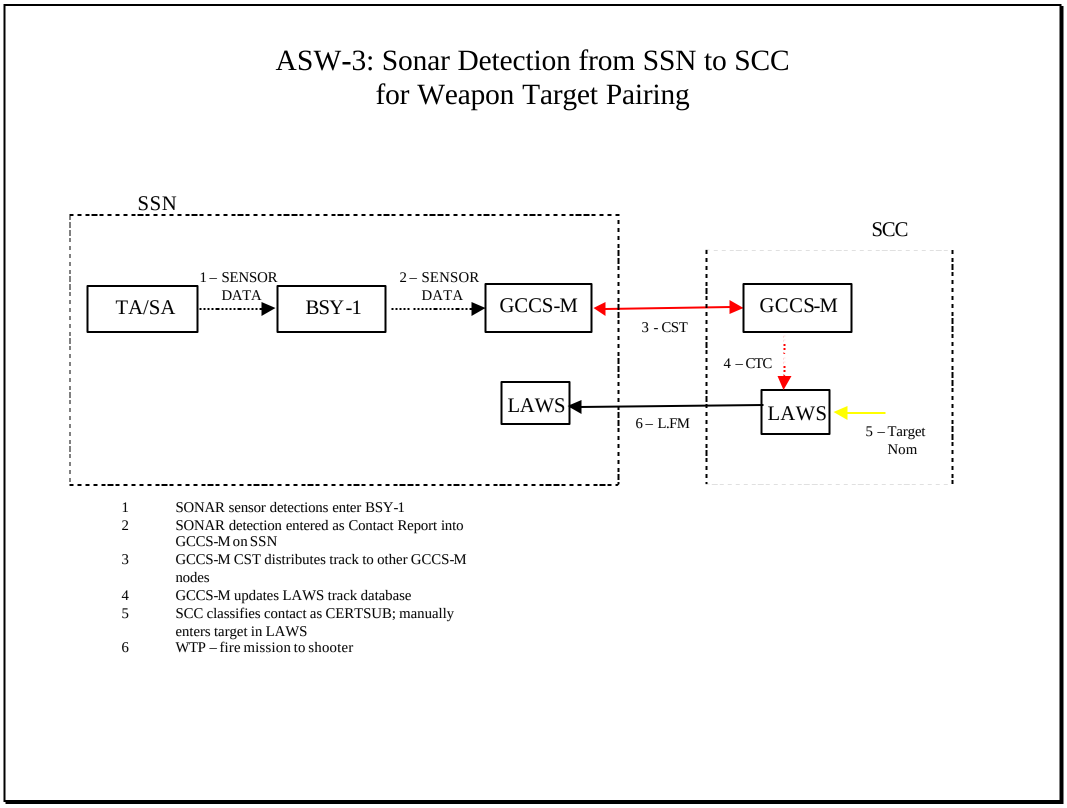


Figure A12-33. ASW-3: Sonar Detection from SSN to SCC for Weapon Target Pairing.

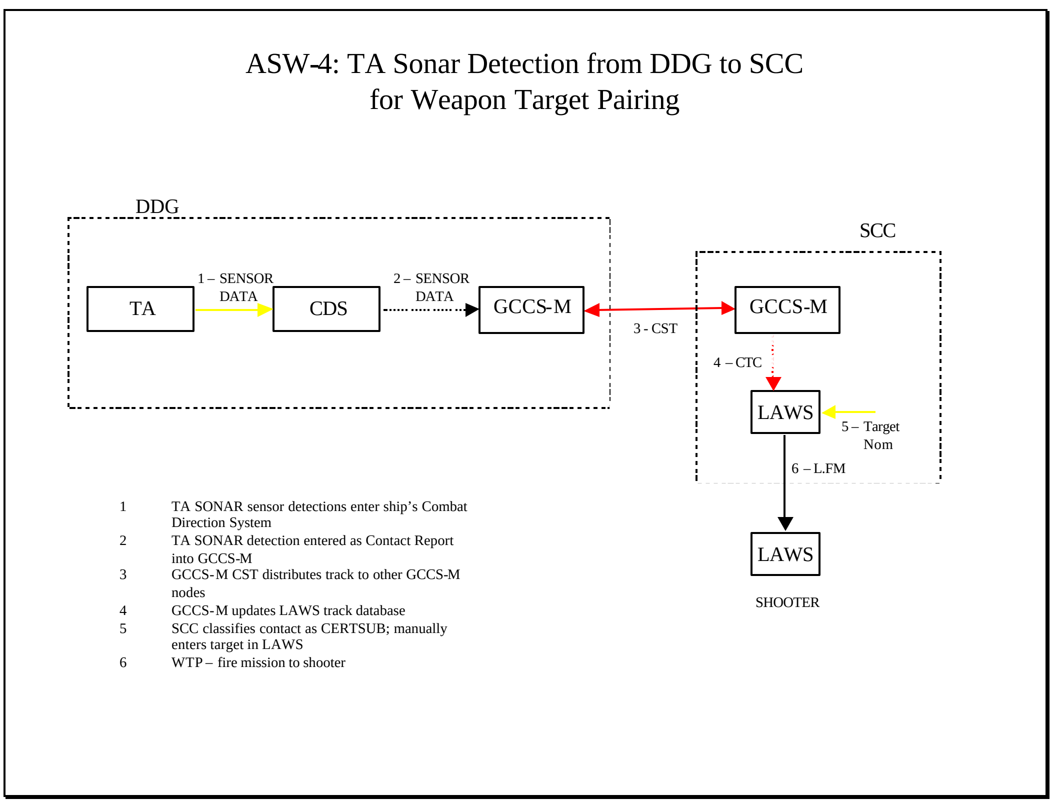


Figure A12-34. ASW-4: TA Sonar Detection from DDG to SCC for Weapon Target Pairing.

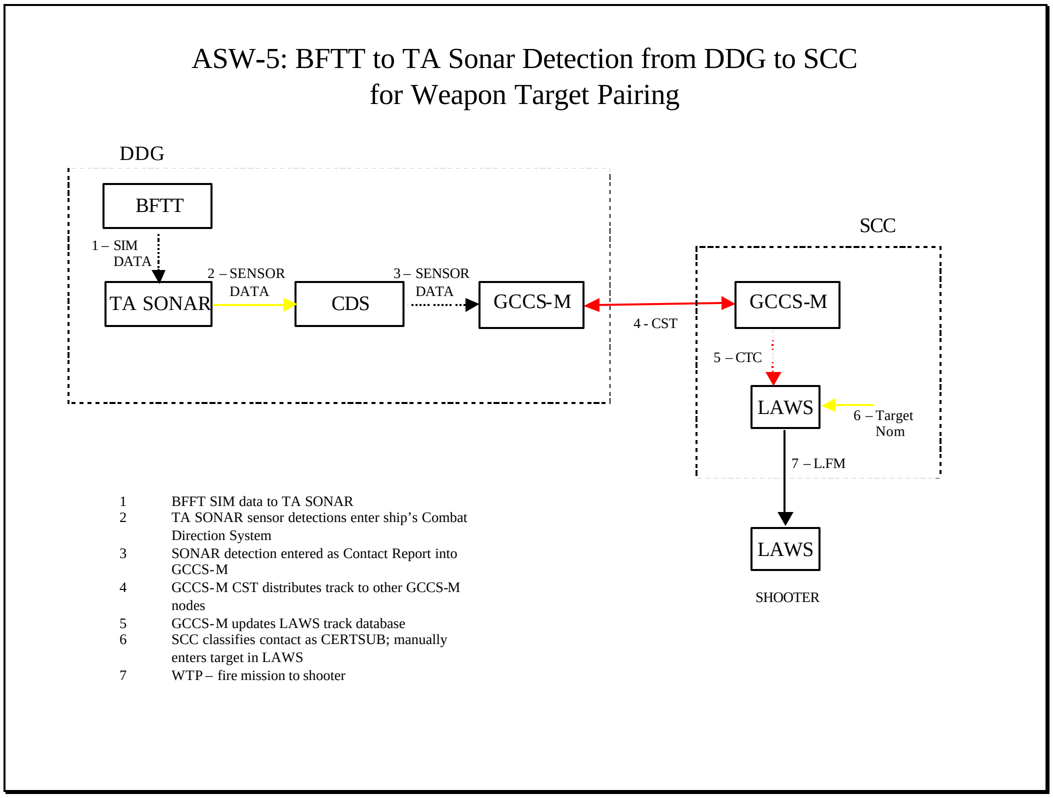


Figure A12-35. ASW-5: BFTT to TA Sonar Detection from DDG to SCC for Weapon Target Pairing.

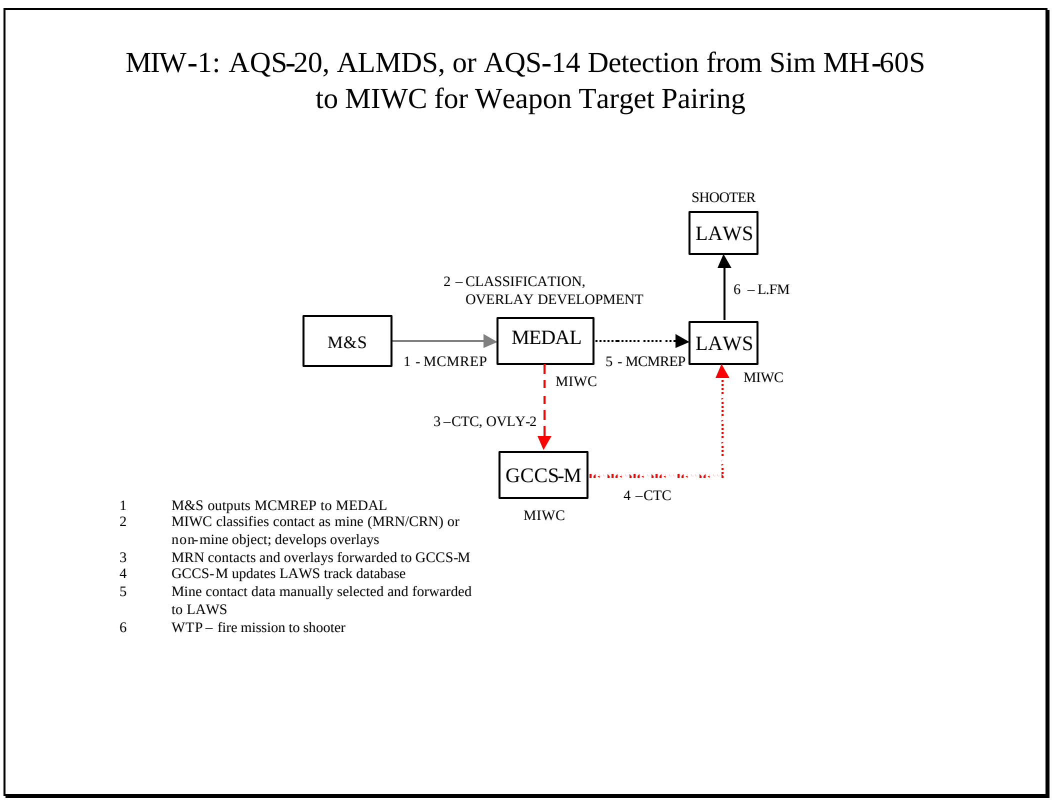


Figure A12-36. MIW-1: AQS-20, ALMDS, or AQS-14 Detection from Sim MH-60S to MIWC for Weapon Target Pairing.

