STRG

DEPARTMENT OF THE NAVY SCIENCE AND TECHNOLOGY REQUIREMENTS GUIDANCE

OFFICE OF CHIEF OF NAVAL OPERATIONS
DIRECTOR, TEST AND EVALUATION
AND TECHNOLOGY REQUIREMENTS
N091

JUNE 1996

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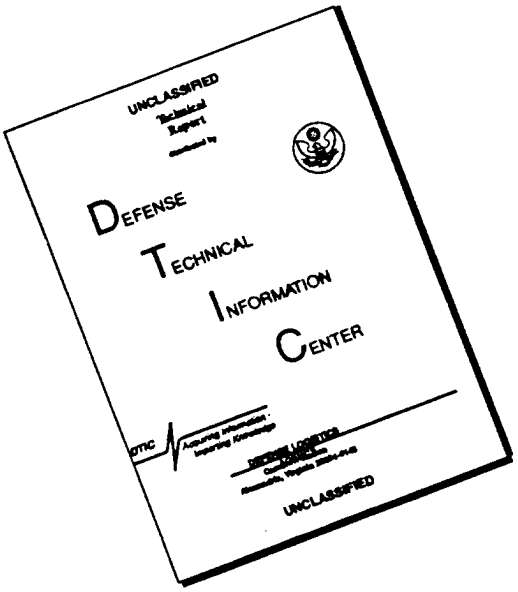

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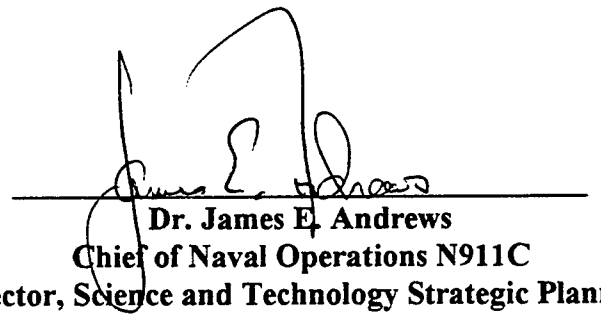
Department of the Navy

SCIENCE AND TECHNOLOGY REQUIREMENTS GUIDANCE (STRG)

16 July 1996

Submitted By:



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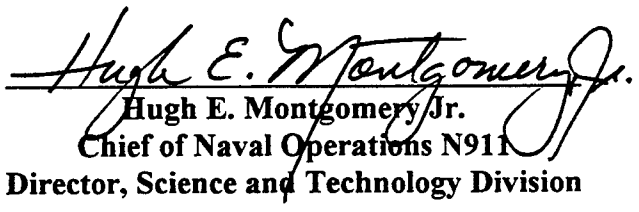

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Contents

Science and Technology Requirements Guidance

EXECUTIVE SUMMARY

The Navy Science and Technology Requirements (STRG)process was significantly restructured for 1996. Requirements review and development were accomplished within a single Round Table structured on Functional Areas (e.g., Air Warfare, Logistics, etc.) instead of Joint Mission Areas. This change both eliminated the fiscal and program confusion created by overlapping mission needs, and allowed the development of an investment perspective within functional and technology domains.

Requirements priorities were established for the functional areas and for broad tiers of requirements within each functional area. These priorities are guides to Office of Naval Research (ONR) for developing the science and technology investment strategy. Priorities for future funding decisions will be made on the basis of the existing investment strategy, leveraged investments of other services and agencies, and the state-of-the-art in available science and technology capabilities.

Overarching concerns of the Round Table discussions were the issues of 'enabling' technologies, affordability and human performance issues -- all aimed at extracting maximum advantage from new weapons and platform technologies and reducing the confusion created by the ever increasing data assimilation pressures placed on operators. Among the twelve functional areas, those ranked highest are Command, Control, Communications and Computers; Intelligence, Surveillance and Reconnaissance; and Logistics, which are the enabling technologies that provide the situational awareness and distributed support needed for future operations as envisioned in Vision 2020 and Sea Dragon.

During 1994-5 the requirements were more strongly oriented towards weapons and sensors. As seen above, the overarching concerns of the 1996 Round Table addressed more of the common support and enabling technology concerns of the fleet. Areas which show increased emphasis from the 1995 ***STRG*** include affordability, human performance (especially man-machine interface and information overload), environmental show stoppers (green platforms and munitions as well as other issues leading to operating restrictions), and non-lethal weapons and Special Operations Forces (SOF) needs. The cross cutting emphasis on Command, Control, Communications and Computers and on Intelligence, Surveillance and Reconnaissance is not new in 1996, but was so widely spread throughout the Joint Mission Area needs in 1995 that it's impact was not clear. These changes reflect both the evolving missions of the Navy and Marine Corps in the post-cold war world and the fact that requirements this year were the sole purview of the operators.

Within the Functional Areas, sub-topics were created to facilitate review of the requirements. Priority tiers were assigned by the Round Table working groups and also by correlation with critical issues and show stoppers submitted by the Round Table participants. The functional areas and their main goals are listed below.

Command, Control, Communications and Computers:
Connectivity for all forces and all data types; battlefield web system; sensor and systems integration with attention to workload of the man in the loop; combat identification (ID) and battle damage assessment to support tactical picture; data fusion and processing for common tactical picture and situational awareness; man-machine interface enhancement; interoperability enhancements; information warfare.

Intelligence, Surveillance and Reconnaissance:
Situational awareness and hostile intent indications; management of data stream/data bases and decision aids; target ID and battle damage assessment; theater wide target, track and fire control; improved sensors at all wave lengths for all environments.

Air Warfare:
Improved weapons, especially detection and targeting capabilities and lethality; reduce platform vulnerability through stealth, agility and systems improvements; ensure affordability through reduced life cycle costs, reduced manpower and improved training; and develop environmentally friendly systems to ensure access to unrestricted training.

Surface Warfare:
Precision fires for support of land forces and precision strike at extended ranges; sensors and non-lethal systems for maritime interdiction roles; reduce vulnerability and increase self defense capabilities; reduce ship's signatures at all wave lengths; theater ballistic missile defense (TBMD); enhance platforms with lower life cycle costs; innovative weapons; and ability to dominate the battlespace.

Mine Warfare:
Mines and mine field surveillance and intelligence; rapidly deployable and covert survey systems; sensors for all environments; organic systems; in-stride neutralization and unmanned systems; mine field control; and knowledge of seafloor and mine-like objects.

Undersea Warfare:
Increase stealth and survivability against air independent diesel electric submarines in the littorals through reduced signatures and more flexible operating envelopes (quick reaction attack and evasion); on-board and off-board sensors and weapons for the littorals; enhanced undersea communications (e.g., Joint Task Groups (JTG) connectivity); unmanned underwater vehicles (UUV) for mine field and covert reconnaissance; enhanced strike capability; affordability through reduced manning and enhanced training.

Amphibious Warfare:
Naval surface fire support (NSFS) to support forces ashore; improved SOF capabilities; adaptive logistics; Command, Control, Communications, and Computer C^4 architectures; enhance individual Marines ashore.

Logistics Support:
Affordability through life cycle cost reduction; increase over the shore and combat logistics/underway replenishment (CLF/UNREP) capabilities; condition based maintenance; reduce vulnerabilities during operations.

Manpower and Personnel:
Improve human performance through information management, robotics, understanding of human capabilities; management methodologies to enhance personnel utilization.

Training:
Innovative approaches to instructional methods and in situ capabilities; enhance delivery and feedback in instruction; systems and methodologies to manage training resources efficiently.

Medical / Personnel Protection:
Operational medicine -- assessment of effects, detection of agents, immunization and prevention and treatment; combat casualty care -- casualty management, treatment and delivery of treatment.

Environmental Support:
Navy wide database to support environmental issues; environmental warfare countermeasures; sensors and monitoring systems; management of hazardous materials to improve operational effectiveness; environmentally compliant platforms to preserve forward presence and operational capabilities; meterological and oceanographic (METOC) forecasting and organic systems.

BACKGROUND

S&T Round Table Process.

The Department of the Navy (DoN) established the Science & Technology (S&T) Round Table process to improve the identification, prioritization and communication of mid-term to long-term S&T requirements. This process consists of a series of annual meetings and subsequent briefings of results to flag-level sponsors. The FY-96 Round Table brought together knowledgeable, senior military officers from the various fleets, warfighting, and support communities. Participants provided practitioner-level information as well as higher level policy perspectives. In addition to developing a prescribed set of products, Round Table participants exchanged views; identified operational goals and functions; developed community-level understanding of definitions, needs, functions, and S&T gaps; facilitated communication; built consensus; facilitated jointness; and focused on the community's long-term S&T needs.

The S&T Round Table process was inaugurated in FY-94 and its Science and Technology Requirements Guidance (***STRG***) has served as the baseline for the subsequent efforts. For the FY-95 ***STRG***, each requirement was identified with one of the FY-95 Joint Mission Area/Support Area (JMA/SA) categories through individual JMA/SA Round Tables plus an additional Round Table to address medical requirements. Each Round Table produced goals and objectives leading to the realization of its strategic vision and the functions necessary to achieve its goals and objectives. Frequently, however, these functions were the same as those for other JMA/SAs. The resulting 1995 ***STRG***, in the JMA/SA format, created a variety of problems for recognizing and assessing the investment balance.

To address these problems, the 1996 requirements process was restructured to follow functional areas (e.g., Air Warfare, Surface Warfare) in order to examine mission and technology issues in a cross-cutting context and to minimize the confusion of previous Round Tables regarding the levels of investment across JMA's (which included common functional areas). A single Round Table I was held in order to maximize the cross-cutting view of the S&T investment and to improve communications among the user communities.

The FY-96 ***STRG*** documents this new approach to the Round Table and provides the S&T requirements in the more technologically unique Functional Area classification.

INTRODUCTION

Priorities

Priorities provide a set of guidelines which allow the design of a sound S&T investment plan. Priorities can be set on the basis of perceived need, perceived funding adequacy, perceived time line for accomplishment, perceived probability of success, or on any number of other metrics. To develop a meaningful S&T investment plan a priority scheme must capture as many of these issues as possible.

The Round Table process separates the two main parts of this problem. Round Table I identifies priorities in terms of mission needs and capabilities desired and imagined (the more futuristic requirements). Priorities often derive from perceived urgency for mission accomplishment and 'far term' and 'near term' are common modifiers. No emphasis is placed on how achievable a particular goal may be either in terms of fiscal exigencies or the realities of the laws of physics. This is by design. The goal is to set the science and technology community requirements which span a range from five years to two or more decades.

ONR's investment plan (which precedes Round Table II), will provide the basis for the second part of the priority issue. Namely, what is feasible within anticipated time lines, what priorities should be placed on funding decisions given the investments of other services and agencies and which problems remain more in the realm of science fiction than science. Investment decisions for the funding categories 6.3/6.2/6.1 effectively define the 'near' through 'far' term nature of the issues. ONR's knowledge of investments defined by Tri-Service Reliance (for DoD) and planned by other agencies (e.g., National Science Foundation (NSF), Department of Energy (DOE), industrial research and development (IRAD) and international programs) define priorities for investment in terms of maximizing leverage and minimizing duplication of effort. ONR's technical expertise is the basis for the determination of what approaches are possible, affordable and provide probability of success.

Round Table II will be the final review and endorsement of the Navy Science and Technology investment. This Round Table is based on the ***STRG*** requirements set and the ONR program plan. Endorsement and final guidance for Navy Science and Technology will complete this cycle of the dialogue between the operators, platform sponsors and the science and technology community.

All requirements presented in the 1996 ***STRG*** are important to one or more of the participating commands and are worthy of investment to ensure success in future Navy and Marine Corps missions. Priorities for planning the investment strategy are presented in the ***STRG*** in two categories:

1) Relative priorities of Functional Areas reflecting the common application and cross-cutting criticality of technologies.

2) Broadly tiered priorities of individual requirements within each Functional Area.

Functional Area Priorities

The set of priorities for the Functional Areas were developed based both on the functional area rankings provided by the Round Table participants as part of the workup for Round Table I, and on the categories of critical issues or show stoppers submitted by each participating command.

Command and Control, Communications and Computers (C4), Intelligence, Surveillance and Reconnaissance (ISR), and Logistics ranked as the most critical functional areas. These are key enablers needed to meet the vision of Navy and Marine Corps operations in the future.

Round Table discussions made it clear that the issue of affordability is an underlying theme to all of future capability needs. Affordability in this context was defined to mean life cycle costs as opposed to simple acquisition costs, and included maintenance, manning, training and best use of resources and personnel. Note that, again, the critical enabling technologies are needed drivers for operational capabilities in light of problems such as the information overload placed on operators in aircraft, surface ships and submarines as our ability to collect and transmit data increases. The capabilities of the sensors and the weapons are still of great importance, and yet the sophistication of the technology demands more of the man in the loop in all scenarios. Overriding guidance for the Navy science and Technology investment is that these critical enablers must be addressed and must be addressed in consort with the weapons and platforms which will provide the technological edge to our naval forces in future operations.

Ranking of the functional areas was done in two sets: a) Warfare Functional Areas (Figure 1) and b) Support Functional Areas (Figure 2). We did not ask participants to rank the two groups, or their components, relative to one another, on the assumption that an appropriate S&T investment must address both warfighting and its enablers, as well as support and efficiency areas.

The high aggregate scores for the , Command, Control, Communications and Computers, Intelligence, Surveillance and Reconnaissance and Logistics areas are the result of mid to high level rankings by <u>all</u> respondents. When the scores are examined for the mean ranking instead of for aggregate scores, the middle tier areas move to the top of the rankings -- in other words, fewer voters voted for these areas, but each voter gave these areas higher average ranks. Relative priorities as presented here reflect then, the broadness of the constituency or the cross Navy emphasis for a particular requirement.

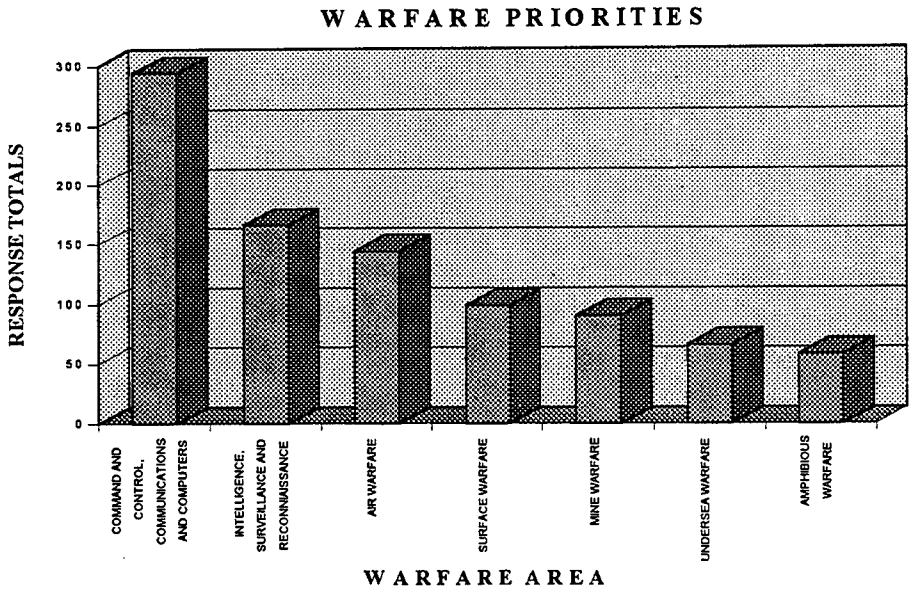

Figure 1. Aggregate scores for Warfare Functional Area Priorities

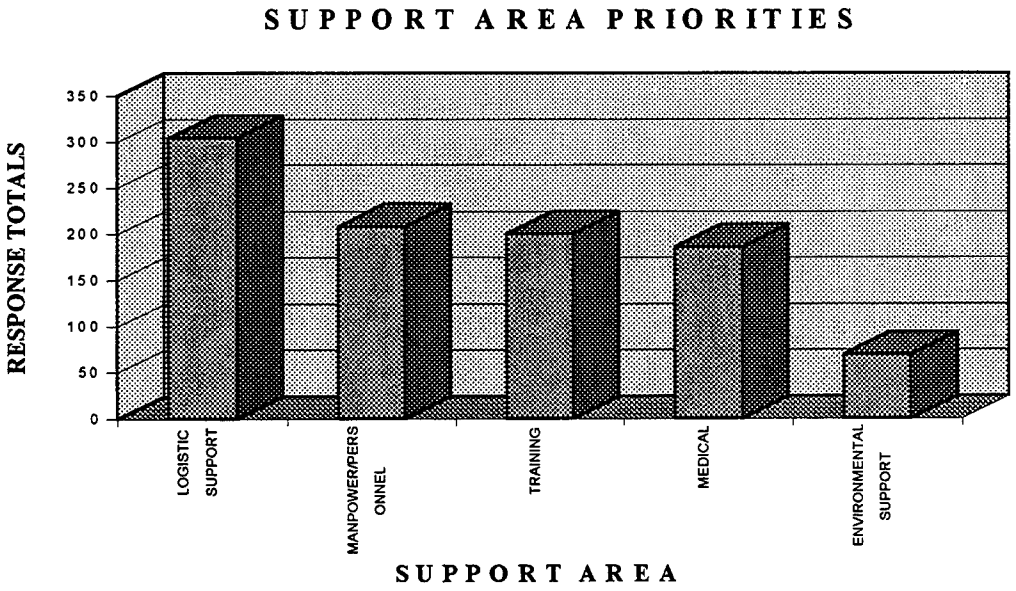

Figure 2. Aggregate scores for Support Functional Area Priorities

This same pattern of functional priorities appears in the critical issues or show stoppers submitted prior to the Round Table (Fig. 3). The largest number of issues submitted were in the areas of Intelligence, Surveillance and Reconnaissance , Command, Control, Communications and Computers and Logistics. However, it must be recognized that all areas have show stoppers. For instance the absence of an environmentally clean ship will, in the near future, limit the ability to provide Forward Presence in peace time.

It is clear that priorities for areas that have variously broad and narrow ranges of impact are difficult to measure in a manner that would permit reasonable controls based simply and solely on the priorities. A simple scoring will put at risk many areas that are the highest priorities for one or two sponsors or commands while giving precedence to areas with common, if less highly rated concerns. It is therefore incumbent on the participants to review the requirements as well as the investment strategy to be presented by ONR in terms of a balanced program which address the range of topics required rather than funding only high aggregate scoring areas.

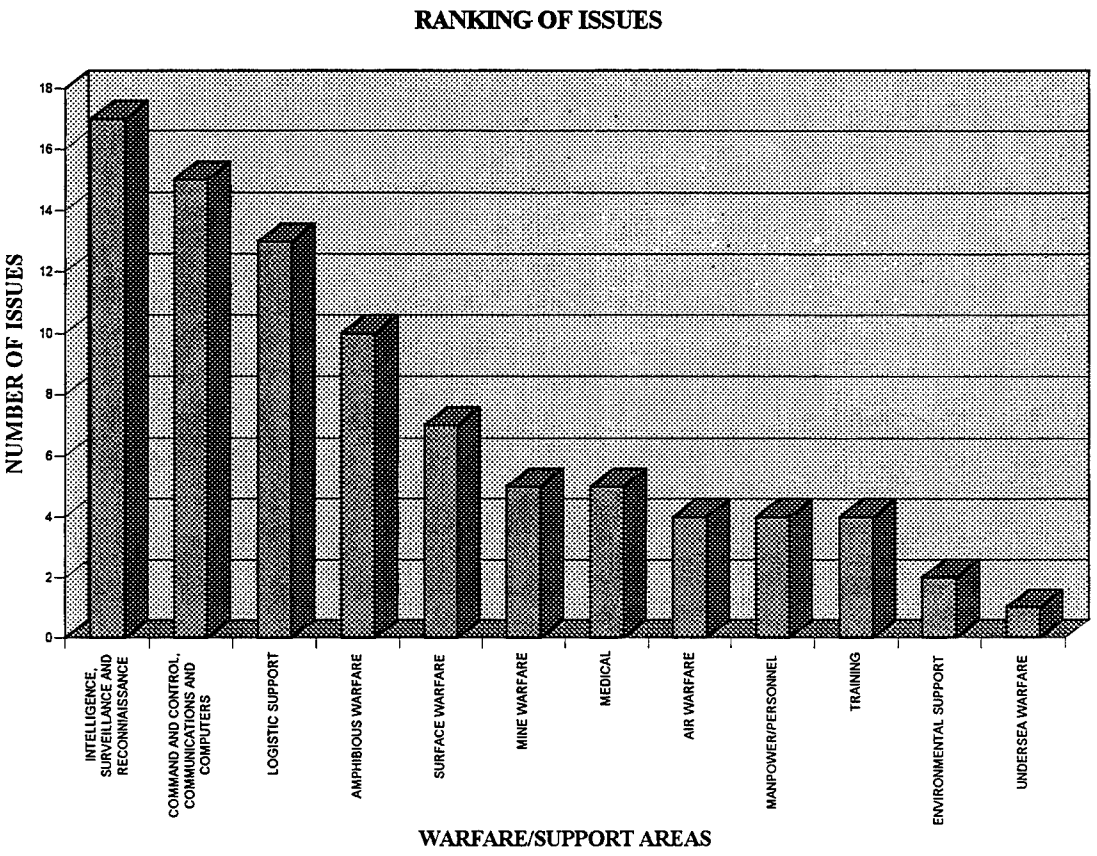

Figure 3. Distribution of Critical Issues / Show Stoppers by Functional Area.

The contradictory issues of high tech solutions and contracting budgets were apparent throughout the Round Table discussions. For the fleet it is clear that if research is to provide cost savings it has to address affordability, maintenance and manpower issues. More broadly stated this means that maintenance, life cycle costs, fuel efficiency, training, manning and human performance are the areas in which the fleet seeks potential measures to provide funds to reinvest in weapons and platforms. Affordability also calls on ONR and the operational community to define where and when enough is enough.

Command, Control, Communications and Computers and Intelligence, Surveillance and Reconnaissance are dominating themes throughout all functional areas, and indeed through all current visions of future mission capabilities -- whether viewed through the Navy 2020, Sea Dragon, Force 2100, or Joint Requirements Oversight Committe (JROC) visions. These capabilities are critical enablers for precision strike, maneuver from the sea, distributed forces and maximum multiplier effect for advanced technologies in general. Non-warfare issues are also arising through the impact of outside forces such as the Law of the Sea, environmental regulations and decreasing force structures.

Because of all of these developments the process of the Round Table and the dialogue between the operational and the science and technology communities which it creates are increasingly critical to the maintenance of technological superiority through the appropriate focusing of resources and the development of the fullest understanding of both operational needs and the opportunities arising from scientific progress. This ***STRG*** volume is part of this ongoing dialogue.

Requirements Priorities within Functional Areas

Within each Functional Area priorities were derived through two mechanisms. First, Round Table working groups produced consensus rankings of high, medium and low for most of the requirements. These were supplemented post-Round Table during the review of the draft requirements statements by all participants. Then, the Critical Issues/Show Stoppers submitted by participants were matched to the requirements lists to define highest priority requirements. Because the critical issues/show stoppers tended to be broader than the individual requirements, they generally map to several requirements. And in some cases this results in mapping to requirements which were rated medium to low during the Round Table. All of these rankings are preserved in the body of the ***STRG***.

In each of the following chapters in the ***STRG*** these priorities are presented in the tables of requirements opposite each requirement in the column headed **Tier** as: **H** (high), **M** (medium) or **L** (low). In parallel columns are shown the references to the Critical Issues/Show Stoppers submitted by Round Table participants and the Command Tecthnology Issue (CTI's) from the Commanders In Chief (CINC). The Critical Issues and CTI's are presented in Appendices 2 and 3 at the end of the document. The CTI's for 1995 and 1996 were submitted under the JMA/SA structure and this structure is maintained here.

Chapter 1

COMMAND, CONTROL, COMMUNICATIONS, AND COMPUTERS

Introduction - C^4 is the conduit through which U.S. and allied forces act in order to achieve their operational objectives. C^4 elements include 1) Measures to coordinate, correlate, fuse and employ aggregate capabilities in communications, surveillance, reconnaissance, data correlation, classification, targeting and electromagnetic attack. 2) Measures to direct and control employment of friendly forces. 3) Systems and methods required for the transmission, processing and storage of friendly-force, enemy and environmental data. In short, C^4 is directed toward the reduction of both time and uncertainty as a means of facilitating intelligent decision making.

Requirements Categories - Underlying C^4 are eight sub-categories which are grouped as follows:

1. Connectivity
2. Sensing
3. ID and BDA
4. Data Processing
5. Man-Machine Interface
6. Interoperability
7. Navigation
8. Information Warfare

1. Connectivity

Connectivity is the ability to:

1. Provide timely I & W to all warfare commanders.
2. Provide a common tactical picture to all users.
3. Provide secure interoperable voice comms to all users.
4. Provide secure data communications to all users.
5. Provide accurate geopositioning to all users.

To enable DBA/DBK in any given operation, connectivity that is secure and resistant to hostile actions must exist at all levels not only in order for warfare commanders to make sound, timely and informed decisions, but also facilitate large volumes of information (e.g., imagery, mission data, video teleconference).

2. Sensor System Integration

Sensor systems integration seeks to assimilate data received/collected from all sources and provide the user with the capability to make timely and informed decisions. Sensor systems integration is a critical factor in I & W cueing as well as the ability to communicate with weapons once it has been employed by providing update information in realtime.

3. ID and BDA

ID and BDA are critical elements of inflicting the maximum amount of damage on the target while minimizing collateral damage. ID, by definition, is the ability to identify a target as a friend or foe. Timely BDA is a critical element in ensuring that 1) high value targets are destroyed while obviating the expenditure of additional ordnance (1 shot, 1 kill), and 2) high value targets can be reattacked quickly if necessary. Current and future requirements not only dictate that U.S. forces be able to support weapons' guidance outside the threat envelopes, but also possess the capability to conduct ID, BDI/BDA at those standoff ranges.

4. Data Processing

Data processing, by definition, is the processing of data received from both organic and non-organic sources, and is a function by which tactical decisions can be reduced. Data processing is a critical element of DBA/DBK in that data, once received, must be disseminated, sorted, fused and presented in a timely fashion, and allow the warfighter to easily visualize the information. Current and future data processing requirements include: 1) the ability to provide a clear and comprehensive common tactical picture for all forces that eliminates blue-on-blue and aids accurate navigation; 2) the ability to perform all source data fusion with a high degree of confidence; and 3) compatible with other tactical systems.

This category also includes data management improvements which must be made to provide U.S. warfighters with ready access to information to support mission objectives. Information (tactical, intel, METOC, etc...) must be compatible with Joint Service operations, non-exploitable, and provisions must be made to sanitize information in a timely fashion and made readily available to the warfighter.

