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This article discusses the Navy's development of the C4I system "Copernicus". The Navy's goal is to make Copernicus the pillar for Naval C4I responsive to warfighers; to field these systems quickly; to capitalize on advances in technology; and to shape Naval doctrine to reflect these changes. Designed as a user-centered C4I architecture it provided a blueprint for capturing technological change. It answered critical C4I problems and articulated the essence of modern command and control.

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FOREWORD

In the 1980s companies like Apple and IBM revolutionized industry by introducing the first desktop personal computers and the Information Age was born. The Navy recognized the potential of using information as a warfighting tool and in 1990, published Copernicus. Copernicus is the Navy's initiative to make command, control, communications, computers and intelligence (C4I) systems responsive to the warfighter; to field these systems quickly; to capitalize on advances in technology; and to shape our doctrine to reflect these changes.

We must recognize that success on many past battlefields has come from innovative ways of combining available new technologies, and not solely from technological advances, per se. History is full of examples where outnumbered forces were victorious because they controlled critical information. Many times both sides had the same tools or technology available, but one was able to achieve an advantage through innovation.

We are in the midst of a time of significant change that is no less revolutionary than the advent of steam propulsion, carrier aviation or nuclear submarines. The Revolution in Military Affairs has moved information and the requirement for information dominance in the joint battlespace to center stage in our thinking about modern warfare. One important element of this revolution is Information Warfare (IW) — a powerful capability that will have profound implications in the ways Naval forces influence, deter and, if necessary, fight wars. The Naval services will, correspondingly, have a prominent role in IW. Forward presence requires the Naval services to aggressively approach IW from the perspective of both an engaged and enabling force. Unlike the other Services, the Navy must imbed IW capabilities in the fleet and be capable of conducting IW from the time we leave CONUS to the end of an extended deployment.

It has been five years since the Navy published Copernicus. As the role of C4I in the Information Age progressed, Copernicus evolved. We now understand the benefits of having a systematic way to use information to influence future military operations. We have come to grips with the fact that we have crossed the threshold into the Information Age. In a time when one of the most important enablers for the Naval expeditionary forces is information, tactics flow in large part from characteristics of our information processing capability. We can only gain an advantage over our opponents if we are the first to implement offensive and defensive information tactics into our warfighting arsenal.

Because our forward posture allows the Navy to be in position when crises develop, we can use IW to slow and influence the enemy's decision making cycle, to prepare the battlespace before the start of open hostilities, and to dictate the battle on our terms. Information-based warfare, employing advanced IW with its rapid, reliable and secure communications, permits integration of battlefield information and increases effects from offensive firepower and maneuvers of our dispersed units.

Information-based warfare allows our forces to exploit new weapons technology to increase the speed of battle. Impeding the enemy's ability to communicate, attacking command and control (C2) nodes, and shutting down enemy sensors will give us the upper hand on the battlefield. Likewise, information-based warfare will give the U.S. the operational flexibility to allocate forces and fires in real time, and to defeat enemy forces at the time of our choosing. In the battlefield of the future, decisive victory will depend on having a comprehensive, global C2 system. This comprehensive analytical approach to IW which combines strategy, tactics, and doctrine fully prepares the Navy/Marine Corps team to meet the challenges of the 21st century. Implementing IW will be one our biggest challenges in the near future.

To realize this future vision, all C4I systems must be built under a JCS unified strategy. Copernicus provides this focus for the Navy and Marine Corps. Our approach demands implementing state-of-the-art technology with highly trained operators. Copernicus although not in its final form, is fielded and operational. It is a robust and dynamic architecture based on the Navy and Marine Corps' vast experience over the past 30 years digitizing the battlefield and providing global C4I in support of the National Military Strategy.

We have to be able to adapt quickly to changing technology to fight and win wars in the Information Age. It is clear that information has become a major factor in warfare and will grow in importance in the next century. I challenge you all to join me as we redefine how wars are fought and won!

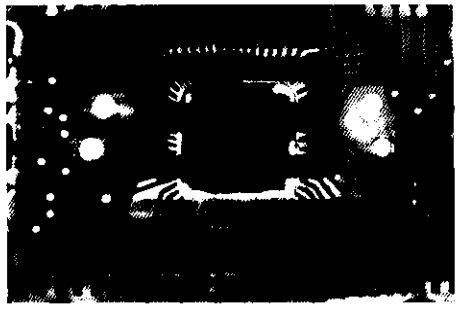
Admiral J. M. Boorda, USN
Chief of Naval Operations

COPERNICUS

1990: The Beginning

IBM PC AT

During the early 1980s, the introduction of the desktop personal computer and advances in telecommunications sparked the Information Age and forever changed the way nations conduct business *and warfare.* Late in the decade, the collapse of the former Soviet Union marked the end of the Cold War resulting in a shift in our national priorities. This shift, however, was not a move away from military leadership or capability. Instead, it was a move toward capturing the forces of change, especially information dominance and technological advancements, to move into the 21st century. Struck by the strategic implications of information dominance in boardrooms and on the battlefield, the Navy, in a white paper, defined Copernicus.



Microchip

In 1992, the Navy and Marine Corps made another bold move by publishing *"...From the Sea."* Copernicus and *"...From the Sea"* reflect a shift from maritime, open ocean warfighting to joint operations in the littoral.[1]

Landing Craft Air Cushion (LCAC) transporting armor and troops ashore during littoral operations

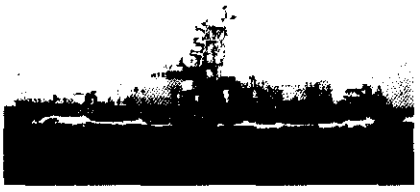
Copernicus, designed as a user-centered command, control, communications, computers and intelligence (C4I) information management architecture, provided a blueprint for capturing technological change. Copernicus answered critical naval C4I problems and articulated the true essence of modern command and control (C2). It laid the foundation, through its pillars, for joint and allied operations.

Copernicus...Forward

The Evolution

When Copernicus debuted it was revolutionary. Its planners recognized the technological limitations challenging Copernicus and selected a building block approach to accommodate innovation. By focusing on fielding systems that provide access to essential data, Copernicus allows the decision making process to migrate from upper echelons down to the tactical commander, or the shooter, realizing a goal of Copernicus — ***a true sensor-to-shooter environment.***

Five years later, one of Copernicus' enduring characteristics is its evolutionary nature. Fielded advances in data processing and storage media technologies permit the operational commander at sea and in the field to process, store and manipulate greater amounts of information more efficiently, improving both the view of the battlespace and the decision making process.



Cyclone class coastal patrol ship designed for operations in the littoral

Today's Naval forces perform an increasing number of non-combat and contingency operations as part of United Nations or coalition forces. These operations highlight the need to respond quickly to diverse threats that are not easy to predict or identify. Additionally, these operations emphasize the continuing need for Copernicus as the best means of moving from stovepipe systems to joint operations capability and systems interoperability.

