THE COPERNICUS ARCHITECTURE

AUGUST 1991

Phase I: REQUIREMENTS DEFINITION

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Navy's C4I Architecture for the Post-Cold War

OP-094

Copernicus Project Office
Director, Space and Electronic Warfare
Office of the Chief of Naval Operations
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INTRODUCTION

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This document is a Phase I Requirements Definition that provides necessary architectural guidance to restructure all Navy command and control, communications and computers, and intelligence (C^4I) systems under the Copernicus Architecture. All existing Navy C^4I-related plans and programs under the sponsorship of OP-094 shall be subordinated to this document and the architecture described in it.

Specific programmatic and implementation requirements are detailed in Chapters 9 and 10 of this document, which provides direction to the Commander, Space and Naval Warfare Systems Command (COMSPAWARSYSCOM) to implement it.

This document is the result of an 18-month architectural effort sponsored by OP-094 to develop a post-Cold War C^4I architecture for the Navy. The requirements definition stems from multiple efforts including those of the Copernicus Project Team and three specially convened working groups: one each for technology, communications, and investment strategy. Key findings and recommendations from the reports of the working groups, which had representation from OPNAV, COMSPAWARSYSCOM, the Fleet Commanders-in-Chief (FLTCINCs), and various claimancies and industry, are contained in Appendices A, B, and C. Figure I-1 shows the process.

The undertaking of an entirely new architecture for Navy C^4I is an enormous task that will require considerable effort over several years and the continued involvement of not only OP-094 and COMSPAWARSYSCOM personnel, but also of the customer, the FLTCINC. This process is planned to occur in phases, and will employ the principles of the Total Quality Leadership program, especially Process Action Teams, as well as standing working groups. Most importantly the process reflects OP-094's commitment that the Copernicus Architecture be an unprecedented model for OPNAV, COMSPAWARSYSCOM, claimancy, and FLTCINC cooperation.

PHASE II EFFORTS

Phase II will consist of three main thrusts (see fig. I-2):

- The establishment on the OP-094 staff of a Space and Electronic Warfare (SEW) Architect delegated broad architectural, managerial, and operational authority over the development of the SEW systems including the Copernicus Architecture;
- The establishment on the Space and Naval Warfare Systems Command (COMSPAWARSYSCOM) staff of a SEW engineer, delegated systems integration and engineering oversight of the SEW systems, including the Copernicus Architecture; and

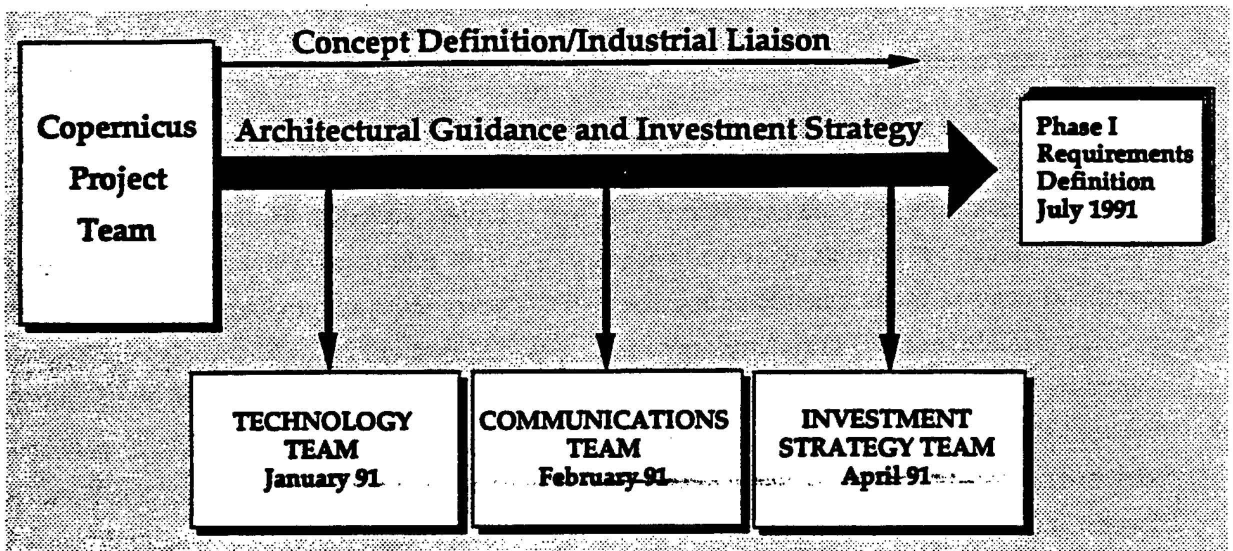

Figure I-1. Phase I Methodology

- The establishment on the OP-094 staff of a SEW programmer, delegated responsibility for programmatic integration of SEW systems, including the Copernicus Architecture.

The SEW architect will be established as a staff element independent of existing division directors. The architect's responsibilities will include architectural and operational oversight of all OP-094-sponsored programs, existing and future, to ensure full compliance with Copernicus standards and applicability within the architecture.

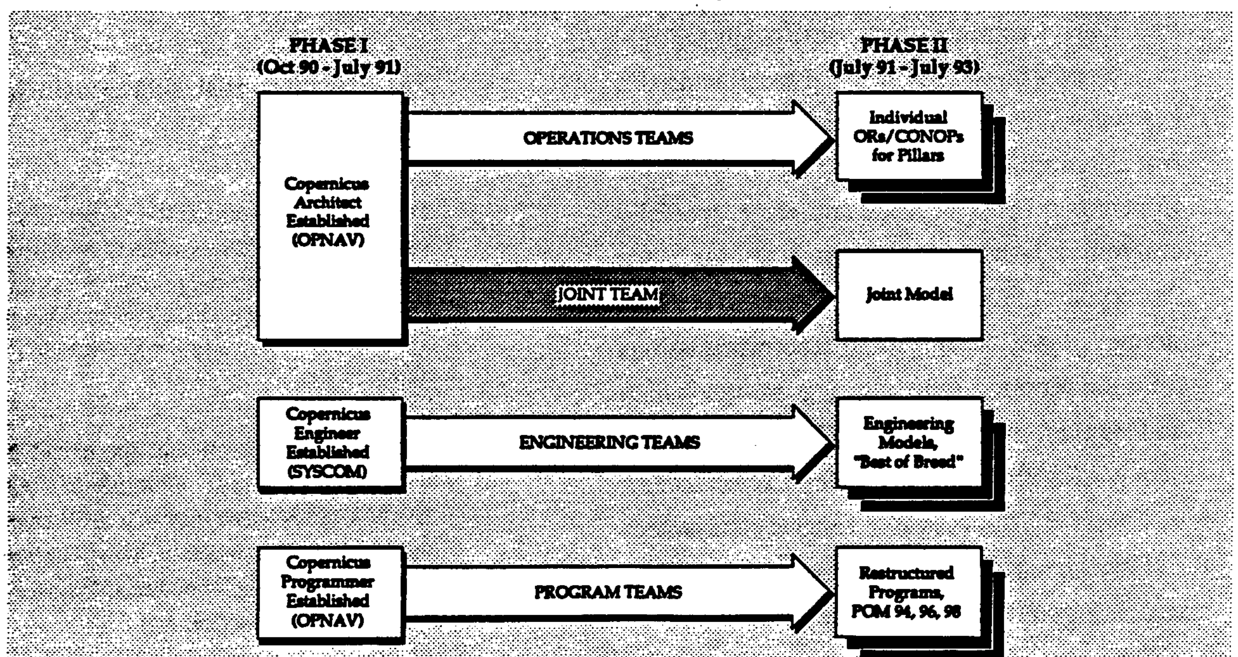

Figure I-2. Phase II Copernicus Efforts

During Phase II efforts, the architect will focus on two broad areas, the establishment of working groups composed of fleet, claimancy, and industry personnel to produce individual operational requirements (OR) and concepts of operations (CONOP) for the four pillars, and to expand the level of detail in the architecture across Navy Department disciplines (e.g., Submarine Forces, Marine Air Ground Task Forces, Special Operating Forces) and, if directed, up and across echelons into a joint model.

The SEW engineer will be established in COMSPAWARSYSCOM. The engineer's responsibilities will include Copernicus systems engineering, the development of engineering models, "best of breed" building block selection, rapid prototyping efforts, Common Operating Environment (COE) definition, and general technical support for the SEW architect.

During Phase II efforts, the engineer will focus on four tasks:

- The development of a functional description document for each of the pillars;
- The development of an end-to-end, integrated, engineering model of the pillars;
- From that model, a "best of breed" building block selection recommendation to the Architect; and
- The expansion of existing fleet engineering and monitoring efforts Over-the-horizon targeting (OTH-T) into SEW field engineering support.

The SEW Programmer will be established within the current programming division of OP-094. This office will affect the transition to Copernicus programmatically (versus from an engineering standpoint) from stove pipe programs of today to three basic types in the future: 1) building block programs, 2) pillar programs, and 3) Research, Development, Test and Evaluation (RDT&E) programs.

DOCUMENT STRUCTURE

This Requirements Definition contains 10 chapters and 4 appendices. Chapter 1 describes the relationship between Space and Electronic Warfare (SEW), C4I and naval command and control. It provides the doctrinal basis for the architecture. Chapter 2 describes eight systemic shortfalls in our existing architecture, and Chapter 3 details the Copernicus concept.

Chapters 4 through 7 discuss each of the four pillars from an operational perspective. Chapter 8 describes the technology— the building blocks to define the architecture in engineering terms. Chapter 9 addresses programmatic issues and provides our strategic plans for POM development. Finally, Chapter 10 details our implementation strategy for Phase II of the Copernicus Architecture.

CHAPTER 1
DEFINITION OF NAVAL C^4I

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CHAPTER 1
DEFINITION OF NAVAL C^4I

REFERENCES:

(a) JCS Publication 3-02 (Joint Doctrine for Amphibious Operations)
(b) NWP 8 (Command and Control)
(c) NWP 10-1 (Composite Warfare Commander)
(d) NWP 10-1-40 (Electronic Warfare Coordination)
(e) NWP 10-1-41 (Navy Operational Deception and Counter Deception)
(f) NWP 10-1-42 (Command, Control, and Communications Countermeasures)
(g) NWP 10-50 (Battle Group Communications)
(h) NWP 12-2 (Tactical Threat to Naval Surface Forces)
(i) NWP 25 (The SSN in Direct Support)
(j) Space Tactics Manual (April 1989)

SUMMARY

With the establishment of Space and Electronic Warfare (SEW) as a designated warfare area within Navy by the Chief of Naval Operations in 1989, command and control (C^2) functions have been doctrinally designated to the SEW mission. Naval Command and Control is the warfare function through which a maritime commander delegates warfighting responsibilities to subordinate commanders and their units under his command. Command and control is exercised through a supporting technological, doctrinal, and organizational system known today as command and control, communications and computers, and intelligence (C^4I). C^4I should be viewed as the *means* to the *end* of C^2.

C^4I is a technological, doctrinal, and organizational *support system* that facilitates the command and control of forces by the tactical commander. Naval C^4I consists of three components:

- Command and control, which in the Navy is embodied in the carrier battle group (CVBG) Composite Warfare Commander (CWC) doctrine, in the submarine force deployment and water management doctrines, and in the amphibious doctrine— all evolutionary outgrowths of World War II. In the joint task forces (JTF) of the future, command and control will be embedded in that commander's doctrine, which, like all doctrine, will continue to evolve as the unified commanders and the Services plan, practice, and participate in joint operations;

- Communications and computers, the modern technological "glue" that ties the commander to his forces and to the shore-based intelligence and command centers, which enables *information management*; and

- Intelligence, which in the context of C^4I, is at once both a process of discerning enemy intentions and capabilities and a technological, organizational, and a sensor system that provides much of the information from which to initiate that process.

Today, maritime command and control is embodied in five forms, four of which— the CVBG, the SSN in independent and associated support, the Marine Air Ground Task Force (MAGTF), and the Amphibious Task Force (ATF) — will be incorporated into this architecture in the near future. Strategic (meaning nuclear) Command and Control has unique intelligence, communications, and command requirements that necessitate a somewhat different C^4I infrastructure than non-nuclear command and control. While the Copernicus Architecture does not specifically address strategic Command and Control, by definition strategic Command and Control will ultimately be incorporated into Copernicus.

We should consider C^4I as a "triangular" acronym, with Command and Control at the apex and information management (communications and computers) and intelligence at the supporting angles. To enable doctrinal flexibility in Command and Control, it is critical we develop a C^4I support system that is far more flexible than we have today. It is important to understand that flexibility will be the cornerstone of post-Cold War operations— today's C^4I system is characterized by inflexibility. Serious limitations both in information management and in intelligence dissemination are setting unnecessary and artificial limits on command and control. The C4I system of today has become technologically, doctrinally, and organizationally obsolete.

Copernicus, which provides the doctrinal, technological, and organizational infrastructure needed to weave the modern tactical fabric of war at sea, was designed to replace it.

DISCUSSION

Naval command and control is the warfare function through which a maritime commander delegates warfighting responsibilities to subordinate commanders and their units under his command. Command and control is exercised through a supporting technological, doctrinal, and organizational system known today as C4I. C4I should be viewed as the *means* to the *end* of command and control.

With the establishment of SEW as a designated warfare area within Navy by the Chief of Naval Operations in 1989, command and control functions (including the operation and development of Navy's C4I system) have been doctrinally subordinated to the SEW mission.

SEW is the destruction or neutralization of enemy targets and the enhancement of friendly force battle management through the integrated employment and exploitation of the electromagnetic spectrum and the medium of space. It encompasses measures that are employed to:

- Coordinate, correlate, fuse, and employ aggregate communications, surveillance, reconnaissance, data correlation, classification, targeting and electromagnetic attack capabilities;
- Deny, deceive, disrupt, destroy, or exploit the enemy's capability to communicate, surveil, reconnoiter, classify, target, and attack; and
- Direct and control employment of friendly forces.

SEW, COMMAND AND CONTROL, AND C4I

Thus, while the relationship of SEW to Command and Control and C4I is hierarchal in nature, the characteristics of each are different. Like other warfare areas (e.g., Anti-Air Warfare [AAW], Anti-Submarine Warfare [ASW], Strike Warfare [STW]), SEW is fundamentally doctrinal in nature, but (like the C4I, a subset of SEW) relies on a broad technological, organizational and doctrinal infrastructure to execute its tactical functions: C4I, C4ICM, ESM/ECM/ECCM, SIGINT, SIGSEC[1], surveillance and counter-surveillance, and targeting and counter-targeting.

Like all naval doctrine, the doctrine of SEW had its genesis in developments in technology and the tactical applications of that technology. As AAW and ASW arose from the development of the aircraft and the submarine,

[1] C4I Countermeasures (C4ICM), Electronic Support Measures (ESM), Electronic Countermeasure (ECM), Electronic Counter-Countermeasures (ECCM), Signals Intelligence (SIGINT), Signal Security (SIGSEC)

SEW has emerged from the development of technologies over the last two decades that portend the promise of future strategic and tactical breakthroughs.

The establishment of SEW, therefore, is the doctrinal recognition of the maturity of these developments and of the paramount importance of managing the invisible domain of the spectra as well as the geography of space in the next century. (See figure 1-1).

Command and control is also doctrinal in nature, supporting as it does all of the commanders delegated warfare responsibilities by the tactical commander. Naval command and control, as we shall describe below, has evolved parallel to the technological diversification of naval platforms and weapons, which have moved from operations in line-ahead formations on the surface of the world's oceans to the complexity of today.

C4I, on the other hand as we have seen, is a technological, doctrinal, and organizational *support system* that facilitates the command and control of forces by the tactical commander. Naval C4I, above all, is a system that consists of three components:

- Command and control, which in Navy is embodied in the carrier battle group CWC doctrine, in the submarine force deployment and water management doctrines, and in the amphibious doctrine—all evolutionary outgrowths of World War II. In the JTF of the future, command and control will be embedded in the commander's doctrine, which like all doctrine, will continue to evolve as the unified commanders and the Services plan, practice, and participate in joint operations;

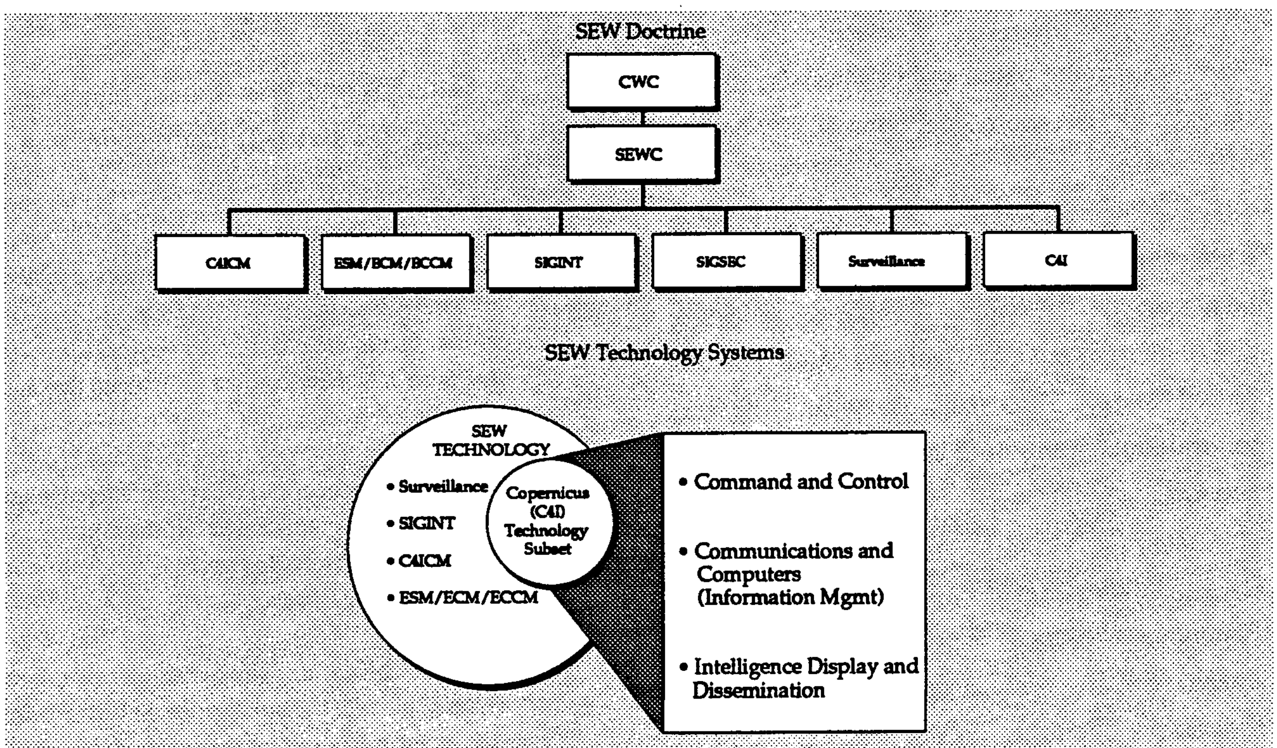

Figure 1-1. Relationship Between SEW and Copernicus

- Communications and computers, the modern technological "glue" that ties the commander to his forces and to the shore-based intelligence and command centers, which enable *information management*; and

- Intelligence, which, in the context of C4I, is at once both a *process* of discerning enemy intentions and capabilities and a technological, organizational, and *sensor system* that provides much of the information from which to initiate that process.

ORIGINS OF MODERN NAVAL C4I

In early naval warfare, in which surface actions were the sole tactical means available to the commander, command and control was accomplished through an understanding reached between the commander and his captains of the proposed battle plan. The best example of this is Lord Nelson's famous "band of brothers"— the captains with whom Nelson discussed his intentions prior to the battle and in whom he trusted would carry out those intentions during battle.

Navies, however, are inextricably tied to technology: in the past as in the present, weapons, sensors, and tactics— and the supporting C4I systems— are all reflections of the technology of the day. Thus, technology can either add to, or detract from, both command and control and C4I.

Modern Naval C4I has its origins in the Pacific campaigns of World War II, where the transition from surface forces, acting in line formations operating on the sea, gave way to composite forces operating in, on, over, and under the sea. The impact was that single-dimensional battle space was transitioned tactically to three physical dimensions.

Equally revolutionary was the realization that the advent of air power made time a far more significant tactical consideration than relative position, the centerpiece of surface tactics in the preceding 25 centuries of seapower.

The tactical and doctrinal impact of air power was to aggregate large carrier task forces for strike, necessitating delegation of warfighting functions for simultaneous offense and defense, which in turn placed a premium on distant indications and warning of enemy formations and intentions. Surprise at sea— always disadvantageous— took on near-calamitous proportions in an age of air power with its swift, concentrated application of firepower.

Out of World War II arose elements of C4I (see figs. 1-2 and 1-3) that remain with us today:

- The development of technological sensor systems to provide indications and warning and targeting information to the commander beyond his defensive zone and, therefore, act to "expand the battle space;"

- The establishment of shore-based intelligence centers able to fuse multi-sensor information and turn the information around to the commander in tactically significant time;

- The establishment of communications networks by which to transfer the intelligence and other information and through which to command and control tactical forces; and

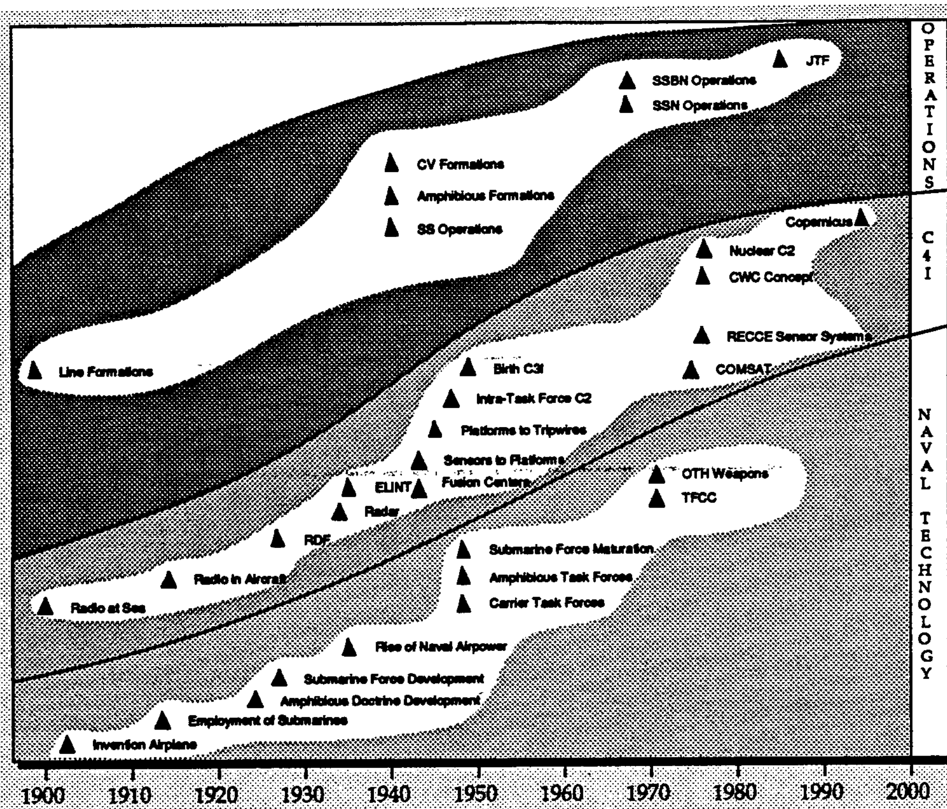

Figure 1-2. Rise of Naval C4I

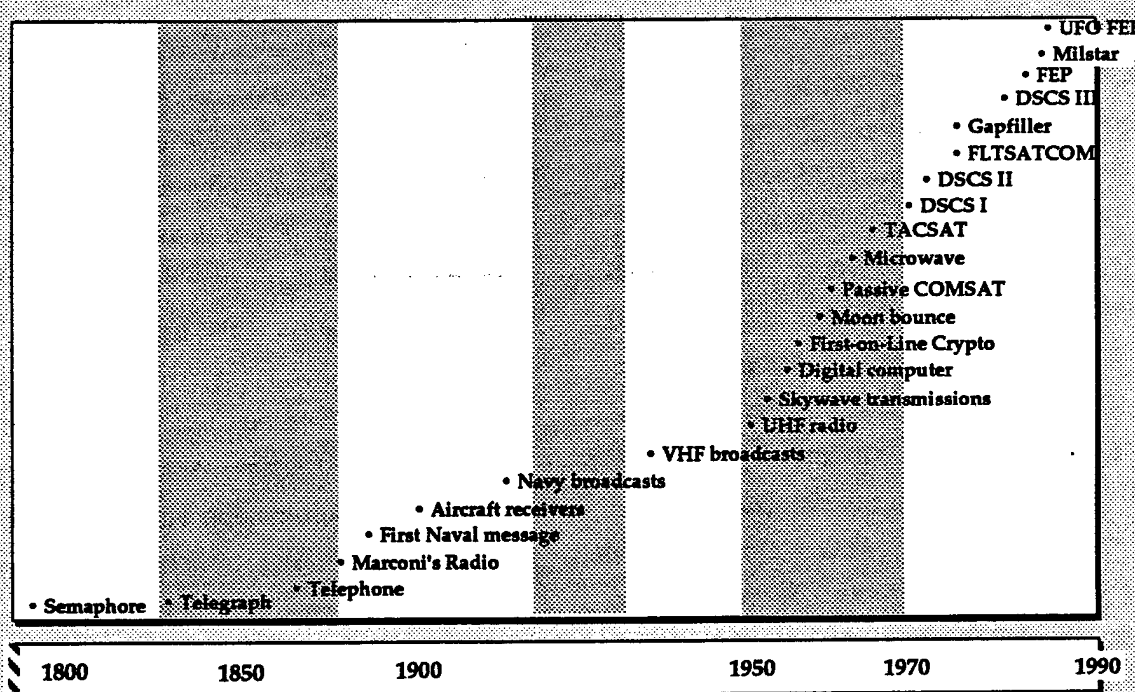

Figure 1-3. Evolution of Communications Technology

- The transition of command and control doctrine itself from surface action groups to multi-platform, multi-dimensional task forces.

Command and control doctrine was developed in World War II not just for carrier task forces, of course, but also for amphibious forces and for submarine operations. In both cases, however, the elements of C4I to support them remained fundamentally analogous to those supporting the carrier task forces. The differences lay in the applications of those elements to those missions.

Today, maritime command and control is embodied in five forms, four of which— the CVBG, the SSN in independent and associated support, the MAGTF, and the ATF— are at the heart of this document, which proposes a new C4I architecture for Navy in the post-Cold War. The fifth strategic (meaning nuclear) command and control, has unique intelligence, communications, and command requirements that necessitate a somewhat different C4I infrastructure than non-nuclear command and control. While the Copernicus Architecture is intended ultimately to improve strategic command and control, such planning is at the earliest stages at this writing and not discussed in this document further. Similarily, the discussion of communications in this document is currently limited to HF and SATCOM communications. During phase II, submarine operations revelent to the Copernicus architecture will be determined (see chapter 10). During that effort the lower frequency will be considered.

POST-COLD WAR COMMAND AND CONTROL

Two overarching trends in maritime warfare have been visible from the development of air power and the submarine early in this century. First has been the increasing expansion of battle space brought about by air power and the advent of over-the-horizon weapons. Second has been the "systemization" of war at sea from the quasi-independent tactical action of surface action groups to extraordinarily complex tactical forces of today: multiplatform, multidimensional, and multinational.

The impact of the close of the Cold War on both developments above will be significant. The ever-increasing battle space, characteristic of global, open ocean warfare planned for in the last 90 years— in reality since Alfred Thayer Mahan— has given way to post-Cold War era of contingency and limited objective warfare (CALOW). While they conceivably can occur in open ocean environments or mixed environments like the Falklands conflict, many undoubtedly will involve power projection overland from a JTF. Thus, as the mission becomes more diverse, battle space may *expand or contract dramatically*. (See fig. 1-4.)

The end of the Cold War also will bring about a further systemization of naval warfare, not only technologically, but organizationally. The trend toward multiplatform, multidimensional naval operations begun in 1943 will continue to accelerate and expand in the next decade to joint and combined (perhaps standing) task forces.

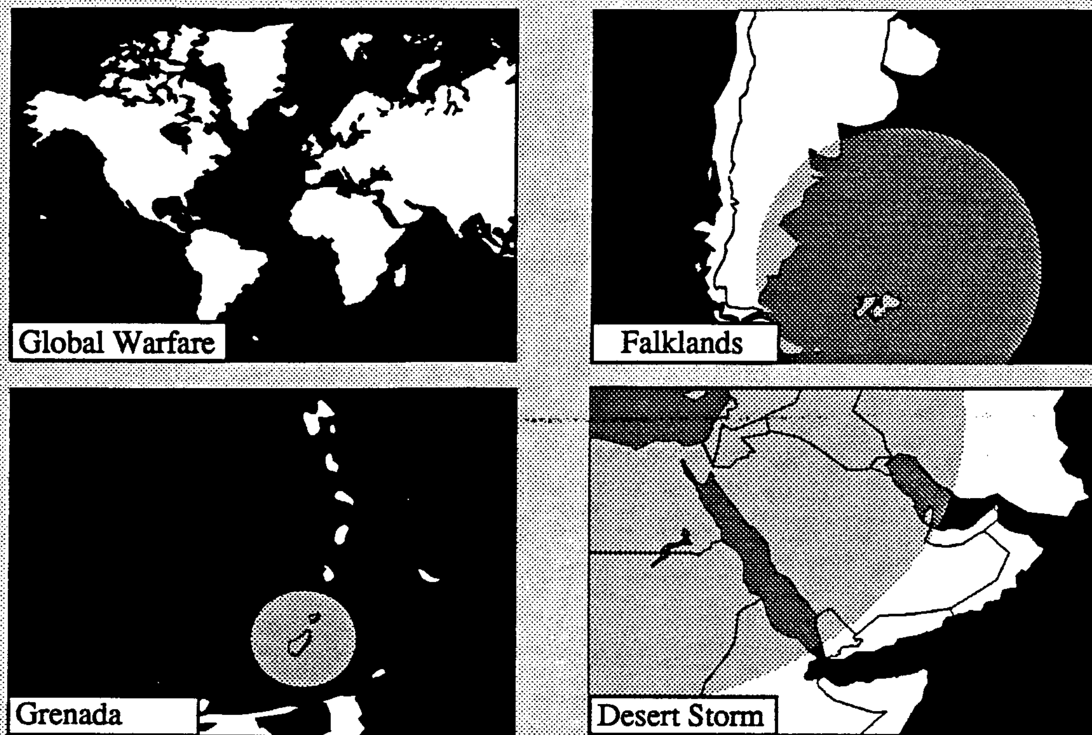

Figure 1-4. Changing Battle Space

As a result of these developments, the very nature of war at sea will change dramatically over the next decade; threat, alliances, geography, technology, and resources all will be catalysts.

From the standpoint of command and control, we will need to develop a technological capability to implement a flexible command and control doctrine for the multiplicity of post-Cold War missions. With a 45-year focus on a global, Soviet-oriented threat, Navy command and control doctrine— the delegation of warfighting means to tactical ends— reflected the target: ASW, AAW, and STW are examples. However, in a CALOW mission, command and control doctrine will not only be delegated across a JTF, of which Navy units will only be one component, but also within the Navy component, therefore it is desirable to give the tactical commander doctrinal flexibility in missions where the CWC doctrine is not appropriate.

We should consider C4I as a "triangular" acronym, with command and control at the apex and information management (communications and computers) and intelligence at the supporting angles (see fig. 1-5). To enable doctrinal flexibility in command and control, it is critical we develop a C4I support system that is far more flexible than we have today. While we discuss shortfalls in the current architecture in the next chapter, it is important to understand that just as flexibility will be the cornerstone of post-Cold War operations— today's C4I system is characterized by serious limitations both in informa-

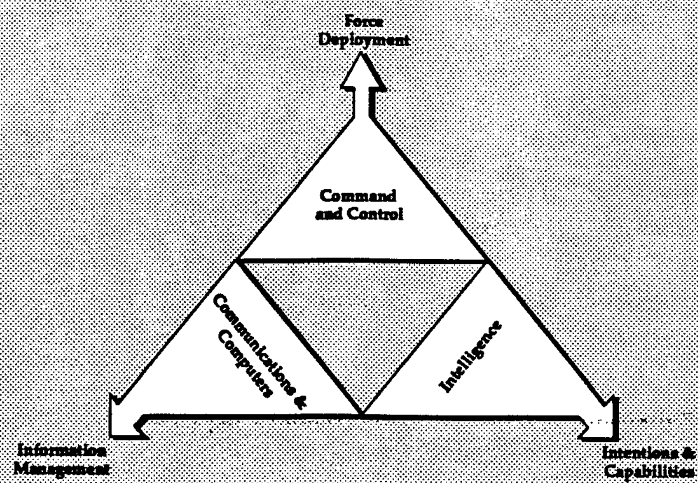

Figure 1-5. Naval C4I

tion management and in intelligence dissemination. The C4I system of today has become technologically, doctrinally, and organizationally obsolete.

American industrial magnate Henry Ford's enduring achievement was not the Model T Ford. On a larger scale, it was the technological *macro-system* surrounding the Model T Ford: the assembly line, the showroom, the gasoline station, and ultimately the infrastructure of roads. From that system arose a change in our culture. To understand the invention and not comprehend the technological system required to utilize the invention is to miss the deeper undercurrents of the first industrial revolution.

While Thomas Edison can be credited with the invention of the incandescent light, it remained for Samuel Insull of Chicago to construct the technological system of dynamos, power stations, and transmission lines that made electric lights possible. Like Ford, Insull's technological system had a broad, enduring cultural impact.

So too, we should view C4I as a *macro-system*, composed, as we have seen above, of command and control doctrine, information management through communications and computers, and the intelligence and sensor processes.

Copernicus is most easily grasped when viewed, like Ford's automotive and Insull's electric technology, as a new technological system for C4I, the purpose of which is to facilitate command and control for the commander at sea, his subordinates, and his superiors.

Copernicus arises from empiricism: the technological and operational conclusion is that today's C4I "system" is not hemorrhaging, but that the patient has been dead for some years now.

While the "macro-system" Copernicus consists of many evolutionary and revolutionary components— and even whole, complex sub-systems such as the Communications Support System discussed in Chapter 6— its purpose is to provide the means for command and control functions in a new age of naval warfare.

Indeed, it may not be an exaggeration to say Copernicus is for a new school of naval warriors. Our goal with Copernicus is to provide a 21st century C4I system that will allow these new warriors to affect the tactical innovations made possible by high technology.

Copernicus, then, is a C4I system delegated to the Space and Electronic Warfare Commander (SEWC) by the tactical commander. However, the delegated C4I function supports all commanders—Copernicus is to SEW as Copernicus is to AAW, ASW, ASUW, and STW.

Clearly, however, Copernicus provides the technological means by which the tactical commander can take advantage of the non-organic sensors that SEW doctrinally provides. But we should clearly understand that a particular CWC commander's battle domain, in terms of time, space, and capabilities, is primarily a function of technology. The AAW Commander exists because of the airplane; the ASW Commander because of the submarine and ASW platforms. The Anti-Surface Warfare (ASUW) commander, in the modern context, exists because of Harpoon and Tomahawk, and because of the threat posed by the enemy through such weapons.

In the same way, the SEWC exists because of the revolution in space and electronic warfare technology that has occurred over the last 20 years. The SEWC's assets are as tangible as the AAWC's-- it is simply that some of them are not physically on deck. Copernicus, relative to the SEWC's functions, gives him the means to make non-organic sensors organic.

In the context of the Navy CVBG, the introduction of SEW has greatly expanded the battle space. Figure 1-6 depicts the typical battle space in which the organic sensors of a CVBG would operate and therefore represents the doctrinal and practical limitations imposed on the tactical commander prior to the delineation of SEW as a warfare area.

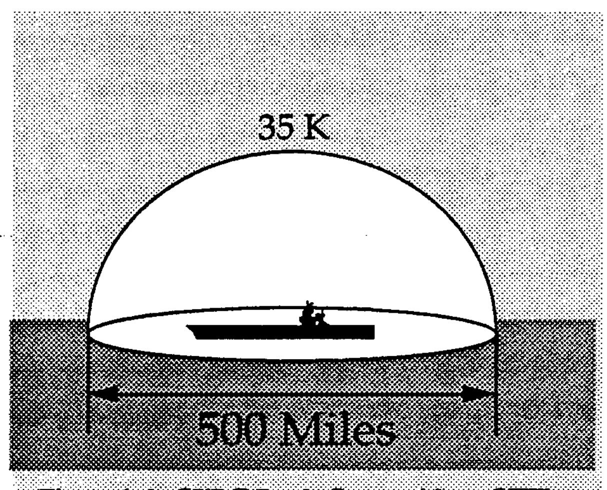

Figure 1-6. CVBG Battle Space without SEW

Figure 1-7 shows the potential expansion of CVBG battle space made possible by SEW in an open-ocean scenario— nearly 200 times the

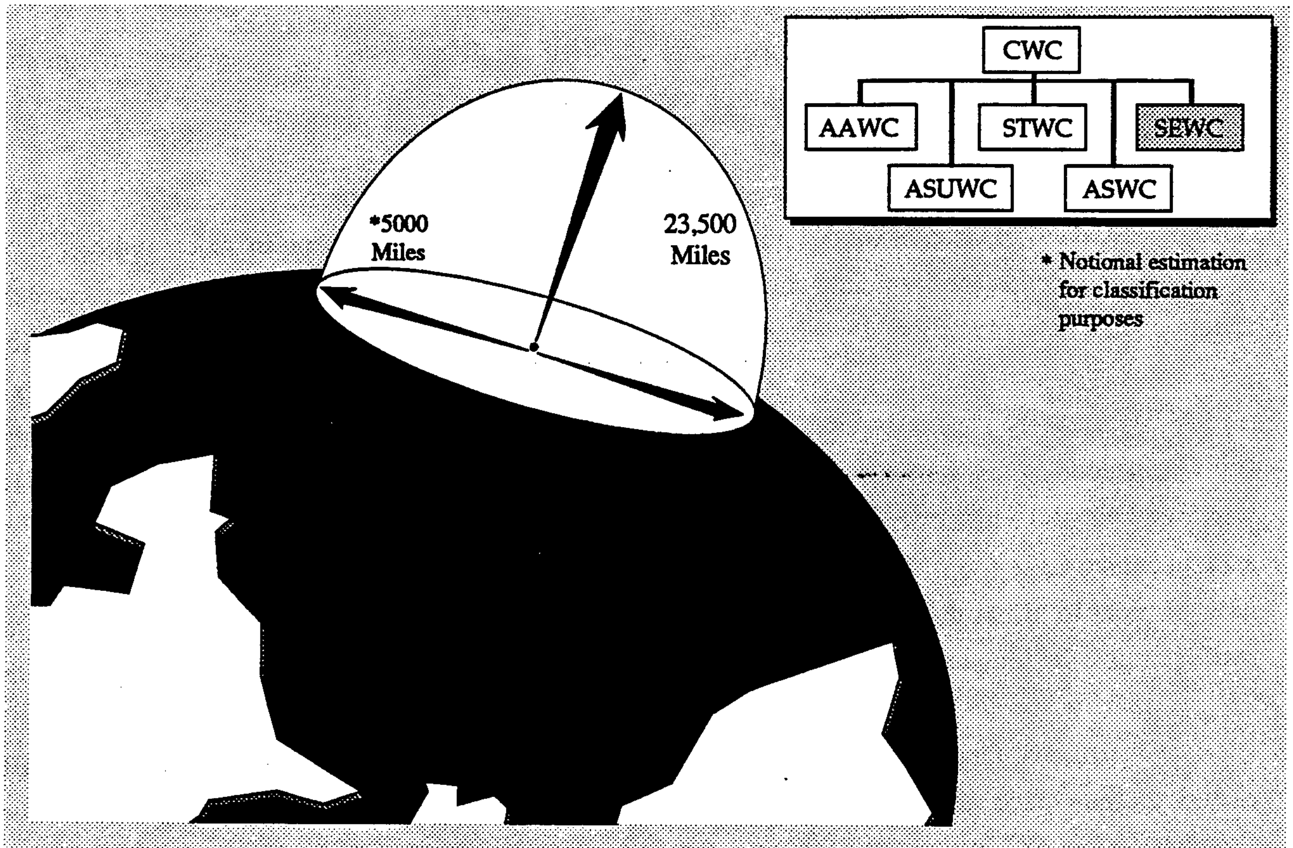

Figure 1-7. CVBG Battle Space with SEW

pre-SEW space— *provided* organic and non-organic sensors are organized with the "shooters" into a capable system that can be accessed and manipulated by the CWC commanders.

Doctrinally, SEW is made possible within the CWC concept through the emergence of a new commander— the SEWC— on the CWC's staff (see fig. 1-7). But technologically, the leverage promised by a more modern systemization of sensors, communications, and ashore and afloat fusion nodes has eluded us. We cannot conduct SEW— or modern ASUW, AAW, ASW, and STW— on 75-baud or even 2400-baud narrative message circuits.

SEW promises to bring new strategic tools to the OTC, which arise from its shore-based component, and new tactical options and perspectives at sea. SEW expands the tactical continuum both in terms of time and space, as figure 1-8 shows. But SEW — as modern AAW, ASUW, STW, and ASW — is to a great degree dependent on making non-organic assets more tangible and more available to the tactical commander.

The means to this end — the force multiplier we seek — is C4I, which provides the doctrinal, technological, and organizational infrastructure needed to weave the modern tactical fabric of war at sea. Copernicus was designed to be that infrastructure.

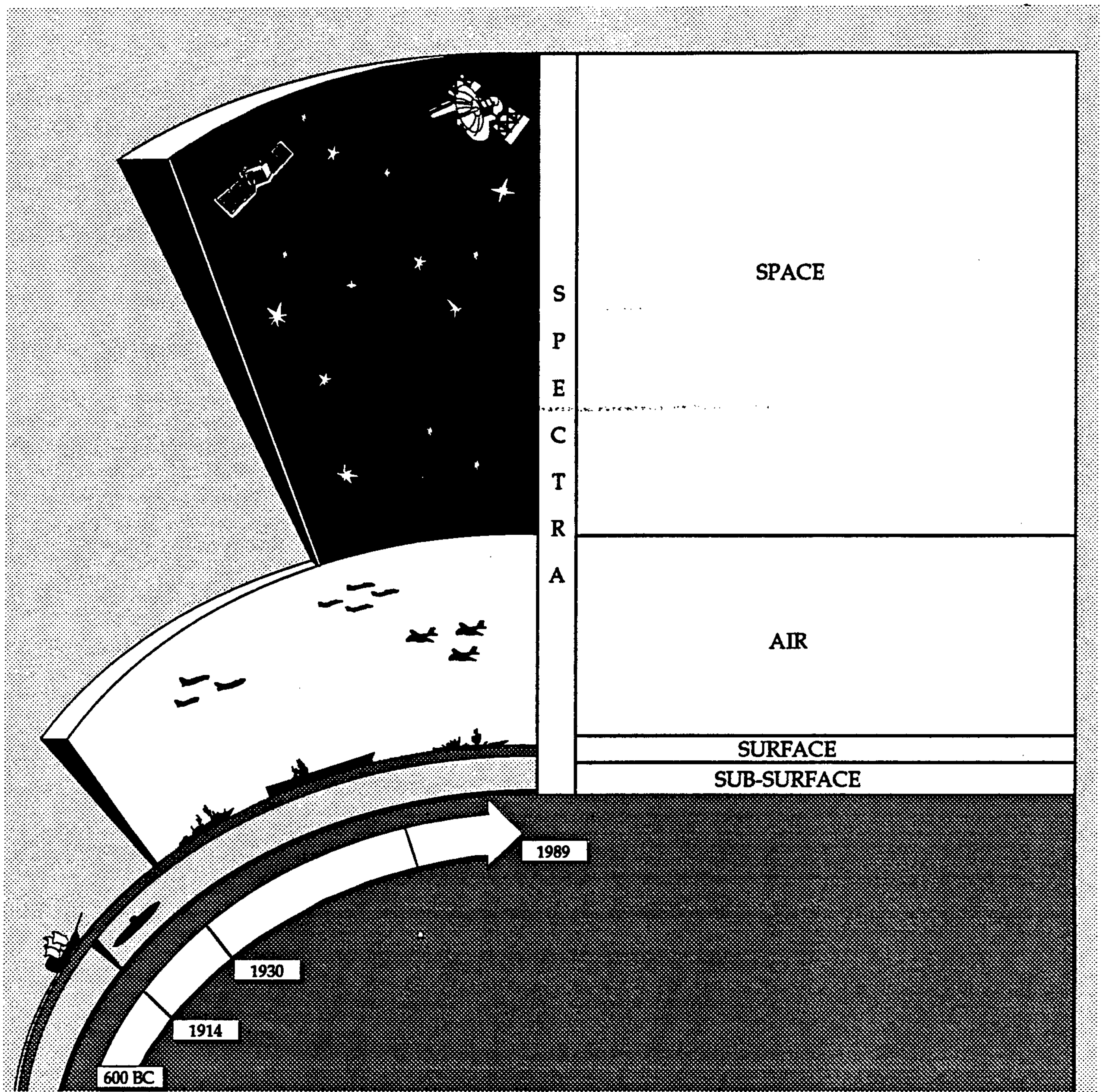

Figure 1-8. Five Dimensions of Naval Warfare

CHAPTER 2
SHORTFALLS IN THE CURRENT ARCHITECTURE

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SHORTFALLS IN THE CURRENT ARCHITECTURE

SUMMARY

Perhaps the most important lesson from the history of naval warfare is that it does not teach that better technology prevails— it teaches that he *who uses technology* better or he who *can deny* the other technology on which he depends, prevails. Marc Antony learned that lesson at Actium in 31 B.C.; we learned that lesson in Vietnam; and the Soviets learned that lesson again in Afghanistan. War does not necessarily favor the belligerent with the most men and weapons. Nor does it favor the one with the latest technology. Rather, it is only when men, weapons and technology are incorporated together in an operationally and doctrinally sound manner does one gain an advantage over an opponent. In modern warfare, the superior application of concentrated force is the result of superior command and control of naval systems.

Perhaps the most difficult hurdle to leap in constructing a new C^{4}I architecture like Copernicus is getting the right level of focus. One person's architecture is another person's multiplexer. Today, program managers are awash in acronyms, while operators are drowning in installation schedules and line drawings. However, if one steps away from today's system and toward tomorrow's operational problem, and if one does so with experience and understanding of the technology both behind and in front of the compartmented "green" door, a series of eight architectural shortfalls emerge.

In discussing them, it is helpful to recall the discussion in Chapter 1 of C^{4}I as a macro-system— a "triangular acronym" with command and control at the apex. Command and control has to do with the delegation of warfighting means to ends. Ends, of course, range from tactical through strategic to political in nature. It is characteristic of the post-Cold War that, for the tactical commander, this distance between tactical ends and political ends will diminish sharply.

Communications and computers— the second element of command and control, on the lower left of the triangle, as it were— has to do with information management. Finally, intelligence, on the lower right, not only has to do with the traditional view of enemy intentions and capabilities, but in the last 20 years also with the management of the wide-area surveillance systems from which we derive so much of our tactical intelligence.

There are eight systemic shortfalls in today's architecture:

- At the apex of the triangle, command and control itself, the first functional shortfall today is that we are trying to take the threat to our existing command and control doctrine instead of taking a flexible approach to command and control doctrine based upon the threat;

- The second problem is that, taken in the aggregate, today we cannot decant operational traffic from administrative traffic. When we go to war, we have no real technological means to gain capacity to support the increased operational tempo;

- Third, the information is conveyed in the wrong format— narrative messages, and in the wrong form— paper. It should not surprise us that we are drowning the tactical commanders;

- Fourth, the current system, with its emphasis on narrative traffic and its reflection of diverse sensors and analytic nodes ashore, is inefficient. What traffic goes on the satellites to the tactical commander is, today, less a conscious operational decision than an administrative decision to parcel out precious communications capacity. Thus, the tactical traffic is more a reflection of long-term staff compromises than real-time operational requirements: staff wars versus star wars;

- Fifth, the technology of communications, and the diversity of communications services, is inadequate. We must develop virtual networking with broad choices of services, both in format and in media;

- Sixth, several factors— the narrative format, the lack of common display, relative versus true navigation references, a plethora of computers, and staff compromises— have resulted in a significant loss of operational perspective with respect to sensor traffic. Architecturally and operationally, the goal must be *one emission sensed* leads to *one location report* over *one communications path* to sea at *one time*;

- The seventh problem in today's C⁴I system is presented by the close of the Cold War era: the necessity to develop and disseminate information on a far broader category of potential threats. Technologically, doctrinally, and organizationally, we must construct an intelligence infrastructure that can allow a Defense Intelligence Agency (DIA) analyst assigned to a specific problem to be in contact with colleagues in State, CIA, DIA, and in industry who are also working daily on the same problem but from a different angle. And, we must move that information to sea in a structured, efficient, tactical context on short notice; and

- Eighth, and following from this information problem, we must develop the means to more efficiently disseminate and display intelligence information. Today, data file transfer to sea happens by flying disks onto the carrier decks by aircraft. Tomorrow, the data file and the image must replace the message as the principal operational format. Moreover, the data file and image must be displayed and utilized in context on a common workstation, so that an operational synergism is achieved between sensor tracks, images, and analytic files, both organic and non-organic, can be achieved.

In the following chapter, we will return to these problems in the context of the Copernicus Architecture.

DISCUSSION

Perhaps the most important lesson from the history of naval warfare is that it does not teach that *better technology* prevails— it teaches that he who *uses technology better* or he who *can deny the other technology* on which he depends, prevails. Marc Antony learned that lesson at Actium in 31 B.C.; we learned that lesson in Vietnam; and the Soviets learned that lesson again in Afghanistan.

War does not necessarily favor the belligerent with the most men and weapons. Nor does it favor the one with the latest technology. Rather, it is only when men, weapons, and technology are incorporated together in an operationally and doctrinally sound manner does one gain an advantage over an opponent. In modern warfare, the superior application of concentrated force is the result of superior command and control of naval systems.

It is for this reason that it is important to understand the historical foundations — and therefore the systemic functions — of command and control. A technological development without a corresponding tactical development is an idle musing in the naval profession. Technology without tactical and doctrinal context is merely engineering curiosity: operationally it is a force *divider*.

A NEW WORLD ORDER

The likelihood of global war with the Soviets has been significantly reduced. U.S. strategic emphasis now must shift from global containment to a global stability strategy with a regional focus. With the world order in flux, and the continuing forecast of fewer U.S. naval forces in the future, there is also a clear need for a naval policy that matches means to ends. Evolutionary concepts, such as those put forth by the

Copernicus Architecture, will compensate somewhat for unavoidable shrinking force levels while providing the agility for a genuine multimission capability.

America's economic fate is linked inseparably to the fortunes of trading partners, energy suppliers, capital markets, and foreign industries. The United States must remain globally engaged to maintain the political and military stability upon which this interdependent economic system rests. Even with a reduced global Soviet challenge, potent threats to U.S. security remain and will be increasingly ambiguous in the future. Even with so much ambiguity and uncertainty, it is clear that regional instability will be the main threat in the emerging geostrategic environment.

Throughout the Cold War, military planning focused on the extreme right portion of the spectrum: preparation for global conventional war and strategic nuclear war (see fig. 2-1). The United States and a coalition of allies pursued a strategy of containment of the Soviet Union. Despite the low probability of occurrence, all planning was greatly influenced by the worst-case Soviet threat, including a "bolt out of the blue" attack. In the past, we believed that countering the Soviet threat inherently prepared U.S. forces for conflict with less capable adversaries.

In reality, even while the national strategic spotlight was focused on a Soviet threat, all of the Services routinely responded to threats and contingencies around the globe at both ends of the spectrum of conflict. Of over 200 regional crises that naval forces responded to between 1945 and 1989, only 18 directly involved the Soviets.

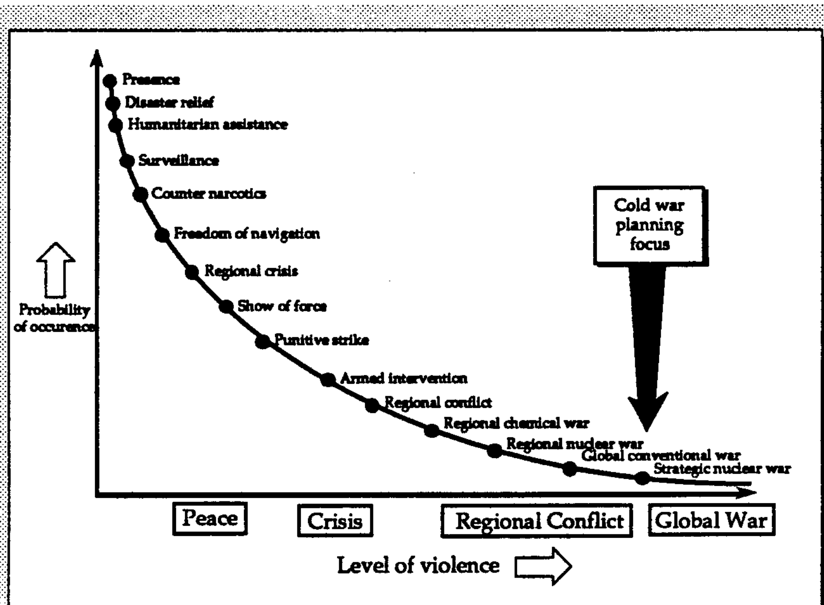

Figure 2-1. Operational Continuum (1945-1989)

Except for the Soviets, there are no potential adversaries capable of conducting a global military campaign against the United States. Therefore, nuclear deterrence of the Soviet Union will continue to be the top strategic priority, and sound military judgment compels the U.S. to remain prepared to counter the Soviet's significant conventional military capability. But the reduced probability of such a confrontation allows a shift in the planning focus.

The curve's new plateau (see fig. 2-2) represents the increased likelihood of instability, crisis, and regional conflict outside the Soviet-U.S. context. Regional instability will be the primary threat to global economic interdependence and U.S. national security interests. The United States must plan for multiple, unrelated crises and regional conflicts falling under the definition of Contingency and Low Objective Warfare (CALOW) missions, a warfare environment of increasing significance.

Future emphasis must be on stability operations and on crises that can occur in one or more regions simultaneously with little or no warning. U.S. commanders will need at least as much, if not more, flexibility and combat power in the future for these "come as you are" scenarios. Operational tempos will take on a joint and combined acceleration (see fig. 2-3). Joint C4I and battle management will be a prerequisite in a CALOW environment. U.S. forces must be able to control the battle space wherever they operate— and whatever size it might be. As we saw in the previous chapter, one implication of the post-Cold War, is that battle space, which for naval forces has been expanding for 90 years, is now far more unpredictable.