5. Man-Machine Interface

Man-machine interface refers not only to the ability of a particular system to provide functional aid to a user, but also the ability of the system to help reduce the fog of war by presenting information that is clearly and easily understood. Current and future requirements for man-machine interface must be met by systems that are easily reconfigured to the warfighters' needs, be able to "learn" from the user, and present the information in such a way as to allow the warfighter to visualize the information quickly during operations.

6. Interoperability

As U.S. forces become more involved in Joint/coalition operations, an imminent need exists for systems to be interoperable. C^4I information must only be compatible but also interpretable. This interoperability must also incorporate the capability to sanitize information in an automated manner to facilitate sound, timely and informed decisions by coalition players.

7. Navigation

The advent of the Global Positioning System (GPS) has greatly increased U.S. forces' capability to navigate accurately. However, the capability to navigate accurately remains even if GPS is rendered inoperable. Consequently, the need for a precise navigation system is critical in order to provide a backup to GPS.

8. Information Warfare

Electronic superiority of the battlespace is a critical aspect of battlespace dominance. Information warfare seeks to gain electronic superiority over the enemy by means such as: jamming, disrupting, denying and/or manipulating the enemy's command and control structure while protecting U.S. and allied forces' capabilities to do the same. Current and future needs for information warfare must be fulfilled in order to achieve superiority of the battlespace by creating confusion, overloading and deception of the enemy's C^2 and information infrastructure.

TABLE I. C4 TECHNOLOGY AREAS

1. CONNECTIVITY	Tier	Issue	CTI
a. Develop fiber-optic networks, backplanes and support equipment using commercial technologies and standards, including FDDI, for implementation on new construction ships.	**M**	CLF-5	
b. Develop improved data links to enhance weapon effectiveness--i.e., with the following attributes: 1. Over-the-horizon (OTH) capability. 2. Interoperability. 3. Low probability of intercept (LPI). 4. Anti-jam. 5. High Bandwidth. 6. Automatic routing. 7. Secure. 8. Enabling third-party weapons control (incl. man-in-the-loop). 9. Improved human factors.	**H**	C4IW-35 MFP-36 N86-39 MCC-63	1-B
c. Develop an inexpensive and unjammable wide-band communications link to a UAV.	**M**	CLF-2	1-A 1-B 4-J 3-A 3-B
d. Provide the capability for real-time covert communications between ships and submarines.	**H**	C4IW-35 CLF-1,2,5 CCENT-15 N86-42,39	4-A 4-E
e. Develop submarine towed/tethered body intercept antennas.	**H**	N87-60 CPF-69 CLF-1,2 ISR-27 N86-42	4-J

1. CONNECTIVITY	Tier	Issue	CTI
f. Provide for ship connectivity with undersea offboard sensors.	**H**	CLF-1,2,5 ISR-27 N86-42 N87-60 CPF-69	**4-J**
g. Provide assured and survivable communications that support a survivable nuclear force. 1. Build channels that transfer re-targeting plans directly from planning authorities to onboard weapons systems. 2. Provide continuous, survivable and interoperable communications across the frequency spectrum for delivery platforms. 3. Improve real-time transfer of new target packages to onboard weapons systems.	**H**		

1. CONNECTIVITY	Tier	Issue	CTI
h. Extend full range of communications services to all users.	**H**	CLF-5	1-A
		CCEN-15	4-A
		C4IW-35	4-B
		MFP-36	
		N81-39	
		MCC-63	

1. Data-transfer: Provide high data-transfer rate to mobile users to support timely re-targeting (air tasking order (ATO) and Tomahawk mission data update (MDU)), imagery, video teleconferencing, etc.
2. Mobility/portability: Provide full communications capability to mobile users.
3. Exploitation of commercial services: Integrate commercial communications services into military networks.
4. Shared-aperture antennas: Reduce the number of antennas aboard ships through development of multi-band, multi-functional antenna.
5. Universal radio: Reduce the number of radio types used in the three services through development of a multi-band, multi-functional, programmable radio.
6. Multimedia communications services: Provide seamless transfer of information in any format (voice, data, imagery, video).
7. Provide real-time communication paths and techniques that work in all environments and have sufficient bandwidth for passing imagery.
8. Create overhead high gain antenna and micro-receivers on individuals
9. Protected: Ensure resistance to communications countermeasures (Anti-jam, anti-spoof, etc.).
10. Reconstitutable: Ensure recovery of communications capabilities following damage or loss (intended or otherwise).
11. Seamless: Make communications process transparent to the user.
12. Interoperable: Enable communications with other services and allied forces.
13. Mission Reconfigurable: Provide capability to tailor system characteristics (e.g., wave form) for specific missions.
14. Open: Base system architectures on evolving commercial standards that allow affordable system growth in an open environment.
15. Secure: Provide multilevel information security over all networks.
16. Universal: Develop communication protocols to allow access to services by special users and other users under special circumstances, including language translators.

1. CONNECTIVITY	Tier	Issue	CTI
i. Architecture for distribution: Ensure timely availability of the information the consumer requires. 1. Ensure information is tailored to specific consumer requirements, and improve distribution efficiency through technology (e.g. export agents, compression) and elimination of unwanted duplication. 2. Develop techniques to maintain accuracy of data bases during data fill through automated discrepancy flagging, automated validation, and automated identification of potential discrepancies. 3. Provide a universal standardized format for imagery dissemination.	**H**	CLF-5 CCEN-15 C4IW-35 N86-39	
j. Develop a battlespace web, which is a system to provide individuals on the battlefield access to a globally distributed and integrated C^4I and surveillance network.	**L**	CLF-5 CCEN-15 C4IW-35 N86-39 MCC-63	

1. CONNECTIVITY	Tier	Issue	CTI
k. Provide timely battle management capability for joint/combined operations. 1. Provide planning information that is: a) Automated b) Measure-of-effectiveness-driven c) De-conflicted for multiple sources d) Situationally constrained e) Predictable in outcome or confident of success f) Capable of assessing and exploiting threat levels g) Capable of using real-time weather information 2. Develop systems that provide initial capability for: a) Interactive dissemination with low data rate/video/imagery capability b) Validation c) Automated data 3. Provide initial rehearsal capability that has: a) Low data rate/video/imagery exchange b) Automation c) Contingency operation d) Validation e) Individual/force levels available f) Simulation 4. Real time dissemination of time-critical orders. 5. Horizontally and vertically concurrent in real time. 6. Prioritization of actions or decisions required. 7. Be able to redirect or deploy METOC and MC&G resources including numerical computing and environmental satellite reception capabilities in support of crisis operations.	**H**	CLF-5 CCEN-15 C4IW-35 N86-39 N096T-56 MCC-63	
l. Develop robust communications using organic assets.	**L**		
m. Provide world-wide satellite independent secure communications (UHF).	**L**		
n. Produce capability for secure medium rate communications through water.	**M**	CLF-2	
o. Allow all platforms to accept T-3 communication rate through an 8 inch receiver.	**L**		
p. Develop C^4I for use on land.	**M**	C4IW-35 MFP-36,37 MCC-63	
q. Generate techniques for rapid incorporation of technology.	**L**		
r. Create an antenna-less world with equal throughput for everyone.	**L**		

1. CONNECTIVITY	Tier	Issue	CTI
s. Generate capability to remain connected without being detected (covert connectivity).	**L**		

2. SENSOR SYSTEMS INTEGRATION	Tier	Issue	CTI
a. Develop improved targeting and communications systems, specifically tailored to support Precision Guided Munitions (PGM) and cruise missiles currently in the inventory (and also those weapons planned for the mid-term future; see below), per the following specifications: 1. Targeting and terminal guidance based on localization by GPS 2. Targeting and terminal guidance to include input of such data as target image, target aspect angle, target's relative position to other objects (e.g., third building in a row of five), and target depth (e.g., detonate after penetration).	**M**	CCEN-13 CPF-67	
b. Integrate all sensor/weapons input, giving ability to detect/engage threats in all quadrants. 1. Ensure correlation of off-board sensors for I&W cueing to allow man-in-loop and autonomous operation at full capability against all classes of targets in all environments. 2. Ensure real-time assimilation of data and communications with employed weapons. 3. Improve missile seeker and target detection device (TDD) sensitivity versus all classes of targets in all environments.	**M**	CLF-9 CCEN-13 CPF-67	
c. Improve collection management process to increase accessibility and responsiveness. 1. Provide better connectivity and feedback from collection management system through brokering agency/organization. 2. Explore long-term storage and indexing as means to mitigate collector tasking by providing extant information. 3. Provide current status of active taskers to all customers.	**H**	CCEN-13	
d. Develop battle damage assessment for C^2W deception, disruption, denial and destruction.	**M**	N6-30	
e. Targeting in real time.	**M**	C4IW-35	

3. ID & BDA	Tier	Issue	CTI
a. Provide accurate ID of all elements in area of regard beyond employment range of threat and commensurate with ability to redirect current/near-term weapons.	**M**	CLF-4,10 C4IW-33 CLF-4,10	
b. Implement electronic chip identifiers installed in combat vehicles and craft.	**M**	C4IW-33	

3. ID & BDA	Tier	Issue	CTI
c. Develop "tagging mechanisms" for friendly forces in war zones.	**M**	C4IW-33	
d. Develop "Dual Passive" combat ID.	**M**	C4IW-33	
e. Develop sensor suite to support remote control of weapons via data link and provide BDI/BDA capability to support weapon control at standoff range from enemy defenses.	**M**	C4IW-33	
f. Provide capability for timely and correct ID and precise location of friendly and hostile:	**H**	F-4,5,10 C4IW-33	1-A 1-B 4-A 4-B
1. Aircraft.			
2. Missiles (cruise, ballistic, etc.)			
3. Ships.			
4. Boats.			
5. Submarines			
6. Mines			
7. Troops on shore			
8. Land vehicles and fixed sites			

4. DATA PROCESSING	Tier	Issue	CTI
a. Develop a capability to support data fusion from all-sources and disseminate a fused, real-time, unambiguous picture to all forces.	**H**	CLF-5 CCEN-15 C4IW-35 N86-39	
b. Develop a "fusion engine" that supports automatic correlation and fusion of dissimilar sensor, data source or report information (e.g., fusion engine should universally parse and extract data from any type of joint or allied tactical data report).	**H**	CLF-5 CCEN-15 C4IW-35 N86-39	
c. Provide deploying units with an appropriate and robust imagery data base, with capability to update the data base via routine automated incorporation of the deltas.	**M**	N096T-56	
d. Provide real time, concurrent update, control, processing, fusion and dissemination of Battle/Crisis management information.	**H**	CLF-5 CCEN-15 C4IW-35 N86-39	1-A 4-A
1. Provide BDI/BDA of quality sufficient to allow operators and strike managers to optimally allocate strike assets.			
2. Prioritize information based on accuracy and urgency with operator assistance; prioritize information accuracy and urgency automatically.			
3. Concurrent update, access control, and dissemination.			
4. Provide accurate, real time assessment of the effects of actions in a battle/crisis management situation.			

4. DATA PROCESSING	Tier	Issue	CTI
e. Establish the capability to develop and maintain a real-time common tactical picture of all forces, derived from a fusion of multi-sensor and multi-platform data, with the completeness and accuracy to ensure zero BLUE-on-BLUE attacks and ensure that this contributes to navigational safety. 1. Automatic data fusion and force-wide dissemination of the common tactical picture. 2. Ensure compatibility with other tactical data systems through common tactical data bases, common graphical displays, common symbols and common formats. 3. Continue priority emphasis on *in situ* optimum track routing for all force capabilities to provide viable weather avoidance recommendations and improved precise navigation. 4. Must be horizontally and vertically concurrent in real time. 5. Must provide a consistent, relevant and scaleable overview to the user. 6. Must have a level of confidence attached to the data which conveys the degree of timeless, latency and accuracy.	**H**	CLF-5 CCEN-15 C4IW-35 N86-39	
f. Determine threat intent using all-source information.	**L**		
g. Develop full active/passive Personnel Status Monitor (PSM) with appropriate secure filters.	**M**	MP/N12-21 MP/N12-24	

4. DATA PROCESSING	Tier	Issue	CTI
h. Develop expert systems that integrate various intelligence data bases with different standard formats and protocols. Provide ready access to required information databases and sources to support any mission objective: 1. Improve methods to fuse, process, assess and disseminate data. 2. Develop improved decision aids. 3. Develop improved planning methods. 4. Develop database methods not exploitable by unauthorized users. 5. Develop means to maintain data bases. 6. Develop methods to sanitize information automatically. 7. Develop means to include coalition forces. 8. Establish a data highway for access to all sources of information. a) National (Mapping, Charting, and Geodesy (MC&G); meteorological and oceanographic (METOC); non-traditional, non-combatant sources; joint intelligence; national sensors). b) Tactical (organic sensors - unit/force/theater). c) Readiness (plans, status, and capability). d) Allied/coalition. 9. Establish recognized repositories/databases. a) National (MC&G; METOC; non-traditional, non-combatant sources; joint intelligence; and national sensors). b) Tactical (organic sensors - unit/force/theater). c) Readiness (plans, status, and capability). d) Allied/coalition 10. Develop submarine I&W systems that provide tactical information to the common tactical database.	**H**	CLF-5 CCEN-15 N86-39 CLF-2	1-A 4-A 10-C
i. Develop a sanitization system which allows dissemination of Special Compartmented Information (SCI) intelligence via non-compartmented paths.	**L**		

5. MAN-MACHINE INTERFACE	Tier	Issue	CTI
a. Produce a display functionality that is automatically configurable to the user's (warfighter's) needs with minimum man-machine interface. 1. System must be capable of providing automatic correlation / data fusion of organic and non-organic information. 2. System must manage, store, retrieve, and disseminate relevant contact data for timely, optimized and prioritized data display. 3. Man-machine interface must minimize human interaction in order to produce an optimized display for the tactical situation.	**M**	CLF-5 CCEN-15 MP/N12-25 N86-39	
b. Develop tools to allow the analyst to access/manipulate/analyze data more efficiently. 1. Develop capability to retrieve data for fast browsing of data. 2. Provide automated capability to recognize target / signal of interest. 3. Provide automated capability to detect/flag changes in area of interest.	**H**	CLF-5 CCEN-15 MP/N12-25 N86-39	
c. Design aircraft avionics with a virtual reality interface and the capability to "learn" from the operator.	**L**		
d. Provide execution aids which are survivable, reduce the fog of war, and are fully integrated with their intended environment. 1. Adaptive output including multimedia to attract immediate attention of users when necessary but not distracting to the user.	**H**	CCEN-15 MP/N12-25 N86-39	
e. Design "expert agents" as tactical aids that support the employment of weapons and provide an as-soon-as-possible reaction time while enabling correct, flexible decision making and control of weapons.	**M**		

5. MAN-MACHINE INTERFACE	Tier	Issue	CTI
f. Develop mission planning systems which are simple and easy to use, traceable to commander's requirements, doctrinally correct, and provide for collaborative planning at all levels. 1. All levels share a common planning core in a common operating environment. 2. Sufficient independence of operation environment to permit easy migration to other environments as technology advances. 3. Automatic update (< 2 hrs) of plans to/from next level up/down. Real time, concurrent update to/from next level. 4. Define littoral battlespace in terms of meteorological / oceanographic / MC&G parameters. 5. Develop collaborative planning systems that allow joint/combined forces to operate as effectively as a single unit. a. Develop system that simplify the replacement of a similar systems from other countries or services. b. Develop functional modeling techniques to support virtual reality and incorporate them into planning, training, and assessment processes.	**H**	CCEN-15 MP/N12-25 N86-39	
g. Develop enhanced Combat Operations Centers with standardized procedures and advanced technology displays of tailored information.	**M**	CCEN-15 MP/N12-25 N86-39	
h. Produce better ways to visualize information in order to enhance pattern recognition.	**L**		
i. Work on voice recognition systems.	**L**		
j. Develop 3-D displays.	**L**		
k. Model the cognitive process to deliver information in such a way to complement the way the brain works and prevent information overload.	**L**		
l. Miniaturize C4 equipment to maximize portability and match physical limitations of users.	**M**	MFP-36	

6. INTEROPERABILITY	Tier	Issue	CTI
a. Translate text among several foreign languages; translate text and speech among most foreign languages and alphabets.	**M**	N6-32 N81-54	
b. Implement the joint command structure and the naval component command structure in a flexible and robust C4I hardware/software system that is capable of being replicated in sea, air, land, and space environments.	**M**	MFP-36 N81-54	

6. INTEROPERABILITY	Tier	Issue	CTI
c. Develop capability to integrate, interoperate, and transfer C⁴I information and equipment to allied and coalition forces during peacetime presence, crisis, response and wartime operations.	**M**	N81-54	
d. Develop improved aircraft communications systems that incorporate an automatic language translator.	**M**	N81-54	
e. Submarine seamless integration into tactical and national networks.	**M**	CLF-2	
f. Develop automated sanitization processing of intelligence to expand accessibility to customers.	**L**		
g. Provide controlled access to required information geared to user security level and needs. 1. System must provide for multi-level security. 2. Security levels must address access by: a) Joint multi-level. b) Allied/coalition.	**H**	N81-54	

7. NAVIGATION	Tier	Issue	CTI
a. Create a back-up system for GPS in the event that GPS is disabled due to future combat. Develop GPS independent navigation alternatives. Provide accurate geopositioning to all theater and allied users (platforms and weapons). 1. Provide position accurate to within 3 meters. 2. Provide a secure, jam resistant system for geopositioning. 3. Provide a system for the Commander that is portable/modular enough to allow common reporting from the unit level through platform level to the individual unit / man on the ground. 4. Improve accuracy to the point where targeting of individual weapons can be accomplished to an accuracy of 3 meters.	**H**	N6-31	

8. INFORMATION WARFARE	Tier	Issue	CTI
a. Conduct effective command and control warfare (C^2W). 1. Develop methods for improved protection of C^2 assets and techniques. 2. Develop improved methods to counter enemy C^2 assets and methods. 3. Develop C^2W measures of effectiveness	**H**	N6-30	4-F
b. Develop Tactics Technologies and Procedures (TT&P) to disrupt enemy's decision process (e.g. information overload, disinformation).	**L**		

8. INFORMATION WARFARE	Tier	Issue	CTI
c. Maintain the ability to produce and deploy "trusted" software.	**H**		
d. Develop portable and deployable systems that will deceive the enemy.	**H**		4-F

Chapter 2

INTELLIGENCE, SURVEILLANCE AND RECONNAISSANCE

Introduction - Intelligence is the collection, processing, integration, analysis, evaluation and interpretation of available information regarding the threat. Surveillance is the collection and categorization of target information. It provides systematic observations of the battlespace, with timely and accurate reporting of the information to the warfare commander. Reconnaissance considers the integration of intelligence with surveillance. It leads to systems that use intelligence to cue sensors for detection. Once detected, the tactical reconnaissance mission collects all available information for the identification task and then provides automated notification to operators of any changes.

Requirements Categories - Underlying Intelligence, Surveillance and Reconnaissance are four sub-categories which are grouped as follows:

1. Situational Awareness
2. ID, BDA and Target Recognition
3. Target Track and Fire Control
4. Sensors and Processing

1. Situational Awareness
Issues in this category are an integral part of battlespace dominance. Situation Awareness not only provides U.S. and allied forces with potential hostile intentions but also enables the use of intelligence to cue sensors for detection. Real-time indication and warning (I&W) is critical to our warfighters in order to exploit and respond to threats in a timely manner, and if possible, create a perception for the enemy that its hostile action can only be a Pyrrhic victory.

2. ID, BDA and Target Recognition
This category addresses critical elements needed to inflict maximum damage on the target while minimizing collateral damage. ID and Target Recognition is not only the capability to classify and identify targets, but also the ability to discriminate between real targets and decoys. BDA is a critical element in ensuring that high value targets are destroyed while obviating the expenditure of additional ordnance (1 shot, 1 kill). The necessity to have real-time ID, BDA and Target Recognition is imperative if U.S. forces are to achieve battlespace dominance.

3. Target Track and Fire Control
Target, track and fire control addresses not only the ability of ISR to detect and track targets, but also the ability to pass fire control quality data to relevant participants. In addition, real-time sensor-to-shooter requirements and theater-wide tracking requirements are addressed.

4. Sensors and Processing

This category focuses on the need for sensors to possess the capability to operate under any condition and at any time, and be able to process the data in a timely manner. To achieve this capability, imagery must be high resolution and be available real-time/near real-time. Data fusion must be automated, with a high degree of confidence.

TABLE II. ISR TECHNOLOGY AREAS

1. SITUATIONAL AWARENESS	Tier	Issue	CTI
a. Develop interactive systems that forecast potential aggressive actions and recommend deployment of intelligence and surveillance actions: 1. Develop improved means for determining hostile intent. 2. Develop means to make effective use of future information highways. 3. Automate lower-level information processing. 4. Enhance ability to consider alternate forecasts. 5. Ensure that timeliness of information supports weapons employment beyond enemy weapons capability.	H		
b. Provide timely, tailored and common situational awareness: 1. Provide for timely transmission of information to the initial user. 2. Provide increased imagery throughput.	H		1-A 4-A 10-C
c. Implement real-time indication and warning (I&W) methods into combat operations. 1. Separate real targets from decoys. 2. Develop techniques to detect the movement, storage and presence of nuclear/chemical/biological compounds.	M	C4IW-35 ISR-29 MFP-38	
d. Develop improved surveillance systems that support detection, classification and covert tracking of merchant ships.	M		2-I 4-J
e. Develop systems to automatically provide vulnerability alert: 1. Develop a TDA for real-time optimization of sensor utilization. 2. Develop an enabling C^2 for timely tasking/retasking of theater and national assets by tactical commanders; automate the process.	M		

2. ID, BDA AND TARGET RECOGNITION	Tier	Issue	CTI
a. Provide real-time (or near real-time) battle damage assessments: 1. Provide report of bomb hit with failure assessment, if unsuccessful, within 1 to 30 seconds. (MOE: response in seconds) 2. Provide sensor data that detects and records physical damage to a target which is highly resistant to environmental conditions and battle effects - 95%. (MOE: confidence factor) 3. Provide BDI/imagery data link (300 Mbytes/sec) between platform and battle commander. (MOE: data Mbytes/sec) 4. Provide analysis of damage to functional capability with a high degree of certainty (P>.85) within the enemy's decision cycle (0.5 hours). (MOE: response time in hours)	H	C4IW-34	1-B
b. Develop the technology to perform a cooperative identification of own forces upon detection and with virtually 100 percent accuracy in all weather conditions to enable the following types of capabilities: 1. Using air-launched weapons at maximum weapons range. 2. Covert use of weapons from air platforms. 3. Discriminating between targets within 5 nm of each other (e.g., a group of friendly and hostile aircraft in proximity, as seen from a third party). 4. Performing a raid count of inbound targets (e.g., up to 8 in close proximity). 5. Determining the classification of air targets (aircraft, missiles, and helicopters) by type and mission (e.g. MiG 27 or MiG 29, SCUD or Exocet). 6. Cataloging signature characterizations in all spectrums by target classification. 7. Improving the capability to discriminate targets from decoys. 8. Performing target identification and classification simultaneously with target detection. 9. Permitting high-resolution imaging. 10. Developing credible, reliable IFF techniques that are covert, secure, and jam-resistant and are able to provide the identifications and positions of multiple OTH surface contacts in various environmental and countermeasures environments.	H	CLF-4,10 C4IW-33	1-B

2. ID, BDA AND TARGET RECOGNITION	Tier	Issue	CTI
c. Develop autonomous target recognition systems that can, in real-time, distinguish a specific shore target from background targets, false targets and other clutter:	**M**		2-F
1. Develop systems to provide Marine Corps tactical IFF and combat ID to a rifle squad engaged in combat.			

3. TARGET TRACK AND FIRE CONTROL	Tier	Issue	CTI
a. Provide ISR with a targeting and fire control capability for joint and combined operations. Develop sensors that can provide fire control quality data:	**H**		1-B 4-C 5-B
1. Provide data links with the following attributes:			
a) Unconstrained operations.			
b) OTH capability.			
c) Interoperability.			
d) Low Probability of Intercept (LPI).			
e) Anti-jam.			
f) Secure.			
g) Enabling 3rd-party weapons control (incl. man-in-loop).			
2. Provide a seamless platform/weapon interface.			
3. Develop advanced capability for automated platform-based target classification/identification.			
4. Provide capability for producing fire-control-quality targeting information outside the threat envelope that fully exploits the weapon's capability.			
5. Improve and automate sensor-to-shooter capability.			
6. Provide platform targeting capability that does not increase the platform signature. Include passive targeting sensors and multi-sensor/platform cooperative techniques.			
7. Provide real-time sensor-to-shooter targeting capability.			
8. Reduce false-alarm and fratricide rates to zero.			
b. Develop theater-wide target tracking techniques:	**H**		3-B
1. Implement tracking algorithms that provide "weapons-quality" data.			
a) Develop methods to tag targets with earned information.			
b) Develop methods to prioritize and maintain tracks.			
2. Provide over-the-horizon (OTH) detection, tracking and signature cataloging of suspect merchant ships.			
3. Provide wide-area detection, tracking and signature cataloging of all merchant ships, probably by satellite surveillance.			