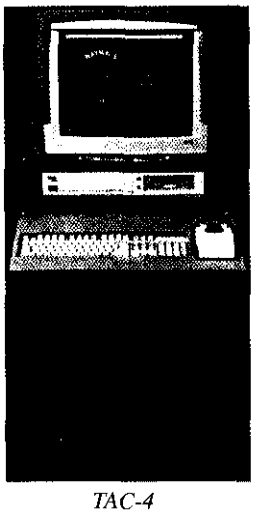
Humanitarian assistance

In this document, we reaffirm the Copernicus foundation, summarize its original vision, discuss Copernicus today and describe the vision for Copernicus' evolution into the 21st century.

COPERNICUS' FOUNDATION

There are five essential elements of Copernicus that provide architectural oversight to leverage the C4I infrastructure effectively and enhance the C4I operational perspective. These elements:

- Seamlessly blend, through common applications in one workstation, critical tactical, operational and administrative data to the warfighter, thus allowing tactical objectives to drive operations.
- Assimilate required information rapidly through standardized data formats, permitting operational commanders and users to "pull" desired information to accomplish tasks. A two-way intelligent "push" capability supplements user-pull when required and prevents information overload.
- Provide information using integrated data formats in a multimedia environment where form fits function (i.e., voice, video, imagery, and tactical data at high speeds).



TAC-4
The TAC-series computer, based on commercial open system standards and interfaces, is one of the hardware building blocks of Copernicus

- Provide a common operating environment (COE) that standardizes workstations for the operator. Workstation and user interface standardization permits greater operator proficiency while reducing training requirements.

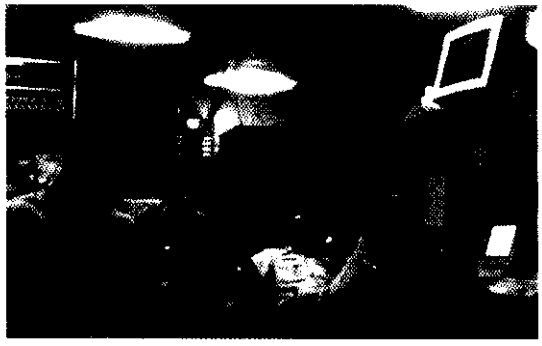
- Use common building blocks for modular and standardized hardware design, which permit upgrades and additions to the architecture in an expeditious, cost-effective manner.

The watchstander

Copernicus supports the warfighter at all levels:

- The **watchstander**, by employing high-tech computer workstations and common interfaces.

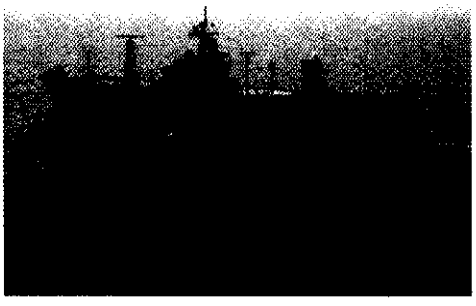
- The **shore commanders**, by developing multimedia connectivity and establishing rapidly configurable shore networks that link commanders to all echelons, across all Services, to all allies (whether temporary or enduring) across the full spectrum of warfare.



CWC mission planning

- The **Composite Warfare Commander (CWC)**, by employing a series of tactical information networks that change in number and nature to suit the CWCs doctrinal decisions and allow commanders to customize their C2 needs.

- The **Commander Joint Task Force (CJTF)**, by employing networks that must be flexible to permit commanders to customize their C2, especially during joint and allied operations.



The CJTF has gained predominance as new force structures require greater emphasis on joint operations

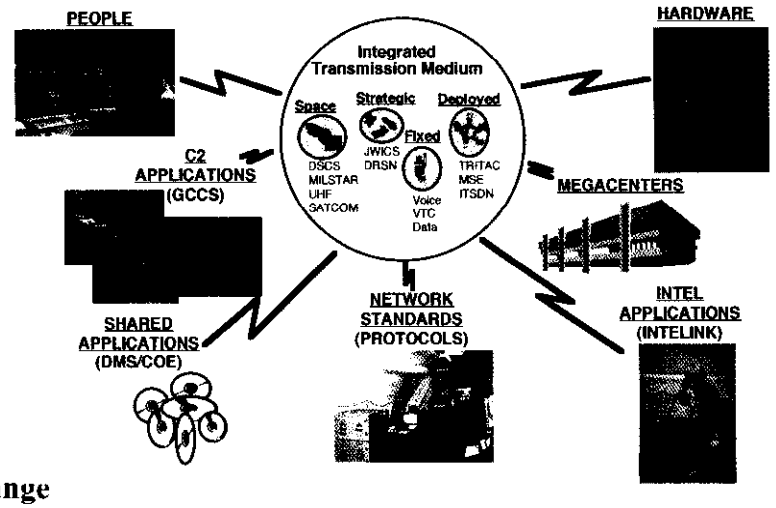
The Pillars of Copernicus

Copernicus, an interactive framework of pillars, links the C2 processes of the warfighter at all echelons of command.

The pillars of Copernicus include:

- The **Global Information Exchange System (GLOBIXS)** supports the joint and allied tactical commanders by providing access to all required information from any location through a series of wide area Defense Communications System (DCS) networks.

- The **CINC Command Complex (CCC)** serves as the primary gateway for communications and information flow from GLOBIXS to forward deployed warfighters via Tactical Data Information Exchange System (TADIXS). The CCC performs C2, correlation and fusion functions. A CINC decision making capability, with a focus on rules of engagement and operational intent is included. Battlespace decisions are made by the tactical commanders and shooters.

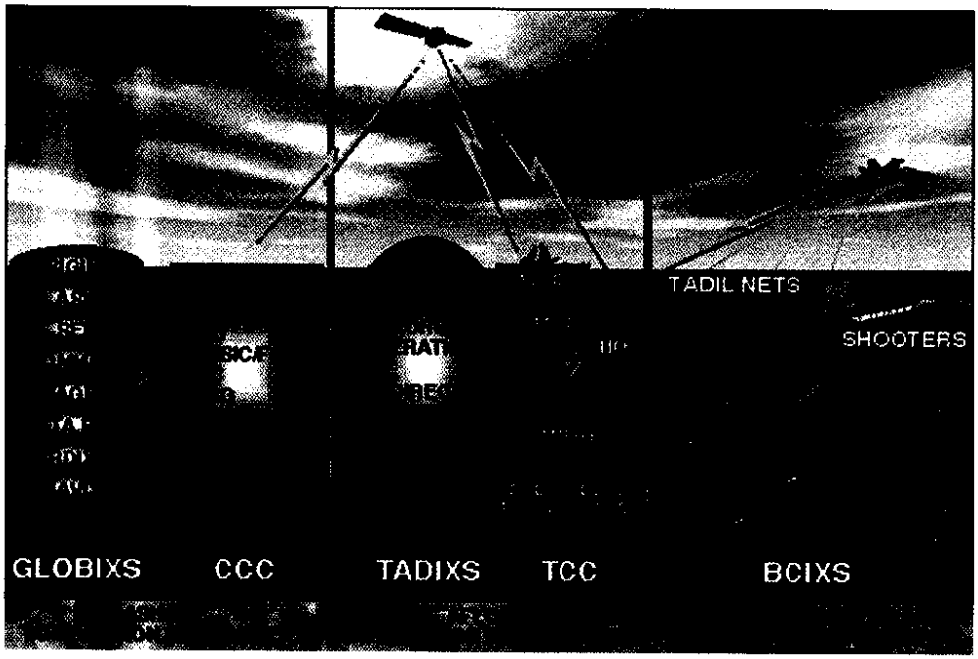


The Defense Information Infrastructure (DII), a seamless web of communications networks, computer databases, applications and other information processing and transport capabilities, is an example of a GLOBIXS