CALOW missions will expose naval forces to a plethora of opposing weapon systems on an extremely complex battlefield. The trend towards higher technology weapons will demand robust close-in and overland air defense

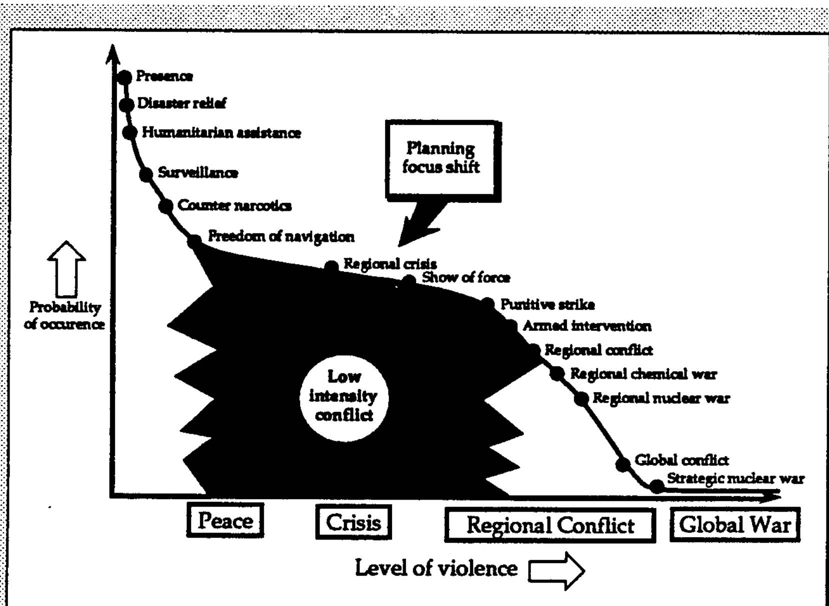

Figure 2-2. Operational Continuum (1990-Beyond)

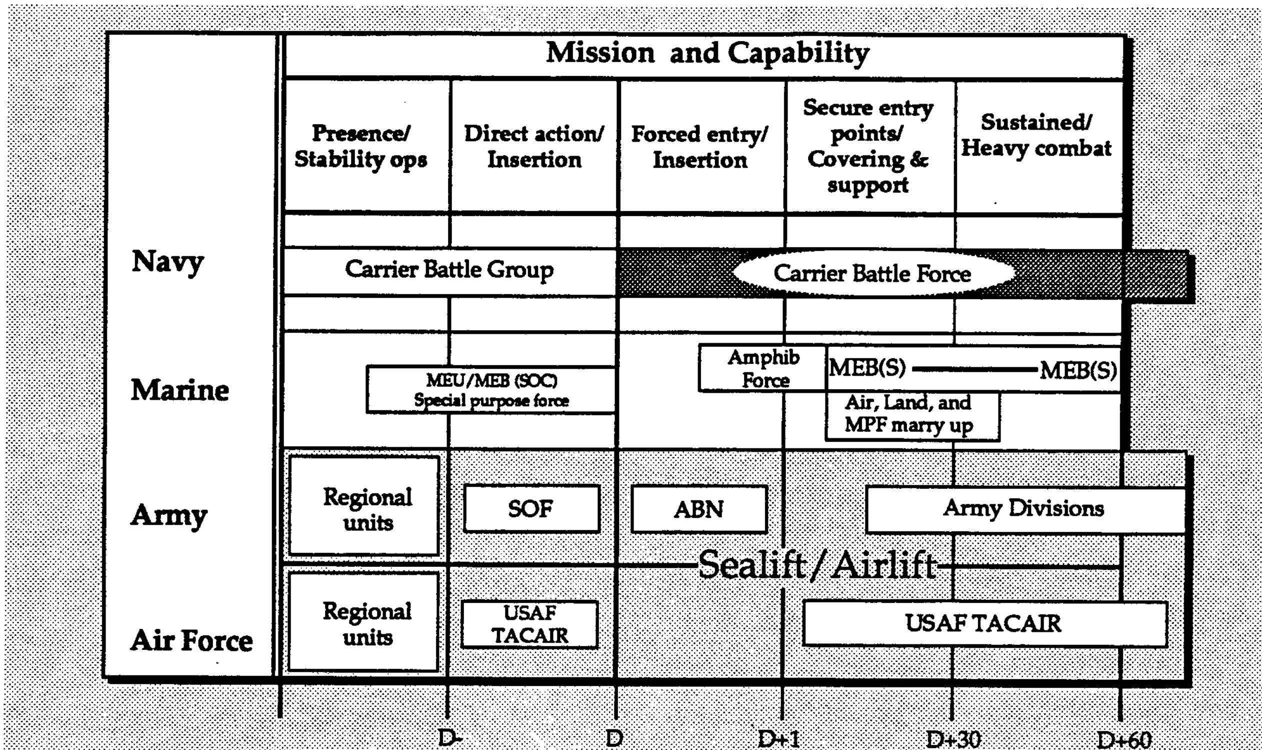

Figure 2-3. Joint Force Sequencing for Maritime Presence and Power Projection

and a connective system of C4I that enhances joint and allied capabilities— and that can keep pace with the tactical force development structure from the Carrier Battle Group (CVBG) to Joint Task Force (JTF).

Naval forces must continue to develop resources to maintain the edge against increasingly more capable adversaries. Maintaining the lead in advanced technologies is critical to success in combat. Naval forces must be prepared for instant response to the threat posed by sophisticated First-World weaponry in the possession of Third-World adversaries. Enhanced capabilities in battle management and interoperability of C4I systems are and will be prerequisites for future joint and combined operations. The Copernicus Architecture was constructed for this tactical world of the future.

SHORTFALLS IN CURRENT ARCHITECTURE

Twenty years ago, the character of conventional war at sea once more fundamentally changed and did so as dramatically as it had with the advent of air power 40 years before. Precipitated by the Soviet's introduction of the Chárlie class SSGN in 1968 and the Soviet Naval Air doctrine of massed attack on the CVBG, the importance of wide-area surveillance and over-the-horizon targeting (OTH-T) became paramount.

These developments dovetailed with the technological development of national sensors, put in place largely to provide Indications and Warning (I&W) against the Soviet nuclear threat. These same wide-area sensors, however, when added to Navy-specific sensors, made possible ocean surveillance and OTH-T, the development of which became the focus of Navy intelligence and sensor organizations. Because of the sensitivity of the sensors and their applications, much of the work was accomplished in compartments in relative isolation from the "General Service" (GENSER) Navy.

The achievements were remarkable and led to the tactical discussion that has culminated today in the establishment of Space and Electronic Warfare (SEW) doctrine. However, penalties were paid. Sensor products proliferated as diverse operational commands, recognizing their value, demanded it, and unnecessary ambiguities were introduced for the tactical commander. It is a fair statement to say that the ambiguities introduced by multiple sensor reports created an "iron wall" 500 miles distant from the CVBG battle space that was delineated by the limitations of organic sensors, perceived as more reliable to the operators shut off from the technological capabilities behind the Sensitive Compartmented Information (SCI) "green door." The SCI information was provided, but an understanding of the technology generally was not.

Moreover, communications nets constructed by the sensor and intelligence communities also proliferated, with little or no architectural oversight until communications capacity was in serious shortage. One result was that the components of C^4I— the corners of the triangle described in Chapter 1— began to grow apart and out of proportion from each other and from the whole of the system.

The post-Cold War era exacerbates this problem. While we have over 40 years experience developing Soviet intelligence capabilities, we do not possess an agile, capable non-Soviet intelligence dissemination capability, because to a large degree, such a capability is dependent on the development of data bases and analytical tools not readily available for non-Soviet targets. Moreover, most of the Navy's intelligence sensors are neither owned nor operated by the Navy. Post-Cold War budgets present to the Services a critical problem in keeping a tactical influence on national agencies that must face large cutbacks in resources.

Programmatically, many of today's C^4I systems were procured like weapons systems, which are expected to last 20 years. The *downside* to this is that technology is improving at such an accelerated rate that by the time planned C^4I systems are introduced into the fleet they are obsolete. Many sailors operate far more capable computer systems in their homes than in their work spaces. End-to-end systems with distinct hardware, protocols, software, and sponsors are creating logistical and training pitfalls— manpower and funding we can no longer afford.

Thus, military C^4I systems, unless we change our way of doing business, are swimming against two powerful tides: budget cuts that will force deep reductions in funding and manpower needed to keep equipment operating and technological advances that make computer generations less than one-third the length of the acquisition cycle.

The *upside* is that technology is changing; it is becoming standardized within industry; and it portends an information management capability only dreamed about before. Systems that cost us $250,000,000 in the 1980s, now cost only a tenth of that and bring with them standards as well as improvements in size, weight, and electronic reliability.

From the standpoint of communications, we are in a dilemma. Military satellite capacity already is significantly behind that of land-based capacity (see chap. 6). As data speeds increase to fiber optic capabilities ashore and on shipboard LANs, satellite throughputs will lag relative to systems ashore and those within the hull of the ship. The application of anti-jam wave forms further reduces the potential inherent in Satellite Communications (SATCOM). And High Frequency (HF), while suitable for narrative traffic and for intra-battle group communications, is not affordability suited for data rates above 1200 baud and, by comparison, is manpower-intensive to operate.

Moreover, SATCOM channels can be likened to personal computers before the advent of operating systems. Access to the channels serving afloat forces is rigid and inefficient. SATCOM channels as currently designed are not dynamic and have a limited surge capability.

Narrative formats cause the operator to suffer not from a lack of knowledge but from the inability to assimilate the avalanche of information being sent, much of which is repetitive. The majority of the data is sent in textual format. What little machine-to-machine traffic we do have is limited by diverse protocols and data formats.

FUNCTIONAL PROBLEMS

Perhaps the most difficult hurdle to leap in constructing a new C4I architecture like Copernicus is getting the right level of focus. One person's architecture is often another person's multiplexer. Today, program managers are awash in acronyms, while operators are drowning in installation schedules and line drawings.

However, as we step away from today's C4I system toward tomorrow's operational problem, and if we do so with experience and understanding of the technology both behind and in front of the compartmented "green" door, a series of eight, functional shortfalls emerge.

In discussing them, it is helpful to recall the discussion in Chapter 1 of C4I as a system— a "triangular acronym" with command and control at the apex. Command and control has to do with the delegation of warfighting means to ends. Ends, of course, range from tactical through strategic to political in nature. It is characteristic of the post-Cold War that, for the tactical commander, this distance between *tactical* ends and *political* ends will diminish sharply.

Communications and computers— the second "Command and Control" of the acronym on the lower left of the triangle— has to do with information management. Finally, intelligence, on the lower right, not only has to do with the traditional view of enemy intentions and capabilities, but, in the last 20 years it also has come to include the management of the wide-area surveillance systems from which we derive so much of our tactical intelligence.

Problem 1: Command and Control Inflexibility

At the apex of the triangle, command and control itself, the first functional shortfall today is that we are trying to absorb the threat into our existing command and control doctrine instead of taking a new and flexible approach to command and control doctrine based upon the threat.

For the last 45 years, each of the Services has developed command and control doctrines against the Soviet— global and theater— threat. The Composite Warfare Commander (CWC) concept had its origins in World War II and matured to the current concept during the 1970s, but its focus remained the same for 4 decades— open-ocean war at sea with a sophisticated naval foe. Similarly, the AirLand battle doctrine adopted by Army and Air Force originated in the European crucible as a direct outgrowth of the Soviet Army threat and its similar doctrine. Both ground and air forces, NATO and the former Warsaw Pact alike, were influenced— like Navy's CWC concept— in doctrine developed during World War II. In the former case, the antecedent was the German Wehrmacht's Blitzkrieg.

The world, however, has changed. Single-service, global-war-oriented doctrines inevitably will give way to or be modified by both the sheer diversity of the CALOW threats and by the similar diversity in task force composition— joint and allied, and different allies today than tomorrow. In the post-Cold War, both the ends and means of each mission may be different. Therefore, command and control for the new age must offer the tactical commander much more flexibility than today: doctrinally, technologically, and organizationally.

We will discuss this shortfall in detail in the next chapter.

Problems 2-6: Information Management

Information management— communications and computers— poses four serious functional shortfalls.

The second problem is that, taken in the aggregate, today we cannot decant operational traffic from administrative traffic. Therefore, when we go to war, we have no real technological means to gain capacity to support the increased operational tempo. Indeed, that was the experience in Desert Storm (see fig. 2-4) as well as every major exercise for the last two decades.

Literally today, 33,000 commands ashore can send the tactical commander a message at their collective whim, not his. All the commander can do is turn his radio off.

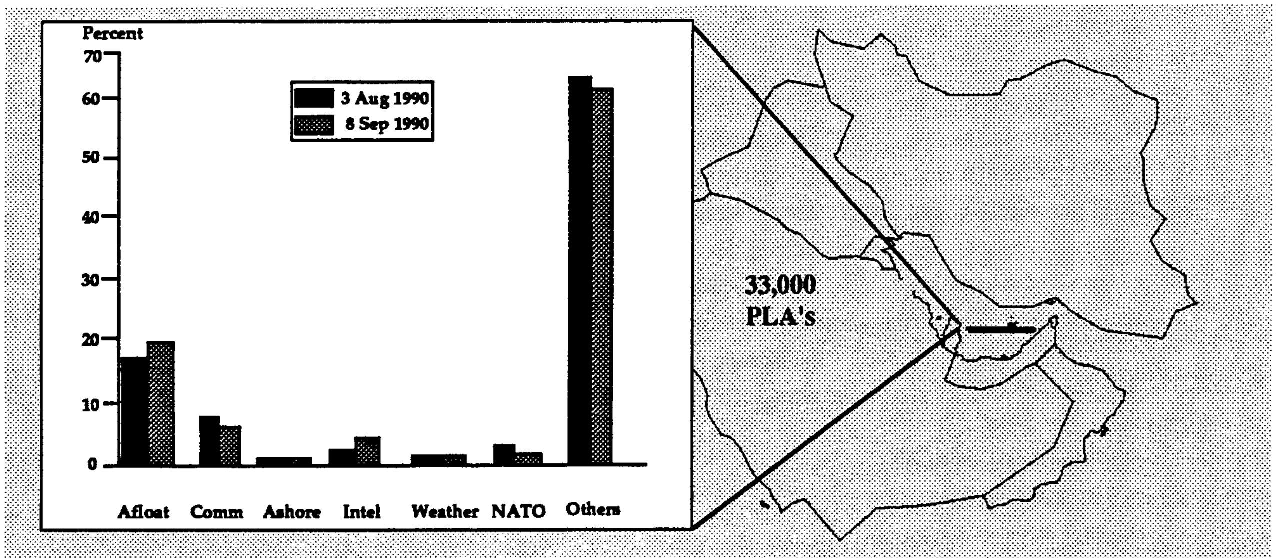

Figure 2-4. Message Loading During Desert Storm

Third, the information is conveyed in the wrong format— narrative messages, and in the wrong form— paper. It should not surprise us that we are drowning the tactical commanders. In effect, we are communicating in a "pre-television age." We communicated in Desert Storm in the same way we communicated in the desert storms of the North African campaigns 50 years ago— by narrative message. Today, we tell the ship on the starboard beam 1,000 yards away to replenish us tomorrow by sending a message back to the beach 5,000 miles away, where it is returned 5,000 miles back to sea to the ship abeam.

Tactically, the commander at sea, in effect, is forced to read the equivalent of all editions of the *New York Times*— every day, every page, every column— in order to glean the information he needs. Moreover, he has to read all the editions, some of which, because of delivery delays, are received out of sequence.

And, to continue the analogy, he must remember what he saw on page 6, paragraph 15, line 4, and associate it with the society page and the sports page to correlate it— because the editors of the front page, society page, and sports page, all have different offices in town and different perspectives on the problem.

There are serious implications of this reliance on narrative traffic to communicate:

- It is necessary for the tactical commander to read narrative in order to gain information, recognizing as we must the two are not the same;

- Because it has not been possible in the past decade for the commander to read all the traffic, much discussion has arisen about an apparent *operational* issue as to whether to fuse ashore or fuse afloat. In reality, this is a *technological* issue as well as an operational issue. Although there are absolute limits on how much can be fused at either location (e.g., security, experience, manpower), better communications and computer technology can lead us to a less black and white choice. Our goal should be simultaneous, distributed fusion leading to a consistent tactical picture ashore and afloat;

- Narrative is not only inefficient from an informational standpoint, but also from a communications perspective, resulting in the unnecessary waste of capacity. Moreover, this is not only caused by the technical inefficiency of narrative transmission. The current system with its proliferation of messages forces on the tactical commander a "push-it-all-at-you" architecture instead of facilitating a "pull-it-from-the-shelf" information flow; and

- Finally, today's narrative is the technological and human bridge between organic sensors and non-organic sensors. Using narrative, arriving as it does from many different sources and pathways in different timeframes (see fig. 2-5), introduces a redundancy and a resulting unnecessary ambiguity to the tactical picture. Today, that is manifested in the 500-mile tactical wall that represents the practical limit of organic CVBG sensors. Breaking down that wall means displaying wide-area sensor locational data in a true navigational display side-by-side with organic information on the same screen. The effect is to render non-organic sensors organic.

Fourth, the current system, with its emphasis on narrative traffic and its reflection of diverse sensors and analytic nodes ashore, is inefficient. What traffic goes on the satellites to the tactical commander is, today, less a conscious operational decision than an administrative decision to parcel out precious communications capacity. Thus, the tactical traffic is more a reflection of long-term staff compromises than real-time operational requirements: staff wars versus star wars.

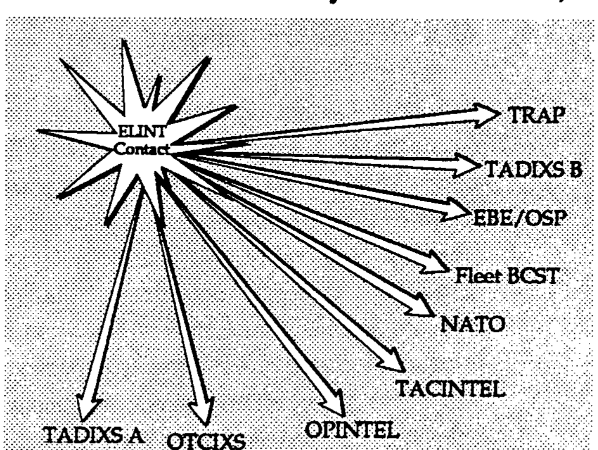

Figure 2-5. ELINT Contact: Multiple Paths

Fifth, the technology of communications and the diversity of communications bearer services is inadequate. We must develop virtual networking with broad choices of services, both in format and in media. This shortfall is discussed at length in Chapter 6.

Sixth, several factors— the narrative format, the lack of common display, relative versus true navigation references, a plethora of computers, and staff compromises— have resulted in loss of operational perspective. Architecturally and operationally, the goal must be *one emission sensed leads to one location report over one communications path to sea at one time.*

Like the novice deck officer who finally learns to abandon the maneuvering board for the bridge wing during his first turns to station, we must look out the bridge window at the tracking problem. In open ocean warfare, problems do not arise instantly; they arise over a time and space continuum that begins with indications and warning and moves closer to the battle group in both dimensions through cueing, tracking, targeting, engagement, battle damage assessment, and re-engagement.

The current system does not allow us to reliably develop a multisensor track on a tactical display of 5,000 nm (arbitrarily) and follow it into the organic sensor, tactical killing zone at 500 nm from the CVBG center with a minimum of redundancy and ambiguity. It is important to realize over the years the current C4I system has become so complex that redundancy and ambiguity have *increased*, not decreased.

We must restore operational perspective. If there are 2,500 surface ships in the Mediterranean, of which 250 must be tracked, and a total of 5 organic and non-organic sensors can be brought to bear over an 18-hour tactical continuum from I&W to engagement, *the amount of communications traffic that results should have a direct relationship to those operational parameters*. In other words, the communications loading should reflect some model of 250 ships x number of emissions/18 hours x 5 sensors.

C4I communications loading should reflect the enemy's actions, our actions, and the C4I system that reports those to us. While we cannot always control the first, and it is not desirable to limit the second, we can bring efficiencies to the third. C4I should decrease, not increase, the fog of war.

Problems 7 and 8: Intelligence

The seventh problem in today's C4I system is presented by the close of the Cold War era: the necessity to develop and disseminate information on a far broader category of potential threats. This challenge goes beyond the wide-area, non-organic sensors, which by and large can be tasked against Second and Third World targets as well as the Soviets. It goes to the heart of the post-Cold War intelligence problem:

- Where is the threat?
- Who is the ally?
- What are their (both ally and threat) intentions and capabilities?
- What are the strategic goals of the mission and how do we measure when they have been achieved?

Thus, we should understand that the new age brings us full bore into limited, objective warfare. The intelligence system is no longer just Navy, nor even just the Department of Defense. It includes Government agencies, possibly multinational corporations, and news services. In a world of diverse, diffused threat, the intelligence infrastructure must be powerful, flexible, and able to reach out for information quickly.

Technologically, doctrinally, and organizationally, we must construct an intelligence infrastructure that can allow a DIA analyst assigned to a problem to be in contact with colleagues in State, CIA, DIA, and industry who are also working daily on the same problem from a different angle. And, we must move that information to sea in a structured, efficient, tactical context on short notice. We must come about from a Soviet-oriented, single-Service-oriented infrastructure to a CALOW-capable infrastructure— one which can respond to the component commander tactically and to the National Command Authorities strategically within the same CALOW battle space.

Eighth, and following from this information problem, we must develop the means to disseminate and display intelligence information more efficiently. Today, data file transfer to sea happens by flying disks onto the carrier decks by aircraft. Tomorrow, the data file and the image must replace the message as the principal operational format. Moreover, the data file and image must be displayed and utilized *in operational context* on a common workstation, so that a synergism is achieved between sensor tracks, images, and analytic files, both organic and non-organic.

Figure 2-6 summarizes the eight systemic shortfalls in our current architecture. In the following chapter, we will return to these problems in the context of the Copernicus Architecture.

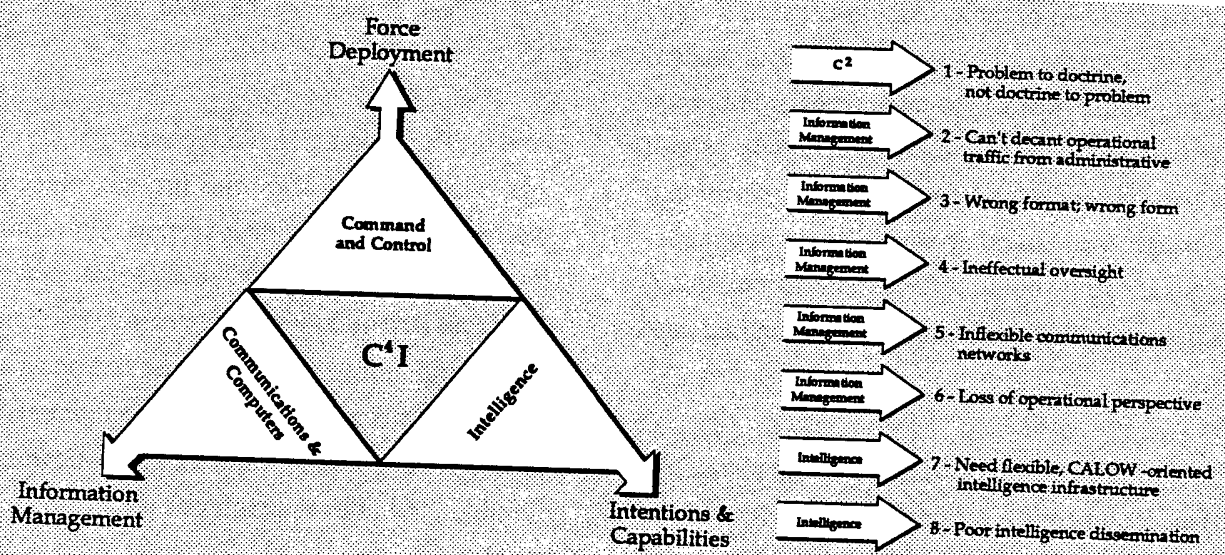

Figure 2-6. Shortfalls in the Current Architecture

CHAPTER 3
THE COPERNICUS CONCEPT

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CHAPTER 3
THE COPERNICUS CONCEPT

SUMMARY

The Copernicus Architecture is both a new C^4I architecture to replace our current system and an investment strategy that provides a programmatic basis to construct it over the next decade. The remainder of this document details both the architecture and investment strategy in sequence. Chapters 4 through 7 discuss the four pillars of the architecture: the Global Information Exchange Systems (GLOBIXS), the CINC Command Complex (CCC), the Tactical Data Information Exchange Systems (TADIXS), and the Tactical Command Center (TCC). Through the four pillars, Copernicus, as a C^4I architecture, will be constructed as an interactive framework that ties together the command and control process of the Navy tactical commander afloat, the Joint Task Force (JTF) commander, the numbered fleet commander and others with ~~the CINCs ashore. Copernicus has 10~~ architectural goals (see boxed text 3-1).

GLOBIXS are global, virtual networks imposed on the Defense Communications System (DCS) or commercial systems. GLOBIXS tie together existing shore sensor nodes, analytic nodes, and other selected activities into communities of like interests. They are by definition joint in construction, and some will be combined. All GLOBIXS share a common intersection with the CCC.

The CCC is also a virtual network, imposed over metropolitan area networks (MANs) on Oahu, HI, in Norfolk, VA, and in Naples, Italy. The CCC will tie together existing command and staff organizations and proposes to construct two new ones— a Space and Electronic Warfare (SEW) Center and a research center. Viewed from the afloat perspective, the CCC provides a means to manage the information flow for the tactical commander, with sufficient doctrinal and technological flexibility to allow each commander to decide how much and what kind of information he wants. Thus, the afloat commander should see the CCC as a group of shore-based assistants somewhat analogous to the Composite Warfare Commander (CWC) of the Carrier Battle Group (CVBG) afloat. In the same way CWC commanders are delegated warfighting ends and means *afloat*, the CCC will have analogous personnel to whom ends and means *ashore* may be delegated.

The TADIXS are a series of tactical virtual nets. Copernican TADIXS are not to be confused with the existing TADIXS A and B. Rather, Copernican TADIXS are virtual networks of variable duration (i.e., 5 minutes, 5 hours, 5 days) depending on the information exchange load. TADIXS should not be considered communications circuits; but information networks sharing communications circuitry over a broad menu of bearer services from HF and VHF to UHF, SHF, and EHF military satellites, as well as commercial satellites.

The final pillar of the architecture is the TCC, which is intended to be a generic term reflecting the nerve centers of tactical units— whether carriers (see fig. 3-3), submarines, or Marine Air/Ground Task Forces (MAGTF) in the Navy-Marine model, or Corps, Air Wings, and Joint Task Forces (JTFs) in the joint model.

In Copernicus, data forwarded to the tactical commander from ashore and from the tactical commander to shore (and all subscribers in between) is differentiated by two factors. The first is precedence; the second is format. By precedence, we mean three cases of data. Case 1 data is defined as immediate in precedence and is typically in the form of a sensor location report in a binary format or a voice report. Case 1 data originates from sensor nodes ashore and afloat. Case 2 data may also originate from sensor nodes, but more typically from analytic nodes ashore and from other tactical units. Case 2 data typically will be in the form of OPNOTES and voice reports over the GLOBIXS-TADIXS networks; however, data files and imagery are also likely formats. Like Case 1 data, Case 2 data may also be "toggled" on or off dynamically over time and is envisioned to be part of a doctrinal process described in a future Copernicus Naval Warfare Publication (NWP). Case 3 data is "term" data: data that is not time-sensitive, relative to Case 1 and Case 2.

Copernicus provides the tactical commander with six doctrinal choices that allow him to construct his new C^4I system to support the mission and his decision to delegate forces to carry out that mission. The first decision available under Copernicus is to determine who and what comprises— technologically, doctrinally, and organizationally— the TCC for the mission. The second decision includes what the tactical commander will delegate to his "anchor" desks in the CCC ashore and what will he retain for himself. The third decision the tactical commander makes is who may talk to him from the GLOBIXS infrastructure and in what cases. Fourth, there is an information management decision: who gets what information? The fifth decision is the instantaneous construction of the virtual networks— what is the network (i.e., TADIXS) mix? Finally, the sixth decision, made possible through the Communications Support System (see chap. 6), is to select communications pathway or bearer services for the virtual nets.

DISCUSSION

The Copernicus Architecture is both a new C^4I architecture to replace our current system and an investment strategy that provides a programmatic basis to construct it over the next decade. The remainder of this document details both the architecture and investment strategy in sequence.

Chapters 4 through 7 discuss the four pillars of the architecture: the GLOBIXS, the CCC, TADIXS, and the TCC. Through the four pillars, Copernicus, as a C^4I architecture, will be constructed as an interactive framework that ties together the command and control process of the Navy tactical commander afloat, the JTF commander, the numbered fleet commander and others with the CINCs ashore. Copernicus has 10 architectural goals shown in the accompanying boxed text 3-1.

GLOBIXS are global, virtual networks imposed on the DCS or commercial systems. GLOBIXS tie together existing shore sensor nodes, analytic nodes, and other selected activities into communities of like interests. They are by definition joint in construction, and some will be combined. Eight strawman GLOBIXS are proposed; however, it is intended and is architecturally desirable that the number and nature of GLOBIXS be flexible. GLOBIXS are discussed in detail in Chapter 4. The implementation of the GLOBIXS, and the rest of the architecture, is described in Chapter 10.

The CCC is also a virtual network, imposed over MANs on Oahu, HI, in Norfolk, VA, and in Naples, Italy. The CCC will tie together existing command and staff organizations and proposes to construct two new centers— a SEW center and a research center.

Viewed from the afloat perspective, the CCC provides a means to manage the information flow for the tactical commander, with sufficient doctrinal and technological flexibility to allow each commander to decide how much and what kind of information he wants. Thus, the afloat commander should see the CCC as a group of shore-based assistants somewhat analogous to the CWC in the CVBG afloat. In the same way CWC commanders are delegated warfighting ends and means afloat, the CCC will have analogous personnel to whom ends and means ashore may be delegated.

Viewed from the shore perspective, these CCC personnel are similar to television news anchor desks. They "anchor" each GLOBIXS in order to shape, sort, analyze, and move the information from shore to ship and from ship to

Boxed Text 3-1. Ten Architectural Goals of the Copernicus Architecture

1. Technological, organizational, and doctrinal flexibility to accommodate open ocean operations, prolonged regional conflict, and crisis action;
2. An investment strategy with force-planning criteria to scale down in post-Cold War, jettison outdated programs, and ensure new programs are part of an overall blueprint;
3. Centralized architectural development and oversight with standardized technological components and consolidated, operational, tactical networks;
4. Decentralized development of mission-specific, multimedia, global networks within the blueprint to maximize experience and innovation down-echelon;
5. Analogous command centers ashore and afloat that share a consistent tactical picture, and connect Navy to the joint and allied picture;
6. Marriage of national assets to tactical applications; the accommodation of SEW;
7. A new logistics strategy - PIM - to keep the leading edge of technology in the fleet while reducing the Navy ILS and maintenance tail;
8. An end to domination of the Navy communications by the message format; an approach to true office automation;
9. Both functional and technological consolidation of military SATCOM bandwidth and an affordable high-data rate alternative to it; and
10. Better security through MLS in the intelligence fusion process, elimination of hardcopy cryptographic key (i.e., Over-the-Air Rekeying[OTAR] and Over-the-Air Transfer [OTAT]), and establishment of a Navy-wide secure RDT&E network.

shore (see fig. 3-1). They are the tactical gateways to the fleet for the shore communities. CCCs, which may be either Navy only or unified in construct, are discussed in Chapter 5.

The TADIXS are a series of virtual nets that link: 1) the afloat commander with the CCC (and, by extension, to the National Command Authorities, allies, and Government agencies); 2) the afloat commander to units under his command; 3) the component commander to the JTF commander; and 4) the afloat commander to the wide-area sensors managed ashore that are not routed through the CCC (e.g., direct targeting TADIXS [see chap. 6]).

Copernican TADIXS are not to be confused with the existing TADIXS A and B. Rather, Copernican TADIXS are virtual networks of variable duration (e.g., 5 minutes, 5 hours, 5 days) depending on the information exchange load. TADIXS should not be considered communications circuits; but information networks sharing communications circuitry over a broad menu of bearer services from HF and VHF to UHF, SHF, and EHF military satellites to commercial satellites.[1]

[1] For purposes of this document, we should differentiate among the terms "bearer services," "communications services," "communications circuits," and "information networks." See fig. 3-2. A bearer service is a physical transmission system (e.g., fiber optic cable, digital microwave, or satellite transmission path.) A communication service is data (e.g., voice, data file transfer, message, image) that is sent over bearer services. A communication circuit defines a specific pathway over a bearer service (e.g., channel one, UHF FLTSATCOM.) An information network is analogous to yesterday's telephone party lines; it is the means by which different users convey information to one another.

Thus, in the context of Copernicus, a TADIXS is an information network (i.e., users in a community of interest) that conveys one or several communications services (e.g., voice, data files) over a communications circuit of a bearer service. TADIXS can be thought of, then, as having temporal nomenclatures: ASW/data/ch. 4/UHF; ASW/voice/ch. 1SHF; or ASW/imagery/ch. 1/INMARSAT. The duration of the temporal TADIXS is a function of information load and tactical situation.

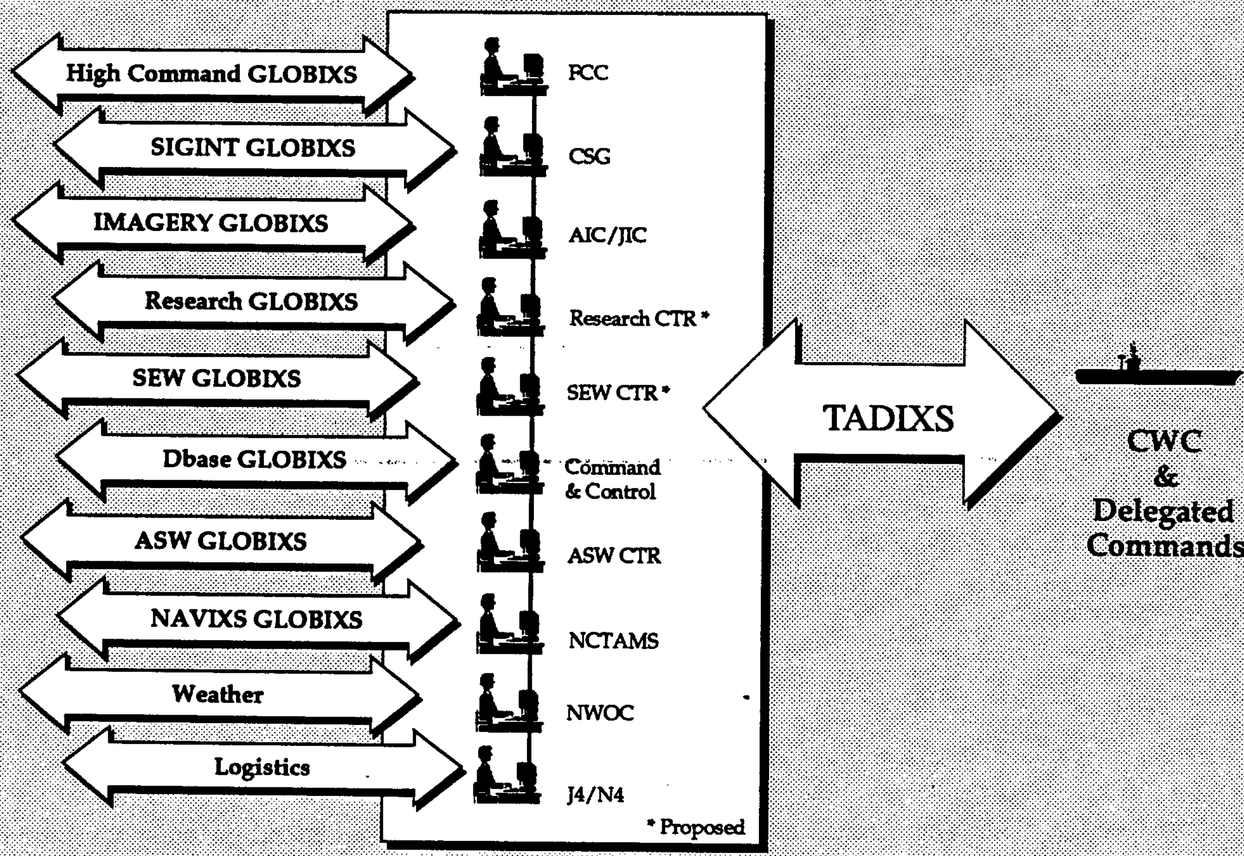


Figure 3-1. CCC Anchors

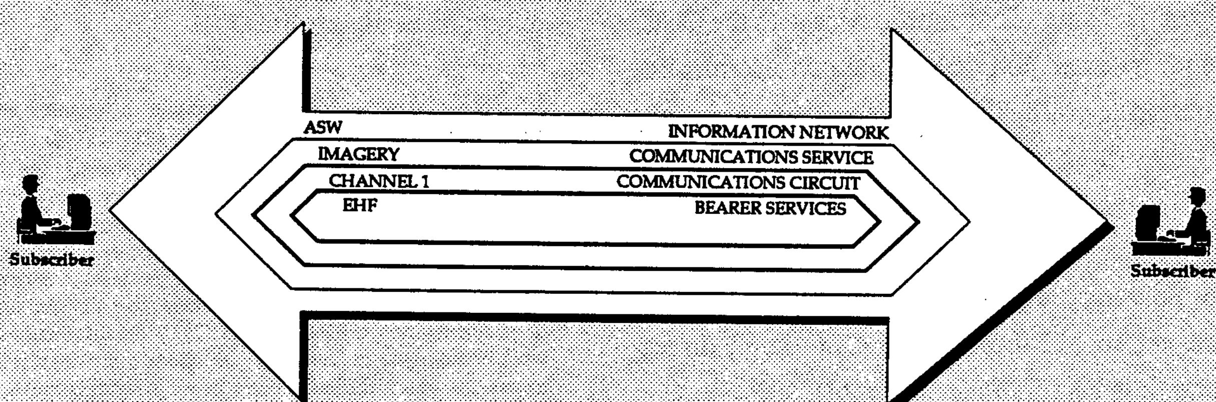


Figure 3-2. Bearer Services, Communications Services, Communications Circuits, and Information Networks

TADIXS, then, are not communications constructs, but operational constructs, which is a concept alien to our current C^4I system but familiar in industry. TADIXS are discussed in Chapter 6.

The final pillar of the architecture is the TCC, which is intended to be a generic term reflecting the decision centers of warfighting commanders — whether in carriers (see fig. 3-3), submarines, or the MAGTF in the Navy-Marine model or Corps, Air Wings, and JTF in the joint model. At the heart of the concept of the TCC are two technological goals.

First, the TCC should be designed as an open systems architecture based on standards to create a modular environment that can be configured for many missions, not just one. Today, we sit in front of an electronic warfare, imagery, or data base terminal. Tomorrow, all terminals will be the same, but each can be configured by software to accept information from many sources and display it on a human-machine interface (HMI) software application that provides operational context and decision-making tools. Technological standards are discussed in Chapter 8.

Second, through this flexibility, the tactical commander can construct his TCC — and his wardroom — to reflect the mission rather than shoe-horning the mission into a fixed

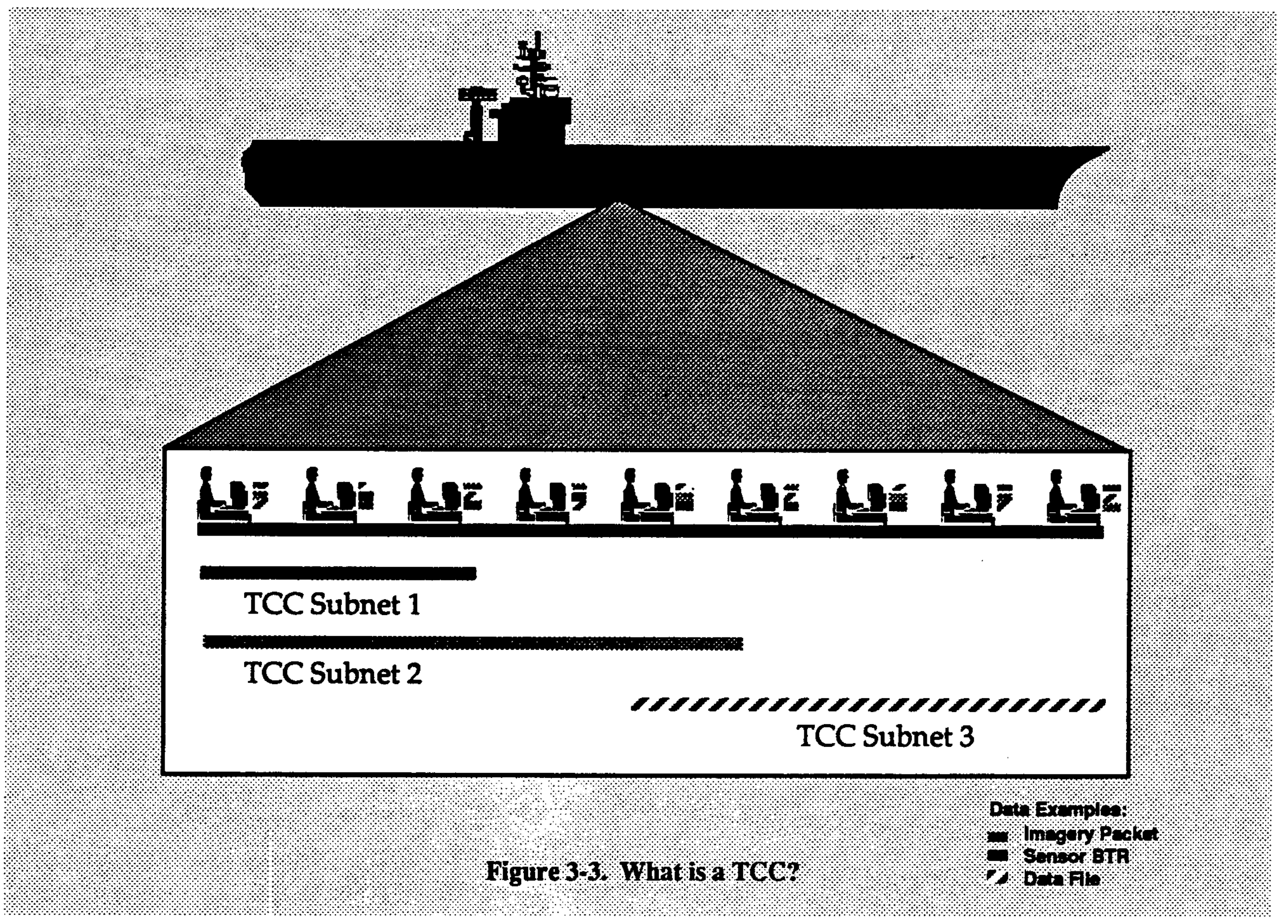


Figure 3-3. What is a TCC?

technological configuration[2]. TCCs are discussed in Chapter 7. Figure 3-4 shows the interconnectivity among the four pillars using ASW as an example.

[2] Thus, somewhat paradoxically, we come around full circle in command and control. In Lord Nelson's time, technology was brought *to* the tactical problem through an intuitive process by which Nelson conveyed his intentions beforehand to his captains. The captains then took their ships into the fray. This concept was carried through for 175 years into today's CWC concept.

However, with the rapid growth of workstations and command and control technology in the last two decades, a trend toward fixed-workstation positions has materialized – ELINT, SIGINT, imagery, and so on. This portends a move away from command and control as an *operational* construct built from the tactical commander's view of the mission toward a command and control that reflects an existing *technological configuration* that has resulted not from operational but from programming and engineering considerations. Central to the Copernican thesis is the operator – not the programmer, communicator, or engineer – is in tactical command, and the operator should be provided the technological, doctrinal, and organization means to construct C^4I to support his command and control needs.

FOCUS ON THE OPERATOR

Copernicus focuses on the operator at four levels:

- The watchstander, through the employment of common, and high-technology, computer workstations[3] that are identical from station to station— and pillar to pillar— except for a mission-specific software "veneer" that delineates the communities of interests. Using this workstation, the Anti-submarine Warfare (ASW) analyst in the GLOBIXS, the ASW anchor at the CCC, the ASW TADIXS subscribers, and the ASW commander in the TCC all share a common HMI hosted on identical terminals (see fig. 3-5);

- The Navy tactical commander, through the employment of the virtual TADIXS, the number

[3] Called Fleet All-Source Tactical Terminals or FASTTs.

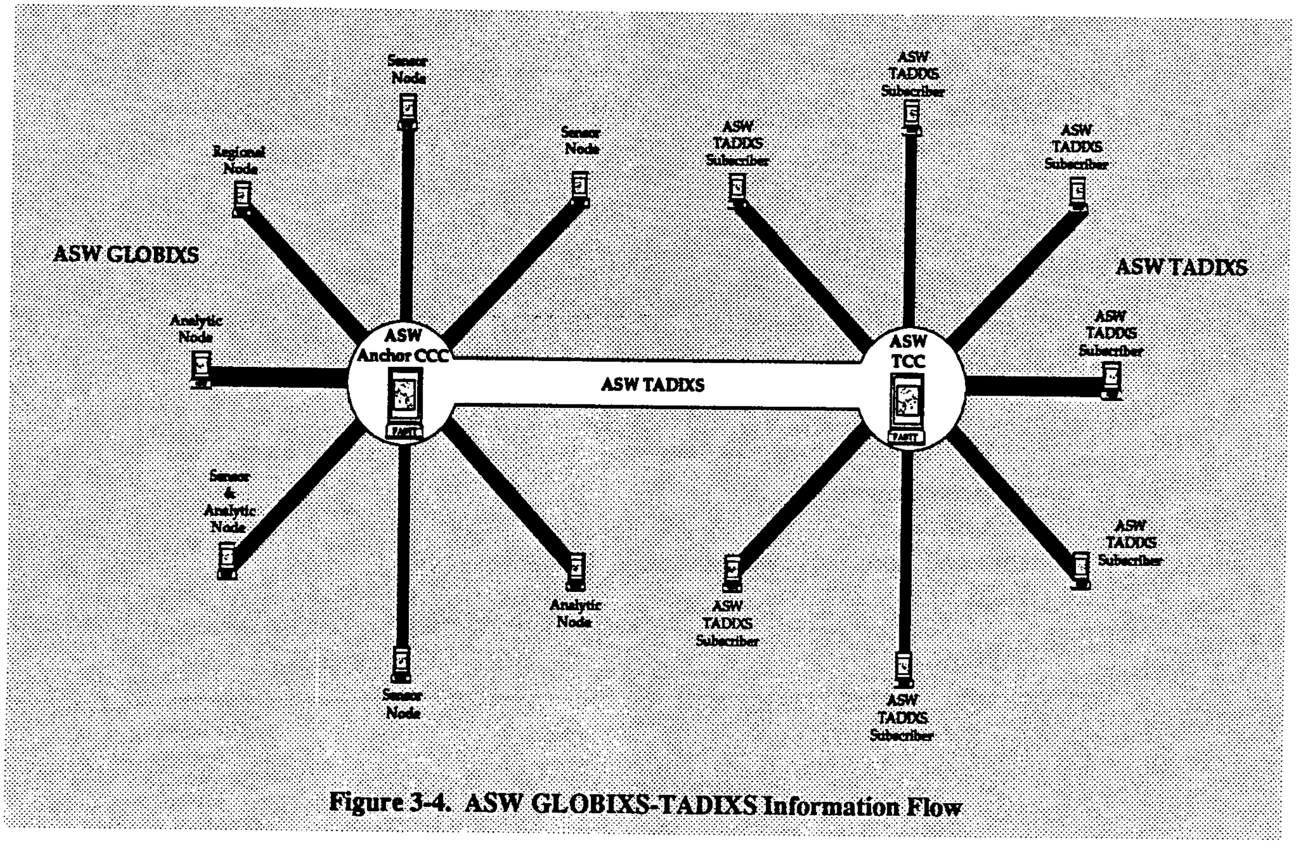
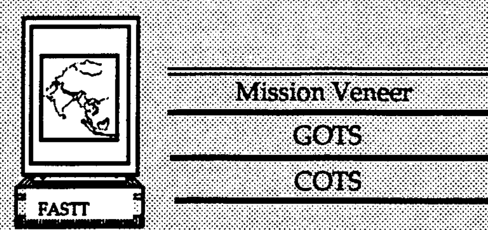


Figure 3-4. ASW GLOBIXS-TADIXS Information Flow

COTS Software
- UNIX, X WINDOWS, MOTIF
- Digital/terrain maps
- Imagery processing boards
- High-speed text search
- Jane's on CD ROM
- DBMS
- DOS emulation
- Word Processing



GOTS Software
- Panther/PAWS correlation
- MIIDS/IDB reference data bases
- Trusted port software ("Trans-sanitization")

GLOBIXS/TADIXS Analytical software

Figure 3-5. Off-the-shelf, DTC-2-based FASTT

and nature of which are changeable to suit his command and control doctrinal decisions, and through the configurable TCC. The TADIXS and the TCC allow one commander to shape his command and control one way and another commander in the same theater to shape his a different way;

- The JTF commander, who in the post-Cold War command structure likely will emerge as the on-scene tactical commander in many actions, through the development of an architectural capability to size, shape, and scope many diverse shore and tactical components into the GLOBIXS-TADIXS model of Copernicus; and

- The shore commander, from the Fleet Commander in Chief (FLTCINC) to the unified CINC to the National Command Authorities (NCA), through the development of a broad, high-technology command connectivity (e.g., video, voice, narrative) and through the establishment of the rapidly configurable GLOBIXS that can tie the commander to all echelons, across all Services, to all allies (whether temporary or enduring), and across the spectrum of warfare.

INFORMATION FLOW

It is important to understand how Copernicus seeks to differentiate data from information and to emphasize the latter over the former (see fig. 3-6). For our purposes, *data* happens "below" the HMI of the tactical terminals. *Information* is data displayed within the operational context provided by the HMI. Signals Intelligence (SIGINT) locational data, for example, is ASW information when placed in the operational context of the ASW problem. While this may seem at first glance to be an esoteric delineation, on further reflection it enables us to consider more easily the nature and efficiencies of transmitting data and the multiple opportunities of sending data to different users with different contexts. Simply put, we can use this construct to define data as a raw material—a commodity— that contributes to operational information.

	User Software	Copernicus Tactical Software
Information	User Software	Copernicus Tactical Software
Data	OPS Layering	TADIXS/GLOBIXS
	Operating System	e.g., CSS
	Protocols/Standards	e.g., X.400
	Transmission Media	e.g., DDN, SATCOM, IC2

Figure 3-6. Data/Information Interface

In Copernicus, data is forwarded to the tactical commander from ashore and from the tactical commander to shore (and all subscribers in between) and is differentiated by two factors. The first is precedence; the second is format.

Cases of Data

By precedence, we mean three cases of data. Case 1 data is defined as immediate[4] in precedence and is typically in the form of a sensor location report in a binary format or a voice report. Case 1 data originates from sensor nodes ashore and afloat. These sensors may be "toggled" on or off— sent to a tactical commander or not— at the commander's discretion (see fig. 3-7). If the tactical commander decides to toggle off a sensor, the sensor report nevertheless

[4] The immediate Case 1 data requirement is defined as less than 3 minutes from the sensor to the user.

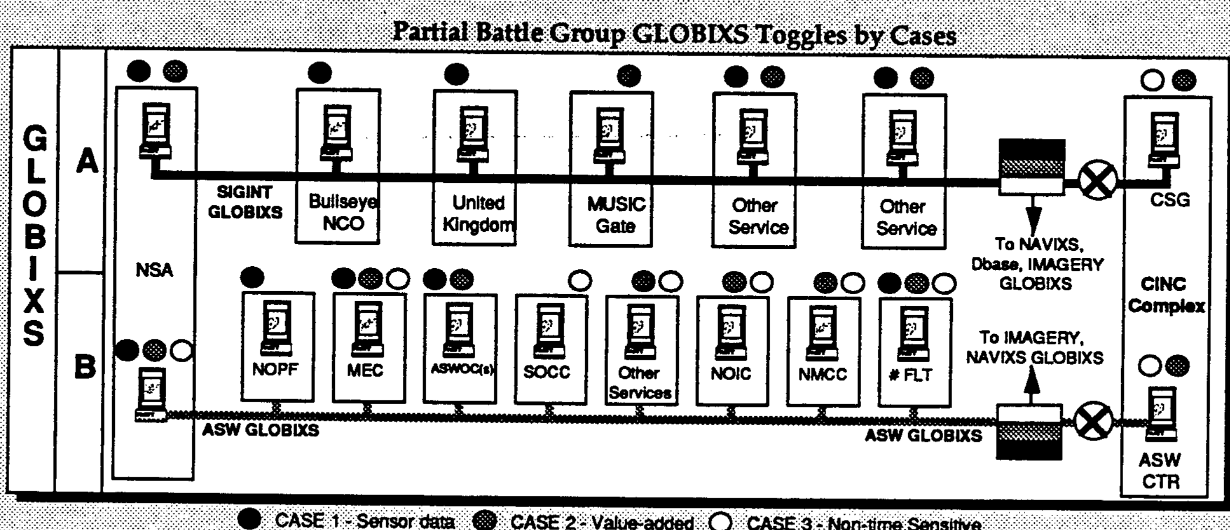


Figure 3-7. Copernicus C⁴I Planning

would be monitored by the appropriate GLOBIXS anchor.

Technologically, this is achieved by converting the sensor locational reports into binary packets (see chap. 4) and addressing the packets to those commanders who desire them (see figs. 3-8 through 3-10)[5]. Doctrinally, this is anticipated to be a choice from a communication services matrix to be contained in a future Copernicus NWP. (We will return to this concept in the section "Copernicus Doctrine" below.)

Thus, it is possible for tactical commander A and tactical commander B to make separate decisions about *how* Case 1 data is received and *which* Case 1 data to receive even if they are steaming in formation together side-by-side.

Moreover, since the terminals of the TCC are configurable in both Battle Groups, and the data may be addressed (or not) to any terminal, each Battle Group commander may decide differently who will get which data. We therefore can achieve technological standardization without operational rigidity.

Because the operator is in the center of the Copernican universe and makes decisions to aggregate data into operational information (e.g., locational data into tracks), and because this is an art dependent on experience, manpower, perspective, and other factors, we must provide compensation for lack of those factors afloat (or

[5] Certain sensors require data transmission. Such sensors may not be able to use packet switching. With those cases, dedicated circuits will be necessary.