3. TARGET TRACK AND FIRE CONTROL	Tier	Issue	CTI
c. Improve the real-time capability to determine the identification (ID) of shore targets, localize shore targets, and obtain knowledge of the weather ashore while operating in a variety of weather conditions at sea and/or while at over-the-horizon (OTH) ranges.	**H**	CLF-4 N096T-55	
d. Develop improved systems that provide a three to four fold increase in the detection ranges of high altitude cruise missiles, theater ballistic missiles (TBMs) and other air targets; and provide the operator with discrimination, contact identification, and kill assessment.	**H**	N86-41	2-C 2-D 5-A

4. SENSORS AND PROCESSING	Tier	Issue	CTI
a. Improve sensor efficiency and ability to see through the environment:	**H**	CLF-1 ISR-27 N86-42 CPF-69	3-B 1-A 3-A 4-A
1. Improve module efficiency.			
2. Reduce sensor size and weight			
3. Improve performance in clutter.			
4. Provide continuous detection and location of major units and prime targets of interest over the entire theater of operation (150,000 km^2 area). Major units include troop concentrations, artillery and logistic support. Prime threats include TBM armored vehicles, aviation and mobile defenses, power plants, oil refineries, weapons production facilities, etc.			
5. Provide continuous location and tracking of tactical combat units, supporting units and defenses in/around the battle area (100,000 km^2 area). (Tactical combat units are at platoon level; supporting units include direct support aviation.)			
b. Improve signal and data processing:	**M**	CLF-1	
1. Increase throughput by 300% to allow for shared aperture, multi-mission. (MOE: data bit/sec improvement)			
2. Improve multi-sensor data integration / fusion.		CLF-3	
3. Improve timely integration and dissemination of all source sensor data in an accessible database with minimum redundancy / ambiguity (MOE: confidence factor)		CLF-5	
c. Develop wide-area, anti-sensor weapons for deception, disruption, denial and destruction. For air, land, and subsurface	**H**		

4. SENSORS AND PROCESSING	Tier	Issue	CTI
d. Develop sensor integration/function compatible with Low Observable (LO)/Very Low Observable (VLO) characteristics: 1. Surveillance, reconnaissance and combat identification/positive identification (CID/PID) functionality in LPI modes - 90%. (MOE: integration into platforms)	**M**		
e. Develop the following improvements in imaging capability: 1. Provide a high-resolution capability for multi-band IR imaging. 2. Provide a passive imaging capability for direct fire weapons that is unaffected by weather conditions.	**M**		
f. Improve acoustic LF and MF processing capabilities for bi-static (separate source and receiver) and multi-static (multiple sources and receivers) active prosecutions.	**H**		
g. Improve/enhance sensor preprocessing.	**M**	CLF-1	
h. Develop sensor suite to support remote control of weapons via data link and provide BDI/BDA capability to: 1. Support weapon control at standoff range from enemy defenses. 2. Provide BDI/BDA of quality sufficient to allow operators and strike managers to optimally allocate strike assets.	**M**	C4IW-34	1-B
i. Develop untethered, unmanned offboard surveillance platforms.	**M**		3-B
j. Expand sensor area of coverage.	**L**		
k. Develop an improved precision ESM capability with: 1. At least 0.1-degree resolution in azimuth and elevation 2. Pulse feature analysis and recognition 3. Low probability of intercept (LPI) detection capability 4. Simultaneous processing of multiple signals in a high pulse environment.	**H**		3-D
l. Explore bio-technologies for applications to ISR.	**M**	MFP-38	
m. Develop capability to deploy small, lightweight sensor systems on indigenous craft of coalition forces.	**M**		2-F
n. Develop capability to provide unobtrusive ISR of naval vessels for nuclear weapons and materials.	**M**	ISR-29	
o. Improve capabilities for mapping the battlefield using covert systems (e.g., low probability of intercept/detection (LPI/LPD)), that have high endurance, and work in various environmental and countermeasures environments. (This is the same capability needed for naval surface fire support (NSFS)).	**M**	N86-40	

Chapter 3

AIR WARFARE

Introduction - Air warfare is the conduct of battle from the earths surface to the endo-atmosphere, with the principle objective of achieving battlespace dominance; that is, to fully neutralize enemy offensive and defensive weapons/systems and allow friendly forces to meet their operational objectives with minimal losses. Aircraft threats include next-generation, multi-role fighter and/or attack aircraft, unmanned aerial vehicles, and slow flyers at low altitudes. Surface-to-Air threats include not only high G endgame SAMs, manpads or directed energy weapons that can be used against both personnel and aircraft but also Integrated Air Defense Systems (IADS) that can precisely track/target friendly aircraft. Our ability to meet operational objectives is dependent upon our ability to decisively defeat these threats and project power under all conditions at any time.

Requirements Categories - Underlying Air Warfare are five sub-categories which are grouped as follows:

1. Precision Strike
2. Air Superiority
3. Platforms (airframes & propulsion)
4. Affordability
5. Environment

1. Precision Strike

Precision Strike addresses those requirements needed to enable the warfighter to inflict the maximum amount of damage on high-value targets while minimizing collateral damage in the target area. This category addresses not only Positive ID (PID) in the target area, but also pinpoint targeting in order to minimize the amount of ordnance that needs to be expended for a particular target.

2. Air Superiority

This category addresses those requirements needed for possession of absolute control over the air battlespace while denying the enemy the same ability. Air superiority helps to ensure an effective transition from open ocean to littoral waters and back, and enables a full range of potential missions. To achieve this capability, future generation TACAIR will require technologies that enable the following:

1. Multi-mode highly autonomous weapons that increase lethality.
2. Highly automated aircraft to counter multiple threats
3. Lower observablity to delay detection and reduce enemy reaction time.
4. The ability to identify targets as positively hostile (PHID).
5. The ability to effectively counter TBMs in both boost and ballistic phases
6. To deny the enemy, through a variety of means, the ability to track and target friendly forces.

3. Platforms (Airframe & Propulsion)
This category addresses requirements necessary for sustainability and survivability of future aircraft. Sustainability means that radical improvements will be required in the design of airframes and their propulsion systems in order to not only keep aircraft in the air longer but also the availability of aircraft to maintain a constant presence or a given quantity of force. Survivability refers to the ability of an aircraft to successfully perform its mission against hostile forces and retain sufficient capability for follow-on missions. This includes reducing signatures to avoid detection, using countermeasures to foil attacks, and aircraft hardening and other design technologies to improve the chances of surviving combat damage.

4. Affordability
This category addresses requirements to minimize the costs of achieving battlespace dominance. Battlespace dominance requires that a given level of force is maintained from the air. To be able to achieve the levels of U.S. Naval air forces required for future conflicts, aircraft must not only be designed and manufactured to fight future conflicts, but also affordable such that the required force levels can be achieved and maintained.

5. Environment
The Environment category addresses requirements to minimize the impact of training and peace time operations on our environment. Training in the future requires that ordnance employed will need to be more environmentally friendly; that training areas with or without wildlife sanctuaries will absorb minimal/no environmental impacts.

TABLE III. AIR WARFARE TECHNOLOGY AREAS

1. PRECISION STRIKE	Tier	Issue	CTI
a. Provide improved weapon seeker capabilities for strike platforms which: 1. Provide autonomous target recognition capability. 2. Detect, acquire and track at ranges to ensure manned aircraft do not penetrate air defense envelopes. 3. Provide All weather - day/night. 4. Ensure engagement capability in high natural and man-made clutter.	M	CLF-8 CCEN-13 CPF-67	1-B
b Improve weapons lethality for current and programmed strike platforms. 1. Improve single-shot probability of kill (P_k) of all weapons. 2. Increase penetration by 50 percent over Bomb Live Unit (BLU)-109. 3. Develop capability for multiple kills per weapon versus massed tactical vehicles beyond BLU-108.	M	CLF-8 CCEN-13 CPF-67	1-C

1. PRECISION STRIKE	Tier	Issue	CTI
c. Develop improved capability to attack mobile theater ballistic missile (TBM) launchers and time-critical fixed sites.	**H**	N86-41	1-B 1-C 2-D
d. Improve sensor accuracy for strike platforms to ensure: 1. Improve first-pass single-target kill (P_k) to 1.0 with minimum weapons. 2. Improve first-pass multiple-target kill (P_k) to 1.0 with minimum weapons. 3. Optimize bombing circular error of probability (CEP) to $\leq$ 10 feet.	**H**	CLF-8 CCEN-13	1-B
e. Develop weapons systems that will detect and attack high value targets. 1. Develop improved hard kill, penetrating weapons. 2. Develop soft kill systems against vent and power systems. 3. Develop weapons systems to sever bunkers from C^3 nodes, sensors & weapons. 4. Develop the capability to destroy fiber-optic cables. 5. Provide the capability to positively identify targets in target area in order to minimize collateral damage.	**H**	CLF-8 CCEN-13 CPF-67	1-C
f. Improve the capability of current and future naval weapon systems for the Suppression of Enemy Air Defenses (SEAD). 1. Develop alternate targeting capabilities for anti-radiation missiles (ARM) that counter threat shutdown. 2. Develop weapon system for preemptive strike against Integrated Air Defense Systems (IADS). 3. Develop improved ARM antenna to have sensors with 100% direction of arrival accuracy. 4. Define capabilities and parameters to isolate IADS emitters.	**L**	CLF-8 CPF-67	
g. Design advanced avionics using new technologies to provide the following improvements in capabilities: 1. Positive identification in all aspects, day or night, to allow weapons employment at maximum range. 2. In-flight mission reprogramming to allow targeting of time critical targets.	**L**	CLF-4,10 N6-31 C4IW-33,35	1-B
h. Integrate sensor suites with strike weapons and platforms to allow man-in-the-loop, and autonomous operation, at full capacity of weapon and platform.	**L**	MP/N12-25	

1. PRECISION STRIKE	Tier	Issue	CTI
i. Develop improvements to weapons systems and launching systems: 1. Develop precision guided munitions (PGM) with autonomous target recognition. 2. Improve propulsion systems to result in higher speeds and longer ranges. 3. Design conventional munitions with a man-in-the-loop terminal guidance capability.	**L**	CCEN-13 CPF-67	1-C
j. Design and produce more variants of submunitions, including warheads with greater penetrating capability.	**M**	CLF-8 CPF-67	1-C
k. Develop improved weapon capability to engage multiple, mobile/moving targets, such as tanks, armored personnel carriers and light armored vehicles.	**H**	CCEN-13 CPF-67	1-C

2. AIR SUPERIORITY	Tier	Issue	CTI
a. Develop a highly maneuverable, air-launched, multi-mode weapon that will outperform all current and projected air-to-air and surface-to-air threats (LO and non-LO). 1. Possess a high G endgame capability to defeat any projected air-to-air or surface-to-air threat. 2. Possess an air-launched weapon capability with at least a two-fold F-Pole advantage over any projected air-to-air threat. 3. Able to perform autonomous flight control and precise homing with a hit-to-kill guidance solution. 4. Equipped with a high-speed TDD/fuse and advanced discrimination logic. 5. Fitted with a warhead containing high-capacity explosive technology and improved penetration technology. 6. Equipped with a kill mechanism that is improved over today's kinetic energy transfer methods. 7. Has improved missile seeker system counter countermeasure (CCM) suite. 8. Has built-in LO characteristics to thwart detection. 9. Possesses seeker head agility to enable high-off-boresight launch and track capability. 10. Has improve detection/acquisition/track capability in range and in high clutter environments.	**H**	CLF-8,9	1-C
b. Develop an air-launched, multi-mode weapon capable of engaging low observable cruise missiles and theater ballistic missiles (TBMs) with the following characteristics: 1. Capable of in-flight programming. 2 Capable high kinematic performance from sea level to exo-atmospheric. 3 Fitted with more precise homing and hit-to-kill guidance solution. 4 Capable of engaging TBMs in their boost or ascent phases of flight.	**M**	N86-41 FE/N51-44	2-D 5-A
c. Develop an air-launched missile which can perform stand-alone track correlation or link with external sensors for target correlation and decoy avoidance.	**L**		

2. AIR SUPERIORITY	Tier	Issue	CTI
d. Design a directed energy weapon for use aboard tactical aircraft per the following specifications: 1. Designed to minimal size, weight and plumbing requirements. 2. Designed to maximize effective range. 3. Designed to require minimal engagement time. 4. Designed to permit multiple, simultaneous target engagements.	L		
e. Design a multiple target air-launched weapon with the following capability: 1. Able to engage 18 targets in 30 seconds. 2. Designed with an engagement system operational availability of Ao = 0.99. 3. Equipped with precision aiming and guidance: one shot, one kill.	L		1-C
f. Provide ability to achieve air-to-air superiority (engage, destroy, and influence enemy so as to deny tactical use of the airspace) under all environmental conditions: 1. Enhance existing weapons /develop future weapons with the ability to detect, acquire, track, engage and destroy threat platforms in: a. Clutter (natural environment). b. Countermeasures (electronic, multi-spectrum, decoys, lasers). 2. Provide the capability for air intercept radars to sort targets in all environmental conditions and altitudes.	H	CLF-5 CCEN-15	
g. Improve counter-air capability: 1. Improve active and passive acquisition and tracking capability of fighter and airborne early warning (AEW) aircraft against all classes of targets in all environments. 2. Improve missile seeker and TDD sensitivity against all classes of targets in all environments. 3. Provide platform/weapon ID capability for friendlies. 4. Provide ID capability for foe (non-cooperative). 5. Provide high-off-boresight target detection, acquisition, and tracking. 6. Provide a Positive Hostile ID (PHID) capability beyond the kinematic range of threat airborne weapons.	M	CLF-4,5,9 CLF-10	

3. PLATFORMS (AIRFRAME & PROPULSION)	Tier	Issue	CTI
a. Create strike aircraft with the ability to loiter on station until they are needed for a strike.	L		

3. PLATFORMS (AIRFRAME & PROPULSION)	Tier	Issue	CTI
b. Reduce strike aircraft signature to delay detection and targeting from threat sensors. 1. Reduce signature of planned designs by 40% to 50% (inventory weapons) to improve survivability against RF and IR sensors. 2. Reduce the designed signature of follow-on systems to reduce acquisition range by 50% (over existing and planned airframes) and 80% (weapons) to provide survivability against RF, IR, electro-optic (EO), UV, and acoustic threat sensors. 3. Develop platform and weapon technologies to allow platforms to carry current weapons/stores without compromising signature.	M		1-D
c. Develop technologies which use new materials and structures in airframe design: 1. Achieve a 40% savings in aircraft weight and cost. 2. Integrate new materials and designs to reduce signature. 3. Design with commonality for compatibility, support and economy, yielding 50% cost savings.	M		1-D
d. Provide an aerodynamic design which optimizes carrier-suitable, multi-role performance in future naval aircraft which exceeds existing or postulated adversary performance: 1. Provide short-period agility (aircraft pointing) capability for air superiority. 2. Provide stable bombing system for accurate release of air-to-ground ordnance. 3. Develop technology which allows high performance fifth-generation aircraft to operate off naval ships without penalizing performance or survivability features.	L		
e. Develop an integrated sensor/weapons/countermeasure system which reduces platform susceptibility of strike assets to enemy tracking/targeting: 1. Develop a system integrating existing weapon systems, sensors and countermeasures on strike assets, allowing unrestricted sensor operation while denying threat tracking and targeting by future generation air and ground defense systems. 2. Enable follow-on aircraft to use sensors and countermeasures in concert with signature management. 3. Provide the capability to employ non-expendable, defensive measures to defeat any projected air-to-air and surface-to-air threat.	M	N6-30	

3. PLATFORMS (AIRFRAME & PROPULSION)	Tier	Issue	CTI
f. Reduce vulnerability of strike assets to single-hit kill: 1. Provide aircraft the capability to overcome single, catastrophic subsystem failure (electric, hydraulic or fuel) and return to safe area for recovery or ejection. 2. Provide follow-on aircraft the ability to overcome catastrophic main subsystem failure (electric, hydraulic, control surfaces, fuel, etc.) and continue the assigned mission.	**M**		1-D
g. Reduce an aircraft's vulnerability to air- or ship-launched weapon impact through the use of various technologies: 1. Man-portable missile defense and/or suppression. 2. Propulsion system vulnerability reduction. 3. Engine bay fire protection. 4. Fire suppression and extinguishing agents. 5. Detection, mitigation and protection from fires in onboard stores. 6. Self sealing integral fuel tanks. 7. Adaptable active damage control systems.	**M**		1-D
h. Develop plug and play systems to achieve multi-mission configurations.	**L**		
i. Develop safety enhancements to situational awareness to reduce mishaps.	**L**		
j. Develop unmanned aircraft and flight vehicle technologies.	**L**		
k. Improve operator interface w/platforms: 1. Improve situational awareness 2. Reduce information overload 3. Increase adaptability to different missions	**M**	MP/N12-26	
l. Develop an aerodynamic design which optimizes multi-role performance, including capability for Short Take-Off and Vertical Landing (STOVL).	**L**		

4. AFFORDABILITY	Tier	Issue	CTI
a. Develop methodologies, processes, and techniques to reduce life cycle costs of current and future weapons systems. 1. Reduced manpower requirements 2. Reduced maintenance weapon systems 3. Reduced training requirements	**M**	N4-16,19 N81-47,50	
b. Develop technologies that provide for life cycle extension and modernization of all systems (e.g. weapons, platforms, machinery, electronics, etc.)	**M**	N4-16 N81-48	

5. ENVIRONMENT	Tier	Issue	CTI
a. Develop environmentally friendly weapons, platforms and sensors to enable unrestricted training.	**L**		

Chapter 4

SURFACE WARFARE

Introduction - Surface warfare is the conduct of battle from the sea and land, from the open ocean to the littorals, with the principle objective of achieving battlespace dominance; that is, to fully neutralize enemy offensive and defensive weapons/systems and allow friendly forces to meet their operational objectives with minimal losses. Threats to surface forces include next generation fighter/attack aircraft with a variety of cruise missiles as well as shore based cruise missiles, tactical ballistic missiles, low slow flyers, sea and land-based gunfire, surface/ subsurface torpedoes and mines. Our ability to dominate the surface battlespace depends not only upon our ability to counter these traditional threats but also our ability to provide the ability for U.S. and allied ships to operate freely, and with that freedom of action to make the beaches and surrounding areas safe for landing by amphibious forces.

Requirements Categories - Underlying Surface Warfare are eight sub-categories, grouped as follows:

1. Naval Surface Fire Support (NSFS) and Interdiction
2. Precision Strike
3. Signature Reduction
4. Theater Air Dominance
5. Ship Design for Enhanced Warfighting
6. Weapons
7. Maritime Dominance
8. Military Operations Other Than War (MOOTW)

1. Naval Surface Fire Support (NSFS)
Naval surface fire support addresses the requirements for weapons, support equipment, personnel and tactics needed to achieve the objective of making the beaches safe for landing and protecting the personnel and equipment located ashore. This category includes those extended range, fast reaction land attack systems beyond close support.

2. Precision Strike
Precision Strike addresses those requirements needed to enable the warfighter to inflict the maximum amount of damage on high-value targets while minimizing collateral damage in the target area.

3. Signature reduction
Signature reduction addresses those requirements needed to reduce ship signatures from all sources. Survivability of our surface ships, it is critical that the signatures they produce and become visible to the enemy be reduced to a minimum in all battlespaces; that is, air, surface and undersea. Advanced technologies are required and include:

1. Reduction/control of EO signatures
2. Reduction/control of IR signatures
3. Reduction/control of RCS
4. Reduction/control of acoustic signatures
5. Reduction/control of magnetic signatures
6. Reduction/control of wake signatures

4. Theater Air Dominance

This category includes requirements for over-the-horizon target identification, target localization. Advanced defensive systems for CW/BW, unmanned aerial vehicles, and theater ballistic missile defense are also addressed.

5. Ship Design for Enhanced Warfighting

Ship Design for Enhanced Warfighting addresses requirements sustainability, survivability, and affordability issues which can be improved by ship designs; Hard-kill and Soft-kill systems, sensors, signature suppression, hardening technologies, countermeasures, damage control equipment and procedures that collectively prevent or limit combat damage from enemy fire. Ships designed for enhanced warfighting is a critical need as U.S. forces are continued to be called to contingency operations. Ship designs will need to be more modular to accommodate tailored mission packages.

6. Weapons

This category includes requirements to address threat weapons with increased performance (e.g. cruise missiles: LO-VLO, supersonic, waypoint capable, simultaneous arrival capable, deceptive maneuvers, multi-mode, jinking). With increased performance in threat weapons friendly forces reaction times are reduced to a minimum and require that engagements result in a high Pk. U.S. surface force weapons will need to be smarter, more autonomous, and more lethal.

7. Maritime Dominance

Maritime Dominance addresses those requirements to fully neutralize enemy offensive and defensive weapons/systems and allow friendly forces to meet their operational objectives with minimal losses. This not only requires that friendly units have absolute battlespace awareness (air, surface and undersea), but also the capability to counter any threat entering the battlespace.

8. Military operations other than War (MOOTW)

Military Operations Other Than War includes efforts to stop illegal trafficking in drugs, weapons, people (e.g., illegal immigration) or other contraband and recently has become a key aspect of enforcing United Nations Sanctions.

TABLE IV. SURFACE WARFARE TECHNOLOGY AREAS

1. NAVAL SURFACE FIRE SUPPORT & INTERDICTION (and associated sensor/information systems)	Tier	Issue	CTI
a. Develop targeting, weapon kinematics, and weapon control to stand outside 10-20-year threat envelope.	**H**	CLF-8 CCEN-13 N86-40 CPF-67	2-G
b. Develop precision guided munitions (PGM) for the 5-inch gun that is affordable and effective against low-cost surface and land targets, and which possess the following characteristics: 1. Payload of 24-40 pounds 2. Range of 40 nm (conventional round in a 5-inch gun) 3. Range of 75 nm (adv. propulsion gun with twice the muzzle energy) 4. CEP of less than 20 m (non-GPS guided) 5. CEP of less than 2 m (GPS guided) 6. Built-in terminal seeker (e.g., mm wave, IR, EO, SAL).	**H**	CLF-8 CCEN-13 N86-40 CPF-67	2-G
c. Create long-range, precision, onboard, renewable weapons capable of high rates of fire with scaleable lethality and timely (speed of light) engagement.	**M**	CCEN-13 N86-40 CPF-67	2-G
d. Improve propulsion systems, including the combination of launcher and projectile, to increase gun and missile ranges while maintaining shore targeting precision.	**H**	N86-40	2-G
e. Develop sub-munitions variants that are appropriate for given target sets (e.g., based on target size, location, etc.) to permit a distribution of firepower against shore targets including between several targets or between areas within a single target.	**M**	CLF-8 CCEN-13 N86-40 CPF-67	2-G
f. Improve the design of conventional munitions to permit longer ranges (possibly via wave rider or drag reduction technology), increased payload capacity, greater structural strength and a capability against hard targets ashore.	**L**	CLF-8 CCEN-13 N86-40 CPF-67	2-G

2. PRECISION STRIKE	Tier	Issue	CTI
a. Improve existing targeting and C^4ISR systems to maximize accuracy and speed of ordnance on target.	**H**	CCEN-13 N86-40 CPF-67	
b. Develop systems to destroy Weapons of Mass Destruction (WMD) vice just dispersing CW/BW agents.	**M**	ISR-29 MP-38	
c. Provide improved weapon seeker capabilities: 1. Provide autonomous target recognition. 2. Provide All weather - day/night capability. 3. Ensure engagement capability in high natural and man-made clutter.	**M**	CLF-8 CCEN-13 CPF-67	1-B
d. Improve weapons lethality for current and programmed strike platforms. 1. Improve single-shot probability of kill (P_k) of all weapons.	**M**	CLF-8 CCEN-13 CPF-67	1-C
e. Develop improved capability to attack mobile Theater Ballistic Missile (TBM) launchers and time-critical fixed sites.	**H**	N86-41	1-B 1-C 2-D
f. Develop weapons systems that will detect and attack high value targets. 1. Develop improved hard kill, penetrating weapons. 2. Develop soft kill systems against vent and power systems. 3. Develop weapons systems to sever bunkers from C^3 nodes, sensors & weapons.	**H**	CLF-8 CCEN-13 CPF-67	1-C
g. Improve the capability of current and future naval weapon systems for the Suppression of Enemy Air Defenses (SEAD). 1. Develop weapon system for preemptive strike against integrated air defense systems (IADS). 2. Define capabilities and parameters to isolate IADS emitters.	**L**	CLF-8 CPF-67	
h. Integrate sensor suites with strike weapons and platforms to allow man-in-the-loop, and autonomous operation, at full capacity of weapon and platform.	**L**	MP/N12-25	
i. Develop improvements to weapons systems and launching systems: 1. Develop precision guided munitions (PGM) with autonomous target recognition. 2. Improve propulsion systems to result in higher speeds and longer ranges. 3. Design conventional munitions with a man-in-the-loop terminal guidance capability.	**L**	CCEN-13 CPF-67	1-C
j. Design and produce more variants of submunitions, including warheads with greater penetrating capability	**M**	CLF-8 CPF-67	1-C

2. PRECISION STRIKE	Tier	Issue	CTI
k. Develop improved weapon capability to engage multiple, mobile/moving targets, such as tanks, armored personnel carriers and light armored vehicles	**H**	CCEN-13 CPF-67	1-C

3. SIGNATURE REDUCTION	Tier	Issue	CTI
a. Provide highly survivable surface combatants with features that minimize signature and enable forces to transit clandestinely through dynamic platform signature controls.	**H**	CCEN-14	
1. Develop technologies to reduce and/or control the *electro-optical* (EO) signature of ships via coatings, cloaking or reconfigurable camouflage. Employ LO technology in the design of submarine sails, rudder, masts, antennas and exposed decks for SSNs that engage in SOF operations. Employ LO technology in the design of surface ship superstructures.			
2. Develop the technology to permit multi-spectral signature reduction via coatings or hull shaping to reduce the *radar cross section* of ships and to reduce the radiation of antennas and other sensors.			
3. Improve the technology to reduce ships' (subs, UUVs, SOVs) *acoustic* signatures by developing quieter propulsors, improved acoustic coatings, machinery silencing techniques, hydroacoustic silencing techniques and/or active noise control methods. Reduce the acoustic signatures of surface ships, submarines, UUVs and SDVs to reduce the probability of counter-detection.			
4. Improve the technology to reduce ships' *magnetic signatures* by developing the capability for closed loop degaussing and active field suppression, and by a greater use of non-magnetic materials and/or variable moment magnets.			
5. Improve the technology to reduce and/or control ships' *infrared* (IR) signatures, possibly by the use of material treatments, active cooling systems or improvements in the design of propulsion systems.			
6. Employ *LO* technology in the design of surface ship superstructures.			
7. Employ *LO* technology in the design of submarine sails, rudder, masts, antennas and exposed decks for SSNs that engage in SOF operations.			
b. Improve the technology to reduce and/or control a ships' wake signature, possibly via modified hull designs, modified propulsion designs or by surfactants.	**H**		

4. THEATER AIR DOMINANCE	Tier	Issue	CTI
a. Improve shipboard capabilities to perform over-the-horizon (OTH) target identification, target localization, and knowledge of the environment (in the target's area) in various environmental and countermeasures environments.	**H**	CLF-4,10 N096T-55	1-B 10-D
b. Develop advanced active defensive systems.	**H**		2-C
1. Develop a TBMD capability that detects and attacks missiles in the boost phase and provides automated multi-sensor data fusion.		N86-41 CLF-7 FE/N51-45	2-D 10-D
2. Provide capabilities to counter high altitude, long duration unmanned air vehicle (UAV).			
c. Develop an Active Phased Array Radar (APAR) that can detect, control and engage theater missile and air threats, including TBMs, in sea, land, and coastal environments.	**H**	N86-41 FE/N51-44	5-A

5. SHIP DESIGN FOR ENHANCED WARFIGHTING	Tier	Issue	CTI
a. Develop modular design to accept tailored mission packages, including	**H**	MP/N12-26	
1. Open architecture (see C^2/C^4IW).			
2. Commonality of HM&E systems.			
3. Mother ship support craft.			
b. Improve sustainability	**M**	N4-17,20	
1. Explore alternative fuel sources.			
2. Improve food storage capacity.			
3. Control waste generation.			
c. Develop affordability	**H**	CLF-12	
1. Reduce manning.		N4-16,19	
2. Reduce life cycle costs.		N81-47,48	
3. Reduce preservation requirements.		N81-49	
4. Reduce dependence on parts.		N81-50,52	
5. Reduce maintenance and CBI			
6. Shipboard embedded training.			
d. Significantly increase speed (to 50+ knots) without sacrificing combat capability	**M**		
e. Improve damage-control/ ship-survivability through:	**M**		
1. Mine/torpedo resistant hulls.			
2. Fire suppress on systems.			
3. Non-combustible hydraulic fluids.			
4. Self-extinguishing hydraulic fluids.			
5. Clean ship.			
f. Provide Automated Damage Control (ADC).	**L**		