- The **Tactical Data Information Exchange System** is the tactical networks connecting the CCCs with the Tactical Command Centers (TCCs). These tactical networks fall into four general categories: Command, Direct Targeting, Force Operations and Support. TADIXS provide enhanced digital communications links to the shooters' combat systems from the Copernicus infrastructure, enabling user-pull functionality and enough computer power and bandwidth to receive and process tactical information.

- The **Tactical Command Center** disseminates information to the warfighter. The TCC can be any forward deployed command center, ashore or afloat, mobile or fixed, and includes tactical centers for individual units. The TCC is the gateway for information flow between TADIXS and the shooter and weapons using Tactical Data Information Links (TADILs).

Operations in the TCC



The pillars of Copernicus

Copernicus Pillar Evolution

The shooter

As Copernicus evolved, a new pillar emerged—the **Battlecube Information Exchange System (BCIXS)**. The original pillars flowed and filtered information to and from the TCC for use in the battlespace. The Copernicus battlespace is defined as the entire military and political infrastructure that spans the range of the pillars to the TCC. The BCIXS extends the architecture to include the battlecube, the area in which shooters and weapons reside. The battlecube is a conceptual, multi-dimensional area that includes subsurface, surface, air and space as the environment for conducting warfare.

- **BCIXS** represents the battlecube in which tactical forces operate. BCIXS boundaries are fluid and defined by the dynamics of the battle. Shooters operating in the battlecube form the operational nodes in the BCIXS. Shooters are equipped with C4I tools that allow them to receive and process information from the Copernicus architecture.

Essential Functions of C4I

Copernicus provides the following four essential C4I functions:

- Common Tactical Picture (CTP)
- Connectivity
- Sensor-to-Shooter
- Information Warfare (IW).

Common Tactical Picture is all information spanning the spectrum from the sensor to the shooter that allows tactical commanders to understand the battlespace. CTP consists of surveillance, intelligence, identification, environmental and positioning inputs and tactical decision aids. Key factors in the CTP include timeliness, coverage, sensor revisit rates, accuracy and completeness. All users then share the same scaleable picture and can extract the pieces relevant to their specific needs and tactical situation.

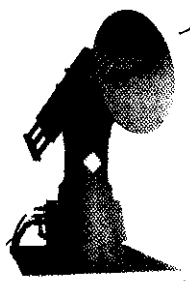
Operations Support System (OSS) provides shore commanders a CTP

Reducing fratricide during hostilities is an objective of national policy. This depends on a near-perfect tactical picture with common grid (locational) references on all platforms. The Joint Requirements Oversight Council (JROC) established the General Officer Steering Committee Combat Identification (GOSC-CI) and the Joint Combat Identification Office (JCIDO) to address these issues.

ES-3A with Battle Group Passive Horizon Extension System (BGPHES) transmitting data via a Common High Bandwidth Data Link (CHBDL)

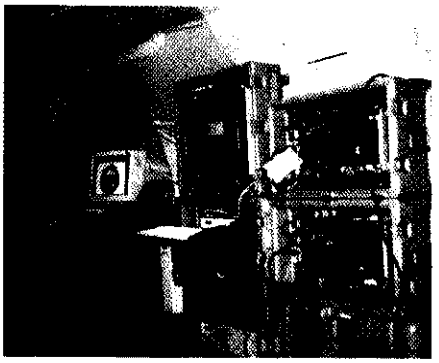
Connectivity: Connectivity links nodes throughout Copernicus to implement the sensor-to-shooter construct. Rapid and reliable connectivity is the cornerstone of all C4I provided by GLOBIXS, TADIXS and BCIXS. Connectivity is critical to the CTP because it provides the managed bandwidth for timely transmission of imagery, video, voice and data. Connectivity is critical to DII users in peace, crisis, conflict, humanitarian support and war. It is the widely-distributed, user-driven infrastructure composed of the information assets owned by the Services into which the warfighter can gain access from any location, for all required information.

Defense Information System Network (DISN) is the information superhighway of the DII and is the primary connectivity for GLOBIXS. DISN consolidates voice, video, data, imagery and record traffic stovepipes into the global, joint C4I grid. Implementation of the Integrated Tactical Strategic Data Networking (ITSDN) structure within the DISN will enable horizontal and vertical cross-connection of the global grid. DISN will also be the transport medium for TADIXS and BCIXS shore networks. The worldwide shore-based communications infrastructure will continue to play a vital role in supporting the Copernican and DII architectures.

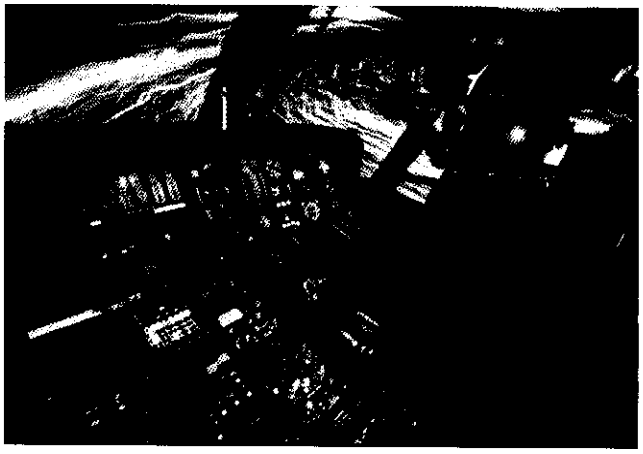


CHBDL shipboard antenna

Continuing expansion of available bandwidth to the warfighter will be a hallmark of Copernicus in the 21st century. Exploitation of fiber optic wavelength multiplexing techniques, direct satellite broadcast and wideband transmission systems will sustain the Copernican evolution and result in increased precision, lethality and survivability of the warfighter. In addition, these technological advances will allow other quality of life enhancements for personnel including tele-medicine, tele-training, tele-education or something as simple as a phone call home from remote sites.



Mobile Ashore Support Terminal (MAST) - a self-contained mini computer center that acts as a shore-based extension of the afloat C4I network



Special Forces receiving real-time information

Sensor-to-Shooter focuses on the process of *putting* a weapon on target. This includes surveillance and reconnaissance, acquisition and localization, combat identification, targeting, engagement and guidance, and battle damage assessment.