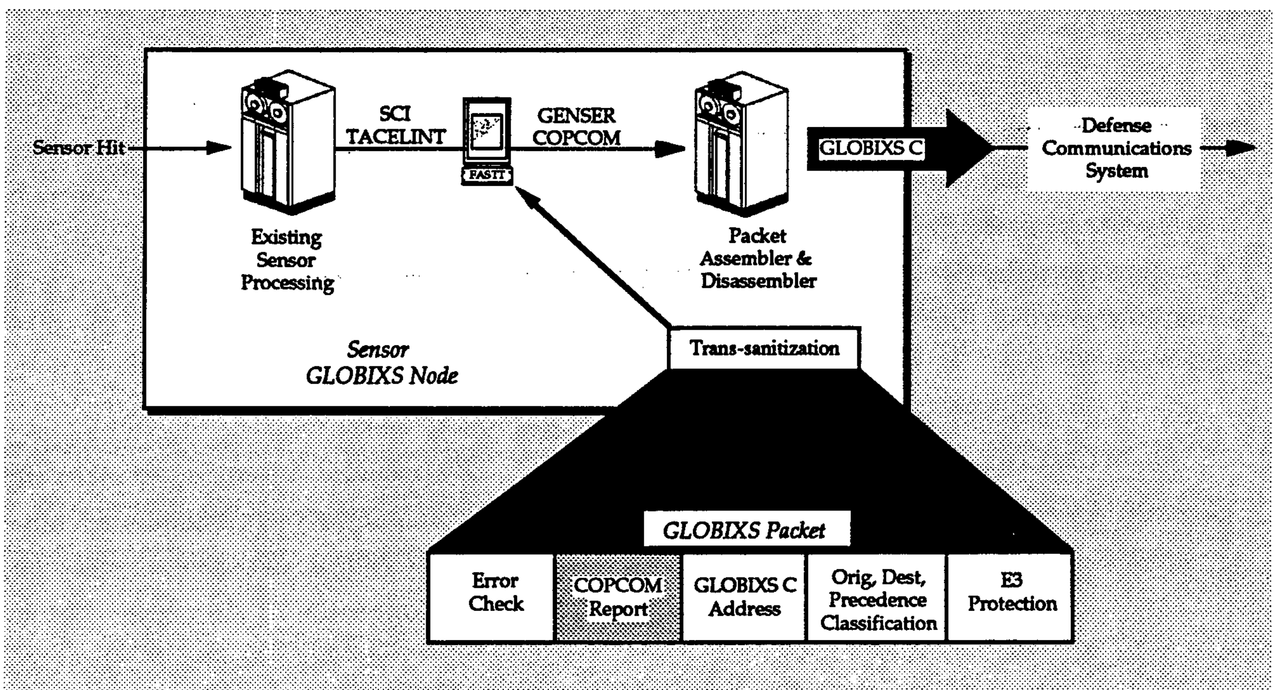


Figure 3-8. Sensor Report "Trans-sanitization" onto GLOBIXS

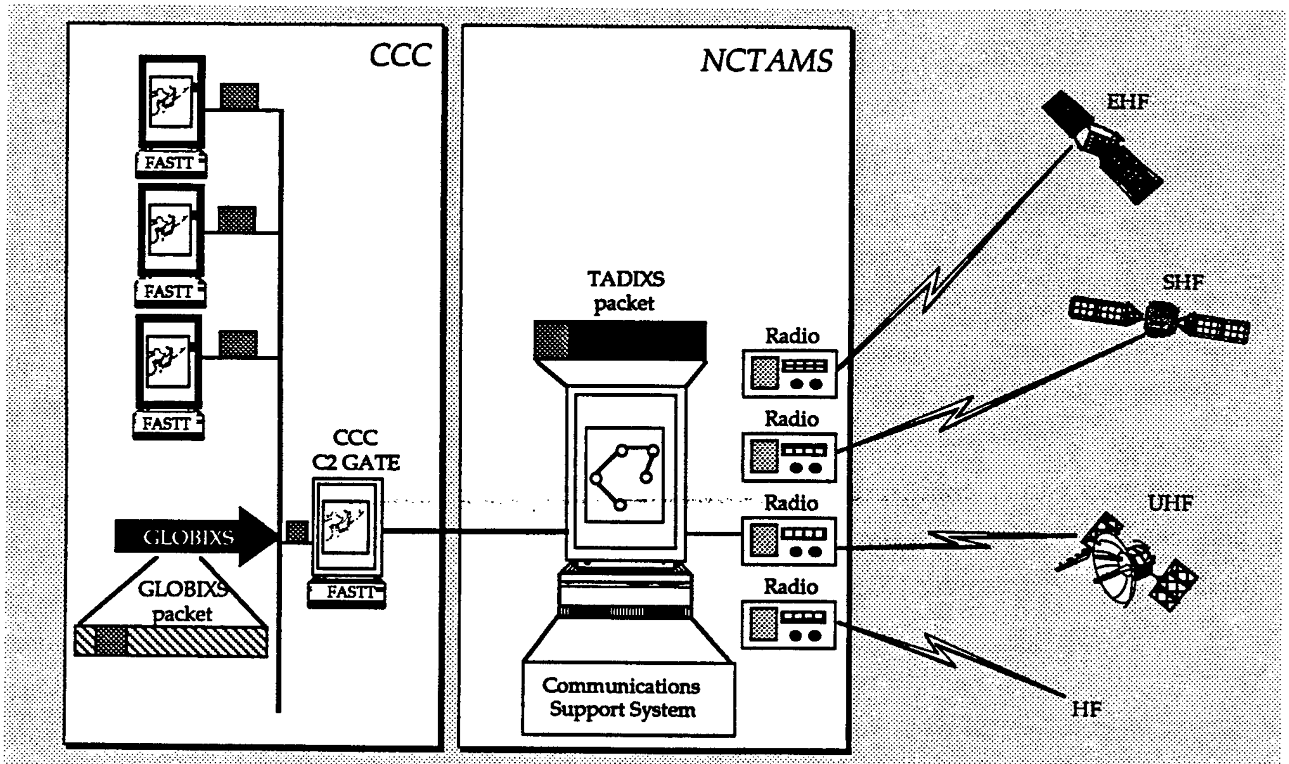


Figure 3-9. Sensor Report Movement From GLOBIXS Through CCC

ashore). Case 2 data is intended to provide value-added to Case 1 data and provide that compensation in near-immediate time.[6]

Case 2 data may originate from sensor nodes, but more typically from analytic nodes ashore and from other tactical units. Case 2 data typically will be in the form of OPNOTES and voice reports over the GLOBIXS-TADIXS networks; however, data files and imagery are also likely formats.

Like Case 1 data, Case 2 data may also be toggled on or off dynamically over time and is envisioned to be part of a doctrinal process described in the future Copernicus NWP.

Case 3 data is "term" data: data that is not time-sensitive, relative to Case 1 and Case 2. It is anticipated that Case 3 data will be data with a time-transmittal requirement of less than 3 hours; however, ultimate definition of sub-categories of Case 3 data with different timeframes are probable during Phase II of Copernicus development (see chap. 10).

Operational Formats

By operational formats, we mean eight types of communications services (see footnote 1): voice, OPNOTE, narrative message, facsimile, Copernicus Common Format (COPCOM), data base files, imagery, and video.

6 The near-immediate requirement is defined as less than 15 minutes between nodes.

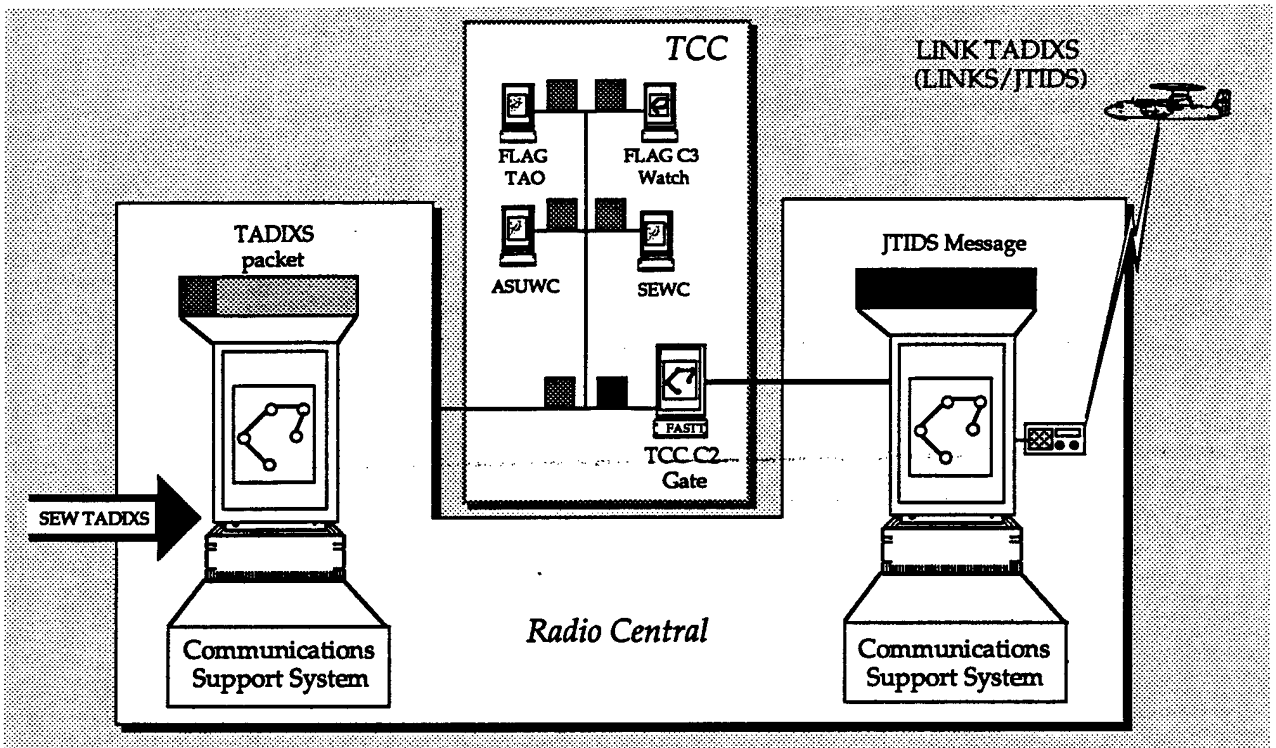


Figure 3-10. Sensor Report Movement From TADIXS to TCC to E-2

Voice is self-explanatory. OPNOTE is a short, interactive, analyst-to-analyst exchange similar to E-mail. Narrative messages are the existing character-oriented formats. COPCOM is a sensor locational report that has been transliterated into a standard, binary format (see chap. 4). Data files, imagery, and video are also binary formats.

Using these data formats and coupling them with the precedence cases, we can define the communications services for each of the virtual networks of the four pillars. See figure 3-11 for a matrix of those services.

In constructing the communications pillars, it becomes possible to develop a taxonomy that describes five characteristics of the pillars — bearer services, communications circuits, communications services (i.e., format), and information networks (i.e., subscribership) and precedence (i.e., case). It is important to recognize that while it is possible to describe requirements for the pillars in these terms, such requirements must be both generalized and instantaneous because several of the characteristics are variable with time. Figure 3-12 shows the taxonomy for an ASW GLOBIXS, and figure 3-13 shows a similar taxonomy for the ASW TADIXS.

Information flow ashore is discussed in Chapter 4. Afloat information flow is discussed in Chapter 6. Taxonomic requirements for each pillar will be discussed in their respective chapters.

PRECEDENCE	Voice	OPNOTE	MSG	Facsimile	COPCOM	Data Base File	Imagery	Video
CASE 1 (Immediate)[1]	VOICE	OPN 1	MSG 1	N/A	COPCOM	DAT 1	IM 1	VIDEO
CASE 2 (Near -Immediate)[2]		OPN 2	MSG 2	Fc 2	COPCOM	DAT 2	IM 2	
CASE 3 (Term)[3]		OPN 3	MSG 3	Fc 3	N/A	DAT 3	IM 3	

FORMAT

[1] ≤ 3 minutes
[2] ≤ 15 minutes
[3] ≤ 3 hours

Figure 3-11. Copernicus Common Services by Precedence and Format

COPERNICUS COMMAND AND CONTROL DOCTRINE

In the previous chapter on shortfalls in the current architecture, we discussed eight systemic C^4I problems. Today with an eye toward those problems, let us examine how the Copernicus Architecture will change command and control.

Copernicus provides the tactical commander with six doctrinal choices that allow him to construct his command and control to support the mission and his decision to delegate forces to carry out that mission. In doctrinal sequence, they are described below and in figure 3-14.

During the planning stage of an operation, the tactical commander must make a deter-

ASW Subscribership	ASW Bearer Services	ASW Communications Circuits	ASW Communications Services	ASW Cases Available to OTC
ASWOC	DCS	DDN, DCTN	COPCOM, OPNOTE, MSG, Data	COPCOM 1,2; OPN 1,2,3; * Data 1,2,3
NOIC	DCS	DDN, DCTN	COPCOM, OPNOTE, MSG,, Data, Imagery	OPN 1,2,3; Image 1,2,3; Data 1,2,3; Video

* Msg 1,2,3 available only throughout NAVIXS GLOBIXS

Figure 3-12. ASW GLOBIXS Taxonomy

ASW Subscribership	ASW Bearer Services	ASW Communications Circuits	ASW Communications Services	ASW Cases Available to Platform
DD-951	HF → COMSAT	Channel X	COPCOM, OPN, Data, Image	COPCOM 1,2; OPN 1,2,3; * Data 1,2,3; Image 1,2,3
P-3	HF, UHF	Channel Y	COPCOM, OPN, Image, Data	COPCOM 1,2,3; OPN 1,2,3 *

*Msg 1,2,3 available only throughout NAVIXS TADIXS

Figure 3-13. ASW TADIXS Taxonomy

mination as to what forces to use and who to delegate the forces to. To facilitate and parallel that decision, the commander will configure the TCC (and, by extension, the TCCs of units under his control) to reflect his plan. Thus, the first decision under Copernicus is to determine who and what comprises— technologically, doctrinally, and organizationally— the TCC for the mission.

What are the operational tasks in the execution order for the mission? To whom will the tactical commander delegate those tasks? Implicit in these decisions is a technological flexibility that allows one delegated commander to do one task in one mission and a different task elsewhere (or at another time in the same mission).

	DECISION	DECISION MAKER
• TCC:	What C2 functions are delegated to whom?	OTC
• CCC:	What is delegated to the "ANCHOR" & what is retained by TCC? What is the CCC Watch?	OTC
• GLOBIXS:	Who is "ON" & "OFF" and in what circumstances?	OTC
• TCC:	What data goes to which delegate?	OTC
• TADIXS:	How many TADIXS?	OTC
• TADIXS:	What Bearer Service?	OTC

Figure 3-14. Copernicus NWP Choices

The second decision is, what will the tactical commander delegate to his anchor desks in the CCC ashore, and what will he retain for himself? One commander may want all information to be sent to him; another may want some information in one category and all information in another; a third may want the anchor to watch all information 500 miles from the task force and provide periodic reports. These delegation decision are both personal and scenario-driven. It may even be a personality-driven one— does he have more confidence in the shore imagery anchor than the intelligence officer afloat?

Now that a decision has been made about who is doing what afloat and ashore, behind the anchor desks we constructed the anchor's shore-based organization— the GLOBIXS. The third decision the tactical commander makes is who may talk to him from the GLOBIXS infrastructure and in what cases (i.e., when). This decision is not monolithic. The tactical commander may delegate the decision to one anchor, but not another. He may also change the decision by moving to a different "toggle" setup in a GLOBIXS as the mission changes.

Thus, instead of 33,000 commands *pushing* messages onto the tactical commander, the primarily binary data is aggregated through GLOBIXS gateways managed by the anchors who respond to the tactical commander's delegation. Fundamentally, then, Copernicus is not a "push-it-all-at-you" architecture; it is a "pull-it-from-the-shelf-as-you-want-it" architecture.

Now that the commander has exercised command and control by delegating functions both afloat and ashore— a revolutionary process made possible by the GLOBIXS— there is an information management decision: *who gets what information*?[7] This fourth decision returns us to the discussion of data versus information. It is a doctrinal decision made possible technologically by selecting communications services from figure 3-11 and addressing them to the chosen units and TCC positions.

The fifth decision is the instantaneous construction of the virtual information networks— what is the *network* (i.e., TADIXS) mix? Now that the tactical commander has decided who will talk to whom and in what circumstance, he decides *how* they will talk. In the Copernicus Architecture, this decision is not wholly a communications circuit and bearer service decision. See figure 3-15.

The decision about how many TADIXS has to do equally with what kind of communications services are pulled from the shelf and how many. Communications services for a TADIXS may be provided over a single communications circuit in some cases, and communication services of more than one TADIXS may be provided over the same/common communications circuit in a time or frequency multiplexed manner. A TADIXS may consist of more than one communications circuit and/or bearer service, or more than one TADIXS may use the same communications service and/or bearer service, and therefore it is not correct to map TADIXS into fixed communications circuits and bearer services. TADIXS, therefore, take shape in the decision about where to send the data and how to display it. Simply put, Copernican TADIXS manifest *themselves at destinations*— they exist at the CCC and at the TCC but not en route to either. The data bound for one TADIXS may be mixed among data bound for another.

The physical appearance of a TADIXS boundary is a communications software segment that sends and receives data to others holding the same segment and a mission-specific HMI on the FASTT, which provides the context in which the data becomes operational information.

Finally, the sixth decision is to select the communications resources (communications circuits and bearer services) over which the TADIXS virtual information networks will be

[7] Inherent in this decision is the security issue of authorization of access to the data.

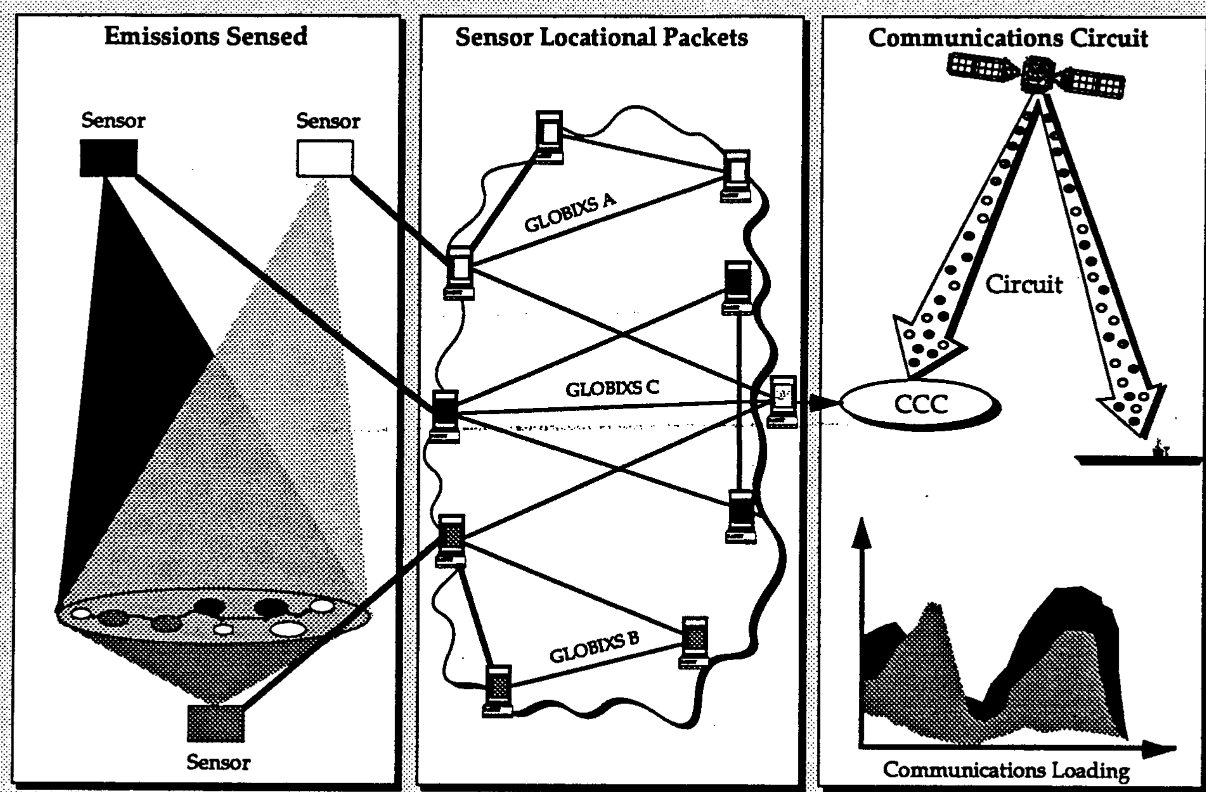


Figure 3-15. What is a TADIXS?

transmitted and received. That selection is made in accord with the Communications Support System Communications Resource Manager.

In the next chapter, we will discuss the nature and the requirements for the first Copernican pillar, the GLOBIXS.

CHAPTER 4
GLOBAL INFORMATION EXCHANGE SYSTEMS (GLOBIXS)

CONTENTS

BOXED TEXT

LIST OF FIGURES

CHAPTER 4
GLOBAL INFORMATION EXCHANGE SYSTEMS (GLOBIXS)

REFERENCES:

(a) DOD Directive 5200.28 (DOD AIS Security Program)
(b) SECNAVINST 5239.2 Navy AIS Security Program
(c) OPNAVINST 2800.3 (Data Communications Architecture)

SUMMARY

Global Information Exchange Systems (GLOBIXS) are virtual networks that link the commands and activities ashore to support the forces afloat. They are configured on a theater or worldwide basis and are constructed to transport, standardize, and concentrate shore-based sensor, analytic, command support, administrative, and other data for further passage to commanders afloat. GLOBIXS will use current and planned common-user communication systems, such as the evolving Defense Communication System (DCS), as vehicles for network communications.

GLOBIXS reflect the belief that the post-Cold War operating environment will be far more data-intensive and require far more technological agility in obtaining, handling, and transmitting data than during the Cold War. The development of modern communications backbones ashore over the last 10 years, both within industry and within the Department of Defense (DOD), has increased our national communications infrastructure by orders of magnitude. These modern systems enable subscribers to pass large volumes of data hundreds of times faster than the existing teletype circuits resident today in most Navy communications centers.

A second and equally critical development over the last 10 years has been the growth of small computers, both personal computers (PCs) and workstations. The computing power that put Apollo on the moon is now on the desks of American workers. The developmental trends in computing over the last decade have led to more clearly visible industry standards and to open systems architectures.

These two developments, the establishment of "information highways" and the movement towards open systems architectures, make possible the aggregation of many shore-based commands— both Navy and non-Navy into powerful networks of "communities of common interests." These virtual, shore-based nets, called GLOBIXS, are defined not by physical boundaries, but by DCS addresses and a common software "veneer." Thus, it becomes possible to construct a global Signals Intelligence (SIGINT) or a High Command net with little investment in communications infrastructure, using standardized hardware "engines," and, to make the conceptual leap from data to information via the software "veneer."

GLOBIXS will be constructed like interstate highways— they are limited-access, high-speed, and highly concentrated. Additionally, like interstate highways, they have connections among each other so that traffic may be shunted (as provided, by doctrine) across several GLOBIXS as well as to the operating forces through a consolidated Commander in Chief's (CINC) Command Complex (CCC), the second pillar of Copernicus.

As we saw in Chapter 3, in today's architecture, 33,000 commands ashore can send messages to sea at the whim and timing of the sender, not the receiver. The receiver— the operator— is thus inundated and robbed of critical communications capacity. Tomorrow, under Copernicus, GLOBIXS, intersected and managed through the CCC, will form a limited-access information system that can be controlled and configured by the operator, not the sender.

Through GLOBIXS, operational priorities can be set and managed by the operator using doctrine established to manage the system. One Composite Warfare Commander (CWC) may desire to be connected to one set of GLOBIXS nodes while another CWC may want to talk to a different set. Technologically, this is a matter of addressing. Doctrinally, this will be achieved through the development of a Naval Warfare Publication (NWP) for Copernicus management. Through the matrix of GLOBIXS information options introduced in the previous chapter, the CWC will select his CINC

Command Complex Watch and activate the GLOBIXS nodes he wants in the information cases desired to reflect the command and control decisions he has made for the mission.

The number and nature of GLOBIXS is intended to be dynamic, so the architecture can support the command structure over the next 5 decades, not merely the next 5 years. For example, some CINCs may desire to construct a logistics, weather, planning, and/or contingency GLOBIXS. Doing so simply means developing a software veneer for the common hardware "engines" envisioned as Copernicus building blocks. We also can envision temporary, contingency GLOBIXS as well as the major, standing GLOBIXS.

The eight standing GLOBIXS currently defined are joint both in character and by definition because they reflect the aggregation of communities of interest DOD-wide. Five of the eight GLOBIXS are operationally oriented and contain the major sensor and analytic nodes, both Navy and national; SIGINT GLOBIXS; Anti-Submarine Warfare (ASW) GLOBIXS; Space and Electronic Warfare (SEW) GLOBIXS; Imagery GLOBIXS; and Data base Management GLOBIXS. A sixth, the Command GLOBIXS, is a multi-media (e.g., video teleconferencing, voice, facsimile, narrative) net, connecting major commands (i.e., numbered fleets, Fleet Commander in Chiefs [FLTCINCs], component commanders, Joint Task Force [JTF] commanders, unified Commander in Chiefs [USCINCs]). The seventh and eighth standing GLOBIXS are primarily supportive in nature. The Research and Development Information Exchange System (RDIXS) ties together Navy research and development laboratories, weapons testing facilities, and other developmental entities for security and for information exchange. Navy Information Exchange System (NAVIXS), will be the Navy implementation of the Defense Message System (DMS). NAVIXS is the main textual data pathway for Navy, and until true multilevel security is achieved, will operate separately at the GENSER and Sensitive Compartmented Information (SCI) levels.

DISCUSSION

Global Information Exchange Systems (GLOBIXS) are virtual networks that link the commands and activities ashore in order to support the forces afloat. They are configured on a theater or worldwide basis and are constructed to transport, standardize, and concentrate shore-based sensor, analytic, command support, administrative and other data for further passage to commanders afloat. GLOBIXS will use current and planned common-user communication systems such as the evolving Defense Communication System (DCS) or FTS2000 depicted in (see fig. 4-1) as vehicles for network communication.

This chapter explains the operational need for GLOBIXS, how they are technically possible, defines the kinds of information functions and services to be transported, and defines the initial set of GLOBIXS now being considered in terms of their user communities and information functions and services.

OPERATIONAL NEED FOR GLOBIXS

GLOBIXS reflect the belief that the post-Cold War operating environment will be far more data-intensive and require far more technological agility in obtaining, handling, and transmitting data than during the Cold War.

The development of modern communications backbones ashore over the last 10 years, both within industry and within DOD, has increased our national communications infrastructure by orders of magnitude. The DCS will enable subscribers to pass large volumes of information many times faster than the existing teletype circuits resident today in most Navy

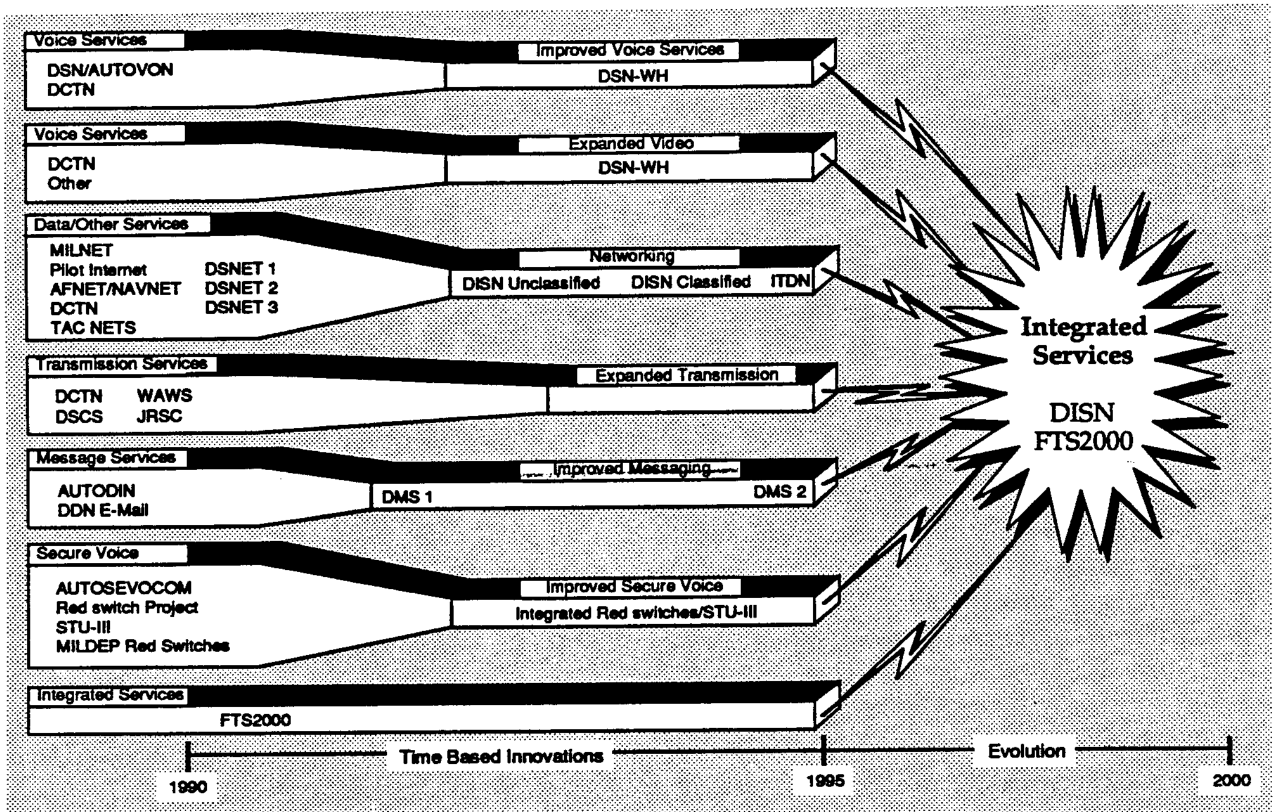


Figure 4-1. Bearer Services Evolution

communications centers. Moreover, the DCS is but one manifestation of an increasingly complex nationwide data infrastructure that will be as critical to American industry and Government for the next century as the physical infrastructure of roads, telephones, and power plants was in the last. Fiber optic cable, with the promise of massive data transfer, is circling the globe.

A second and equally critical development over the last 10 years has been the growth of small computers, both PCs and workstations. The computing power that made it possible for the Apollo program to put a man on the moon is now on the desks of the American workers. The developmental trends in computing over the last decade have led to more clearly visible industry standards and to open systems architectures (see accompanying boxed text 4-1 and boxed figure 4B-1.1), signalling relief to the necessity to invest in unique systems.

These two developments, the establishment of "information highways" and the movement towards open systems architectures, make possible the aggregation of many shore-based commands— both Navy and non-Navy into powerful networks of "communities of common interests." These virtual, shore-based nets, called GLOBIXS, are defined not by physical boundaries, but by DCS addresses and a common software "veneer." Thus, it becomes possible to construct a global Signals Intelligence (SIGINT) or a High Command net with little investment in communications infrastructure using standard-

Boxed Text 4-1: Open Systems Interconnection (OSI)

In the world of computers, protocols are vital to communications. They permit two systems that may have no other commonality to exchange ideas with a minimum of confusion and misinterpretation. The use of layered protocols does not automatically provide open systems interconnection. All computer network architectures designed since the 1960s are based on layered protocols, yet the problems of incompatible protocols still plagues industry.

Since a layered network architecture can only provide open systems when there are common definitions of the protocols at each layer, the first step toward making an open system possible is the definition of layers. In the area of international standards, the standard seven-layered network architecture is defined by the Open Systems Interconnection (OSI) Reference Model. The layering definitions provided by this model have been used as a framework for defining standard protocols that can be used to implement open systems networking.

The OSI Reference Model alone is not sufficient to provide general purpose connectivity. It defines only a framework for a layered architecture; it does not provide the protocol specifications necessary to implement a networking capability.

The Government Open Systems Interconnection Profile (GOSIP) (see boxed figure 4B-1.1) represents a profile based on available stable international standards. A profile specifies the exact protocols to be implemented, including features to be included, features not to be used, and the "correct" interpretation of ambiguities in the international standards. The GOSIP specification of protocols is based on agreements reached by vendors and users of computer networks participating in the National Institute of Standards and Technology (NIST) OSI Workshops. Approval for GOSIP was published in Federal Information Processing Standard (FIPS) Number 146 on 15 August 1988. GOSIP is to be used by all Federal Government agencies when acquiring computer network products, services, and communications systems. Implementation has been mandatory since August 1990.

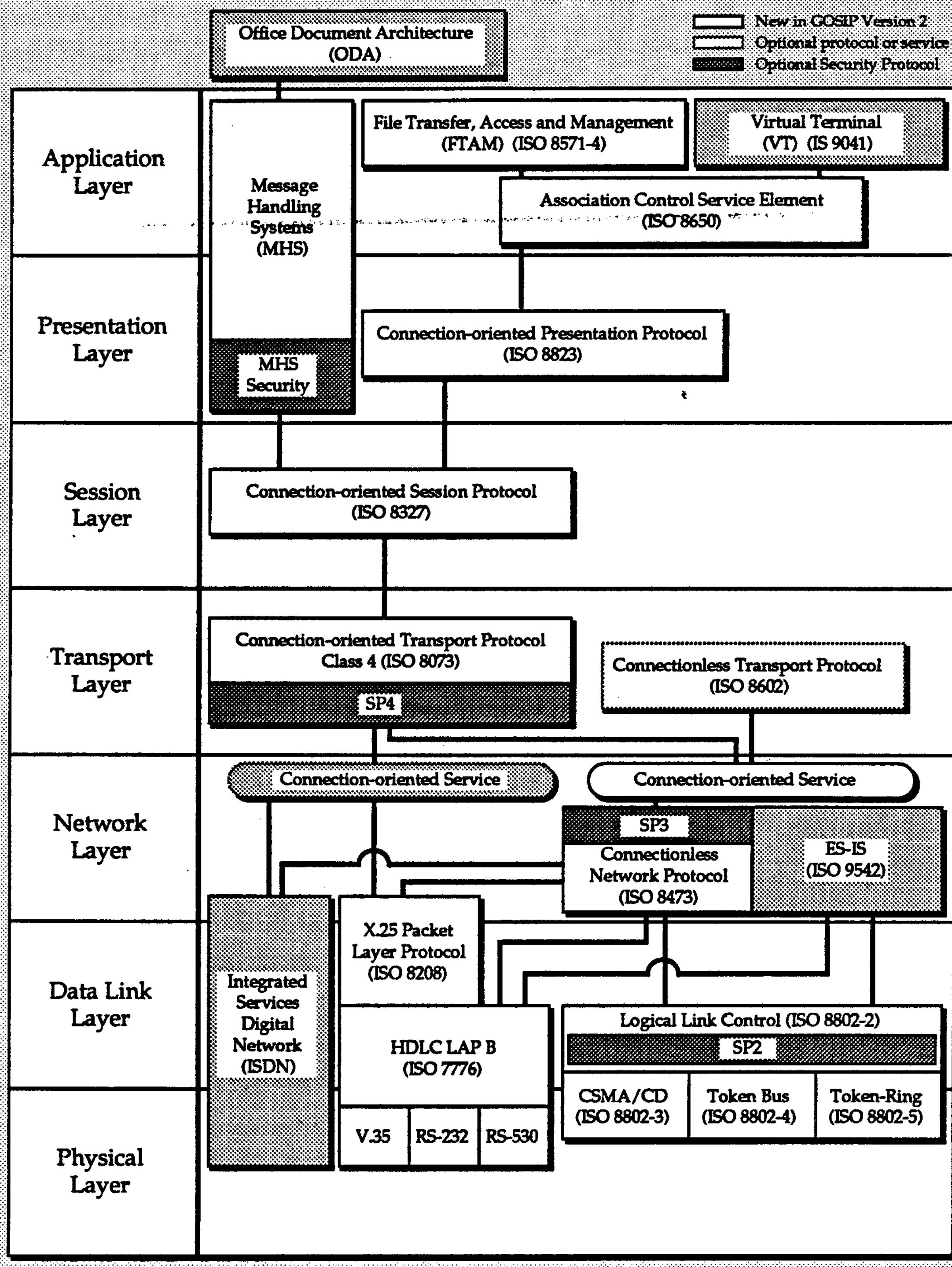
Widespread use of GOSIP will provide several important benefits:

- Lower hardware costs for distributed computer systems;
- Lower software development costs for network-related functions; and
- Lower training costs for support personnel and users.

The main features of GOSIP 1 were the ability to send and receive E-Mail using Message Handling System (MHS) X.400; and the ability to access and transfer files using File Transfer, Access, and Management (FTAM). For network technology, GOSIP supports the International Electrical, Electronics and Engineers (IEEE) Standard 802.3 (Ethernet) over baseband or broadband, 802.4 (Token Bus) over 10 mbps broadband or 5 mbps carrier band, 802.5 (Token Ring), and X.25 packet switching access. In addition, GOSIP specifies Connectionless Network Protocol (CLNP) to provide reliable end-to-end data paths between networks, allowing several LANs to operate together. GOSIP 2 added protocols for Virtual Terminal (VT) applications and the Integrated Services Digital Network (ISDN) protocols to support a wide range of voice and non-voice applications in one network. Future versions of GOSIP will include:

- FTAM expansion to incorporate more capabilities and document types;
- X.400-1988 MHS;
- Directory Services;
- Network Management;
- Transaction Processing (TP);
- Electronic Data Interchange (EDI);
- Intermediate System-to-Intermediate System (IS-IS);
- Transport Protocol Class 2 (TP2);
- Fiber Distributed Data Interface (FDDI) medium access control, Physical Layer protocol, and physical medium dependent; and
- Security protocols.

While GOSIP may be applicable to GLOBIXS, there are currently unresolved differences when GOSIP is applied to the tactical RF communications environment supporting voice and real-time tactical information networks.



Boxed Figure 4B-1.1. Framework for GOSIP

ized hardware "engines", and to make the conceptual leap from data to information via the software "veneer."

The intention is to allow the Commander in Chief U.S. Pacific Command (USCINCPAC) to tap into the Command GLOBIXS to communicate with the Commander in Chief U.S. Pacific Fleet (CINCPACFLT) whether the former is in Camp H.M. Smith or TAD in Australia. Moreover, such nets, through the GLOBIXS/TADIXS concept, allow a SIGINT analyst at the National Security Agency (NSA) to assist a SIGINT watchstander afloat without dedicating precious satellite communications capacity end-to-end as we must do today.

Thus, the first pillar of the Copernicus Architecture consists of the GLOBIXS— the ashore nets. The GLOBIXS will be a series of virtual sensor and analytic nets that will provide information management and information concentration by acting as the shore gateways for specific reports to sea.

GLOBIXS will be constructed like interstate highways— they are limited-access, high-speed, and highly concentrated. Additionally, like interstate highways, they have connections among each other so that traffic may be shunted (as provided by doctrine) across several GLOBIXS as well as to the operating forces through a consolidated CINC Command Complex (CCC), the second pillar of Copernicus.

As we saw in Chapter 2, in today's architecture, 33,000 commands ashore can send messages to sea at the whim and timing of the sender, not the receiver. The receiver— the operator— is thus inundated and robbed of critical communications capacity. Tomorrow, under Copernicus, GLOBIXS, intersected and managed through the CCC, will form a limited-access information system that can be controlled and configured by the operator, not the sender.

Through GLOBIXS, operational priorities can be set and managed through doctrine. One CWC at a particular time may desire to be connected to one set of GLOBIXS nodes while another CWC may want to talk to a different set. Technologically, this is a matter of addressing. Doctrinally, this will be achieved through the development of a Naval Warfare Publication (NWP) for Copernicus management. Through the matrix of GLOBIXS information options introduced in the previous chapter, the CWC will select his CCC Watch and activate the GLOBIXS nodes he wants in the information cases desired to reflect the command and control decisions he has made for the mission.

Of course, all commanders will require a certain core of information from shore-based analytic nodes and sensor sites. However, commanders who want large volumes of one type of data but not another or who want greater or lesser diversification of data among the CWC subordinates can tailor their information receipts from the GLOBIXS matrices accordingly.

In addition to providing for information management and concentration, GLOBIXS will reflect a dramatic change in information format. Most GLOBIXS will be characterized principally by voice, sensor location reports in digital format through "trans-sanitization" (see boxed text 4-2), video, imaging and data files, although OPNOTE traffic will be significant. NAVIXS, the Navy implementation of the DMS will carry traditional narrative messages.

The number and nature of GLOBIXS is intended to be dynamic, in order that the architecture may support the command structure over the next 5 decades, not merely the next 5 years. For example, some CINCs may desire to construct a logistics, weather, planning, and/or contingency GLOBIXS. Doing so simply means developing a software veneer for the common hardware "engines" envisioned as Copernicus building blocks. We can also envision temporary, contingency GLOBIXS as well as the major, standing GLOBIXS.

The eight standing GLOBIXS are joint both in character and by definition because they reflect the aggregation of communities of interest DOD-wide. Five of the eight GLOBIXS are operationally oriented and contain the major sensor and analytic nodes, both Navy and national. They are:

- Signals Intelligence (SIGINT) GLOBIXS;
- Anti-Submarine Warfare (ASW) GLOBIXS;
- Space and Electronic Warfare (SEW) GLOBIXS;
- Imagery GLOBIXS; and
- Data base Management GLOBIXS.

A sixth is a multimedia (e.g., video-teleconferencing, voice, facsimile, narrative) net, connecting major commands (i.e., numbered fleets, FLTCINCs, component commanders, JTF commanders, USCINCs):

- Command GLOBIXS

The seventh and eighth standing GLOBIXS primarily are supportive in nature. They include:

- RDIXS, ties together Navy laboratories, weapons testing facilities, and other developmental entities for security and for information exchange; and

- NAVIXS, as previously mentioned, is the Navy implementation of the DMS. Until true multi-level security is achieved, it will operate separately at the GENSER and SCI levels.

WHAT IS A GLOBIXS?

GLOBIXS can be best described in a layered concept, such as that shown in figure 4-2. We have characterized them already by mission, defining the eight currently proposed GLOBIXS above. In the remaining sections of the chapter, we will look at other characteristics of GLOBIXS, including the physical makeup of a GLOBIXS using the Command GLOBIXS as an example. We will then look at the subscribership and communications services to see how GLOBIXS can improve operations and examine their functions.

Boxed Text 4-2. "Trans-sanitization" and the Copernicus Common Format

Moving away from the message as an operational format is a critical requirement for all of the reasons discussed in Chapter 2 of this document. As a practical matter, we must move into our new architecture gradually over a Six Year Defense Plan (SYDP) (as a minimum) and be able to use as much of our existing hardware and software as possible until a full transition is completed.

Although the task sounds monumental, in reality, it is achievable. What is required is construction of a building block we call a "trans-sanitizer"[1] after its two functions: transliterating many existing character-oriented message formats into a common binary format (called the Copernicus common [COPCOM] format), and sanitizing the resultant binary message in such a way that it can be received over one communications pathway by several users who have different security accesses.

By placing the "trans-sanitizer", which is envisioned as a GOTS software package overlaid on the FASTT, between existing equipment both on the GLOBIXS end and the TADIXS end, the existing character messages can be transliterated into an efficient, and common, binary format. See accompanying figures 4B-2.1 and 4B-2.2.

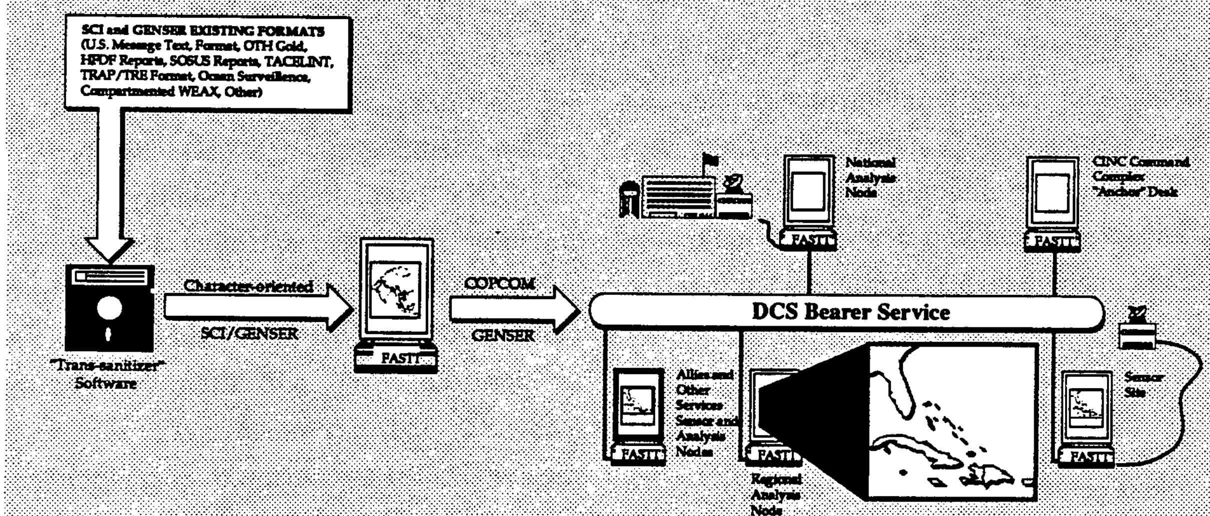
[1] One form of a "Trans-sanitizer" currently in development is RADIANT Mercury, developed under the auspices of Navy Tactical Exploitation of National Capabilities (TENCAP).

From an operational standpoint, COPCOM formats provide for the exchange of all locational data among all FASTTs, if desired, by using different "trans-sanitizer versions" in the FASTTs for different data recipients. Thus, while the data from the sensor gateway on DDN may be SCI, it can be read by consumers from SCI to non-SCI consumers on a GLOBIXS or TADIXS net. The implications are several:

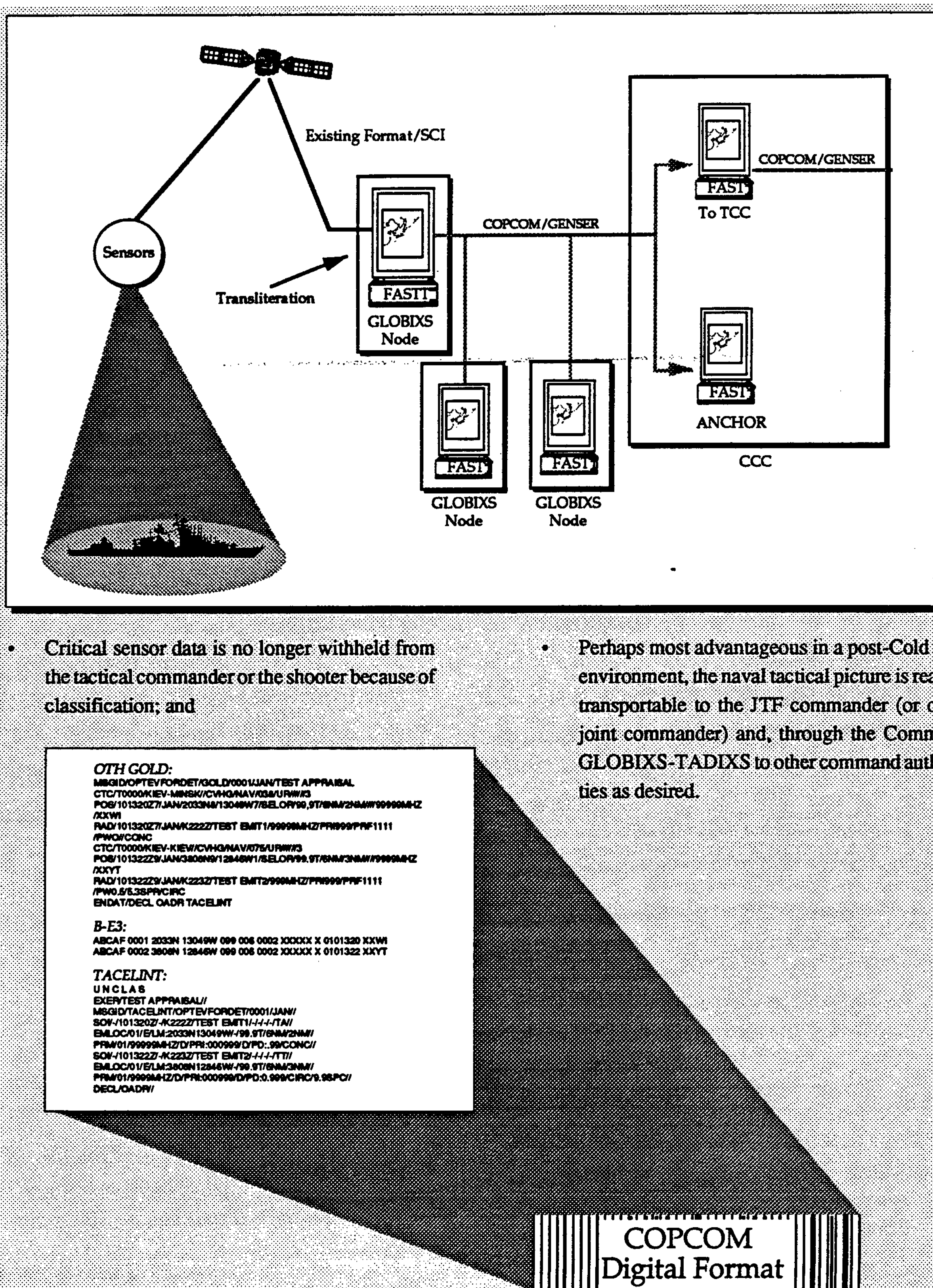
- Sensor data from any sensor, non-organic or organic, can be displayed alongside data from another sensor because all such data is in a common format;

- Because all sensor data is in the same format, contact reports become manageable. Each sensor datum is in the same format;

- Because data management becomes possible--that is, the sensor data acquired on the 2500 ships in the Mediterranean discussed in Chapter 2 yield a much more realistic number of contact reports--the delegation of warfare tasks achieved doctrinally of warfare tasks is achieved technology as well. The result is to greatly leverage the CWC delegation, which in turn will lead us to better tactics and better doctrine;



Boxed Figure 4B-2.1. Trans-sanitization



- Critical sensor data is no longer withheld from the tactical commander or the shooter because of classification; and

- Perhaps most advantageous in a post-Cold War environment, the naval tactical picture is readily transportable to the JTF commander (or other joint commander) and, through the Command GLOBIXS-TADIXS to other command authorities as desired.

Boxed Figure 4B-2.2. Sensor Report Trans-sanitization

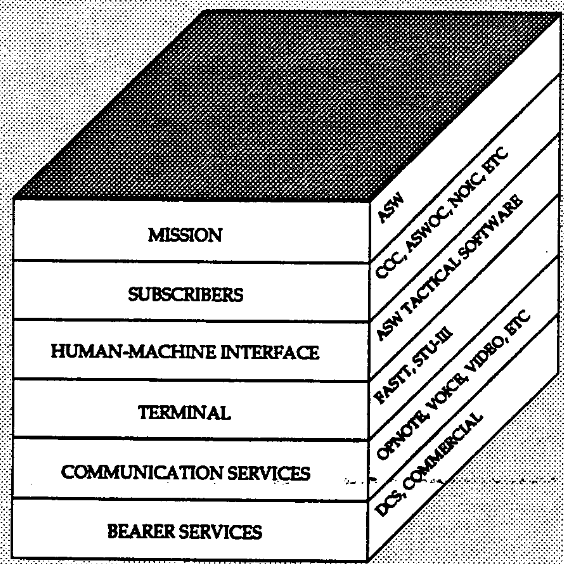


Figure 4-2. GLOBIXS Layered Concept

GLOBIXS BUILDING BLOCKS

The technological manifestation of GLOBIXS are derived from four types of Copernicus building blocks (see fig. 4-3) that will be discussed in considerable detail in chapter 8:

- Network services, which for GLOBIXS are imposed over both the DOD DCS and over commercial bearer services;
- Hardware, which will be finite in number. Most hardware building blocks for GLOBIXS exist today; however, selecting a standard building block from the many duplicative stove-pipe programs will be necessary (see chaps. 9 and 10);
- Operating systems, which will be commercial-off-the-shelf (COTS) in origin; and
- Software, which will largely be COTS; however, all software that is Government-unique will be written in Ada.

Using these four components, it is possible to construct a model of a less conceptual GLOBIXS and add it to the information product matrix (i.e., cases and formats of data) shown in Chapter 3 and repeated in figure 4-4. Of the eight GLOBIXS described, all are constructed identically; the difference among them will be subscribership and product. Using the Command Model, we will examine briefly the construction of a GLOBIXS. In the section following this, we will examine the purpose of a GLOBIXS to see what a GLOBIXS does.

THE COMMAND MODEL

Although the Command GLOBIXS interconnect the National Command Authorities (NCA) and the numbered fleet commanders[2], there likely will be split operational claimancy of the GLOBIXS among CINCLANTFLT, CINCPACFLT, and CINCUSNAVEUR along the existing theater lines[3]. Programmatic claimancy and architectural oversight will be assigned to the Naval Computers and Telecommunications Command (NCTC), who will interface with the Defense Communications Agency (DCA).

Command GLOBIXS Network Services

Subscribership on the GLOBIXS would vary by theater and reflect the CINCs direction.

[2] And, through the Command TADIXS, to the tactical commander.
[3] If Copernicus is adopted by the USCINCs, those commanders would be expected to be the Command GLOBIXS claimants.

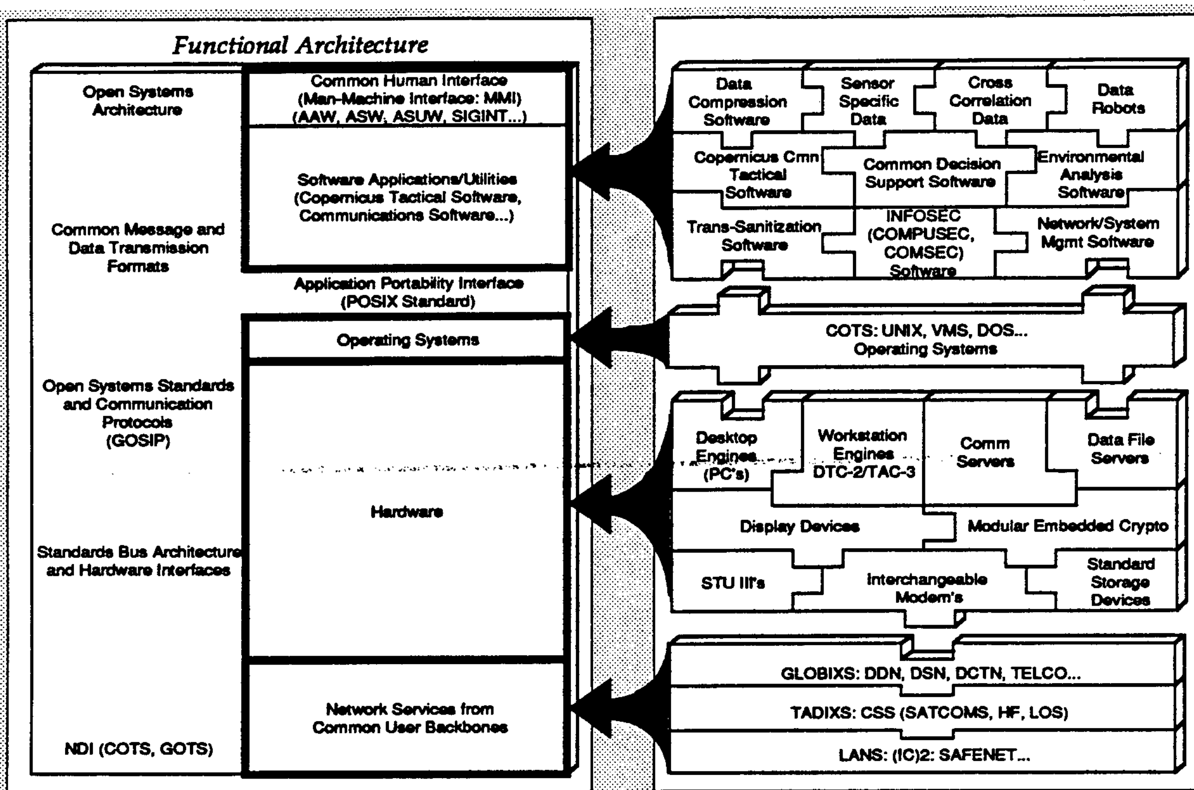


Figure 4-3. Copernicus Building Blocks

PRECEDENCE

	Voice	OPNOTE	MSG	Facsimile	COPCOM	Data Base File	Imagery	Video
CASE 1 (Immediate)[1]	V	OPN 1	MSG 1	N/A	COPCOM	DAT 1	IM 1	V
CASE 2 (Near -Immediate)[2]	O I C	OPN 2	MSG 2	Fc 2	COPCOM	DAT 2	IM 2	I D E
CASE 3 (Term)[3]	E	OPN 3	MSG 3	Fc 3	N/A	DAT 3	IM 3	O

FORMAT

[1]≤ 3 minutes
[2]≤ 15 minutes
[3]≤ 3 hours

Figure 4-4. Communications Services: Precedence and Format

The GLOBIXS command networks are intended to directly support the command authorities. Therefore, of the eight formats shown in figure 4-4, it is anticipated that those used by the Command GLOBIXS will be voice, OPNOTE, data files, imagery, and video teleconferencing. (Architecturally, all services can be made available, however.) Messaging also will be available on the Command terminals; however, such messages will be released and passed, not over the Command GLOBIXS, but through NAVIXS, and routed onto the Command terminals. Transmission path will be transparent to the user[4].