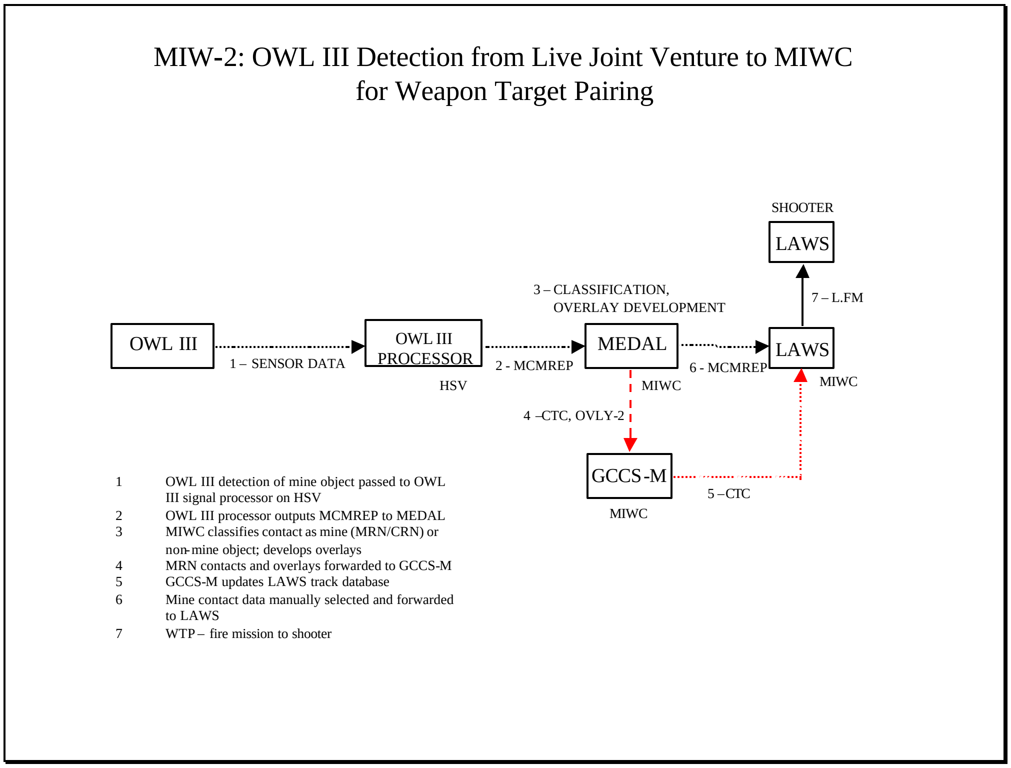


Figure A12-37. MIW-2: OWL III Detection from Live Joint Venture to MIWC for Weapon Target Pairing.

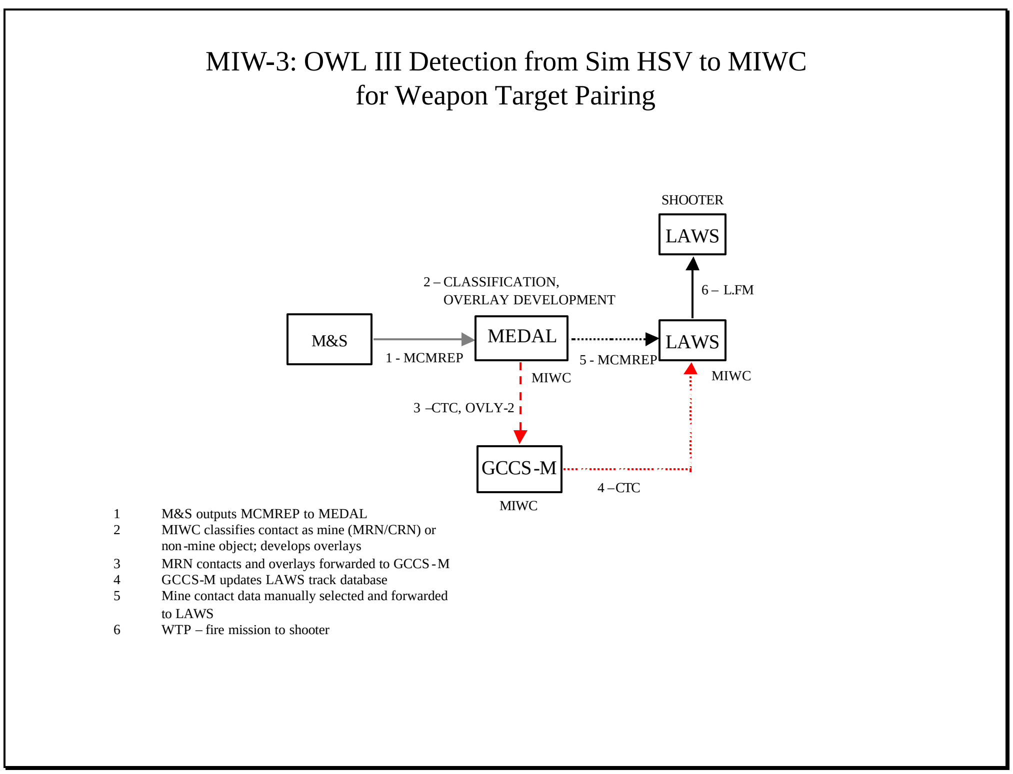


Figure A12-38. MIW-3: OWL III Detection from Sim HSV to MIWC for Weapon Target Pairing.

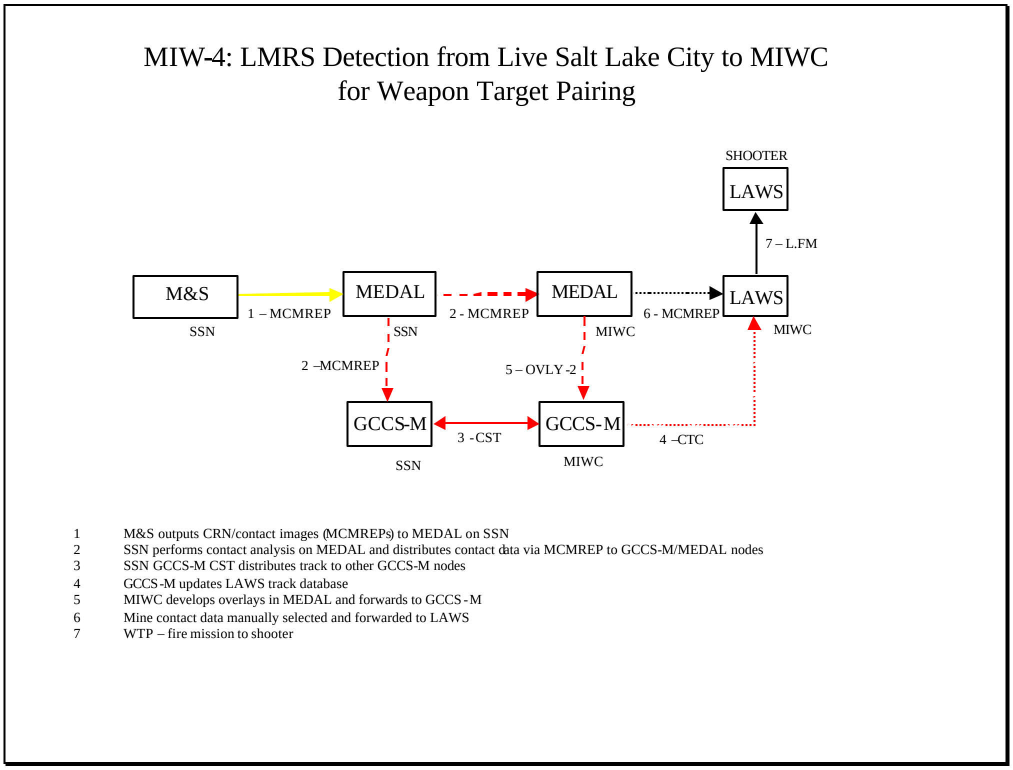


Figure A12-39. MIW-4: LMRS Detection from Live Salt Lake City to MIWC for Weapon Target Pairing.

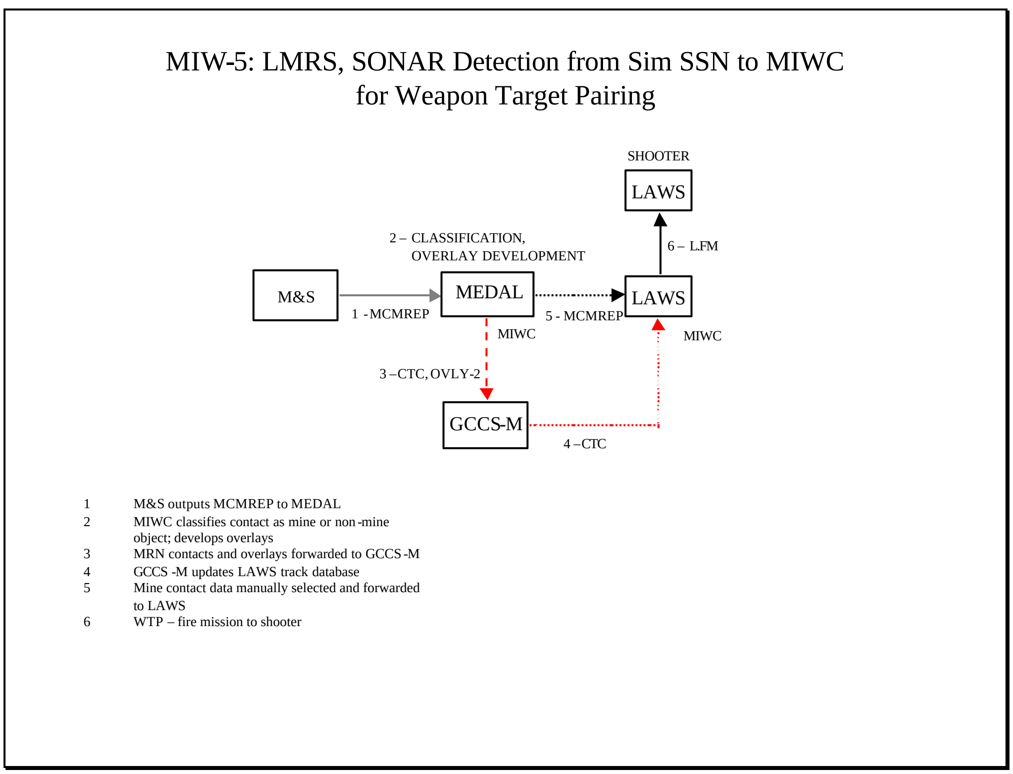


Figure A12-40. MIW-5: LMRS, SONAR Detection from Sim SSN to MIWC for Weapon Target Pairing.

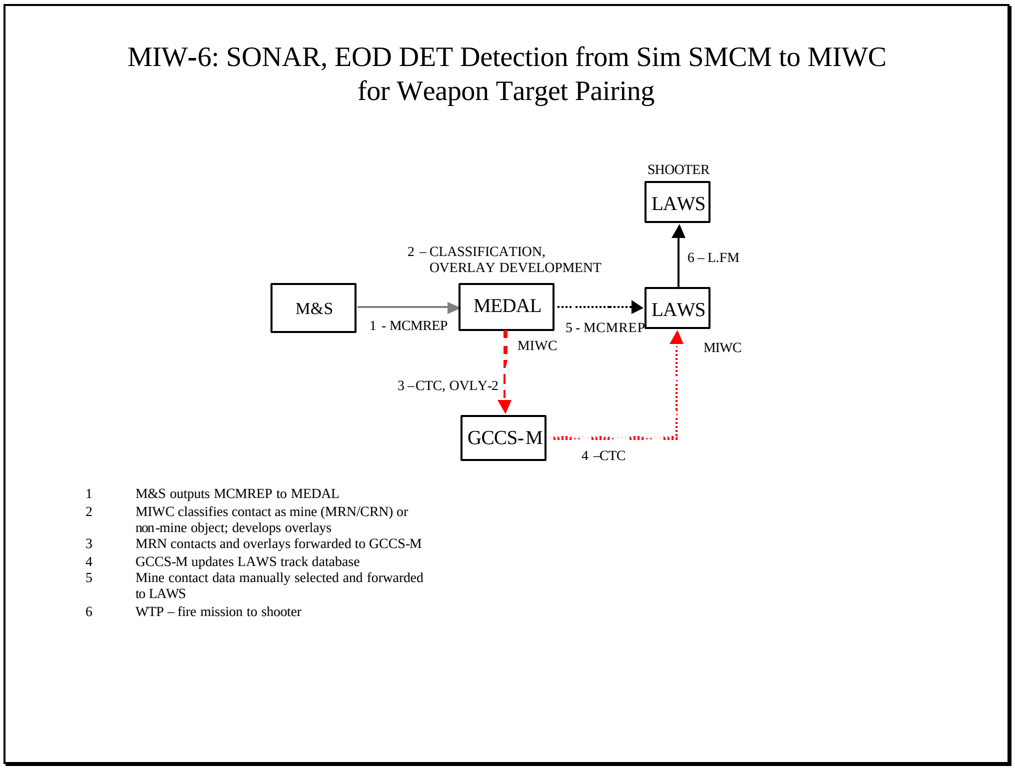


Figure A12-41. MIW-6: SONAR, EOD DET Detection from Sim SMCM to MIWC for Weapon Target Pairing.