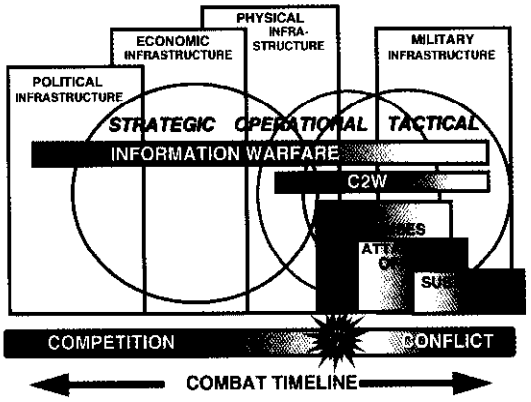
Historically, systems were developed to engage a specific threat with little regard for the interrelationship with other systems or supporting infrastructure. Stovepipe systems made it difficult for platforms to share information in a timely manner causing inefficiencies, especially in joint and allied operations. The sensor-to-shooter construct integrates all systems in the weapon procurement and employment process.

Information Warfare/ Command and Control Warfare (C2W) is any action to exploit, manipulate or destroy an adversary's information and/or information systems while leveraging and defending friendly information and information systems to achieve information dominance. IW can be employed before and during hostilities and is fought in the information battlespace.

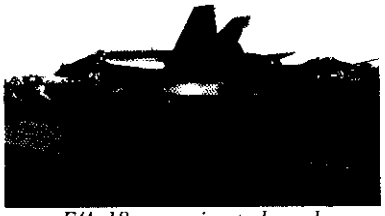
IW is used to deceive opposing forces and disrupt command and control

IW:

- Permeates strategic, operational and tactical levels,
- Encompasses political, economic, physical and military infrastructures,
- Expands the spectrum of warfare from competition to conflict,
- Redefines traditional military and national security concepts, and
- Spans the spectrum from peace through warfighting.



Information Warfare Spectrum



F/A-18 preparing to launch

C2W, the military implementation of IW, is the integrated use of operations security, military deception, psychological operations, electronic warfare and physical destruction to deny information to, influence, degrade or destroy an adversary's C2 capabilities, while protecting friendly C2 capabilities against such actions.

IMPACT OF INFORMATION TECHNOLOGY

Trends

Information will continue to be a critical driver of warfare, changing the fundamental way warfare is conducted. The same technological advancements that have provided business users greater computing power in smaller packages at lower cost have improved decision making within the battlespace. Technology has profound effects in the battlespace:

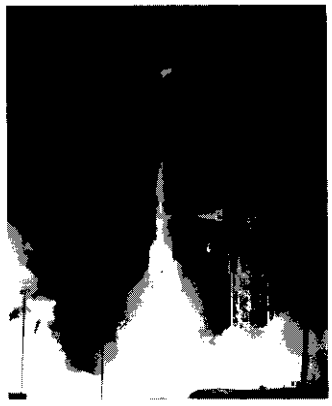
- Decreased time from identification to engagement,
- Improved precision and rates of fire cause dispersion of all forces,
- Enhanced digitization and integration of battlecube information increases effects from fire and maneuver of dispersed units,
- Improved situational awareness, and
- Better campaign assessment tools to evaluate courses of action.

"Wearable" C4I - a voice activated computer worn on the belt

Warfare is changing because of enhanced battlecube effectiveness. *Massing of troops is giving way to massing of firepower.*

Warfighting Challenges

Even though technology enhances battlecube effectiveness, there will always be challenges to overcome. For example, during battle there is a tendency of each Service to resort to its individual **operating rhythm**. C2 systems must integrate and synchronize the operations of forces *to optimize individual Service's strengths and synergize capabilities.* Other cultural differences which distinguish our armed Services such as **organization and doctrine** must continue to be modified to accommodate technological advancements and to improve battlecube effectiveness. **Intelligence** gathering in the battlecube *must be wholly integrated to realize the system's full potential.* Finally, there must be adequate **communications** capability to ensure effective C2.



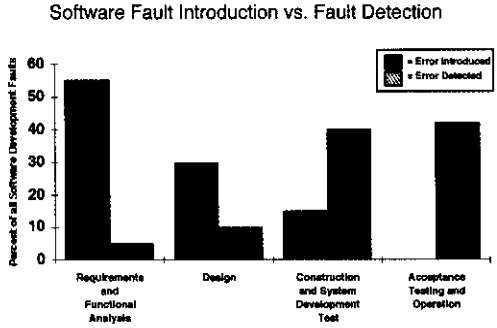
The UHF Follow-On program is a model for streamlining acquisition strategies using a fixed price, multi-year contract and taking advantage of competitive commercial launch capabilities

Information Technology Challenges

Besides the warfighting challenges that exist, there are information technology challenges too. For example:

Technology evolves at a faster pace than the acquisition cycle procures systems

- The **acquisition cycle** is slower than the pace of technology expansion. The Copernicus building block approach has allowed the Navy/Marine Corps team to insert advanced technology during system upgrades; however, *the acquisition cycle still cannot keep pace with the speed of advancing technology.* Standardizing interfaces and replacing military standards with commercial standards are positive steps toward obtaining needed bandwidth and greater price performance of computing capability. Other steps can and are being taken to capitalize on technology in the areas of software development and the application of modeling and simulation (M&S).



Faults are usually introduced in the early stages of software development

- The Services must correctly define requirements early in the *acquisition process.* Affordable **software** requires reduction of costly error correction in later stages of software development. Using software engineering tools and techniques, systems can be modeled and tested for compatibility and interoperability before the engineering

process begins. M&S and code development, using formal methods, can be an effective means of reducing errors, accelerating the acquisition process and reducing costs.

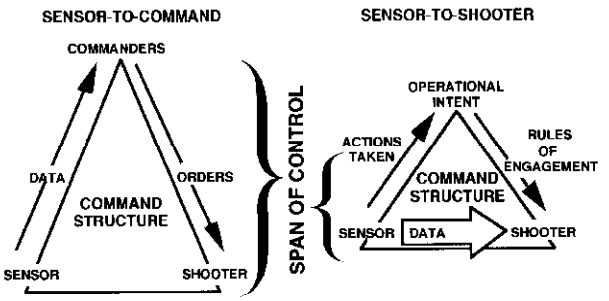
- As information requirements increase, not only must bandwidth in the **electromagnetic spectrum** be managed, but data transmission techniques must be developed to minimize or optimize the amount of data to be transmitted. This must be accomplished without degrading the quality of information in that data. Techniques which can be employed include demand assigned multiple access (DAMA) and time division multiple access.

- C4I systems can now inundate the warfighter with data but must transition to providing information and **knowledge of the battlecube.**

- As our warfighting capability migrates from weapons and platforms to the information systems that drive *warfare,* our susceptibility to **IW** is increased.