5. SHIP DESIGN FOR ENHANCED WARFIGHTING	Tier	Issue	CTI
g. Develop integration technologies - human /system interfaces.	**L**		
h. Improve quality of life (QOL).	**L**		
i. Develop shipboard systems that can operate in high sea states, at rates appropriate for future mission taskings.	**H**		2-C
1. Expand ships' parameters for weapons launch (i.e., firing rate, shoot at faster speeds, shoot in any sea state, shoot from greater depths).			
2. Enhance ships' sea-keeping for aircraft launch and recovery.			
3. Develop rapid, reliable and safe weapons load, reload and test systems which provide a rapid fire rate while minimizing manpower.			
4. Develop sufficient shipboard weapons protection systems to ensure survivability of onboard weapons and systems.			
j. Reduce a ship's vulnerability to weapon impact through the use of various technologies, possibly including:	**H**		2-C
1. Redundancy and separation of critical functions.			
2. Improved personnel protection.			
3. Improved internal communication and information management.			
4. Improved emergency escape breathing devices.			
5. Longer lasting oxygen breathing apparatus.			
6. Integrated survivability management system.			
7. Graphic display of damage areas.			
8. Damage containment decision aids.			
9. Blast resistant decks and bulkheads			
10. Damage resistant construction materials and coatings.			
11. Lightweight armor.			
12. Active armor (absorbs energy of the blast).			
13. Improve CBR defenses.			
k. Develop systems to neutralize and self-cleanse CW/BW agents in a surface ship environment			
l. Develop CW/BW sensors for surface warfare	**H**	MFP-38	
m. Develop capability to defend a ship, in-port, against threats of terrorist attacks, mob action, protesters, etc., using multi-layered defense, including non-lethals.	**H**		2-C

6. WEAPONS	Tier	Issue	CTI
a. Create and use unmanned combatant craft targeted for surface missions.	**H**	CCEN-13	
b. Create a directed-energy weapon system that can use energy from a remote source.	**L**	CPF-7	2-C

6. WEAPONS	Tier	Issue	CTI
c. Create an exhaust-riding missile that can follow the threat exhaust back to the launcher.	L		
d. Develop renewable weapons, such as directed energy weapons (e.g., lasers), that are agile, easy to target, need little logistics support, are compatible with a shipboard ElectroMagnetic (EM) environment and can deliver both lethal and non-lethal charges in all types of weather against both surface and low-altitude air targets.	H	CLF-8	2-C
e. Develop improved gun/missile propellant that has a higher energy content and is more insensitive (possibly including low-cost turbines in the design or take advantage of electro-chemical or electro-thermal effects).	H		
f. Design a multi-target capable weapon for shipboard use (close-in) against small boats, sea skimmers, aircraft, submarines, mines, etc. Implement a swarm vehicle defensive system.	H	CCEN-13	1-B
g. Improve the design of surface-launched, smart-weapons fusing so that the fuse is not triggered by ground or water when engaging surface, low-altitude air or sea skimming targets.	H	CLF-8 CCEN-13	1-B
h. Develop a large volume coverage capability for submunitions.	H	CLF-8 CPF-67	
i. Design cheap, dumb, powerful bullets and a gun system that permits improved accuracy and smaller dispersion.	H	CLF-8 CCEN-13	

7. MARITIME DOMINANCE	Tier	Issue	CTI
a. **Develop an integrated ASW sensor system that can detect, control and engage/neutralize submarines, torpedoes and naval mines.**	**H**	CLF-1,7,11 ISR-28 FE/N51-43 CPF-68	2-B 5-B
b. **Develop a lightweight ASW sensor system suitable for transfer and use by allied/coalition partners on small ships and indigenous craft during MRC/LRC situations.**	**H**	CLF-1 N81-54 CPF-69	2-B
c. **Develop the capability to detect, identify and engage small, low-speed multiple surface threats while operating in severe environmental and countermeasures environments.**	**M**	CLF-4,10 C4IW-33	2-C
d. **Develop the capability for autonomous target recognition systems that can, in real-time and in all types of weather, distinguish a hostile air or small surface-contact from background tracks, false targets, and other clutter.**	**M**	CLF-4,10 C4IW-33	2-C
e. **Develop the capability to counter supersonic stealth cruise missiles.**	**L**		2-C
f. **Develop multi-sensors/satellite-linked/all-weather air dropped mines.**			
g. **Improve the capability to conduct ASW in littorals**	**H**	CLF-1,6 N86-42 CPF-72	2-B 10-D

8. MILITARY OPERATIONS OTHER THAN WAR	Tier	Issue	CTI
a. **Develop sensors that can be used onboard a merchant ship to detect drugs, munitions or weapons (including biological and chemical) anywhere on the ship (including in cargo the holds or attached to the ship's external or internal hull).**	**H**		2-I
b. **Develop sensors that can be used *remotely*, prior to boarding, to detect drugs, munitions, weapons (including biological and chemical) or people anywhere on the ship (including in the cargo holds or attached to the ship's external or internal hull).**	**H**		2-I

8. MILITARY OPERATIONS OTHER THAN WAR	Tier	Issue	CTI
c. Provide the capability to conduct maritime intercept operations, such as blockades, embargoes or quarantines. 1. Provide capability to tag and track all shipping--neutral, friend, foe. 2. Provide capability to inspect shipping by noninvasive methods. 3. Control movement/intent of shipping by non-lethal methods. 4. Connectivity of boarding party, with mother ship.	L		2-I
d. Develop new non-lethal anti-ship weapons for use against merchant ships with the following characteristics: 1. Capable of stopping a merchant ship with minimal damage to its structure at a range of up to 500 yards and with an accuracy of better than 5 m. 2. Capable of stopping a merchant ship without casualties and with no damage to its structure at a range of up to 1000 yards and with an accuracy of better than 1 m.	H		2-I 2-E
e. Develop equipment and/or procedures to permit the boarding of merchant ships per the following specifications: 1. In sea states 5 and higher. 2. In any sea states in the daytime or at night.	L		2-I
f. Develop real-time communication support for the boarding team	H		2-I

Chapter 5

MINE WARFARE

Introduction -- Mines are a relatively cheap way to deny access to an ocean area and otherwise disrupt maritime traffic. Through their use, commercial and military ports can be closed, the sea lanes can be shaped and controlled, and beaches protected against amphibious landing. Some mines sink to the bottom, others are bouyant and are tethered some distance below the surface, and still others float and drift on the surface. But all mines lie still and are silent, making their detection and avoidance particularly difficult.

The overriding issue for mine warfare is the development or improvement of the capability to detect, track, and destroy all types of mines at all times and in any environment. A second issue is the use of selective mining as a tool to inhibit an enemy's freedom to operate by closing ports or sea routes to his shipping traffic.

The technology of mine warfare involves not only the mines themselves and their sensors but also mine laying and mine removal, all aspects of Mine CounterMeasures (MCM) and mine warfare effectiveness and readiness through training systems and better support for mission planning.

Requirements Categories - Mine warfare S & T issues come under one or more of the eight following categories:

1. Command and Control, Communications, and Computers and Intelligence (C^4I)
2. Mine Warfare Surveys
3. Mine Warfare in Stride
4. Platform Survivability
5. Mines and Mine Field Control
6. Sensors
7. Mine Warfare Environmental Support
8. MCM -- Neutralize Mines

1. Command and Control, Communications, and Computers and Intelligence
This category includes all aspects of command, control, and communications, largely but not exclusively through the use of or with the help of computers. It also includes all aspects of intelligence about mines and mine fields as well as the means of collection of intelligence data.

2. Mine Warfare Surveys
The emphases under this category are various covert survey operations involving mines and MCM.

3. Mine Warfare in Stride
In stride mine warfare operations imply the ability to rapidly detect, track, and destroy all mines and other obstacles for amphibious operations from long distances over the horizon.

4. Platform Survivability
This category is concerned with all aspects of the survivability of platforms to mine encounters with emphasis on various signatures of the platforms.

5. Mines and Mine Field Control
The development of improved mines and their control systems is the focus of this category.

6. Sensors
This category involves the development of new and improved sensors to sense and detect mines.

7. Mine Warfare Environmental Support
One of the key environmental factors in MIW is having the knowledge of the ocean bottom topography and mine-like objects.

8. MCM - Neutralize Mines
This category deals with all aspects of mine countermeasures with emphasis on the ability to neutralize mines through their detection, classification and detonation.

TABLE IV. MINE WARFARE TECHNOLOGY AREAS

1. C^4I	Tier	Issue	CTI
a. Provide mine warfare (MIW) assessments that are integrated into overall the Navy C^4I systems and architectures (i.e., connectivity, capacity, data correlation, data fusion and interoperability) which are installed within MCM force elements, the task force, supporting forces, and the chain of command.	**H**	CLF-5,7 CCEN-14 CPF-68	2-A 3-B

1. C^4I	Tier	Issue	CTI
b. Develop tactical decision aids (TDAs) to support MIW mission planning and related MIW training as follows: 1. Predict a minefield's boundaries, the mine content within those boundaries, the risk to traffic and the likelihood of success for a given MCM mission. 2. Define optimal minefield boundaries as well as the mine density, configuration and settings needed to achieve a commander's goals. 3. Predict interrelationships of mining intelligence, mine laying and clearing activities, area reconnaissance and naval operations against suspected/known/ unknown minefields, and then predict the likelihood of mission success in various timeframes and also accurately predict the mine risk or probability of safe transit to the tactical commander.	**M**	CLF-11 MP/N12-25 N86-42	2-A 3-B
c. Develop ability to conduct 24 hour enemy mine surveillance.	**H**	ISR-28	3-B
d. Develop ability to know about and avoid mine fields.	**H**	CLF-11 ISR-28	2-A
e. Develop means and methodology for detecting and tracking naval mines ashore for the purpose of interdicting them prior to water deployment.	**H**	ISR-28	2-A 3-B

2. MINE WARFARE SURVEYS	Tier	Issue	CTI
a. Improve covert operations through multi-platform Q-routes survey and wide area detection.	**H**	CLF-7	3-B
b. Provide rapidly deployable, 24 hour MCM (wide area).	**M**		2-A
c. Provide capability for covert mine reconnaissance.	**H**	CCEN-14	3-B 4-J

3. MINE WARFARE IN STRIDE	Tier	Issue	CTI
a. Develop the ability to conduct manned or unmanned, in-stride, deliberate clearing and/or breaching of mines and obstacles (cement blocks, barbed wire, etc.) from over the horizon to the amphibious craft landing zone (CLZ).	**H**	CLF-7 CCEN-14 N86-42 MCC-61	2-A
b. Develop the capability to conduct mine and obstacle reconnaissance of an amphibious operations area (AOA) during the advance phase of an amphibious operation. Note: A nominal AOA is considered to include 200 nm of coastline, 8 days of required availability, and 50 nm standoff from the beach.	**H**	CLF-7,11 CCEN-14 MCC-61 CPF-68	

4. PLATFORM SURVIVABILITY	Tier	Issue	CTI
a. Develop technologies to reduce and/or mask the acoustic, electromagnetic, Underwater Electric Potential (UEP) and pressure signatures of ships and submarines to levels commensurate with current and projected threat.	**M**	CCEN-14	2-B
b. Improve the survivability of platforms to withstand mine damage.	**M**		

5. MINES AND MINE FIELD CONTROL	Tier	Issue	CTI
a. Develop mines that are capable of detecting and immobilizing quiet diesel submarines, surface warships and high-speed surface craft operating in water as deep as 500 feet.	**H**	CLF-7 CCEN-14	
b. Create liquid mine field technologies to: 1. Clog and/or disrupt onboard cooling and other systems. 2. Enhance bioluminescence that would use organisms to locate and track submarines. 3. Produce a dye/chemical tag that allows tracking of submarines.	**L**		
c. Develop smaller mines allowing wide area high volume delivery of all types of mines from aircraft, submarines and artillery/mortars.	**M**		
d. Develop the ability to perform remote command and control of individual smart mines that include a re-targeting capability.	**M**		
e. Develop the ability to emplace, selectively arm, and continuously monitor mine fields.	**L**		
f. Develop a wide area surveillance mine that senses and swims to its target.	**L**		

6. SENSORS	Tier	Issue	CTI
a. Develop sensors with the ability to sense and detect buried mines at sea	**H**	CLF-7	
b. Develop sensors with the ability to detect non-metallic mines.	**H**	CCEN-14 CPF-68	2-A 3-B
c. Develop non-conventional sensors to detect underwater mines	**M**	CPF-68	2-A 3-B
d. Develop the capability to detect and avoid mines out to 2000 yards by organic means. (Note: The definition of "organic" depends on the makeup of the functional unit, e.g., ship, task force, carrier battlegroup.)	**H**	N86-42 FE/N51-43	2-A 3-B

6. SENSORS	Tier	Issue	CTI
e. Develop compact sensors and energy sources for remotely operated vehicles and reconnaissance platforms.	**M**		3-B

7. MINE WARFARE ENVIRONMENTAL SUPPORT	Tier	Issue	CTI
a. Provide world wide knowledge of ocean bottom topography and mine-like objects.	**M**		4-I

8. MCM -- NEUTRALIZE MINES	Tier	Issue	CTI
a. Develop the technology to deploy rapid, unmanned mine neutralization system(s) that are effective against bottom, moored and drifting mines, are low-cost (e.g., expendable), and can find/detect and identify the mine being neutralized.	**H**	CLF-7,11 N86-42	2-A 3-B
b. Develop the technology to rapidly neutralize/detonate (in stride detect and classify) from deep water through surf, over the beach to the objective.	**M**	FE/N51-43 CPF-68	2-A 3-B
c. Develop a remotely operated capability to neutralize mines that : 1. Is controllable from a variety of platforms. 2. Provides high-fidelity emulation of magnetic, electric, acoustic and seismic signatures. 3. Is easily deployable. 4. Operates covertly. 5. Has 24 hour capability. 6. Is effective against bottom, moored and drifting mines.	**H**	CPF-68	2-A 3-B

Chapter 6

UNDERSEA WARFARE

Introduction - Undersea warfare is the conduct of battle beneath the surface of the oceans with the principle objective of achieving battlespace dominance; that is, to fully neutralize enemy offensive and defensive weapons and systems and allow friendly forces to meet their operational objectives with minimal losses. U.S. submarine operations two decades from now are predicted to include anti-SSBN operations in hostile bastions, anti-SSN/anti-SSGN operations in the open ocean, and a multitude of diverse operations in littoral areas. Littoral operations include ASW, ASuW, surveillance, special warfare, and strike. Obviously, operations in bastions or the open ocean could include ASuW, surveillance, and a variety of other missions. Undersea threats will include air independent diesel electric subs, mini-subs, moored homing torpedoes, mines and other unmanned underwater vehicles. Technology in this area will aid in the development of improved acoustic sensors and arrays, improvements in offensive torpedo performance and other offensive ASW capabilities, improved communications with underway submarines and technology to reduce own sub signature levels. All of this is to be accomplished in an affordable manner.

Requirements Categories - Underlying Undersea Warfare are eight sub-categories which are grouped as follows:

1. Undersea Superiority
2. Offensive ASW
3. Support
4. Strike
5. Manning
6. Training
7. Affordability
8. Survivability

1. Undersea Superiority

Undersea Superiority involves developing technologies which will improve our undersea defensive capabilities. This includes developing new systems to better neutralize threats posed by hostile subs, torpedoes, mines and UUVs, and neutralizing the adversary's sensor systems and arrays. The most significant submarine requirement which will remain unchanged is stealth. Two decades from now, U.S. submarines must be concerned about their detectable signatures from radiated acoustic noise, reflections from active pulses, and their susceptibility to a variety of non-acoustic sensors which may detect various scars or residue trails. The new Air Independent Propulsion diesel electric submarines will radiate considerably less noise than current vessels. This will cause submarines to get very close before one can detect the presence of another acoustically. As a result passive sonars must be augmented by other long range detection capabilities. Active sonars and non-acoustic systems must be explored. Since

stealth remains the cornerstone of submarine operations, active sonar operations must explore bi-static and multi-static systems using other platforms and remotely deployed systems.

2. Offensive ASW

Because of the expected quietness of future threat submarines, our submarines may encounter these threats at close ranges. Therefore, offensive ASW must develop technologies to provide a quick reaction attack and evasion capability. The submarine which can develop a quick fire control solution, rapidly shoot weapons, and effectively evade will have superiority. A quick fire control solution will be needed. Rapid shooting may involve an automatic weapon aiming and firing system. Evasion may involve sophisticated decoys, countermeasures against incoming weapons, and submarine speed or stealth. Further it will be necessary to improve offensive torpedo performance and signature in both shallow and deep water; to optimize coordinated ASW between platforms and in bi-static modes with deployed sources; and to provide the capability to covertly tag threat submarines and mines. Additionally, the threat of mines, including potential stealthy mines, may require the development of submarine-launched unmanned underwater vehicles (UUVs) as surrogates for the submarine in mined waters. Also critical in the undersea picture is the change in the submarine's customer. Joint Task Group operations have shown that JTG commanders and other authorities want and need data from the submarine in an understandable and timely form. This emphasizes the need for improved covert high rate communications.

3. Support

This requirement category addresses developing technologies to support warfighting capabilities in the undersea environment. This includes the development of technologies and systems which support the submarine's warfighting capability such as deployable sensors to detect, track and classify ASW contacts and communicate that information back to the parent submarine, improved SOF vehicle technology, and the capability to assess in real-time, own ship acoustic vulnerability to maintain situational awareness, stealth and tactical control.

4. Strike

Providing an improved timely and cost effective precision strike capability with high speed strike weapons is a key requirement in Undersea Warfare.

5. Manning

In the interest of reducing cost and risk, Manning addresses reducing the manning requirements on ships and submarines.

6. Training

Improvements in onboard training systems that integrate all ship sensors and fire control systems for more meaningful and realistic training is required.

7. Affordability

In keeping with the reduced budget levels forecast for the future and the Navy's goals to reduce costs, developing affordable platforms, sensors and weapons systems is a hard requirement.

8. Survivability

With the reduction in the number of submarine platforms, the introduction of quiet diesel-electric submarines by foreign navies, and the increasing threat of mines in the littorals survivability is even more critical. New technologies to reduce own submarine signatures and to improve the submarine's maneuverability and responsiveness and capability to operate at faster speeds and more quietly are required. Also the improvement in the use of distributed architectures, cooperative engagement techniques are key to increased survivability. For the mine threat a likely response will be the submarine launched UUV. This surrogate will need significant endurance, effective navigation, good communications and a variety of mission payload packages.

TABLE VI. UNDERSEA WARFARE TECHNOLOGY AREAS

1. UNDERSEA SUPERIORITY	Tier	Issue	CTI
a. Develop systems to better neutralize threats posed by hostile subs, mini-subs, moored homing torpedoes and other unmanned underwater vehicles (UUVs) per the following specifications: 1. Develop ASW sensors and processors that can detect and track low-signature subs at tactically significant ranges and speeds. 2. Develop affordable systems for installation on all platforms. 3. Develop systems to maintain tactical control of engagements. 4. Develop systems with cooperative engagement architecture.	H	CLF-1,6,11 CCEN-13 ISR-27,28 N86-42 N87-58 CPF-69	2-B 2-C
b. Develop an improved capability to neutralize an adversary's sensor systems and arrays : 1. Provide capability to deny the enemy an ability to detect, identify and target friendly submarines through signature control or the use of improved acoustic or non-acoustic countermeasures. 2. Develop improved methods to covertly locate and neutralize enemy sensors and arrays or UUVs.	M	CLF-1,6	2-B 2-C
c. Provide a UUV based layered defense in all environments: 1. Capable of speeds ≥ 12 kts, reverse and hover. 2. Capable of endurance in excess of 72 hrs at 8 kts. 3. Possesses communications ≥ 20 kilo Baud (kB)/sec without a wire. 4. Possesses positive ID capability.	M	CLF-5,10 CCEN-13 CCEN-15 CPF-69	2-B 2-C

1. UNDERSEA SUPERIORITY	Tier	Issue	CTI
d. Develop improved systems to neutralize the threat posed by enemy torpedoes and mines: 1. Design improved threat detection and alert systems with improved and more automated classification techniques (including underwater IFF), and faster targeting systems, to increase the probability of survival against inbound torpedoes from any aspect angle. 2. Provide the above capability against salvos of torpedoes in all environments and in the presence of countermeasures. 3. Develop improved countermeasures and decoys. 4. Develop improved weapons with better fusing technologies for use against inbound torpedoes.	**H**	CLF-7,11 CCEN-14 N86-42 FE/N51-43 N87-58 CPF-68	2-B 3-B
e. Improve self-defense capability in littoral waters: 1. Develop the capability for automated decoy release and a quick-response counterweapon launch. 2. Develop a robust anti-air capability for use against patrol aircraft. 3. Develop a weapon against light and fast combatants. 4. Develop means to counter enemy acoustic/non-acoustic ASW advances.	**M**	CLF-6 ISR-27 FE/N51-43 N87-58 CPF-69	2-B
f. Optimize data fusion of sparse information (on board individual ship, submarine or aircraft).	**H**	CLF-5 CCEN-13 CCEN-15 MP/N12-24 C4-35 N86-39 N81-54	1-A 4-A
g. Develop real-time, auto passive ranging and classification systems.	**H**	CLF-1,4 CCEN-13	1-G
h. Improve power density for remote sensors (sonobuoys, ADS, UUV, etc.).	**H**	CLF-1	3-B

2. OFFENSIVE ASW	Tier	Issue	CTI
a. Develop improvements in torpedo technology: 1. Improve torpedo sensor signal-to-noise ratio (S/N) for acoustic detection, classification and homing against submarines in shallow water with low-Doppler returns and a faint acoustic signal strength. 2. Provide the capability for terminal homing against small, bottomed or near-surface targets with a probability of kill (P_k) of $\geq$ X with the automatic selection of hit location. 3. Develop environmentally safe explosives, fuels & propulsion systems. 4. Reduce torpedo's flow, propulsion and machinery noise to make them as quiet as the submarine launch platform. 5. Develop the capability to perform IFF queries to prevent attack against the launching ship while maintaining an open azimuth for attacking the intended target. 6. Develop the capability to perform a quiet torpedo launch without maneuver constraints on the launching platform.	**H**	CLF-6 CCEN-13 CPF-67,69	2-B
b. Develop technologies to achieve torpedo performance levels in shallow water that are equivalent to, or better, than today's capabilities in deep water (without compromising superior performance in deep water).	**H**	CLF-6 CCEN-13	2-B
c. Develop technologies to optimize coordinated ASW between platforms	**H**	CLF-2 C4-35 N86-39 N81-54 N87-58 CPF-69	
d. Develop ability to covertly tag threat submarines and mines.	**H**	CLF-4,11 CCEN-14 C4-33 CPF-68	

2. OFFENSIVE ASW	Tier	Issue	CTI
e. Establish the following capabilities to search the undersea battlespace and improve unit self-defense, control important Sea Lanes Of Communication (SLOCs), perform area clearance, and contribute to an undersea common tactical picture: 1. Develop sensors with better prime power sources and conversion technologies to more efficiently convert electrical energy into acoustic energy. 2. Develop better sensors and improve array technology. 3. Develop improved remote array handling mechanisms to permit rapid, covert array deployment. 4. Develop more capable, non-acoustic sensors (e.g., electro-optical, EUP, electromagnetic, and infrared), to include outboard and offboard sensors. 5. Develop non-lethal weapons to provide quick reaction neutralization.	**H**	CLF-1 CCEN-14 ISR-27 N86-42 FE/N51-43 N87-58 CPF-67,69	3-A 3-B 3-D 4-A
f. Develop UUV capabilities.	**H**	N87-58	3-B
g. Provide Maritime Patrol Aircraft (MPA) an effective, shallow water, ASW capability.	**M**	CLF-6 CCEN-14 ISR-27 CPF-69	

3. SUPPORT	Tier	Issue	CTI
a. Provide submarine connectivity at speed and depth: 1. High data rate, bi-directional, telemetry to and from submerged submarines.	**H**	CLF-5 CCEN-15 N87-58	
b. Improve underwater platform survivability during communications: 1. Develop techniques that allow communications reception with conformal antennae. 2. Develop technologies to determine the terrain covertly in proximity of submarines. 3. Develop covert internal submarine navigational systems that provide continuous communications. 4. Develop technologies to minimize active emissions in submarine communications.	**H**	CLF-3 N096T-56 N87-58	4-E
c. Develop the capability for a submarine to maintain continuous super high frequency (SHF) connectivity to support maintenance of the joint common tactical picture and uninterrupted participation in the Joint Targeting Network (JTN).	**H**	CLF-2 N096T-56	4-I 4-E

3. SUPPORT	Tier	Issue	CTI
d. Integrate the global atmospheric and ocean models into a Defense Simulation Network, and then utilize the models for high fidelity simulations to aid in training and to develop improved sensors, weapons and platforms.	M		
e. Improve the resolution of onboard oceanographic and atmospheric analysis and forecasting models and provide these improved models to the ship's weapon system platforms.	H	CLF-3 N096T-57	
f. Develop a shipboard capability for small object avoidance (e.g., floating mine).	M	CLF-7,11 MCC-61 CPF-68	
g. Improve SOF vehicle technology to significantly increase insertion range.	M		
h. Develop an organic and deployable off-board sensor to detect, track, classify and communicate ASW contacts to parent submarine.	M	CLF-6 ISR-27 N87-58	
i. Develop real-time assessment capability of acoustic vulnerabilities and environment to maintain situational awareness, stealth, and tactical control.	H	CLF-3 N096T-55	3-B 4-I

4. STRIKE	Tier	Issue	CTI
a. Provide timely and cost effective precision strike capability improvement: reduced cost; high speed strike weapons; rapid mission planning; and targeting/re-targeting.	H	CLF-8 CCEN-13 N87-59 CPF-67	1-B

5. MANNING	Tier	Issue	CTI
a. Reduce battlestation manning requirements on ships and submarines.	M	MP/N12-26 N81-46	

6. TRAINING	Tier	Issue	CTI
a. Improve onboard training systems that integrate all ship sensors and fire control systems.	M	N81-51	7-A

7. AFFORDABILITY	Tier	Issue	CTI
a. Develop platforms, sensors, and weapons that are more affordable.	H	N4-16	

8. SURVIVABILITY	Tier	Issue	CTI
a. Develop technologies to reduce own submarine signatures.	H	CCEN-14 N87-58	2-B

8. SURVIVABILITY	Tier	Issue	CTI
b. Improve own ship survivability through the use of distributed architectures, cooperative engagement techniques, improved platform maneuverability and responsiveness with improvements in platform-specific Hull Maintenance and Electrical (HM&E) technology.	**M**		
c. Develop technologies to allow submarines to operate at faster speeds, more quietly	**L**		

Chapter 7

AMPHIBIOUS WARFARE

Introduction - Amphibious warfare is the ability to engage the enemy from the sea, project power ashore and achieve battlespace dominance in the world's littorals. This battlespace dominance allows U.S. and allied ships to operate freely, and provides friendly forces with the freedom of action to make the beaches and surrounding areas safe for landing by amphibious forces. Operations in the Amphibious Operational Area (AOA) require combat forces to transition equipment ashore with speed in order to minimize risk to the transitioning forces. Threats to amphibious forces include sea/land mines, land based cruise missiles and artillery sites and small arms fire. Technology development in this area will lead to improved Naval Surface Fire Support (NSFS) systems, SOF capabilities, high speed transporter craft and logistics systems, and improved personnel protection and improved individual warfighting capabilities for Marines ashore.