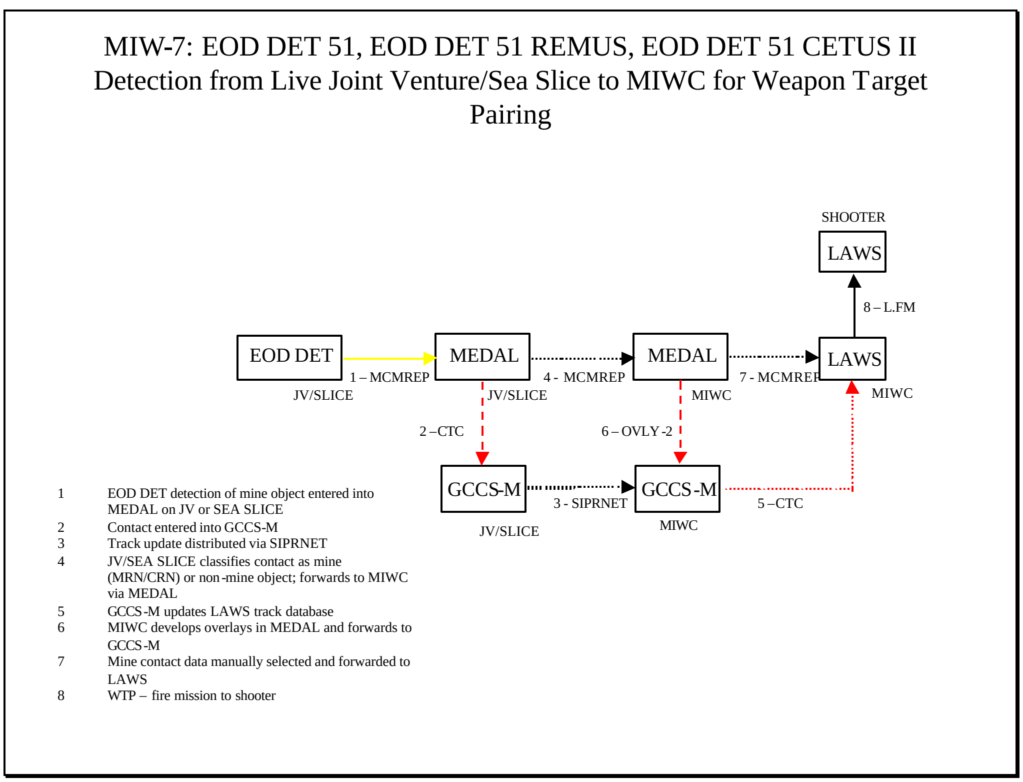


Figure A12-42. MIW-7: EOD DET 51, EOD DET 51 REMUS, EOD DET 51 CETUS II Detection from Live Joint Venture/Sea Slice to MIWC for Weapon Target Pairing.

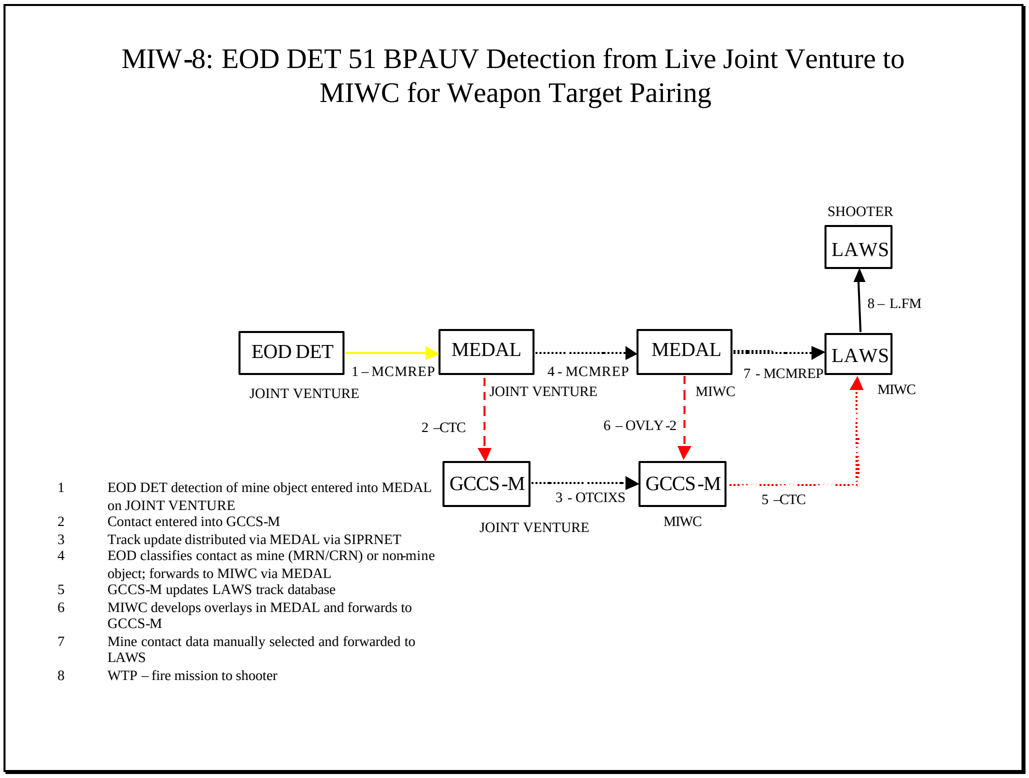


Figure A12-43. MIW-8: EOD DET 51 BPAUV Detection from Live Joint Venture to MIWC for Weapon Target Pairing.

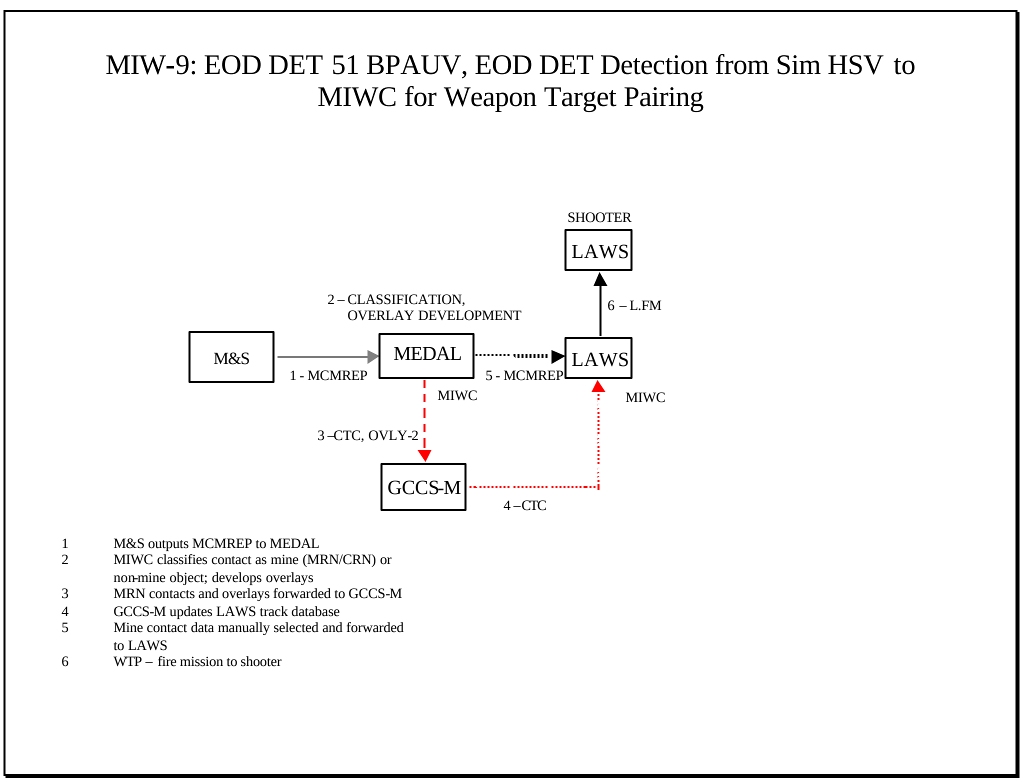


Figure A12-44. MIW-9: EOD DET 51 BPAUV, EOD DET Detection from Sim HSV to MIWC for Weapon Target Pairing.

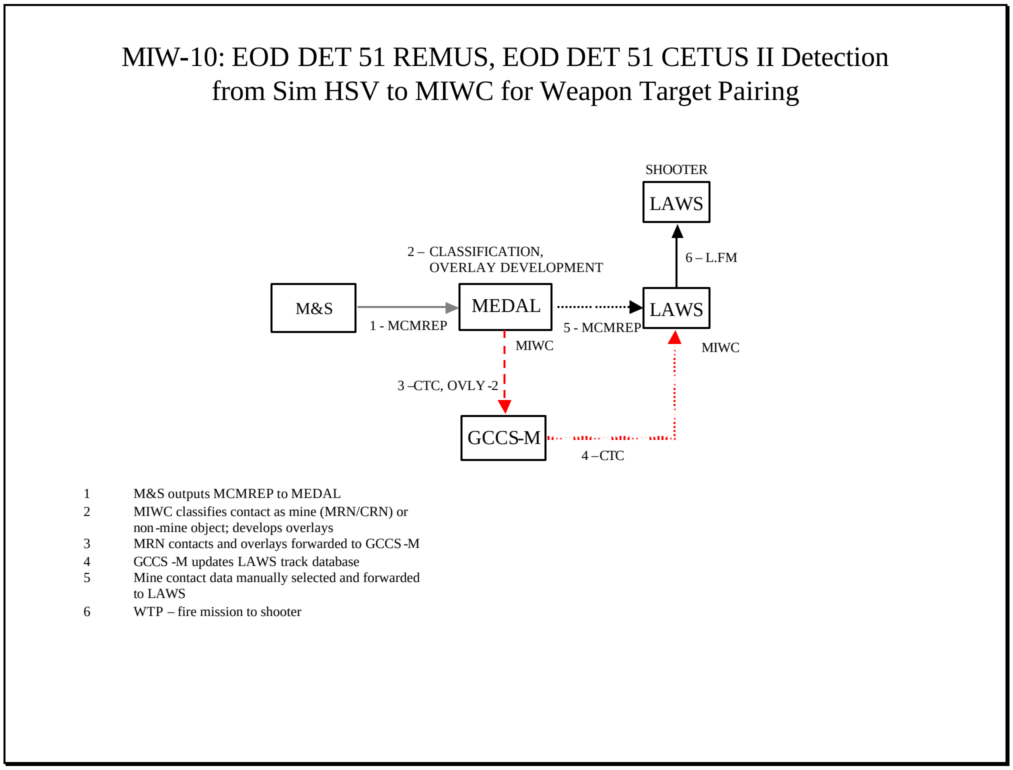


Figure A12-45. MIW-10: EOD DET 51 REMUS, EOD DET 51 CETUS II Detection from Sim HSV to MIWC for Weapon Target Pairing.

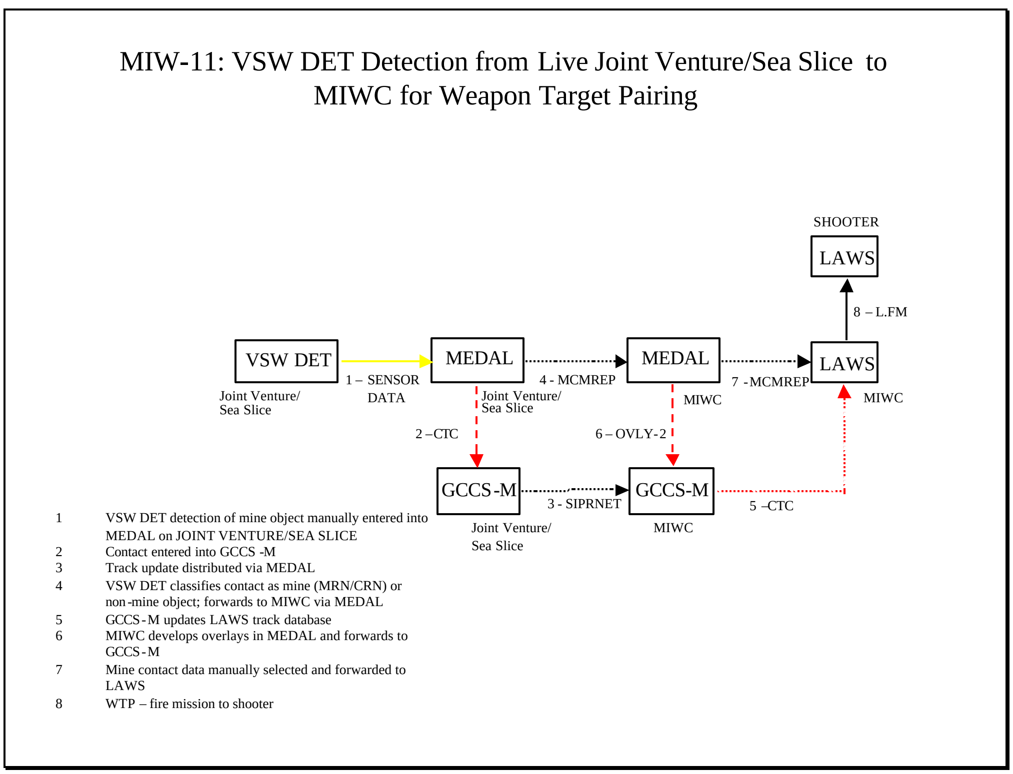


Figure A12-46. MIW-11: VSW DET Detection from Live Joint Venture/Sea Slice to MIWC for Weapon Target Pairing.