- To maximize its timeliness and effectiveness, information dissemination in the battlecube requires a more direct **organizational structure**. The focus must shift from sensor-to-command to sensor-to-shooter. With mission objectives and rules of engagement established, warfighters and shooters will perform their missions and commanders will command by negation.

Mission planning center encompassing all facets of C4I



Span of control compresses under sensor-to shooter construct

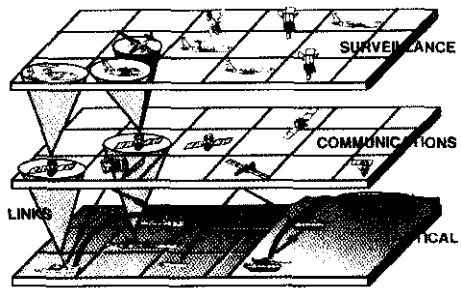
Flowing Information Forward: Building Sensor-to-Shooter

The original Copernicus pillars have also evolved to support the shift to *"Forward...From The Sea"* and *"Operational Maneuver From The Sea."* In *"Forward...From The Sea,"* there was a recognition that the most important role for Naval forces, short of war, is to be engaged in forward areas, preventing conflicts and controlling crises.[2] The Copernicus evolution reflects the need for the C4I infrastructure to support the architecture, down to the shooter and the weapon. Deployed forward, Naval C4I gives the joint commander **C2 on arrival**.

The highlighted areas indicate population density - over 70% of the world's population lives in the littoral

Copernicus supports worldwide C4I coverage to the shooter. Fixed and mobile elements now provide the shooter the same information previously available only to decision makers in command centers.

[2] *"Forward...From the Sea,"* 1994.



At the tactical level, the shooter uses the communications grid to pull necessary C4I information and commanders use the same links to push mission essential information to the shooter

Conceptually, platforms are linked by moving information around the information spectrum. The information spectrum consists of three integrated grids.

- **Surveillance Grid**: A *capabilities* grid blanketing the battlespace *instead* of a series of single sensors. This grid consists of national, theater and platform sensors that the warfighter can access directly or through GLOBIXS and TADIXS.

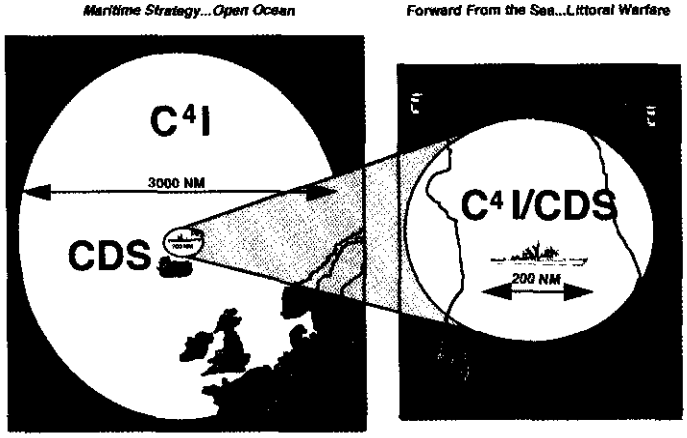
- **Communications Grid**: An overlaying wide area network of pathways that use multiplexing and digital technology to move data and information into and around the battlespace. Copernican connectivity facilitates the movement of information among operators and analysts.

Information assets in the information spectrum will be accessible by "plugging" into the grids. The user will be able to "pull" surveillance data by plugging into the communications grid.

- **Tactical Grid**: A tactical network of communications links that ties together all units of a force regardless of the platform or component. This grid connects the Combat Direction Systems (CDSs) among units' TCCs to provide fire-control grade information across the battlecube to the shooters. The BCIXS can "plug" and "play" to access C4I information directly by using TADILs tied to higher echelon TCCs and the tactical grid itself.

The tactical grid is used by the shooter

COPERNICUS EVOLVING

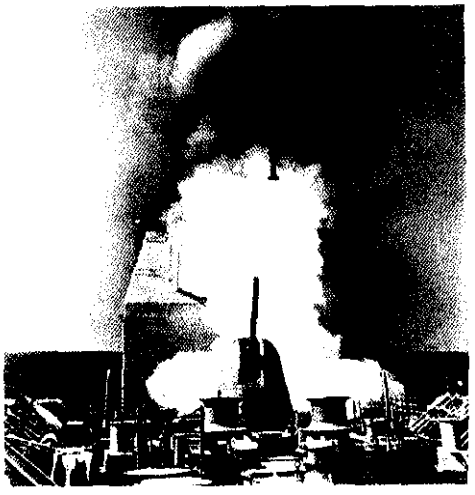


Reaction time is shortened in the littoral

Strategy to Match the Change - "Forward... From The Sea"

The Navy and Marine Corps team's focus in "*Forward...From The Sea*" moves operations into the littoral and is consistent with the Navy and Marine Corps' traditional forward presence role. Operating in the "blue water" environment, a battle group commander could identify threats and have time to react in a battlespace diameter that spanned 3000 nm. Threat cueing and advanced warning could occur long before engaging hostile forces. The time advantage is lost for

forces operating in littoral areas which might span a radius of less than 100 nm. Transitioning to littoral operations required a fundamental shift in how we think about C4I from operations at sea, to mobile versus fixed units. Proliferation of cruise missiles, mines and even more common devices such as cellular phones provide potentially hostile forces with capabilities that demand an inordinate amount of attention and could delay friendly operations.

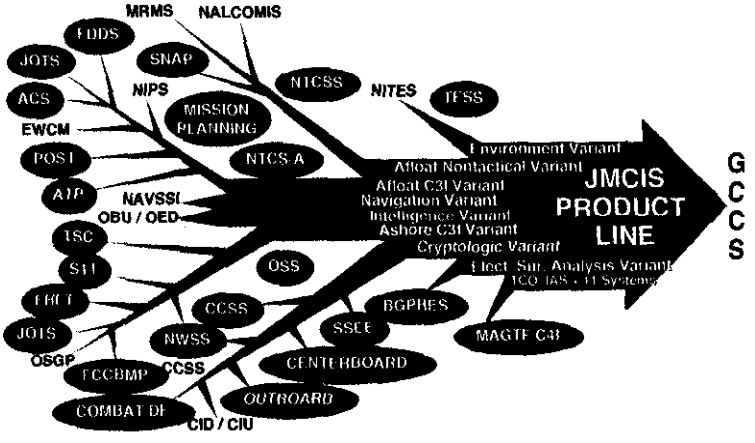


Joint Tactical Information Distribution System (JTIDS) - Cooperative Engagement Capability (CEC) is the first step towards C4I/CDS integration and Theater Ballistic Missile Defense (TBMD)

C4I/CDS Integration

Reduced reaction times, combined with increasingly capable threat weapons, make full C4I/CDS integration a critical objective of Copernicus. Fewer nodes and integration of C4I/CDS accelerates the decision making process and assists the joint warfighter in achieving information dominance over the enemy. Copernicus is accomplishing this integration by prescribing the interfaces between C4I systems and the CDS, empowering platforms to react immediately to threats. These interfaces depend on common standards and protocols so that systems in the architecture can transfer data.