Requirements Categories - Underlying Amphibious Warfare are five sub-categories which are grouped as follows:

1. Fire Support
2. Special Operations Forces (SOF)
3. Platforms and Logistics
4. C^4I
5. Marines Ashore

1. Fire Support
Key to making any amphibious operation successful is fire support from the afloat and airborne forces. Development of precise, affordable and scaleable NSFS systems including guns, missiles and directed energy weapons is required.

2. Special Operations Forces (SOF)
Support for SOF is required in any amphibious operation. Improvements in host ship SOF capabilities including covert communications capability with the SOF units is required. Technology development is also needed for SOF unit equipment including imaging sensors, control of electromagnetic and acoustic signatures of equipment, and swimmer delivery vehicles. The development of a capability to conduct infiltration in lieu of amphibious operations with total surprise is also required.

3. Platforms and Logistics
Transporting personnel and equipment ashore in any type of combat environment and weather with speed and safety is paramount. Development of high speed, stealthy transporters capable of operating in a CBR environment is required. Additionally, a high speed escort craft equipped with PGMs for fire support and transporter defense is needed along with a just-in-time combat logistics system to resupply the ashore forces.

4. C^4I

The amphibious forces must be fully interoperable with the battle force C^4I and ISR systems to insure full battlespace awareness in the AOA. They must also have a means to insure DBA/DBK to reduce the overall operational risk.

5. Marines Ashore

Marines ashore are always vulnerable to a variety of threats and risks. Technology is needed to develop new equipment to protect the marine in all types of hostile environments, day and night. This would include enhancement to personal protection systems, providing them with new lethal and non-lethal weapons, and giving them greater mobility on the battlefield.

TABLE VII. AMPHIBIOUS WARFARE TECHNOLOGY AREAS

1. FIRE SUPPORT	Tier	Issue	CTI
a. Develop NSFS systems to include guns, missiles and directed energy weapons.	**H**	MFP-37 N86-40	2-G
b. Develop precise, affordable, instantaneous, scaleable fire support to cover future schemes of maneuver.	**H**	MFP-37	2-G
c. Provide propellants, warheads, SUNS, missiles, and reactive explosives which are environmentally friendly.	**M**	CLF-8	

2. SPECIAL OPERATIONS FORCES (SOF)	Tier	Issue	CTI
a. Develop or improve the SOF capabilities listed below: 1. Improve the capability of designated ships to host SOF units, particularly in its ability to rapidly transit to the egress location while improving readiness and logistics support for SOF. 2. Provide the capability to covertly communicate with SOF units from a host submarine throughout the period from egress to recovery. 3. Improve SOF sensors to covertly image in any environment, e.g., dark and turbid waters, surf zone, etc.. 4. Control SOF equipment signatures to be compatible with mission requirements, e.g., no or low magnetic signature in proximity of minefield. 5. Control Swimmer Delivery Vehicle (SDV) signatures to be equivalent to or less than the host platform's as a means to prevent counter-detection.	**M**	MFP-36	2-F 2-H 2-F
b. Develop capability to detect and locate weapons of mass destruction.	**M**	ISR-29 MFP-38	
c. Develop technology to conduct infiltration in lieu of amphibious operations with total surprise.	**L**	MFP-37	

3. PLATFORMS AND LOGISTICS	Tier	Issue	CTI
a. Explore technology for an advanced stealth survivable transporter for independent operation at high speed, with no signature, impervious to attack, that can carry 10K tons and operate in a chemical/biological/radiation (CBR) environment.	**H**	MFP-37,38 FE/N51-45 MCC-62 N931-64	6-A
b. Provide a ship deployable, high-speed, shallow-draft craft equipped with PGMs for use in escorting and defending Landing Craft Air Cushioned (LCAC) and Advanced Amphibious Assault Vehicle (AAAV), and for fire support ashore, in operational maneuver from the sea (OMFTS) missions.	**H**	MFP-37 MCC-62	2-F
c. Develop high speed, survivable, stealth, medium-capacity ship/shore lift to operate in a CBR environment.	**H**	N4-18 MFP-37,38 FE/N51-45 MCC-62 N931-64	6-A 10-B
d. Develop a sea-based, adaptive-combat logistics and resupply, with total asset visibility and access, and "just-in-time" resupply.	**M**	N81-47 MCC-62	
e. Develop miniaturized equipment.	**L**		

4. C^4I	Tier	Issue	CTI
a. Develop means to insure DBA/DBK to increase: 1. Up-to-date beach area databases (high resolution) 2. Predictable environmental models 3. Means to do *in situ* rehearsals	**M**	MFP-37 N096T-57	
b. Develop a joint C^4/ISR architecture adaptable to amphibious environment to: 1. Facilitate seamless transition to follow on forces. 2. Provide full battlespace awareness in the AOA in the most complex environment. 3. Provide an updated, accurate, high-resolution Beach Survey Database (analogous to Qroute).	**H**	CLF-5 CCEN-15 C4IW-34 N86-39	1-A 4-A 4-B

5. MARINES ASHORE	Tier	Issue	CTI
a. Develop lightweight, affordable, direct/indirect precision fire power capability for use in OMFTS ship-to-shore and shore-to-objective movement in landing vehicles, assault craft, light armored vehicles, personnel carriers, etc.	**H**	MFP-37	2-F

5. MARINES ASHORE	Tier	Issue	CTI
b. Develop improved all weather, day/night capability with attention to operations other than war such as urban environments. Capability must be: 1. Adaptable from team to division 2. Support lethal to non-lethal 3. Stealthy	**H**	MFP-37	2-E 2-F 2-H
c. Develop individual marine protections for the following environments: 1. NBC 2. All weather 3. Lightweight body armor 4. Universal vaccine	**H**	FE/N51-45 N931-64	11-B
d. Develop technologies to protect the soldier/sailor from small arms and NBC.	**M**	MFP-37	
e. Develop technologies to enhance the ability to fight in a "dirty" battlefield providing NBC detection and protection.	**M**	MFP-37,38 FE/N51-45 N931-64	
f. Develop non-lethal weapons for marines which are anti-personnel and anti-machinery.	**H**	MFP-37 N931-66	2-E
g. Develop technologies to give greater mobility to Marines with something like jet packs.	**M**	MFP-37	
h. Develop technologies to provide virtual/holographic marines using something like robotics.	**M**	MFP-37 FE/N51-45	

Chapter 8

LOGISTICS SUPPORT

Introduction - Logistic support for the purposes of identifying S&T requirements, focuses on developing and maintaining an affordable logistical support capability that enables the rapid deployment and sustainment of U.S. combat forces. Technology in this area aids in the enhancement of our strategic sealift capabilities; improvements to the Logistics Over The Shore (LOTS) to increase throughput in higher sea states; new salvage technologies and systems; improvements to the combat logistics force ships; equipment improvements to reduce maintenance requirements, increase life cycles and reduce material failures; advanced integrated logistics systems; and just-in-time logistics.

Requirements Categories - Underlying Logistics Support are ten sub-categories which are grouped as follows:

1. Affordability
2. Strategic Sealift
3. Joint Logistics Over The Shore (JLOTS)
4. Salvage Systems
5. Combat Logistics Force (CLF)/Underway Replenishment (UNREP)
6. Maintenance
7. Infrastructure
8. Sea-Based Logistics
9. Vulnerability
10. Other

1. Affordability
Affordability includes new technologies to increase life cycles and modernize all systems while maintaining or increasing capability. This means the development of methodologies, processes and techniques to make current and future weapons systems and infrastructure more affordable.

2. Strategic Sealift
Strategic sealift is required to support deployments and sustain operations of U.S. combat forces. To this end, it is critical to have self-sustaining, high speed, large capacity ships to enable rapid surge deployment of critical combat forces and supplies. Improved high speed sealift ships could be used to augment strategic airlift to accommodate just-in-time logistics. These vehicles can be both organic assets or converted commercial vessels.

3. Joint Logistics Over The Shore (JLOTS)
JLOTS provides the capability to quickly move large quantities of bulk cargo and fuels from ship to the shore to support the landing forces. Analysis of sea state patterns indicates in

certain CINC Area of Responsibilities (AORs) sea state 3 occurs up to 50 percent of the time. To significantly enhance this JLOTS capability it is critical to develop JLOTS systems that can safely and productively operate through sea state 3

4. Salvage Systems
Salvage systems are necessary to support the recovery of Naval vessels, aircraft and other assets in the sea environment including the recovery of trapped personnel. Salvage also includes the rapid clearing of blocked chokepoints critical to combat operations.

5. Combat Logistics Force / UNREP
The combat logistics force consists of those ships and vessels used for resupplying ships at-sea. Underway replenishment is key to the sustainment of at-sea forces. Increasing the flexibility, capacity, cargo handling and transfer rates reduces UNREP time and thereby the vulnerability of the battle force. Additionally, an underway vertical launch system (VLS) re-arm capability is required for combatants.

6. Maintenance
Maintenance and repair of equipment is costly but key in the readiness of combat forces. Navy's reduced budgets necessitate cutting weapons systems maintenance life cycle costs. Some ways to reduce maintenance costs include designing equipment with more diagnostics, self repair and fault tolerant capabilities, developing advanced materials with lower failure rates and using new failure prediction techniques to determine probable time to failure.

7. Infrastructure
Infrastructure is always a major component of any logistics system. Investments in infrastructure improvements are required to standardize lighter, smaller, easier to handle containers and logistics handling and control systems. New materials and maintenance procedures are also required to reduce facilities infrastructure life-cycle costs.

8. Sea-Based Logistics
Improvements in Sea-Based Logistics include total asset visibility and tracking from manufacturer to the end user. Development of just in time logistics systems can reduce the inventories and personnel required to support a given force and thereby increase the efficiency and reduce the costs of the total logistics support force.

9. Vulnerability
Sealift and Combat Logistics Force ships are not only vulnerable to hostile threats but also to the hazards of the cargoes they carry. Reducing the vulnerability to hazards is a key requirement. This includes improving Sealift and CLF ships' systems for fire fighting, damage control and safe cargo handling and developing counters to air, surface, and subsurface threats.

10. Other
Since Combat Logistics Force ships operate routinely in joint and combined operations it is required that improvements be made in their C4I interoperability capability. Additionally,

energy R&D is required to ensure fleet fuel availability and quality, without increasing costs or sacrificing performance, safety and reliability. Increasing energy efficiency of all systems and equipment is key to reducing life-cycle costs.

TABLE IX. LOGISTICS SUPPORT TECHNOLOGY AREAS

1. AFFORDABILITY	Tier	Issue	CTI
a. Develop methodologies, processes and techniques to make current and future weapons systems and infrastructure more affordable: 1. Develop system designs and techniques to reduce/minimize life cycle costs, (e.g., corrosion prevention, structural loading and response analysis models and concepts for multifunctional applications). 2. Develop new/better operations research techniques to optimize logistics force structure. 3. Develop systems, processes, and technologies that result in reduced manpower.	H	N4-16 N81-46,49 N81-52 MP/N12-26	
b. Develop technologies that provide for life cycle extension and modernization of all systems/infrastructure, e.g., machinery, electronics, platforms, buildings/piers, etc.	H	N4-16 N81-52	
c. Pursue improvements in component reliability as a method to reduce overall life-cycle costs for sea-based logistics.	L		

2. STRATEGIC SEALIFT	Tier	Issue	CTI
a. Improve sealift platform concepts, design and equipment technology to yield significantly higher cargo transport rates (High value, time critical goods require timely delivery). 1. Evaluate cost-effective vehicle concepts for sealift in three speed ranges: 20-40 knots, 60-80 knots, and 250+ knots.	H	MCC-62	6-A

2. STRATEGIC SEALIFT	Tier	Issue	CTI
b. Improve cargo-handling capability to reduce time and cost to load/offload sealift platforms including offload capabilities at piers or via JLOTS through sea state 3: 1. Develop technology to increase cargo density. 2. Integrate in-transit visibility (ITV) technology and automated cargo-handling systems into sealift platforms. 3. Identify alternative, self-sustaining sealift platforms. 4. Integrate sealift platform concepts with JLOTS requirements. 5. Optimize cargo movement within sealift platforms to minimize offload times and provide selective offload capabilities. 6. Improve the mooring and anchoring system of ship-to-pontoon, enabling cargo transfer in higher Sea States. 7. Explore technologies to improve the Offshore Petroleum Discharge System (OPDS) capability. 8. Improve capability to handle containerized ammunition.	H	N4-18	
c. Improve sealift platform regeneration capability to include reduced turn-around time.	H		
d. Improve sealift platform storage capability, inventory management and environmental control, and reduce maintenance of systems and stowage in long-term lay-up.	H	N81-47	
e. Develop dual-use technologies and platform concepts that improve commercial viability of military useful platforms and commercial vessels: 1. Develop augmentation systems which provide enhanced cargo handling capabilities on existing and future merchant ships. 2. Develop augmentation systems which provide enhanced fuel product transport and handling on existing and future merchant ships. 3. Develop and demonstrate cargo and terminal control systems for use in conjunction with augmented sealift support platforms. 4. Expand underway replenishment capability.	L	MCC-62	
f. Develop improved materials to reduce weight and improve performance while reducing fuel costs.	L		
g. Improve sealift platform deactivation and lay-up technology to preserve and store platform and equipment to maintain its ability for rapid recall.	L		

3. JOINT LOGISTICS OVER THE SHORE (JLOTS)	Tier	Issue	CTI
a. Develop JLOTS deployment and retrieval technology to: 1. Reduce installation and retrieval times of JLOTS subsystems with a goal of at least 25-50% of established doctrine (e.g., elevated causeway).	**H**	N4-18	
b. Develop throughput technology to: 1. Increase ability to operate through Sea State 3 in all phases of ship to shore cargo movement. 2. Provide a rapidly deployable bulk fuel delivery system to support the assault echelon and JLOTS which can be installed within 12 hours in Sea State 4 and provides up to 1.2M gallons per day. 3. Extend standoff distances from the shore that support Operational Maneuver from the Sea (OMFTS). 4. Integrate LOTS capability with offshore basing and portable ports.	**H**	N4-18	
c. Explore technology to reduce Sea States > 5 to < 3.	**H**		
d. Improve or develop advanced modeling and simulation techniques: 1. Develop operations analysis techniques to maximize effective use of JLOTS assets. 2. Develop analytical tools to support design, assessment and acquisition of future JLOTS systems.	**H**		
e. Improve mechanized cargo/weapons handling from sea to shore.	**L**		

4. SALVAGE SYSTEMS	Tier	Issue	CTI
a. Explore technologies to provide improvements to the following salvage capabilities: 1. Lightweight beach gear. 2. Rapidly deployable, easily relocatable, salvage lift (>500 tons). 3. Environmentally safe flotation foam for use in salvage operations. 4. Rapid emergency towing system. 5. Method to identify, track and retrieve salvage equipment, materials and supplies brought to an AOA from many sources. 6. Lightweight, low-maintenance towing hawser. 7. Improved, environmentally sound, off-ship fire-fighting capability. 8. Autonomous underwater search system. 9. Fly-away, deep-ocean salvage system capable of 15 tons. 10. Remotely operated cable-splicing vehicle capability. 11. High-rate, oil-pollution containment and abatement system for operating up through Sea State 2.	M		
b. Develop technologies for rapidly deployable, easily relocatable salvage lift capability (> 5000 tons).	L		
c. Develop technologies for a rapidly deployable, chokepoint salvage clearance system.	H		

5. COMBAT LOGISTICS FORCE (CLF)/UNREP	Tier	Issue	CTI
a. Explore technologies to expand underway replenishment (UNREP) capability for station and shuttle ships: 1. Increase all types of cargo throughput delivery capability and at the same time reduce UNREP manning requirements. 2. Increase ship separation between CLF and receiving ship. 3. Provide stowage, strike up and down, deck handling and transfer capability during sea state 5 and icing conditions. 4. Improve receipt and strikedown rates to match CLF ship delivery rate. 5. Integrate ITV technology and automated cargo-handling systems. 6. Optimize cargo movement within CLF platform to minimize offload times and provide selective offload capabilities.	H		
b. Develop techniques to reduce UNREP time, e.g., concurrent single-spot arming, refueling and inspection.	L		

5. COMBAT LOGISTICS FORCE (CLF)/UNREP	Tier	Issue	CTI
c. Decrease cycle time for re-supply:	**H**	N81-47	
1. Decrease turn around time for re-supply ships, e.g., automated handling / management and ship design.			
d. Maximize cargo and weapons stowage and handling capability:	**H**	MCC-62	
1. On and between decks/holds.			
2. Flexible storage.			
3. Reduced explosive arc.			
4. Provide selective offload.			
e. Develop multipurpose logistics ships with interchangeable storage and weapons spaces.	**L**		6-A
f. Develop at-sea VLS re-arm capabilities	**H**		

6. MAINTENANCE	Tier	Issue	CTI
a. Develop condition-based maintenance capabilities (diagnostic and prognostic) for all naval platforms and facilities.	**H**	N4-19 N81-50 MCC-62	
1. Improved non-destructive inspection and vibration analysis for engines and structural components.			
2. Integrated expert systems (sensors).			
3. Provide improved engine failure prediction			
4. Provide improved system failure prediction			
5. Provide failure prediction for arresting gear.			
b. Improve the following maintenance and repair capabilities:	**H**	N4-19 N81-52	
1. Open-ocean underwater BDA in sea state 3.			
2. Underwater joining and cutting techniques for patching battle damage.			
3. Portable, deck-mounted handling system for underwater husbandry and repair tasks.			
c. Improve shipboard fiber optic systems maintainability.	**H**	N81-52	
d. Improve capability for corrosion detection/inspection, preservation, repair, and elimination.	**H**	CLF-12 N81-52	
1. Materials and coatings engineered for the life of the system.			
2. Low-cost/low-manpower and/or no surface preparation.			
3. Alternative concepts for corrosion mitigation.			
4. Environmentally benign internal/external anti-fouling coating.			
5. Non-intrusive detection.			

6. MAINTENANCE	Tier	Issue	CTI
e. Develop new technologies to enhance equipment maintenance and overhaul with goal of maintenance self-sufficiency among naval forces: 1. On-line technical assistance at-sea and ashore. 2. Improved in-theater low observable material/composite repair capabilities. 3. In-theater micro-miniature component repair capability. 4. Develop and employ fault-tolerant systems and equipment. 5. Develop auto-repairing equipment/systems. 6. Develop multi-function equipment with common components	**H**	N4-19 N81-50,52	
f. Design increased reliability, maintainability and availability into equipment: 1. Interchangeable systems. 2. Modular systems. 3. Non-fluid cooling and lubricating.	**H**	N81-52	
g. Develop more durable materials which require less maintenance.	**H**	N81-52	
h. Develop techniques that predict material-cause failures.	**H**	N81-52	
i. Develop a real-time logistics interface that ensures products reflect actual system configuration: 1. 100% accuracy of product technical and training manuals, maintenance capability, piece parts, etc. 2. *In situ* validation. 3. Automated, simultaneous, low-cost, rapid, concurrent update.	**L**	N81-52	
j. Develop technologies which eliminate material cause factors: 1. Provide reliable Unmanned Air Vehicle (UAV) engines. 2. Provide "all-lighting-condition"-capable displays. 3. Provide safer catapult gear energy delivery and control systems. 4. Provide Recovery, Assistance, Securing, and Transversing (RAST) cable visibility. 5. Provide alternative cooling for avionics without impacting OBOGS breathing air and engine performance.	**L**	N81-52	

7. INFRASTRUCTURE	Tier	Issue	CTI
a. Minimize logistics footprint without loss of capability: 1. Develop equipment and methods to reduce personnel requirements. 2. Improve the efficiency of energy-consuming systems. 3. Reduce equipment size, weight and volume without loss of capability. 4. Develop methods to efficiently preposition needed supplies and equipment.	M		
b. Provide a standardized, adaptable, integrated logistics system with: 1. Decision analysis support system for integrated maintenance, supply, configuration and data. 2. Single, simplified, standardized accounting for property and financial systems for ashore/afloat assets. 3. Real-time interface with transportation system.	H		
c. Develop concepts, materials and techniques that permit reduced facilities investment: 1. Develop alternative construction materials and concepts. 2. Develop techniques that support condition-based maintenance. 3. Develop techniques that support timely condition assessment. 4. Develop cost-effective concepts for multi-functional facilities. 5. Develop structural loading and response analysis models.	H	N4-19	

8. SEA BASED LOGISTICS	Tier	Issue	CTI
a. Provide total asset visibility and accessibility from manufacturer to end user.	H		6-B
b. Develop capability for just-in-time responsive logistics with: 1. Selective/responsive pull. 2. Automated supply visibility. 3. Supply sufficiency. 4. Logistics push.	L		
c. Develop a sea-based logistics concept that supports Operational Maneuver from the Sea (OMFTS) concept and minimizes combat logistics footprint ashore. 1. Develop capability to perform selective offload from sealift and amphibious ships	H		6-B

9. VULNERABILITY	Tier	Issue	CTI
a. Develop technologies to maximize fire-fighting capability through:	**L**		
1. Low-combustibility fuels and fuel systems.			
2. Adequate fire suppression and reflash systems.			
3. Improved fuel containment.			
4. Effective, safe and environmentally sound HALON and AFFF replacement.			
5. Fire source diagnostic systems.			
6. Nonflammable, non-toxic hydraulic fluid that is compatible with existing systems.			
7. Reduced weight of fire fighting ensemble.			
8. Heat-reactive bulkheads.			
9. Full fire-fighting potential of fog stream application.			
b. Decrease vulnerability of Sealift and CLF platforms:	**L**		
1. Provide battle damage assessment and containment capability including limiting loss of critical cargo and preventing sympathetic detonations.			
2. Provide an automated, environmentally safe fire fighting system for sealift concept.			
3. Provide damage-resistant, high-performance magazines/cargo holds.			
4. Develop damage-tolerant designs.			
5. Develop a real-time hull integrity monitoring system.			
6. Explore technologies to reduce signatures and provide effective countermeasures.			
7. Explore affordable, modular alternatives to detect, identify and counter prevalent air, surface and subsurface threats.			
c. Develop improved shipping containers/systems that are lightweight, high-strength, low-volume, shock-absorbent and non-toxic.	**H**	MCC-62	
d. Develop reduced dependency on MoGas equipment.	**H**		

10. OTHER	Tier	Issue	CTI
a. Improve interoperability, including C^4I, of CLF platforms in joint and combined operations.	**L**		
b. Ensure fuel availability and quality, without increasing cost, while increasing performance, safety and reliability:	**H**	N81-52	
1. Improve thermal stability			
2. Develop non-toxic environmental friendly additives			
3. Develop in-line purification.			
4. Develop portable, miniaturized fuel quality analyzer.			
5. Stabilization additives for diesel and crude fuels.			

10. OTHER	Tier	Issue	CTI
c. Increase energy efficiency of naval systems and equipment: 1. Improve fuel economy. 2. Real-time efficiency measurement. 3. Effective biological-fouling control to increase hull efficiency. 4. Propellant and explosives recycling or reuse.	**H**	N81-52	

Chapter 9

MANPOWER/PERSONNEL

Introduction - Manpower and Personnel for the purpose of identifying S&T requirements, focuses on the human-performance aspects of military systems including human-system interfaces and human-performance measurements. Technology in this area aids the forecasting of manpower requirements, placement of individuals in appropriate jobs, and improvement of the fit between humans and equipment. It includes tools for manpower planning; methods of personnel testing, selection, classification and utilization; methods of improving military performance and reducing the required numbers and skill levels of system operators and maintainers; and principles and techniques for the design, acquisition and use of military systems to provide an operating environment suited to human capabilities.

Requirements Categories - Manpower and Personnel S&T issues fit into two sub-categories:

1. Human Performance
2. Personnel Management.

1. Human Performance
This category addresses the ability of individuals, teams and units to conduct effective military operations under a variety of conditions. Human operators and maintainers are integral components of military systems so their performance must be factored into any meaningful test of overall system effectiveness. DON requires the ability to assess and predict military job performance and to diagnose, remedy or prevent shortfalls. In addition, it seeks to maximize the performance of military systems by ensuring that humans can operate and maintain them effectively.

2. Personnel Management
This category addresses DON's ability to achieve the right shape, size and composition of personnel force structure for maximum capability and flexibility. DON must anticipate manpower requirements, recruit individuals to fill those needs at the right time, match people to jobs, and manage careers to ensure retention of the top performers. Military force management also must reflect shifting resource constraints and major societal changes.

TABLE IX. MANPOWER/PERSONNEL TECHNOLOGY AREAS

1. HUMAN PERFORMANCE	Tier	Issue	CTI
a. Develop methods or technologies to improve individual decision making to the full extent of human capability: 1. Modeling the human brain. 2. Reducing the information workload. 3. Enhancing decision making under complex conditions, with sparse and/or ambiguous data.	**M**	MP/N12-24	
b. Develop methods or technologies to enhance individual performance: 1. Determining optimum human/automation workload mix. 2. Enhancing physical capability, e.g. with robotics and tele-operations. 3. Enhancing mental capability, e.g. with artificial intelligence. 4. Enhancing physiological capabilities.	**H**	MP/N12-26 N81-46	
c. Develop technology for cognitive-friendly data/information, to include: 1. Critical data presentation. 2. Tactical/situational awareness. 3. Data extraction filters.	**M**	MP/N12-24	

2. PERSONNEL MANAGEMENT	Tier	Issue	CTI
a. Develop decision support models that correlate personnel force structure issues such as pay, bonuses, recruiting, demographics, etc. to warfighting readiness: 1. Optimization of end strength. 2. Impact of manning changes (increases and decreases) on readiness.	**M**	MP/N12-21 MP/N12-23 N81-51	
b. Develop predictive models to determine impact of satisfiers/disatisfiers such as special pays, homebasing, OPTEMPO/PERSTEMPO on personnel retention.	**M**	MP/N12-22	
c. Develop a predictive instrument and assignment model that determines best unit assignment for individuals to maximize unit cohesion.	**M**	MP/N12-22	
d. Develop manpower estimation tools for acquisition of new systems.	**H**		

2. PERSONNEL MANAGEMENT	Tier	Issue	CTI
e. Develop decision support models that improve utilization of personnel to meet force requirements, while predicting best opportunity for individual success, to include all facets of personnel solicitation, selection, classification and distribution and accomplish the following: 1. Accurately measure technical and nontechnical personal attributes at each stage of a person's career. 2. Monitor overall capabilities of personnel. 3. Provide this individual information to recruiters, classifiers, and detailers in a useful format. 4. Operate as "smart" systems, able to simulate logic and thought processes of the decision makers involved, in order to recommend "best fit" personnel actions.	**M**	N81-51 MP/N12-23	

Chapter 10

TRAINING

Introduction - Training includes accession training, with its facilities, equipment, services, and instructors, specialized skill training, undergraduate flight training and DON education programs to maintain fleet and shore-establishment readiness. It also includes simulation for training and mission-rehearsal for defining S & T requirements. Ultimately, training must be adaptable, responsive, global, efficient, and consistent.