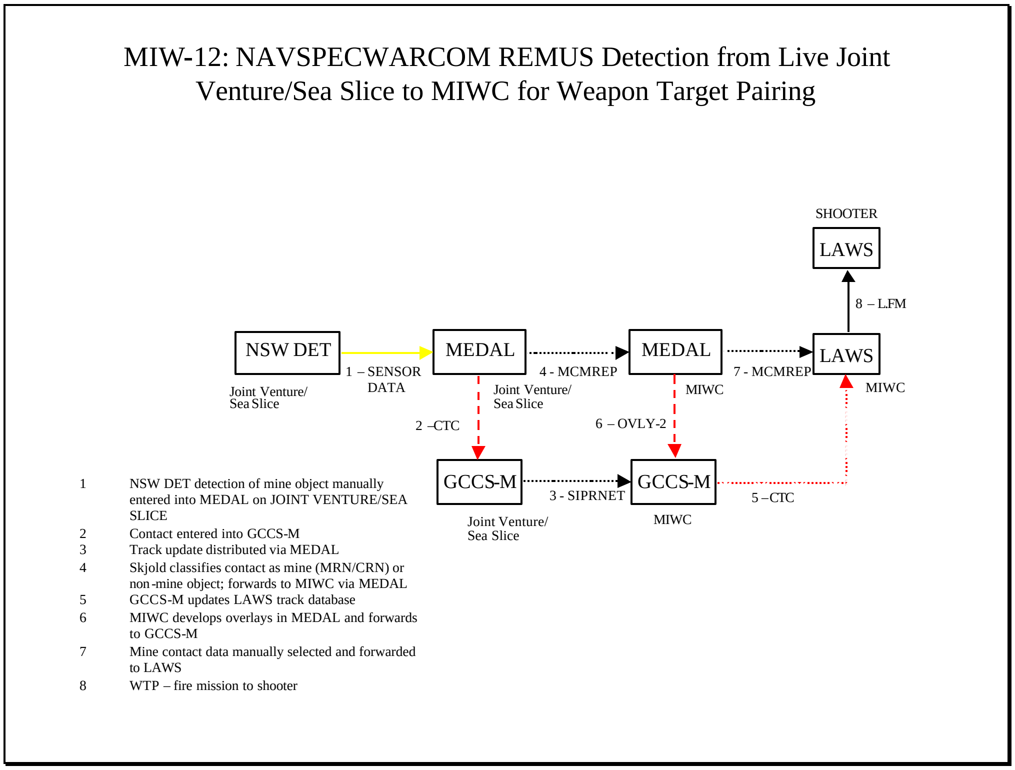


Figure A12-47. MIW-12: NAVSPECWARCOM REMUS Detection from Live Joint Venture/Sea Slice to MIWC for Weapon Target Pairing.

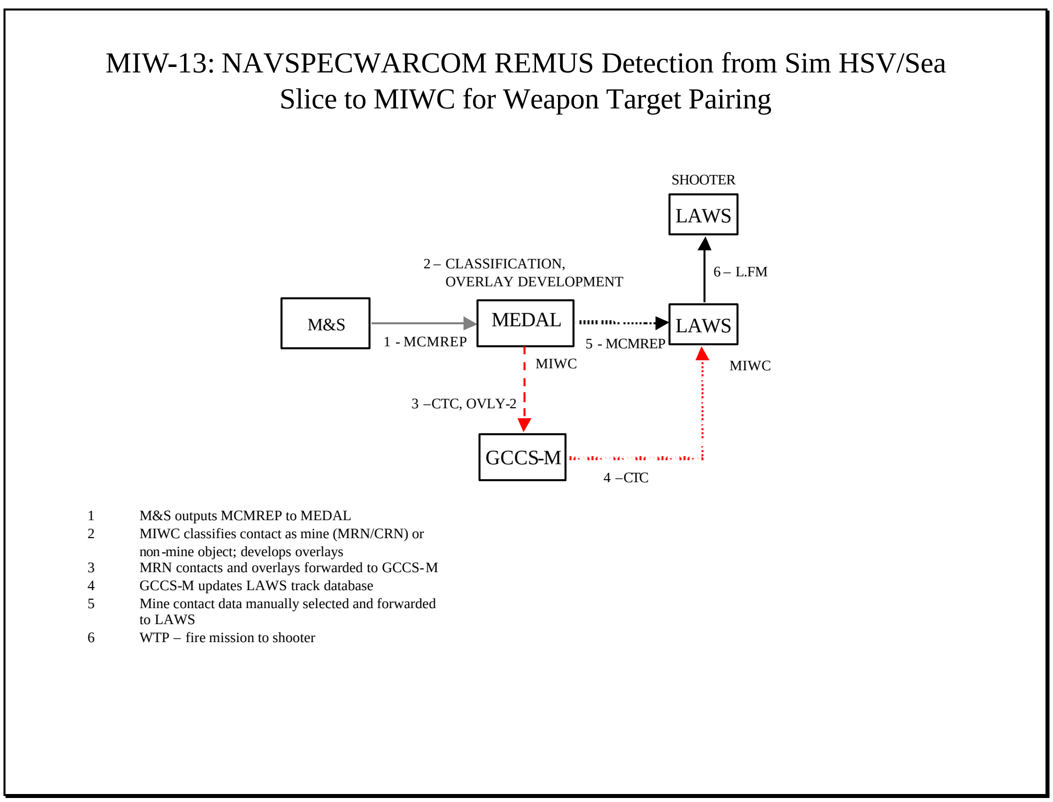


Figure A12-48. MIW-13: NAVSPECWARCOM REMUS Detection from Sim HSV/Sea Slice to MIWC for Weapon Target Pairing.

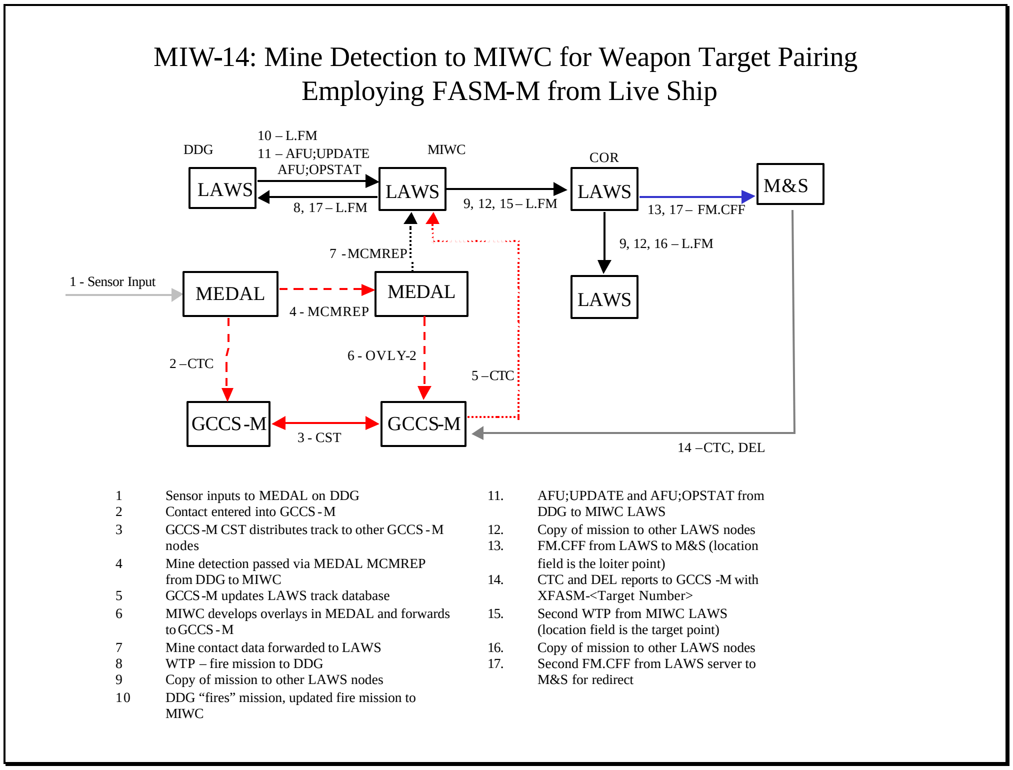


Figure A12-49. MIW-14: Mine Detection to MIWC for Weapon Target Pairing Employing FASM-M from Live Ship.

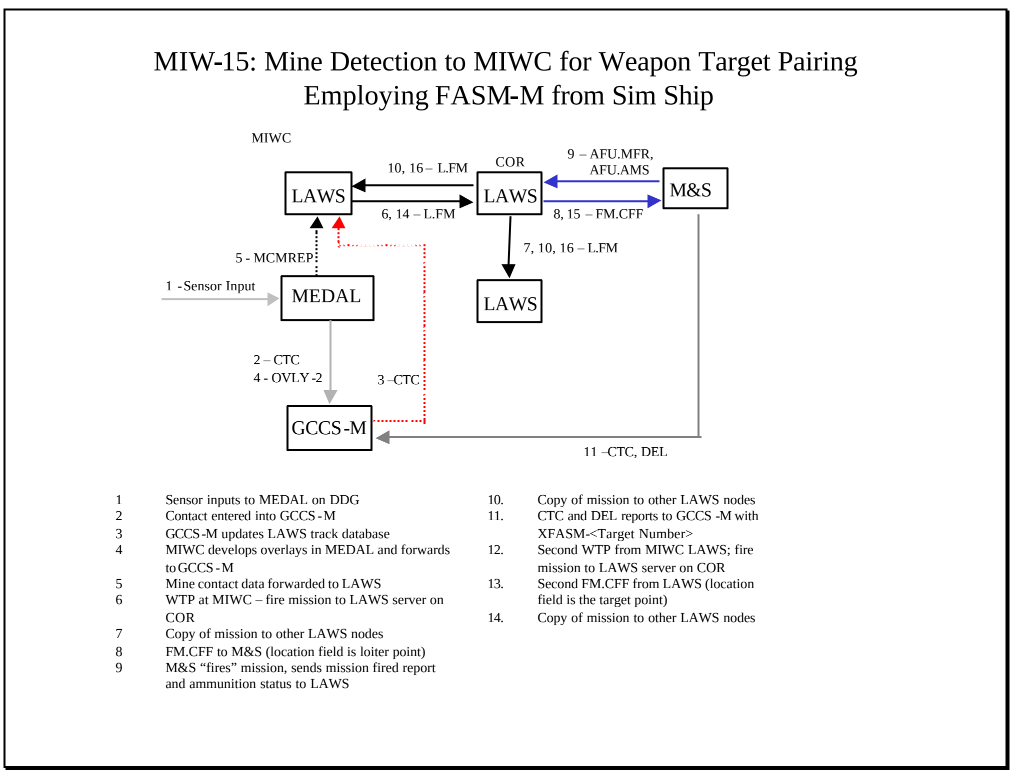


Figure A12-50. MIW-15: Mine Detection to MIWC for Weapon Target Pairing Employing FASM-M from Sim Ship.