The first major step in fielding Copernicus was implementing the Joint Maritime Command Information System (JMCIS) strategic concept. The JMCIS architecture links C2 systems into functional categories and creates an environment for Services to field interoperable systems with common user interfaces. Using the JMCIS strategy, the Navy has migrated numerous stovepipe systems into applications on a single-client server system to produce a CTP. More Navy and Marine Corps C4I systems will continue to migrate into the JMCIS architecture as Copernicus evolves. JMCIS software forms a kernel of the Global Command and Control System (GCCS).



Systems evolution into the JMCIS architecture, which will ultimately migrate to GCCS

GCCS supports an open system environment for automated information processing at all warfighting levels of the Department of Defense (DOD). The GCCS, in a departure from traditional developmental programs, promotes a rapid migration strategy that cost-effectively and continuously builds on changing technology and user information needs. A major DOD integration initiative is the selection of those migration systems that will ultimately lead to the creation of standard DOD systems.

Fielded JMCIS equipment

COPERNICUS AND THE WARFIGHTER

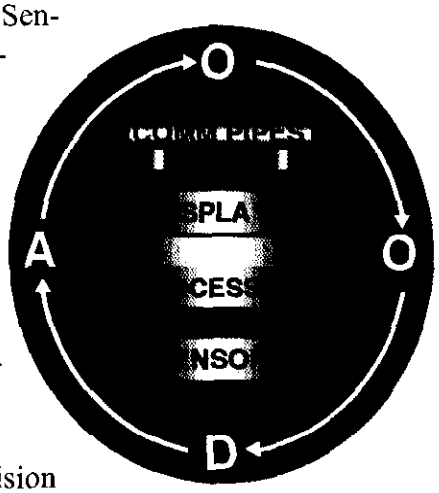
Organization and Doctrine

For the warfighter to benefit from improved information availability and processing power, the Services must streamline their command structures. Joint doctrine must be developed to ensure technology and investment are captured for the warfighter. Evolving to a sensor-to-shooter construct, information management systems must correlate and fuse data and automatically update the CTP. Rules of engagement and operational intent combined with real-time sensor information will guide warfighters in executing their missions. Rapid information exchange enables decisions at lower command levels where timeliness is paramount. Direct access to information allows shooters to engage targets of opportunity more rapidly.

Echelons of command will act through negation

Decision Process

The C2 decision making process has four phases: Observe, Orient, Decide, and Act — the OODA loop. The OODA loop drives decision implementation within the battlespace. Sensors *observe* reality. Processors and displays supply decision makers with the means to visualize and *orient* themselves to the scenario. Perceptions lead to the commanders' intentions and allow decision makers to *decide* on a course of action. Following the decision comes the execution, or the *act*. The benefits of technology allow simultaneous C2 decision making processes, empowering the warfighter with faster, better and more direct access to the decision making process.

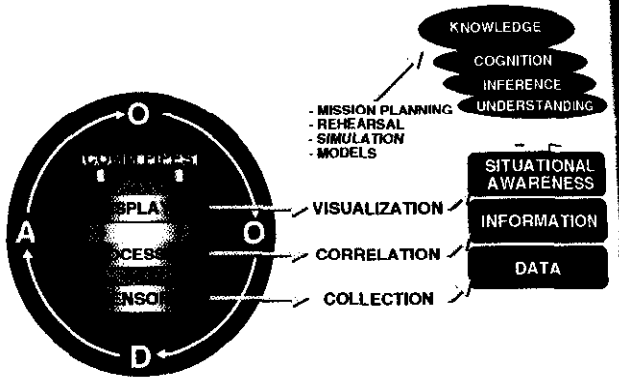


OODA loop

Command and Control

Decision makers can be given all available situational information; still, understanding the total scenario involves knowing *why* hostile forces are acting. When opposing forces engage, the battle progresses at a pace set by each combatant's actions. C2 becomes difficult at best. Under such

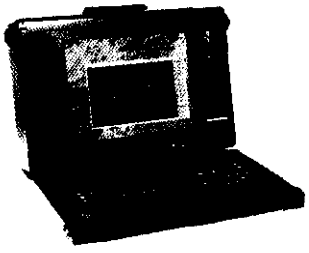
conditions, commanders must rely on training, doctrine and knowledge of the enemy. Knowledge goes beyond just situational awareness and includes the enemy's motives and doctrine. It is important that C2 systems have the capability to transcend situational awareness and free the commander for higher understanding tasks. Actions, visualization, collection and correlation drive the C2 engine toward understanding. Ascending the cognitive hierarchy will allow decision makers to create strategy, plan missions and rehearse based on an understanding of how the enemy is thinking.



Ascending the cognitive hierarchy

Real-Time Mission Planning

When commanders conduct operations with a streamlined command structure and improved C2, there are mission planning implications. Mission planning maximizes the enhanced capabilities provided by advanced technologies. Increased intelligence in the mission planning process provides the mechanism for the sensor-to-shooter construct to build a mission planning capability into the launch platform, and even into weapons. Real-time mission planning allows weapon in-flight reprogramming, updating and terminal homing based on sensor inputs.



Tactical Aircraft Mission Planning System (TAMPS)

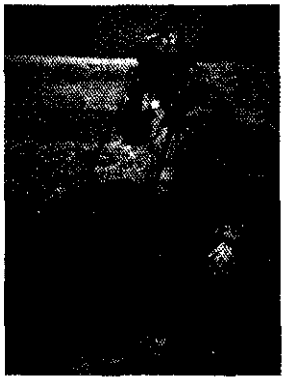
Real-time mission planning is enhanced by M&S, which provides tactical commanders planning option alternatives based on scenario variables and produces rapid answers to "what-if" questions. Eliciting and storing details of mission plans is especially useful in the battlecube when the shooter is relying on the system to provide executable plans for targets of opportunity.

M&S can be used for mission rehearsal

Information Spectrum

An objective of Copernicus is to provide worldwide, seamless communications by integrating the surveillance, communications and tactical grid systems within the Information Spectrum. These capabilities will provide worldwide commanders the operational coverage needed to perform their missions. Interoperability will be fully realized when the surveillance, communications and tactical grids seamlessly transfer information on a user-pull basis across boundaries.

Currently, each Service uses components of the Information Spectrum to obtain data; however, due to insufficient or non-interoperable communications links, the data is still not transferred seamlessly. The Navy is in the process of eliminating stovepipe systems and implementing Copernicus using COTS/GOTS technology.