Technology in this area focuses on the development, conduct, and management of instructional programs and on the development of simulators, training devices and other training systems. It addresses professional skills required for career progression and technical abilities required for job performance; individual job skills and unit collective tasks; instruction in procedures, tactics and the operation and maintenance of military equipment; shore-based classroom training; and on-the-job, on-board and embedded training. It encompasses basic entry training, initial and specialized skills training, fleet training for individuals and teams, and leadership training.

Requirements Categories - Underlying Training are three sub-categories which are grouped as follows:

1. Training Strategies and Methods
2. Instruction Delivery
3. Management of Training Resources

1. Training Strategies and Methods
This category involves strategies and methods which will result in the ability to train more rapidly and effectively and yet be able to make timely changes in training methods and materials.

2. Instruction Delivery
Instruction delivery addresses requirements for effective training in dispersed geographic areas, in a variety of environments and at affordable cost.

3. Management of Training Resources
This category focuses on management of resources for greater effectiveness with a smaller training establishment as the Navy becomes smaller.

TABLE X. TRAINING SUPPORT TECHNOLOGY AREAS

1. TRAINING STRATEGIES AND METHODS	Tier	Issue	CTI
a. Innovate and optimize instructional approaches (e.g., on-demand and just-in-time training) for initial, replacement, refresher and joint training: 1. Develop training based on fleet-based common tactical picture. 2. Combine real-life training with realistic simulation and stimulation. 3. Examine methodologies and technologies such as media options and gaming, conduct cost-benefit and risk assessment and risk management analyses, and assess applicability to specific instructional goals. 4. Develop advance technologies (e.g., virtual reality) to make simulation more realistic. 5. Develop improved techniques to support embedded training. 6. Make training fun and relevant.	**H**	N81-51	7-A
b. Develop integrated risk-assessment/risk-management tools for all training missions/evolutions.	**L**		
c. Correlate changes in training to mission effectiveness.	**M**		
d. Develop the capability to allow forward presence forces to conduct all appropriate training and exercises.	**M**		
e. Develop complements to live-fire training.	**H**		
f. Develop *in situ* training to reduce training time away from unit and increase number of people receiving the training and proficiency.	**H**	N81-51	7-A
g. Improve capability to evaluate training. Provide: 1. Methods to evaluate individual and group performance and proficiency. 2. Methods to evaluate instructor performance. 3. Methods to rate course/exercise effectiveness.	**H**	N81-51	
h. Optimize human ability to learn through understanding how people learn and how machines can augment and enhance these learning capability.	**H**	N81-51	7-A

2. INSTRUCTION DELIVERY	Tier	Issue	CTI
a. Develop 3-D virtual reality simulators.	**M**	N81-51	7-A
b. Provide student and team instruction techniques to deliver effective, just-in-time training anywhere on demand.	**H**	N81-51	7-A

2. INSTRUCTION DELIVERY	Tier	Issue	CTI
c. Enhance ability to provide individual and group training and mission rehearsal: 1. Maximize student comprehension and retention. 2. Provide deployable, reconfigurable training systems. 3. Optimize balance and interface between shore and fleet training. 4. Develop common architectures for training systems.	**H**	N81-51	
d. Provide capability for realistic, large-scale naval and joint tactical training: 1. Link wide range of geographically dispersed units, platforms, weapon systems, models, simulators and databases to exercise all elements. 2. Maximize performance under highly stressful conditions. 3. Provide timely post-ex evaluation and diagnostic feedback to all hands. 4. Provide for rapid development and modification of complex scenarios. 5. Increase interoperability for joint training. 6. Enhance systems which optimize utilization of system sensors in training. 7. Develop techniques for brigade (BG) and Joint Task Force (JTF) level simulation and stimulation.	**M**		7-A
e. Develop capability to measure and maintain unit individual proficiency at all tasks: 1. Provide capability for training on demand. 2. Provide capability to customize training to missions and environments. 3. Provide capability to customize training to individuals.	**M**	N81-51	
f. Develop feedback system that identifies training shortfalls by providing the following: 1. Validated input/output criteria for training effectiveness. 2. An effective, timely mechanism for fleet feedback on training.	**M**	N81-51	
g. Develop shipboard training as the primary means of delivering individual and team training.	**H**	N81-51	7-A
h. Develop reconfigurable and adaptive training systems for both individual and groups.	**H**	N81-51	

3. MANAGEMENT OF TRAINING RESOURCES	Tier	Issue	CTI
a. Increase use of off-the-shelf components, adaptable simulations, predictive modeling, reusable software and innovative techniques.	**M**	N81-51	
b. Develop strategies and techniques for training-resource planning, programming, budgeting and execution.	**L**	N81-51	

3. MANAGEMENT OF TRAINING RESOURCES	Tier	Issue	CTI
c. Optimize development and maintenance of instructional materials:	L	N81-51	

1. Develop techniques for task analysis, objective setting, media selection, curriculum development, and effectiveness measurement.
2. Improve writing and content of instructional materials.
3. Reduce reliance on paper-based technical and training materials.
4. Develop dynamic, real-time life-cycle management of materials.
5. Ensure adaptability to advancing technology and methodology.

Chapter 11

MEDICAL/PERSONNEL PROTECTION

Introduction - The objectives of medical technology area are to maximize health, safety and mission performance of military personnel. Traditional roles have centered around supporting the combat readiness of the Navy and Marine Corps by supporting global medical requirements to accomplish the missions. As the nature of deployment for combat troops changes, so must medical support. Consequently, preventive medicine practiced on collective and individual levels, aerospace medicine, human factors and human capabilities in relation to new weapons and platforms are emphasized.

Navy medicine encompasses aspects of medical practice from basic research to mass casualty treatment. From pure research to battlefield medicine of the most basic nature, medical developments affect the capability of Navy personnel to accomplish the mission. The S&T Round Table considered many areas within its functional area in the early stages of the round table process. After review of the FY 95 medical functional architecture, other medical requirements were added to complete a list relevant to current needs.

Requirements Categories - This list, comprising five categories pertaining to medicine and the protection of military personnel, spans traditional areas of concern:

1. Operational Medicine - Assessment & Detection
2. Operational Medicine - Prevention
3. Operational Medicine - Treatment
4. Combat Casualty Care - Casualty Management
5. Combat Casualty Care - Delivery and Treatment

1. Operational Medicine - Assessment & Detection
This category includes those requirements needed to detect and assess operational and occupational health threats. Operational health threats include chemical and biological weapons and non-lethal weapons. This category address occupational health threats including radio frequency radiation, industrial chemicals, and noise.

2. Operational Medicine - Prevention
Operational Medicine - Prevention addresses prevention of operational and occupational health threats through vaccine development, disease identification, and risk prevention.

3. Operational Medicine - Treatment
This category addresses those requirements for development of neutralization and treatment of operational and occupational health threats including neutralization of chemical and biological agents, countermeasures for performance degradation, and limiting effects of Navy specific hazardous materials.

4. Combat Casualty Care - Casualty Management

This category addresses those requirements for development of improved management of operational casualties, including Special Operations Forces, through improved afloat medical facilities, and treatment regimens.

5. Combat Casualty Care - Delivery and Treatment

Combat Casualty Care - Delivery and Treatment includes those requirements for the development of products and treatment regimens to decrease morbidity and mortality of combat injuries.

TABLE XI. MEDICAL SUPPORT TECHNOLOGY AREAS

1. OPERATIONAL MEDICINE -- ASSESSMENT & DETECTION	Tier	Issue	CTI
a. Assess bioeffects of non-lethal technology that affects bodily functions, such as brain waves, hearing, vision, low frequency water-borne sound.	**H**	N931-66	
b. Develop techniques for remote heartbeat detection and identification.	**L**		
c. Develop more sophisticated chemical/biological weapons detectors for availability as built-in component of future combat vehicles and craft.	**H**	MFP-38	**ISR-29 MP-38**
d. Identify and evaluate reproductive hazards.	**L**	N931-65	

1. OPERATIONAL MEDICINE -- ASSESSMENT & DETECTION	Tier	Issue	CTI
e. Improve and validate current medical criteria for Naval duty: 1. Validate medical screening criteria for naval duty. 2. Evaluate effects of therapeutic drugs on crew performance. a. Validate medications considered for use while flying. 3. Develop validated mannequin/engineering model for cockpit development. a. Develop anthropometric gender-neutral safety limits. b. Provide gender-neutral anthropometric requirements for cockpit. c. Reduce neck and back strain in combat aviators. 4. Develop safe ejection criteria for next generation aircraft. 5. Evaluate validity of color vision requirements for shipboard personnel. 6. Evaluate effects of photo refractive keratectomy on mission specific performance. 7. Improve prevention /identification of persons at risk for adverse psychological responses. 8. Develop gender/race neutral crew selection/test battery. 9. Improve predictive mechanics of psychological/sociological/medical adaptability & screening for special duties.	**L**	N931-65	**1-D**
f. Identify issues associated with women in operational environments. 1. Evaluate epidemiological data and provide tools regarding medical impact of women at sea. 2. Identify issues associated with women in aviation. a. Provide user-accepted urinary collection devices. b. Establish impact acceleration limits for females (cadavric studies). c. Reproductive hazards (esp. noise/vibration and ionizing/non ionizing radiation. d. Ejection escape induced hazards.	**H**	N931-65	
g. Optimize physical fitness programs to sustain/enhance performance. 1. Eliminate injuries due to physical fitness programs. 2. Develop alternative recruit physical training requirements and programs. 3. Minimize effects of orthopedic injuries training on operational readiness.	**L**		
h. Develop expert systems for workplace environmental surveillance and monitoring.	**L**		

1. OPERATIONAL MEDICINE -- ASSESSMENT & DETECTION	Tier	Issue	CTI
i. Improve measures and quantification of RF and microwave energy absorption humans.	**L**		
j. Develop methods to predict/prevent oxygen toxicity 1. Identify mechanisms of oxygen toxicity. 2. Integrate O_2 and CO_2 machine sensors with human sensors for multi-level diving.	**L**		
k. Develop reagents with longer shelf lives, reduced refrigeration requirements.	**L**		
l. Automate/enhance laboratory procedures for independent duty corpsmen.	**H**		11-A

2. OPERATIONAL MEDICINE -- PREVENTION	Tier	Issue	CTI
a. Create a universal vaccine for biological warfare agents with no side effects	**H**	FE/N51-45 N931-64	11-B

2. OPERATIONAL MEDICINE -- PREVENTION	Tier	Issue	CTI
b. Eliminate human factors errors/problems that put personnel at risk.	**H**		
1. Develop real-time predictive models of human error factors involved in mishaps.			
2. Provide a manageable system workload for all warfare areas through:			
a. Information assimilation and integrated workload planning.			
b. Collision avoidance system.			
c. Adequate crew displays.			
d. Improved software safety analysis tools.			
3. Provide risk-assessment/risk-management and decision-making tools for naval missions.			
4. Develop real-time decision-making aids for crew safety.			
5. Develop deployable human impairment testing systems.			
a. Improve cognitive performance monitors in naval operations.			
b. Automatic pilot physiological monitoring and feedback system.			
6. Develop human factors hazards assessments and countermeasures for virtual environments.			
7. Reduce risk to aviation flight deck/flight line personnel.			
a. Develop methods to reduce risk on flight decks/flight lines.			
b. Provide fleet with shift work scheduling alternatives.			
8. Provide method to screen for susceptibility to spatial disorientation.			
a. Provide alternative methods for spatial orientation.			
9. Optimize countermeasures for air sickness and simulator sickness.			
10. Determine Predictive/causative factors correlated with potential safety hazards.			
c. Improve identification/prevention/treatment of new or re-emerging military relevant diseases.	**H**		
d. Determine effect of military chemical, biological, and protective gear on mission performance.	**L**	FE/N51-45	**2-C**

2. OPERATIONAL MEDICINE -- PREVENTION	Tier	Issue	CTI
e. Develop lightweight, user-friendly, and reusable Military Operations Protective Posture (MOPP) gear. Develop passive systems for personnel defense. 1. Implement advanced respiratory protection and antibody development. 2. Develop agent-impermeable membranes. 3. Improve body armor. 4. Determine personal protective equipment requirements for protection from chemical, biological and radiological attack.	**H**	FE/N51-45	**1-D** **2-C**
f. Improve surge capability in vaccines and immunizations.	**L**	N931-64	**11-B**
g. Minimize thermal effects on human physiology (undersea, aerial, surface).	**L**		
h. Improve prevention and treatment of dental emergencies.	**L**		

3. OPERATIONAL MEDICINE -- TREATMENT	Tier	Issue	CTI
a. Create a system to neutralize chemical/biological agents rather than just using physical shielding (MOPP)	**H**	FE/N51-45	11-2-C
b. Develop potable water contamination indicator technology.	**H**		
c. Improve toxicological tools for analysis of Navy specific hazardous materials. 1. Determine permissible personnel exposure limits for naval fuels.	**L**		
d. Develop methods to decrease/treat decompression sickness. 1. Identify basic mechanisms of decompression sickness. 2. Increase multi-level repetitive diving duration and decrease decompression requirements.	**H**		
e. Develop countermeasures for performance degradation due to environmental factors (e.g., fatigue, thermal stress). 1. Investigate psycho-physiological effects and develop countermeasures. 2. Provide risk-assessment/risk-management tools for fire fighting and damage control missions (incl. operations in CBR environment). 3. Determine requirements for fire fighting / damage control in a CBR environment.	**L**		
f. Develop an orally administered insect repellent.	**H**		
g. Determine optimum fluid resuscitation as a function of time to definitive surgical intervention.	**H**		

4. COMBAT CASUALTY CARE -- CASUALTY MANAGEMENT	Tier	Issue	
a. Improve management of operational casualties.	**H**		11-A
1. Define and provide optimal medical care in special warfare scenarios.			
b. Improve on-hull communications and information management in the medical facility.	**H**		
c. Improve mass casualty management (to include war game modeling and simulation).	**H**		

5. COMBAT CASUALTY CARE -- DELIVERY AND TREATMENT	Tier	Issue	CTI
a. Greater availability of blood and blood substitutes.	**H**		
1. Increase reconstitution throughput of blood products.			
2. Enzymatic conversion to O-type blood.			
3. Eliminate immunoreactivity in emergency transfusion.			
b. Rapid non-invasive blood chemistry monitoring.	**H**		
c. Rapid wound healing and debridement.	**L**		
d. Develop organ replacement therapy.	**L**		
1. Skin transplants for burns.			
2. Traumatic single organ failure.			
e. Develop treatment protocols for laser eye injuries.	**H**		**1D**
f. Shipboard manufacture of injectable fluids.	**H**		
1. Improve therapy of reperfusion injury.			
2. Reduced bulk fluid resuscitation technology.			
g. Develop early detection and location capability of personnel incapacitation and injury.	**H**		
1. Real-time, *in situ* portable life sign monitor.			
2. Remote sensing of medical data (vital signs monitor).			
h. Improve medical translator capabilities for special warfare use.	**L**		

Chapter 12

ENVIRONMENTAL SYSTEMS AND OPERATIONS

Introduction - Environmental support focuses on the development of technologies, processes and materials which are environmentally safe to the operating forces and the geographical locations in which U.S. Navy and Marine Corps forces operate. Technology in this area will aid in the development of sensors and systems to detect and safely process environmentally hazardous materials and emissions. It will also aid in the development of new materials and processes used in weapons systems, ships, submarines, aircraft and shore facilities that environmentally friendly.

Environmental support also includes providing environmental information, meteorological and oceanographic, to Naval Forces afloat and ashore in support of their operations. This includes the capability to generate current and future weather forecasts and get them to the forces that need them in real-time. Technology development in this area will aid in the development of meteorological and oceanographic models capable of providing forecasts well into the future and sensors to provide inputs into these models.

Requirements Categories - Underlying Environmental Support are four sub-categories which are grouped as follows:

1. Environmental Sensors and Processes
2. Materials Management
3. Environmentally Compliant Platforms
4. Meteorological and Oceanographic Support (METOC)

1. Environmental Sensors and Processes
The Navy must reduce the amount of hazardous emissions and use of hazardous materials in its operations to meet the target of developing environmentally sound weapon systems. Emissions range from liquids, aerosols and gases to acoustics. It is necessary to develop new processes to eliminate or minimize hazardous emissions and develop new materials/processes to reduce/eliminate the use of hazardous materials. New methods for the safe testing of weapons are required to reduce the environmental impact of testing.

2. Materials Management
Materials management involves the safe handling and disposition of hazardous materials and wastes (cradle to grave design and acquisition). Such materials and wastes include cleaning and de-greasing agents used in hull cleaning and blasting, shipboard coatings and paints, ozone-depleting substances, marine sludge and sediments from remediation and reclamation and hazardous waste destruction. The focus of this sub-category is on the identification of problems and its elimination through material substitution and process changes.

3. Environmentally Compliant Platforms

To insure it operates environmentally compliant platforms, the Navy must develop processes and systems for control, treatment, and destruction of shipboard wastes including solids, plastics, sewage, power plant emissions and oil and non-oily liquid wastes. It must also develop techniques to prevent the incidental intake and transport of non-indigenous marine species in ballast water.

4. Meteorological and Oceanographic Support (METOC)

To be able to provide the most accurate meteorological and oceanographic forecasts in real-time, high resolution, advanced simulation forecasting models need to be developed that will support forecasts out well into the future. These forecasting models must be able to support both open ocean and littoral areas including undersea. They also require sensor systems, both on-board and deployable, that can provide real-time inputs. Finally, technology is required to develop the capability to assist in environmental mine warfare to monitor the natural forces acting upon mines while they are deployed and then provide an analysis of that information.

TABLE XII. ENVIRONMENTAL TECHNOLOGY AREAS

1. Environmental Sensors and Processes	Tier	Issue	CTI
a. Develop Navy unique knowledge base to address and support operations specifically driving compliance/legal mandates.	**M**	N4-17	
b. Develop 3-D models and simulations of containment and dispersion effects in the marine environment.	**M**	CLF-3	
c. Develop environmental warfare countermeasures to include: 1. Detection systems 2. Cleanup and neutralization 3. Spill management 4. Dispersion and effects models	**H**	N4-17	
d. Determine the effects of acoustic and other emissions on marine mammals and threatened/endangered species: 1. LFA effects 2. Technology to assess and mitigate effects of operations and pollution on endangered species	**M**	N4-17	
e. Improve procedures for blast-noise mitigation on test ranges.	**L**		
f. Develop Special Operations Forces (SOF) capabilities to counter environmental destruction and degradation, such as oil well shutoffs, chemical containment and neutralization, fire retardant, etc.	**L**		
g. Develop materials and processes for improved sensing and monitoring of contaminants in marine environments.	**H**	N4-17	

1. Environmental Sensors and Processes	Tier	Issue	CTI
h. Provide Navy unique improved field analytical sensors, methods and protocols to supplement traditional sampling and laboratory analyses.	**M**	N4-17	
i. Improve the monitoring and sensing of Navy unique toxic air emissions.	**M**	N4-17	
j. Develop standardized, regulator-approved methods and protocols for conducting environmental marine risk assessments.	**M**		
k. Develop methods to control jet and rocket engine emissions.	**L**		
l. Develop improved processes for waste minimization, in ordnance manufacturing and demilitarization.	**M**		
m. Develop methods to reduce environmental effects of weapons testing.	**M**		
n. Improve techniques for environmental impact assessment for new systems.	**L**	N4-17	
o. Develop real-time, *in situ* sensors to measure Navy unique effluents.	**L**	N4-17	
p. Develop techniques for rapid containment, cleanup, control and assessment of actions.	**M**	N4-17	

2. Materials Management	Tier	Issue	CTI
a. Develop non-hazardous, and environmentally compliant, safe substitutes for hazardous materials and processes, including hazardous discharge in hull cleaning: 1. Non-polluting, non-toxic cleaning and degreasing agents. 2. Aircraft hydraulic system decontamination and filtration (particle counters.) 3. Improved processes to reduce wastes in ordinance. 4. Coatings, composites, processes and sealants.	**H**	CLF-12	9-A
b. Develop methods for improved marine sediment/dredge spoil decontamination, remediation and reclamation.	**L**		
c. Develop methods to control or reduce emissions from coatings, strippers and cleaners.	**M**	CLF-12	9-B
d. Develop improved methods for hazardous waste destruction ashore, e.g., lithium batteries.	**L**		

2. Materials Management	Tier	Issue	CTI
e. Develop improved shipboard coatings and coating techniques: 1. More durable non-skid systems. 2. Advanced development of anti-fouling/fouling release hull coatings. 3. Improved paint stripping and blast media technologies. 4. Advanced development of unit-coat systems. 5. Techniques for handling flaking lead-based paints. 6. Techniques for sealing lead-based paints.	**H**	CLF-12	9-A 9-B
f. Eliminate ozone-depleting substances: 1. Develop replacement for R114. 2. Develop alternative refrigeration cycle equipment 3. Develop alternate fire-fighting agents to replace HALON. 4. Control and reduce VOCs from coatings, strippers, and cleaners.	**M**	N4-17	9-A

3. Environmentally Compliant Platforms	Tier	Issue	CTI
a. Develop processes for treatment and destruction of shipboard solid, hazardous, medical and plastic waste.	**H**	N4-17,20	9-C
b. Develop effective ship power plants that will comply with future emissions control standards.	**L**	N4-17	
c. Develop processes for the treatment and destruction of shipboard gray and black liquid waste.	**M**	N4-17,20	
d. Develop methods to control emissions from all existing ship engines.	**L**	N4-17	
e. Develop processes for control, treatment and destruction of shipboard oily liquid waste: 1. Improved oil-water separation. 2. Sensors which will not be masked by AFFF contaminated oily bilge water. 3. High volume oil-water separators for aviation wash racks. 4. Improved bilge water processing.	**M**	N4-17,20	
f. Develop technology to reduce incidental intake and transport of non-indigenous marine species in ballast water.	**M**	N4-20	
g. Develop a system to prevent discharge of fuel entrapped in compensating ballast water from fuel system.	**M**	N4-17,20	
h. Devise environmentally friendly alternate fuels and energy sources. 1. Utilize waste, hazardous, non-hazardous, packaging, etc., as fuel.	**M**	N4-17	

4. METEOROLOGICAL AND OCEANOGRAPHIC SUPPORT (METOC)	Tier	Issue	CTI
a. Provide the capability for real-time weather forecasting and "now casting". Key weather parameters can include factors such as precipitation, visibility, fog, cloud cover and heights, aerosols, as well as terrain-induced mesoscale and microscale circulation patterns and anomolies.	**M**	N096T-55	
b. Through effective communication architecture, provide on scene commanders and theater operations managers with timely and detailed environmental characterizations for the highest priority areas of regional conflict.	**M**	N096T-55	
c. Develop organic, high-resolution, fully functional oceanographic and meteorological models of the littoral region, e.g., from the shelf break to the beach and including estuarine areas that can assimilate multi-sensor data, are re-locatable, may be coupled or nested, and are seamless at all boundaries between models.	**H**	CLF-6 N096T-55	
d. Improve the scientific understanding of the environmental physics of the littoral environment to aid in: 1. The design of remote sensors, *in situ* sensors and undersea weapons. 2. Sensor and weapon prediction performance models. 3. Non-acoustic methods of submarine and mine detection.	**L**		
e. Develop the capability to provide organic, high-resolution, fully functional oceanographic and meteorological analyses, or "now casts," of the littoral region, even for those denied areas where direct measurements are not possible.	**L**	N096T-55	4-I
f. Provide an onboard and deployable suite of sensors (possibly including UUVs) to sample the undersea environment in any given area, including a rapid survey for bathymetry and bottom analysis, and then communicate this *in situ* oceanographic and atmospheric information to ships and primary production centers in real-time.	**M**	N096T-55	3-B 4-I
g. Improve the resolution of oceanographic and atmospheric analysis and forecasting models and provide these improved models on board ship for use in sensor and weapon system employment, and as tools to help develop new systems (i.e., LFA) and to maintain battlespace dominance.	**M**	N096T-57	

4. METEOROLOGICAL AND OCEANOGRAPHIC SUPPORT (METOC)	Tier	Issue	CTI
h. Develop global oceanographic and meteorological forecast models that are accurate out to X days and can be used with the littoral seas models and with other higher resolution models of regional areas.	**L**	N096T-57	
i. Develop a more complete understanding of the physics involved in monitoring the environmental parameters associated with MCM, and in the physics associated with sensor vs. mine vs. environment interactions, effects on performance and overall system effectiveness.	**L**		
j. Develop the capability to perform the following real-time, *in situ*, environmental mine warfare monitoring and analysis of the natural forces that act upon mines while they are deployed: 1. Monitor and measure relevant *in-situ* geophysical, marine biological, magnetic, optical, oceanographic, hydrographic and meteorological parameters. 2. Link these data in real-time with historical databases of related data to provide real time display. 3. Provide instantaneous analysis in an understandable format to the MCM task force commander and other local or remote users.	**H**	CLF-7 CCEN-14 N096T-56	2-A 4-I

Appendices

The appendices in this Science and Technology Requirements Guidance contains the following:

1. Acronyms of terminology used in this STRG
2. Coordinated Fleet CINC Consolidated Command Technology Issues
3. Critical Issues/Show Stoppers