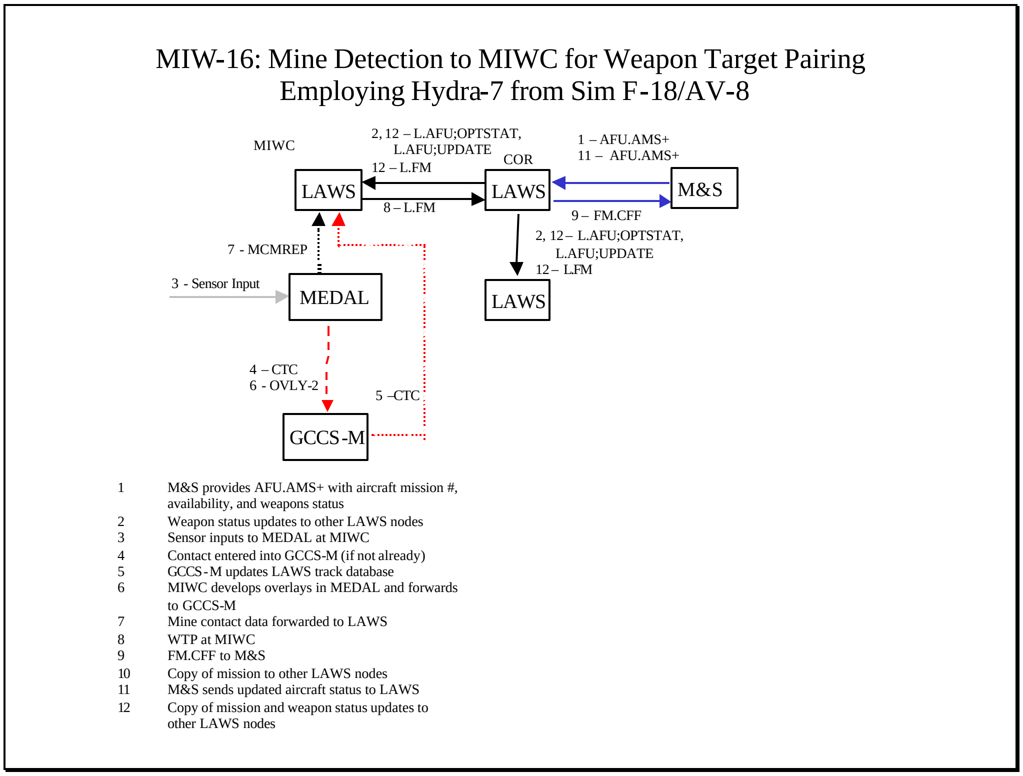


Figure A12-51. MIW-16: Mine Detection to MIWC for Weapon Target Pairing Employing Hydra-7 from Sim F-18/AV-8.

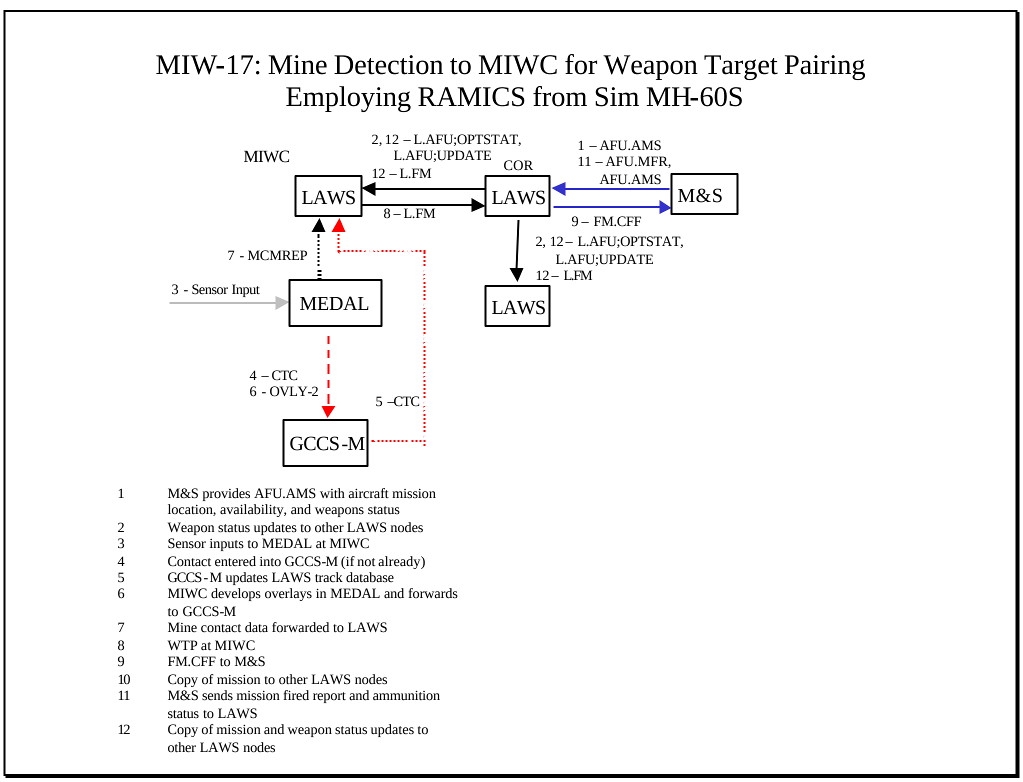


Figure A12-52. MIW-17: Mine Detection to MIWC for Weapon Target Pairing Employing RAMICS from Sim MH-60S.

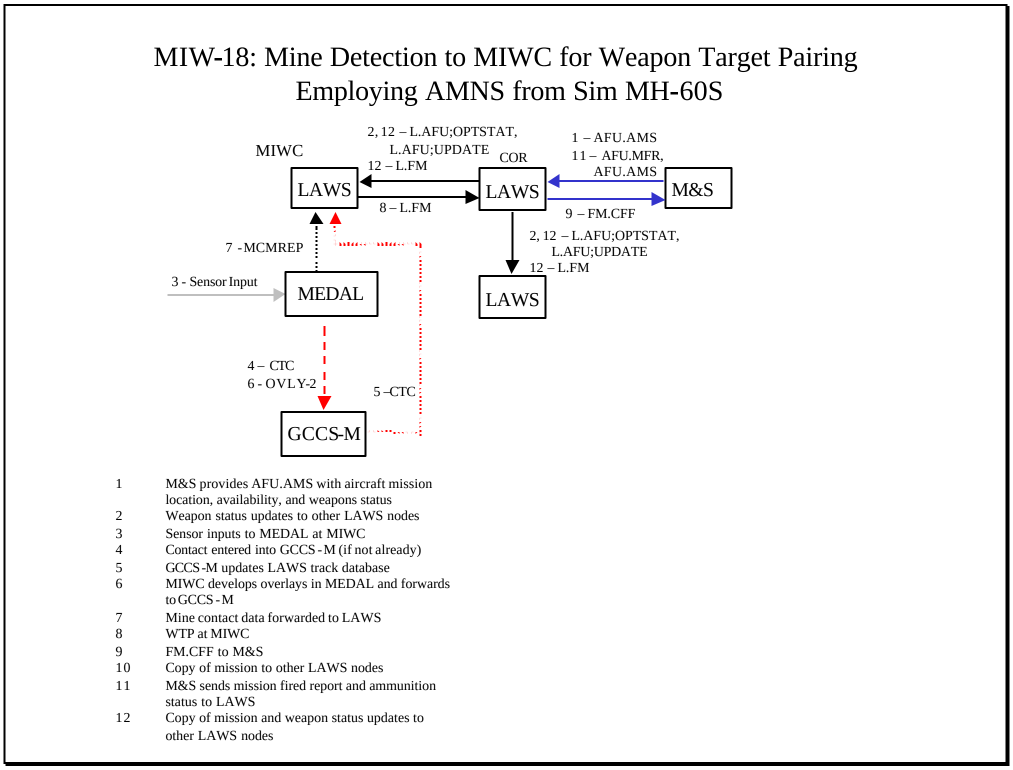


Figure A12-53. MIW-18: Mine Detection to MIWC for Weapon Target Pairing Employing AMNS from Sim MH-60S.

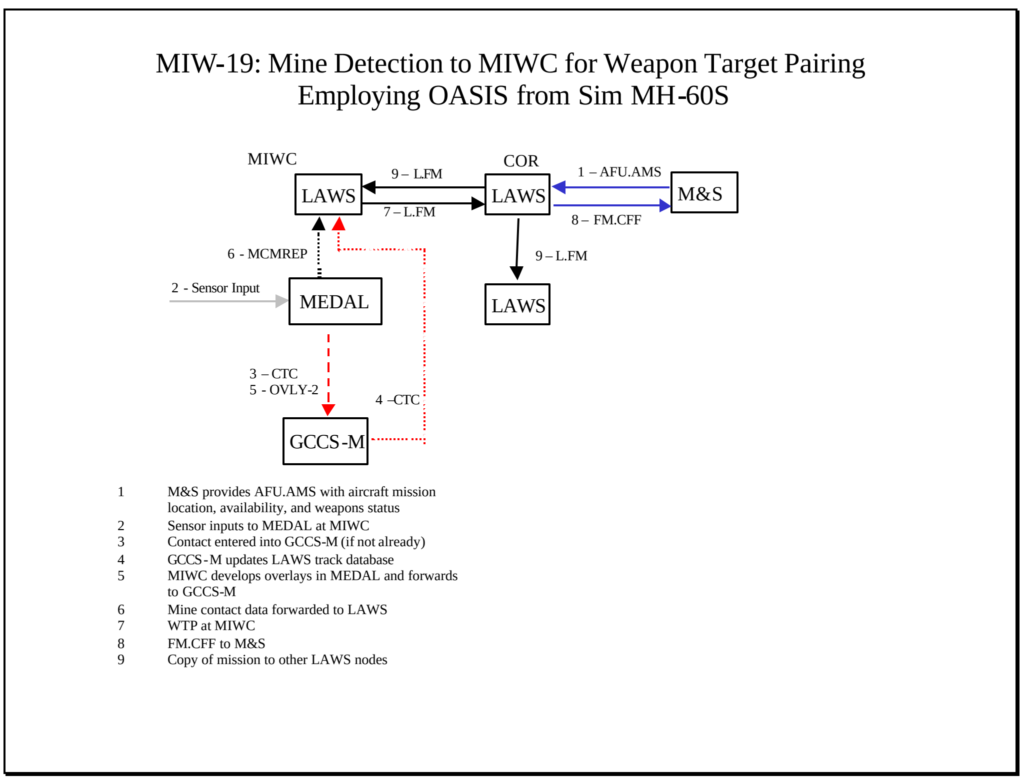


Figure A12-54. MIW-19: Mine Detection to MIWC for Weapon Target Pairing Employing OASIS from Sim MH-60S.

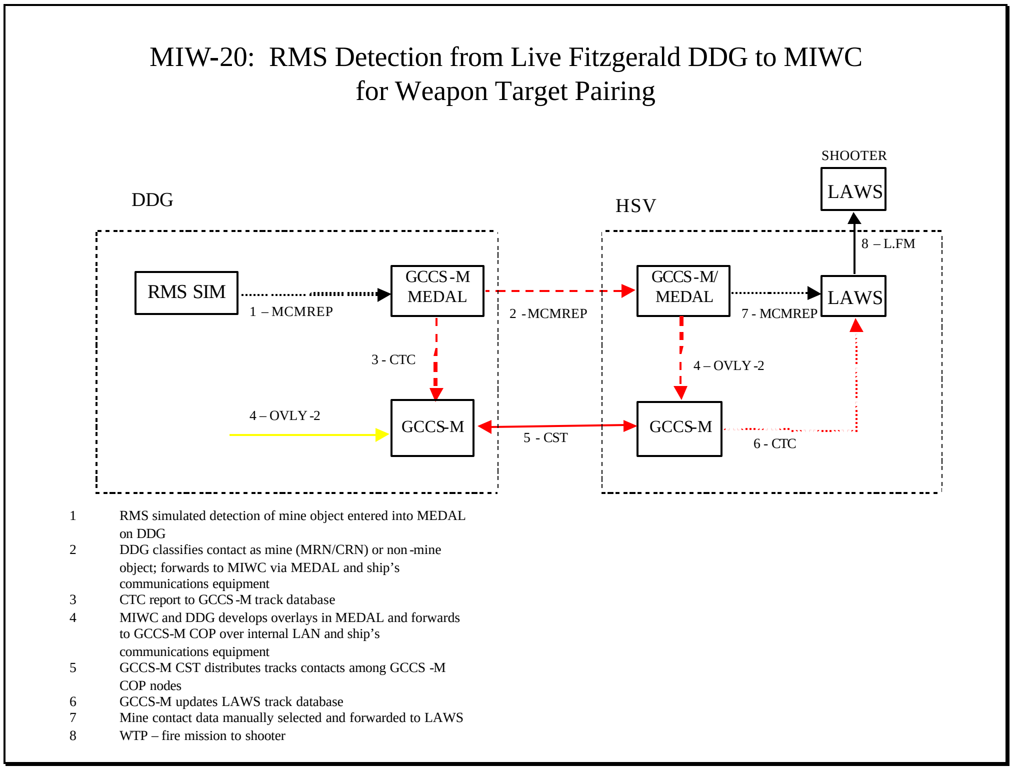


Figure A12-55. MIW-20: RMS Detection from Live FITZGERALD DDG to MIWC for Weapon Target Pairing.