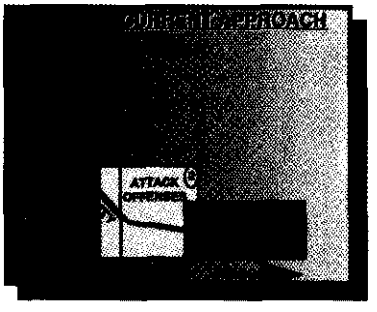
Tactical communications

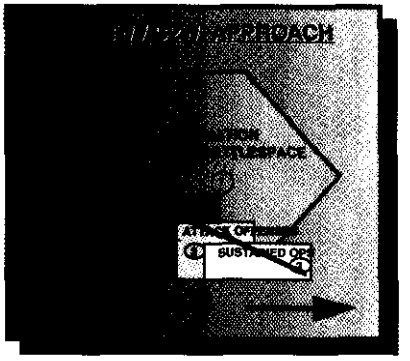
Interoperability lowers the relative cost of information by maximizing a system's ability to reach more users. The grid concept maximizes friendly force use of the Information Spectrum in the battlecube. If mission planners can conceive a grid for Joint forces, they can also conceive analogous hostile grids and devise methods to counter them.

C2W - Walleye targeted at a command bunker

IW/C2W to Preserve National Security

The revolution in military affairs moved the requirement for information dominance to center stage in modern warfare. Our growing reliance on information systems and the global information network results in emergent national security requirements. The Naval services must meet the challenge of these new requirements by supremacy in IW.





The IW/C2W approach degrades enemy warfighting capability before armed conflict

IW is rapidly becoming a primary tool to discourage and deter potential adversaries. By leveraging information technologies, we can shape opponents' information to confuse or convince them that we will win if conflict is initiated. IW seeks to avoid hostilities or gain an information advantage before shots are fired, missiles are launched or Marines are landed.

Should deterrence fail, IW can be implemented at the operational and tactical levels through C2W to disrupt the adversaries' decision making process. C2W attacks the various phases of the opponents' decision cycle which slows their decision making, generates confusion, magnifies uncertainty and results in their inability to take effective action. Conversely, we must protect our decision making processes to maintain the tactical advantage.

C2W provides an efficient, potentially non-lethal capability to neutralize an adversary's warfighting capability through a measured response. Naval forces deployed in a "presence" role will be optimally positioned to conduct C2W.

The Joint/Allied Perspective

Future wars will be fought with joint, allied and coalition forces. Alliances will have the potential to produce a powerful synergy of forces and capabilities. However, individual strengths can easily be offset if the interfaces among forces are not transparent to the commanders and warfighters. Technology infusion, standards and protocols, concepts of operations, a flexible architecture and a common command structure are required to bring diverse forces together. "The joint force is the source for service capabilities not the result of individual service capabilities coming together."[3]

MIDS is an allied information exchange system supporting C4I for the warrior

"C4I For The Warrior" is the conceptual roadmap for achieving global joint C4I interoperability that will allow any warfighter to perform any mission, any time, any place and is responsive, reliable, secure and affordable. In *"C4I For The Warrior,"* information exchange must incorporate interoperable technologies to fuse and automatically update information for **joint** users to "pull" when required. The command hierarchy must be flattened for the warfighter to benefit from the revolution in technology and information availability. Information flow to the warfighter must be as direct as possible, with command being exercised by negation to accelerate the decision and action processes.

U.S. forces training allied/coalition forces

Each Service has its own strategy for achieving global, joint C4I interoperability:

- **Navy/Marine Corps - Copernicus**
- **Army - Enterprise**
- **Air Force - Horizon**

"Enterprise" takes a "holistic, process-oriented view of C4I systems development, weapon and weapon support systems development requirements definition, systems acquisition, systems integration, systems improvement, systems employment, and sustainment across the tactical,

[4]

[3] *"C4I For the Warrior,"* 12 June 1993.

"Horizon" provides the warfighter with responsive, advanced C4I services. It is a charge for leading the Air Force into an era of technological innovation and better satisfying the warrior's requirements. *"Horizon"* charts the course to orient Air Force thinking toward providing warfighters with C4I support in an expeditionary environment and to seek advantages in the coming age of information warfare.[5]

The Navy/Marine Corps team enthusiastically embraces these architectures. Together with each Service, we will fulfill the Joint Chief of Staff's *"C4I For The Warrior"* vision. Each Service can maximize their operational specialties by working together to achieve battlespace dominance. *"C4I For The Warrior"* requires interoperable systems that can move information among mobile units. Mobile units that characterize the battlecube will share information across the information grids, using space as the common information transfer medium. The Services will fight synergistically, seamlessly transmitting critical information to become fully integrated in the battlecube.

EA-6B is the Navy's primary airborne C2W attack system

COPERNICUS...FORWARD

U.S. forces will continue to participate in U.N. missions

Copernicus in the 21st Century: C4I for the Warrior

In the 21st century, Naval forces will achieve C4I for the warrior through the implementation of Copernicus. While the planning horizon extends into the 21st century, Copernicus emphasizes action and near-term results that can immediately benefit the warfighter. By designing for continuous change, Copernicus creates an evolving systems environment that focuses on the process of how we get there from here rather than defining the ultimate destination.

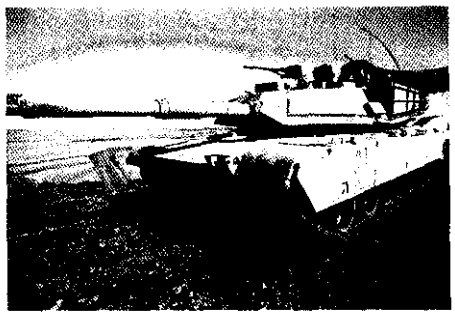
Submarines are ideal platforms for data collection

Future Joint Warfighting

Future warfare will take on a new dimension with IW being employed before and during hostilities. Forward deployed forces will conduct continu-

[5] O'Berry, Carl, LTGEN., *"Horizon"*

ous surveillance and intelligence collection, providing critical battlespace information. IW preeminence will start early in a crisis. It will shape the conflict and reduce the adversary's warfighting capabilities before hostilities begin. This gives our forces the clear advantage. Technology proliferation makes a clear requirements statement for a robust, interoperable, highly responsive C4I system to provide timely and accurate data and machine-assisted planning options to joint force decision makers.