Bearer services for the GLOBIXS would be selected by Naval Computer and Telecommunications Command from those shown in figure 4-1, using cost, availability, suitability and other attributes for selection.

In this way, we can define the Command GLOBIXS model both in terms of subscribership and in information type, the latter of which is shown in figure 4-5. Thus, from the standpoint of the information network and communications services, the Command GLOBIXS is a network imposed over DCS (or commercial) bearer services that ties together the high command infrastructure ashore (and via the TADIXS, afloat) using immediate and near-immediate priority services: voice, OPNOTE, data files, imagery and videoteleconferencing.

Command GLOBIXS (From Figure 4-2)

- Voice
- Imagery 1 and 2
- OPN 1 and 2
- Video
- Data File 1 and 2

Figure 4-5. Command GLOBIXS Information

Command GLOBIXS Hardware

As we change perspective from network services to hardware, GLOBIXS construction remains straightforward. At each command node, the Command GLOBIXS "positions" would include a Secure Telephone Unit (STU-III) terminal and a FASTT, configured for videoteleconferencing. (However, it is recognized that some command nodes will utilize full videoteleconferencing studios, while others will need only the video-configured FASTT terminal.) A file server may be necessary at large command nodes to support the Command GLOBIXS. This server, however, will likely be a local area network (LAN) file server, not a distinct Command GLOBIXS server.

Moving from the command position to the bearer service, the position will be served by a communications processor, which may be a stand-alone processor or a card in the FASTT at small nodes.

[4] It is important to recognize this point: GLOBIXS are intended to decant information into layers. A command GLOBIXS terminal, while it will have the capability to create and receive traditional messages, is intended to place one commander in direct contact with another. A NAVIXS terminal, on the other hand, would be the normal position to send and receive messages. The use of the word "terminal" here is intended to convey a position-- that is, a second Fleet All-Source Tactical Terminal (FASTT), not a unique hardware and software engine for Command and another for NAVIXS.

Hardware from the processor to the bearer service will depend on that service as shown in figure 4-6. It is desirable ultimately that cryptography be embedded in the terminal.

Software Components

Software segments for the Command GLOBIXS will be modular, based on open systems standards. Figure 4-7 shows a FASTT terminal configured for the Command position. It represents the simplest case, one in which one position is used in the absence of a larger, more complex series of positions such as that envisioned in a large command center.

SENSOR GLOBIXS: WHAT ARE GLOBIXS FUNCTIONS?

The sensor GLOBIXS—SIGINT, ASW, Imagery, and SEW—are more complex technologically than the Command GLOBIXS, both in terms of type and quantity of information. Both for simplification and for classification purposes, we will discuss these GLOBIXS generally to describe their functions.

The sensor GLOBIXS will be composed of five types of subscribers, some of which are co-located, others of which are not (see fig. 4-8):

- Sensor nodes;
- Regional analytic nodes;
- Non-Navy nodes, including allied, that may fall into either category;

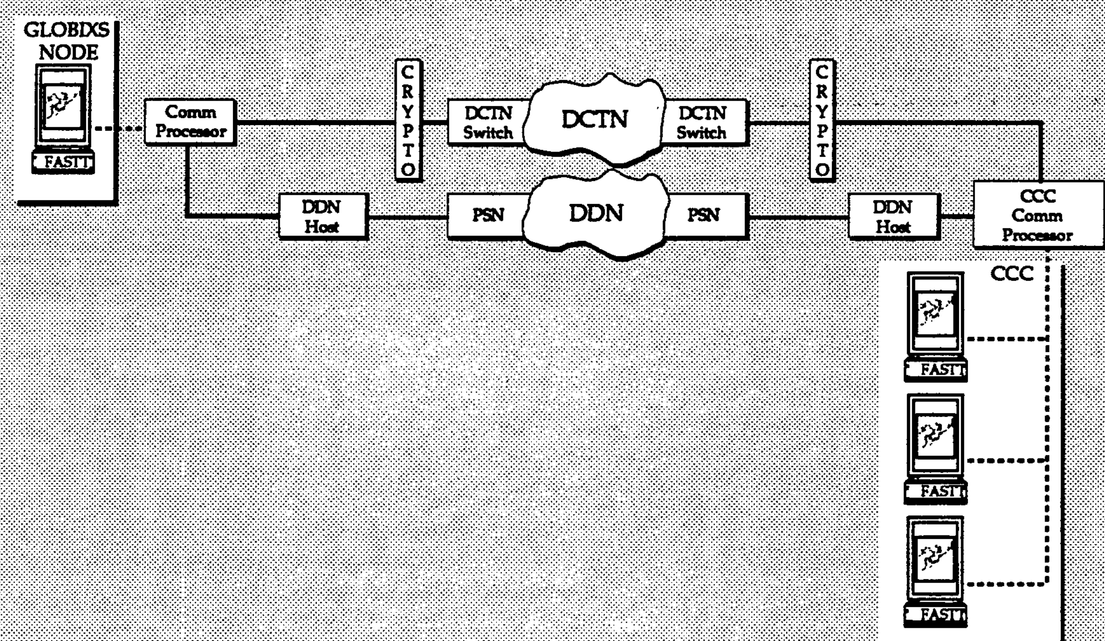


Figure 4-6. GLOBIXS Connectivity from NODE to CCC

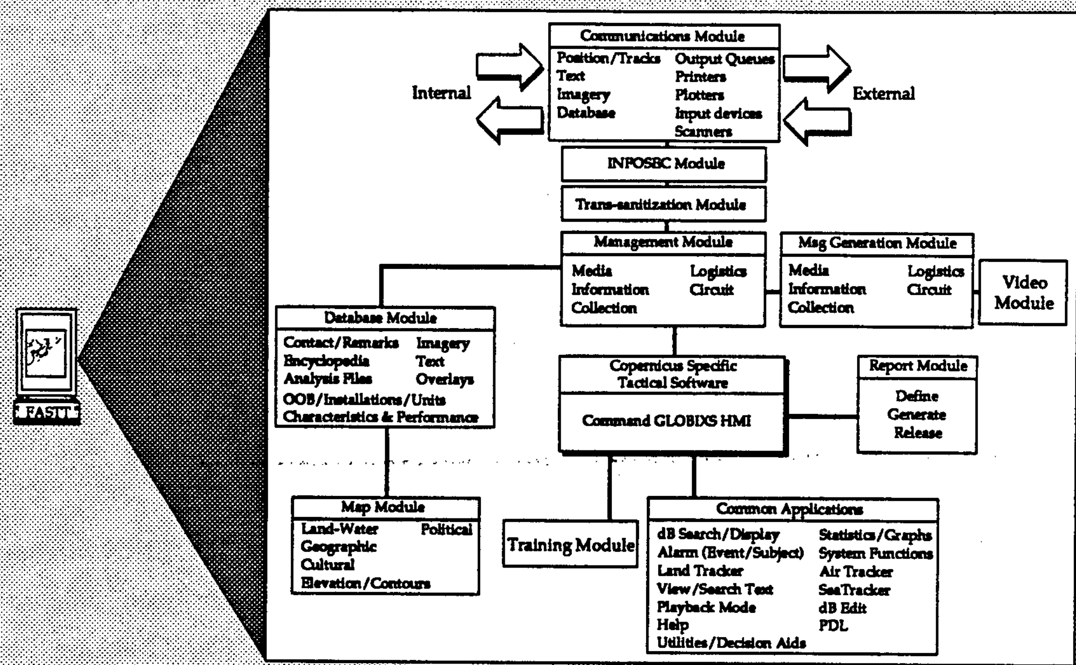


Figure 4-7. FASTT Functional Modules

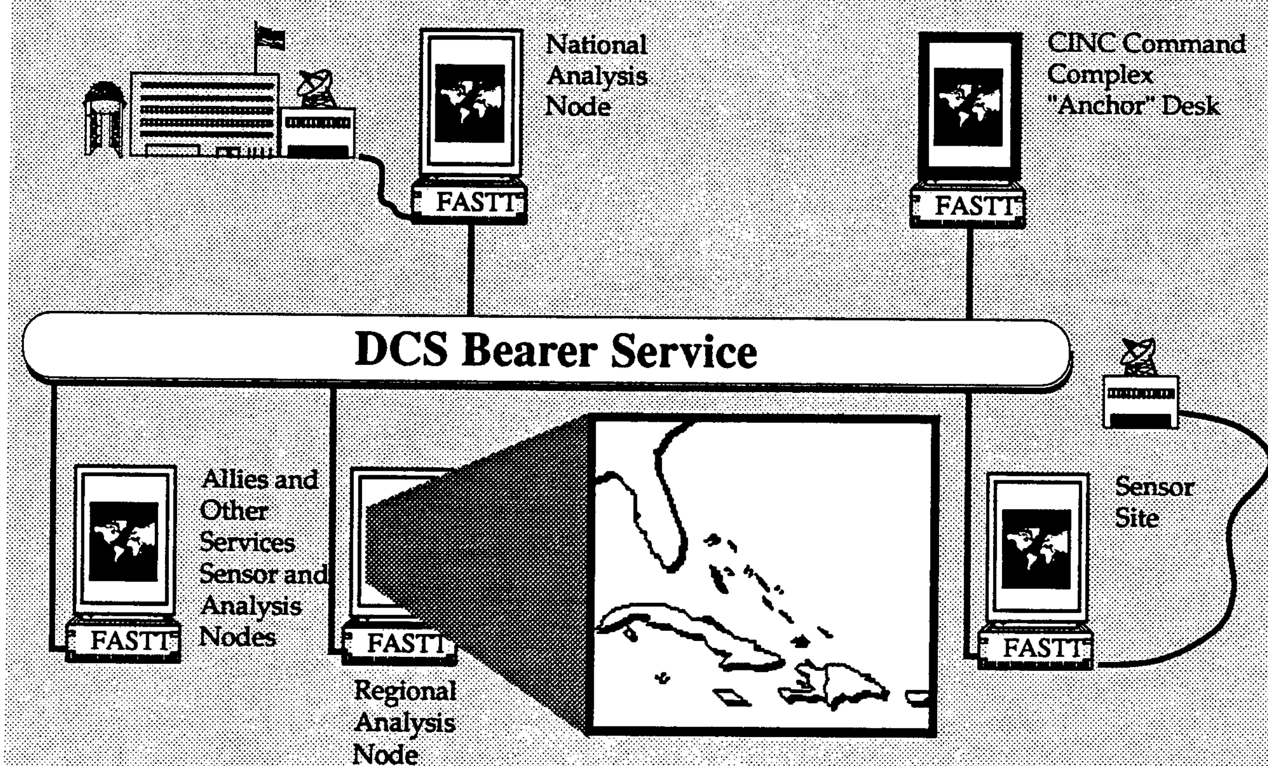


Figure 4-8. GLOBIXS Model

- Theater or national analytic nodes; and
- The "anchor" desk connected to the CCC MAN.

GLOBIXS Model Missions

The sensor GLOBIXS have distinct missions from those of the RDIXS, NAVIXS, Data base, and Command GLOBIXS. The sensor GLOBIXS provide locational and analytic data to the tactical commander and, importantly, except for the direct targeting TADIXS (which are not discussed in this document for classification purposes) are the sole gateway for that information to the commander. That is, as a matter of doctrine, sensor traffic will not be duplicated on NAVIXS and the SIGINT GLOBIXS, although architecturally for redundancy the CCC technically can shunt any traffic over any GLOBIXS if necessary. The functions of the SIGINT, ASW, Imagery, and SEW GLOBIXS will be:

- Within the warfare mission area, to provide the Navy shore-based analytic conduit from the CCC to the Navy and national sensors;
- Collection management through the CCC to maximize the national sensors for tactical use;
- From the sensor and other data inputs, to provide technical analytic experience and expertise within the mission area that is not available afloat;
- To develop and maintain historical and regional data bases and standardized modeling, analytic, and decision software tools;
- To provide an ashore intersection with the other Services, DOD agencies, and allies within the mission area; and
- To provide the CCC with a common formatted graphics and OPNOTE product via a standard analyst FASTT station with tailored software for each GLOBIXS.

The operations of the sensor GLOBIXS are:

- To collect input sensor or other data from the source[5];
- To analyze it for use within the mission area the GLOBIXS is designed to support; and
- To disseminate the data efficiently in a standard format to the CCC for dissemination to the fleet.

How the Sensor GLOBIXS Help

The construction of the sensor GLOBIXS improves current operations and information management several ways. First, they provide an organizational infrastructure with analysts and data bases to provide a structured handoff between Navy and other agencies, including the other Services, law enforcement agencies, and the allies.

Second, the technological base becomes standardized, as we saw in the Command GLOBIXS model above. The bearer services are common. End terminal equipment is centrally proscribed: STU-IIIs, standard secure facsimiles, and FASTTs.

Third, because of prescribed architecture, the technological base can be maintained

[5] Provided that the source does not already disseminate that data through the direct targeting TADIXS.

through Planned Incremental Modernization (PIM), a logistics approach to C4I hardware and software that provides for vendor replacement of components as they reach obsolescence (see chaps. 9 and 10).

Fourth, by prescribing the architecture *up-echelon*, the actual development of analytical tools, decision software, net and nodal composition can all be developed *down-echelon.* Such an approach has two distinct advantages:

- It provides for local innovation, which is critical to the development of flexible doctrine, and leverages the technological sophistication of Navy men and women today; and

- From a programmatic standpoint, it provides a buffer against the impending cutbacks risked by centralized procurement of end items. GLOBIXS subscribers need to be able to go to a "catalog" and order the standard end-terminal equipment to service the nets under a prescribed "blueprint."

Fifth, using FASTT as a host, we can also standardize software libraries associated with it (e.g., word processing, data bases, imagery processing, digital mapping, correlation algorithms), while allowing great innovation, both in Navy and, importantly, in industry, to continue in software library *applications* within a specific GLOBIXS. The use of FASTT with a veneer of application software puts an end to an era of end-to-end, vendor-unique systems.

Sixth, the GLOBIXS product and format going to the CCC can be standardized for multi-GLOBIXS fusion there and for correlation with the TADIXS product inbound to the CCC from sea.

Seventh, by using X-windows, the Copernicus Common sensor reports (COPCOM) (see boxed text 4-2), and an OPNOTE format like the Officer in Tactical Command Information Exchange System (OTCIXS) as the principal format between SIGINT, SEW, and ASW GLOBIXS nodes and the analogous "warfighting" TADIXS, we can at last move away from the formal naval message as the principal operational format. We are on the road to true digital information exchange instead of paper (or electronic) messages.

GLOBIXS DESCRIPTIONS AND ENGINEERING MODELS

This section provides brief descriptions of each GLOBIXS. Of the currently identified eight GLOBIXS, two SIGINT and ASW, are considered to be most closely structured in a manner that would allow for expeditious investment. For this reason, GLOBIXS A and B are presented here in greater detail to serve as engineering models. As discussed in Chapter 10, each of the GLOBIXS will be the subject of considerable effort over the next year to refine their structures and requirements as individual operational requirements. The definitions below are intended to provide the reader an overview of the GLOBIXS.

GLOBIXS A

Signals Intelligence (SIGINT)

GLOBIXS A supports shore-based signals intelligence operations. It will allow, as required, incorporation of allied inputs and links the Bullseye Net Control Outstations, the Classic Wizard Regional Reporting Centers, NSA Special Support Activity, the National Signals Operations Center, and other activities designated by Commander Naval Security Group Command and the FLTCINCs. Additionally, special data bases may be available through the DCS backbones, the Defense Special Security Communications System, and commercial means in addition to those available from the data base GLOBIXS[6]. Figure 4-9 shows proposed GLOBIXS responsibilities.

The GLOBIXS A CCC interface point will be the communications server, anchored by a desk on the CCC to be designated by the FLTCINC— perhaps an expanded Cryptologic Support Group (CSG) co-located in the Joint Intelligence Center (JIC). Data base support, as determined by the structure of the GLOBIXS, will be developed by regional analysis centers. The CCC will access the data base via the network to support the planning of specific operations.

Inputs in the form of existing multiple formatted messages (as determined by the various originators), will be transliterated into COPCOM, and information forwarded in "trans-sanitized" binary format beyond the CCC. This will be accomplished via one or more of the force operations TADIXS, as selected by the

[6] Of all the GLOBIXS, the data base GLOBIXS poses the most serious technical challenges. Multilevel security, Computer Security (COMPUSEC), and information robots– software routines that seek out information in remote data bases– are all difficult problems. It is anticipated that until the arrival of these capabilities, some GLOBIXS (e.g., the sensor GLOBIXS) will operate system high. Data bases for security reasons will probably reside on the sensor GLOBIXS early in implementation.

GLOBIXS	Purpose	Architectural Authority	Engineering	Claimant	Operational Authority
GLOBIXS A	SIGINT MGMT	CNO (OP-094)	COMSPAWARSYSCOM	COMNAVSECGRU	FLTCINC
GLOBIXS B	ASW MGMT	CNO (OP-094)	COMSPAWARSYSCOM	COMNAVCOMTELCOM	FLTCINC
GLOBIXS C	SEW MGMT	CNO (OP-094)	COMSPAWARSYSCOM	COMNAVSPACECOM	FLTCINC
GLOBIXS D	HICOM	CNO (OP-094)	COMSPAWARSYSCOM	COMNAVCOMTELCOM	FLTCINC
GLOBIXS E	IMAGERY MGMT	CNO (OP-094)	COMSPAWARSYSCOM	COMNAVINTCOM	FLTCINC
GLOBIXS F	DATABASE	CNO (OP-094)	COMSPAWARSYSCOM	COMNAVCOMTELCOM	FLTCINC
GLOBIXS G	RDIXS	CNO (OP-094)	COMSPAWARSYSCOM	COMSPAWARSYSCOM	FLTCINC
GLOBIXS H	NAVIXS	CNO (OP-094)	COMSPAWARSYSCOM	COMNAVCOMTELCOM	FLTCINC

Figure 4-9. Proposed GLOBIXS Responsibilities

tactical commander selects and as configured by the CCC.

GLOBIXS B
Anti-Submarine Warfare (ASW)

GLOBIXS B provides the ASW "communities of interest" with the capability to merge data from diverse tactical sensors and intelligence sources, to collect and assess that data, and then, to disseminate it. Transmission links include fiber optic systems, microwave, SATCOM, cable, and landlines when practical. GLOBIXS B will be structured in a manner that will lend itself to early implementation.

Like all the sensor GLOBIXS, subscribership to this GLOBIXS will include the five types of nodes presented above. ASW sensor input will include the Integrated Underwater Surveillance System, and TAGOS, as well as SEW and SIGINT information supplied through cross-connects at GLOBIXS nodes or at the CCC (see fig. 4-10). In early implementation, input data formats from sensor nodes will be in existing character-oriented messages and will require transliteration into the COPCOM format within the network. The Naval Computer and Telecommunications Area Master Stations (NCTAMS) (for TAGOS and SOSUS connectivity) will serve as communications gateways.

Examples of GLOBIXS B nodes will include the CCC ASW centers and the Regional ASW Command Centers; the ASW Operations Center; the Commander Oceanographic Systems, Atlantic and Pacific; the Naval Ocean Processing Facility; the Shore ASW Command Centers; and the Submarine Operations Command Centers. Each node will have the broad categories of communications services shown in figure 4-10.

As in GLOBIXS A, information from GLOBIXS B will be forwarded via the force operations TADIXS as they are configured for ASW purposes by the CCC.

GLOBIXS C: Space and Electronic Warfare

GLOBIXS C will provide focus for strategic and tactical SEW, and direct, near-real-time ocean surveillance information of airborne and space-borne targets. It will operate and develop tactical analytical tools to interface SEW TADIXS with GLOBIXS C. Connectivity between nodes will be via the DCS or commercial systems into the CCC communications server.

GLOBIXS D: Command

As we have seen, GLOBIXS D ties together the FLTCINCs, the numbered fleet commanders, the CCC, and designated joint and allied commands. War plans, operational orders, and related traffic will be promulgated via GLOBIXS D. The GLOBIXS D network will intersect with the World Wide Military Command and Control (WWMCCS) Intercomputer Network (WIN). Media services provided will

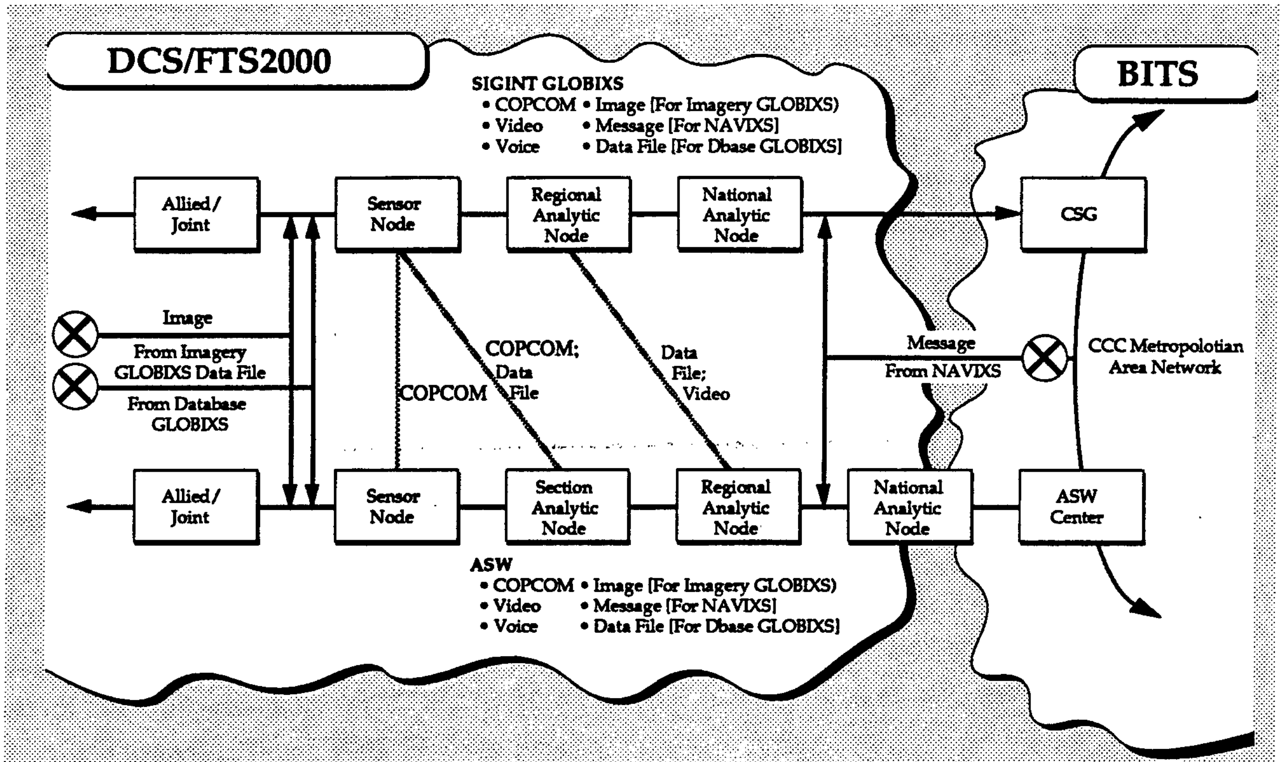


Figure 4-10. ASW, SIGINT GLOBIXS Interaction

include parallel voice, record, and video (teleconferencing and television). Format will be media-dependent. GLOBIXS D connectivity will be by the DCS or commercial service as required.

GLOBIXS E - Imagery

GLOBIXS E provides a means for controlled flow of imagery to and from the fleet in support of strike, amphibious, and other tactical operations. Potential nodes include the CCC, Defense Intelligence Agency, Naval Strike Warfare Center, NOIC, Cruise Missile Support Activities, and elements of other services. Access into the CCC is via a communications server on the CCC metropolitan area network (MAN). The imagery GLOBIXS anchor will be the JIC. GLOBIXS E connectivity will be via the DCS or commercial networks with format being a functional derivative of the sensor/originator.

GLOBIXS F: Data Base Management

GLOBIXS F provides a means to access data base files for their movement to and from sea. GLOBIXS F nodes may include the CCC anchors, JICs, Fleet Ocean System Intelligence Centers, Fleet Ocean System Intelligence Facilities, the Foreign Technology Directorate, Naval Technical Intelligence Center, DIA, CIA, NSA, Naval laboratories, war colleges, the SYSCOM community and others. GLOBIXS F will be anchored at a Research Center to be constructed as part of the CCC (see chap. 5).

GLOBIXS G: Research & Development Information Exchange System (RDIXS)

GLOBIXS G provides a secure means to exchange information within the research and development (R&D) communities and uses mode-appropriate cryptographic systems augmented by parallel STU-IIIs. GLOBIXS G nodes include CNO, the various SYSCOMs, Operational Test and Evaluation Force (OPTEVFOR), and the Navy laboratories and test ranges.

GLOBIXS H: Navy Information Exchange System (NAVIXS)

GLOBIXS H provides a pathway for the narrative messages. NAVIXS enables practical elimination of hard copy traffic with Navy administrative offices and has a data base scheme predicated on sender, receiver, Standard Subject Identification Codes, and text searches. Message originators will draft and release messages at their desktop for secure transport to the message recipients. On-line storage and update of Navy instructions as an aid to Computer Aided Logistics System and paper reduction is anticipated.

GLOBIXS H will be the Navy implementation of the DMS. Connectivity will primarily be via the DCS with the primary controlling nodes at the NCTAMS, where interfacing with the similar NAVIXS *TADIXS* will occur. GLOBIXS H is a "special case" where a linear communications/information flow does not transit the CCC in all instances. The responsible claimant for this GLOBIXS is COMNAVCOMTELCOM.

GLOBIXS I - (N + 1)

GLOBIXS I - (N + 1) is a generic definition of those GLOBIXS not presently addressed or "designed." They are future GLOBIXS that will satisfy unique requirements not available through the eight basic GLOBIXS previously defined. The GLOBIXS I - (N + 1) structural composition will conform to the pattern or schema established by the eight original GLOBIXS. The responsible claimants for each additional GLOBIXS will be determined by user requirements.

GROUPING GLOBIXS INTO COMMAND CENTERS AND NODES

All of the GLOBIXS, as we have seen, are carried over common bearer services, use common formats, and terminate in a common terminal, the FASTT. What, then, is a GLOBIXS node, and how are they combined to form a command center? In the next chapter we will examine the CCC. Before we do, however, let us see how GLOBIXS come together. Figure 4-11 shows a diagram of DCS or commercial bearer services connecting large command nodes. In this case, we have included the United Kingdom, Canada, Australia, and New Zealand command nodes as well.

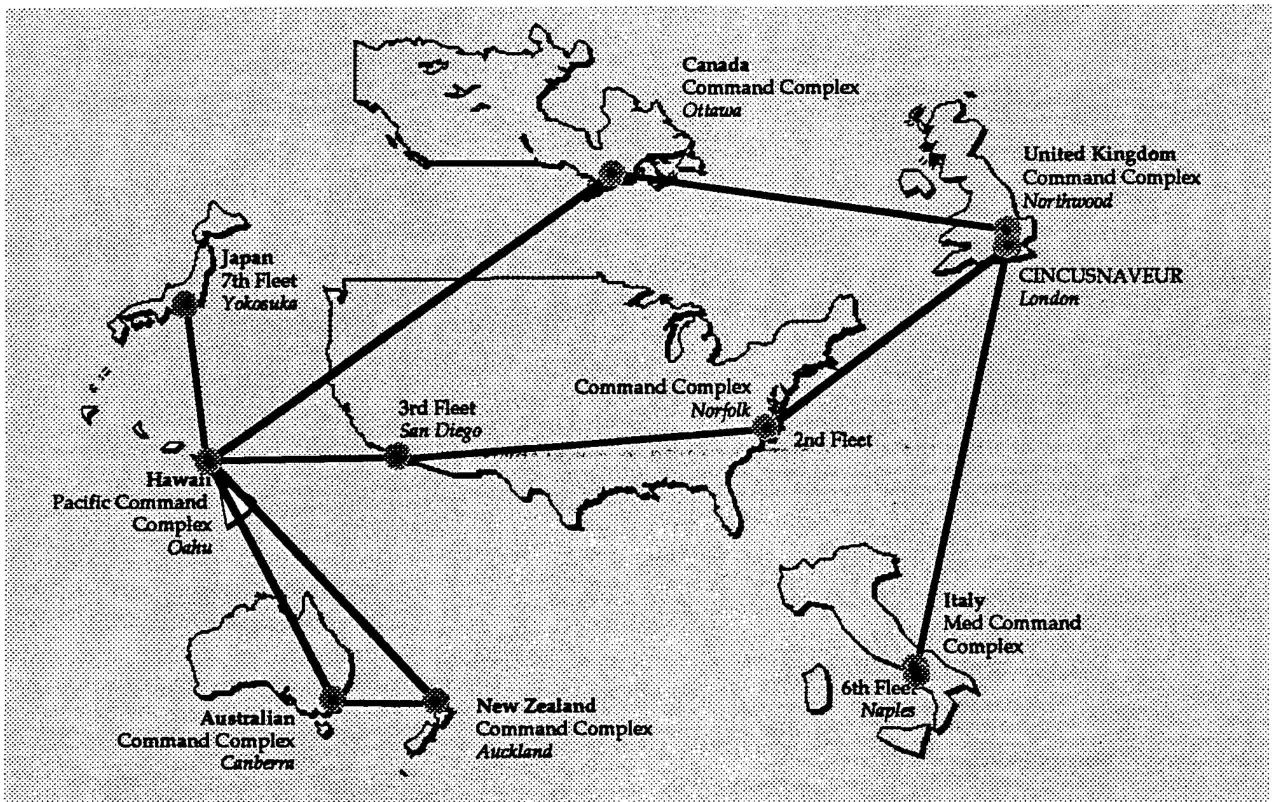


Figure 4-11. GLOBIXS Bearer Services Connectivity Among Command Centers

On the command center end, it is envisioned that the long-haul bearer services would terminate in a MAN such as the proposed Base Information Transfer System (BITS). Each of the command nodes indicated in the figure would implement such a MAN.

At the GLOBIXS node end, the termination would be a local area net, served by a Copernican building block communications and file server analogous to that on the MAN (see chap. 9). If we focus on one area, we will see that most of the five types of GLOBIXS nodes currently have access to the bearer services. What is necessary is to define the GLOBIXS networks on the existing bearer service connections. To do so, let us connect three nodes into the Norfolk area CCC, implemented through BITS.

Logically, the first sensor node, the Bullseye NCO, is connected to the CSG on the SIGINT GLOBIXS, exchanging voice, COPCOM reports, message, and data files, which appear on the SIGINT position end terminals (e.g., FASTT, secure telephone, message terminal). In Washington, the Naval Operational Intelligence Center (NOIC) is connected to the CCC ASW centers exchanging similar services over the ASW GLOBIXS. In Dahlgren, VA, Commander Naval Space Command (COMNAVSPACECOM) shares similar services logically with the SEW cell in the Norfolk CCC. See figure 4-12.

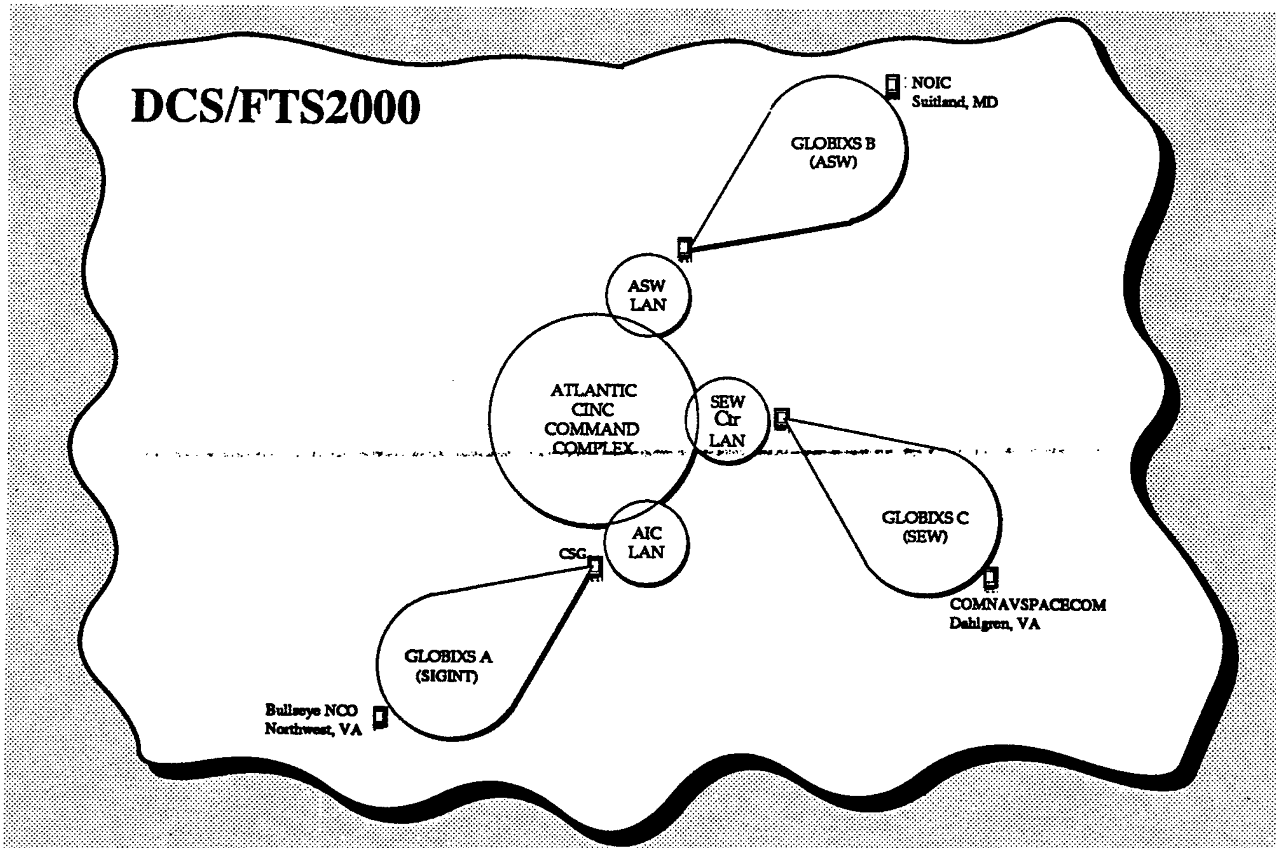


Figure 4-12. GLOBIXS (Logical) Connectivity Among Three Nodes and CCC

Physically, however, these services can be provided through any of the services shown in figure 4-1, provided the service is available at the node and CCC location. Figure 4-12 is redrawn to depict physical connections in figure 4-13.

Providing GLOBIXS services to a command center, then, simply means physical connection to the bearer service through the bearer service switch and the GLOBIXS communications processor to a FASTT terminal that hosts the GLOBIXS operational Human-Machine Interface (HMI). Extending that concept, then, a large command center serviced by several bearer services may subscribe to a number of GLOBIXS, the operators of which perhaps sit side by side on each watch. See figure 4-14.

In the next chapter, we will examine the functions of the second pillar of the architecture, the CCC.

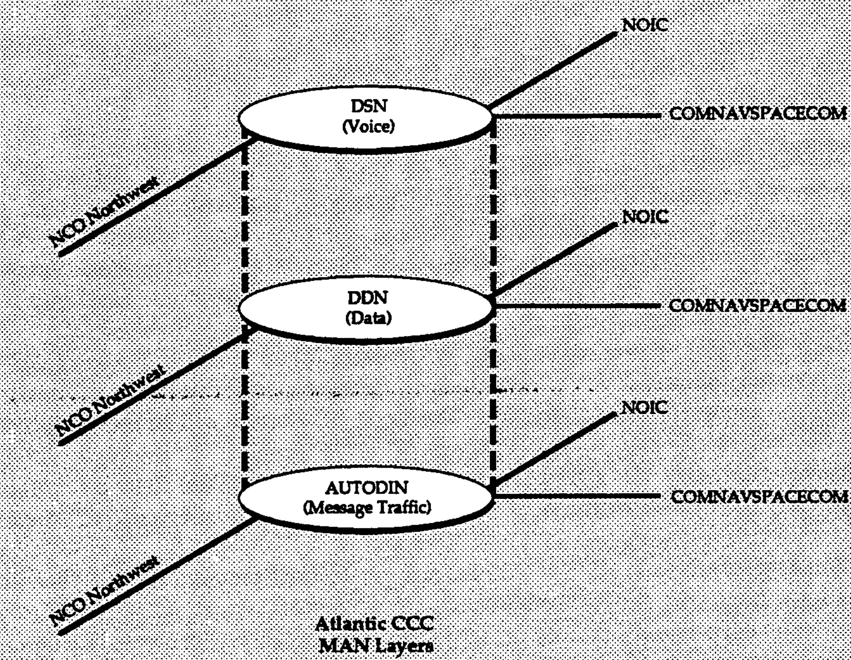


Figure 4-13. Near-Term Physical Connectivity Among Three Nodes to Atlantic CCC

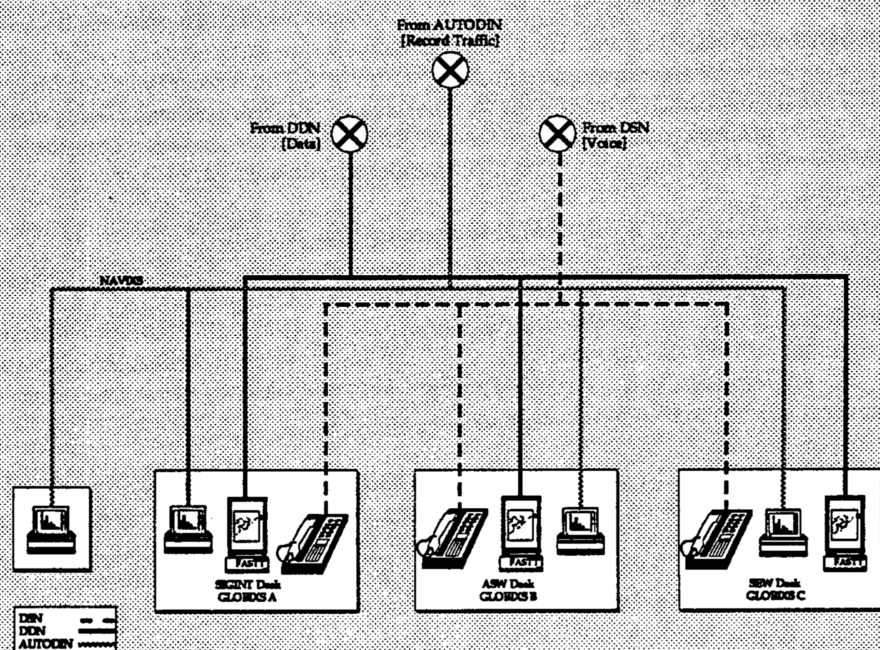


Figure 4-14. A Multi-GLOBIXS Command Node

RELATED PROGRAMS

Automatic Digital Network (AUTODIN): AUTODIN is a digital record traffic system operated as part of the DCS. AUTODIN traffic is transmitted via the Defense Switched Network (DSN) and provides world-wide connectivity to the U.S. unified and specified commands and to the Services. The AUTODIN system will be phased into the Defense Message System (DMS) by the year 2000.

Automated Network Control Center (ANCC): The ANCC is a shore-based, interactive, real-time system capable of facilitating the overall operation of technical control and data operation facilities by automating functions that are presently performed manually. It will support the Naval Computer and Telecommunications System (NCTS) and DCS technical control functions as well as provide interface capability for commercial and DOD transmission systems. The ANCC will serve as the hub for communications circuits passing through a shore-based communications station.

Base Information Transfer System (BITS): BITS defines the future structure of communications systems on Navy bases and stations. It is the integrated voice, data, image, message, and video communications architecture for intrabase communications and support of ships at pierside. The target architecture will be accomplished in 1996 and beyond.

Classic Lightning (Formerly Navy Key Distribution System (NKDS)): Classic Lightning is a system designed to transition cryptographic key distribution from a paper-based system to an automated electronic system.

Communication Support System (CSS): CSS is a communications program designed to enhance battle force communications connectivity, flexibility, and survivability through multimedia access and dynamic link sharing. It will permit users to share total network capacity on a priority demand basis in accordance with a specified communications plan.

Defense Commercial Telecommunication Network (DCTN): DCTN, a leased communications system, is a DCA operated telecommunications network that provides routine common-user switched voice, dedicated voice/data, and video teleconferencing services throughout the United States. It is a fully integrated digital system that uses a mix of satellite (TELSTAR 3) and terrestrial transmission paths. The DCTN contract terminates in 1996.

Defense Data Network (DDN): The DDN is a worldwide digital packet switched network, operated as a long-haul backbone transmission system by the DCA. It currently provides near-worldwide coverage in support of operational systems, including the World Wide Military Command and Control System (WWMCCS) and intelligence systems, as well as general purpose ADP and command-based data networks with long haul communications requirements. DDN uses packet-switching technology and currently consists of four separate networks operating at different security levels: MILNET (unclassified), DSNET 1 (secret), DSNET 2 (top secret), DSNET 3 (SCI). The three DSNETS are presently being merged into a DISNET that includes survivable links (through redundancy), and uses the X.25 protocol for network access, the X.400 for messaging, and the X.500 for directory services. Bulk encryption is accomplished with a BLACKER encryption system.

Defense Message System (DMS): DMS is a flexible X.400 based system that will provide a store and forward service via the use of a "Universal Mailbox" supporting the full range of information media. Today's DMS consists of the AUTODIN and DDN E-Mail. Over the next 3-4 years, E-Mail will migrate from the DOD Simple Mail Transfer Protocol (SMTP) to the Government Open System Interconnection Protocol (GOSIP) X.400. By 1995, a DMS implementation will begin phasing out AUTODIN by providing an X.400/X.500 based system on DDN that provides both the AUTODIN (organizational) and E-Mail (individual) grades of service. DMS will provide a secure desktop-to-desktop messaging system that will phase out AUTODIN and close most telecommunications centers by the year 2000.

Defense Switched Network (DSN): The DSN is the primary DOD telecommunications network and evolved from the existing AUTOVAN system. It will provide multi-level precedence and pre-emption for clear and secure voice) services in conjunction with the Red Switch and Secure Telephone Unit III (STU-III) projects of the Secure Voice System (SVS). Upon full implementation in the mid-1990s, the DSN will interconnect all U.S. military bases worldwide to provide terminal-to-terminal, long distance common user and dedicated telephone, data, teleconferencing, and video services.

Federal Telecommunications System (FTS) 2000: FTS2000 is a General Services Administration (GSA) managed digital telecommunications system utilizing leased capabilities for a government-wide network that will be interoperable with DSN and DCTN. It will provide switched voice, switched data, video transmission, packet-switched data, dedicated transmission service (voice to 1.544 Mbps), and switched integrated services using Integrated Services Digital Network (ISDN) or T-1 trunks. AT&T and U.S. Sprint are the FTS2000 contractors. Access to FTS2000 will be via dedicated lines from government locations called Service Delivery Points (SDPs).

Information Security (INFOSEC) Research, Development, Testing & Evaluation (RDT&E): A series of projects with INFOSEC and Computer Security (COMPUSEC) objectives, conducted in coordination with the National Security Agency (NSA) to provide open systems, end-to-end security processes (rather than hardware) that can be applied to numerous DOD programs. NSA/CSS is the certification authority for projects that are intended for near-term application in prototypes or operational systems and participates in projects that explore technology applications for attacking and/or protecting information systems. GLOBIXS networks will provide ample opportunity to use these technological solutions.

Integrated Tactical-Strategic Data Network (ITDN): ITDN is an architecture consisting of a multimedia, multisystem, multilevel security, integrated strategic and tactical packet-switched data communications network based on non-developmental technology that would support information transfer within the backbone data networks and over tactical networks.

Navy EHF SATCOM Program (NESP): NESP is the Navy portion of the Milstar satellite joint service program that focuses on a limited capacity, antijam, survivable, low probability intercept/low probability detection (LPI/LPD) communications system for strategic and tactical forces. The NESP AN/USC-38 terminal will be installed ashore and afloat on both surface and subsurface platforms. NESP will be compatible with the EHF portion of Fleet Satellites (FLTSATs) 7 and 8, UHF Follow-On (UFO) satellites 4-9, and all Milstar satellites.

Radiant Mercury: A program being developed by the Navy to provide two-way transliteration under which any bit-oriented or character-oriented format can be accepted, and any bit-oriented or character-oriented format can be generated. It also provides sanitization (under NSA certification oversight) that will permit information up to the level of Special Intelligence (SI) Top Secret to be "sanitized" to the level of General Service (GENSER) Secret.

CHAPTER 5
CINC COMMAND COMPLEX (CCC)

CONTENTS

LIST OF FIGURES

SUMMARY

The second pillar of the Copernicus Architecture is the CINC Command Complex (CCC). Although the organizational and doctrinal structure of the CCCs will be determined by the Fleet CINCs (FLTCINCs), the technological manifestation of the CCCs will be identical. It is currently planned to construct three complexes, one each in Oahu, HI; Norfolk, VA; and Naples, Italy.

The CCC, as envisioned in this architecture, would include a number of existing organizations brought together technologically by common workstations connected to a metropolitan area network (MAN) using common bearer services available in that area. Like the Global Information Exchange System (GLOBIXS), the CCC is a virtual network. The CCC MAN would provide the "information highway" over which GLOBIXS and Tactical Data Information Exchange System (TADIXS) data would travel, as well as that data generated at the CCC.

The CCC MAN would be connected to many local area networks (LANs) contained within the organizations that collectively make up the CCC. Recalling from Chapter 4 that the GLOBIXS terminate into the CCCs, and recognizing that the CCC is a MAN onto which any organization could (if permitted) join, the CCC should be viewed as an extremely flexible construct that could include the Navy; joint, non-Department of Defense (DOD) agencies; and allied organizations as desired by the CINC.

Significant differences exist, however, between a GLOBIXS, which is an aggregation of "communities of common interest," and the CCC, which is an aggregation of CINC command structures ashore.

As a result of that, and because theater focus in a post-Cold War world will likely be more divergent than the past, the CCCs undoubtedly will be configured somewhat differently in each theater. Moreover, it is conceivable that one theater may desire the unified CCC model, and another only the Navy implementation. Such differences, as long as the architectural standards are common, are inevitable and, indeed, desirable because they allow the commander— the center of this architecture's universe— the latitude to restructure his command and control when necessary over the course of several decades.

Through the CCC and Tactical Command Center (see chap. 7) interaction, the command and control processes of planning, assessing, observing, executing, and reporting are structured with respect to command level. Differences are evident in attributes: timeliness of processing, level of hierarchical view of the problem (global, theater, scene of action), and volumes of information stored, retrieved, and processed. A broad range of computational capabilities also are common across command levels: arithmetic, geometric, statistics/probabilities, and conversions. These and other types of commonalities suggest that at equal command levels, there will be a high degree of commonality in required systems functions. At other levels in the hierarchy, there is still a degree of commonality, but less than that found among equal levels.

These considerations become evident in the amount of redundancy in the requirements of the CCC and TCC. This suggests that a modular design for the CCC and TCC configurations is a rational approach. Common data base structures, dictionaries, and management techniques are possible, as are common application programs, display generators and displays, and communications interface and processing algorithms. These attributes of commonality and modularity, while allowing for unique applications tailored to warfare mission area and command level, are characteristics of the Copernicus concept.

DISCUSSION

The second pillar of the Copernicus Architecture is the CCC. Although the organizational and doctrinal structure of the CCCs will be up to the FLTCINCs, the technological manifestation of the CCCs will be identical[1]. It is currently planned to construct three complexes, one each in Oahu, HI; Norfolk, VA; and Naples, Italy.

The CCC as envisioned, would include a number of existing organizations brought together technologically by common workstations connected to a MAN using common bearer services available in that area. Like the GLOBIXS, the CCC will be a virtual network. The CCC MAN would provide the "information highway" over which GLOBIXS and TADIXS data would travel, as well as that data generated at the CCC.

The CCC MAN would be connected to many LANs contained within the organizations that collectively make up the CCC. Figure 5-1 shows a conceptual CCC connected to other MANs through the GLOBIXS. Recalling from Chapter 4 that the GLOBIXS terminate into the CCCs and recognizing that the CCC is a MAN onto which any organization could (if permitted) join, the CCC should be viewed as an extremely flexible construct that could include Navy; joint, non-DOD agencies; and allied organizations as desired by the CINC. Figure 5-2 shows a strawman PACFLT CCC connected to the other Services and USCINCPAC.

Significant differences exist, however, between a GLOBIXS, which is an aggregation of "communities of common interest," and the CCC, which is an aggregation of CINC command structures ashore.

As a result of that, and because theater focus in a post-Cold War world will be more divergent than the past, the CCCs undoubtedly will be configured somewhat differently in each theater. Moreover, it is conceivable that one theater may desire the unified CCC model, and another only the Navy implementation. Such differences, as long as the architectural standards are common, are inevitable and, indeed, desirable because they allow the successive commanders the latitude to restructure his command and control as he wishes over the course of several decades.

Moreover, the transition from component CINC to unified CINC, coupled with the potential changes in the number of unified commanders, portends a lengthy adjustment period for command centers ashore. As architects, we recognize the need to develop a CCC that can accommodate either design, and can do so, if necessary, differently on either coast. Doing so may mean developing the Navy CCC from the

[1] In this chapter, we will discuss the CINC Command Complex as a principally Navy infrastructure. However, we do so in the current absence of direction from DOD and the unified commanders to implement the architecture in a joint construct. Copernicus was intended from its conception to be a Joint architecture. At this writing the current FLTCINC structure is partially joint: that is, the intelligence centers have merged in the Joint Intelligence Center in the Pacific theater and the Atlantic Intelligence Center in that theater. We believe implementation of the CCC pillar will be evolutionary and will reflect the continuing trend toward unified command centers. The reader is asked to bear in mind that the Navy-only model discussed above is intended to be a subset of the eventual Unified CINC Command Complex.

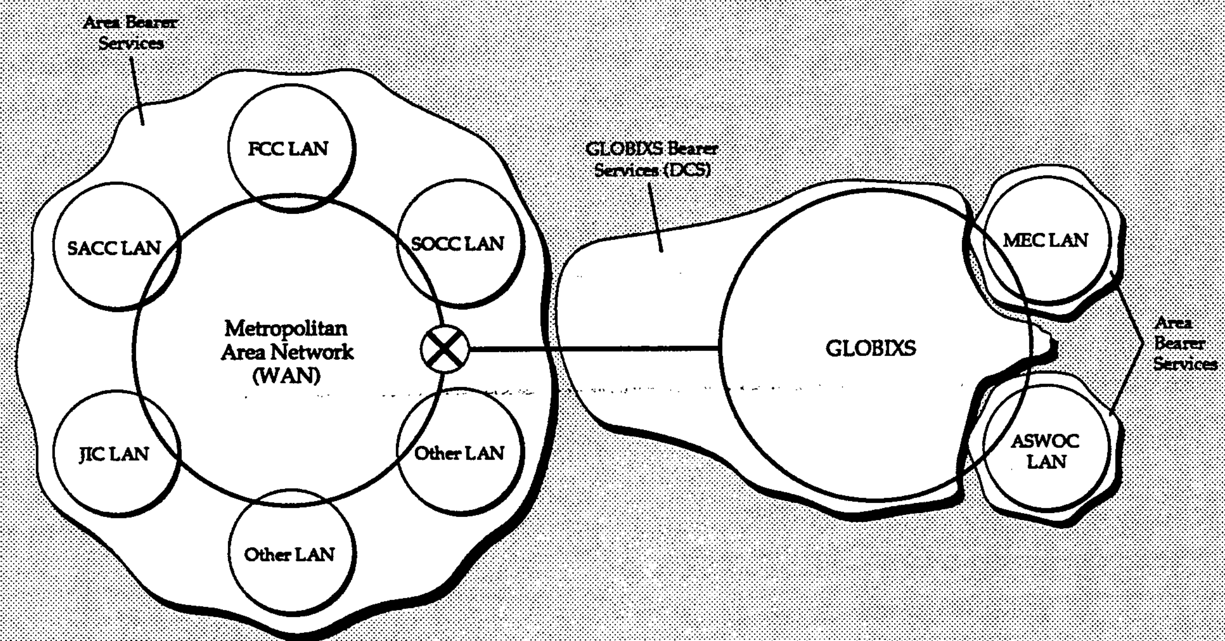


Figure 5-1. Conceptual CCC with GLOBIXS Intersection

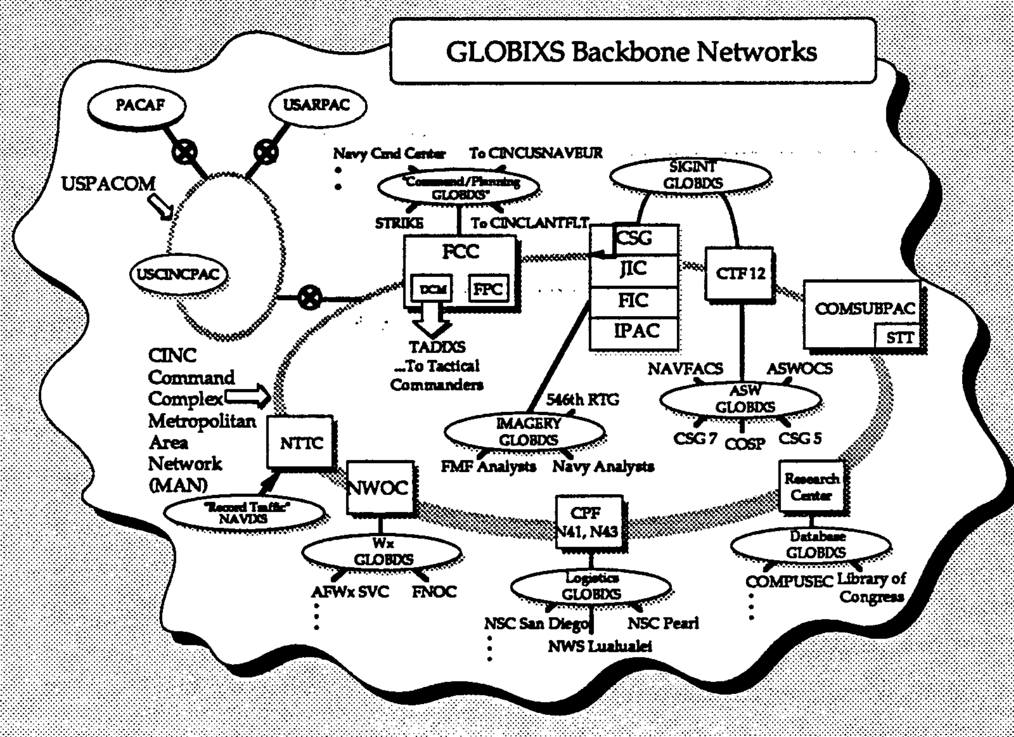


Figure 5-2. PACFLT Command Complex

start as a building block of a future unified CCC. In the event that the architecture is adopted for joint use, creating the unified CCC is simply a question of doctrine and connectivity. In practice, the architecture, with its already-joint GLOBIXS structure and its DOD-approved building blocks (e.g., DTC-II), may be seen as a de facto solution to unified commanders, and the development of the unified CCC will be an iterative process from the Navy structure.