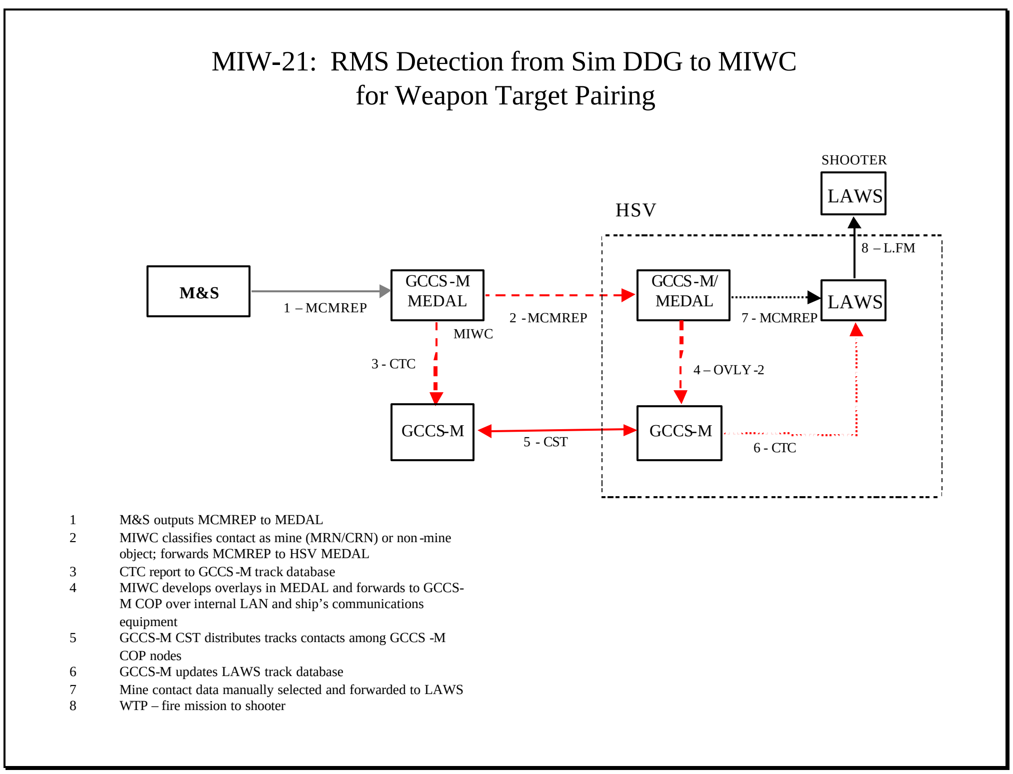


Figure A12-56. MIW-21: RMS Detection from Sim DDG to MIWC for Weapon Target Pairing.

Appendix 13: Acronym List
Final Report: Fleet Battle Experiment - Juliet

AA – Assured Access
AAAV – Advanced Amphibious Assault Vehicle
AADC – Area Air Defense Commander
AAMDC – Army Air and Missile Defense Command
AAR – Air-to-Air Refueling
ABC – Agent Based Computing
ABC – Air Battle Cell
ABFC – Assault Breach Force Commander
ABN – Airborne
ABT – Air Breathing Threat
ACE – Airborne Command Element
ACES – Active Capable Expendable Surveillance
ACRS – Area Covered Rate Sustained
ACO – Airspace Control Order
AD – Air Defense
AD – Airspace Deconfliction
ADA – Air Defense Artillery
ADC – Air Defense Commander
ADOCS – Automated Deep Operations Coordination System (USA, USAF, SOF)
ADF – Automatic Direction Finding
ADF – Autonomic Distributed Firewall
ADS – Advanced Deployable System
ADS – AUV Data Server
ADVISR-T – Advanced Video ISR Tool
AEF – Air Expeditionary Force
AFATDS – Army Field Attack Tactical Data
AFC2TIG – Air Force Command and Control Training and Innovation Center
AFIWC – Air Force Information Warfare Center
AI – Area of Interest
AISR – Airborne ISR
ALAM – Advanced Land Attack Missile
ALMDS – Airborne Laser Mine Detection System
ALSE – Aviation Life Support Equipment
AMAT – ASW Mission Analysis Tool
AMCM – Airborne Mine Countermeasures
AMNS – Airborne Mine Neutralization System
AMTO – Air/Maritime Tasking Order
AMWC – Amphibious Warfare Commander
ANLAS – Advanced Naval Land Attack System
AO – Area of Operations
AOA – Amphibious Operating Area
AOA – Analysis of Alternatives
AOBSR – Airborne Observer
AOC – Air Operations Center
AODA – Attack Operations Decision Aid
APL – Applied Physics Laboratory
ARC – Advanced RISC Computing
AREC – Air Resources Element Coordinator
ARG – Amphibious Ready Group
ARGUS – Advance Remote Ground Unattended Sensors

ASAS – All Source Analysis System
ASCM – Anti-Ship Cruise Missile
ASD – Area Search Detachment
ASN (RDA) – Assistant Secretary of the Navy (Research, Engineering, and Acquisition)
ASP – Ammunition Supply Point
ASPO – Army Space Program Office
ASUPPO – Assistant Supply Officer
ASUW – Anti-Surface Warfare
ASW – Antisubmarine Warfare
ASWC – Antisubmarine Warfare Commander
ATI.ATR – Artillery Target Intelligence - Artillery Target Report
ATACMS – Army Tactical Missile System
ATARS – Advanced Tactical Advanced Conventional Munitions System
ATLoS – Acoustic Transmission Loss Server
ATF – Amphibious Task Force
ATO – Air Tasking Order
ATO/A – Air Tasking Order / Air Combat
ATR – Atlantic Test Range
ATRC – Aegis Training and Readiness Center
AUV – Autonomous Underwater Vehicle
AW – Air Defense Commander of Battle Force
A2IPB – Automated Assistance with Intelligence Preparation of the Battlespace
BAS – Basic Allowance for Subsistence
BCC – Battle Control Center
BDA – Battle Damage Assessment
BDASPT – Battle Damage Assessment Support
BDE – Brigade
BEZ – Beach Exit Zone
BE# – Basic Encyclopedia Number
BFTT – Battle Force Tactical Trainer
BG – Battle Group
BM-CD – Bottom Mapping-Change Detection
BPAUV – Battlespace Preparation and Autonomous Undersea Vehicle
BRITE – Broadcast-Request Imagery Technology Experiment
BTV – Blast Test Vehicle
BZ – Beach Zone
CA – Combat Assessment
CAAT – Course of Action Analysis Tool
CAC – Computer Aided Classification
CACU – Computer Aided Classification Unit
CAD – Computer Aided Detection
CADRG – Compressed ARC Digitized Raster Graphic
CADRT – Computer-Aided Dead Reckoning Tracer
CAL – Critical Asset List
CAOC – Combined Aerospace Operations Center
CAP – Combat Air Patrol
CAS – Close Air Support
CASCAN – Casualty Cancellation
CASCOR – Casualty Corrected
CASREPT – Casualty Report
CAST – Cooperative Agents for Specific Tasks
CATF – Commander Amphibious Task Force
CCG3 – Commander, Carrier Group Three

CCIR – Commander’s Critical Information Requirement
CCTV - Closed-Circuit Television
CENTCOM – U.S. Central Command
CETUS – Composite Endoskeleton Test-bed Untethered Underwater Vehicle System
CDCM – Coastal Defense Cruise Missiles
CDE – Collateral Damage Estimate
CDL-N – Common Data Link – Navy
CDS – Combat Direction System
CDP – Cumulative Detection Probability
CFACC – Combined Force Air Component Commander
CHAT – Conversational Hypertext Access Technology
CHENG – Chief of Engineering
CID – Combat Identification
CIE – Collaborative Information Environment
CINC – Commander in Chief
CJTF – Commander Joint Task Force
CLA – Contact Localization Accuracy
CLF – Commander Landing Force
CM – Collection Management
CM – Counter Measures
CMA – Collection Management Authority
CMTC – Critical Mobile Target Cell
CMWC – Commander Mine Warfare Command
CAN – Center for Naval Analyses
CNA – Computer Network Attack
CND – Computer Network Defense
CO – Commanding Officer
COA – Course of Action
COABS – Control of Agent Based Systems
COAMPS – Coupled Ocean Atmosphere Mesoscale Prediction System
COBRA – Coastal Battlefield Reconnaissance and Analysis [System]
CODEL – Congressional Delegation
COE – Common Operating Environment
COI – Contact of Interest
COMCMRON – Commander Mine Countermeasures Squadron
ComE – Compare to Expectation
COMEX – Commencement of the Exercise
COMMS – Communications
ComS – Compare to Standard
COMOPTEVFOR – Commander, Operational Test and Evaluation Force
COMPTS – Components
CONOPS – Concept of Operations
CONUS – Continental United States
COP – Common Operational Picture
CORRUS – Correlation Using SEI
COTS – Commercial Off-The-Shelf
CPC – Current Planning Cell
CPM – Chokepoint Monitoring
CPS –Current Planning Shell
CPT – Collaborative Planning Tool
CRC – Control and Reporting Center
CRD – Capstone Requirements
CRN – Contact Reference Number

CROP – Common Relevant Operational Picture
CRRC – Combat Rubber Reconnaissance Craft
CS – Case Studies
CSAR – Combat Search and Rescue
CSNP – Causeway Section, Non-Powered
CSS – Coastal Systems Station
CST – COP (Common Operational Picture) Synchronous Tools
CTDL – Common Tactical Data Link
CTF-12 – Commander, Task Force Twelve
CTII – Combat Track II
CVBG – Carrier Battle Group
CWC – Composite Warfare Commander
CWT – Collaborative Workflow Tool (IWPC)
C2 – Command and Control
C2PC – Command and Control Personal Computer
C2/COMM – Command and Control Communications
C3 – Command, Control, and Communications
C4I – Command, Control, Communications, Computer, and Intelligence
C4ISR – Command, Control, Communications, Computer, Intelligence, Surveillance, & Reconnaissance
DAADC – Deputy Area Air Defense Commander
DAL – Defended Asset List
DAMA – Demand Assigned Multiple Access
DARPA – Defense Advance Research Projects Agency
DAS – Dynamic Attack Section
DBC – Dominant Battlespace Command
DBO – Dynamic Battle Order
DCA – Defensive Counterair
DCAG – Deputy Carrier Air Group Commander
DCGS – Distributed Common Ground Station
DCP – Data Collection Plan
DCP – Distributed Collaborative Planning
DC&A – Data Collection and Analysis
DD – Destroyer
DET – Detachment
DEW – Directed Energy Weapons
DGPS – Diffential GPS
DIA – Defense Intelligence Agency
DICASS – Directional Command Active Sonobuoy System
DID – Defense in Depth
DIDSON – Dual Frequency Identification Sonar
DII – Defense Information Infrastructure
DIM – Daily Intentions Message
DIME – Diplomatic Information, Military and Economic
DIOP – Data Input/Output Port
DISRM – Dynamic ISR Management
DLQ – Deck Landing Qualification
DMPI – Desired Mean Point of Impact
DOD – Department of Defense
DOTMPLF – Doctrine, Organization, Training, Material, Leadership, Personnel, and Facilities
DPG – Deliberate Planning Group
DRMS – Distance Root Mean Square
DREAM – Directed Radio Frequency Energy Assessment Model
DREN – Defense Research and Engineering Network