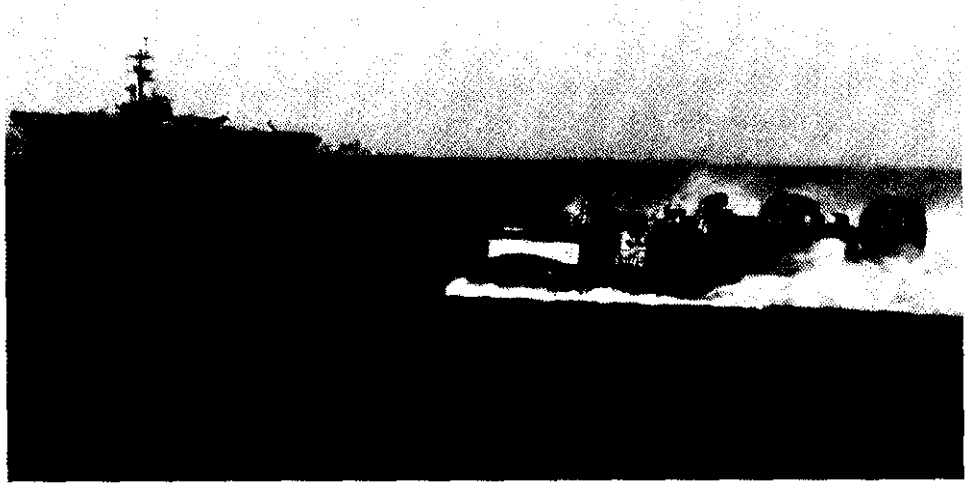


Army operations

Joint Battlespace

The Services must work together without boundaries so that offensive actions can be executed with maximum effectiveness and economy of resources. Smaller, diverse forces will use C4I systems to integrate their operating rhythms, creating a distinct advantage over adversaries. Communications will be seamless over multimedia interfaces. Workstations will correlate and fuse data, and users will pull information necessary to the mission. Information will be received in a common format, through standard graphical user interfaces. Copernicus empowers users to act on real-time information, which enables swift, decisive moves to dominate the battlespace.

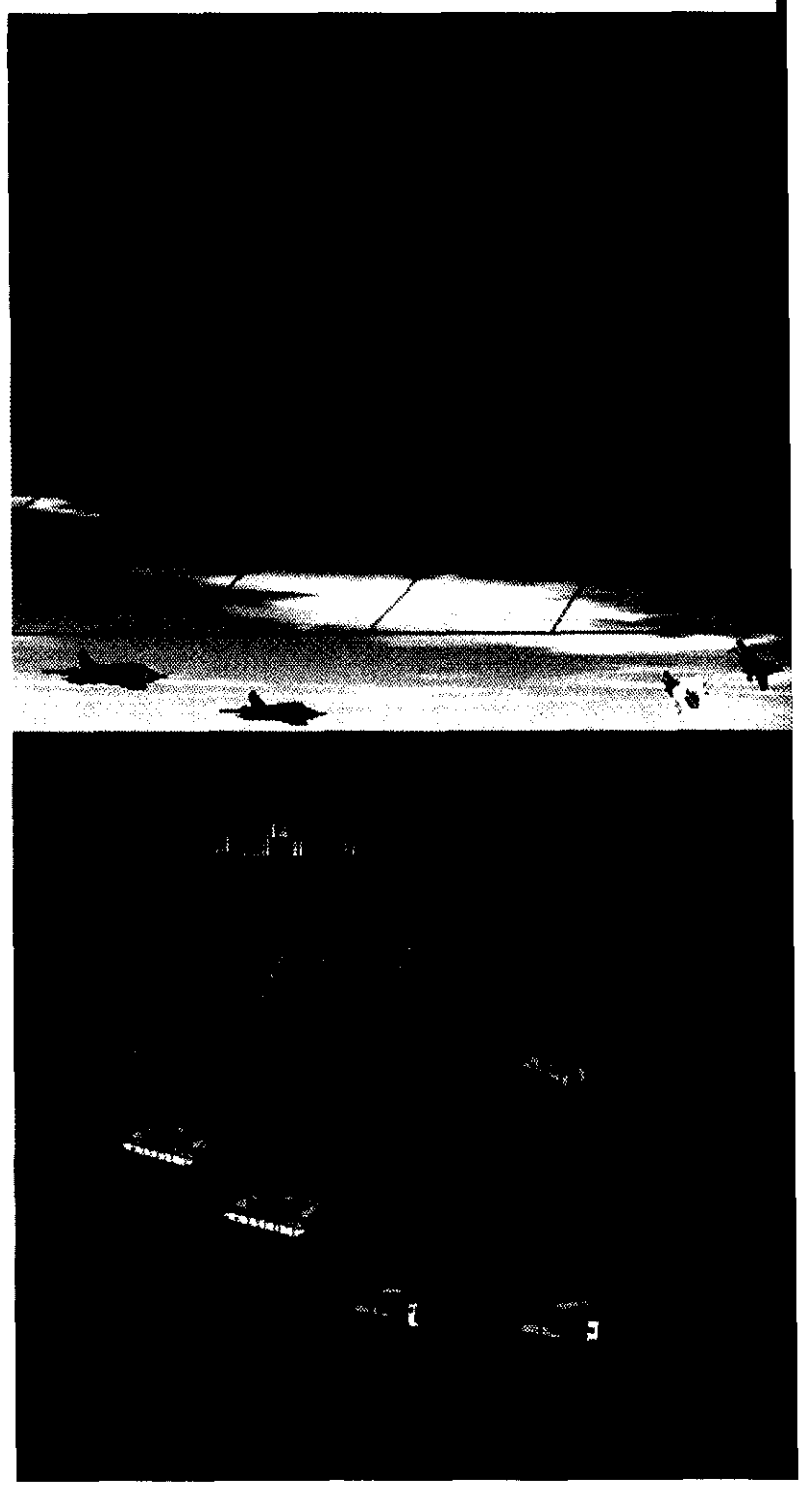
Air Force operations



Marine amphibious operations

In Summary Copernicus...Forward

The Navy/Marine Corps team continues to ensure the architecture remains a viable and evolving construct that fully supports the warfighter. Copernicus continues to adapt to new technologies and requirements. As a result of fielded systems that support the Copernicus architecture, the Naval forces' goal of true joint and allied interoperability is becoming a reality as is the establishment of an IW strategy and capability. The Joint force of the future will require C2 on arrival. This capability is being addressed by each Service as we all strive toward coherent joint operations. Army "*Enterprise,*" Air Force "*Horizon*" and Copernicus represent tremendous leaps forward in achieving this goal. The integration of these architectures are the mainstay of "*C4I For The Warrior.*" Examples of systems that work together to support the C4I needed for the battlespace of tomorrow include: JMCIS-based C2 systems like the Naval Tactical Command System-Afloat (NTCS-A) and Marine Air-to-Ground Task Force (MAGTF) C4I and their compliance with the GCCS Common Operating Environment, UHF Follow-on, JTIDS-CEC, and ongoing TBMD efforts.



C4I for the 21st Century

The anticipated speed of future battles dictates fundamental changes in the way Joint forces organize, plan and execute warfighting. New concepts of operation and doctrine will force C4I systems and architectures from linear, centralized constructs to simultaneous, adaptable systems allowing almost continuous planning, execution and replanning in near real time and real time. The Navy/Marine Corps team's implementation of the Copernicus vision is now paying dividends. Our ability to adapt new technology and continually improve systems to support the battlespace of the future is a proven element of that vision and our acquisition strategy.

The enduring success of Copernicus is assured by its inherent ability to capture change. Copernicus continues to reduce redundancies and accommodate evolving requirements, technological innovations, systems improvements, standards-based interoperability at the lowest possible level, and rapid refinements in policy and doctrine such as "*Forward...From the Sea*" and "*C4I For The Warrior.*" As the Services continue to improve and refine their joint-oriented C4I efforts, Copernicus will provide the warfighter a leading-edge architecture.