Therefore, at this writing, the precise configuration of the Copernicus CCC in each theater is still under review by the FLTCINCs and OP-094, who responds to their requirements. It is important to realize, however, that while precise configuration remains in question, the fundamental building blocks of the CCC are not. It is, therefore, possible to describe CCC operations in some detail.

ORGANIZATIONAL BUILDING BLOCKS

There are six organizational building blocks envisioned to comprise the core of a Navy CCC.

First is the Fleet Command Center (FCC), which is discussed at length later in this chapter.

Second is a virtual "center", the operations watch center, which, perhaps, would be a subset of the CCC MAN rather than a physically co-located structure. The Operations Watch Center, like the GLOBIXS, would be selected by "toggling on" specific desks and would interactively connect with watchstanders from intelligence centers, the theater Anti-Submarine Warfare (ASW) Center, the Space and Electronic Warfare (SEW) Center, and the Research Center[2], as well as other watchstanders the CINC might desire to suit a particular mission (e.g., weather, logistics.) The Operations Center is best viewed as the gateway for the Composite Warfare Commander (CWC) into the shore GLOBIXS structure—a collection of GLOBIXS "anchor" desks and other personnel aggregated to suit the mission being executed.

The structure of the Operations Watch Center is variable and is achieved in a similar manner to the GLOBIXS "toggling" process presented in the previous chapter. Selected desks on the MAN would comprise it; some for one mission, others for a second mission. The Operations Watch Center would provide tailored support to the tactical commander afloat[3] and manage the flow of information in accordance with the CWC's command and control plan, selected from a future Naval Warfare Publication (NWP) matrix that would describe Copernicus GLOBIXS-TADIXS configurations.

The Operations Watch Center is the heart of the architecture ashore and will be connected, as will be the GLOBIXS, via the CCC MAN to the other organizations that make up the CINC Complex.

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[2] See discussion pg 5-5.

[3] Or JTF, or component command in the unified CCC construct.

A third core organization, the SEW Center would have the responsibility for strategic and theater-level SEW, including operational deception (OPDEC) and operational security (OPSEC.) As the doctrine of SEW develops, this may be constructed as a single center connected to all three CCCs or a series of three smaller organizations located near the CINCs themselves[4].

Fourth, the Research Center, a modern day electronic library, eventually will be needed to provide a data-retrieval capability for the CCC through the data base GLOBIXS. The Research Center also would house the file servers and common data bases for the CCC MAN.

Fifth is the Joint Intelligence Center (JIC)[5], which has the following Navy components:

- The Fleet Intelligence Center (FIC) would provide an interface with the imagery GLOBIXS and the imagery TADIXS;
- The Fleet Ocean Surveillance Intelligence Center (FOSIC) would provide operational intelligence (OPINTEL) for both maritime and overland operations; and
- The Cryptologic Support Group (CSG) would provide the interface between SIGINT GLOBIXS subscribers ashore and the corresponding TADIXS afloat.

[4] The SEW center described above is currently under active discussion among the FLTCINCs, OPNAV, and the usual fleet comanders. In addition to the functions listed, the SEW center is also envisioned to incorporate the CSS GLOBIXS/ TADIXS interface. See chap 6.

[5] For simplicity, we will refer to the JIC in the remainder of this document, intending by that term to mean both

Finally, the ASW centers in the CCC would similarly interface with the ASW GLOBIXS and the ASW TADIXS.

CCC AND TCC COMMONALITIES

The Copernican CCC will serve as the centralized command and control, communications and computers and intelligence (C^4I) center for implementation of the missions assigned to the CINC. It supports the commander by processing, displaying, and disseminating organic and non-organic information (including national and theater sensor information) to provide a clear picture of operations within the theater. This information is the basis for plans of action and force direction decisions.

Through the interaction of the CCC and the TCC, the command and control processes of planning, assessing, observing, executing, and reporting are structured with respect to command level. Differences are evident in attributes: timeliness of processing, level of hierarchical view of the problem (e.g., global, theater, scene of action), and volumes of information stored, retrieved, and processed. A broad range of computational capabilities are also common across command levels: arithmetic, geometric, statistics/probabilities, and conversions, for example. These and other types of commonalities suggest that, at equal command levels, there will be a high degree of commonality in required system functions. At other levels in the hierarchy, there is still a degree of commonality, but less than that found among equal levels.

These considerations become evident in the amount of redundancy in the requirements of the CCC and TCC and suggests a modular design for the CCC and TCC configurations is a rational approach. Common data base structures, dictionaries, and management techniques are possible, as are common application programs, display generators and displays, and communications interface and processing algorithms. These attributes of commonality and modularity, while allowing for unique applications tailored to warfare mission area and command level, are characteristics of the Copernicus concept.

In addition to the six core organizations above, the CCC, as a Copernican pillar, will also include a number of general and special purpose command cells that are integral to the CINC's exercise of command and control. These centers may be located within a relatively small radius of the CINCs principal command center or at some distance from the CINC area. They may also be conceivably shared by all CINCs, connected to all three MANs.

Each center will be served by a computer-based system meeting its particular mission needs and the Copernicus architectural standards (see chap. 8). The Copernicus goal is to connect these "centers" doctrinally and technologically into a cohesive organization.

Within all CCC centers, a local area network connects computer-based systems and system components. The local area network provides gateways to a larger (metropolitan area) network that connects the centers and also provides gateways to afloat (TADIXS) through the Communications Support System (CSS) and to shore GLOBIXS networks.

Through the CCC, the Copernicus objective is to provide to the CINCs and subordinate commanders a flexible set of system capabilities that support tactical and strategic command functions and responsibilities as well as a second, and interrelated, set of system capabilities that aid in developing products that support the command functions (e.g., intelligence, weather, surveillance).

OPERATIONAL CCC MODEL

As a means to the CCC end goal, the exploitation of common functional areas can be achieved by unbinding the development programs and converging the various command and support functions under a common program umbrella. The discussion that follows focuses on a subset of CCC command and command support centers and builds a partial, operational model of a future Navy CCC. The model uses an over-the-horizon-targeting (OTH-T) mission as operational context and assigns missions notionally[6].

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[6] In the model that follows, mission responsibilities and CCC Centers should be seen as notational. References are here only to illustrate a hypotherical future CCC capability.

The Fleet Command Center (FCC)

In the operational CCC OTH-T model, the FCCs support the FLTCINCs in the exercise of their responsibilities as naval component commanders. FCC functional interfaces are shown in figure 5-3. The FCCs would support the FLTCINCs to:

- Implement theater USCINCs' directives and policies;
- Allocate combat ready, logistically sustainable, tactical naval, naval air, and United States Marine Corps (USMC) forces to joint commanders as directed by unified commanders;
- Prepare, evaluate, promulgate and supervise plans, orders, and tactical decisions;
- Allocate/reallocate assigned resources;
- Schedule employment of forces;
- Assess and predict tactical situations and fleet readiness;
- Support miscellaneous command support activities such as: transit planning; search and rescue operations; and civilian catastrophe relief; and
- Support the reconstruction and evaluation of completed actions/exercises.

In the OTH-T mission example, the CINC through the FCC would:

- Assign the mission to subordinate forces;
- Allocate resources (e.g., ships, aircraft, submarines, weapons, fuel, communications);

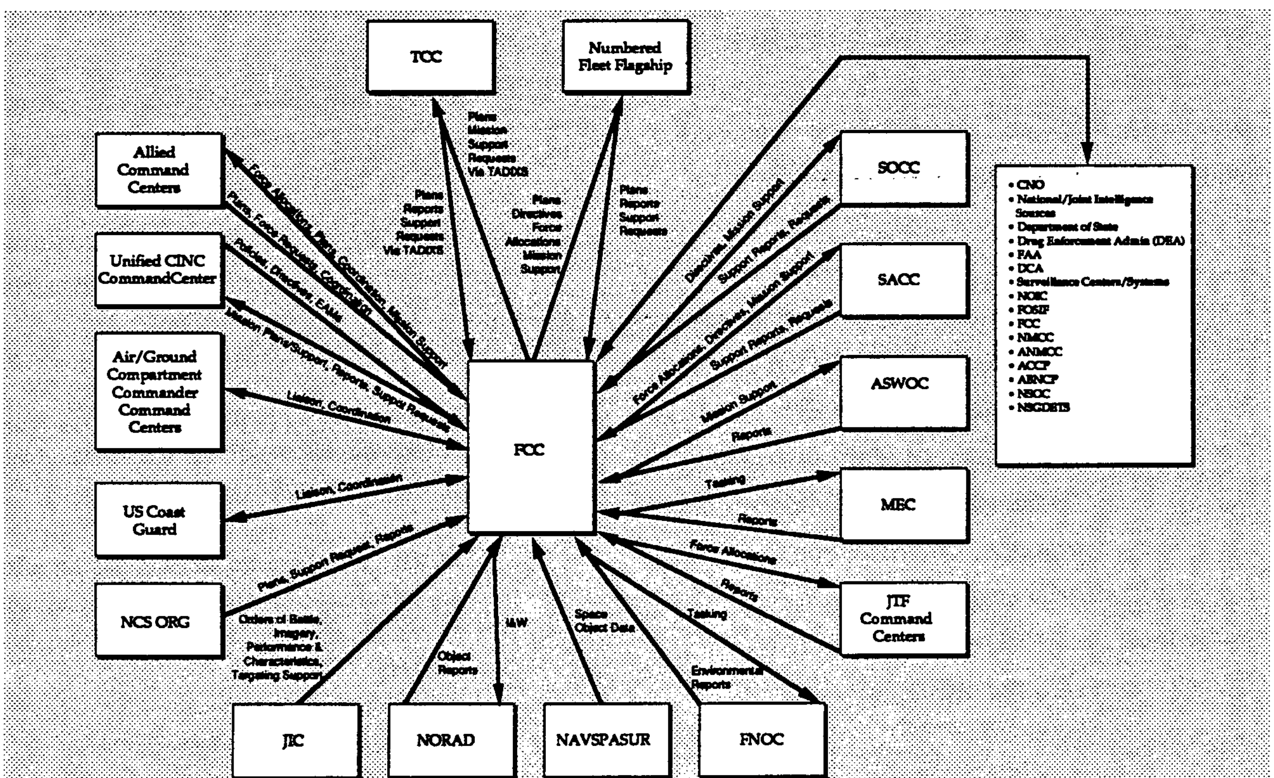


Figure 5-3. FCC Functional Interfaces

- Monitor execution of the mission;
- Keep higher echelon authorities advised of mission status (along with status of all FLTCINC missions and forces); and
- Modify mission objectives and constraints as necessary to meet changing national and theater directives.

To perform these functions, FCC personnel must provide mission direction to subordinate forces. Mission direction may be provided as a file transfer or a directive message stating policy. Information transfers will be Case 2 or 3 data, depending on mission urgency (see chap. 3).

FCCs must manage resources at the theater level through use of Case 2 and 3 file transfer. In many cases, information transfers will be among FCC subordinates within the LAN or MAN. In other cases (for example, exchanging information with fuel management activities), software bridges will be required to support query/response and file transfers.

One resource to be managed will be communications. As noted in connection with related programs, the CSS software veneer and human-machine interface (HMI) will be used to manage communications. In addition to managing U.S. Navy resources, FCC would coordinate with other component commanders and with supporting CINCs (e.g., to assure flow of required munitions and repair parts by CINC U.S. Transportation Command).

To monitor mission execution, the FCC could receive Case 1, 2, and 3 track data (in Copernicus Common format) from subordinate forces and prepare summary reports (as Case 2 and 3 file transfers) for higher echelons. Case 2 OPNOTES will support analyst-to-analyst exchanges at all levels over both GLOBIXS and TADIXS. The FCC is expected to be the "anchor" for the Command GLOBIXS.

Mission modifications may be in the form of Case 2 or 3 file transfers (e.g., modifying a "no-attack" zone in which target surface ships may not be engaged, for example) or as messages over Navy Information Exchange System (NAVIXS), if necessary, stating new constraints (e.g., revised rules of engagement).

The Submarine Operations Control Center (SOCC)

Submarine Operations Control Centers (SOCCs) in Pearl Harbor, Norfolk, and Naples are part of the Pacific, Atlantic, and Naples CCCs, respectively. SOCC interfaces are shown in figure 5-4. These centers support submarine force and submarine group commanders to:

- Plan, train, and act as the USCINCs' executive agent for command and control of strategic submarines;
- Plan, train, and exercise command and control of independent operating tactical submarines and submarine rescue surface and deep submergence platforms;
- Plan, train, coordinate and ensure the safety of tactical submarines operating with other naval forces;

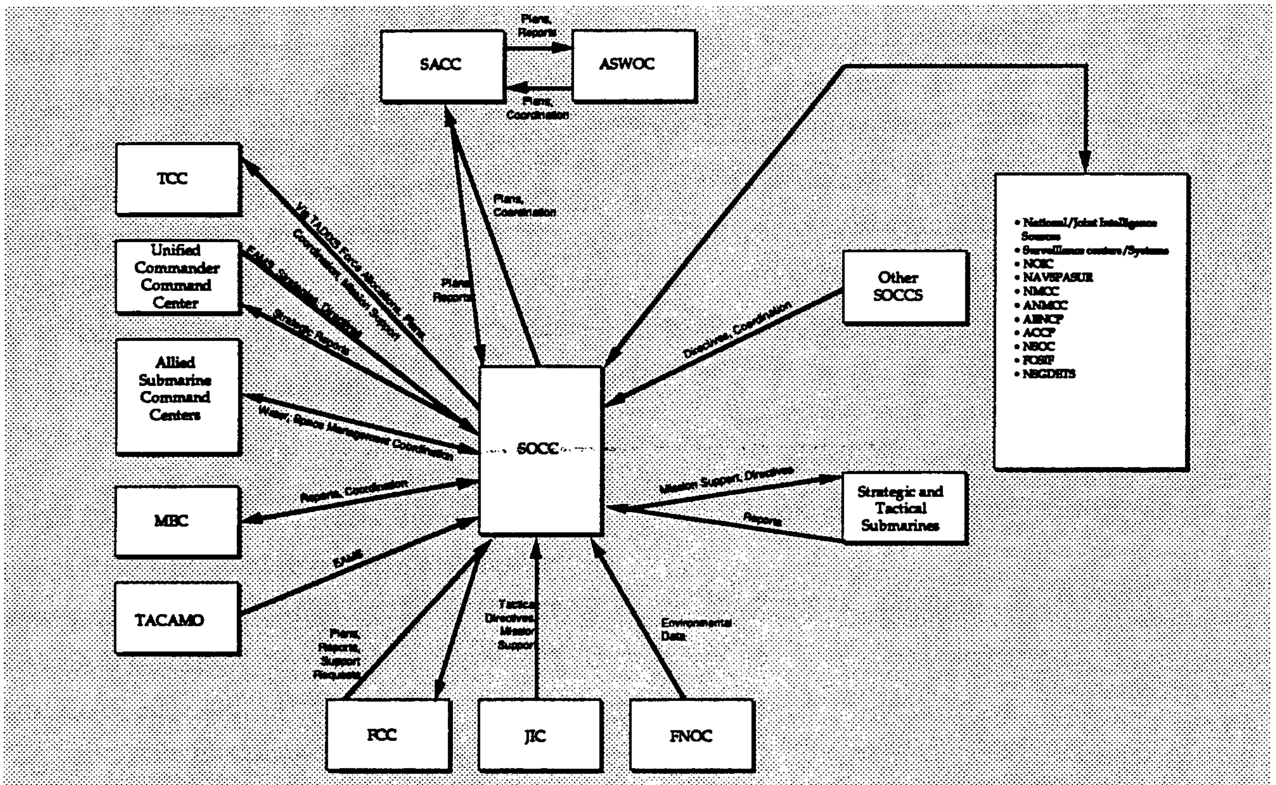


Figure 5-4. SOCC Functional Interfaces

- Conduct post-exercise/mission reconstruction and analysis;
- Exercise water space management in coordination with FLTCINC's area/sector ASW commanders and bilateral force commanders;
- Maintain direct liaison with area/sector ASW commanders for antisubmarine warfare operations;
- Prepare, operate, and manage submarine broadcasts and ship-shore links; and
- Direct submarine search and rescue operations and coordinate employment of submarines in other search and rescue operations.

The SOCCs would report to the FCC or the unified CINC command center as appropriate and communicate as a peer with other subordinate nodes. In the OTH-T mission context, SOCC operates U.S. submarine forces in offensive and defensive roles. The SOCC is one of the subordinates that could receive OTH-T mission tasking and must coordinate with peer command nodes to execute the tasking.

SOCC would provide a strong information management capability for submarine forces. Due to the unique nature of submarine communications, information must be reviewed and filtered at SOCC before being transmitted to the submarine force. In the single case of submarine support, therefore, even Case 1 data may experience some delay. The principal format of information transfer will be Copernicus Common sensor reports and other file transfers.

Exchange of information with the SOCC provides a good example of security requirements. The SOCC must provide timely and accurate information concerning submarine force units, but information must be disclosed only to persons with proper clearance and need-to-know. CCC information handling doctrine must provide effective protection without delaying information flow.

Shore ASW Command Centers (SACC)

Shore ASW Command Centers (SACCs) (and subordinate nodes: Regional ASW Command Center [RACC], Main Evaluation Center [MEC], and ASW Operations Center [ASWOC]), would exercise command and control over assigned ASW forces. Shore ASW Command Centers are located in Makalapa, Norfolk, Kami Seya, and Naples. SACC functional interfaces are shown in figure 5-5. These facilities would exercise control primarily over maritime patrol aircraft (MPA) and Integrated Undersea Surveillance System (IUSS) units; however, surface ships and other units may also be assigned via the appropriate task group commander.

In the OTH-T mission, the SACC and subordinate nodes will be tasked with specific operational support roles. This tasking would probably include reconnaissance and ASW defense of surface OTH-T units. The SACC must coordinate with the SOCC and with allied ASW forces.

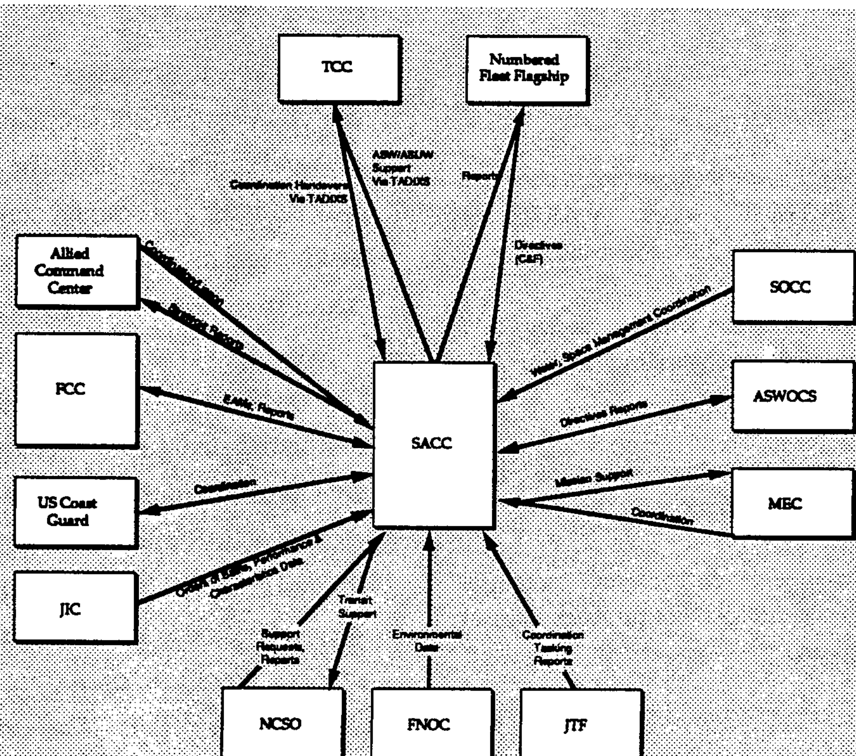


Figure 5-5. SACC Functional Interfaces

The SACC could set doctrine for how Case 1, 2, and 3 data flows to and among subordinate units. Naval Oceanographic Processing Facilities (NOPF), for example, may exchange OTH-T-related information through a special, unique GLOBIXS managed by the Surveillance Direction System (SDS) under doctrinal guidance provided by SACC. Case 1 data will, however, flow directly from a NOPF to fleet units through CCC without delay. Other Case data would probably not flow directly to the fleet unless ASW became an important threat to the accomplishment of this OTH-T mission. Figure 5-6 shows a notional GLOBIXS to CCC connectivity.

Main Evaluation Centers (MEC)

MECs would process acoustic information received from multiple facilities to locate, identify, and track submarines. That information can be correlated with other submarine intelligence sources to produce threat submarine location and predicted movements and/or identity by hull or class. The product can be disseminated to FCC, SOCC, SACC, and ASWOC users. At the FCC, the MEC product would be correlated with other ocean surveillance information. In this OTH-T mission, MEC data can make a secondary contribution to mission accomplishment.

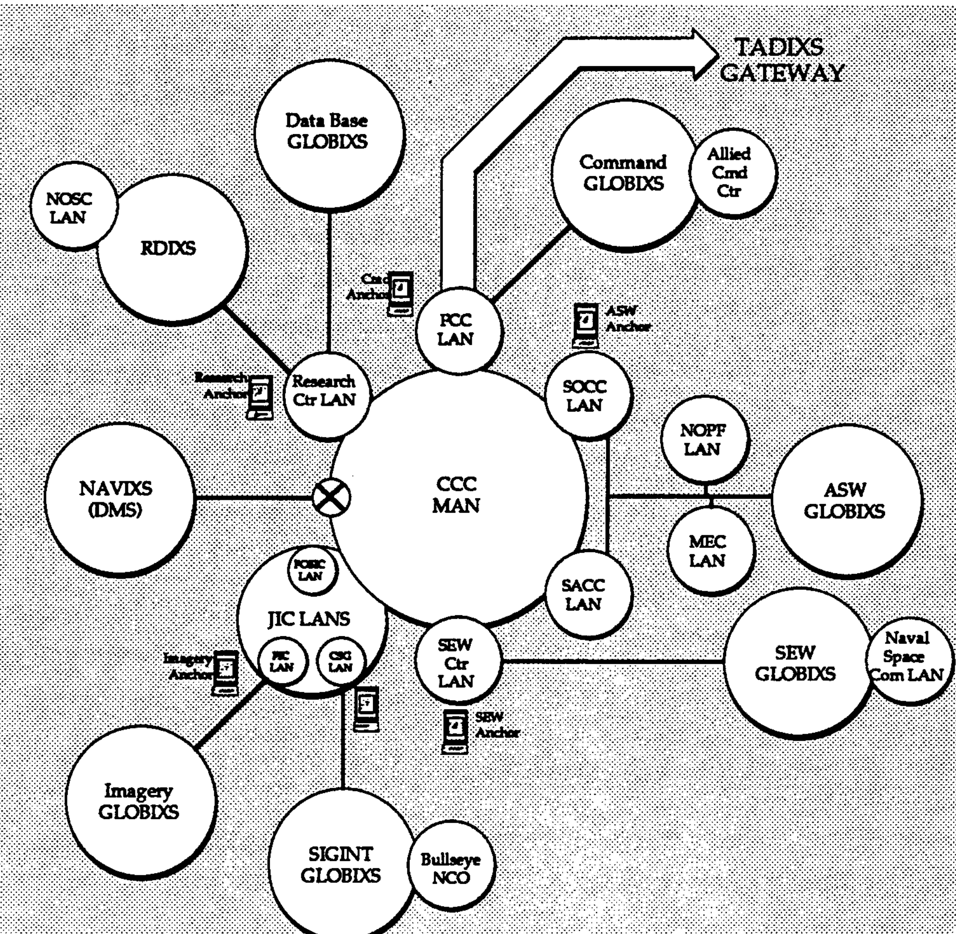


Figure 5-6. Notional GLOBIXS to CCC Connections with Services GLOBIXS and CCC Nodes

FLEET NUMERICAL OCEANOGRAPHIC CENTER (FNOC)

The FNOC would provide natural environmental data (current and forecast status) for periodic and tailored reporting. Periodic reporting and tailored reporting are in response to requirements of commanders.

OTH-T mission environmental support focuses on two areas: 1) support for aviation operations (manned and unmanned) and 2) support for reconnaissance. Almost all of this information is Case 2 data, provided by file transfer on an environmental (i.e., support) TADIXS. Forces afloat also provide environmental information to assist in predictions. This information is sent by file transfer on an environmental TADIXS from ship to shore.

Joint Intelligence Centers (JIC)

JICs produce threat orders of battle, characteristics and performance data, general and tailored intelligence estimates, threat submarine locations/characteristics, imagery interpretation, and targeting support. These products are disseminated to national, fleet, and joint users. These centers combine with the FOSICs and are augmented with joint personnel to become the JIC (Pacific) and the Atlantic Intelligence Center (AIC).

In the OTH-T mission context, contributions of the JIC are of great importance. For Strike Warfare operations, JIC order of battle information (Case 1 and 2 data, provided by file transfer) is vital to mission planning and battle damage assessment (BDA.) For Anti-Surface Warfare, JIC technical data base information (also Case 1 and 2 data, provided by file transfer) would help to assure the correct ship is targeted and that appropriate C4I Counter Measures (e.g., jamming and radiation suppression munitions) would be provided to the strike package.

Similarly, JIC requires updates of information from forces afloat. This information may be Case 1 through Case 3 and may be provided by imagery or file transfer.

Naval Control of Shipping Organizations (NCSO)

The NCSOs would generate convoy compositions, assembly plans, route plans, dispersal plans, and convoy protection plans. These plans are implemented by the NCSO when the use of convoys of merchant shipping is directed by the Joint Chiefs of Staff. Convoy progress is monitored to ascertain needs for rerouting and/or additional protection against air, surface, or submarine attacks. In the OTH-T mission context, information from NCSO is used by appropriate elements to prevent inadvertent attack on friendly or neutral shipping.

OPERATIONAL MODEL CCC

The critical functions discussed in the previous pages were derived from an examination of user functions, current systems capabilities, and system interface requirements. They lead to four subsystem categories in an operational model:

- Information dissemination;
- Information processing;
- Briefing and display; and
- Facilities.

Information Dissemination Subsystem

The information dissemination subsystem would connect the information processing, briefing and display, and communication equipment within a command center and among command centers. It would interface with networks to connect geographically dispersed centers. LANs, MANs, and GLOBIXS networks could provide these connectivities and manage network information flows. The subsystem will provide all requisite communication system interoperability, compatibility, adaptability, security, reconfigurability, system management, and security. It could function in secure voice, imagery, data, and video modes.

Information Processing Subsystem

The information processing subsystem would provide a single, integrated capability for users to access all processing resources based on their requirements and authorized data/application program accesses. Each user could access all applications through a "single window" (or successor) environment that provides a consistent interface to all applications.

An open system architecture maintains the flexibility needed to accommodate changing requirements and to ensure continuing interoperability. The following capabilities are needed in the information processing subsystem:

- External data interfaces with all terminating networks and dedicated links;
- Internal data interfaces with existing and evolving systems;
- Data protocol compatibility with external systems;
- Automated message handling;
- Multilevel security (i.e., secure handling of information at multiple levels of classification without compromise of information confidentiality or integrity);
- LANs to permit authorized sharing of intra- and inter- command center data, applications, and various terminal devices;
- Standardized user interfaces across all applications and decision aids;
- Office automation;
- Data management and storage in a relational data base environment;
- Integration of imagery processing into ocean surveillance and intelligence products;
- High resolution geographic and topographic maps with capabilities to overlay standardized user-friendly icons; pan, zoom, convert, re-register; and to annotate with narrative or graphic data;

- User-oriented tactical decision aids including planning, assessment, and optimization models;
- Briefing preparation; and
- Report generation.

Briefing and Display Subsystem

The briefing and display subsystem would be comprised of video switches, controllers, large screen displays, monitors, and teleconferencing and audiovisual support equipment. It would interface directly with the information processing and communication subsystems and support: generation of situation summaries; direct display of tactical situations with annotations; television reception; imagery displays registered on a geographic/topographic map; and any display created by a CCC subscriber.

Operational Decision Aids

Operational decision aids provide the ability to assess operational plans prior to and after execution to assist the fleet commander in resource allocation and in evaluation of alternative operational courses of action. The Copernicus architecture will allow CCCs to conduct interactive operational planning through the use of the Command (on a CINC planning) GLOBIXS and with like capabilities at sea via the appropriate TADIXS.

Facility Subsystem

The facility subsystem would provide the space, power, environmental controls, and human support environment that is responsive to needs of decision makers, watchstanders, analysts, and maintenance and administrative personnel. Self-sustainability for continued operations in an isolated environment should be considered.

RELATED PROGRAMS

Ocean Surveillance Information System (OSIS) Baseline Upgrade and OSIS Evolutionary Development (OBU/OED): The OBU/OBE provides automated receipt, processing, fusion and dissemination of all-source surveillance and intelligence data of interest to fleet and command authorities. Intelligence and event-by-event data is supplied to forces afloat for tactical support and over-the-horizon targeting (OTH-T) in a timely manner.

Operations Support System (OSS): OSS is a system evolving from the functionalities of the Navy WWMCCS Standard Software, Operations Support Group Prototype, Fleet Command Center Battle Management Program, and Joint Operational Tactical System (JOTS). The CINC staff uses JOTS II and a JOTS variant the Joint Visually Integrated Display System (JVIDS), in the current partially integrated OSS. OSS is converging the functionalities of these developments into a single system. OSS supports multi-warfare fleet and allied readiness assessments; tactical and strategic situation assessments; operations and logistics plan development and assessment; and resource allocation planning and optimization, processing, preparation, and dissemination. The Information Processing and Dissemination System (IPDS) is being developed for the Naples relocation project, intended to be the first Copernican CCC.

ASWOC Modernization: ASWOC is a shore-based, on-line, interactive, real-time netted system to support the missions of the Maritime Patrol Aircraft Sector Commander. ASWOC provides mission planning assistance, in-flight support and post-flight analysis for ASW, ocean surveillance, OTH-T, and Anti-Surface Ship Warfare (ASUW) missions. ASWOC also supports Battle Force (BF), Battle Group (BG), Surface Action Group (SAG), and Towed Array Surveillance System (TASS) and Tactical Towed Array Surveillance System (TACTASS) units, operating in or transitioning through ASWOC sectors, with pertinent tactical information. The twenty ASWOC sites are currently undergoing a modernization program to transition the system to COE hardware and software elements. The program incorporates DTC-2 computers and selected COTS/GFE software in a LAN based architecture.

Base Information Transfer System (BITS): BITS is a backbone scheme for integrating basewide communications systems in order to provide voice, data, image message and video communications to users. A pier facility will be provided to interface ships to the backbone. BITS will provide interface to the DCS. Control and management will be through a central facility.

Fleet Imagery Support Terminal (FIST): FIST provides a capability for worldwide transmission of imagery between USN forces ashore and afloat using military satellite communications systems. Hard copy imagery is digitized at the originating site, transmitted via satellite, and permanently recorded at the receiving site. The receiving site can display the imagery on a high-resolution cathode ray tube display or convert the display to hard copy. The terminal can enlarge, annotate, and enhance imagery for further analysis.

WWMCCS ADP Modernization (WAM): WAM is a joint program to redesign and replace the ADP systems within WWMCCS. Key elements include modernization of software (translation from COBOL to Ada), implementation of Joint Operations Planning and Execution System (JOPES), and the installation of additional elements of the National Military Command System (NMCS) as directed. The Defense Communications Agency (DCA) is the lead agency.

CHAPTER 6
TACTICAL DATA INFORMATION EXCHANGE SYSTEMS (TADIXS)

CONTENTS

BOXED TEXT

LIST OF FIGURES

CHAPTER 6
TACTICAL DATA INFORMATION EXCHANGE SYSTEMS (TADIXS)

REFERENCE:

(a) Space and Electronic Warfare Communication Support System Technology Base Application Plan, October 1990

SUMMARY

The new centers of the universe for Navy— the CINC Command Complex (CCC) in "co-orbit" with the Tactical Command Center (TCC)— will share a common tactical picture through a series of Tactical Data Information Exchange Systems (TADIXS), the third pillar of the Copernicus Architecture.

Like the Global Information Exchange System (GLOBIXS) and the CCC, the TADIXS are not physical but virtual nets, established at the request and in the mix desired by each tactical commander. As we saw in Chapter 3, TADIXS are *operational constructs, not communications networks*. The information contained in a single TADIXS may be provided via several communications channels or vice versa. TADIXS, therefore, spring from an operational decision about where to send data *onto* the TCC and CCC networks and how to display them.

It is important to understand that, because of their virtuality, TADIXS are essentially doctrinal delineations of information to and from the GLOBIXS ashore and from the afloat platforms and sensors at sea.

Like the GLOBIXS, the TADIXS should be considered a minimal set, with consolidation and expansion of their numbers and types a reflection of *command* structure and doctrine. Thus, we should conceive of the information flow from GLOBIXS to TADIXS and back again on three conceptual planes, which we will further develop into an operational model later in this chapter:

- First, the different technological "envelopes" in which the data are packaged and formatted (e.g., Government Open Systems Interconnection Profile [GOSIP] or Communication Support System [CSS] custom protocols for tactical application);
- Second, the operational *data layering*; that is, the doctrinal decision to place the data on a particular TADIXS and route the data to a particular commander's workstation; and
- Third, the *transformation of data* from the TADIXS *to information*, which is a function of the software interface on the Copernican tactical computers— the Fleet All-Source Tactical Terminals (FASTTs) and other "engines."

Because they are virtual nets and have a common engineering basis, Copernican TADIXS can be likened to telephone calls over a commercial network: the call can be made to anyone for any purpose over any available communications pathway for the length of time necessary to convey the information. Unlike telephone calls, Copernican TADIXS may support all eight formats of communications services and in three cases of precedence (see chap. 3). However, like telephone calls, the number of TADIXS will not be fixed; instead, they will be connected for the length of time necessary to transport the data to the subscribers and then broken.

For these reasons, Copernican TADIXS are classified into four broad categories— a menu is a good analogy— like the GLOBIXS by "communities of interests":

- *Command* TADIXS have as their purpose both high command and force command, whether Navy, joint, or allied. Both types of command TADIXS are envisioned as multiformat, with the former including video teleconferencing.
- The second broad category is the *Support* TADIXS. In this group, we include such streams as an Environmental TADIXS, a Logistics TADIXS, a Data Base-File Transfer TADIXS, an Imagery TADIXS, and Navy Information

Exchange System (NAVIXS), which as the narrative message pathway, is the only TADIXS envisioned to carry that format. All other TADIXS, including those other than Support, are being designed in formats other than messages.

- The third category is *Direct Targeting*, which will encompass several TADIXS that can be tailored for allies and filtered for geographic and targeting differences. Direct targeting will not be further discussed in this document.

- The final category includes *Force Operations* TADIXS, constructed around the tactical force.

Developing a virtual networking TADIXS concept that offers both jamming protection and sufficient communications capacity requires a new approach to procuring and implementing Navy's communications assets. Today, Navy communications effectively are centered on ultra-high frequency (UHF). Existing high frequency (HF) equipment is antiquated, necessitating high manpower requirements in return for low data throughputs. Super-high frequency (SHF) is only in adolescent stages in Navy, and extremely-high frequency (EHF) availability and throughput will be limited. Commercial satellite, like SHF, has the promise of adding high data rate capacity to the Navy afloat platforms.

Four critical shortfalls exist today in Navy Radio Frequency (RF) bearer services. First, we have not invested across a broad range of service from HF through military SATCOM to commercial satellite. Second, because our current architecture revolves around the message and is driven by the sender not the receiver, it has proven extremely difficult to make operational decisions concerning information management. Third, we have not engineered the means to switch traffic from one RF asset to another— a key requirement in a jamming environment. Instead, as mentioned previously, we have focused on designing an anti-jam waveform, thereby trading off throughput as in Milstar. Fourth, we have never engineered virtual networks that allow us to use the capacity we do have efficiently.

In the Copernicus architecture, we propose to remedy all four shortfalls.

DISCUSSION

The new centers of the universe for Navy— the CCC in "co-orbit" with the TCC— will share a common tactical picture through a series of TADIXS, the third pillar of the Copernicus Architecture.

Like the GLOBIXS and the CCC, the TADIXS are not physical but logical nets, established at the request and in the mix desired by the tactical commander. As we saw in Chapter 3, TADIXS are *operational constructs, not communications circuits*. The information contained in a single TADIXS may be provided via several communications circuits or vice versa. TADIXS, therefore, spring from an operational decision about where to send data *onto* the TCC and CCC networks and how to display them.

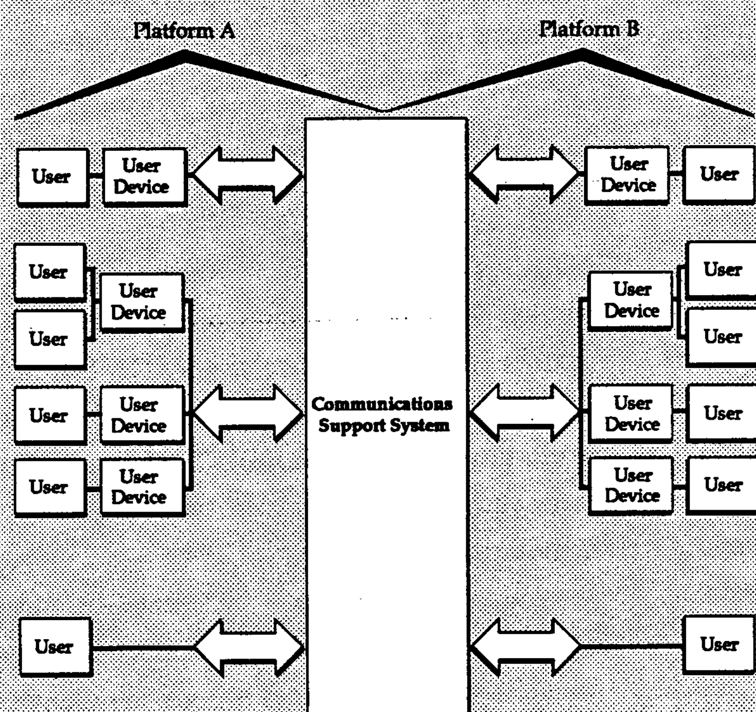
Simply put, Copernican TADIXS, unlike the current and planned TADIXS A and B, manifest themselves at their points of origin and destination— they exist at the CCC and at the TCC, but not en route to either.

Between the CCC and the TCC, TADIXS data will be routed over a virtual network system, the first Navy implementation of which will be the CSS (see boxed text 6-1).

Boxed Text 6-1. Communications Support System (CSS)

CSS uses a communications architecture that utilizes multi media (i.e., UHF SATCOM, UHF LOS, HF) and media-sharing to provide improved communications flexibility, survivability, connectivity, and efficiency. It will be implemented through development of new systems and equipment and modifications to existing systems and equipments. Backward compatibility with existing systems and equipment will be maintained during transition periods. CSS defines standard hardware and interfaces, defines requirements for reusable software, defines standard protocols, defines a security policy that combines COMSEC and COMPUSEC, and develops plans for common logistics support and configuration management by its implementing programs. The TADIXS pillar of Copernicus is manifested by communications systems managed by CSS. CSS has as its major components Users, Communications Resources (i.e., radios, transceivers, frequencies, channels, timeslots, etc.) and a software-based Communications Manager that assigns the Resources to Users in accordance with direction from the tactical commander in the form of a connection plan. Resources provide their technical performance data (i.e., RF link error rate, data rate, summary BIT status) to the tactical commander for his use in selecting which Resource(s) to use for a particular User or set of Users, or in Copernican terminology, for a particular TADIXS or set of TADIXS. TADIXS include all functions between the User input/output communications port on one platform (i.e., ship, shore, aircraft, submarine) to the User input/output communications ports on another platform, and includes the radio frequency media (see fig. 6B-1.1).

Users provide data in the following Copernican operational formats: voice, OPNOTE, narrative message, facsimile, Copernicus Common Format (COPCOM), data base files, imagery, and video. Resources provide over-the-air data rates from 75 bps to 64 kbps, although data rates above 4.8 kbps generally await fielding of additional SHF SATCOM Terminals and commercial SATCOM Terminals.



Boxed Figure 6B-1.1. Communications Support System (CSS) External Interfaces

One major impact of the TADIXS will be to nearly eliminate the Navy message as an operational format, moving instead toward the eight formats discussed in Chapter 3. Information will be displayed in the context of high-resolution graphics and imagery. Typically (although not absolutely) binary data transfer is more efficient from a communications standpoint; moreover, the current trend toward more and more computing power in smaller and smaller packages soon will enable sophisticated data compression and transmission techniques to reduce the amount of data actually sent.

In addition to virtual networking (and like the GLOBIXS), TADIXS thus will provide a second major improvement in information management: not only will the information veneer— the mission software that present data as operational information— be both more efficient and more powerful than text, but Copernican TADIXS will result in greater efficiency in communications capacity.

The third advantage of TADIXS is conveyed in the CSS multimedia capability. In the past, anti-jamming techniques were focused on the waveform of the SATCOM terminal. Milstar, with its very survivable EHF waveform is an example. However, the trade-off for anti-jam manifested in the waveform is clear: the throughput of Milstar is far less than the potential inherent in the physics of the EHF band.

Copernicus recognizes there are other alternatives to jamming than producing an anti-jam waveform. While it is clear that tactical commanders will continue to require a core of anti-jam communications such as that provided by Milstar EHF, even less critical communications— "general purpose" in the lexicon of MILSATCOM planners (see fig. 6-1)— can be provided with jam-resistance if TADIXS agility is provided.

Earlier in this document we addressed the importance of operational perspective. When operational perspective is considered, a full media capability for ships and a capability to move TADIXS dynamically across the media assigned to the tactical commander is an affordable, suitable, and feasible method of achieving this jam-resistance. This operational flexibility is at the heart of the Copernican philosophy of placing the operator— not the engineer, not the fiscal programmer, not the communicator— at the center of the universe.

WHAT IS A TADIXS?

Returning to individual TADIXS, it is important to understand that because of their virtuality, TADIXS are essentially doctrinal delineations of information to and from the GLOBIXS ashore and from the afloat platforms and sensors at sea.

Like the GLOBIXS, the TADIXS should be considered a minimal set, with numbers and types being a conscious reflection of *command* structure and doctrine. Thus, we should conceive of the information flow from GLOBIXS to TADIXS and back again on the following three

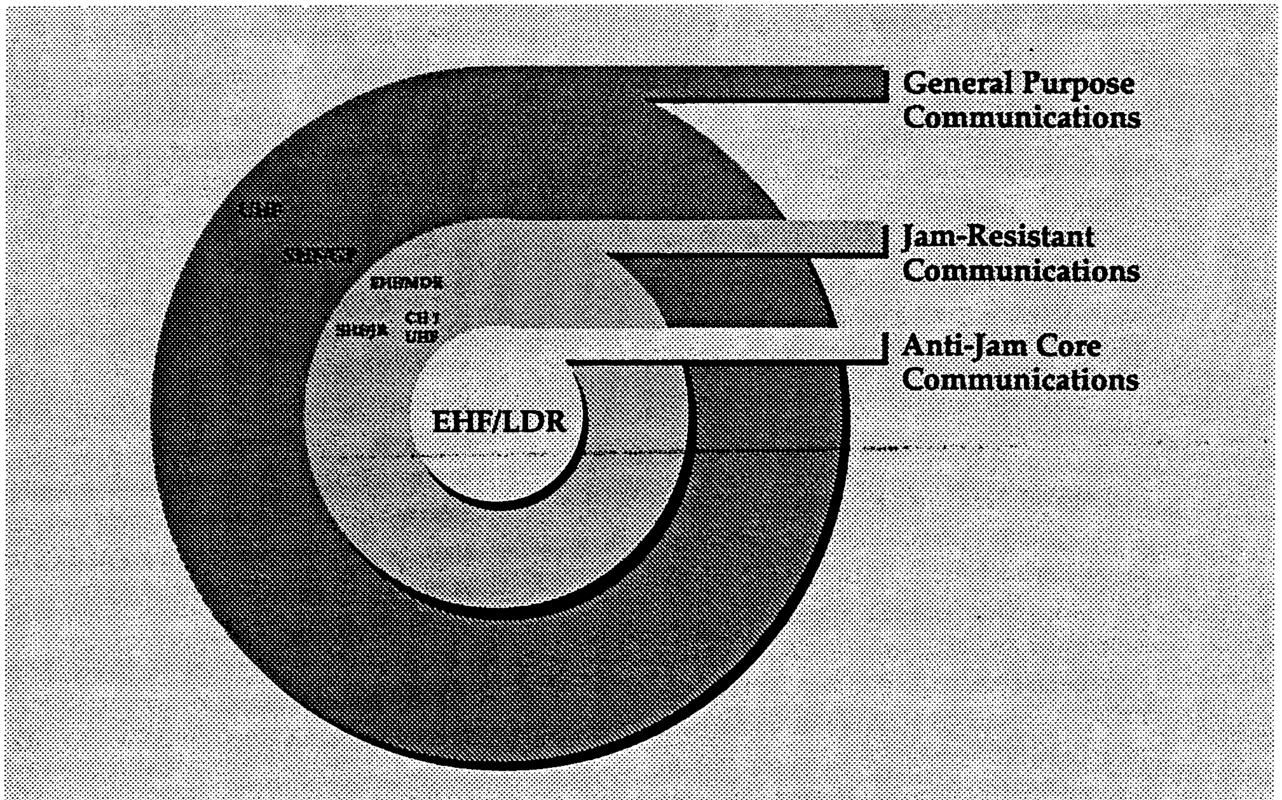


Figure 6-1. Anti-Jam Core and General Purpose SATCOM

conceptual planes, which we will further develop into an operational model later in this chapter.

- First, the technological "envelope" in which the data is packaged and formatted (e.g., GOSIP, X.400, or CSS custom protocols for tactical application, which are discussed in Chapter 8);
- Second, the operational *data layering*; that is, the doctrinal decision to place the data on a particular TADIXS and to route the data to a particular commander's workstation; and
- Third, the *transformation of data* from the TADIXS *to information*, which is a function of the software interface on the Copernican tactical computers— the FASTTs and other "engines."

Because they are virtual and have a common engineering basis, Copernican TADIXS can be likened to telephone calls over commercial network: the call can be made to anyone for any purpose over any available communications pathway for the length of time necessary to convey the information. Unlike telephone calls, Copernican TADIXS can support all eight formats of communications services and in three cases of precedence (see chap. 3). However, like telephone calls, TADIXS will not have a fixed connectivity over time, but, rather, will be connected only for the length of time necessary to convey the data to the subscribers and then broken.

For these reasons, Copernican TADIXS are classified in four broad categories— a menu is a good analogy,— like the GLOBIXS, by "communities of interests" (see fig. 6-2):

- *Command* TADIXS have as their purpose both high command (i.e., the connectivity between the National Command Authorities to the tactical force commander and the nodes in between) and force command, whether Navy, joint, or allied (i.e., TADIXS that affect the command and control of tactical battle forces from the tactical commander to his designated subordinate— CWC to CWC commanders and units). Both types of command TADIXS are envisioned as multiformat, with the former including videoteleconferencing;

- The second broad category are the *Support* TADIXS. In this group, we include such streams as an Environmental TADIXS, a Logistics TADIXS, a Data Base-File Transfer TADIXS, an Imagery TADIXS, and NAVIXS, which as the narrative message pathway, is the only TADIXS envisioned to carry that format. All other TADIXS, including those other than Support, are being designed in formats other than messages;

- The third category of TADIXS is *Direct Targeting*, which will encompass several TADIXS, including a multisensor broadcast that can be tailored for allies and filtered for geographic and targeting differences. Direct targeting will not be further discussed in this document; and

- The final category of TADIXS includes *Force Operations* TADIXS, which will be constructed around the tactical force to produce the information flow to answer the commander's tactical questions. See figure 6-3. For a CVBG, for example, Force Operations TADIXS might be expected (in addition to the three categories above) to include the following TADIXS for a complex mission:

  - The ASW Information Exchange System (ASWIXS), designed to connect ASW platforms to the CCC and the ASW GLOBIXS;

  - A Strike TADIXS, set up to provide consolidated overland targeting products and to connect Strike platforms, the Strike Warfare Commander, and the CCC with the several appropriate GLOBIXS;

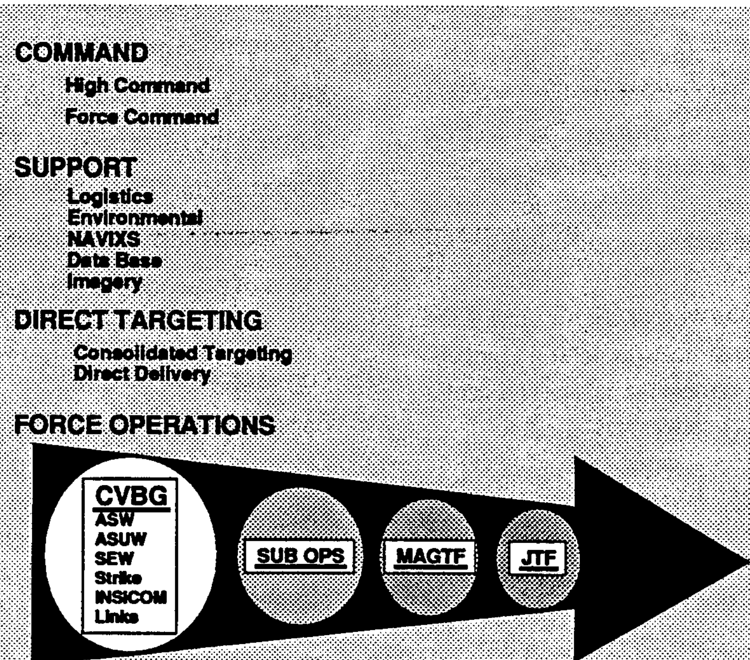


Figure 6-2. TADIXS by Category and Model

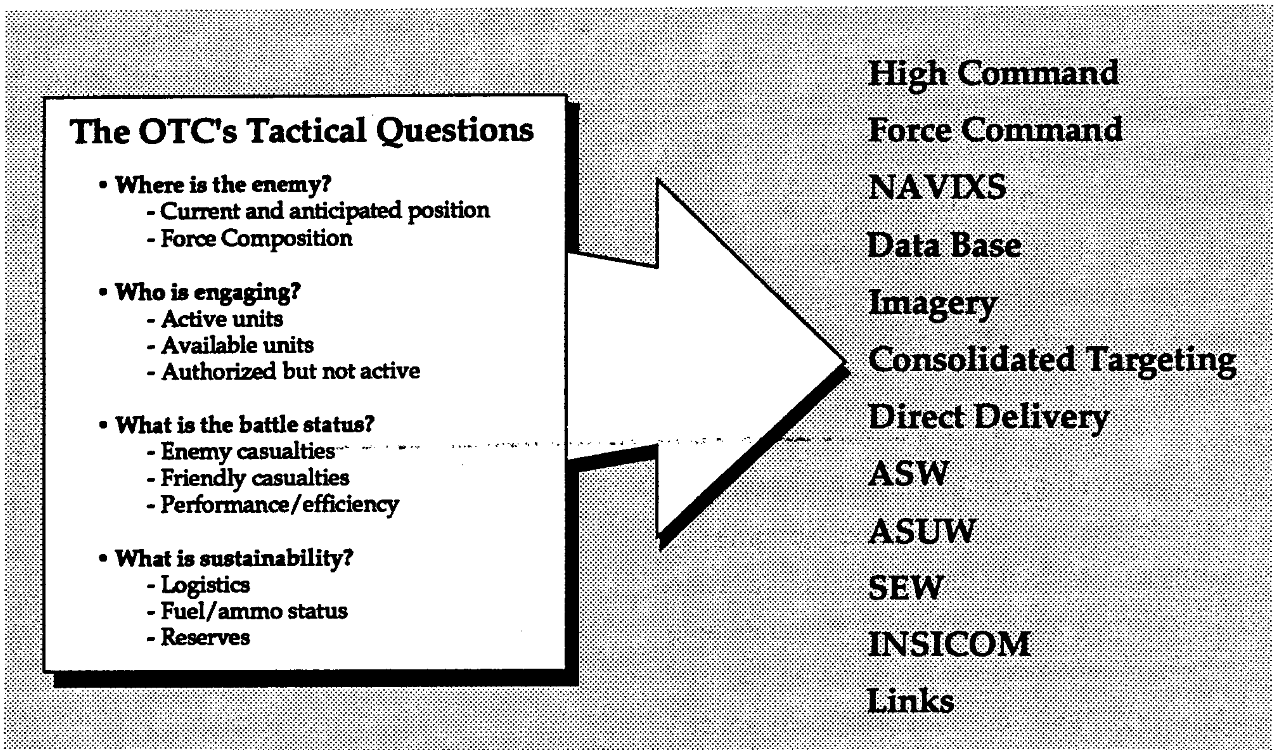


Figure 6-3. CVBG TADIXS

- The real-time Links, including Joint Tactical Information Display System (JTIDS), which will be the primary conduits for AAW information;
- The Integrated Special Intelligence Communications (INSICOM) TADIXS, a series that includes the TACINTEL, Intelligence Network (INTELNET), Intelligence Broadcast (INTELCAST), MUSIC/SPECIAL INTELLIGENCE (SI) Common, and Operational Intelligence (OPINTEL) functionalities; and
- A Space and Electronic Warfare (SEW) TADIXS, designed to connect the CCC SEW Center and the SEW Commander afloat.

For a JTF commander, an SSN in associated support or independent operations, a Marine Air Ground Task Force (MAGTF), or an amphibious task force, the TADIXS for Force Operations will be a somewhat different mix. As part of the PHASE II (see chap. 10) Copernicus effort, operational requirements for these TADIXS will be refined. Although the number of TADIXS seems large at first glance, it is important to understand that TADIXS are virtual nets, established and disestablished by the CWC and the CCC Watch as the tactical situation demands. Instantaneous capacity will be in the hands of the CWC and will be a function of how he configures his radio frequency (RF) assets, how many and what mix of TADIXS he chooses to establish, and the tactical situation.

TADIXS BEARER SERVICES

Central to Copernicus requirements is the necessity for Navy to invest broadly across the communications frequency from HF and military SATCOM through commercial satellite. Functionally, Navy will continue to require a modest amount of the anti-jam capability inherent in EHF low data rate (LDR) SATCOM. However, it is anticipated that EHF LDR will be much less common than medium data rate (MDR) EHF; moreover, if technically feasible, the ability to shift from MDR to LDR in a tactical situation is highly desirable.

Developing a virtual networking TADIXS concept that offers both jamming protection and sufficient communications capacity requires a new approach to procuring and implementing Navy's communications assets. Today, Navy communications effectively are centered on SATCOM. Existing HF equipment is antiquated, necessitating high manpower requirements in return for low data throughputs. SHF is only in adolescent stages in the Navy, and EHF availability and throughput will be limited. Commercial satellite, like SHF, has the promise of adding high data rate capacity to the Navy afloat platforms.