Appendix 1

Acronyms

APPENDIX 1

List of Acronyms

	--------- A ---------
A/D	Analog to Digital
AO	Area of Operations
AAA	Anti-Aircraft Artillery
AAAV	Advanced Amphibious Assault Vehicle
AAM	Air-to-Air Missile
AAW	Anti-Air Warfare
ADC	Automated Damage Control
AEW	Airborned Early Warning
AFFF	Aqueous Fire Fighting Foam
AOA	Amphibious Operating Area
AOR	Area of Responsibility
APAR	Active Phased Array Radar
ASCM	Anti-Ship Cruise Missile
ASTOVL	Advanced Short Take-Off, Vertical Landing
ASuW	Anti-Surface Warfare
ASW	Anti-Submarine Warfare
ATDG	Advanced Technology Demonstration Guidance
ATO	Air Tasking Order
ADC	Automated Damage Control
	--------- B ---------
BDA	Battle/Bomb Damage Assessment
BDI	Battle Damage Information
BG	Brigade/Battle Group
BLT	Battalion Landing Team
	--------- C ---------
C2W	Command, Control Warfare
C4	Command, Control, Communications and Computers
C4I	Command, Control, Communications, Computers & Intelligence
CBM	Conditioned Based Maintenance
CBR	Chemical, Biological, Radiation
CCM	Counter-Countermeasures
CEC	Cooperative Engagement Capability
CEP	Circular Error Probability
CFC	Chlorofluorocarbons
CID	Combat ID

CINC	Commander In Chief
CINCLANTFLT	Commander In Chief, Atlantic Fleet
CINCPACFLT	Commander In Chief, Pacific Fleet
CLF	Combat Logistics Force/Commander, Landing Force
CLZ	Craft Landing Zone
CNR	Chief of Naval Research
COA	Course of Action
CONOPS	Concept of Operations
CONUS	Continental United States
COTS	Commercial Off-The-Shelf
CTI	Command Technology Issues
CVBG	Carrier Battle Group
CW/BW	Chemical/Biological Warfare

--------- D ---------

DAMPS	Denied Area Measurement and Processing System
DBA	Dominant Battlespace Awareness
DBK	Dominant Battlespace Knowledge
DBM	Data Base Management
DEPTEMPO	Depot/Deployment Tempo
DIV	Division
DMA	Defense Mapping Agency
DOE	Department of Energy
DON	Department of the Navy

--------- E ---------

ECCM	Electronic Counter-Countermeasures
ECM	Electronic Countermeasures
EFI	Electromagnetic Field Interference
EMP	Electro Magnetic Pulse
EO	Electro-Optic
EOD	Explosive Ordnance Disposal
ESM	Electronic Support Measures
EW	Electronic Warfare

--------- F ---------

FCS	Fire Control System
FDDI	Fiber optic Digital Data Interface
FFTS	Forward From The Sea
FLIR	Forward Looking InfraRed
FMS	Foreign Military Sales
FOTC	Force Over-the-horizon Track Coordinator
FOV	Field of View

---------- G ----------

G & C	Guidance and Control
GOB	Ground Order of Battle
GPD	Gallons Per Day
GPS	Global Positioning System

---------- H ----------

HARM	High-speed Anti-Radiation Missile
HAZMAT	Hazardous Materials
HF	High Frequency
HM & E	Hull Maintenance & Electrical
HMMWV	Highly Mobile Multi-purpose Wheeled Vehicle

---------- I ----------

I & W	Indications and Warnings
IADS	Integrated Air Defense Systems
ID	Identification
IDC	Independent Duty Corpsman
IFF	Identification Friend or Foe
IOC	Initial Operational Capability
IR	Infrared
IRAD	Internal Research and Development
IRST	Infrared Search and Track
ISAR	Inverse Synthetic Aperture Radar
ISR	Intelligence, Surveillance and Reconnaissance
ITV	In Transit Visibility
IW	Information Warfare

---------- J ----------

JLOTS	Joint Logistics Over-The-Shore
JMA/SA	Joint Mission Area/Support Area
JMCIS	Joint Maritime Command Information System
JMOCC	Joint Maritime Operations Command Center
JROC	Joint Requirements Oversight Council
JTF	Joint Task Force
JTG	Joint Task Group
JTIDS	Joint Tactical Information Distribution Systems
JTN	Joint Targeting Network

---------- K ----------

Kb	Kilobytes

---------- L ----------

LABS	Laser Airborne Bathymetry System
LAN	Local Area Network
LASER	Light Amplification by Stimulated Emission of Radiation
LCAC	Landing Craft, Air Cushioned
LCC	Amphibious Command Ship/Life Cycle Costs
LCU	Landing Craft, Utility
LF	Low Frequency
LFA	Low Frequency Active
LIDAR	Light Detecting And Ranging
LO	Low Observable
LOTS	Logistics Over-The-Shore
LPD	Low Probability of Detection
LPI	Low Probability of Intercept
LRC	Lesser Regional Conflicts

--------- M ---------

MARFORPAC	Marine Forces Pacific
MC & G	Mapping, Charting and Geodesy
MCCDC	Marine Corps Combat Development Command
MCM	Mine Countermeasures
MDU	Mission Data Update
MEF	Marine Expeditionary Force
METOC	Meteorological and Oceanographic
MEU	Marine Expeditionary Unit
MEW	Marine Expeditionary Warfare
MF	Medium Frequency
MHD	Magnetohydrodynamics
MIW	Mine Warfare
MOE	Measure of Effectiveness
MOPP	Military Operations Protective Posture
MOOTW	Military Operations Other Than War
MPA	Maritime Patrol Aircraft
MPF	Maritime Preposition Force
MPS	Maritime Preposition Ship
MRC	Major Regional Conflicts
MTBF	Mean Time Between Failures

--------- N ---------

NATO	North Atlantic Treaty Organization
NAVMETOCOM	Naval Meteorological Command
NAVOSH	Naval Occupational Safety and Health
NBC	Nuclear, Biological, Chemical
NCTR	Non-Cooperative Target Recognition
NEF	Naval Expeditionary Force

NL	Non-Lethal
NOX	Nitrous Oxide
NSF	National Science Foundation
NSFS	Naval Surface Fire Support
NVG	Night Vision Goggles

--- O ---

OBA	Oxygen Breathing Apparatus
OBOGS	Onboard Oxygen Generating system
OMFTS	Operational Maneuver From The Sea
ONR	Office of Naval Research
OOB	Order of Battle
OPAREA	Operations Area
OPDS	Offshore Petroleum Discharge System
OPTEMPO	Operational Tempo
OSHA	Occupational Safety and Health Agency
OTH	Over-The-Horizon

--- P ---

PERSTEMPO	Personnel Tempo
PGM	Precision Guided Munitions
PHID	Positive Hostile ID
PID	Positive ID
Pk	Probability of kill
PSM	Personnel Status Monitor
PTTI	Precise Time/Time-Interval

--- Q ---

QOL	Quality of Life

--- R ---

RAP	Rocket Assisted Projectile
RAST	Recovery, Assistance, Securing and Transversing
RCS	Radar Cross Section
RF	Radio Frequency
RLT	Regimental Landing Team
RMA	Revolution in Military Affairs
ROE	Rules of Engagement
RO/RO	Roll-On/Roll-Off
ROV	Remotely Operated Vehicle
RTEM	Real Time Environmental Measures

--- S ---

S & T	Science and Technology

SADARM	Surface to Air Defensive Anti Radiation Missile
SAL	Semi-Active Lasers
SAM	Surface to Air Missile
SAR	Synthetic Aperture Radar/Search And Rescue
SCI	Sensitive Compartmented Information
SDV	Swimmer Delivery Vehicle
SEAD	Suppression of Enemy Air Defenses
SEI	Specific Emitter Identification
SEW/I	Space and Electronic Warfare/Intelligence
SHF	Super High Frequency
SK	Soft Kill
SLOC	Sea Lines of Communication
S/N	Signal to Noise
SOC	Special Operations Capable
SOCRATES	Special Operation Command Research, Analysis & Threat Evaluation System
SOF	Special Operations Forces
SOW	Statement of Work
SSBN	Nuclear Ballistic Missile Submarine
SSC	Surface/Subsurface Coordinator
SSG	Guided Missile Submarine
SSGN	Nuclear Guided Missile Submarine
SSN	Subsurface, Nuclear (submarine)
STOVL	Short Take-Off/Vertical Landing
STRG	Science and Technology Requirements Guidance

---------- T ----------

TACAIR	Tactical Aircraft
TASM	Tactical Air-to-Surface Missile/Tomahawk Anti-Ship Missile
TAMPS	Tactical Air Mission Planning System
TBG	Technology Based Guidance
TBM	Theatre Ballistic Missile
TBMD	Theatre Ballistic Missile Defense
TDA	Tactical Decision Aid
TDD	Target Detection Device
TLAM	Tomahawk Land Attack Missile
TMD	Theater Missile Defense
TTP	Tactics, Techniques and Procedures

---------- U ----------

UAV	Unmanned Airborne Vehicle
UEP	Underwater Electric Potential

UHF	Ultra High Frequency
UNREP	Underway Replenishment
UUV	Unmanned Underwater Vehicle
UV	Ultraviolet

---------- V ----------

VOC	Volatile Organic Compounds
VLO	Very Low Observable
VLS	Vertical Launch System

---------- W ----------

WAN	Wide Area Network
WMD	Weapons of Mass Destruction

Appendix 2

Command Technology Issues

APPENDIX 2

COORDINATED FLEET CINC
CONSOLIDATED COMMAND TECHNOLOGY ISSUES
OCT 1995

1. JOINT STRIKE WARFARE

A. COMMON/CONSISTENT TACTICAL PICTURE (HIGH Priority)

Current systems cannot collect and fuse all-source tactical information from Navy, Joint, Allied and Coalition sources. This results in a foggy overall tactical picture. All elements of this picture including primary collection, fusion and dissemination architecture, de-confliction, classification, broadcast, and display technologies are critical. The architecture for pulling this picture together is a major system engineering challenge, and should include all sensor platforms (air, surface, submarine and space) and two-way information sharing. Any such system must be reliable, robust, and secure for effective command and control. Naval forces cannot play in the joint arena without it. The requirement is for improved reliability for all communication channels, including those connecting Navy, Joint, NATO and other coalition partners. In addition, this capability must be supported by databases, models and decision aids for METOC issues, Mapping Charting and Geodesy (MC&G) overlays and electro-magnetic propagation prediction.

B. TARGETING/BATTLE DAMAGE ASSESSMENT/COMBAT IDENTIFICATION (ID) (HIGH Priority)

Recent conflicts have required threat identification beyond visual range. In many cases, air crews are forced to use visual or TV sightings to confirm an aircraft is not friendly or is a non-combatant, thus limiting long range anti-air missile use to daytime with clear skies. Improved combat ID is needed to prevent fratricide and identify non-cooperative targets. Without improved combat ID air crews cannot use their long range missiles effectively. Targeting decisions require BDA as requisite input. BDA in the tactical time frame is required for mission planning, attack and re-attack assessments. The unmanned airborne vehicle (UAV) provides an essential tool for tactical reconnaissance, targeting and BDA. Improvements in technologies such as digital imagery and transmission are required. Target bearing and range accuracy must be improved to increase standoff ranges and intercept probability.

C. ADVANCED STANDOFF WEAPONS (HIGH Priority)

Smarter weapons are essential to improved mission capability and aircraft survivability. They must be released outside the range of point defense envelopes and attain "one weapon released equals one target destroyed" criteria. Incorporating precision navigation, new/improved sensors and onboard sensor data fusion will improve weapon lethality and shooter survivability. Smart air-to-ground munitions, improved TLAMs, and improved long and short range air-air missiles are examples. Such weapons should include the ability to reconfigure and retarget post-launch. Ships also need new weapons for this environment. For instance, platforms like AEGIS or SSNs require more flexible weapons than Harpoon anti-

ship missiles and MK-48 torpedoes when dealing with small combatants or recalcitrant merchants.

D. ENHANCED AIRCRAFT/AIR CREW SURVIVABILITY (HIGH Priority)

Battlespace dominance in the littoral requires air superiority. Dazzling/damaging lasers pose a threat to the required air superiority. Protection against fixed-line and frequency-agile lasers, short/long pulse or continuous wave, is a requirement. Protection is required for ground and air forces, and for sensitive equipment. Additionally, protection for air crews from NBC attack requires significant improvements in the protective equipment provided to aircrew and maintenance personnel. Finally, improved aircraft design and introduction of new materials have allowed aircraft performance capabilities to outpace that of human ability to withstand flight stresses. Improved flight suits and flight control aids are required to maintain aircrew safety during maximum aircraft performance.

2. JOINT LITTORAL WARFARE

A. MINE WARFARE/MINE COUNTER MEASURES (HIGH Priority)

Mines present a major littoral warfare threat. MCM capabilities are required for surface, submarines, air and Naval Special Warfare forces. Landing forces need the capability to land without suffering major casualties and equipment losses by mine warfare. These forces must either avoid, neutralize or remove the mine threats. Deep moored mines and very shallow surf zone mines pose extremely difficult threat. MCM C^4I capabilities are required. This C^4I requirement needs to be in a cooperative engagement format so ALL forces provide/share MCM collected information. MCM improvements include, but are not limited to: new sweeps and neutralization techniques, ship and small craft tracking system, avoidance/detection sonars and other sensors, reduced ship signature and vulnerability, methods to land without triggering mines, improved EOD mine clearance technology, trainers and simulators.

B. SHALLOW WATER ASW (HIGH Priority)

Littoral operations require mission performance in shallow water inside enemy threat envelopes of surface, submarine and air forces. The mission requirement is to detect, classify, localize, attack and destroy diesel submarines in this complex environment. Improved acoustic and non- acoustic sensors, processors, displays and tactical decision aids are needed. A capability to quickly identify threat submarines from neutrals and friendlies in the littorals is required. There is a need to reduce submarine signatures to maintain a U.S. acoustic advantage. Surface and air forces require a better periscope detection capability. This is especially critical against diesel submarines which spend a great deal of time at periscope depth. An improved ASW weapon tailored for this environment is required. Submarines must have weapons which operate in the shallow water environment. Minisub defense and methods to deter covertly deployed enemy SOFs (i.e., sapper teams) are required. Improved submarine navigation and depth control are required for shallow water operations.

C. SHIP SELF DEFENSE (HIGH Priority)

All ships (especially surface ships, but including submarines) need improved self-defense capabilities against diesel submarines (periscope detection), torpedoes, small boats, cruise missiles, and floating mines. In the event damage does occur, expert ship damage control could saves lives and ships. Ship systems and personnel protective clothing/equipment are needed for protection during NBC attack. Also required is a soft kill capability for incoming anti-ship cruise missiles. Current ASCM-capable systems have not been optimized for BG operations with ships close in company. Synergism between hard kill and soft kill is assumed, but inappropriate use of either can result when target information is inadequate, unclear or misjudged. Attack helicopters are required to provide surveillance and kill in littoral waters for surface ship defense. Systems that provide enhanced EO/IR/Visual detection capabilities (i.e., Smart Mast Mounted Sight) and multi-spectral decoys are needed. Detection systems (sensors) for littoral waters need to be fused and provide high probability of detection and validation.

D. THEATER MISSILE DEFENSE-TMD (HIGH Priority)

Littoral warfare exposes CVBGs and forces deployed ashore to the TMD threat. Regional powers already possess TMD capability, including conventional warheads and Weapons Of Mass Destruction (WMD). An organic capability to defeat all facets of this threat is needed, shortly after launch or before apogee. TMD should also include protection against the Anti-Ship Cruise Missile (ASCM). Long range detection and CEC is needed, not only against the TBM, but also against long range, stealthy ASCM's.

E. NON-LETHAL (NL) WEAPONS (HIGH Priority)

A NL capability is required to immobilize opposition personnel and equipment in order to neutralize and contain during initial mission phases. NL weapons are also needed during occupation to ensure minimal injury to personnel. NL weapons should have the capability to vary duration and intensity of incapacitation and to select targets.

F. NAVAL SPECIAL WARFARE (MEDIUM Priority)

Naval Special Warfare operations are an essential part of Littoral Warfare. Special Warfare forces require new covert means to interdict enemy territories. Requirements for interdiction center around: high energy density propulsion systems, stealthy platforms and advanced life support systems. These systems must have small rugged sensor fusion and C^4I capable hardware. Special Warfare forces must be able to covertly transmit collected intelligence in a timely manner. Shallow Water MCM capabilities are required. Other important requirements include: non-lethal tunable weapons, advanced sensors, target location and marking, advanced weapons and munitions, and overall weight reduction and miniaturization of equipment.

G. NAVAL SURFACE FIRE SUPPORT (MEDIUM Priority)

Current NSFS systems are limited in range and types of munitions delivered. Longer ranges with increased accuracy using advanced munitions are required to support Littoral Warfare.

H. LANDING FORCES (MEDIUM Priority)

Need improved night operations capabilities, medium range man portable anti-tank weapons, covert/stealthy reconnaissance, signature reduction (including special operations equipment), and improved expeditionary airfield capabilities (light weight matting, night-ops capability and modular aircraft revetments). Improved NBC protection is required for ground personnel including protective clothing and detection systems.

I. MARITIME INTERDICTION FORCE SURVEILLANCE (LOW Priority)

Recent experience in regional conflicts shows maritime interdiction is a required mission. The maritime force must possess the capability to detect, track, and monitor potential embargo violators. Boarding parties also must possess the capability to search a vessel rapidly and thoroughly, without damaging non-embargo cargoes.

3. JOINT SURVEILLANCE

A. RECONNAISSANCE (HIGH Priority)

A system which facilitates integration of Joint, Multi-National or Coalition reconnaissance data is required. It should be compatible with the concepts embodied in the "Common Tactical Picture" described under Joint Strike. Real-time processing and transmission of tactical reconnaissance data from manned and unmanned aircraft is required. Littoral Warfare requires organic real-time Ground Order of Battle (G0B) definition. Improved organic surveillance capabilities are needed, including better EO sensor suites and better ISAR. Sensors are primarily intended for aircraft, but could also be placed aboard surface ships or submarines .

B. OFFBOARD SENSORS (HIGH Priority)

(Also applies to Joint Littoral) Offboard sensors are required to increase the capability for conducting covert surveillance in a littoral warfare scenario. Sensors are needed for mine detection, identification and avoidance; wide area search and covert surveillance of diesel submarines; oceanographic surveys; and undersea BDA/BDI. Improved cost effective UUV's are required. Platforms require offboard sensors that can be vectored on short notice to provide critical surveillance and targeting information. Low cost UAV's that can be controlled by local commanders ashore or afloat are required to provide joint surveillance data. For interdiction missions, improved over-the-horizon radar is required for detection and tracking of vessels and aircraft.

C. SPECIFIC EMITTER IDENTIFICATION (SEI) PLATFORM TRACKING (HIGH Priority)

SEI is a promising concept for tracking all air and ship traffic in the BG AOR and contributes to the Common Tactical Picture without requiring a large investment in additional aircraft or other surveillance systems. The technical feasibility of making the SEI measurement has been demonstrated. Improved equipment, standardized databases, and better matching algorithms are needed to reduce the procedure to an operationally useful tactic. This concept also includes small craft with low profiles used in drug trafficking. Surface Search Coordination (SSC) and Force OTH Track Coordination (FOTC) can be enhanced by developing a similar tactic using HF transmissions. The tactic should be fully automated to search, detect, parametrically classify and correlate to platform.

D. IMPROVED EM/EO SENSOR PREDICTION SYSTEM (MEDIUM Priority)

(Applies to Joint Strike also). The EM/EO spectrum provides important information about enemy deployments, OOB, etc. EM energy propagates in the wave guide of the atmosphere over the irregular boundary of the earth's surface. The combination of variable atmospheric conditions and variable terrain creates a highly range-dependent environment that makes propagation prediction difficult, but essential. Current EM and EO prediction systems use a single atmospheric profile, obtained from a ship at sea; this is inadequate. Operations require "volume/synoptic" sampling across the battlespace, vice "point" sampling; and a model capable of predicting EM/EO behavior across the transition from sea to land. A Tactical Decision Aid is needed that displays the geo-referenced result.

4. JOINT SEW / INTELLIGENCE

A. COMMON/CONSISTENT TACTICAL PICTURE (HIGH Priority)

A system which provides a common/consistent joint, multi-national, or coalition tactical picture is required. It should possess the ability to fuse all-source data, have multi-level security (including the ability to selectively pass information to different operational partners), and allow two-way transfer of information (e.g. from Navy units to JTF units). Above all, it should respond in tactical time frames. Shear volume of message traffic requires improved communication and processing equipment. Increased capability provided by BG/Theater-wide WAN (interconnection of high reliability LANs to the unit level), is needed for high volume reliable communication. Building the Common Tactical Picture is enhanced by maximum usage of standard software and databases.

B. JOINT/MULTI-NATIONAL/COALITION C4I2 SYSTEM (HIGH Priority)

(See also "Common Tactical Picture"). This is a Roll On/Roll Off capability for use by hurriedly-assembled coalition partners, which also would address the needs of JTFs assembled from widely dispersed units. Today's battlefield will most likely contain not only other services but other nations serving in coalition efforts, neutrals, civilians, and hostiles. The ability to adequately separate the various entities and maintain tracks and their separate identifying parameters is essential. A second facet of this capability could be a Joint Maritime Operations Command Center (JMOCC).

C. COMMUNICATION RELIABILITY (HIGH Priority)

Reliable and secure communications are fundamental to effective command and control. Naval forces rely on advanced, emerging communication technology to participate in joint operations. The need exists for improved reliability of all communication channels as well as multi-level secure computer networks, including those connecting Navy, Joint, NATO, and other coalition partners. Battle Group and fleet-wide automated frequency and bandwidth management, electronic mail and automated data base management capabilities are needed.

D. BATTLEGROUP COOPERATIVE ENGAGEMENT EW (HIGH Priority)

(See ship self defense in the Joint Littoral also). Optimized soft kill measures against Anti-Ship Cruise Missiles (ASCM) are needed. We need to know the effects of using EW measures on other ships at close ranges. We also need to know the effects of using multiple ECM systems simultaneously in a constrained battlespace. Optimum deployment of chaff, SLQ-32 units, unit positioning, etc. need to be known in advance for expected threat axes.

E. SECURE SUBMARINE COMMUNICATIONS (HIGH Priority)

Two-way communications with submarines at speed and depth is not optimum for all offensive and defensive missions. We need the capability to process bi-static active signals to support SSN/SSBN security and operate effectively while the submarine is at speed and depth. While a one-way (receive) capability is adequate for some missions, two-way communications is required. In both cases, security demands high data rate transmissions to reduce ship vulnerability and exploit the ship's stealthiness.

F. INFORMATION WARFARE (HIGH Priority)

There is a need for comprehensive coordinated multi-platform capability to plan and conduct C2 warfare for crisis and combat operations. There is the need for C^2 protection improvements in the areas of: unauthorized access prevention; data base exploitation; software/data base corruption from organized threats and hackers; and, LAN/WAN multi-level security and firewalls.

G. JOINT BATTLEFIELD SIMULATION/STIMULATION (HIGH Priority)

Distributed network. Should provide stimulation of embedded capabilities in addition to simulation ashore (at training centers, etc.). This will allow enroute training on actual equipment, tailored to the situation at hand. Many technological issues are included in the requirement and it must be Joint and Interoperable.

H. SHIP TO SHORE COMMS OTH (MEDIUM Priority)

Amphibious operations envision launching assaults from OTH stand-off distances. Sensors for OTH use and communications for Beyond-Line Of Sight forces are limited. Means of collecting sensor data for OTH targets and for communicating with forces that are beyond line of sight are needed. Communications must be secure, jam-resistant, voice and data capable and interoperable with joint, multi-national and coalition forces.

I. MAPPING CHARTING AND GEODESY (MC&G) DATA DISTRIBUTION & TRANSMISSION (MEDIUM Priority)

Littoral operations may take place in unanticipated and unsurveyed areas of the world. The ability to collect and process Mapping, Charting and Geodesy (MC&G) data as quickly as possible is critical. After processing, immediate distribution to all units is required for mission planning and execution (e.g., amphibious, mine warfare, submarine operations, etc.) Such collection, processing and distribution must be digital for transmission to units afloat.

J. COVERT TRACKING (MEDIUM Priority)

(Also see Joint Surveillance, SEI Platform Tracking) Many Navy missions require covert tracking. The capability to detect, track and monitor small craft with low profiles and small or semi-submerged craft utilizing conventional or non-conventional sensors is required. This includes the use of unmanned air vehicles, Specific Emitter Identification (SEI), night vision devices, laser radars, and command level networks which can also collect and relay tactical real-time video. These capabilities are also required for other larger craft that might be involved in evading embargoes. The problem includes separating suspect craft from friendlies and neutrals; marking and tagging such craft; and, enhanced detection of drugs in the cluttered littoral environment.

5. STRATEGIC DETERRENCE

A. THEATER MISSILE DEFENSE (HIGH Priority)

Littoral warfare exposes BGs and forces deployed ashore to the TMD threat. Regional powers already possess TMD capability, including conventional warheads and WMD (see Joint Littoral description). This problem statement extends the need to include the strategic threat within the larger AOR (vice strictly the littoral during localized operations). As before, an organic TMD capability to defeat this threat is needed, shortly after launch or before apogee.

B. COOPERATIVE ENGAGEMENT CAPABILITY-CEC (HIGH Priority)

Today's battlespace is compressed in time and stretched in space. When coupled with stealthy, high-speed threats, this changed battlespace demands a quicker, more effective way to engage incoming weapons. With sensors and engagement capabilities spread over multiple platforms, an integrated system is needed to optimize search, detection, tracking, and engagement options.

6. MARITIME SUPPORT OF LAND FORCES

A. SEALIFT CAPABILITY(MEDIUM Priority)

Advanced/improved air or surface craft are needed to include a strategic lift vehicle and surge sealift capability.

B. VISIBILITY OF EQUIPMENT, MATERIALS, & SUPPLIES (MEDIUM Priority)

Naval Expeditionary Forces (NEF's) must transit from CONUS or prepositioned sites to the Amphibious Objective Area (AOA). These forces must provide the right equipment and supplies, in the correct amounts, to ensure ready combat forces can be inserted into and sustained in a hostile environment. In any large operation, the supplies and equipment will depart from several ports on many different ships. When they all arrive in the AOA, it is difficult to locate any individual piece of equipment or supply item. This makes sustainment difficult and jeopardizes landing forces. NEFs need the capability to identify, locate and track equipment, materials and supplies during transit. They also need the ability to access the needed supplies and move them to the combat element.

7. TRAINING

A. SIMULATION/STIMULATION EMBEDDED IN EXERCISES (HIGH Priority)

Funding for steaming to participate in exercises and travel to training ranges is becoming scarcer. Also, current training does not stress the operators like a real combat situation, resulting in unrealistic training. Training can be more cost effective if exercises can be augmented with realistic simulation or stimulation (preferred). There is also a need to advance technologies like virtual reality, making simulation more realistic. Improvements in embedded training, especially those tied to stimulation, are required. Realistic training also requires BG level and JTF level simulation and/or stimulation. Training should be based on the common/consistent tactical picture (see text under Joint Strike, Common/Consistent Tactical Picture).