DS – Direct Support
DSCS – Defense Satellite Communications System
DSP – Defense Satellite Program
DTF – Digital Target Folders
DTL – Dynamic Target List
DTM – Dynamic Target Manager
DTMS/PTW – Dynamic Target Management System/Precision Targeting Workstation
DTP – Dynamic Target Planner
DTQ – Dynamic Target Queue
DTS – Dynamic Targeting Section
DV – Distinguished Visitor
D3A – Detect, Decide, Deliver, Assess
D&S – Deployment and Sustainment
EA – Effects Assessment
EAP – Experiment Analysis Plan
EBO – Effects-Based Operations
EBP – Effects-Based Planning
ECOA – Enemy Course of Action
ECOM – Estuarian and Coastal Ocean Model
EDIP – Experiment Design and Implementation Plan
EEI – Essential Elements of Information
EFW – Embedded Firewall
EHF – Extra High Frequency
ELINT – Electronic Intelligence
EMC – Execution Management Control
EMCON - Emission Control
EMI - Electromagnetic Interference
EMPS – Enhanced Mission Planning Sub-System
EMV - Electromagnetic Vulnerability
EMW – Expeditionary Maneuver Warfare
ENDEX – End of Exercise/Experiment
ENTR – Embedded National Tactical Receiver
EO – Electro-Optical
EOB – Enemy Order of Battle
EOD – Explosive Ordnance Disposal
EODC – Explosive Ordnance Disposal Coordinator
EODMU – Explosive Ordnance Disposal Mobile Unit
EO/IR – Electro Optical and Infra Red
EPLRS – Enhanced Position Location Reporting System
ERGM – Extended Range Guided Munitions
ESG – Expeditionary Strike Group
ESG – Expeditionary Sensor Grid
E-Stk – Electronic-Strike
ETCTL – Emerging Time Critical Target List
ETF – Electronic Target Folder
ETL – Emerging Target List
EMCON - Emission Control
ETO – Effects Tasking Order
EW – Electronic Warfare
EXPLAN – Exercise Plan
E2E – End to End (Testing)
FACSFAC – Fleet Air / Area Control and Surveillance Facility
FASM-M – Fleet Air Support Munition – Mine Application

FBE – Fleet Battle Experiment
FCS – Future Combat System
FCTCPAC – Fleet Combat Training Center, Pacific
FFLD – Friendly Force Laydown
FFTTEA – Find-Fix-Track-Target-Engage-Assess
FID – Fidelity
FIWC – Fleet Information Warfare Center
FLIR – Forward Looking Infrared
FLS – Forward Looking Sonar
FM-CCF – Fire Mission Call for Fire
FNMOC – Fleet Numerical Meteorology and Oceanography Center
FOB – Forward Operating Base
FOTC – Force Over-the-Horizon Track Coordinator
FPC – Future Planning Cell
FRAGO – Fragmentary Orders; Tasking Orders
FRD -- Fired
FSCL – Fire Support Coordination Line
FSW – Feet Salt Water
FTI – Fast Tactical Imagery
FTP – File Transfer Protocol
FYDP – Future-Years Defense Program
F2T2EA – Find, Fix, Track, Target, Engage, and Assess (kill chain)
GAT – Guidance, Apportionment, and Targeting
GCCS-M – Global Command and Control System - Maritime
GCS – Ground Communications
GDAIS – General Dynamics Advanced Information Systems
GFE – Government Furnished Equipment
GIG – Global Information Grid
GISRC – Global Intelligence, Surveillance, and Reconnaissance Capability
GLOBIXS – Global Information Exchange System
GPS – Global Positioning System
GSTF – Global Strike Task Force
GUI – Graphical User Interface
G&I – Guidance and Intent
HABD – Helicopter Air Breathing Devices
HARM – High Speed Air Radiation Missile
HC – Hardened Client
HEC – Helicopter Element Coordinator
HERO – Hazards of Electromagnetic Radiation to Ordnance
HFSP – High Frequency Sonar Program
HITS – Hostile Forces Integrated Targeting Sub-System
HMMWV – High Mobility MultipurposeWheeled Vehicle
HPM – High Power Microwave
HPT – High payoff Target
HQ -- Headquarters
HSI – Hyper Spectral Imagery
HSS – Health Service Support
HSV – High Speed Vessel
HTTP – Hyper Text Transmission Protocol
HVT – High Value Target
IA – Image Analyst
IBAR – Integrated Battlespace Arena (a facility at NAWC -WD China Lake)
IBCT – Interim Brigade Combat Team

IBS – Intelligence Broadcast System
ICAPS II – Integrated Carrier ASW Prediction System II
ICSF – Integrated C4I System Framework
ID – Identification
IDM – Improved Data Modem
IDS – Identification Sensor
IFF – Identification Friend or Foe
IKA – Information and Knowledge Advantage
IMINT – Imagery Intelligence
IO – Information Operations
IP – Internet Protocol
IPB – Intelligence Preparation of the Battlespace
IPC – Initial Planning Conference
IPL – Image Product License/Library
IPT – Integrated Process Team
IRAIR – Infrared (from an) Aircraft
IRC – Internet Relay Chat
ISDN – Integrated Services Digital Network
ISG – Information Superiority Group
ISR – Intelligence, Surveillance, and Reconnaissance
ISRM – ISR Manager/Management
IT – Information Technology
ITA – Inner Transit Area
ITD – Integrated Topside Design
ITL – In Theater Logistics
IWC – Information Warfare Commander
IWPC – Information Warfare Planning Capability
IWS – Information Work Space
I&W – Indications and Warning
JAG – Judge Advocate General
JAOP – Joint Air Operations Plan
JASSM – Joint Air to Surface Standoff Missile
JATF – Joint Automated Targeting Folder
JCPT – Joint Collaborative Planning Tool
JDAM – Joint Direct Attack Munition
JDCAT – Joint Data Collection Analysis Tool
JDN – Joint Data Network
JDTL – Joint Dynamic Target List
JECG – Joint Exercise Control Group
JEFX – Joint Expeditionary Force Experiment
JET – Joint Execution Tool (USAF)
JEZ – Joint Engagement Zone
JFACC – Joint Force Air Component Commander
JFC – Joint Force Commander
JFI – Joint Force Initiative
JFLCC – Joint Force Land Component Commander
JFMCC – Joint Force Maritime Component Commander
JGAT – Joint (Combined) Guidance, Apportionment, and Targeting
JGL – JFACC Guidance Letter
JHU – Johns Hopkins University
JIACG – Joint Interagency Coordination Group
JIBP – Joint Intelligence Preparation of the Battlespace
JIM – JTF Integration Matrix

JIP – Joint Interactive Planning
JIPTL – Joint Integrated Prioritized Target List
JISC – Joint Information Superiority Center
JISR – Joint Intelligence, Surveillance, and Reconnaissance
JIVA – Joint Intelligence Virtual Architecture
JI&I – Joint Interoperability and Integration (USJFCOM J8)
JMCIS – Joint Maritime Communication and Information System
JMOP – Joint Maritime Operations Plan
JMS – Java Messaging Server
JMPS – Joint Mission Planning System
JPSD – Joint Precision Strike Demonstration
JOA – Joint Operations Area
JOAF – Joint Operations Area Forecast
JOC – Joint Operations Center
JOCG – Joint Ordnance Commander's Group
JOPES – Joint Operations Planning and Execution System
JP – Joint Publication
JPC – Joint Planning Center
JPN – Joint Planning Network
JPOTF – Joint Psychological Operations Task Force
JSAF – Joint Semi-Automated Forces
JSHIP – Joint Shipboard Helicopter Integration Process
JSIPS-N – Joint Services Image Processing System – Navy
JSOTF – Joint Special Operations Task Force
JSTARS – Joint Surveillance and Target Attack Radar System
JSOW – Joint Stand Off Weapon
JSWS – Joint Service Work Station
JTA – Joint Tactical Action
JTAA – Joint Tactical Action Area
JTAT – Joint Terrain Analysis Toolkit
JTCB – Joint Targeting Coordination Board
JT&E – Joint Test and Evaluation
JTF – Joint Task Force
JTFEX – Joint Task Force Exercises
JTT – Joint Targeting Toolbox
JWCS – Joint Warfighter Counterfires System
JWICS – Joint Worldwide Intelligence Communications System
JWIS – Joint Weather Information System
KK – Knowledge Kinetics (also K2)
KM – Knowledge Management
KMO – Knowledge Management Officer/Organization
KTS – Knots (Nautical Miles per Hour)
K2 – Knowledge Kinetics (also KK)
LAM – Loitering Attack Munition
LANTIRN – Low Altitude Navigation and Targeting Infrared for Night
LASM – Land Attack Standard Missile
LAV – Light Armored Vehicle
LAWS – Land Attack Warfare System (USN, USMC)
LCAC – Landing Craft Air Cushion
LCS – Littoral Combat Ship
LEAPS – LOCAAS Engagement Analysis Program and Simulation
LBL – Long Base Line
LGB – Laser Guided Bomb

LHD – Landing Ship Helicopter Dock/Amphibious Assault Ship
LIO – Littoral Intercept Operations
LMRS – Long Term Mine Reconnaissance System
LNO – Liaison Officer
LOC – Line of Communication
LOCAAS – Low Cost Autonomous Attack System
LOE – Limited Objective Experiment
LPD – Amphibious Transport Dock
LRLAP – Long Range Land Attack Plan
LRS – Littoral Remote Sensing
LST – Landing Ship Tank (former amphibious support vessel)
LVS – Logistics Vehicle System
MAAP – Master Air Attack Plan
MAC – Media Access Control
MAGTF – Marine Air Ground Task Force
MAOT – Maritime Asset Optimization Tool
MARSUPREQ – Maritime Support Request (also MSR)
MASINT – Measures and Signals Intelligence
MBA – Model Based Analysis
MCC – Maritime Command and Control
MCC – Maritime Component Commander
MCM – Mine Countermeasures
MCWL – Marine Corps Warfighting Laboratory
MC02 – Millennium Challenge 2002
MDA – Mine Danger Area
MDR – Medium Data Rate
MDS – Mission Design Series
MEDAL – Mine Warfare and Environmental Decision Aids Library/GCCS-M Segment
METOC – Meteorology and Oceanography
MGAT – Maritime Guidance Apportionment Targeting
MHC – Coastal Mine Hunter
MIC – Maritime Intelligence Cell
MICO – Maritime Interface Control Officer
MIDB – Modernized Integrated Database
MILC – Minelike Contacts
MILDEC – Military Deception
MIO – Maritime Intercept Operations
MIPR – Military Interdepartmental Procurement Request
mIRC – shareware Internet Relay Chat (for Windows)
MISE – Meyer Institute of Systems Engineering, Naval Postgraduate School
MIUGS – Micro-Internetted Unattended Ground Sensors
MIW – Mine Warfare
MIWC – Mine Warfare Commander
MLO – Mine-Like Objects
MLRS – Multiple Launch Rocket
MMAP – Master Maritime Attack Plan
MMS – Marine Mammals System
MMTI – Maritime Moving Target Indicator
MNCO – Maritime Network Control Officer
MNS – Mine Neutralization System
MOA – Military Operations Area
MOC – Maritime Operations Center
MOD – Maritime Operations Directive (formerly Joint Maritime Ops Plan –JMOP)

MODAS – Modular Ocean Data Assimilation System
MOE – Measure of Effectiveness
MOP – Magnetic Orange Pipe
MOP – Measure of Performance
MOS – Military Occupational Specialty
MPA – Maritime Patrol Aircraft
MPF – Minefield Planning Folder
MPP – Maritime Planning Process
MPS – Maritime Planning Shell
MRN – Mine Reference Number
MSEL – Master Scenario Events List
MSIC – Missile Systems Intelligence Center
MSN – Mission
MSR – Maritime Support Request (also MARSUPREQ)
MTA – Mine Threat Area
MTE – Moving Target Exploitation
MTI – Moving Target Indicator
MTO – Maritime Tasking Order
MTP – Mission Data System Tactical Processor
MUSE – Multi-User Shared Environment
MUST – Multimission UHF SATCOM Terminal
MWMF – Microsoft Windows Media Framework
M&S – Modeling and Simulation
M&S – Monitoring and Surveillance
NALE – Naval Liaison Element
NAR – Notice of Ammunition Reclassification
NAT IPT – Naval Afloat Targeting Integrated Process Team
NATOPS – Naval Air Training and Operating Procedures Standardization
NAV – Navigation
NAVAID – Navigation Aid
NAVAIRSYSCOM – Naval Air Systems Command
NAVOCEANO – Naval Oceanographic Center
NAVPACMETOCCEN – Naval Pacific METOC Center
NAVSEASYSCOM – Naval Sea Systems Command
NAWC-WD – Naval Air Warfare Center -Weapons Division
NCA – National Command Authorities
NCC – Naval Component Commander
NCCT – Network-Centric Collaborative Targeting
NCO – Non-Commissioned Officer
NCS – Naval Control of Shipping
NCW – Network-Centric Warfare
NDB – Non-Directional Beacon
NDIA – National Defense Industrial Association
NEO – Noncombatant Evacuation Operation
NETWARCOM – Naval Network Warfare Command
NF – Netted Force
NFCS – Naval Fire Control System
NFN-VPO – Naval Fires Network Virtual Program Office
NFN (X) – Naval Fires Network (Experimental)
NIC – Network Interface Card
NIMA – National Imaging and Mapping Agency
NISC – Naval Intelligence Support Center
NITES – Naval Integrated Tactical Environmental Subsystem