Four critical shortfalls exist today in Navy bearer services. First, we have not invested across a broad range of means from HF systems through MILSATCOM to commercial satellite. Second, because our current architecture is centered around the message and driven by the sender and not the receiver, it has proven extremely difficult to make operational decisions concerning information management. Third, we have not engineered the means to switch traffic from one RF asset to another— a key requirement in a jamming environment. Instead, as mentioned previously, we have focused on designing an anti-jam waveform, thereby trading off throughput as in Milstar. Fourth, we have never engineered virtual networks that allow us to use the capacity we do have efficiently.

In the Copernicus Architecture, we propose to remedy all four shortfalls. However, it is important to realize that there are limits to information transfer capability in a tactical environment. What can be done ashore in the business world over a computer-to-computer fiber optic link from Chicago to New York cannot be done currently over tactical links to sea.

Moreover, military satellite throughput in the future will not only continue to lag behind that of shore transmission media, but the gap will widen dramatically as the shore throughput increases through fiber optics. Similarly, the shipboard Local Area Networks (LANs) will be moving to fiber, also providing a capability to move very high amounts of data. Because military satellite capacity is limited and is inherently less efficient than wire or fiber, the satellites effectively will act as stoplights to the high-speed data flows ashore and at sea. The same is true of non-SATCOM frequencies (e.g., HF). The trend toward fiber optics ashore and afloat, coupled with faster and faster computing capabilities will mean faster information management ashore and afloat than can be provided between the two.

There is no simple answer to improving military SATCOM throughput, limited as it is by the physics of the spectrum, the engineering of the waveform, and the enormous expense of the satellites— approximately $140 million per satellite for the Navy UHF Follow-on constellation (which is much cheaper than the more complex Milstar). However, it is critical that the amount of throughput of the TADIXS bearer services available to us be the absolute maximum that can be achieved. See figure 6-4. To do so, the Communications Working Group (see Introduction), made the following five general requirements, which were approved by OP-094.

First, the Navy must move beyond near-total reliance on UHF SATCOM to a broad spectrum of means including SHF, EHF, and commercial satellite and improve our HF capabilities where appropriate for the architecture.

The Copernican communications services shown in Chapter 3 detail format requirements. Figure 6-5 shows a list of attributes by which bearer services were rated against format requirements. Figure 6-6 shows the methodology by which attributes were compared against bearer services, using videoteleconferencing as an example. In developing this document, a similar analysis was conducted for each format. Figure 6-7 shows the results of the analysis.

Appendix B contains the report of the Communications Working Group. Based on an analysis of suitability, feasibility, and affordability of bearer services to implement the architecture, the following strategy was devised:

- Milstar low data rate and EHF on UHF Follow-on must be deemphasized;

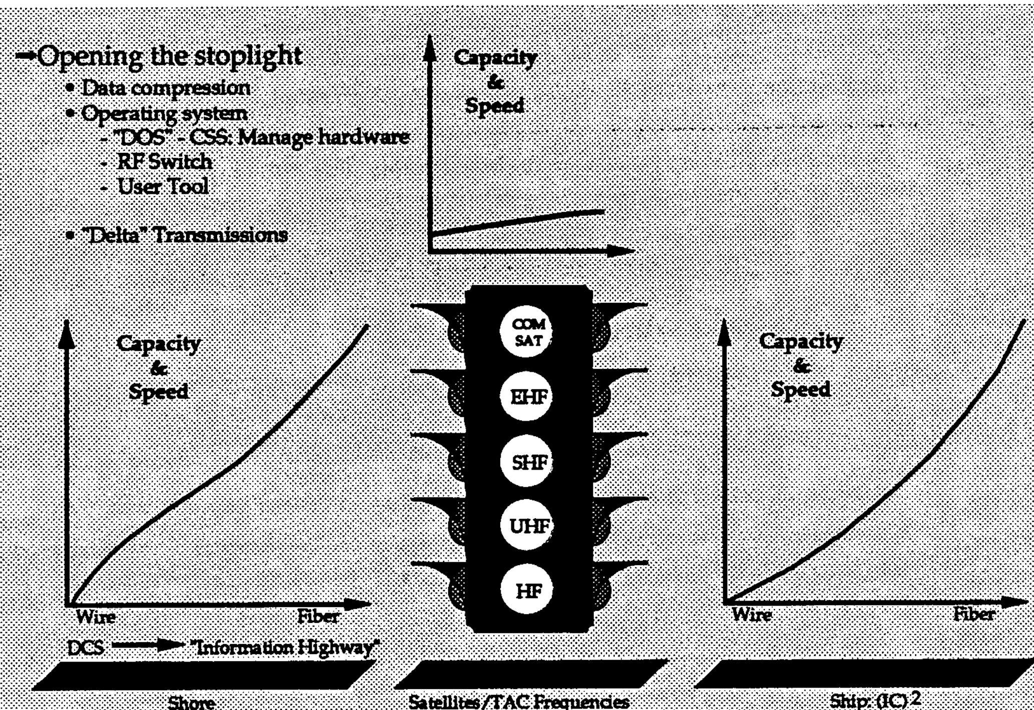


Figure 6-4. Data Capacity Chokepoint

Propagation:

- Coverage of theater shore stations
- Coverage of forces in theater
- Coverage to support shore/ship/shore

Throughput:

- Data rate
- Response time
- Data integrety

Survivability:

- Physically hardened
- Electronic counter-counter measures
- Robust network connectivity

Growth:

- Modularity
- Standards (US, NATO, Allied, Commercial)

Limitations:

- Atmospheric
- Environmental
- Operational security/deception
- Electro-political

Cost:

- Budget
- Military specification vs COTS
- Design to unit cost

Physical characteristics:

- Installation requirements
- Power
- Cooling
- Antenna size

Figure 6-5. Attributes for Rating of Bearer Services

HF	Not suitable
UHF SATCOM	Limited due to current 32 kilobit per second data rate
SHF SATCOM	Applicable, although shore-ship-shore quality may not be good
Milstar Low Data Rate	Not suitable
Milstar Medium Data Rate	Applicable (future system now being designed)
EHF on UHF Follow-On	Not suitable
Commercial SATCOM	Applicable, but high bandwidth satellites may not cover ocean areas.

Propagation Throughput Survivability Growth Limitations Cost Physical Characteristics

Figure 6-6. Copernican Videoteleconferencing Analysis

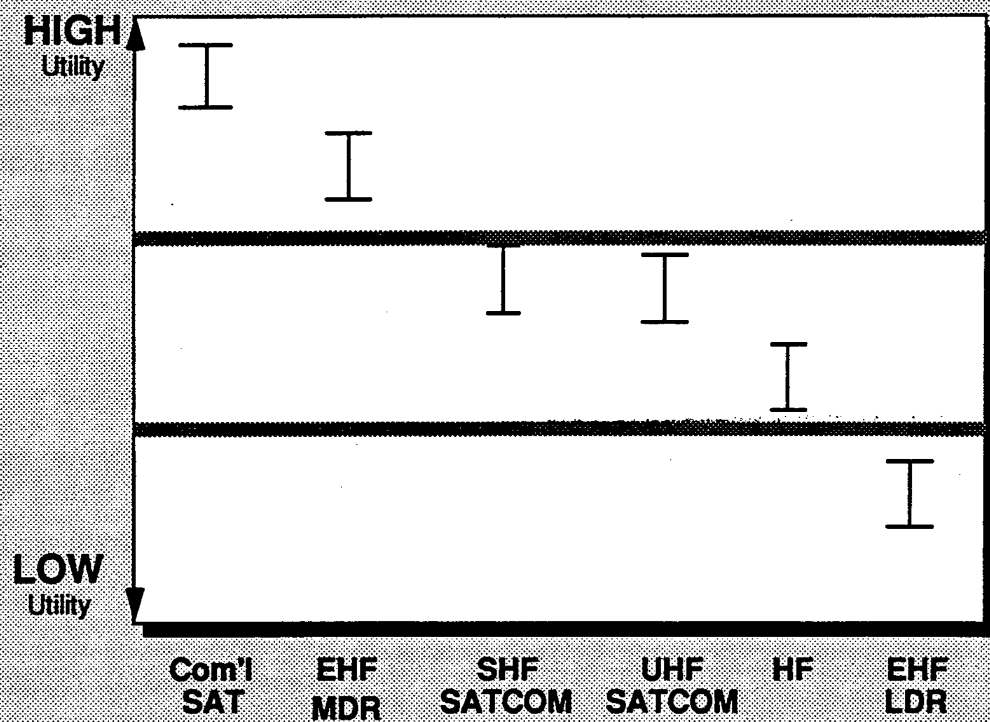


Figure 6-7. TADIXS Bearer Service Priorities

- SHF SATCOM and commercial SATCOM must be accelerated;
- UHF SATCOM throughput must be increased, and a plan must be developed to do so;
- A plan to incorporate commercial satellite technically and operationally into Navy units in the Copernicus Architecture must be developed; and
- A similar plan should be developed for HF.

Second, we must overlay an operating system— analogous to MS-DOS on a personal computer (PC)— that will allow many users to efficiently access the capacity on the satellites through dynamic bandwidth management instead of dedicated channels. This operating system will be manifested in the virtual networking program CSS.

Third, we must use research, development, test and evaluation (RDT&E) to explore better data transfer techniques: data compression, object-oriented transmission packets, "delta" transmission (i.e., sending only the part of data files that actually changes between transmissions). These conclusions mirrored those of the Technology Working Group contained in Appendix A.

Fourth, we must buy a standard family of workstations and file servers afloat with ever-increasing amounts of memory. Memory is far cheaper than SATCOM transponders. The more memory resident at sea, the less data necessary to send and the smaller the "delta" for transmittal.

Fifth, we must replace the many antiquated communications processors with a common family of processors are more efficient, so data transmission can be accomplished with the greatest speed and efficiency possible.

MANAGING THE TADIXS

TADIXS management incorporates two functions: determining the destination of specific data on the CCC and TCC networks and determining what communications channel will be used to transfer the data.

In the Copernicus Architecture, the first function is a deliberate one: data may go to one destination, be shared by more than one destination, or not be sent at all, at the discretion of the tactical commander's designated subordinates afloat and the CCC anchors ashore. This decision is a *distributed* one, meaning it is made within each operational strata (i.e., ASW, AAW, SEW). Thus, the SEW commander afloat, by delegating responsibilities to the SEW anchor ashore, also makes information decisions at the same time as part of the Copernicus C4I decisions discussed in Chapter 3 (see fig. 6-8).

Not only is the decision distributed across warfare functions (which is to say, *how* a TADIXS will be constructed with respect to what data, how much, and in what format will be exchanged), but it has a temporal aspect as well.

Temporal Aspects Of TADIXS

This temporal aspect— how long will the "telephone call" be— has two facets, one operational and one related to engineering. Operationally, the duration of a TADIXS has to

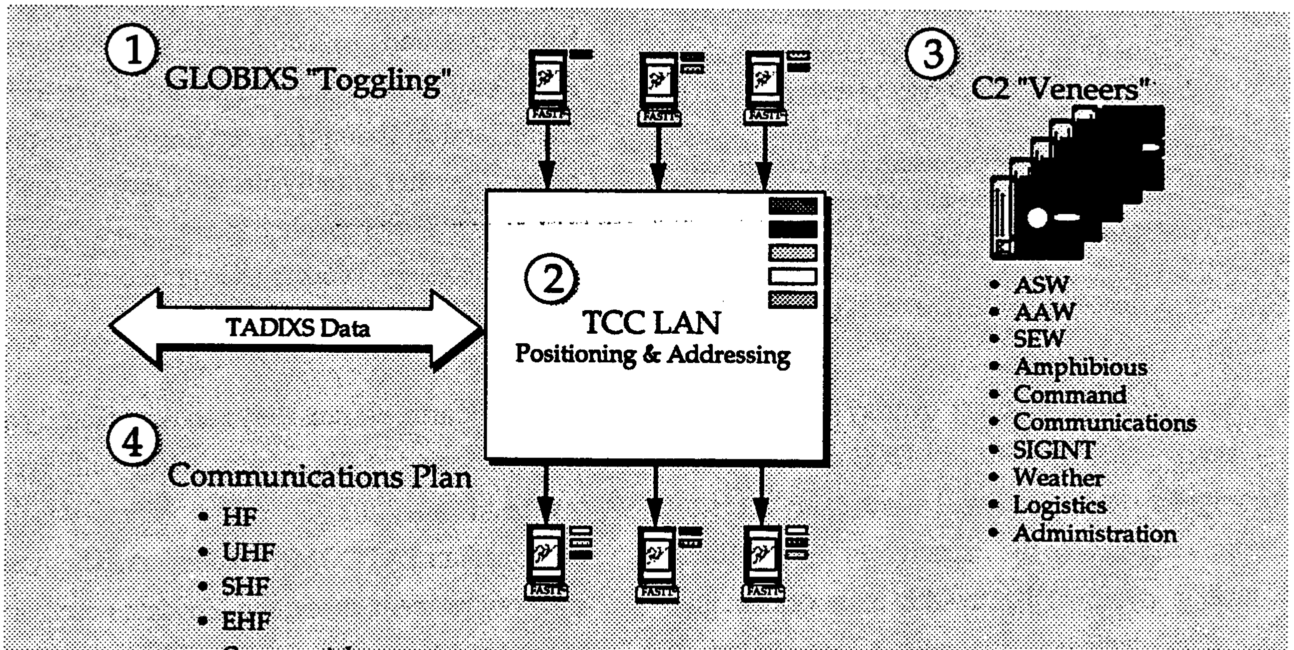


Figure 6-8. C4I Doctrinal Decisions

do with the mission: a decision to construct an ASW TADIXS and keep it operative for the duration of the mission[1].

The engineering facet has to do with *efficiency*— the ability to sustain the ASW TADIXS uninterrupted in the eyes of the analysts, while at the same time moving that TADIXS data and data from other TADIXS over the same communications channel.

Managing Communications Channeling

The engineering consideration as to efficiency of data "bundling" is an integral part of TADIXS communications channeling, the second function of TADIXS management. Unlike the information management function, this function is not distributed. Afloat, the responsibility will be delegated by the CINC to the SEW commander, who will exercise it through one of his principal assistants, the staff communicator. Ashore, this function will belong to the SEW center (or other organization designated by the Fleet CINC), where the operational (i.e., informational) decisions of the CCC anchors and tactical commander and the communications decisions (i.e., data management) to implement them take place.

The technological means to achieve this interface will be through the CSS system, which manages afloat communications functions, and the GLOBIXS communications processors, which manage those functions ashore[2].

The delineation of formats and precedences of data arising from the GLOBIXS will be accomplished technically through the GLOBIXS processor software, which will implement the "toggling" instructions of the respective CCC anchor, who is in turn implementing his serviced tactical commanders' instructions. Afloat, the processing software for a TCC position would also reflect the doctrinal decision of the tactical commander. In this way, by format and precedence, the CCC anchors and their counterparts afloat *define* the TADIXS operationally.

On a communications level, then, the communicators bundle the data from afloat platform to afloat platforms and ashore to the CCC in the most efficient manner through the CSS controller managed from TCC. In practice, to the operator, the TADIXS will seem a constant connection for the duration of the TADIXS "telephone" call, perhaps better termed "session." Similarly, in practice, the CSS automatically will manage the communications pathways until, in a tactical situation, the amount of capacity is insufficient to meet the operational requirements of the commander. In that instance, the decision is an operational decision

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[1] An alternative, for example, might be a 5-minute TADIXS constructed to place a vendor laboratory computer in dialog for on-line diagnostics with automated test equipment modules embedded in the vendor's equipment installed on a ship.

[2] The delineation between the two processors is a technological one. The technological requirements to move GLOBIXS data ashore over DCS and TADIXS data afloat through CSS and the tactical RF infrastructure differ because the standard and protocols of the two differ.

made by the commander, not by the communicator[3].

It is important to note there are other methods by which the tactical commander can choose his data than the one we have just described, although that will be the more typical case. However, the Direct Targeting TADIXS may employ a different approach because of efficiency gained by doing so. Instead of the tactical commander determining what data will be sent from shore to him, in Direct Targeting, the more efficient means may be to broadcast the information to all tactical units and allow the commander to "dial in" on what he wants. The output and nature of some sensor TADIXS may make this approach useful.

[3] The reader should bear in mind, however, that in this architecture, several major advantages are conferred that will add capacity beyond that available today. First, and obviously, we will invest in more capacity across the spectrum. Second, most of the data transferred will be digital, not character-oriented, with a resultant system-wide efficiency in throughput. Third, virtuality maximizes the capacity that is available.

A TADIXS MODEL

Five elements define any TADIXS (see fig. 6-9). Using those elements, we can construct a model of a SEW TADIXS, much in the same manner that the tactical commander would activate that TADIXS in execution of a mission using the architecture.

The first element of a TADIXS is user software (i.e., the FASTT Human-Machine Interface [HMI]) and data addressing. In the case of this SEW TADIXS, the SEW HMI would provide C^4I, electronic warfare (EW), surveil-

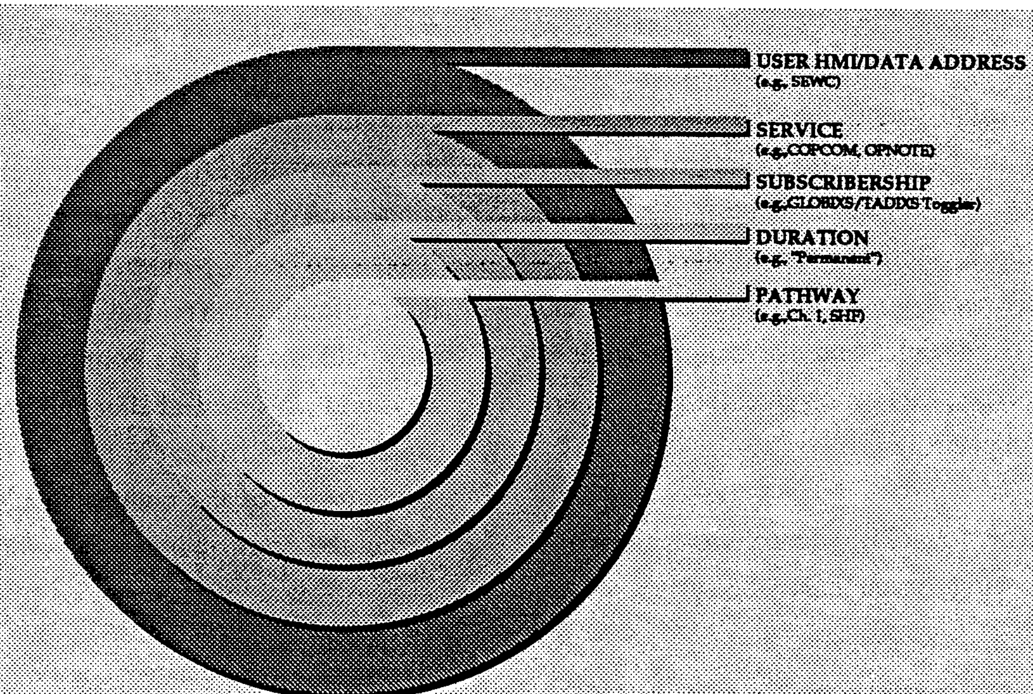

Figure 6-9. Five Elements of a Model TADIXS

lance and C^4I counter measures tools. To delegate responsibilities further, the SEWC may opt to send data relative to blue force communications to one FASTT operated by the staff communicator and the remaining data to the a second FASTT operated by the staff cryptologist.

By this division, the SEWC has decided to delegate his responsibilities into two pieces: a "blue" SEW position displaying information about his own assets and their vulnerability, and a "red" position displaying the known (and unknown) similar information about the enemy.

The second element is the decision to define the data— the communication service— to be sent over the TADIXS in terms of format (e.g., voice, video, COPCOM).

The third element is to define subscribership and the *terms* of subscribership. This element is part of the process of "toggling" the GLOBIXS, but it is important to recognize there is a need to "toggle" other TADIXS subscribers on the net as well. In other words, the tactical commander can send what communications service must be established— by precedence as well as format.

The fourth element is duration. In this case, we will establish the TADIXS as a "permanent" TADIXS, which is to say that it is on line for the duration of the mission as opposed to a distinct time frame like a one-hour data file transfer or the vendor test equipment TADIXS described previously.

The final element is the communications pathway. This decision, made by the staff communicator through the CSS controller, is a function of available path, data format, degree of jam-resistance required, the capabilities of other TADIXS subscribers, and the duration of the TADIXS.

In the next chapter, we will discuss the final pillar of the architecture, the Tactical Command Center.

RELATED PROGRAMS

Advanced Narrowband Digital Terminal (ANDVT): A secure digital voice or data traffic device for use over narrowband voice frequency channels on aircraft, ships, or land vehicles.

Classic Lightning (formerly Navy Key Distribution System — NKDS): This program is described in Chapter 4.

Combination Radio (COMBO RADIO): Designated the AN/ARC-210, it provides anti-jam (voice) communications in the UHF and very-high frequency (VHF) portions of the spectrum. The primary application is for AAW and close air support (CAS) operations. It is applicable to the F/A-18, the AF-8B, F-14D, E-2C, EA-6B, AH-1, CH-53, UH-1N, OV-10, and EP-3. It promotes interoperability with Department of Defense (DOD) and allied HAVEQUICK AND Single Channel Ground to Air Radio System (SINCGARS).

HAVEQUICK: A UHF LOS frequency-hopping, jam-resistant communications system developed by the Air Force for tactical voice applications. It is provided as an applique to existing radios used by the various Services and some North Atlantic Treaty Organization (NATO) allies. In the Navy, it is used with the AN/WSC-3, and the AN/ARC-182. HAVEQUICK IIA is the NATO standard.

High Speed Fleet Broadcast (HSFB): The HSFB is comprised of individually encrypted broadcast packages generated from multiple user subsystems. Multiplexing of the subsystem outputs enables sharing of available satellite capacity and at the same time allows flexibility in altering bit rates in response to varying operational needs and environments. HSFB is transmitted through the OM-51 spread-spectrum modem and the AN/FSC-79 terminal and through broadcast keying and re-keying sites for HF. Mobile platforms receive the HSFB via the modified AN/SSR-1 satellite communications broadcast or the HF receiver in conjunction with an NDI modem using serial tone modulation techniques in accordance with MIL-ST 188-110 CN2.

Joint Tactical Information Distribution System and Multifunctional Information Distribution System (JTIDS/MIDS): JTIDS is a program to provide selected air, sea, and ground units with a crypto-secure, jam-resistant, low-probability-of exploitation tactical data and voice communications system. It will have the additional capabilities of common-grid navigation and the use of automatic relay. MIDS is a pre-planned product improvement (P3I) of the JTIDS Class 2 terminal. As such, it will utilize the Link-16 message standard and will be applicable to the F/A-18 and E-2C. MIDS offers a substantial reduction in size as compared to the Class 2 terminal.

Link Eleven Improvement Program (LEIP): A program designed to improve existing Link 11 high-speed, computer-to-computer digital radio communications in the HF and UHF bands among Combat Direction System (CDS) equipped ships, submarines, aircraft, and shore sites.

High Frequency (HF) radio: An existing capability for plain and secure voice, plain and secure teletypewriter, and secure data information exchange. Modernization programs in planning include the HF modem replacement (HFMR) and broadband HF (AN/URC-109) programs for specific ship types.

Navy Intelligence Processing System (NIPS): A program to update the hardware and software used on flagships. The program will upgrade from a mini-computer base to distributed workstation processing.

Navy Standard Teleprinter (NST): A program to replace outdated teletypes (TTYs) with the UGC-143A(V) teleprinter. The new item is modular and can be configured in four versions (receive only, receive only with bulk storage, keyboard send/receive, auto send/receive). Installation on ships began in FY91.

Officer in Tactical Command Information Exchange Subsystem II (OTCIXS): A Demand Assigned Multiple Access-(DAMA) capable tactical satellite communications network for command and control of Battle Group operations and ship-to-ship, ship-to-shore, exchange of data link and teletype information. It is to provide dependable beyond line of sight (BLOS) communications between surface, sub-surface, and shore installations on a near-real-time basis.

Super High Frequency (SHF) Satellite Communications for Aircraft Carriers (CV) and Flagships: The only ships that currently have capability to use Defense Satellite Communication System (DSCS) SHF SATCOM are the numbered fleet commander flagships. The SHF SATCOM for CV/Flagships program will expand this capability to aircraft carriers and other ships designated as being capable of supporting an embarked flag officer. The operational service to be provided is being determined. At a minimum, the capability will be similar to existing AN/WSC-6(V)2, providing approximately 9600 bps capacity in a benign electronic combat environment. Alternative capabilities that could enable higher data rates are under consideration.

Super High Frequency (SHF) Satellite Communications (SATCOM): An existing Navy program that provides AN/WSC-6(V)1 capability for Surface Towed Array Surveillance System (SURTASS) and AN/WSC-6(V)2 for Numbered Fleet Commander flagships. The SURTASS system has no anti-jam capability and operates at 64 kbps in a benign anti-jam environment. The combatant ship system (AN/WSC-6(V)2 with OM-55 anti-jam modem) operates at a nominal maximum of 32 kbps (actual rate is between 22,000 bps and 4,800 bps) in a benign electronic combat environment, and degrades to 75 bps in a moderately severe electronic combat environment.

Submarine Satellite Information Exchange System (SSIXS II): SSIXS provides a means to use the UHF FLTSATCOM system for a 4800 bps, two-way exchange of text messages between shore-based Submarine Operating Authorities (SUBOPAUTHs) and submarines, and between submarines. SSIXS II is a system block upgrade that replaced the AN/UYK-20 processor hardware and software in shore sites with commercial off the shelf (COTS) hardware and Ada software.

Integrated SI Communication (INSICOM): This program supports Sensitive Compartmented Information (SCI) exchange requirements in support of AAW, ASUW, STW, ASW, and Amphibious Warfare (AMW) operations. It will operate on HF, UHF LOS, and on UHF, SHF, and EHF SATCOM simultaneously or any mix of those systems. INSICOM provides capabilities previously expressed by the INTELCAST and INTELNET programs. It will be capable of netted, point-to-point, or broadcast communications, and INTELCAST will support many information exchange formats.

Tactical Receive Equipment (TRE) (TADIXS B/TRE): An all-Service program to provide for the collection, processing, and timely broadcast, via UHF SATCOM down link, of highly accurate positional and parametric contact data. The AN/USQ-101 (V) is the equipment suite for RF reception, processing, and delivery of the data to user-baseband equipment. TRE operates at 2400, 4800, or 9600 bps and can receive signals with or without forward error coding up to 19.2kbps. There are six configurations (Army, Air Force, United States Marine Corps, Navy ship, Navy submarine, Navy shore).

UHF Follow-on (UFO) Satellite Communications Program: UFO is a program to procure replacements for the FLTSATCOM satellites. A constellation of nine (including one on-orbit spare) is envisioned. The satellites will provide 39 communications channels and will utilize SHF telemetry and command signals. Launch will be via either the shuttle or expendable vehicles. Initial Operational Capability (IOC) 1Q FY92.

UHF Line of Sight (LOS): UHF LOS radios are used for voice and data (primarily Link 11) information exchange among fleet units. Voice may be either clear or encrypted, with VINSON (KY-57/KY-58) used for on-line encryption. All fleet units have some UHF LOS capability. Only air warfare ships, submarines, and some aircraft have UHF LOS Link 11. Ships use secure teletype (KG-84A or KG-84C) via UHF LOS for intra-Battle Group message exchange when within UHF LOS range (approximately 30 nm). UHF LOS equipment is predominantly the AN/WSC-3. Most UHF LOS equipment has no anti-jam capability, but the HAVEQUICK frequency-hopping applique is being provided for combat aircraft and for primary air control ships that communicate with combat aircraft.

UHF Satellite Communication (SATCOM): UHF SATCOM is used for voice and data information exchange among fleet units. Most combatants have at least one Demand Assigned Multiple Access (TD-1271 DAMA) unit to multiplex as many as four user information streams (at 4800 bps or lower) into one carrier frequency up/down link. Voice is covered by one of four voice encryption systems: 1) CV-3333 Narrowband Secure Voice with KG-30 series COMSEC, 2) Advanced Narrowband Digital Voice Terminal (ANDVT, in the AN/USC-43 configuration that is replacing CV-3333), 3) Parkhill (KY-65 or KY-75), and 4) VINSON (KY-57 or KY-58). Data capability includes secure teletype (KG-84A or KG-84C COMSEC) and the automatic information exchange systems listed below. All combatants have some UHF SATCOM capability. UHF SATCOM radios afloat are the AN/WSC-3. The AN/WSC-5 is the principal radio for use ashore. Portable radios (AN/PSC-3 or AN/URC-110) are used for special operations or (in some cases) to provide a special capability for a ship. Current automatic information exchange systems that operate via UHF SATCOM include:

- Officer in Tactical Command Information Exchange System (OTCIXS);
- Tactical Data Information Exchange System (TADIXS A);
- Tactical Intelligence information exchange system (TACINTEL);
- Fleet Imagery Support Terminal (FIST);
- Common User Digital Information Exchange System (CUDIXS); and
- Submarine Information Exchange System (SSIXS).

Very High Frequency (VHF) Radio Systems: Navy uses VHF radios for: 1) communication with Air Force, Army, and allied aircraft, 2) coordination of naval gun fire support (NGFS), and 3) control of landing craft and boats. Conventional VHF radios (AN/VRC-46) are used primarily for encrypted voice service, using the VINSON (KY-57 or KY-58) COMSEC. The Single Channel Ground and Air Radio System (SINCGARS) is a VHF system that provides anti-jam service and is capable of communicating either voice or data.

CHAPTER 7
TACTICAL COMMAND CENTER (TCC)

CONTENTS

BOXED TEXT

LIST OF FIGURES

SUMMARY

The final pillar of the Copernicus Architecture is the Tactical Command Center (TCC), used in this architecture in a much broader sense than conveyed in the past by the existing platform-specific programs, such as the Tactical Flag Command Center (TFCC) program. In the Copernicus Architecture, the TCC is intended to signify the combat "nerve centers" of the tactical commander and his units. Thus, TCC in Copernicus means not only the TFCC, CIC, CVIC, SUPPLOT, and SSES[1] in an aircraft carrier or analogous centers on a fleet flagship, but also the tactical centers for individual units and the command centers for multi-force commanders such as the Marine Air Ground Task Force (MAGTF) and joint task force (JTF).

The TCC provides the tactical displays, integrated information management, and accessibility to tactical communications to support Navy warfighting missions. It provides the requisite battle connectivity to units, other force commanders, and the Commander in Chief Command Complex (CCC). Architecturally, the TCC is analogous to the ashore command center, the CCC. Both will share a consistent tactical picture and connect the Navy to the Services and to allies— at the tactical level and the theater level.

TCC in the Carrier Battle Group (CVBG) context means the creation of periodic and aperiodic local area networks (LANs) afloat. Until multi-level security is achieved, separate Special Intelligence (SI) and "General Service" (GENSER) LANs will be required. With the establishment of fiber optic busses afloat— the ship's "information highway"— the LAN connectivity will also become virtual and fall into two broad categories.

The first category is the periodic LAN, which handles time critical and continuously updated information. The second type is aperiodic where data is not time critical and is updated at various intervals. These LANs will have high bandwidth and provide high speed connectivity for all the TCC spaces, encompassing on a carrier for example, CVIC, SUPPLOT, SSES, and TFCC proper as well as the ships decision centers.

These information LANs will be characterized by different protocols but will operate Copernican Fleet All Source Tactical Terminal (FASTT) workstations (with application specific software) and receive data from various TADIXS. The LANs will be supported by various utilities and servers providing high speed message search retreival, E-mail, and other common user functions.

The CVBG TCC will incorporate the functionality of several formerly separate tactical C^4I systems. As we have seen, FASTTs are application "engines" with high percentages of common commercial off-the-shelf (COTS) and government off-the-shelf (GOTS) software. The shared utilities (data bases, operating systems, etc.) will be resident in various servers available to all. The use of a FASTT for a tactical mission is achieved through a veneer of software application aimed at the warfare mission. Thus, the difference between an Anti-Air Warfare (AAW), Anti-Submarine Warfare (ASW), Space and Electronic Warfare (SEW), and Anti-Surface Warfare (ASUW) FASTT is the mission-software installed over the 95-percent common FASTT and supported by common utilities.

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[1] Combat Information Center (CIC), Carrier Intelligence Center (CVIC), Supplementary Plot (SUPPLOT), and Ship Signals Exploitation Space (SSES).

Using the FASTTs and the LAN concept, the tactical commander achieves an agility in constructing his command and control that heretofore was not possible. The final ingredient is the virtual TADIXS mix which, when shunted onto the LANs to the diverse FASTTs, allows the Officer in Tactical Command (OTC)/Composite Warfare Commander (CWC) to actually configure his command and control system to his tactical doctrine to suit the mission.

As we saw in Chapter 5, the command and control processes of planning, assessing, observing, executing, and reporting are structured with respect to command level. Differences are evident in attributes: timeliness of processing, level of hierarchical view of the problem (global, theater, scene of action), and volumes of information stored, retrieved and processed. A broad range of computational capabilities are also common across command levels: arithmetic, geometric, statistics/probabilities, and conversions. These and other types of commonalties suggest that at equal command levels, there will be a high degree of commonalty in required system functions. At other levels in the hierarchy, there is still a high degree of commonalty, but less than that found between equal levels.

Considerations such as these become evident in the similarities between this chapter and Chapter 5, which relates to the CCC. This commonality suggests that a modular design for both CCC and TCC configuration is a rational approach. Common data base structures, dictionaries, and management techniques are possible as are common application programs, display generators and displays, and communications interface and processing algorithms, all contributing to consistent data base fill. These attributes of commonalty and modularity, while allowing for unique applications tailored to warfare mission area and command level, are characteristics of the Copernicus concept. Chapter 8 presents an engineering model of CCC and TCC and states requirements for CCC and TCC.

DISCUSSION

The final pillar of the Copernicus Architecture is the TCC, used in this architecture in a much broader sense than conveyed in the past with the existing platform-specific programs, such as the TFCC program. In the Copernicus Architecture, the TCC is intended to signify the combat "nerve centers" of the tactical commander and his units. Thus, TCC in Copernicus means not only the TFCC, CIC, CVIC, SUPPLOT, and SSES in an aircraft carrier or analogous centers on a fleet flagship, but also the tactical centers for individual units and the command centers for multi-force commanders such as the MAGTF and JTF.

The TCC provides the tactical displays, integrated information management, and accessibility to tactical communications to support Navy warfighting missions. It provides the requisite battle connectivity to units, other force commanders, and to the CCC. Architecturally, the TCC is analogous to the ashore command center, the CCC. Both will share a consistent tactical picture and connect the Navy to the Services and to allies— at the tactical level and the theater level.

TCC in the CVBG context means the creation of periodic and aperiodic LANs afloat. Until multi-level security is achieved, separate SI and GENSER LANs will be required. With the establishment of fiber optic busses afloat— the ship's "information highway"— the LAN connectivity will also become virtual and fall into two broad categories.

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The CVBG TCC will incorporate the functionality of several formerly separate tactical C4I systems. As we have seen, FASTTs are computing "engines" with high percentages of common COTS and GOTS (i.e., owned and developed by the Government for broad applications, such as algorithms) software. The use of a FASTT for a tactical mission is achieved through a veneer of software application aimed at the warfare mission. Thus, the difference between an AAW, ASW, SEW, and ASUW FASTT become the mission-software installed in the 95-percent common FASTT.

Using the FASTTs and the LAN concept, the tactical commander achieves an agility in construction of his command and control that heretofore was not possible. The final ingredient is the virtual TADIXS mix which, when shunted onto the LANs to the diverse FASTTs, allows the CWC to actually configure his command and control technology to his tactical doctrine to suit the mission.

Copernicus then, provides the CWC with the following unique capabilities:

- The TCC can be configured and reconfigured quickly to suit the changing tactical situation;
- The high-technology FASTT can assimilate, sort, and display large amounts of sensor reports, data files, and imagery onto a warfare specific "veneer" software— making the notion of isolated imagery or data files, now placed in the context of the mission-analytics and fed onto the LAN through the TADIXS, obsolete;
- The construction of virtual TADIXS in common formats— an ASW sensor report in the Copernicus Architecture is formatted identically to an Electronic Intelligence (ELINT) report— allows the CWC to make decisions about which subordinates receive which data, when, and how;
- The advent of the CSS workstation allows the CWC to determine which information is protected by the core of anti-jam media and which is not and, thus, he is provided both reliability and efficiency by his own choice; and
- The CCC, through the addressing of data packets and the configuration of the Global Information Exchange System (GLOBIXS) nodes tailored for each tactical commander can act as facilitator or filter or both, as the CWC directs.

A MODEL TCC

The TCC receives information via the TADIXS, maintains data bases and tactical plots, and transmits information to forces afloat and to the CCC ashore. It is the echelon where organic tactical information, non-organic tactical information, and combat support information are fused to provide a clear, coherent tactical picture. Figure 7-1 and box text 7-1 illustrate the Copernican TCC concept.

While the goal of the Copernicus Architecture is to move all Navy and Marine Corps nerve centers into a flexible building block TCC model, it is recognized this will be an evolutionary process. At this writing, the TCC is closest to implementation in the five flag-configured ships (see next paragraph), and we will confine our model to those. Phase II of the Copernicus effort (see chap. 10) will seek to define Copernican models for other command and control nodes (e.g., the SSN, MAGTF) through working groups comprised of personnel with experience in these areas.

The TCC model is comprised of computer-based TCC subsystems located in five classes of flag-configured ships: LCC, AGF, CV/CVN, LHD, and CG/CGN. The LHA class is also a candidate TCC platform. Within these ships, TCC subsystems are connected by Local Area Networks (LANs). Subsystems are connected to flagship systems (e.g., Advanced Combat Direction System [ACDS]) via network gateways. Network gateways provide control and

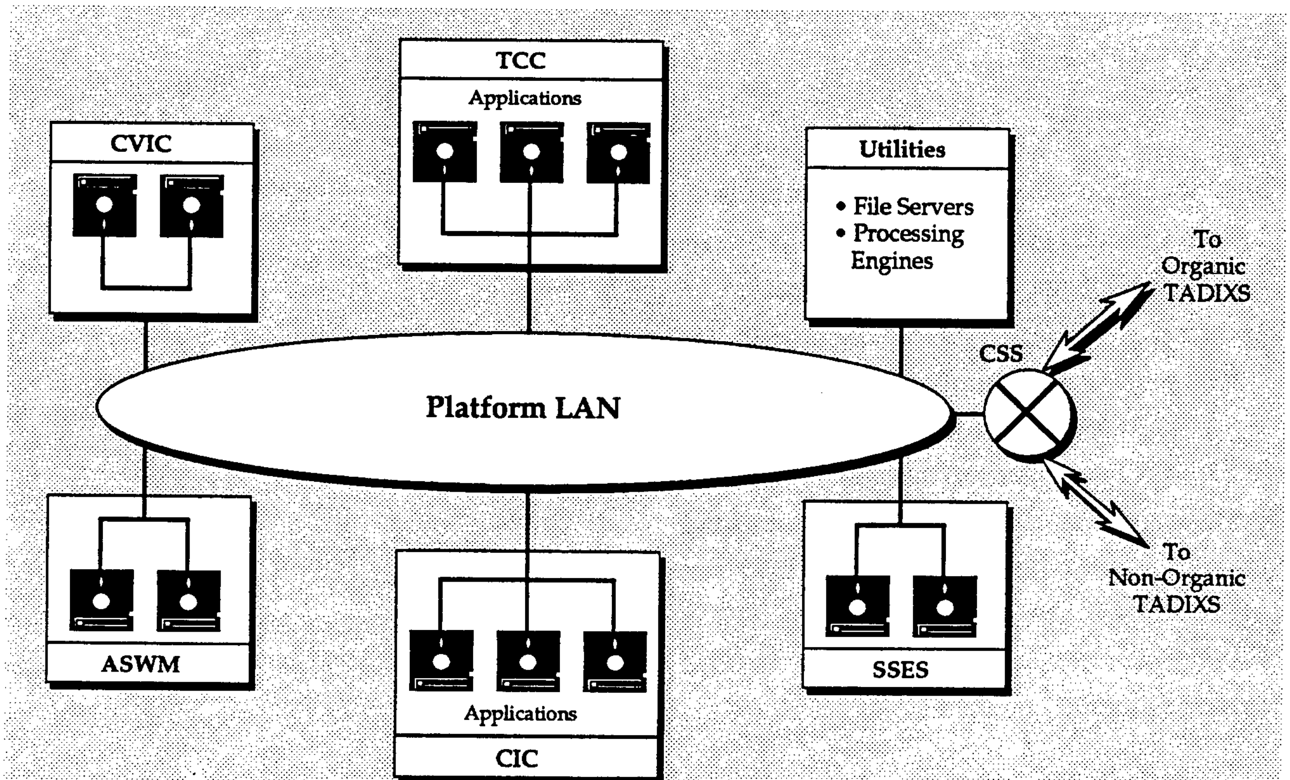

Figure 7-1. Model CVBG TCC

Boxed Text 7-1. Conceptual TCC

The Copernicus model of the TCC necessarily simplifies the complexities inherent in the command and control structure of the modern battle force. Phase II of Copernicus implementation will expand the concept of the TCC and its supporting TADIXS to account for this complexity (see figs. 7B-1.1 and 7B-1.2). There are six guiding principles for implementing the TCC:

- The TCC is a command and control node supporting a particular warfighting commander. A warfighting commander can be the CWC/OTC, the AAWC, the SEWC, a landing force commander ashore, or the commander of a ship/aircraft. The TCC is not defined by the platform/space in which the commander sits, but rather by the warfighting functions he/she performs;
- The TCC is defined by the warfighting functions of the commander rather than the mission capabilities of a platform. Copernicus does away with the conventional notion of the "flag configured" platform in favor of the concept of a platform capable of supporting a particular set of warfighting commander's functions. All platforms have some capability to support a warfighting commander. Some have more than others. All platforms with the necessary Copernicus building blocks can share the same tactical picture. Platform design should concentrate henceforth on being able to support the functions and staff of a warfighting commander, rather than being "flag configured";

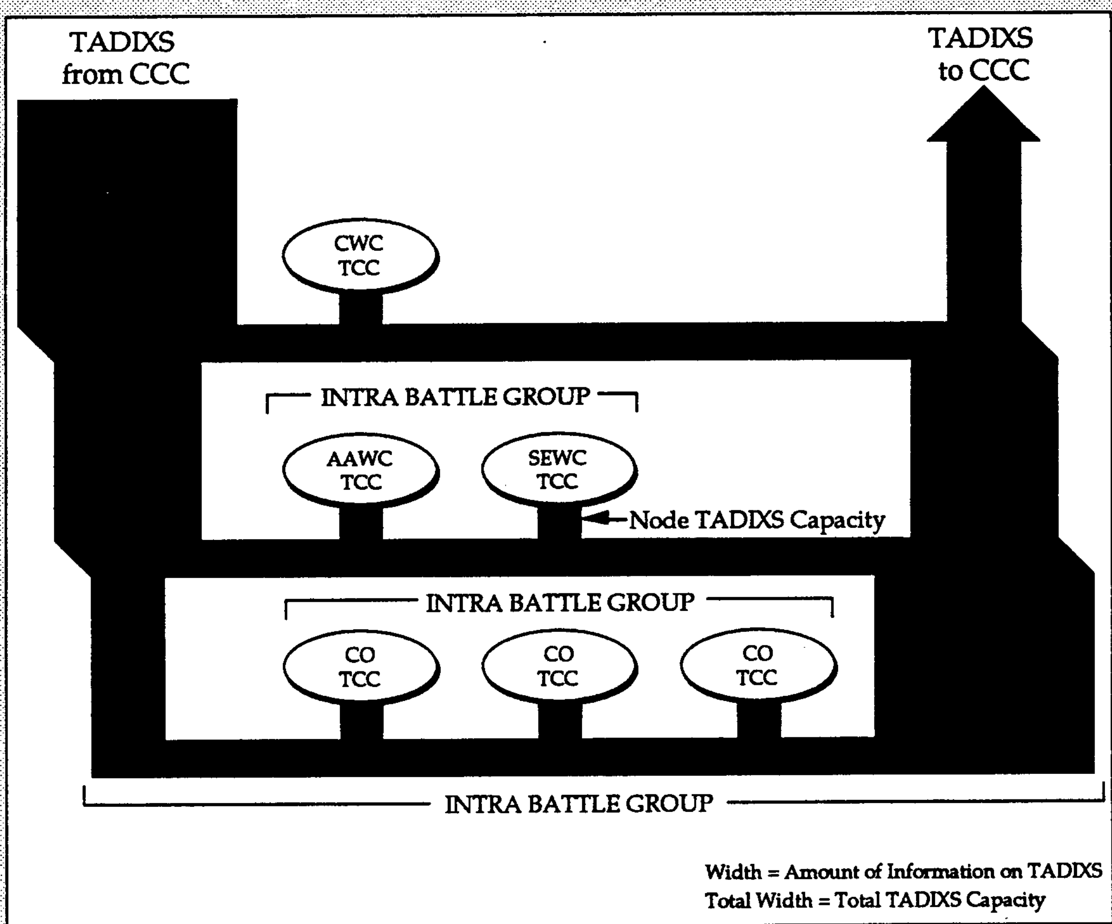

Figure 7B-1.1. TCC Information Flow

- A TCC can support only one warfighting commander at a time (since the TCC functionality is specified by the commander for a particular mission or part of a mission, more than one TCC can be implemented on a given platform, in a given space, depending on the C^4I hardware/software resources available;

- Conversely, a TCC (as well as a CCC) can be distributed among more than one platform at a time (e.g., the TCC of the Landing Force Commander after an assault but before command has passed ashore). Another example of a distributed TCC is one constituted by a JTF commander who chooses to remain ashore (e.g., at the American Embassy) while using the command and control capabilities of a Navy ship present to support an evacuation;

- TADIXS are virtual networks connecting TCCs with each other and with the CCC. Based on the previous discussion, TADIXS are not limited to RF bearer services. In some cases they may be implemented using intraplatform IC bearer services; and

- TCCs are implemented hierarchically in consonance with the command structure imposed for a given mission. All TCCs cannot have unlimited and full access toll TADIXS all the time. Someone has to be in charge of bearer service allocation. This means that the doctrine for TADIXS information flow to, from and among subordinate TCCs is set (dynamically, based on the tactical situation) by the commander of the senior TCC, who must have the capability (via the SEWC) to allocate TADIXS capacity.

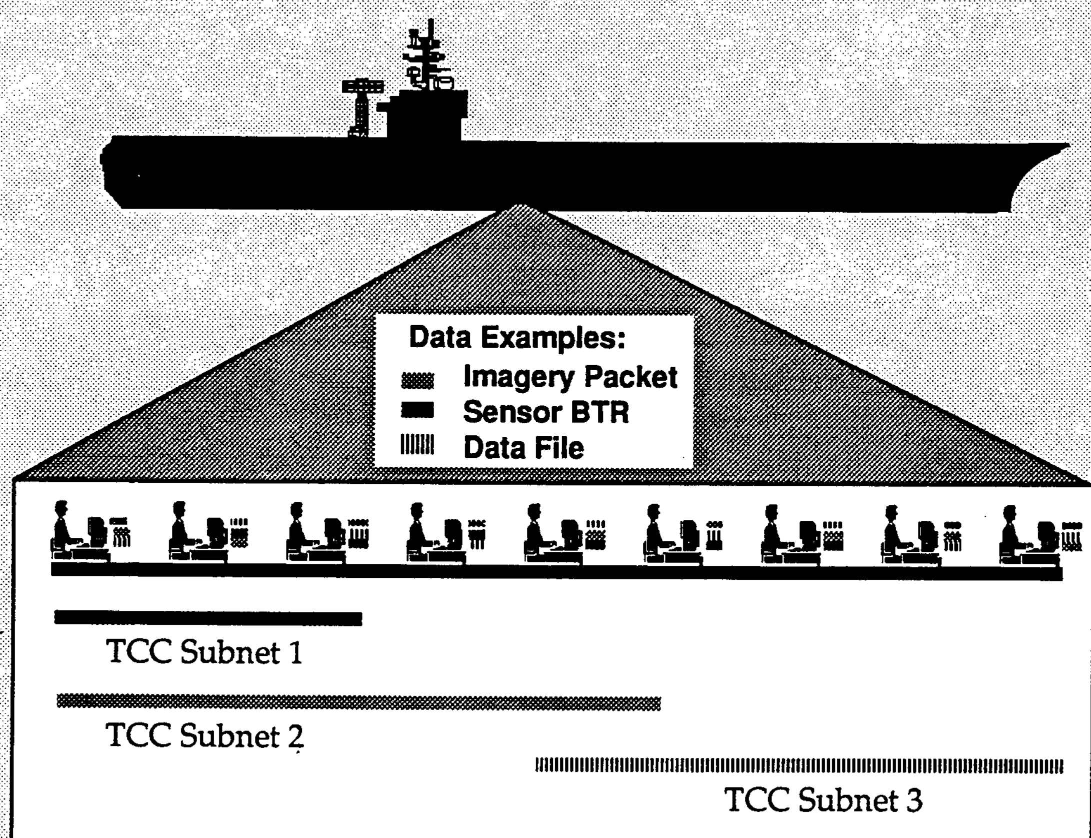

Figure 7B-1.2. What is a TCC?

access to the flagship external communication system.

The TCC encompasses the whole complex of afloat and command activities. Whereas the existing TFCC is merely one space within a flag-configured ship, the TCC will provide an integrated construct that includes not only the TFCC itself, but also the other spaces in which force management functions are performed such as CVIC, SSES, SUPPLOT, Combat Direction Center (CDC), and radio.

DESCRIPTION OF THE OPERATIONAL MODEL

TCCs support numbered fleet commanders, battle force/battle group commanders, amphibious task force commanders, and CWCs to enable them to exercise their responsibilities whether as naval force commanders, joint task organization commanders, or allied force commanders. TCCs help the tactical commander to:

- Respond to Fleet Commander in Chief (FLTCINC), naval component commander, JTF commander, and allied force commanders directives and policies;
- Coordinate battle group, battle force, and/or amphibious force operations in crisis, wartime, and peacetime environments;
- Prepare, evaluate, and promulgate mission and mission warfare plans, orders, and tactical decisions;
- Allocate/reallocate assigned resources including dynamic reconfiguration of communications assets support;
- Assess and predict tactical situations and own force readiness;
- Plan transits, search and rescue operations; manage catastrophic civilian relief efforts; perform air/water space management; plan frequency usage and manage communication and information management systems; drug surveillance and interdiction support operations; and conduct operational planning as well as overall information management;
- Provide all elements (Red, White, Blue, Green)[2] of the near-real-time tactical picture and ensure a consistent tactical picture within the force to enable indications and warning; intelligence support; cryptologic, imagery, and other surveillance support; own force status and disposition monitoring; logistics support to own force; as well as consolidation of environmental/geophysical data;
- Coordinate own force operations with those of other forces and ashore commands;
- Provide correlated, evaluated organic and non-organic, multisource tracks and amplifying information to own forces and to the CCC ashore;
- Prepare targeting information and/or targeting support information;
- Plan for and manage assigned collection resources and coordinate the application of non-organic collection resources;
- Evaluate warfare and warfare support system performance and contribution to mission plan success;

[2] Blue-Friendly, Red-Hostile, White-Neutral, Green-Environmental

- Reconstitute forces after action;
- Restore communication links and networks after natural or man-made degradation;
- Reconstruct and analyze completed exercises/ actions; and
- Plan for, monitor, assess, observe and report on their delegated warfare tasks in response to the CWC's directives, policies, and resource allocations. Mission warfare commanders:
    - Coordinate with each other when the force is engaged in multi-warfare operations; coordinate with afloat and shore-based counterparts when operating in multi-force operations;
    - Prepare, evaluate, and select mission warfare and warfare support plans; promulgate the plans;
    - Allocate/reallocate assigned resources;
    - Direct and coordinate assigned forces mission warfare operations;
    - Assess situations; evaluate outcomes as opposed to expectations;
    - Develop and implement preplanned actions/ force doctrines; and
    - Develop and implement ad hoc actions.

Critical TCC Functions

An initial issue to be resolved is the scope of the TCC capabilities. Its currently existing counterpart, the Naval Tactical Communication System Afloat (NTCS-A), supports the Officer in Tactical Command (OTC)/CWC and, with the addition of the Electronic Combat (EC) Module, the Space and Electronic Warfare Commander (SEWC.) It also supports the host ship command structure. Minimal support is available for specific warfare mission areas (e.g., development and evaluation of alternate courses of action and selection of an optimum course, development of a doctrine for preplanned actions, or optimizing allocation and reallocation of mission warfare resources for combat or combat support).

The OTC/CWC decides in which ships warfare commanders/coordinators will embark. The predominant selection seems to place all but the Anti-Air Warfare Commander (AAWC) in the CV/CVN. Continuation of this practice would indicate that a TCC in the CV/CVN must have a scope of capabilities to serve not only the OTC/CWC, but also the Anti-Submarine Warfare Commander (ASWC), Anti-Surface Warfare Commander (ASUWC), Strike Warfare Commander (STWC), SEWC, and Air Resources Element Coordinator (AREC.) The AAWC and the Light Air Multi-Purpose System (LAMPS) Element Coordinator (LEC) may also require support from the CV/CVN in some cases. The CG/CGN, the preferred AAWC flagship, would have a TCC capable of supporting specifically the AAWC, and possibly the ASUWC, and the ASWC. When post-action force reconstitution is considered, however, it would seem prudent to develop a single TCC that can support the OTC/CWC and all warfare commanders/coordinators. This TCC would be installed in all flag-configured ships.

TCCs installed in potential Commander, Amphibious Task Force (CATF) flagships (i.e., LCC, LHD, or possibly LHA classes) would be augmented by amphibious warfare or mine-warfare-unique support capabilities.

The capabilities of TCCs installed in numbered fleet commanders flagships (i.e., LCC, AGF, or a CG/CGN) would be augmented to reflect a theater scope of responsibilities; multi-force, joint, and allied command coordination; tactical mobile logistics responsibilities; and responsibilities as alternate FLTCINCs.

TCC SUBSYSTEMS

These critical TCC functions are derived from examination of only the OTC/CWC and warfare commander user functions, current systems capabilities, and systems interfaces. They are identified in four subsystem categories: information distribution, information processing, briefing and display, and facilities.

The *information distribution subsystem* connects the TCC information processing subsystem components located in various flagship spaces with each other and with the briefing and display subsystem located in the command center. A gateway connects this TCC local area network with the flagship CSS for interface with other force platforms, with shore-based command and command support centers, and, in some instances, with non-organic sensors. The subsystem provides all requisite communication system interoperability, compatibility, adaptability, reconfigurability, and security. It functions in secure voice, imagery, data, and video modes. The information distribution subsystem terminus of the information processing subsystem is the communication server.

The *information processing subsystem* provides a single integrated capability for users to access all processing resources based on their requirements and authorized data/application program access. Each user can access all applications through a "single window" (or successor) environment that provides a consistent interface to all applications.