B. SHALLOW WATER TRAINING RANGE/CAPABILITY (MEDIUM Priority)

Proficiency and readiness depend on accurate and realistic training. Littoral warfare demands an improved shallow water training capability. One facet of such training is a shallow water training range, used by air, surface and submarine assets for training coordinated operations in mining, shallow water ASW, SOF, etc.

C. TARGETS (MEDIUM Priority)

Low cost realistic surface, aerial and submerged targets are required for crew training and maintaining warfighting proficiency. Surface and submerged targets should be ship deployable.

8. READINESS MAINTENANCE

A. CONDITION BASED MAINTENANCE (High Priority)

Scheduled maintenance for many ship and aircraft systems consume scarce manpower and equipment resources, impacting availability of maintenance capability and ultimately ship readiness. Unnecessary maintenance often adds the costs of handling and disposing of hazardous waste also. Processes and systems are needed for determining the physical condition of systems (especially electro-mechanical systems), either on-line or off-line that signal when preventive maintenance is required. Sensors, neural networks, vibration monitors/analysis and fluid quality test equipment or monitors are examples of technologies that may be applied.

B. SHIP AND AIRCRAFT CORROSION REDUCTION AND CONTROL (HIGH Priority)

Corrosion of ship and airframe internal spaces, bulkheads at deck bulkhead seams, electrical surfaces (i.e., grounding points), seawater piping systems, tanks, voids and bilges require frequent maintenance. Stripping, surface preparation and repainting are costly, occupy scarce resources, impact readiness and add to the hazardous waste problem. New or alternate materials that are more resistant to corrosion and fouling are needed for new/replacement systems. New protective coatings are needed plus new, faster and less expensive stripping and surface preparation techniques for maintenance. New coating materials should be: anti-fouling hull coatings; environmentally safe; applied using equipment/techniques that are not hazardous to personnel or the environment.

C. COMPOSITE AND LOW OBSERVABLE MATERIAL REPAIR (MEDIUM Priority)

Low observable materials are becoming more common throughout fleet aviation. We need the capability to repair them at shipboard intermediate maintenance activities with environmentally safe materials and processes. Repairing composite materials is difficult and costly. Repair is impossible at some levels of maintenance thus causing repairs to be performed at higher maintenance levels which further adds to cost. Composite materials repair equipment, techniques or materials are needed that make repair possible at low (operational) maintenance levels. A new capability is required to repair the composite to original specifications with simple equipment, and be safe for the user and the environment.

D. IMPROVED RELIABILITY OF ELECTRICAL AND MECHANICAL SYSTEMS (MEDIUM Priority)

Frequent repair of leaky seals, gaskets and other common components is very time consuming and impacts availability of maintenance personnel and ship readiness. Improved reliability of common ship and aircraft mechanical and fluid components will reduce overall maintenance workload and costs. A new family of reliable, low maintenance electrical connectors is needed with low corrosion characteristics.

9. SUPPORT & INFRASTRUCTURE ENVIRONMENTAL

A. ENVIRONMENTALLY SAFE ALTERNATE MATERIALS (HIGH Priority)

The Navy uses many materials/chemicals that are environmentally unsafe and/or hazardous to personnel who work with them. The most pressing problem is the replacement of ozone depleting substances such as HALON (used in fire fighting systems), which is no longer being manufactured. ChloroFluoroCarbons (CFCs) should be eliminated by 1995 and shipboard use of plastics should be reduced or eliminated by 1998 or sooner. A new fire fighting system/material is needed that is effective, safe to use and environmentally friendly. New refrigerants and chemicals for spray cans are needed to replace CFC's. Alternatives for plastic packaging materials and a non-toxic, environmentally safe lube oil replacement are needed. Use of heavy metals such as lead and zinc chromate should be eliminated. An improved flight deck non-skid material is needed, one with less silica.

B. ENVIRONMENTALLY SAFE REMOVAL AND DISPOSAL FOR HAZMAT COATINGS (HIGH Priority)

When HAZMAT is present in coatings, removal techniques must comply with federal, state, and local environmental regulations. Techniques must also comply with all personnel safety regulations (e.g., OSHA). Removal processes are time consuming and costly. Environmentally safe techniques and equipment for removing and disposing of HAZMAT coatings are needed. A rapid and reliable portable test method is needed to determine if lead is present in paint on existing surfaces. Equally important are environmentally safe techniques and equipment for removing and disposing of lead-based paints.

C. GARBAGE REDUCTION AND DISPOSAL (HIGH Priority)

Pending laws will require eliminating discharging many types of wastes from ships by 1998. This same law allows no discharging in special areas which will probably grow in number in this same time frame. Accumulating garbage consumes valuable storage and working spaces. Transferring garbage to support ships will become an unworkable alternative as the fleet is reduced with dramatic impact on tenders. Several thermal destruction technologies have been investigated. Plasma arc pyrolysis has been assessed as one of the most promising for success in ship installations. However, it is estimated to take 8-10 years before production equipment may be available. Garbage disposal, or volume reducing, systems must be developed and deployed before the legislation is effective and negatively impacts on the Navy's ability to operate. Garbage treatment systems must comply with emerging regulations and be usable onboard ships of all classes.

D. HAZARDOUS MATERIAL MANAGEMENT (MEDIUM Priority)

A wide-area hazardous materials inventory information-sharing system is needed. Activities needing hazardous materials can obtain them from another activity who has materials near shelf life expiration. Automated inventory, tracking and disposal documentation capability for hazardous materials is also needed to support this HAZMAT sharing capability.

E. OBA CANISTER (LOW Priority)

Current OBA canisters are used frequently for fire fighting and training and are a hazardous waste after use. A new NAVOSH approved OBA canister is needed that does not create a hazardous waste problem after it is used.

10. FORWARD PRESENCE

A. ENVIRONMENTAL COMPLIANCE (HIGH Priority)

The reality of doing business overseas involves complying with foreign environmental regulations and host country sensitivities (i.e., restrictions associated with night landing practice in Japan, limited opportunity for overseas low level training areas, environmental concerns associated with amphibious training areas, environmental compliance associated with port visits, etc.). US ships and aircraft must comply with international regulations in order for the Navy to have a viable Forward Presence. See previous Environmental CTI's.

B. CAPABILITY TO MOVE NAVAL FORCES ANYWHERE IN A TIMELY MANNER

See comments associated with Strategic Sealift and Protection.

C. OPTIMIZED JOINT AND COMBINED FORCE INTEROPERABILITY

See comments associated with Joint SEW/INTELLIGENCE.

D. ENABLE FORCE DEFENSE

See comments associated with Joint Strike Warfare.

11. MEDICAL

A. BG/BATTLEFIELD MEDICAL AIDS (MEDIUM Priority)

Remote medical presence aids are required and have great potential for improving patient care and reducing cost associated with medical evacuation. A WAN with the ability to transmit and receive data and imagery (i.e., digital x-ray, video, ...) is needed to improve diagnosis and treatment of BG and battlefield patients.

B. BW/CW VACCINES (HIGH Priority)

More effective vaccines are needed to counter the biological and chemical agent threat.

SUMMARY - COORDINATED FLEET CINC CONSOLIDATED COMMAND TECHNOLOGY ISSUES (OCT 1995)

JMA COMMAND TECHNOLOGY ISSUE (95 PRIORITY)	1996 PRIORITY
JOINT STRIKE WARFARE	
COMMON/CONSISTENT TACTICAL PICTURE (HIGH)	HIGH
TARGETING/BATTLE DAMAGE ASSESSMENT/COMBAT IDENTIFICATION (HIGH)	HIGH
ADV STANDOFF WEAPONS (HIGH)	HIGH
ENHANCED AIRCRAFT/AIR CREW SURVIVABILITY (HIGH)	HIGH
JOINT LITTORAL WARFARE	
MINE WARFARE/MINE COUNTER MEASURES (HIGH)	HIGH
SHALLOW WATER ASW (HIGH)	HIGH
SHIP SELF DEFENSE (HIGH)	HIGH
THEATER MISSILE DEFENSE-TMD (HIGH)	HIGH
NON-LETHAL (NL) WEAPONS (MED)	HIGH
NAVAL SPECIAL WARFARE (MED)	MEDIUM
NAVAL SURFACE FIRE SUPPORT (MED)	MEDIUM
LANDING FORCES (MED)	MEDIUM
MARITIME INTERDICTION FORCE SURVEILLANCE (LOW)	LOW
JOINT SURVEILLANCE	
RECONNAISSANCE (HIGH)	HIGH
OFFBOARD SENSORS (HIGH)	HIGH
SPECIFIC EMITTER IDENTIFICATION (SEI) PLATFORM TRACKING (MED)	HIGH
IMPROVED EM/EO SENSOR PREDICTION SYSTEM (MED)	MEDIUM
JOINT SEW / INTELLIGENCE	
COMMON/CONSISTENT TACTICAL PICTURE (HIGH)	HIGH
JOINT/MULTI-NATIONAL/COALITION C4I2 SYSTEM (HIGH)	HIGH
COMMUNICATION RELIABILITY (HIGH)	HIGH
BATTLEGROUP COOPERATIVE ENGAGEMENT EW (HIGH)	HIGH
SECURE SUBMARINE COMMUNICATIONS (MED)	HIGH
INFORMATION WARFARE (N/A)	HIGH
JOINT BATTLEFIELD SIMULATION/STIMULATION (MED)	HIGH
SHIP-TO-SHORE COMMS OTH (MED)	MEDIUM
MAPPING CHARTING AND GEODESY (MC&G) DATA DISTRIBUTION & TRANSMISSION (MED)	MEDIUM
COVERT TRACKING (HIGH)	MEDIUM
STRATEGIC DETERRENCE	
THEATER MISSILE DEFENSE (HIGH)	HIGH
COOPERATIVE ENGAGEMENT CAPABILITY-CEC (HIGH)	HIGH
MARITIME SUPPORT OF LAND FORCES	
SEALIFT CAPABILITY (MED)	MEDIUM
VISIBILITY OF EQUIPMENT, MATERIALS, & SUPPLIES (MED)	MEDIUM
TRAINING	
SIMULATION/STIMULATION EMBEDDED IN EXERCISES (HIGH)	HIGH
SHALLOW WATER TRAINING RANGE/CAPABILITY (MED)	MEDIUM
TARGETS (MED)	MEDIUM

READINESS	
CONDITION BASED MAINTENANCE (HIGH)	HIGH
SHIP AND AIRCRAFT CORROSION REDUCTION AND CONTROL (HIGH)	HIGH
COMPOSITE and LOW OBSERVABLE MATERIAL REPAIR (MED)	MEDIUM
IMPROVED RELIABILITY OF ELECTRICAL & MECHANICAL SYS (HIGH)	MEDIUM
SUPPORT & INFRASTRUCTURE	
ENVIRONMENTALLY SAFE ALTERNATE MATERIALS (HIGH)	HIGH
ENVIRONMENTALLY SAFE REMOVAL & DISPOSAL FOR HAZMAT COATINGS (HIGH)	HIGH
GARBAGE REDUCTION AND DISPOSAL (HIGH)	HIGH
HAZARDOUS MATERIAL MANAGEMENT (MED)	MEDIUM
OBA CANISTER (MED)	LOW
FORWARD PRESENCE	
ENVIRONMENTAL COMPLIANCE (HIGH)	HIGH
MEDICAL	
BG/BATTLEFIELD MEDICAL AIDS (N/A)	MEDIUM
BW/CW VACCINES (N/A)	HIGH
MANPOWER & PERSONNEL	
N/A	

COORDINATED FLEET CINC
CONSOLIDATED COMMAND TECHNOLOGY ISSUES
OCT 1995

JMA COMMAND TECHNOLOGY ISSUE (1995 PRIORITY)	LANT	PAC	EUR	CENT	TOTAL	1996 PRIORITY
JOINT STRIKE WARFARE						
COMMON/CONSISTENT TACTICAL PICTURE (HIGH)	3	3	3	3	12	HIGH
TARGETING/BATTLE DAMAGE ASSESSMENT/COMBAT IDENTIFICATION (ID) (HIGH)	3	3	3	3	12	HIGH
ADV STANDOFF WEAPONS (HIGH)	3	3	3	3	12	HIGH
ENHANCED AIRCRAFT/AIR CREW SURVIVABILITY (HIGH)	3	3	3	3	12	HIGH
JOINT LITTORAL WARFARE						
MINE WARFARE/MINE COUNTER MEASURES (HIGH)	3	3	3	3	12	HIGH
SHALLOW WATER ASW (HIGH)	3	3	3	3	12	HIGH
SHIP SELF DEFENSE (HIGH)	3	3	3	3	12	HIGH
THEATER MISSILE DEFENSE-TMD (HIGH)	3	3	3	3	12	HIGH
NON-LETHAL (NL) WEAPONS (MED)	3	3	3	3	12	HIGH
NAVAL SPECIAL WARFARE (MED)	2	2	2	2	8	MEDIUM
NAVAL SURFACE FIRE SUPPORT (MED)	2	2	1	2	7	MEDIUM
LANDING FORCES (MED)	2	2	1	2	7	MEDIUM
MARITIME INTERDICTION FORCE SURVEILLANCE (LOW)	1	1	2	2	6	LOW
JOINT SURVEILLANCE						
RECONNAISSANCE (HIGH)	3	3	3	3	12	HIGH
OFFBOARD SENSORS (HIGH)	3	3	2	3	11	HIGH
SPECIFIC EMITTER IDENTIFICATION (SEI) PLATFORM TRACKING (MED)	3	3	3	2	11	HIGH
IMPROVED EM/EO SENSOR PREDICTION SYSTEM (MED)	2	1	2	2	7	MEDIUM
JOINT SEW / INTELLIGENCE						
COMMON/CONSISTENT TACTICAL PICTURE (HIGH)	3	3	3	3	12	HIGH
JOINT/MULTI-NATIONAL/COALITION C4I2 SYSTEM (HIGH)	3	3	3	3	12	HIGH
COMMUNICATION RELIABILITY (HIGH)	3	3	3	3	12	HIGH
BATTLEGROUP COOPERATIVE ENGAGEMENT EW (HIGH)	3	3	2	3	11	HIGH
SECURE SUBMARINE COMMUNICATIONS (MED)	3	2	3	2	10	HIGH
INFORMATION WARFARE (N/A)	3	3	3	3	12	HIGH
JOINT BATTLEFIELD SIMULATION/STIMULATION (MED)	3	3	3	3	12	HIGH
SHIP TO SHORE COMMS OTH (MED)	2	3	2	2	9	MEDIUM
MAPPING CHARTING AND GEODESY (MC&G) DATA DISTRIBUTION & TRANSMISSION (MED)	2	1	2	2	7	MEDIUM
COVERT TRACKING (HIGH)	3	2	2	1	8	MEDIUM

STRATEGIC DETERRENCE						
THEATER MISSILE DEFENSE (HIGH)	3	3	3	3	12	HIGH
COOPERATIVE ENGAGEMENT CAPABILITY-CEC (HIGH)	3	3	3	3	12	HIGH
MARITIME SUPPORT OF LAND FORCES						
SEALIFT CAPABILITY (MED)	2	3	2	2	9	MEDIUM
VISIBILITY OF EQUIPMENT, MATERIALS, & SUPPLIES (MED)	2	1	1	3	7	MEDIUM
TRAINING						
SIMULATION/STIMULATION EMBEDDED IN EXERCISES (HIGH)	3	3	3	2	11	HIGH
SHALLOW WATER TRAINING RANGE/CAPABILITY (MED)	2	3	2	1	8	MEDIUM
TARGETS (MED)	2	2	1	2	7	MEDIUM
READINESS						
CONDITION BASED MAINTENANCE (HIGH)	3	3	3	2	11	HIGH
SHIP AND AIRCRAFT CORROSION REDUCTION AND CONTROL (HIGH)	3	3	3	2	11	HIGH
COMPOSITE and LOW OBSERVABLE MATERIAL REPAIR (MED)	2	2	2	2	8	MEDIUM
IMPROVED RELIABILITY OF ELECTRICAL AND MECHANICAL SYSTEMS (HIGH)	3	2	2	2	9	MEDIUM
SUPPORT & INFRASTRUCTURE						
ENVIRONMENTALLY SAFE ALTERNATE MATERIALS (HIGH)	3	3	3	3	12	HIGH
ENVIRONMENTALLY SAFE REMOVAL & DISPOSAL FOR HAZMAT COATINGS (HIGH)	3	3	3	3	12	HIGH
GARBAGE REDUCTION AND DISPOSAL (HIGH)	3	3	3	3	12	HIGH
HAZARDOUS MATERIAL MANAGEMENT (MED)	2	2	2	2	8	MEDIUM
OBA CANISTER (MED)	2	1	1	2	6	LOW
FORWARD PRESENCE						
ENVIRONMENTAL COMPLIANCE (HIGH)	3	3	3	3	12	HIGH
MEDICAL						
BG/BATTLEFIELD MEDICAL AIDS (N/A)	2	2	2	2	8	MEDIUM
BW/CW VACCINES (N/A)	3	3	2	3	11	HIGH
MANPOWER & PERSONNEL						
N/A						

Appendix 3

Critical Issues/Show Stoppers

KEY	
C4IW	Command, Control, Communication, Computers/Information Warfare
CCEN	U.S. Navy Central Command
CLF	Commander In Chief, Atlantic Fleet
CPF	Commander In Chief, Pacific Fleet
FE/N51	Forward Engagement/N51
ISR	Intelligence, Surveillance and Reconnaissance
MCCDC	Marine Corps Combat Development Command
MP/N12	Manpower and Personnel/N12
MFP	Marine Forces Pacific

APPENDIX 3

1996 SCIENCE AND TECHNOLOGY ROUND TABLE ISSUES

CINCLANTFLT

Issue: 1
Undersea superiority has eroded to the point where successful completion of some missions may be jeopa
rdized. Revolutionary advances in sensors and processors are needed to restore tactical control in undersea encounters.

Issue: 2
Submarines must be compatible with the C^4I architecture of U.S. naval forces, able to process identical throughput and formats, using the minimum of unique equipment (unique antennas, standard electronics) and development mandated by the submarine's unique operational envelope.

Issue: 3
Submarines need the ability to assess in realtime their ASW performance and vulnerability. The capabilities to monitor realtime spatial environmental parameters and ownship signatures along with geographically adapted models and accurate threat signatures to maintain situational awareness, stealth, and tactical control are required.

Issue: 4
Combat Identification (CID) capability of threat and targets (including air, surface and subsurface contacts).

Issue: 5
Combat Information Management.

Issue: 6
Shallow water ASW.

Issue: 7
Mine Warfare (MW) and Mine Countermeasures (MCM).

Issue: 8
Warheads.

Issue: 9
Multi-sensor/Autonomous air-to-air missile seeker.

Issue: 10
Identification Friend or Foe (IFF).

Issue: 11
Mine avoidance/neutralization.

Issue: 12
Corrosion reduction/control.

NAVCENT

Issue: 13
Improved Precision Strike. Provide affordable precision strike weapon and platform upgrades which can be easily retrofitted into existing systems and: 1) Improve autonomous target recognition, 2) Increase detection, tracking, and acquisition ranges, 3) Improve performance in adverse weather and man-made clutter, 4) Enable aim point selection in the autonomous terminal guidance phase, 5) Improve first-pass single and multiple target kill probability, 6) Can detect and destroy buried fiber-optic cables.

Issue: 14
Improved Mine Countermeasures (MCM). Provide affordable mine countermeasure systems which are organic to the battle force and can: 1. Rapidly clear and/or breach and obstacles in deep water SLOCs and Amphibious Operations Areas (OPAREA). 2. Deploy expendable mine neutralization systems that are effective against bottom, moored, and drifting mines. 3. Conduct covert mine and obstacle reconnaissance of deep water SLOCs and amphibious operations areas. 4. Reduce and/or mask the acoustic, electromagnetic, and pressure signatures of ships and submarines. 5. Monitor, evaluate, and predict the environmental forces germane to mine warfare.

Issue: 15
Optimize the existing Command, Control and Communications architecture. Rapidly develop and field new information management technologies and approaches that will get the right information to the right place at the right time while maximizing the use of existing collection, communication and display systems.

N4
Issue: 16 Affordability/Life Cycle Cost (LCC) Reduction. Issue: 17 Environmentally Sound Ship. Issue: 18 Lack of Logistics Over The Shore (LOTS)/Joint Logistics Over The Shore (JLOTS) - Sea State 3 Capability. Issue: 19 Reduce inspection requirements and perform maintenance based on system condition; develop prognostic technologies and methodologies for predicting failures, including probable time to failure: a. Automated non-intrusive diagnostics (remote, built-in) b. Condition based maintenance vice time based maintenance. Issue: 20 Environmental regulations constrain operations. Require advanced integrated ship waste processing system for environmentally sound ships.

MANPOWER & N12

Issue: 21
Readiness determination and force structure management.

Issue: 22
High quality personnel solicitation/retention in an increasingly technical environment.

Issue: 23
Improve selection, classification, assignment, and detailing.

Issue: 24
Enhance ability to extract critical information under complex and uncertain tactical conditions.

Issue: 25
Complex tactical decision making/mission planning.

Issue: 26
Manning issues in system design and acquisition.

ISR
Issue: 27 Submarines. We suffer a great difficulty in the detection, classification, location and tracking of submarines, especially diesel submarines in littoral waters. Issue: 28 ISR of mining activity. We suffer limited indications and warning (I&W) of mining activities and preparatory evolutions. Issue: 29 WMD. We suffer from limited detection and surveillance capability of weapons of mass destruction (WMD) in the production, preparation and delivery phases. (Note by this, we are concerned with the time BEFORE the weapon is detonated (nuclear) or released into the atmosphere (biological or chemical).

N6
Issue: 30 Resistant Electronics to protect Navy systems against countermeasures. Issue: 31 GPS Follow-on. Issue: 32 Multi-Lingual and multi-cultural systems.

C4 & IW
Issue: 33 Combat ID. Issue: 34 Battle Damage Assessment (BDA). Issue: 35 Realtime update and dissemination of battle information.

MARFORPAC
Issue: 36 Communication and computer equipment limitations. Issue: 37 Mobility and maneuver. Issue: 38 Real Time biological Detection.

N86
Issue: 39 Develop joint, robust, battle management C4ISR architecture. Provide ability to display tactical information over netted, distributed sensors. Improve strike management. Improve data links to enhance weapons effectiveness. Develop battlespace web. Achieve dominant battlespace awareness. Issue: 40 Improve surface combatant precision strike/naval surface fire support (NSFS). Develop enhancements to long range, sea based, precision land attack system (TLAM). Improve precise naval gun fires beyond current 12 nm maximum range. Issue: 41 Provide sea based missile defense against ballistic missiles. Continue to develop area and theater wide ballistic missile defense capabilities. Include enhancements to accomplish boost phase intercept of ballistic missiles over enemy territory. Issue: 42 Improve undersea detection capabilities to include a variety of sea mines and advanced nuclear and diesel submarines operating in both deep and shallow water.

Forward Engagement & N51
Issue: 43 Countering mines, especially bottom mines. Issue: 44 Countering supersonic, stealthy cruise missiles. Issue: 45 Operating for prolonged periods in Weapons of Mass Destruction (WMD) environment.

N81
Issue: 46 Reduce manning levels for the operating force or shore based workforce. Issue: 47 Develop initiatives that would require fewer items in the inventory. Issue: 48 Higher quality output from production or maintenance facilities. increasing mean time between failures (MTBF). Issue: 49 Lowered production costs as a result of a process improvement or a material innovation, etc. Issue: 50 Testing/maintenance techniques that are less intrusive, and less likely to decrease service life (like non-destructive inspection, better trouble shooting techniques, better diagnostics). Issue: 51 Improvements in training. Issue: 52 Reducing maintenance costs, by doing it better, quicker, cheaper, or requiring it less often. Issue: 53 Risk mitigation, i.e., an initiative may not produce any savings over the status quo, but may provide the same technology and/or product at a lower risk. Issue: 54 Improving interoperability in the joint environment.

N096T
Issue: 55 Requirement for capabilities to make oceanographic and meteorological measurements in denied littoral areas over a dense enough grid - or at specific target locations - sufficient for meso - and small scale nowcasting and prediction, on time and distance scales commensurate with tactical expeditionary operations. Microsensors and expendables are likely needs. Issue: 56 Adequate digital communications connectivity to support the whole range of METOC services from global to tactical scales, including transmission of wideband digital imagery to the warfighter, and narrower band - but multiple - links from remote sensors to processing centers. Issue: 57 Development of more highly resolved and accurate numerical models for ocean and atmospheric prediction at the meso and small scale levels (<1 km resolution), yet efficient and user transparent enough for execution of tactical platforms. It will be necessary for these applications to assimilate dense sensor observations on local tactical scales in near realtime.

N87
Issue: 58 Submarine superiority, which includes: ASW, survivability and stealth. Issue: 59 Strike warfare. Issue: 60 ISR.

Marine Corps Combat Development Command (MCCDC)
Issue: 61 Surf zone Technology. Issue: 62 Sea-based cargo transfer technology. Issue: 63 Communications technology.

N931
Issue: 64 Ensure the sustained effectiveness of Navy and Marine Corps forces operating in a Biological Warfare (BW) environment. Issue: 65 Minimize health risks and optimize health care for women in Navy and Marine Corps operational forces. Issue: 66 Determine and evaluate the biomedical effects of novel, emerging "non-lethal" weapons on Navy and Marine Corps personnel.

CINCPACFLT
Issue: 67 Precision strike munitions/weapons. Issue: 68 Mine detection. Issue: 69 Shallow water ASW.

A SAMPLING OF NAVY SCIENCE AND TECHNOLOGY ACCOMPLISHMENTS

1946 - "Whirlwind," The First Digital Computer To Use Magnetic Core Memory

1946 - "Helios" Upper Atmosphere Research Project

1948 - Project "Skyhook" To Study Cosmic Rays

1950 - First Molecular Beam Apparatus For High Precision Spectroscopy

1951 - Ammonia Beam Maser

1956 - First Hurricane Photographic Rocket Program

1960 - A World Record Dive of 35,800 Feet By The TRIESTE

1966 - 1996 - Global Positioning System

1968 - First High Energy Electron Beam Stabilized Carbon Monoxide Electric Discharge Laser

1972 - Lithium-Thionyl Chloride Battery

1985 - Spacelab 2's High Resolution Telescope And Spectrograph

1986 - Acoustic Microscope

1992 - Intel Ni1000 Computer Chip

1994 - Miniature Microwave Active Filter

1995 - Dual-Band Infrared Focal Plane Array

- New Lightweight Micro-machined Directional Hydrophone
- Bacterial Removal of Oily Sludge on Oil/Water Separator Plates
- Freeze-Dried Blood Platelets Processing System
- Laser-Based Countermeasures System Against Infrared Seeker Anti-Ship Cruise Missiles