NLT – Not Later Than
NM – Nautical Mile
NMWS – Naval Mine Warfare Simulation
NOMBO – Non-Mine or Mine-like Bottom Object
NOTACK – No Attack (Zone – for (submarine) safety)
NPMOC-SD – Naval Pacific METOC Center, San Diego
NPS – Naval Postgraduate School
NRF – Naval Reserve Force
NRL – Navy Research Laboratory
NRO-OSO – National Reconnaissance Office
NS – Naval Station
NSAWC – Naval Strike Air Warfare Center
NSFS – Naval Surface Fire Support
NSS – Naval Simulation System
NSW – Naval Special Warfare
NSWC – Naval Surface Warfare Center
NSWCDDCSS – Naval Surface Warfare Center, Dahlgren Division, Coastal Systems Station
NSWTU – Naval Special Warfare Task Unit
NTR – Nothing to Report
NUWC – Naval Undersea Warfare Center
NWC – Naval War College
NWDC – Naval Warfare Development Command
NWP – Naval Warfare Publication
OASIS – Organic Airborne Surface Influence Sweep
OCD – Ordnance Clearance Detachment
OIO – Offensive Information Operations
OMCM – Organic Mine Counter Measures
ONA – Operational Net Assessment
ONI – Office of Naval Intelligence
ONR – Office of Naval Research
OODA – Observe, Orient, Decide, Act
OPGEN – Operating Instruction, General
OPLAN – Operations Plan
OPNOTE – Operational Note
OPORD – Operations Order
OPTASK – Operational Task
OS – Operating System
OSC – Operational Support Center
OSD – Operational Sequence Diagrams
OTA – Operational Test Area
OTC – Officer in Tactical Command
OTH – Over the Horizon
OTHT-GOLD – Over the Horizon Target ("-Gold" is a message format)
PAA – Phased Array Antenna
PAM – Precision Attack Munition
PCIDM – Personal Computer Improved Data Modem
PCIMAT – Personal Computer Interactive Multisensor Analysis Trainer
PCL – Passive Correlation and Localization
PCMCIA – Personal Computer Memory Card International Association
PCSWAT – Personal Computer Shallow Water Acoustic Toolkit
PEDS – Processing, Exploitation, and Dissemination System
PEL – Priority Effects List
PEP – Protocol Enhancing Proxy

PGM – Precision Guided Munitions
PIM – Plan of Intended Movement
PIR – Priority Intelligence Requirement
PK– Probability of Kill
PLA – Plain Language Address
PLATID – Platform Identification
PMA – Post Mission Analysis
Pn – Probability of Negation
PO – Process Observations
POD – Ports of Debarkation
POD – Probability of Detection
POM – Princeton Ocean Model
PRI – Pulse Repetition Interval
PRISM – PhotoReconnaissance Intelligence Strike Mode
PSAB – Prince Sultan Air Base
PSAS – Precision SIGINT Analysis System
PSD – Passed (block in JFI form)
PTW – Precision Targeting Workstation
PWC – Principal Warfare Commanders
QOS – Quality of Service
QRMAG – Quick Reaction Mine Warfare Action Group
Q-Route – A sea lane clear of mines
RADC – Regional Air Defense Commander
RAMICS – Rapid Airborne Mine Clearance System
RAV – Remote Autonomous Vehicle
RCS – Radar Cross-Section
RDF – Radio Direction Finder
RDO – Rapid Decisive Operations
RDS – Rapidly Deployable System
Rec – Reconstruction
RecT – Reconstruction Timelines
REMUS – Remote Environmental Monitoring Unit System
RF – Radio Frequency
RFI – Requirement for Information
RHIB – Rigid Hull Inflatable Boat
RISC – Reduced Instruction Set Computing
RISTA – Reconnaissance, Surveillance and Target Acquisition
RITA – Run Time Interface
RMG – Radiant Mercury Guard
RMS – Remote Minehunting System
RMV – Remote Minehunting Vehicle
ROE – Rules of Engagement
ROZ – Restricted Operating Zones
RPM – Rapid Planning Mode
RPTS – Reports
RP&A – Resource Planning and Assessment
RRDF – Roll-on Roll-off Discharge Facility
RRF – Ready Room of the Future
RSOI – Reception, Staging, Onward movement, Integration
RSTA – Reconnaissance, Surveillance, and Target Acquisition
RTC – Remote Terminal Capability/Component
RTCL – Remote Terminal Capability-Lite
RTI – Run Time Interface

RTIC – Real Time Information to Cockpit
RTO – RISTA Tasking Order
RTP – Return to Port
RVR – Remote View Reader
R&S – Reconnaissance and Surveillance
R/V – Research Vessel
SA – Situational Awareness
SA – Statistical Analysis
SAA – Situation Awareness and Assessment
SABER – Situational Awareness Beacon with Reply
SADO – Senior Air Defense Duty Officer
SAHRV – Semi-Autonomous Hydrographic Reconnaissance Vehicle
SAM – Surface-to-Air Missile
SAR – Search and Rescue
SATCOM – Satellite Communications
SBCT – Stryker Brigade Combat Team
SC – Statistical Comparisons
SCI – Special Compartmented Information
SCC – Sea Combat Commander
SCC – Strike Control Cell
SCE – Strike Control Element
SCIF – Special Compartmented Information Facility
SCORE – Southern California Offshore Range
SCUD – Surface-to-surface Missile System
SDV – Swimmer/SEAL Delivery Vehicle
SEA – Sea Echelon Area
SEAL – Sea, Air, Land
SEAD – Suppression of Enemy Air Defenses
SEARAM – Sea Launched Rolling Airframe Missile
SEI/SEID – Specific Emitter Identification
SEPCOR – Separate Correspondence
SFMPL – Submarine Fleet Mission Program Library
SIAP – Single Integrated Air Picture
SIDO – Senior Intelligence Duty Officer
SIGINT – Signals Intelligence
SIIP – SPPEDS and ICAPS II Integrated Product
SIM – Simulation
SIPRNET – Secret Internet Protocol Router Network
SITREP – Situation Report
SJC2E – Standing Joint Command and Control Element
SJFHQ – Standing Joint Force Headquarters
SLAMER – Standoff Land Attack Missile Expanded Response
SLC – USS Salt Lake City
SLD – Submarine Locating Device
SLOC – Sea Line of Communication
SLWT – Side Loadable Warping Tug
SMD – Sea-based Mid-course Defense
SME – Subject Matter Expert
SO – System Observations
SOA – Speed of Advance
SOAR – Southern California ASW Range
SOCA – Submarine Operations Control Authority
SOF – Special Operations Forces

SOH – Straits of Hormuz
SOI – Ship of Interest
SOLE – Special Operations Forces Liaison Element
SOCAL – Southern California
SODO – Senior Offensive Duty Officer
SOSUS – Sound Surveillance System
SLOC – Sea Line of Communication
SMCM – Surface Mine Countermeasures
SMD – Sea-based Mid-course Defense
SP – System Performance
SPAWAR – Space and Naval Warfare Systems Command
SPAWARSYSCOM – Space and Naval Warfare Systems Command
SPINS – Special Instructions
SPP – Sonar Performance Prediction
SPPEDS – Sensor Performance Prediction Expeditionary Decision System
SPPS – SharePoint Portal Service (Microsoft Software)
SRAS – Surveillance, Reconnaissance, and Assessment Section
SRMT – Surveillance and Reconnaissance Management Tool
SRS – Surveillance and Reconnaissance Section
SSC-SD – SPAWAR Systems Center - San Diego
SSEE – Ship Signal Exploitation Equipment
SSS – Side Scan Sonar
ST – Surface Terminal
STARTEX – Start of the Exercise/Experiment
STO – Special Technical Operations
STOICS – Special Tactical Oceanographic Information Charts
STOM – Ship to Maneuver
STWC – Strike Warfare Commander
STWDA – Strike Warfare Decision Aid (NSS tool)
SUB – Subjective Opinions
SURFPAC - Naval Surface Force, U.S. Pacific Fleet
SUW – Surface Warfare
SUWC – Surface Warfare Commander
SVP – Sound Velocity Profile
SWARMEX – Exercise against a Swarming Surface Threat
SWDG – Surface Warfare Development Systems Command
SZ – Surf Zone
TACELINT – Tactical Electronic Intelligence
TACMS – Tactical Missile System
TACAN – Tactical Aid to Navigation
TACON – Tactical Control
TACREC – Tactical Reconnaissance
TADIL-A –Tactical Automated Data Information Link – A
TADIL-J – Joint Tactical Automated Data Information Link
TADILS – Tactical Data Information Link System
TAMDA – Tactical Acoustic Measurement and Decision Aid
TAPS-VSS – Theater Assessment Profiling System – Valuated State Space
TARPS – Tactical Airborne Reconnaissance Pod System
TASWC – Theater ASW Commander
TBD – To Be Determined
TBM – Tactical Ballistic Missile
TBMCS – Theater Battle Management Core System
TBMD – Theater Ballistic Missile Defense

TCDL – Tactical Communications Data Link
TCP – Tactical Control Program
TCP – Transmission Control Protocol
TCP/IP – Transmission Control Protocol/Internet Protocol
TCS – Time Critical Strike
TCS-UAV – Tactical Control System Unmanned Air Vehicle
TCSO – Time Critical Strike Officer
TCT – Time Critical Target
TDA – Tactical Decision Aid
TDDS – TRAP Data Dissemination System
TDM – Tactical Dissemination
TEG – Tactical Exploitation Group
TEL – Transporter/Erector/Launcher
TES-N – Tactical Exploitation System – Navy
TGT – Target
THAAD – Theater High-Altitude Area Defense
T-Hawk – Tomahawk Land Attack
TIBS – Tactical Information Broadcast Service
TLAM – Tomahawk Land Attack Missile
TMA – Target Motion Analysis
TMS – Tactical Missile System
TNL – Target Nomination List
TOC – Tactical Operations Center
TOPCOP – Tactical Operations Planner COP
TOT – Time On Target
TPED – Tasking, Processing, Exploitation, and Dissemination
TPFDD – Time Phase Force Deployment Data
TPFDL – Time Phase Force Deployment List
TPG – Target Package Generator
TPPU – Tasking, Posting, Processing, and Use
TPS / MDS – Tomahawk Planning System / Mission Distribution System
TRAP – Tactical Related Application
TSC – Tactical Support Center
TST – Time Sensitive Target
TTLAM – Tactical TLAM
TTP – Tactics, Techniques, and Procedures
TU – Task Unit
T3 – Transformational Tactical Targeting
UAV – Unmanned Air Vehicle
UCS – Unified Cryptological System
UDP – User Data Protocol
UEP – Underwater Electric Potential
UGS – Unattended Ground Sensors
UHF – Ultra High Frequency
UHSV – Unmanned Harbor Security Vessel (e.g. OWL Mk III)
UMCM – Undersea Mine Countermeasures
UNISIPS – Unified Image Sonar Processor Software
UNTL – Universal Naval Task List
USMTF – United States Message Text Format
USN – United States Navy
USN – Undersea Sensor Network
USV – Unmanned Surface Vehicle
UUV – Unmanned Underwater Vehicles

U/W – Underway
U2 – Strategic Reconnaissance Aircraft
VBSS – Visit, Board, Search, and Seizure
VDA – Video Distribution Architecture
VDS – Variable-Depth Sensor
VHF – Very High Frequency
VID – Visual Identification
VMR – Virtual Missile Range
VPN – Voice Product Net
VPU – Video Processor Unit
VSW – Very Shallow Water
VTC – Video Teleconference
WAN – Wide Area Network
WARCON – Warfighting Concepts
WCS – Weapon Control System
WeCAN – Web-Centric ASW Network
WHOI – Woods Hole Oceanographic Institution
WMD – Weapons of Mass Destruction
WME – Weapons of Mass Effect
WMF – Windows Media Framework
WO – Watch Officer
WSM – Waterspace Management
WTP – Weapons Target Pairing
WVS – World Vector Shoreline
XC4I – Exercise Command, Control, Communications, Computers, and Intelligence
XMEB – Exercise Marine Expeditionary Brigade
XO – Executive Officer
XTP – Express Transport Protocol

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