An open system architecture maintains the flexibility needed to accommodate changing requirements and to ensure continuing interoperability with other directly (hardwire/LAN) or indirectly (radio frequency communications) connected systems. The following capabilities are needed in the TCC information processing subsystem:

- Data interfaces with platform support systems (e.g., ACDS, ASW Module, Prototype Ocean Surveillance Terminal);
- Data interfaces with the platform CSS;
- Data protocol compatibility among subsystems;
- Automated message handling;
- Multilevel security;
- LAN with access to platform LANs to permit TCC subscribers to share authorized intra- and inter-platform command and support center data, applications, and various terminal devices;

- Standardized user interfaces across all applications and decision aids;
- Office automation;
- Data management and storage in a relational data base environment;
- Integration of imagery processing, storage, and distribution into development of organic and non-organic tactical pictures and situation assessments;
- High resolution (targeting quality) geographic and topographic maps with capabilities to overlay standardized user-friendly icons; pan, zoom, convert, re-register; and to annotate with narrative or graphic data to support mission planning;
- User-oriented tactical decision aids including, planning, assessment, and optimization models;
- Briefing preparation; and
- Report generation.

The briefing and display subsystem is comprised of video switches, controllers, large screen displays, monitors, and teleconferencing and audiovisual support equipment. It intergraphic display, displays created by a TCC subscriber, and multi-media displays showing windows and overlays of user desired combinations of information at various levels of granularity and command levels.

The *facility subsystem* provides the space, power, environmental controls, and human support responsive to the needs of TCC including decision makers, watchstanders, analysts, maintenance, and administrative personnel. The limited space, weight, power, and environmental support capabilities of all flag-configured platforms place a severe constraint on any TCC design criteria.

RELATED PROGRAMS

There is one major program element that is making significant progress toward attaining Copernicus TCC capability: Navy Tactical Command System Afloat (NTCS-A). This program has several elements, some of which are described below:

- **The Joint Operational Tactical System (JOTS):** JOTS work stations, the primary TFCC system component, host common tactical data processing and display software running in standard hardware for the OTC/CWC, CATF and CLF and selected subordinate warfare commanders. At present, JOTS II software is the core of NTCS-A, used in conjunction with Navy Desktop Tactical Computer 2 (DTC-2) hardware onboard both TCC and some non-TCC units. System functionality includes track management, track analysis, environmental prediction, and a variety of tactical overlays as well as Tactical Decision Aids (TDAs)/displays. JOTS is capable of receiving Link 11, Link 14, TADIXS A, OTCIXS, High Interest Track (HIT) Broadcasts, Operational Intelligence, and U.S. Message Text Format (USMTF) messages. Link 16 data will be processed when joint Tactical Information Distribution System (JTIDS) is introduced into the fleet. In the interim (partially integrated) NTCS-A, JOTS interfaces with POST, TFCC Information Management System (TIMS), Naval Intelligence Processing System (NIPS), and non-NTCS command and control systems. The tactical data base manager (TDBM) provides a consistent tactical picture for all supporting warfare commanders. The Fleet Command Centers (FCCs) interface with flag configured ships and other shore nodes via a JOTS variant, JVIDS (Joint Visually Integrated Display System). Data is exchanged ship-shore via the Fleet Broadcast, the SI broadcast and Ocean Surveillance Product (OSP), and among shipboard nodes via OTCIXS and the HIT Broadcast in Over- The-Horizon (OTH) Gold and/or tactical report (TACREP) formats.

- **Electronic Warfare Coordination Module** (EWCM): The EWCM was designed to provide planning, decision aids, and automated data processing support for the CWC/OTC and the Electronic Warfare Coordinator (EWC). The EWCM requirements package has now been folded into NTCS-A as the Electronic Combat (EC) module with software supporting EW functions performed in sea control and power projection operations. The EW Module is being implemented in both the SCI and GENSER NTCS architectures and is the core support package for the SEWC. It supports tactical planning, direction and redirection not only of EC resources for coordination of "soft kill," counter-threat command and control, communications, computers and intelligence counter measures (C^4ICM) operations to degrade the enemy's C^4I, but also to provide C^4I, countermeasures and targeting support for other warfare commanders.

- **The Afloat Correlation System (ACS):** ACS was to be a ship-based, on-line, interactive, near-real-time support system for automated correlation, fusion and other analytical manipulation of multi-source threat information. The ACS was to be installed in TFCC-equipped ships. ACS requirements have been folded into NTCS-A as software supporting the sea control and power projection mission planning, execution, and threat monitoring functions. SCI and GENSER ACS functionality supports the TFCC and interfaces with the FCCs (through their collocated Fleet Ocean Surveillance Information Centers [FOSICs]). ACS functionality is used to correlate the ACDS organic picture with off-board sensor derived, non-organic tactical data to provide the OTC/CWC with a single, comprehensive and consistent tactical picture. Primary offboard inputs are the shore- generated Ocean Surveillance Product (OSP) via TADIXS A, organic data maintained by the ACDS, and non-organic data received from various communications links such as TADIXS B, TACINTEL and the SI broadcast. Providing limited interim correlator capabilities are POST for sea and the Advanced Tracking Prototype (ATP) for land. In FY92, POST and ATP will be replaced by NTCS software that will field an improved correlation algorithm for land as well as sea tracking on DTC-2 workstations.

- **The Naval Intelligence Processing System** (NIPS): NIPS supports analysis packaging and distribution of intelligence data for the OTC/CWC, CATF/CLF and subordinate warfare commanders/coordinators. It directly supports strike and amphibious warfare by providing a resource for mission planning and organization; intelligence assessment and evaluation; photographic and electronic imagery transmission, receipt, interpretation, and exploitation; reconnaissance planning and analysis; and aircrew briefing and debriefing. NIPS will have separate GENSER and SCI processors; a GENSER-to-SCI data base update scheme will generate an all-source tactical picture at the SCI level to support OTC/CWC and especially SEWC SCI resources management as well as tactical intelligence and warning (I&W) and GENSER data base quality assurance (Q.A.). Evolving to become the NTCS-A central data base server (CDBS), NIPS contains technical data on friendly, neutral, and threat systems as well as characteristics and performance (C&P) data, orders of battle, and other capabilities. Based on the Naval Warfare Tactical Data Base (NWTDB), this data base provides easily accessible information in support of other NTCS-A components and Combat Systems such as ACDS, Tactical Air Mission Planning System (TAMPS) and Tactical EA-6 Mission Planning System (TEAMS). The NIPS data base, prepared by the JIC/FIC prior to deployment, is tailored to projected force operational requirements, but will be updatable through a combination of electrical data transmission, tapes and manual entry. Near-term upgrades to NIPS will include porting the software to DTC-2 data base expansion.

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CHAPTER 8
BUILDING BLOCKS OF THE ARCHITECTURE

CONTENTS

LIST OF FIGURES

CHAPTER 8
BUILDING BLOCKS OF THE ARCHITECTURE

REFERENCES:

(a) The U.S. Government's Open System Environment/Application Portability Pro file, National Institute of Standards and Technology, January 1991 (Draft)
(b) DOD-STD-2167-A (NAVY) Military Standards for Software Development, 22 October 1983.
(c) MIL-STD-187-700; Interoperability and Performance Standards for the Defense Information System; 15 May 1991 (Draft)
(d) MIL-STD-1813, Network Management for DOD Communications; 10 June 1991 (Draft)
(e) Communication Support System (CSS) Overview (Draft), October 1990

SUMMARY

Preceding chapters have presented an operationally oriented view of the architecture. This chapter presents a view of the architecture in terms of how it should be designed and implemented. Each pillar of the architecture (presented in fig. 8-1) has some unique characteristics, but strong common elements bind the pillars together to form the architecture.

The first common element is the virtual nature of all four pillars. Global Information Exchange System (GLOBIXS) and Tactical Data Information Exchange System (TADIXS) are virtual communication services that use physical bearer services for transmission. CINC Command Complex (CCC) and Tactical Command Center (TCC) employ virtual command control services, permitting personnel in physical command center spaces to interact as if all the physical spaces were one. The second element is the use of functions to define the services. This structured approach to service definition permits common-user needs to be identified. The third commonality is the application of building blocks to these functions. Building blocks identify in engineering terms how the architecture is to be achieved. The Common Operating Environment (COE) is the final element among the pillars, providing the technical standards that cement building blocks into the architecture.

This chapter also presents (in annexes A, B, and C) the network management services, communication bearer services, and user services required by the architecture.

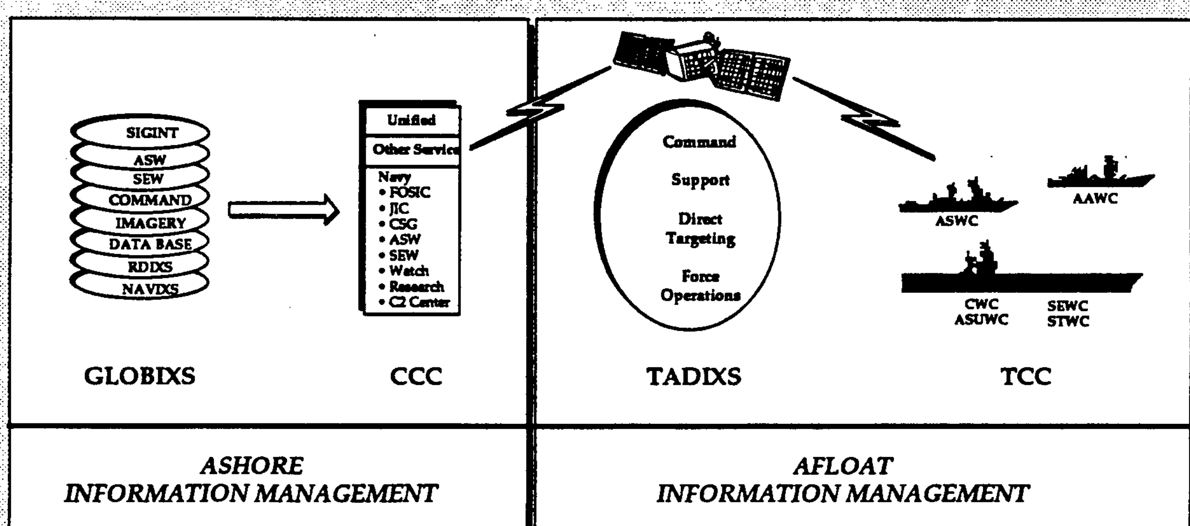

Figure 8-1. The Pillars of the Copernicus Architecture

At its highest level, the engineering model is based on the mapping of virtual services (e.g., communication, data base, analyst support services) to physical, implementable items. Figure 8-2 presents this concept in a diagram. GLOBIXS communication services use physical communication servers to access physical transmission systems and packet- or circuit-switched network services. People using workstations in CCC use virtual communication services and employ distributed data base and operating system facilities to use software veneers running on computers throughout the CCC and on computers at GLOBIXS nodes. TADIXS communication services use tactical transmission systems and networking capability provided by the CSS hardware and software. TCC uses the same distributed computing base, as does CCC, to provide tactical commanders' staffs free access to information.

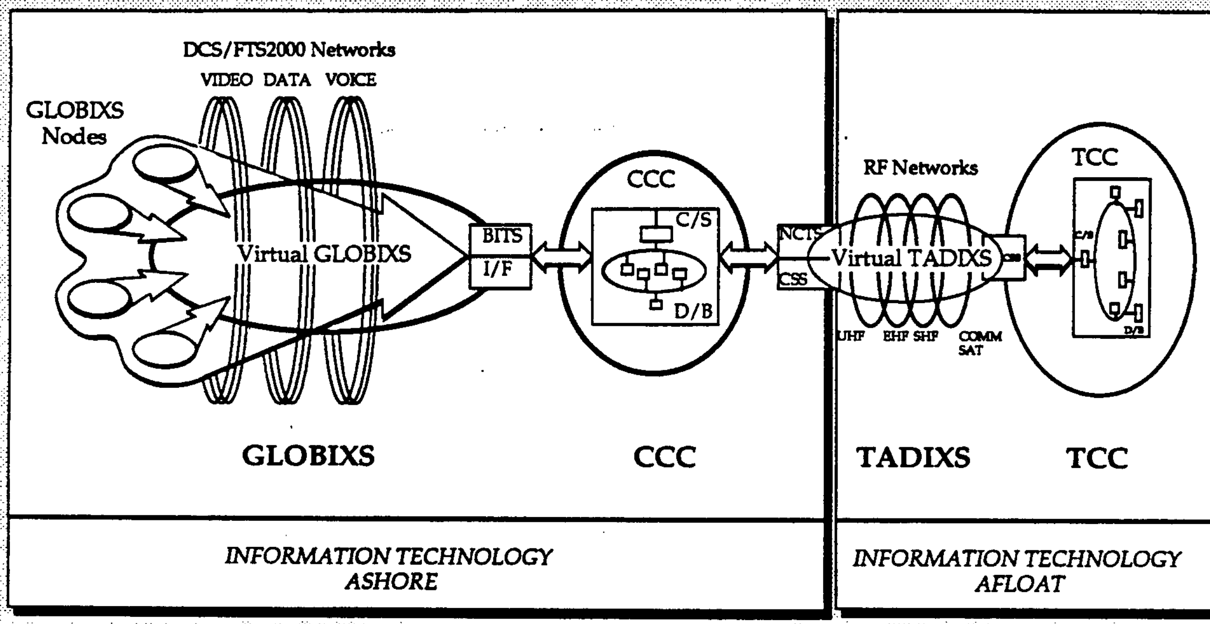

Figure 8-2. Conceptual/Physical Architectural Mapping

Figure 8-3 presents the functions that engineering design must address. The figure re-emphasizes the strong commonality among functionally similar pillars: GLOBIXS and TADIXS, CCC and TCC. To provide these functions, Copernicus implementations use the building blocks represented in figure 8-4.

Building blocks in the "GLOBIXS" column of the figure are, for the most part, obtainable today. Defense Communication System (DCS) communication services are increasing in importance. Base Information Transfer System (BITS) is the wideband local and metropolitan area network (LAN/MAN) to connect nodes in the CCC. Secure voice communication is available by using Secure Telephone Unit III (STU III) and (at unified commander in chief [USCINC] command centers) Red Switch systems. Federal Telecommunication System 2000 (FTS2000) is an existing common-user voice and data, circuit-and packet-switched network administered by the General Services Administration (GSA). Early transliterator implementations are in service now. Prototype sanitizers are also in use. Further development of transliterator and sanitizer technology has been assessed to be well within the grasp of industry. Research and development on multilevel security (MLS) systems can provide additional benefits, but MLS, while highly desirable, is not a prerequisite for GLOBIXS implementation.

CCC building blocks are also well within reach. Introduction of the Navy Desktop Tactical Computer 2 (DTC 2) has shown that it is feasible to target implementations on a family of computing engines, with a view toward follow-on expansion to other evoluntionary engines in the future. LANs provide service for all fleet commander in chief (FLTCINC) headquarters and in many other shore stations as well. CSS has successfully completed technology demonstration and is preparing for implementation with initial operational capability (IOC) in FY 93. Communication servers are commercially available, but it is important to select servers that can be managed by Open Systems

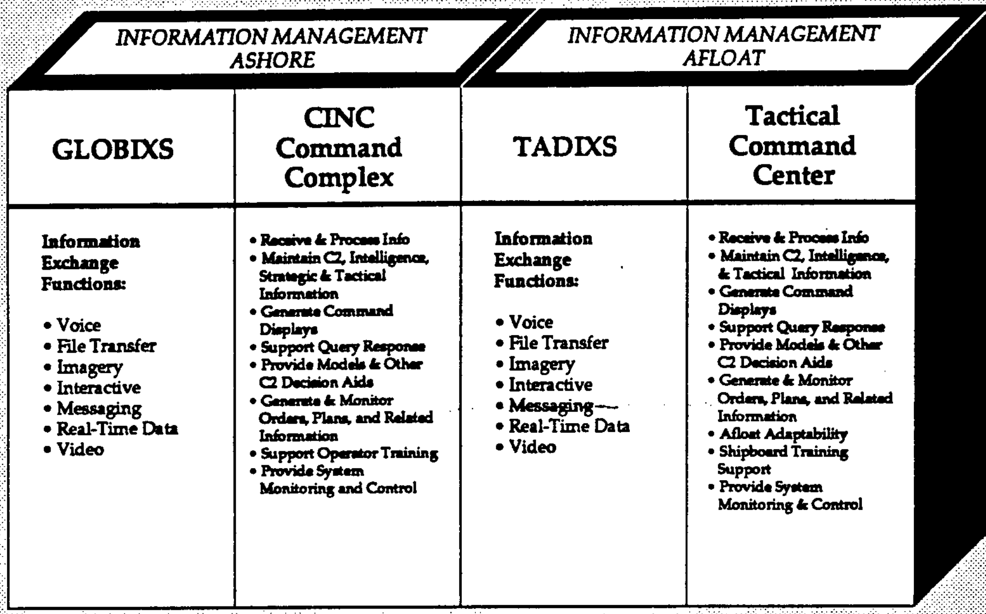

Figure 8-3. Identification of Copernicus Pillar Functions

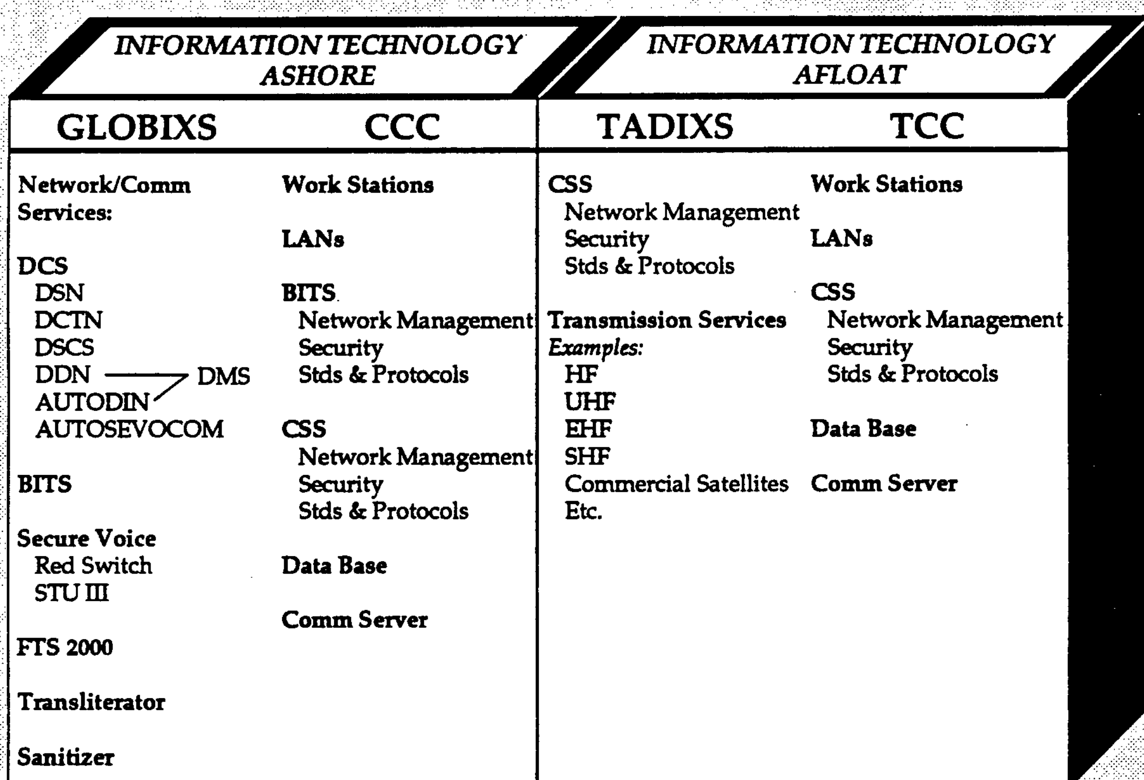

Figure 8-4. Copernicus Building Blocks

Interconnection (OSI) network management protocols. Data base service has made significant progress with implementation of relational data bases, and further improvements are anticipated through the use of object-oriented data bases.

TADIXS building blocks depend on similar network management, security, standards, and protocols as GLOBIXS. TADIXS also depends on government-developed bearer services (discussed in detail in annex B).

TCC building blocks are similar to CCC blocks, except that an afloat LAN is used rather than the BITS LAN. Similarly, CSS is the only source of communication services.

Today, in some cases, more than one existing program is developing a capability that can serve as a building block of the architecture. In these cases, the Navy must carefully consider the requirement for two very similar building blocks and choose one among these as the Copernican "standard". By that means it should be possible to select a "best of breed" that would receive strong programmatic and management support for application to the architecture.

The final feature of the engineering model is presented in figure 8-5, which shows the standards that create a COE. The elements of this COE have been jointly agreed on by the Army staff and Air Force staff proponents for C4I, the Marine Corps Director of C4S, and the Navy Director of Space and Electronic Warfare (SEW) (OP-094). The COE is being implemented by the Navy Tactical Command System Afloat (NTCS-A) and by CSS. The COE is a military implementation of reference (a).

Individual engineering models of the four pillars are presented in the following text. Due to the strong commonality among the four pillars (and particularly in the GLOBIXS/TADIXS, CCC/TCC sets), some detail presented in the GLOBIXS and CCC sections will not be repeated in the TADIXS and TCC sections.

	Standards
System Support	
Operating Systems	UNIX/POSIX Compliant
Comms Interface/Protocols	GOSIP/TCP-IP/SAFENET/CSS
Windowing (MMI)	X-Windows II Release 4
Systems Admin	Diagnostics
System Management	CMIS/CMIP/SNMP
System Security	(Orange Book)/SDNS
BUS Architecture	VME/FUTUREBUS +
C2 Support	
Display Toolkit	MOTIF
Data Base Manager	SQL/RDBMS
Internal Interface	BTR
System Services	ADA/C/ADA Bindings
Display	Chart +
C2 Comm Applications	
External Comms	GLOBIXS/TADIXS Physical Nets
Message Processing	USMTF/Copernicus Common/TADIL J
Correlation	Attribute/ELINT/Probabilistic/Acoustic
Data Base	Track, C&P/008

Figure 8-5. A Notional Copernicus COE

DISCUSSION

At its highest level, the engineering model is based on the mapping of virtual services (e.g., communications, data base, analyst support services) to physical, implementable items. Figure 8-2 presents this concept in a diagram. GLOBIXS communications services use physical communications servers to access physical transmission systems and packet-or-circuit-switched network services. People using workstations in the CCC use virtual communications services and employ distributed data base and operating system facilities to use software veneers running on computers throughout the CCC and on computers at GLOBIXS nodes. TADIXS communications services use tactical transmission systems and networking capability provided by the CSS hardware and software. TCC uses the same distributed computing base as does CCC to provide tactical commanders' staffs free access to information.

BUILDING BLOCKS

Figure 8-3 presents the functions that engineering design must address. The figure reemphasizes the strong commonality among functionally similar pillars: GLOBIXS and TADIXS, CCC and TCC. To provide these functions, Copernicus implementations use the building blocks represented in figure 8-4.

GLOBIXS Building Blocks

Building blocks in the "GLOBIXS" column of the figure are, for the most part, obtainable today. DCS communications services are used by existing Naval telecommunications and are increasing in importance. BITS is the wideband LAN and MAN to connect nodes in the CCC. Secure voice communication is available by using STU III and at (USCINC command centers) Red Switch systems. FTS2000 is an existing common-user voice and data, circuit- and packet-switched network administered by the GSA. Early transliterator implementations are in service now. Prototype sanitizers are also in use. Further development of transliterator and sanitizer technology has been assessed to be well within the grasp of industry (see chap. 4). Research and development on MLS systems can provide additional benefits, but are not prerequisite for GLOBIXS implementation.

CCC Building Blocks

CCC building blocks are also well within reach. Introduction of the DTC-2 has shown that it is feasible to target implementations on a family of computing engines, with a view toward follow-on expansion to other evolutionary engines in the future. LANs provide service for all FLTCINC headquarters and in many other shore stations as well. CSS has successfully completed technology demonstration and is preparing for implementation with IOC in FY 93. Communications servers are commercially available, but it is important to select servers that can be managed by OSI network management protocols (see chap. 3). Data base management has made significant progress with implementation of relational data bases, and further improvements are anticipated through use of object-oriented data bases.

TADIXS Building Blocks

TADIXS building blocks depend on similar network management, security, standards, and protocols as GLOBIXS. TADIXS also depends on government-developed bearer services (discussed in detail in annex B).

TCC Building Blocks

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Today, in some cases, more than one existing program is developing a capability that can serve as a building block of the architecture. In these cases, Navy must carefully consider the requirement for two very similar building blocks and choose among these as the Copernicus "standard." By that means it should be possible to select a "best of breed" that would receive strong programmatic and management support for application to the architecture.

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Individual engineering models of the four pillars are presented in the following text. Due to the strong commonality among the four pillars (and particularly in the GLOBIXS/TADIXS, CCC/TCC sets), some detail presented in the GLOBIXS and CCC sections will not be repeated in the TADIXS and TCC sections.

GLOBIXS ENGINEERING MODEL

GLOBIXS virtual services are indicated in figure 8-6 with relation to other pillars. They are described in Chapter 4 in operational terms.

GLOBIXS Technology Basis

The two primary technological developments that make GLOBIXS possible are:

- Large amounts of terrestrial digital bandwidth at low per unit cost often because of optical fiber facilities; and
- Distributed stored program control of telecommunication transmission and switching facilities.

Distributed stored program control enables network managers to assign transmission

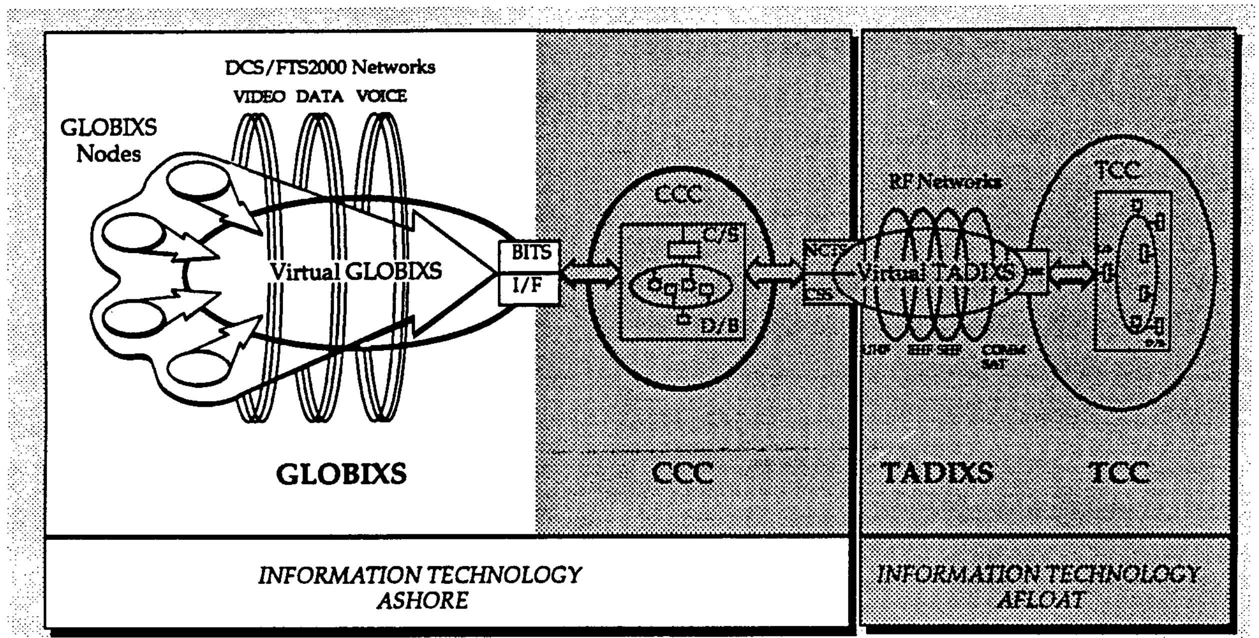

Figure 8-6. Relationship of GLOBIXS to Other Copernican Pillars

channels dynamically on an end-to-end basis, keep track of their configuration, and do fault isolation and restoration. The bandwidth mix of such channels is also very adaptable in multiples and submultiples of 64 kbps ranging up to speeds of hundreds of Mbps. Standard network management structures, interfaces, and services as well as access controls allow user-communities to administer and adapt those channels assigned to them.

User communities can administer and update their own network directories without losing compatibility with global directories and directories of other user communities.

Transmission cross-sections in the hundreds and thousands of Mbps that can be quickly subdivided and reallocated to allow such networks to be created economically. Soon the availability of non-blocking switches based on accepted worldwide standards that can handle any service from 75 bps TTY to high definition television (i.e., broadband Integrated Services Digital Network [ISDN]) will allow the network manager to make it appear to user communities as if they have a virtual network they control.

Because services and interfaces would be common to all networks, virtual networks could interoperate as well as having simultaneous user access to shared networks.

Available networks that can offer this capability today are Defense Commercial Telecommunications Network (DCTN) or FTS2000. Other networks soon will be available including Navy Network (NAVNET), wideband Defense Data Network (DDN), and Defense Integrated Secure Network (DISNET). A future network would be the Defense Integrated Services Network (DISN). It is expected, however, that the DCS would be the primary vehicle since its network management, administrative, security, and services structure would be most compatible with the GLOBIXS concept.

The following presents a summary of three elements common to GLOBIXS and TADIXS, which are necessary to bind effectively these elements into the architecture; 1) management services, 2) bearer services, and 3) user communication services.

GLOBIXS/TADIXS Management Services

This category of services allows planners, maintainers, and operators of communication services to:

- Make the best fit of available capability to the operational requirement;
- Intelligently use available on-line mechanisms to keep systems operating; and
- Make the best use of available capability.

The categories of management service are standard OSI network management categories. Annex A presents a detailed description of these services as they apply to GLOBIXS and TADIXS.

In addition to the management services described in Annex A, GLOBIXS (and TADIXS) managers will require software veneers of application programs to use effectively data gathered through configuration management and accounting management. This capability is required both for operation and for planning.

GLOBIXS/TADIXS Bearer Services

Transmission systems often are referred to as bearer services. They are the physical layer subsystems that provide the radio or wireline path for GLOBIXS and TADIXS virtual network services. Bearer services connect one unit with another.

GLOBIXS/TADIXS User Communications Services

Copernicus communication services are functional and operational information exchange pathways. They are not individual communications streams or separate communications nets. Instead, they will share access to the various bearer services (detailed in annex B). There are precursors to the Copernican TADIXS, although there are no virtual networks that currently serve the operating forces. One precursor to Copernican TADIXS is the Officer in Tactical Command Information Exchange Subsystem, Phase II (OTCIXS II). Annex C presents a detailed discussion of these and other user communication services.

CCC ENGINEERING MODEL

Figure 8-7 presents the relationship of CCC to the other pillars of the architecture.

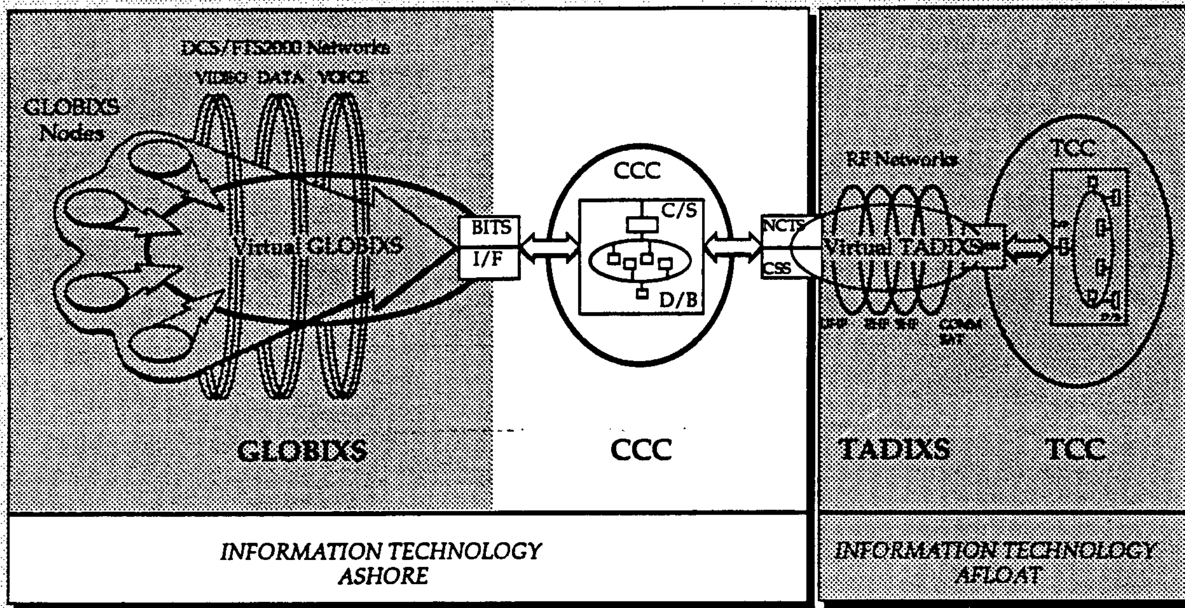

Figure 8-7. Relationship of CCC to Other Copernican Pillars

There are five elements of the model to be considered: evolutionary architecture, evolving technologies, standards, application programs, and data bases.

Evolutionary Architecture

The CCC builds on the evolutionary open systems architecture model of the Navy Command and Control Systems (NCCS) and the NTCS-A, achieving optimum commonality and interoperability among computer systems installed in the CCC and TCC and with interfacing centers. A high degree of commonality is found in data bases and application programs in the Fleet Command Center (FCC), Operations Support System (OSS), Shore Anti-Submarine Warfare (ASW) Command Center (SACC), Submarine Operations Control Center (SOCC), and ASW Operations Centers (ASWOCs). Uniqueness is readily apparent in the Joint Intelligence Center (JIC), Fleet Numerical Oceanographic Center (FNOC), Naval Western Oceanographic Command (NWOC) and the Naval Computer and Telecommunications Area Master Stations (NCTAMS). Figure 8-8 compares the major engineering constructs of current Navy shore-based and afloat systems.

Evolving Technologies

The CCC also builds on the evolving technologies of multimedia networking and distributed systems that facilitate graceful growth and modernization at less cost than earlier stand alone systems. Equally important, these technologies provide an engineering means to achieve desired levels of computer system and commu-

SYSTEM	PROCESSING HARDWARE	PROCESSING SOFTWARE	DISPLAY HARDWARE	OPERATING SYSTEM	DBMS	L.O.C.	SYSTEM NAME
ASWOC Upgrade	DTC-2 Sun 4/110 & 330	Ada, C	Sun	UNIX	ORACLE	700K	ASWOC Modernization Program
CMST-N	Sun 4/370	C, FORTRAN	Sun	SUN OS 4.1	SYBASE	100K	Collection Management Support Tool-Navy
ENWGS	HONEYWELL DPS-8	PL 1	BARCO & Sun Terminals	MULTICS	EMBEDDED (MRDS)	450K	Enhanced Naval Warfare Gaming System
FPC	Macintosh, DTC-2,* (In transition)	C, FORTRAN, LISP, Ada	DTC-2	VMS, UNIX, DOS	ORACLE	>500K	Fleet Planning Center
FHLT	DTC-2 Sun 4/110 & 330 (In transition)	Ada, C	DTC-2 (Dual Monitor)	UNIX	ORACLE	>750K	Force High Level Terminal
JOTS I	HP 9020 A, C	BASIC	HP 9020 A, C	ROCKY MTN. BASIC	EMBEDDED	250K	Joint Operational Tactical System
JOTS II	DTC-2 Sun 4/110 & 330	Ada, C	DTC-2	UNIX	SYBASE	330K	Joint Operational Tactical System
NWSS	HONEYWELL H-6000 or DPS-8	COBOL	TEK 4014, WANG	GCOS-8	Integrated Data Store (IDS)	1,300K	Navy WWMCCS S/W Standardization
OBU	VAX 8650 MICROVAX II	PASCAL, FORTRAN	VMI Alph/Numeric GENISCO Graphic (to be replaced)	VMS Ver 5.2	IMBEDDED & ORACLE	975K	OSIS Baseline Upgrade
OSS	DTC-2 Sun 4/110 & 4/330	Ada, C	DTC-2 BARCO 1001	UNIX	ORACLE	>500K	Operations Support System
STT	DTC-2 Sun 4/110 & 330	Ada, C	DTC-2	UNIX	ORACLE		Shore Targeting Terminal

* Collection of prototypes transitioning to indicated systems.

Figure 8-8. Command and Control Systems Comparison

nication system interoperability within and between Navy centers and between Navy centers and national, joint, and allied centers. The technologies also aid in implementing load-sharing and load-balancing between systems within command centers and between geographically dispersed systems.

Standards

Modular and common design and acquisition approaches will reduce development and implementation time, system operator and maintenance training time, and numbers of required personnel. These factors imply identification and design of incremental improvements to existing CCC/TCC systems that will move the CCC/TCC to the desired spectrum of commonality and interoperability.

Strong configuration management ensures that developments conform to an evolving and guiding architecture and incremental requirements. It enhances the probability of easy integration of new products into existing configurations.

Application of relevant Federal Government, DOD, and industry standards helps to achieve interoperability, reduces manpower/ training costs, and minimizes development and logistics support costs. These standards are derived from sources such as references (a) through (d) and related development and acquisition documents, commercial off-the-shelf (COTS), government off-the-shelf (GOTS), Government Open Systems Interconnection Profile (GOSIP), SOE, COE, and proven nondevelopmental item (NDI) products. Standard use of selected computer-aided software engineering tools will assist in reducing software development time and cost.

A CCC development effort to encourage the reuse of existing software applicable to each increment will be initiated. Trade-off analysis will assess cost and risk of porting old software to a new configuration instead of initiating software development. OSS and NTCS-A experience in this area will be applied to CCC/TCC development.

Application Programs

The CCC/TCC will feature a distributed applications processing environment. Applications will include computations (e.g., data fusion, correlation, closest point of approach (CPA), track projections, probabilities/statistics calculations); specific models; data source catalogs; application program description/location catalogs; and tactical/strategic decision/planning aids. Networks will provide the media for accessing local and distant needed/authorized application programs.

Data Bases

The CCC/TCC data base will be organized from the best features of the OSS and NTCS-A data bases. The construct of the electronic support measures (ESM) portion, however, will be decided after completion of an examination of the current multiple ESM data bases.

The CCC/TCC will adapt an object-oriented design for its data base and data base management schemes. Rules of data relationships and object interactions will provide the logic for intra- and inter- organization information management consistency. In addition, the data management scheme will facilitate ready retrieval of multimedia information related to a particular subject or situation.

TADIXS ENGINEERING MODEL

Figure 8-9 indicates the TADIXS relationship to other pillars of the architecture. It should be emphasized, however, that TADIXS provide virtual networks among the forces afloat as well as linking the CCC and TCC.

CSS is the single most important element of the TADIXS engineering model. Chapter 6 provided an operationally-oriented discussion of CSS features; reference (e) addresses technology applications. CSS provides the ability for the tactical commander, through the Space and Electronic Warfare Commander (SEWC) staff, to control TADIXS in a manner analogous

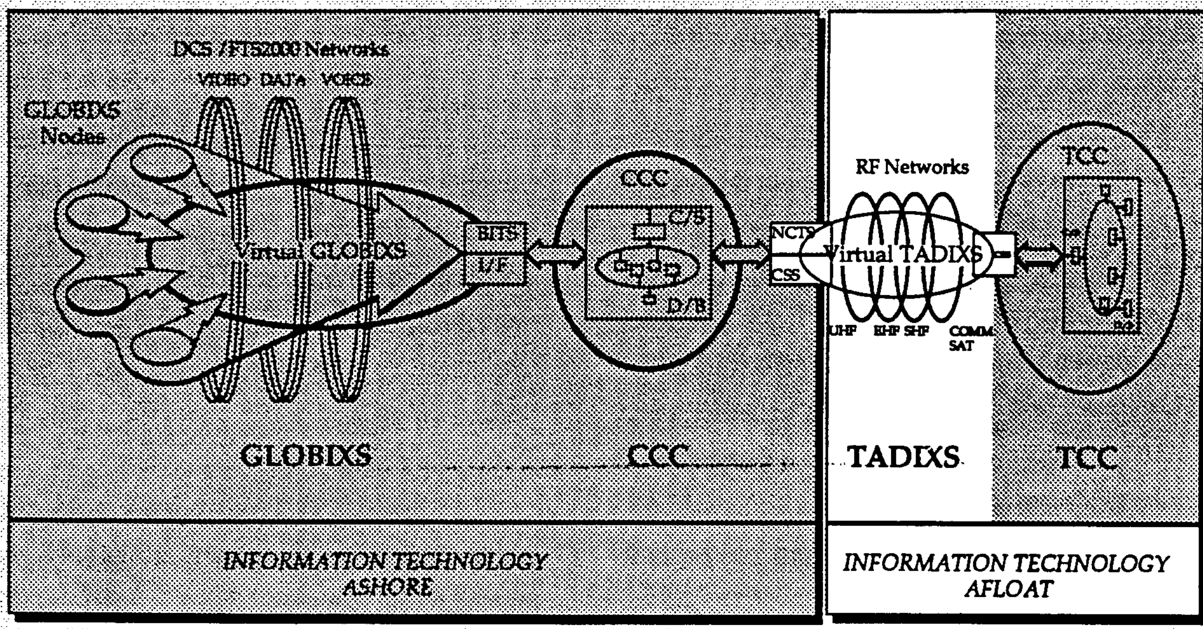

Figure 8-9. Relationship of TADIXS to Other Copernican Pillars

to the fashion other commanders control ASW, Anti-Surface Warfare (ASUW), or Anti-Air Warfare (AAW) forces.

The three services addressed in connection with the GLOBIXS Engineering Model (see annexes A, B, and C) are valid for TADIXS as well. Of at least equal importance, however, are bearer service improvements that will continue recent improvements in tactical communication. Pre-eminent among these is the fitting of super high frequency (SHF) satellite communications (SATCOM) capability on combatant ships. This high quality, relatively wide bandwidth (32 kbs up to a potential capacity of 1.544 Mbs) bearer service with some anti-jam capability will enhance C^4I afloat significantly.

Other key elements of the TADIXS engineering model include bearer service improvement programs: the Satellite Integrated Terminal program for ultra-high frequency (UHF) SATCOM, Navy Extremely High Frequency (EHF) SATCOM Program (NESP), potential medium data rate service (MDR) from EHF SATCOM space craft, and commercial SATCOM afloat.

TCC ENGINEERING MODEL

The TCC (see fig. 8-10) builds on the evolutionary open systems architecture model of the NCCS ashore and the NTCS-A to achieve optimum commonality and interoperability among computer systems installed in the TCC and CCC command and command support centers and with interfacing centers. Figure 8-2 shows a conceptual model of a modular, distributed TCC. Figure 8-8 compares the major engineering constructs of current Navy shore and afloat-based systems.

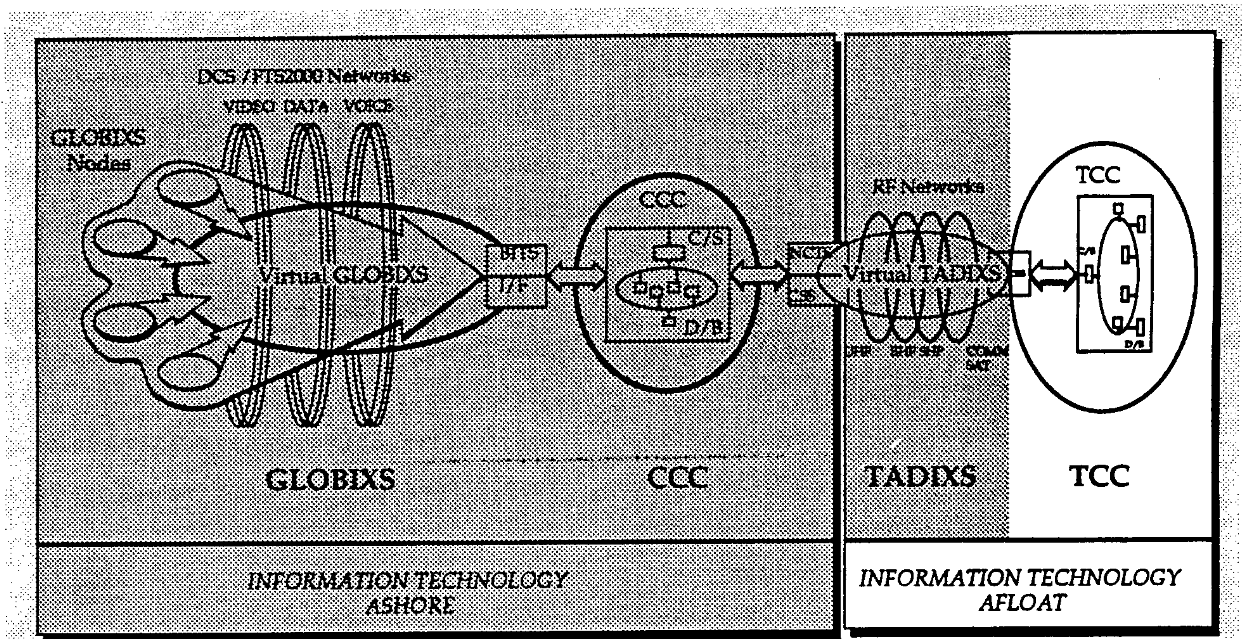

Figure 8-10. Relationship of TCC to Other Copernican Pillars

There is a high degree of commonality (both needed and existing) among the multiple data bases supporting the current NTCS-A and the FCC. The most significant differences are the extent of dynamic track data in the TCC data base and low time perishability of track and support (environment, readiness, engagement situations) data. The FCC can focus on the same area of responsibility that the Officer in Tactical Command (OTC) is viewing, but the data may be time late or more in the aggregate than is usable to the OTC.

Consistency in data and data protocols such as, resolution, registration, coordinates, protocols, formats, data base file structures, and data definitions, among others, is an objective that will be pursued incrementally as the CCC/ TCCs evolve.

Multimedia networking and distributed systems technologies coupled with availability of standard operating systems facilitate graceful growth and interoperability and provide means for local and distant load-sharing and load-balancing.

The standards, application programs, and data base elements of the TCC engineering model are the same as those presented in the discussion of the CCC engineering model.

Specific Configurations

Numbered Fleet Flagships. In numbered fleet commander (NFC) flagships, TCC systems are not required generally to interface with combat systems or sensors but must have large data base and processing capacities for data storage/manipulation relative to the area of responsibility

(AOR). Additionally, such TCCs may have specialized strategic planning, tactical decision aids (TDA), as well as employment scheduling and logistics planning capabilities.

LCC/LHD in Amphibious Flagships. TCCs serving Commander, Amphibious Task Force/ Commander, Landing Force (CATF/CLF) as well as other embarked ground and Special Forces elements must have sea and land-oriented data bases and tailored TDAs. Special plug-in/plug-out tactical data-processor arrangements support data bases ashore to sustain consistency with afloat data bases. While embarked, LAN connectivity may extend to USMC systems such as TERPES[1] and PLRS[2]. Dedicated links extend TCC support to forces ashore until handover of responsibility to CLF.

CV/CVN. TCCs serve Battle Force (BF) and Battle Group (BG) Commanders and embarked subordinate commanders and their staffs using dual ring (Sensitive Compartmented Information (SCI) and general service [GENSER]) LANs to provide inter- and intra-system connectivity. This includes combat direction systems such as Advanced Combat Direction System, Tactical Air Mission Planning System, Tactical EA-6 Mission Planning System, CV-ASW Module, and organic sensors such as BGPHES[3] and TARPS[4], and associated support centers (e.g., Ship's Signal Exportation Space, Carrier Intelligence Center, Supplemental Plot). Carrier TCCs will be capable of the full range of sea control and power projection functionality while having an air operations orientation in TDAs.

Major Combatants. TCCs in cruiser classes (and destroyer, frigate, SSN, etc.) serve warfare commanders generally in AAW, ASW, and ASUW roles. Cruiser/destroyer capabilities will be a subset or downsized version of carrier TCCs.

Other Applications. Due to the unique multimission nature of SSN operations as either part of a BG organization or conducting independent operations, a smaller, tailored TCC will be an adjunct to the submarine's mainframe combat control system. This TCC will provide the necessary connectivity for intelligence, threat data, environmental conditions, water space management, targeting, and command and control with either the BG commander or SSOC.

Similar special application TCC's could be easily established afloat or ashore as part of a mobile command center in support of unconventional warfare or other unique mission areas. The flexibility of the Copernicus architecture is the key to meeting these requirements.

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[1] Tactical Electronic Reconnaissance Processing and Evaluation System (TERPES).
[2] Position Location Reporting System (PLRS).
[3] Battle Group Passive Horizon Extension System (BGPHES).
[4] Tactical Airborne Reconnaissance Pod System (TARPS).

ANNEX A
NETWORK MANAGEMENT

The following descriptions of standard network management services are tailored to Navy GLOBIXS and TADIXS implementations. As stated in Chapter 4, Navy will use COTS implementation for communication among shore establishment nodes. Navy personnel managing communications, however, should not be required to learn different management functions for shore and fleet communications. Network management implementations, therefore, will use the Copernicus human machine interface (HMI) as the standard representation of communication processes and mechanisms that manage them.

The Navy does not require unique network management capability. The Navy does require that COTS implementations provide the functions listed below (or be capable of being adapted to provide these functions). Above all, Navy requires that the management interface be the Copernicus CSS HMI.

Network management encompasses the functions of:

- Configuration management;
- Performance management;
- Fault management;
- Security management; and
- Accounting management.

CONFIGURATION MANAGEMENT

Configuration management serves planners, maintainers, and operators by assuring a common reference of:

- What resources are available;
- Which are in use; and
- How they can be used (both technical capability and doctrinal constraints).

The following briefly outlines requirements for GLOBIXS and TADIXS planners, maintainers, and operators to use configuration management.

GLOBIXS Use of Configuration Management

GLOBIXS claimant planning is a relatively long-term activity. Configurations will be designed to permit user communities to establish virtual networks for information exchange, and these configurations will not change frequently (except at local sites, where consumer premise equipment (CPE) frequently will be moved among offices). The claimant for each GLOBIXS will use configuration management to keep track of bearer services that support the GLOBIXS, to monitor how CCC and other users are employing bearer services and GLOBIXS, and to plan for future expansion of bearer services. Site administrators will provide configuration management "upload" of local site configuration information to the claimant. Nodal personnel (similar to DCS technical control station or patch and test facility) will upload node and inter-site information in an automated process similar to current DCS circuit card maintenance procedures. Naval Computer and Telecommunications System stations will upload regional and communication area information (for shore-to-shore bearer services and networks).

At a Navy-wide level, claimants will provide funding requests and requirements information through electronic submission of configuration management information. Configuration management files of existing and planned capabilities will allow more precise estimates of required funding and equipment provisioning when bearer system changes are being planned. When funding cuts or transfers of claimancy take place, configuration management files will permit more precise estimates of the effects of cost-cutting or transfer of responsibility.

GLOBIXS maintenance will be done primarily by contract personnel because most GLOBIXS bearer service and CPE will be contractor-owned and maintained. Good configuration management practice (and associated accounting management, discussed below) will reduce costs of contractor maintenance by allowing bidders to estimate more precisely the staffing, equipment, and material costs they will incur. Configuration management (and associated fault management, discussed below) will help eliminate "finger pointing" across interfaces by providing precise descriptions of responsibility domains, and technically correct descriptions of interface performance characteristics. Configuration management and accounting management processes will also help the government accurately evaluate the performance and cost of contractor maintenance.

GLOBIXS operation also will be a contractor responsibility in most cases. CCC watch personnel (and personnel at other GLOBIXS subscriber sites) will require the capability to use performance management processes (discussed below) to "look over the shoulder" of contractor personnel, providing visibility into communication system operation. In most cases, this visibility will be to monitor, not to intervene in, system operation. In exceptional cases (such as natural disaster), CCC and GLOBIXS site personnel will need to use configuration management, performance management, and fault management processes in coordination to give direction to contractor operation centers. Even during routine operation, good configuration management and performance management capability will allow CCC and GLOBIXS site personnel to see clearly the status of their communications and the source of problems and the ability to compensate through operational procedures (such as shifting operational responsibility to an alternate site) if communication problems cannot quickly be corrected.

TADIXS Use of Configuration Management

Communication planners will use configuration management to prepare CSS connection plans for use in TADIXS operations. These plans are electronically prepared, coordinated, and disseminated assuring all affected sites provide required services. Ships and NCTS stations will provide site configuration management information through the administrative chain of command for use by operational planners preparing CSS connection plans.

Modernization planners will use configuration management to support the planning and execution of the Fleet Modernization Program (FMP) and related shore modernization projects. By knowing equipment capabilities and configuration, Navy staff FMP and Naval Computer and Telecommunications Command (NCTC) planners can accurately estimate funding requirements. To optimize this modernization planning, configuration management processes will require the capability to relate modernization programs to fleet operational employment (information developed by employment scheduling mechanisms in the CCC).

When operational planners perform time-sensitive force planning under the Joint Operational Planning and Execution System (JOPES), they will use configuration management to determine the communication capabilities of units being considered for use in a crisis or contingency. Interoperability can be assured by selecting ships and aircraft with appropriate capability, and requirements for costly augmentation can be averted by a clear understanding of the operating forces' configuration.

Maintainers at all echelons will use configuration management to plan effectively and will execute planned maintenance and demand maintenance actions in support of operational requirements. Material requirements, test equipment, and personnel skill requirements can be estimated more accurately. Part stocks, test equipment suites, and personnel training plans can be adjusted appropriately by timely and accurately updating configuration management at each unit. In some cases, configuration management can show that accelerating (or delaying) a modernization project can save money in repair-part stocking and personnel training actions.

Operators can use systems more effectively by having access to more precise configuration management information. The CSS connection plan, a successor to the current communication plan, is itself a configuration management file that shows how systems are to be used operationally at a particular time or in a specific mission. Operators then can use performance management to assess effectively how well the pre-planned connection plan is serving the mission or how an alternative connection plan could be developed. Configuration management information will help eliminate ambiguity in the operational coordination of communications, reducing confusion that sometimes develops when personnel from different FLTCINC headquarters or personnel from different Services coordinate communication operations.

PERFORMANCE MANAGEMENT

Performance management mechanisms monitor the functioning of communication subsystems, collect statistics, provide alerts when performance exceeds prescribed bounds, and support operator assessment of system capability against mission requirements.

GLOBIXS Use of Performance Management

Planners will use historical performance management information (primarily statistics) to assess how effectively GLOBIXS are supporting operational information exchange requirements. They also will use performance management information to more intelligently plan for and advocate funding for communication subsystem improvement programs.

Maintainers, as noted in connection with configuration management, will be primarily contractor personnel. They will use performance management as an indicator of the requirement for demand maintenance. Performance management information will also help government and contractor GLOBIXS maintenance personnel optimize spare parts, test equipment, and personnel skill requirements.

Operators will be the principal beneficiaries of performance management capability. Operational users will not have to depend on a small staff of trained communicators at a CCC or GLOBIXS node to monitor and control communication services because performance management information will be accessible through the Fleet All-Source Tactical Terminal (FASTT) HMI. Communication status will be available at any workstation and to any operator. Operators, therefore, will have visibility into the services their software veneer is accessing and increased confidence that they can understand and (if necessary) control the communications required to execute their mission.

TADIXS Use of Performance Management

TADIXS planners will use the results of performance management statistical monitoring to analyze how well communication services supported execution of recently completed missions. They will be able to analyze how well user information transfer requirements were supported and improve planning for subsequent missions. Planners may be able to use modeling and simulation techniques to analyze alternative ways of satisfying the requirements that were presented in a mission and significantly improve the CSS connection plan that would be used for subsequent missions of that type. Planners also will be able to use performance management statistics to advocate requirements intelligently for modernization or updates to communication mechanisms.

Maintainers will use performance management to enhance system availability. During a mission, maintenance personnel will be able to see areas of degraded performance and initiate maintenance action if appropriate or necessary. After a mission, site and administrative chain of command personnel will review system performance to determine if changes in spares stock, maintenance, or training policy could improve performance. Performance information will be particularly useful to software support activities, because they will be able to understand better the operational environment in which software operates.

TADIXS operators, like GLOBIXS operators, will have the greatest benefit from performance management. Naval personnel have direct responsibility for operation of TADIXS and require direct access to information about system performance. Current systems require trained communications personnel (usually Radioman or Communication Technician [Operator] [CTO] ratings) to perform this function by interacting directly with the front panels of the many equipment components making up digital systems. This process requires many people, and each must be trained to evaluate the information on the equipment front panels. This process effectively is hidden from people who use communications systems, because it takes place in radio room spaces. Moreover, RM/CTO personnel use language quite different from the language of communication system users.

Some operational users, however, have responsibility for coordinating not only the information flow among user processes, but also the supporting communications. Examples of these operational users are:

- The Force Track Coordinator (FTC) who is responsible for coordinating operation of Link 11, Link 14, and Joint Information Distribution System (JTIDS) as well as enforcing force information management policy; and
- The Force Over-the Horizon-Track Coordinator (FOTC), who is responsible for coordinating operation of over-the-horizon targeting (OTH-T) communication systems in addition to enforcing OTH-T fusion and track management.

When communication conditions are unstable, each of these watch positions spends a significant amount of time monitoring communication indications and interacting with radio room personnel to the detriment of their information management duties.

By contrast, performance management mechanisms presented at the work stations used for AAW track management and OTH-T data fusion will allow the FTC or FOTC to pay little attention to communication performance. Performance management mechanisms can be represented as simply as a green, yellow, or red box in one corner of the screen denoting satisfactory, marginal, or unsatisfactory communication system performance.

If the CSS connection plan has provided adequate access to media for the AAW or OTH-T service, the performance management box will stay green so long as the service operates without fault or problem. Should unanticipated problems or operational conditions develop, however, the CSS user services (described below) should provide continuing service for at least the minimum essential information. Should human intervention be necessary, fault management (discussed below) will give a common presentation of the problem. Operational user and RM/CTO personnel will use performance management capability as a common reference of what the situation is, and configuration management will give a common understanding of what can be done.

FAULT MANAGEMENT

Fault management is an extension of both performance management and hardware fault indicators. Performance management sets thresholds of service operation (e.g., delay, queue size) that will trigger fault management if thresholds are violated. Hardware fault indicators also will trigger fault management. Some fault management actions may be a simple trouble report for maintenance action and operator information. Other fault management actions may involve days of restoral activity.

GLOBIXS Use of Fault Management

Planners will use GLOBIXS fault management after the fact. They will evaluate the causes of faults and evaluate action taken to restore service (if an interruption occurred). Planners will examine performance management to determine if service requirements were appropriate and will examine configuration management information to determine if adequate redundancy, spares, test equipment, and trained personnel were in place to effectively deal with the fault. Planners also will review fault management history files to determine trends and may use modeling and simulation capabilities to project future fault management requirements.

As a result of this activity, planners may work up proposed changes to communication bearer services or other segments. The configuration management, performance management, and fault management information used to develop the proposed changes will be accessible to higher echelons so the adequacy of the proposed changes can be assessed and cost estimates confirmed.

Contractor personnel responsible for planning will be able to articulate proposed changes more clearly and factually in contract to the government, and government will be able to evaluate the substance of the proposed change more easily. Both contractor and government participants will be able to control cost more effectively by having a clear picture of fault management history.

Maintainers will be a principal user of fault management in real time. Rather than receiving ambiguous trouble reports from human operators who may not have an opportunity to consider all the factors involved in a hardware problem, maintainers will be able to look at the system-level information associated with a particular fault. This will result in more timely, cost-effective, and efficient action to respond to the fault. Fault management may also help avoid unnecessary overtime charges that result when the wrong maintenance person is called to correct a problem. It can also reduce delay in getting the most appropriately trained person to address the problem.

Operators will benefit in the following ways:

- First, when a performance management threshold is violated, operators will be able to quickly assess if a hardware or software fault has caused the problem; and
- Second, operators will be able to focus full attention on restoring service (if CSS multiple resource access has not provided adequate service automatically) rather than spending time diagnosing the problem and writing a clear and factual trouble report.

Operational users of GLOBIXS services will benefit from fault management by getting clear and unambiguous information about what faults exist and (by the coordination of configuration, performance, and fault management mechanisms) the effect of the faults on system capability. This will help operational users continue working the operational problem rather than being required to focus on communication faults.

TADIXS Use of Fault Management

TADIXS planners and maintainers will use fault management for the same purposes that planners and maintainers of GLOBIXS will use it. A significant difference is that TADIXS planners and maintainers will be able to affect change more quickly in many cases. Parts can be shifted quickly from one unit to another to effect repair, test equipment can be cross-decked, and trained personnel can be provided quickly in response to technical assistance requests. As with contractor-provided GLOBIXS services however, there are costs associated with these actions. Fault management information will allow both GLOBIXS and TADIXS planning and maintenance personnel to avoid fault-related costs through more accurate management information on faults.

TADIXS operators also will benefit in the same way GLOBIXS operators benefit. This is more critical in the tactical environment because a small number of RM/CTO personnel will be dealing with many urgent communication support matters. Clear, consistent, fault management information will reduce response times (although in most cases, CSS resource sharing and multiple media access mechanisms will eliminate requirement for operator action). Fault management will help enhance training, because operators will no longer be required to integrate information from several pieces of equipment to deduce the cause of a problem.

TADIXS operations controllers at the Battle Group and Battle Force level will experience an even more significant benefit. These personnel, who will be watch standers in the SEWC organization, may not be RM or CTO ratings. They will depend on fault management information to assess the effect of a communication system fault on Battle Group or Battle Force operations. In many cases, CSS multiple media access will preclude a serious degradation — the SEWC operator will simply note that a fault has occurred. In other cases, the SEWC operator will use fault management information to invoke assistance from the force material control officer or force electronic material officer to ensure that a serious casualty is given priority attention.

TADIXS users also will benefit from fault management. In connection with performance management, we showed that the FTC and FOTC would use information presented at their TCC workstations to monitor operation of supporting communication services. Similarly, these watch personnel will receive fault management reports and monitor (when necessary) restoration activity.

SECURITY MANAGEMENT

Security management features provide access control, trust in the functioning of key processes, and special features such as cryptographic key management. Security management also controls some important configuration management functions. For example, security management would assure that only an authorized person could set up or tear down services, preventing an unplanned service blockage.

GLOBIXS Use of Security Management

Planners and maintainers of GLOBIXS will use security management for a number of purposes. There will be periodic assessments of security requirements, inspections to ensure that physical and information security requirements are met, and assessments of potential compromise when a potential violation is detected. Security management will provide more accurate and reliable records of security activity than current paper records provide.

A Department of Defense (DOD) requirement for security management that is somewhat unique is the management of communication security (COMSEC) processes and keying material. Planners will, in conjunction with the design of updated or expanded services, express requirements for COMSEC processes (which may be stand-alone equipment or embedded firmware in GLOBIXS communication servers), and keying material. Planners and maintainers will supervise installation, testing, and activation of new capabilities. Information security managers (similar to the current COMSEC custodian) will plan for use of key and ensure that keying material is available to GLOBIXS communication servers. To the maximum extent possible, red (unencrypted) key should never be accessible to personnel. In addition, it is a Copernicus requirement that GLOBIXS communication servers should manage real-time use of key through the Classic Lightening key distribution techniques.

Planners will use security management applications to devise information management doctrine for the CCC and TCC, ensuring that incoming information is routed to the correct user. Security management planning also will ensure that TCC-imposed requirements for the immediate handling of Case 1 and Case 2 data are met.

Operators will interact with security management routinely. The site Communication Officer will maintain access control to GLOBIXS communication servers and will qualify personnel to perform operations on the communication servers. Watch personnel will depend on trusted computing base processes to reliably route information to the intended recipient, segregate information streams by classification level and need-to-know, and verify subscriber authorization to access services. Watch personnel will manage key when necessary and monitor the operation of trusted computing base processes to manage key routinely.

TADIXS Use of Security Management

TADIXS planners will have much greater interaction with security management. They will use security management information from past operations to prepare CSS connection plans for upcoming operations. They will use security management planning capability to ensure that the necessary key is in place to support operational requirements and to plan subnetwork sizes to ensure that appropriate crypto net sizes are observed. As mission requirements change and force composition changes, planners will revise information handling and key management plans to accommodate the changing situation. Upon completion of the mission, planners will use the security management reporting capability to assess the effectiveness of security management and improve planning for subsequent missions.

Maintainers will comply with security management policy and will intervene when hardware faults to security equipment are observed. Operators of TADIXS will use security management processes in the same way that GLOBIXS operators use them.

ACCOUNTING MANAGEMENT

Accounting management provides routine "bookkeeping" services. Not all of these are related to cost accounting. The functioning of performance management, for example, depends on collection of statistics by accounting management.

GLOBIXS Use of Accounting Management

GLOBIXS planners will use accounting management to analyze and predict costs of GLOBIXS operation. In conjunction with other network management processes, accounting management will help planners estimate the costs of GLOBIXS service updates or expansions. When Navy policy permits or requires user billing for GLOBIXS services, accounting management will provide accurate and timely information for application programs that handle billing and collection.

GLOBIXS maintainers will use accounting management processes to supplement manually collected maintenance information. Accounting management will provide information about how long a hardware device or software process operated prior to the occurrence of a fault. It also will provide information such as subscriber and resource usage of hardware and software that could help in reconstructing fault scenarios.

GLOBIXS operators will use accounting management reporting features to observe statistics concerning system use. Accounting management will support routine reports, such as number of information units handled or calls processed, that are currently reported by manual means.

TADIXS Use of Accounting Management

TADIXS planners, maintainers, and operators will use accounting management in a similar way. Maintenance support features will be the principal benefit for TADIXS users.

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ANNEX B
TADIXS BEARER SERVICES

The following descriptions expand on information in Chapter 6 regarding existing and planned bearer systems that Copernicus TADIXS will use.

SATELLITE COMMUNICATION (SATCOM) BEARERS

TADIXS (except for Force Operations TADIXS services within a Battle Group or amphibious ready group) are heavily dependent upon satellite bearers. The Navy expects to lease commercial satellite communication bearers through the Defense Commercial Contracting Office (DECCO). Military satellite communication (MILSATCOM) bearers are DOD resources to be used as allocated by the unified commander.

UHF SATCOM

Networks currently operating that are precursors to the Copernican TADIXS use UHF SATCOM. Navy policy currently prohibits the use of UHF SATCOM for shore-to-shore connectivity (GLOBIXS service) due to the shortage of UHF SATCOM space resources and availability of SHF SATCOM and commercial SATCOM.

Other considerations in the use of UHF SATCOM are: All Navy combatant ships and submarines (and most support ships) have UHF SATCOM; requirements have been stated for naval aircraft to have UHF SATCOM, and some planning is going forward to provide this capability; and all DOD tactical forces have some UHF SATCOM.

Joint Chiefs of Staff policy requires UHF SATCOM users (except for human portable terminal users) to employ demand assigned multiple access (DAMA) in accessing UHF SATCOM by 1996. DAMA permits as many as 22 user network requirements to be satisfied on one 25 kHz transponder.

UHF SATCOM is relatively easy to use, and earth terminals are relatively inexpensive. UHF SATCOM space segment is less expensive than SHF or EHF to build, launch, and maintain on orbit.

UHF SATCOM links can be blacked out for hours at a time by nuclear bursts and are considered virtually unusable in an intensive nuclear environment. UHF SATCOM also experiences interference from scintillation coincident to high solar storm activity.

Current Navy applications of UHF SATCOM include secure voice, Fleet Broadcast, the Submarine Satellite Information Exchange System (SSIXS), the Common User Digital Exchange System (CUDIXS), and tactical information exchange systems such as OTCIXS II and TADIXS A.

SHF SATCOM

The military SHF SATCOM system (Defense Satellite Communication System — DSCS) operates in the 7 and 8 GHz bands. DSCS bearer service is appropriate for both GLOBIXS and TADIXS because SHF carrier signals permit large bandwidth. This bandwidth may be used for anti-jam signal processing (low user data rates) or high user data rates. Navy uses both services for fleet operating force support, operating nominal 9.6 kbps services through a processing channel and 64 kbps through a nonprocessed transponder. the Navy is planning to expand the latter category of service, seeking as much as 1.544 Mbps non-anti-jam service per ship. The Navy is also planning to install SHF SATCOM capability on most combatant ships, with initial focus on aircraft carriers, amphibious flagships, and flag-capable cruisers.

Other considerations for use of SHF SATCOM are: SHF is less susceptible to jamming than UHF. SHF anti-jam services are highly resistant to uplink jamming attack. Nuclear air bursts degrade SHF by causing interruptions that vary in length depending on several factors. In addition, the SHF uplink signal is less vulnerable to intercept and direction finding (DF) by tactical units.

EHF SATCOM

The EHF portion of the frequency spectrum extends from 30 to 300 GHz. The extensive bandwidth available at EHF frequencies can be used for either high data rate transmission or for extremely robust anti-jam communications. The currently funded EHF SATCOM programs take the latter approach, and, consequently, user data rates that use the Satellite Data Link Standard wave form through EHF SATCOM are 2.4 kbps. SDLS EHF SATCOM is primarily oriented toward intra-battle group TADIXS service. As a result of congressional tasking, FY90 and FY91 work has commenced to develop a medium data rate (MDR) capability will provide some anti-jam performance at user data rates up to 1.544 Mbps. This MDR EHF SATCOM may provide GLOBIXS service.

Other considerations concerning EHF SATCOM are: The EHF portion of the spectrum is highly sensitive to atmospheric attenuation, the narrow beam makes interception difficult, and EHF is less vulnerable to the effects of nuclear blackout and scintillation. EHF is technically susceptible to the geolocation noted in connection with UHF SATCOM and SHF SATCOM, though there are considerations that make these techniques more difficult at EHF frequencies.

Navy has conducted extensive and successful test and evaluation of EHF SATCOM through the Fleet Satellite Communications Extremely High Frequency Package and has begun limited production of shore, ship, and submarine terminals as part of the NESP. These terminals have demonstrated full interoperability with Army and Air Force terminals.

Commercial SATCOM

Commercial satellite is used routinely for connectivity among the shore establishment, but, until recently, it had only limited use in U.S. Navy tactical operations. Recent highly successful application of commercial SATCOM has caused a broad-based review of its suitability driven by inadequate military satellite capacity to support the substantial requirements of operations in some geographic areas of the world. Under these circumstances, commercial transportable C-Band and Ku-Band earth terminals are available to provide leased T-1 trunks (1.544 Mbps) to interface with joint and component tactical networks in theater.

Commercial carriers that are potential sources of T-1 commercial satellite service include AT&T, various Bell operating companies, GTE, CONTEL, PTI, MCI, INTELSAT, US Sprint, ITT, COMSAT, and USTA. In special applications, the Navy has utilized INMARSAT L-Band (UHF) terminals aboard ship to enable 9.6 kbps throughput for voice and data services. INMARSAT has also shown that it can be applied to the transmission of military imagery. The Navy also has used the capabilities of the least MILSATCOM commercial satellite and is considering use of the TELSTAR-G service being planned by AT&T and the Iridium service being planned by Motorola.

BEYOND LINE OF SIGHT (BLOS) BEARERS

This class of bearers is primarily of interest in connection with TADIXS. They provide physical transmission service within and among Battle Groups. Range of these bearers is generally about 1,000 nautical miles.

High Frequency (HF) Radio

This portion of the frequency spectrum, 2 to 30 MHz, offers communications over distances of several hundred miles (3 to 300 miles groundwave, skywave to 1200 miles), dependent on equipment used and conditions of operation. Because of the portion of the spectrum in which they function and the modulation applied in those frequencies, HF systems are susceptible to atmospheric absorption and intercept, and are the systems most susceptible to jamming. HF skywave communications are considered more vulnerable to nuclear blackout than other frequencies, but ground waves are minimally affected. All of the Services use HF to some extent and all Navy ships have an HF capability. Current Navy applications include the Fleet Broadcast (as a backup to satellite systems) and ship-to-shore teletype systems. Current Navy HF use includes single-channel voice, up to 16 teletypewriter circuits, and Link 11. Copernican TADIXS will use HF to a limited degree because the poor quality of transmission systems and narrow bandwidth provides limited capability. The Support TADIXS (e.g., Logistic TADIXS, Navy Information Exchange System [NAVIXS] TADIXS) may use HF for message services.

Very High Frequency (VHF) Meteor Burst Radio

The Navy has not been a heavy user of VHF meteor burst, although some successful demonstrations have been made. VHF meteor burst is essentially a direct-path system operating between 30 mhz and 300 mhz, using meteor trails to reflect a signal between points 150 to 1200 nautical miles apart.

VHF meteor burst has proven very effective in transmitting small units of data information between two points, when the data units can tolerate delays up to 10 or 20 minutes. One successful demonstration involved having ships in the Hawaiian operating areas transmit own ship location to a shore operating control center.

VHF meteor burst is not suitable for voice because of the short duration of meteor trails and scarcity of trails that will support 2400 bps narrowband secure voice. Neither is it suitable for high volume data exchanges or data exchanges that require very rapid service because it is difficult to predict when a meteor trail will happen. VHF meteor burst is not suitable for networked applications of simulcast or multicast.

It is unlikely that VHF meteor burst will be used extensively for Copernican TADIXS. In a few cases (such as maritime patrol aircraft), VHF meteor burst may be applicable to low data rate Force Operations TADIXS application.

LINE OF SIGHT/EXTENDED LINE OF SIGHT BEARERS

Line of Sight bearer services are applicable to TADIXS. Range of these systems is typically 0 up to 50 nm, although range may be extended up to 300 nm through use of airborne relays.

VHF Line of Sight (LOS)

Most ships have VHF LOS capability. Most radios in the VHF range are single channel, non-hopped equipment used primarily for coordinating Naval Gun Fire Support (NGFS) and air-ground-air coordination networks. Some ships are receiving Single Channel Ground and Air Radio System (SINCGARS) frequency-hopped radios for NGFS coordination, but SINCGARS radios are difficult to operate in the shipboard environment of high RF and electromagnetic interference (RFI/EMI), and it is extremely difficult to simultaneously operate more than one SINCGARS radio per ship. Naval aircraft are being equipped with VHF (SINCGARS capable) radios to be used for close air support coordination and for communication with other services. VHF LOS bearer service will be used with the air-air, air-ground-air Force Operations TADIXS.

UHF LOS

The UHF frequency band is from 300 to 3,000 MHz. Due to the flexibility of this band, distances achieved vary from LOS systems that communicate for 5 to 100 miles (terrain dependent) or aircraft systems that communicate for up to 300 nm. UHF systems are capable of high quality, reliable, and high capacity transmissions with data rates of 2.4 kbps or higher. It is widely used to provide secure/nonsecure voice, record, data, and facsimile service in mobile and fixed applications. UHF LOS systems can be jammed, but, in tactical situations, the jammer must be sufficiently close that it can be engaged with CVBG weapons. Similarly, UHF LOS systems do not experience significant degradation from nuclear weapons effects. UHF LOS will be used with Force Operations TADIXS in many roles.

SHF LOS/Troposcatter

Navy tactical communications do not use SHF troposcatter or other SHF LOS systems; although an SHF backbone troposcatter with a nominal range of 35 nm is being investigated for tactical use.

WIRELINE BEARERS

These bearers connect the shore establishment and, when ships and submarines are in port, make connection at the piers where the vessels are berthed. Current wireline bearers are copper wire in most cases. Very few wideband bearer services are in use at naval bases. Commercial service providers are installing fiber optic, cellular telephone, and other modern bearer facilities in most large cities, and there are some transcontinental and transoceanic services. The Navy will use wireline bearer services for GLOBIXS, sharing access to the bearer for economy and efficiency. When ships and submarines are in port, they will access these bearers for limited TADIXS service. They will operate Support TADIXS message services in port just as they operate them at sea, using wireline bearer rather than SATCOM bearer service.

Base Information Transfer System (BITS) will use wireless (e.g., fiber optic) services to provide transfer of voice, data, and other formats within naval stations with interface to other bearer services (e.g., DDN). Ships in port will be capable of BITS access for multiple services (i.e., in port TADIXS service, NAVIXS, Imagery).

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The current TADIXS/OTCIXS was developed to provide communication user services to afloat units. This concept has continued to evolve. The Copernicus goal is to provide a broader spectrum of user service connectivity to afloat units through the flexible and adaptable TADIXS pillar.

OTCIXS II is a DAMA-capable tactical satellite communications network for command and control of battle group operations and ship-to-ship, ship-to-shore, and shore-to-shore exchange of track data, operational note messages, and data files supporting over the horizon targeting (OTH-T). The mission of the system is to provide dependable, beyond line-of-sight communications among surface, sub-surface, and shore stations on a near-real-time basis. In the current situation, the submarine OTCIXS operates as a separate service from the surface OTCIXS, but both operate via the Fleet Satellite Communications (FLTSATCOM) system.

Important differences exist between the current OTCIXS II and a Copernican Force Operations TADIXS. OTCIXS II occupies a fixed time slot and bandwidth in the UHF SATCOM DAMA transmission system. A Copernican TADIXS will be a virtual network that can share time slots and bandwidth with other networks. The current OTCIXS II is capable of operating through UHF SATCOM; it has no SHF SATCOM, EHF SATCOM, or HF capability. The Copernican TADIXS, however, will be capable of multi-media operation. Units operating current OTCIXS II require a specific set of terminal equipment to subscribe, but the Copernican TADIXS will use common, modular hardware and software from the CSS Standard Communication Environment (SCE). Only one protocol is in use with the current OTCIXS II, and that protocol does not provide equally good service under all network loading conditions. In Copernicus, the TADIXS will be capable of using many session, network, and link protocols as appropriate for the operational situation. Current OTCIXS II requires trained operators to interact directly with several pieces of equipment at each site when troubleshooting net problems but the Copernican TADIXS will be operated through the software veneer of GOTS HMI, and expert system performance aids will help operators perform both system and equipment level fault isolation.

The principal difference between current OTCIXS II and the Copernican TADIXS is that the OTC has very little choice in how OTCIXS II operates. The OTC can either use UHF SATCOM OTCIXS II at 2400 bps or use the same bandwidth for some other network. The Copernican TADIXS will be capable of much more flexible operation, in multiple transmission media, with many alternative subnetwork configurations. As shown in Chapter 6, the OTC will be able to select dynamically how much and what kind of Strike TADIXS and ASUW TADIXS service is appropriate for the operational situation.

The current TADIXS A, another precursor of Copernican TADIXS, is designed to provide a broadcast of tactical data processor data-link traffic on a one-way transmission path from shore sites to fleet cruise missile units. Phase IV of the program provides redundant, automated gateways at all NCTAMS and at the Naval Communication Station (NAVCOMMSTA) Stockton, increased link throughput, message accountability, and improved link diagnostics. Connectivity is provided via FLTSATCOM and dedicated terrestrial paths.

TADIXS A is similar to the Direct Targeting TADIXS of Copernicus, in that it provides shore transmit service of targeting products. Another similarity is the fact that the theater TADIXS A subnetworks are provided internet gateway service at the NCTAMS and NAVCOMMSTA Stockton. As with OTCIXS II, however, many differences exist between current TADIXS A and the Copernican Direct Targeting TADIXS. One important difference is that current TADIXS A operates in a system-high classification configuration, but the Copernican TADIXS will provide cyptographic segregation on a subnetwork basis and, eventually, within subnetworks. Another difference involves the nature of data transmitted, for TADIXS A is used primarily to transmit character-oriented track summaries, and the Copernican TADIXS will contain much more data information exchange traffic.

Building on these precursors, it is possible to conceptualize a model set of Copernican TADIXS for a CVBG, the basis for analysis within this concept. Most of the TADIXS will have connectivity to the CCC where filtering of data will have been accomplished to preclude duplicate traffic from being forwarded to operating units. Within the CCC, anchor desks are delegated control over the TADIXS most related to their functions by the tactical commanders, and these desks enforce operational guidelines for the traffic that is forwarded to sea. Access to a TADIXS is controlled by operational parameters established under those guidelines and implemented by communication servers within the CCC.

The physical layer connectivity to the operating forces will be accomplished by any of a variety of transmission paths available at the time and will be influenced by availability, traffic loads, nature of the requirement to communicate, and the operational situation. The tactical commander will indicate in the CVBG CSS connection plan how the connectivity should be used, and the NCTAMS will provide TADIXS service in accordance with the connection plan. As previously stated, the link can be either military HF radio, UHF SATCOM, SHF SATCOM, EHF SATCOM, or commercial SATCOM. At the distant end, the TADIXS will access the TCC via the SEWC and the TCC LAN to provide information to the various staff elements.

As discussed in Chapter 3, the formats that will pass via the TADIXS are varied and reflect the intent of this architecture that reliance on paper messages will be substantially reduced.

CHAPTER 9
PROGRAMMATIC REQUIREMENTS

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CHAPTER 9
PROGRAMMATIC REQUIREMENTS

SUMMARY

The preceding four pillar chapters (chaps. 4-7) described the architecture from an operational standpoint, and Chapter 8 outlined the building blocks from which the architecture will be constructed. This chapter describes programmatic requirements, methodologies by which we intend to move from many Cold War "stove-pipe" systems to the post-Cold War Copernicus Architecture. The programmatic requirements are contained within the annexes following this chapter and the next. Chapters 4 through 9, then, represent a Phase I (see Introduction) delineation of the operational requirements to implement the architecture. In Chapter 10, we will discuss the implementation strategy.

The establishment of Space and Electronic Warfare (SEW) as a warfare mission area (WMA) by CNO in 1989 represented a Navy commitment to bring together the elements of electronic warfare, C^4I, surveillance, and other tactical and strategic assets into a seamless SEW system. To do so required a synthesis of many existing programs and technologies and the development of the operational doctrine of SEW. The task was not an easy one, and it is not yet complete, nor will it be soon. Like air power in the 1930s, SEW is a revolution in naval warfare that will evolve over several years, perhaps requiring a decade for full maturation. It is clear, however, that to implement SEW, four considerations must be examined.

First, what is SEW *doctrinally*— what are the operational elements of SEW, and what are its tactical and strategic goals? This has been the discussion and focus of several conferences since SEW was established, and the definition provided in Chapter 1 represents the current consensus arising form the 1991 SEW Conference.

Second, *who* is SEW— what kind of sailors and officers must we develop to build and operate the SEW technologies and take them to sea? Like the SEW doctrine, this is also under intense scrutiny at this writing.

Third, what is SEW *technologically*— what technologies are required to construct a strategic and tactical SEW capability, and how can they be molded into a SEW system that can be operated seamlessly? This is really a two-part question:

- What systems related to SEW exist today, and how do they relate to one another (i.e., what is the SEW baseline); and

- What is the desired SEW system (i.e., what will be the SEW technological architecture)?

Finally, what is SEW *programmatically*— how do we migrate the existing systems toward the goal architecture and how will we (and who will) manage the migration?

The purpose of this and the following chapter is to outline some answers to the latter three questions for a subset of SEW— the Copernicus Architecture. Four interleaved efforts that will bring the architecture into programmatic fruition are discussed. The first section describes the intended movement technologically and programmatically from many duplicative and splintered "stove pipe" programs to a functional, end-to-end series of pillars constructed from standard building blocks. In the section following that, we will discuss the OP-094 Program Objective Memorandum (POM) Investment Strategy that is currently underway and describe its methodology. Next, our intentions relative to manpower and training are described. Finally, we set to paper our Research, Development Test and Evaluation (RDT&E) issues.

DISCUSSION

The four pillar chapters (chaps. 4-7) described the architecture from an operational standpoint, and chapter 8 outlined the building blocks from which the architecture will be constructed. This chapter describes programmatic requirements, methodologies by which we intend to move from many Cold War "stove-pipe" systems to the post-Cold War Copernicus Architecture. The programmatic requirements are contained within the annexes following this chapter and the next. Chapters 4 through 9, then, represent a phase one (see Introduction) delineation of the operational requirements to implement the architecture. Chapter 10 provides the implementation strategy.

COPERNICUS AND THE SEW BASELINE SYSTEM

The establishment of SEW as a WMA by Chief of Naval Operations (CNO) in 1989, represented a Navy commitment to bring together the elements of electronic warfare, C^4I, surveillance, and other tactical and strategic assets into a seamless SEW system. To do so required a synthesis of many existing programs and technologies and the development of the operational doctrine of SEW. The task was not an easy one, and it is not yet complete, nor will it be soon. Like air power in the 1930s, SEW is a revolution in naval warfare that will evolve over several years, perhaps requiring a decade to full maturation.

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The purpose of this and the following chapter is to outline some answers to the latter three questions for a subset of SEW— the Copernicus Architecture.

SEW TECHNOLOGY

Let us return to the discussion in Chapter 1 about SEW as a system— a doctrinal, organizational, and technological "macro-system"; it takes all three to construct SEW. Like all macro-systems— even those intended to operate seamlessly— SEW has operational components and resulting technological subsystems that make those operational goals possible.

Doctrinally, SEW encompasses six major disciplines (see fig. 9-1) some of which currently have different sponsors, different technologies, and different programs. In FY 89-90, OP-094 directed the SEW Baseline System Study to catalog existing and planned programs and determine how they interconnected (or did not). This is also a large task, and it too is still ongoing. It answers the first part of the technology question posed above.

The magnitude of the SEW baseline study, which includes more than 180 programs that are not sponsored by OP-094 and 90 more that are, underscores the magnitude of the technological task. Constructing (even defining) the desired, ultimate SEW macro-system will not simply be a task of engineering it correctly, it will require a strategy to bring many current and planned systems together— most of which, as we have seen, not only do not "belong" to OP-094, many do not belong to the Navy.

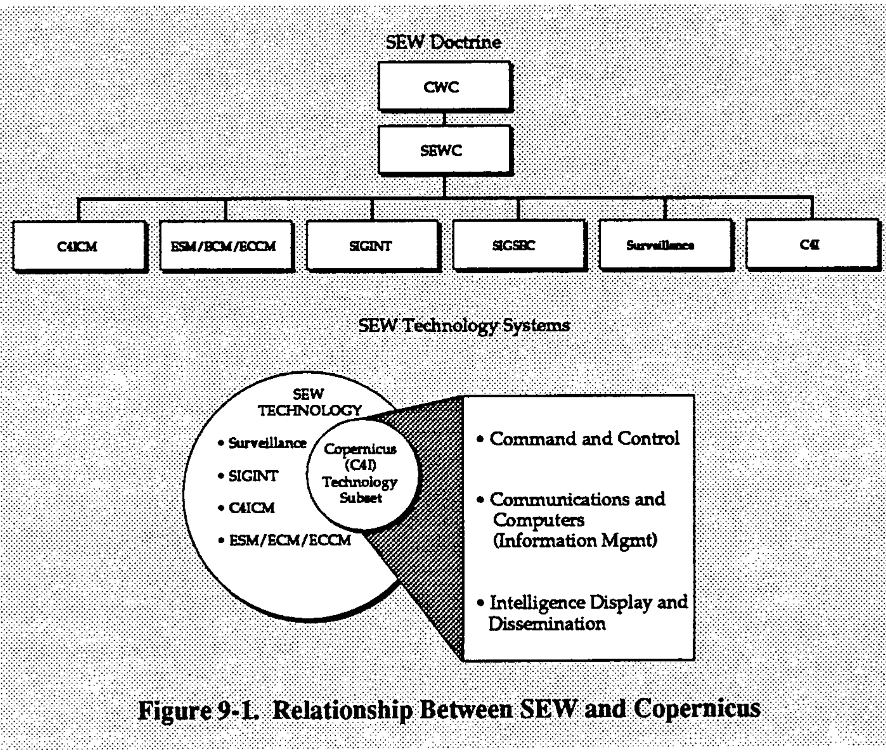

Figure 9-1. Relationship Between SEW and Copernicus

The effort, then— the second of the two technology questions above— will shift from cataloging to bringing existing programs and technologies into groups of like operational focus— subsystems of the desired SEW macro-system— that can be operated together to achieve the SEW tactical and strategic goals. Indeed this second effort is underway in some areas simultaneously with the cataloging effort. This approach not only makes good technological and programmatic sense, it makes common sense. Much like a car that is designed to be driven by one operator but is manufactured in many subsystems by different manufacturers according to an overall *design*, so will be the ultimate SEW system.

COPERNICUS AS A SUBSYSTEM OF SEW

Copernicus is such a design. Like the superset SEW, the subset C4I components of the system are owned by organizations far and wide: sensors from the intelligence community, communications backbones from the Defense Communications System (DCS), and a host of independent command and control systems.

The Copernicus "design" is an architecture in the truest sense: it is not a program or a system, but rather a context for them and a methodology by which to proceed. Copernicus was developed simultaneously with the SEW technology baseline study because, while SEW doctrine was still in its infancy, it was apparent nonetheless that C4I was to be a major subsystem of SEW and that subsystem was hemorrhaging. Moreover, the components of C4I, a doctrinal function well understood for decades, were much clearer than the other potential subsystems of SEW.

The second and third subsystems will likely emerge as the Electronic Combat subsystem, which would encompass strategic and tactical EW and command, control communications, computers and intelligence (C4ICM), and the surveillance subsystem, which probably would include the surveillance assets themselves and the collection management infrastructure necessary to task them for strategic and tactical missions.

Once these subsystems are defined as Copernicus has been, the overriding *technological architecture* for SEW will emerge. Because of the nature of these subsystems, the *organizational infrastructure* will follow from the decisions taken in defining the subsystems. Finally, the achievement of SEW *operationally* will be to achieve the doctrinal framework— putting the key in and turning the engine on— to focus the technology for the mission. The development of the SEW fabric will depend not only on the fabric pieces themselves but also on the ultimate macro-system needed to mesh SEW seamlessly. That goal will be achieved through three broad thrusts:

- The development of a SEW Naval Warfare Publication currently in draft in OP-094 in concert with Second and Third Fleet efforts to develop SEW tactical memorandum (TACMEMOs);

- The continuing effort of the SEW Baseline Study to identify the subsystems of SEW; and

- The implementation of the first of those subsystems, the Copernicus Architecture.

In the remainder of this chapter, we address four interleaved efforts that will bring the architecture into programmatic fruition. The following section describes the intended movement technologically and programmatically from many duplicative and splintered "stove pipe" programs to a functional, end-to-end series of pillars constructed from standard building blocks. The implementation strategy for this process is described in Chapter 10. In the section following that, we will discuss the OP-094 POM Investment Strategy that is currently under development and describe its methodology. Next, our intentions relative to manpower and training are described. Finally, we set to paper our RDT&E issues.

STOVE PIPES TO BUILDING BLOCKS

Programmatically, Copernicus conveys a number of advantages for us: common standards, better and cheaper logistics through Planned, Incremental Modernization (PIM), and evolutionary procurement, to name three. Perhaps most important, however, is that Copernicus as an architecture gives us the ability to define the system components functionally from end-to-end. Figure 9-2 shows a simplified traffic flow diagram of a data packet delivered from a non-organic sensor to an afloat platform[1]. Figure 9-3 is a different, but similarly functional, diagram of the architecture.

Once we are able to describe the end product in functional blocks and to describe those blocks within a common operating environment (see chap. 8), a process can be constructed to move from today's many vertical stove pipe systems to tomorrow's end-to-end systems. The methodology for doing so involves five steps.

Step 1: Copernicus Building Blocks

The first step in the process is to develop engineering models of the Copernican pillars in detail as part of the Phase II engineering effort (see Introduction and chap. 10). The diagrams (generically shown in fig. 9-4) will provide a detailed engineering template from end-to-end.

Step 2: Devolve Existing Programs to Building Blocks

The second step is to devolve existing programs into potential building blocks and select the "best of breed" among the blocks suitable for use in the architecture. This will necessarily be a "cut-and-paste" task. Clearly, the number and diversity of building blocks will vary by program. Some programs, because of the systems engineering, others (e.g., Navy Standard Teletype, KG-84, Combination Radio) may only be building blocks. For comparative purposes, this process will vertically slice existing

[1] See figs. 3-8, 9, and 10 in chap. 3 for a similar view from a communications perspective.

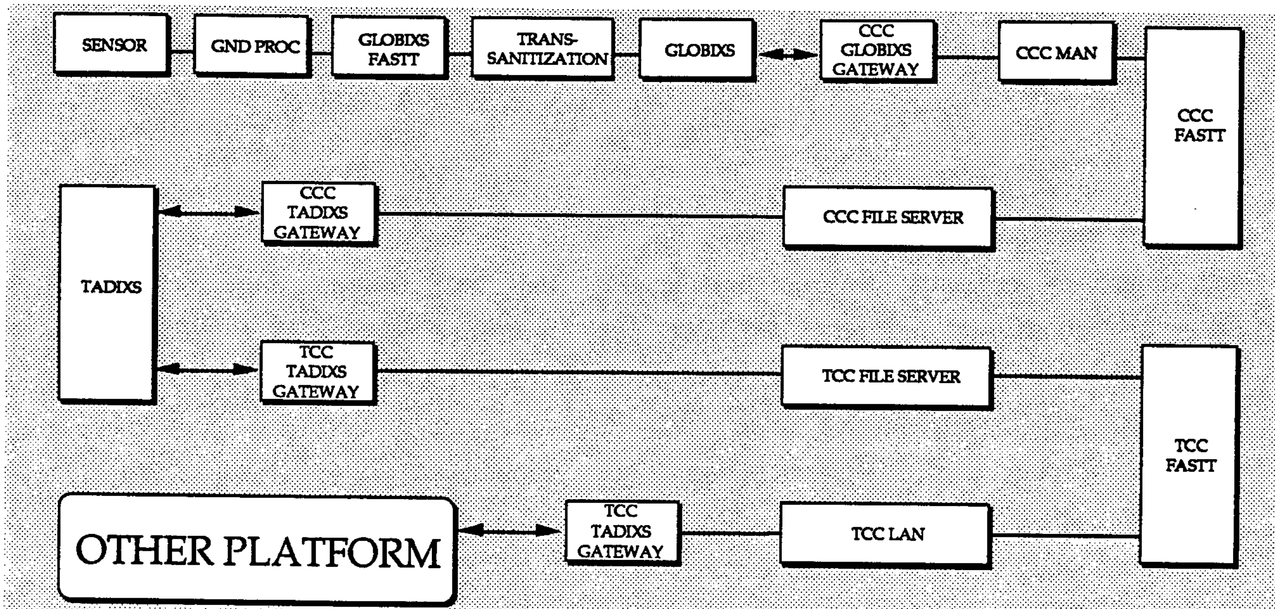

Figure 9-2. Copernicus Traffic Flow Diagram

stovepipes into components defined in Copernican terms.

"Best of breed" analysis will necessarily involve developing engineering criteria of suitability, feasibility and affordability. Affordability, which heretofore has been the domain of programmatic considerations and not engineering efforts, is a legitimate criterion in the step of the process because, when applied to

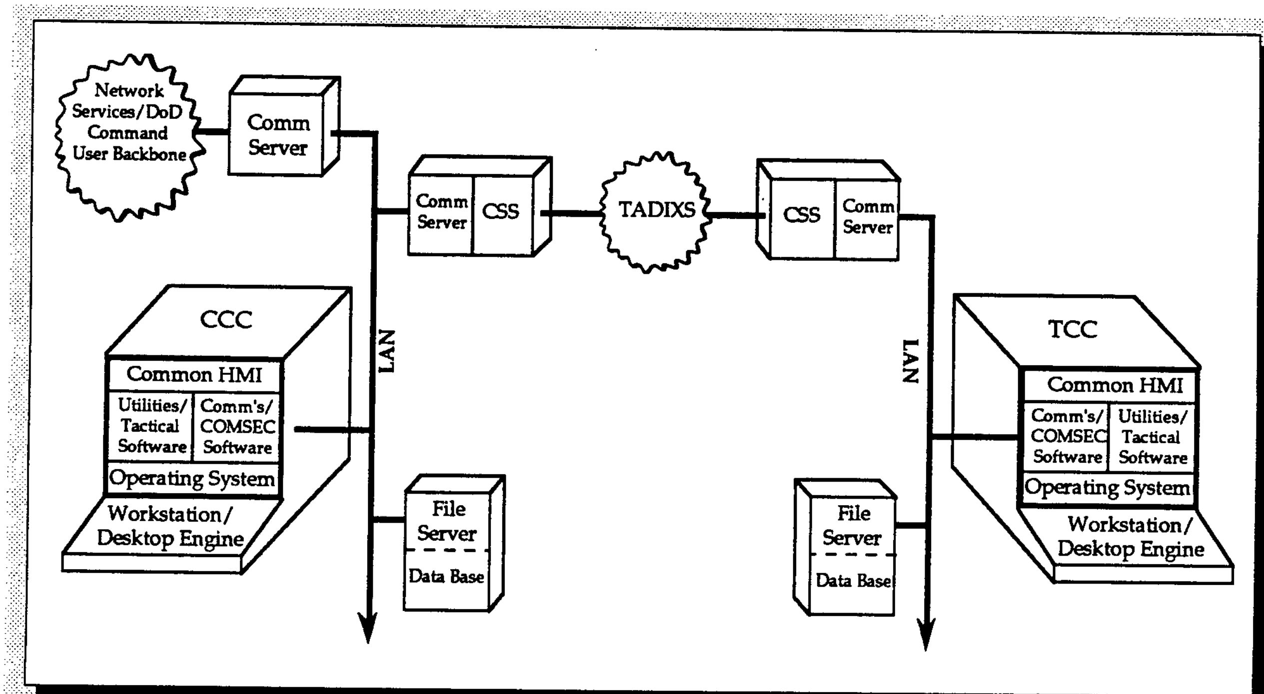

Figure 9-3. Physical Architecture

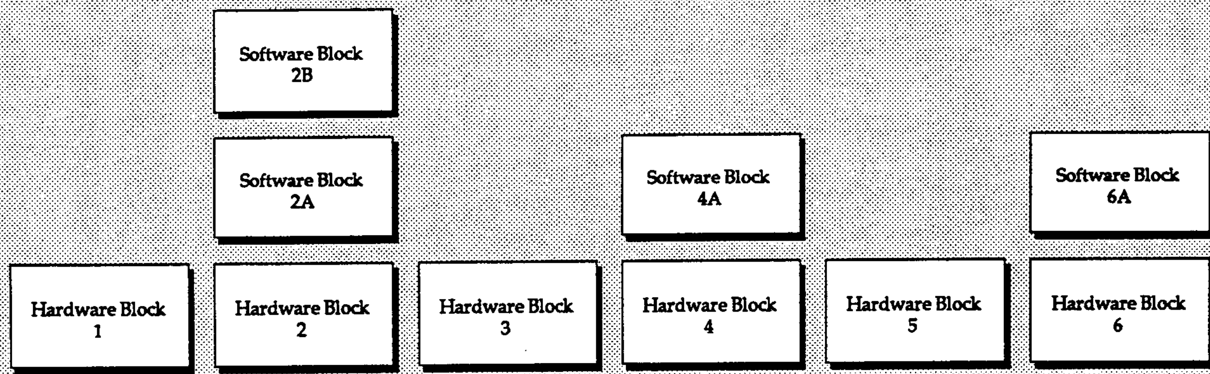

Figure 9-4. Functional Blocks of a Copernican Pillar

building blocks as opposed to whole programs, a comparative analysis is achievable on a one-to-one basis.

Indeed, this is one of the great benefits of horizontal architectures over stove pipe programs. Stove pipes can only be compared against other stove pipes that typically are not being developed to meet similar requirements. Affordability in this vein is a POM issue not a component issue because, in the absence of direct comparison by function and requirement, there is only the question of whether enough money remains in the POM at the end of the process for all (e.g., TACINTEL vs Mini-Demand Assigned Multiple Access [DAMA], or Joint Tactical Information Distribution System [JTIDS] vs OBU). In a "horizontal" comparison, however, communications processor “A” from program “A” can be compared with processors “B” through “Z” to select a Navy standard communications processor.

It is important to recognize that *families* of building blocks will arise. To continue the example, there will likely be two kinds of communications processors in Copernicus— an ashore processor and an afloat processor (i.e., DCS versus Communication Support System [CSS]). Both types will come in several versions; for example, the shore processor probably will be implemented as a circuit card, in a workstation, or as a stand-alone machine depending on size of node and other considerations. Figure 9-5 illustrates “best of breed” selection.

Step 3: Overlay Existing Against Required Blocks

The resultant existing best-of-breed building blocks can be overlaid against the desired template. Copernican building blocks that could not be identified in a best-of-breed are candidates then for Research, Development, Test and Evaluation (RDT&E) programs (see following for a discussion of anticipated RDT&E issues).

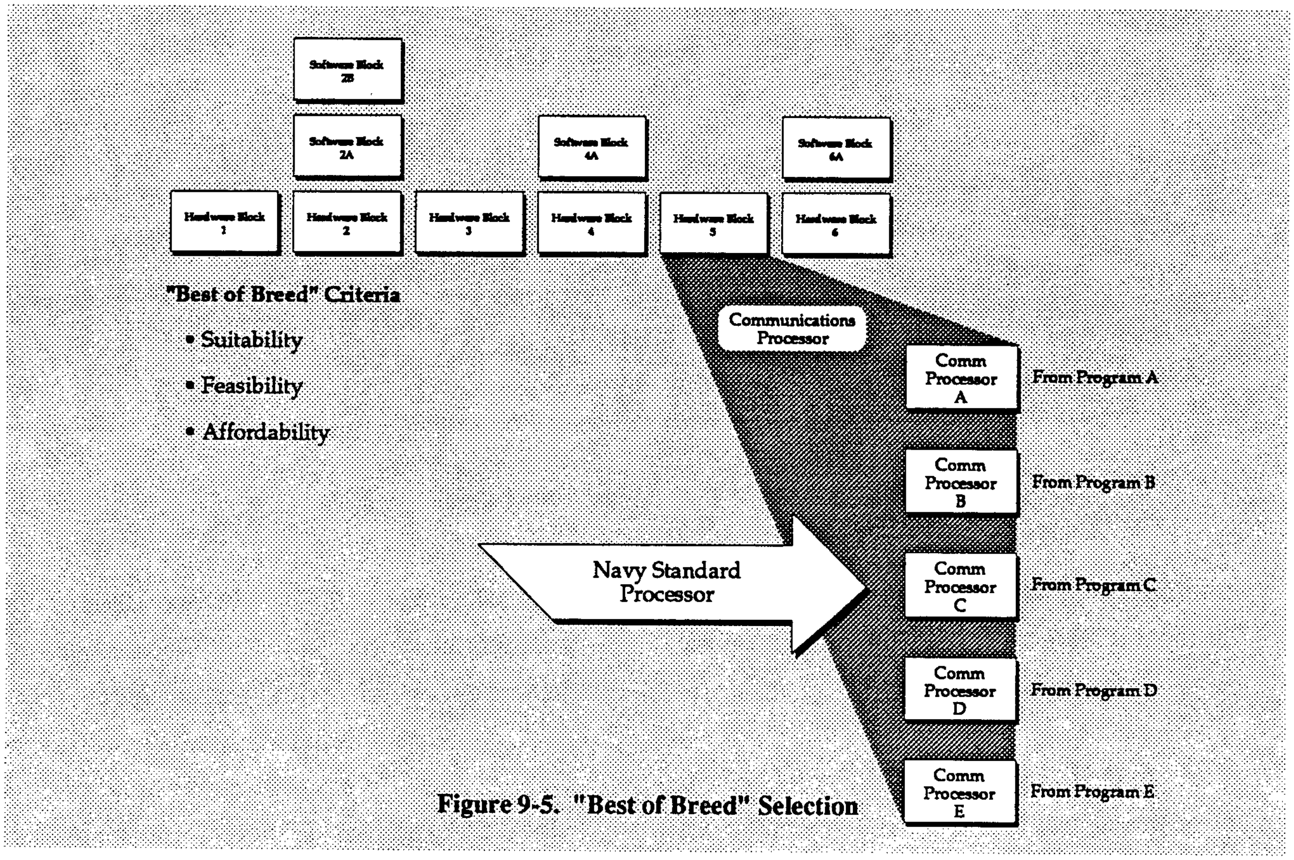

Figure 9-5. "Best of Breed" Selection

Step 4: Develop Integrated Logistics Support Strategy (ILS)

The next step is to develop an ILS strategy for each major functional block. In the past, ILS has been a monolithic process, a series of steps defined across the board for system components with little regard to the component itself. Like all generalizations, this one has exceptions, and, in recent years, the explosion in electronics has attuned the acquisition community to the need for new approaches. However, breaking the back of steep logistics costs is a two-fold process:

- Recognizing the need for both *system* ILS and *component* ILS, and recognizing the life cycle support varies both by component and by system. In component terms, the generational length for a workstation today is probably 18 months; the generation for an antenna may be 10 years. In system terms, ILS should be considered support for the system integration and interfaces, which is quite different from the sum of its components (see fig. 9-6); and

- Defining new criteria for ILS, especially in C^{4}I components that are electronics-intensive. The criteria should not be mean-time-between-failure (MBTF), which today typically exceeds mean-time-before-obsolescence (MTBO) of many components. Use of MTBO instead of MBTF can lead us to strikingly new ILS strategies, such as PIM (see fig. 9-7), which center on technology refreshment techniques.

Step 5: Restructuring Programs

The final step in the process is restructuring programs. This will be a complex process occurring over a Six Year Defense Plan (SYDP) in which three types of programs will emerge:

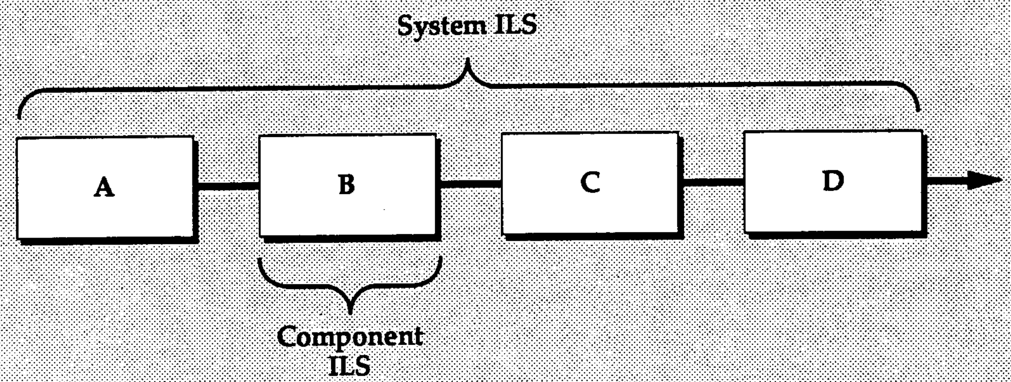

Figure 9-6. System vs Component ILS

building block and *RDT&E* programs which provide raw material for the third type, *pillar* programs. Two of the three types of programs will contain several appropriations. For example, the eventual implementation of the Norfolk CCC will evolve from a restructured OSS program that will draw resources from several building block lines. The Norfolk CCC will require Other Procurement, Navy (OPN) and Operations and Maintenance, Navy (O&M,N), but little RDT&E. Building block programs (e.g., Desktop Computer Terminal [DCT-2]) will require RDT&E, OPN, and O&M,N. It is a goal of the architecture that implementation will

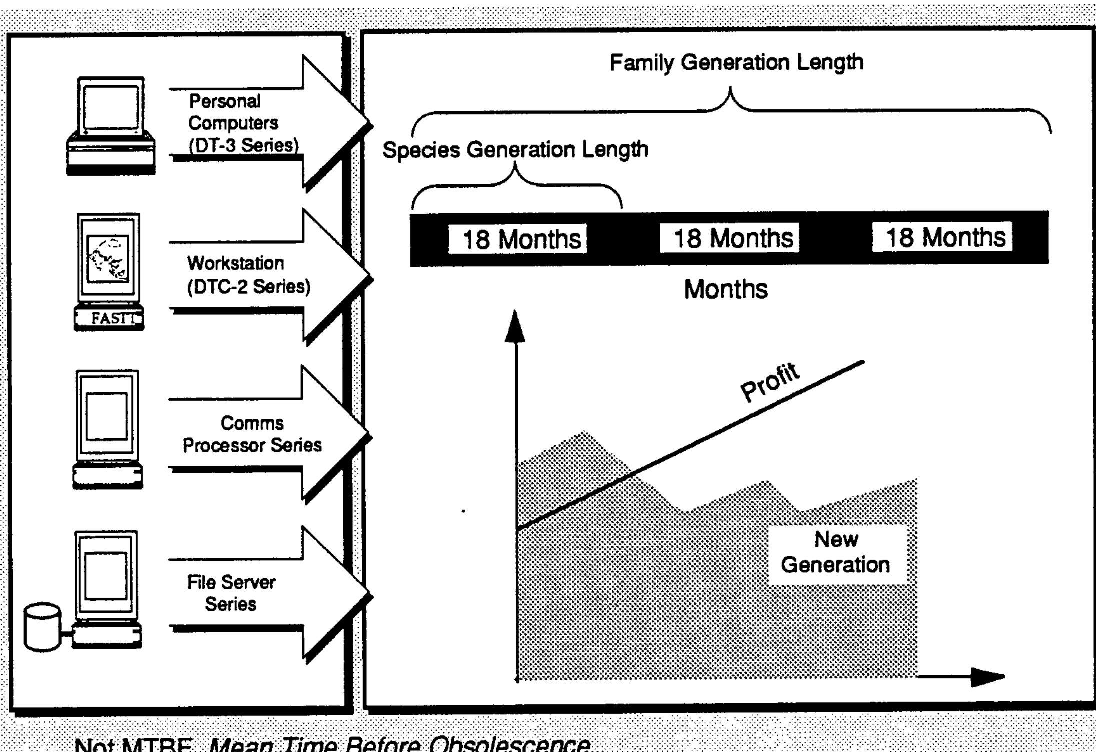

Figure 9-7. Planned, Incremental Modernization (PIM)

result not from a Copernicus program per se, but from a realignment of existing programs into the Copernican mold. Within this context we may find it necessary for near term (SYDP) enhancements to provide interim (pre-Copernicus/transition) fleet upgrades.

Figure 9-8 summarizes this Copernicus technological and programmatic strategy that will be conducted over several POMs. In the section below, we discuss the beginnings of that evolution, the OP-094 POM 94 Investment Strategy.

- **STEP 1:** Identify Functional Building Blocks (Hardware & Software) in Copernicus Pillars
- **STEP 2:** Devolve Existing Programs to Similar Building Blocks
- **STEP 3:** Overlay Existing "Best of Breed" Against Required Copernican Blocks (Shortfalls = RDT&E)
- **STEP 4:** Develop System and Component ILS Strategies
- **STEP 5:** Restructure Programs

Figure 9-8. Five-Step Copernicus Technological and Programmatic Strategy

POM 94 INVESTMENT STRATEGY

POM 94 will be the first SEW POM. The investment strategy for OP-094 is currently in development and will involve the fusion of a series of decision points from the SEW Baseline Study, the Copernicus Project Team, and OP-940. The Investment Strategy is aimed at defining and implementing future program direction and support, for Copernicus component systems, for other SEW Baseline programs under OP-094 sponsorship, and for personnel-related issues.

The investment strategy also identifies R&D efforts that are needed to support SEW and Copernicus implementation (see section below on R&D). The specification of R&D efforts is intended to be used by the Office of Naval Research, Office of Naval Technology, and Office of Advanced Technology in developing SEW programs.

As mentioned, the SEW investment strategy represents a fusion of the recommendations from the Copernicus analysis and those from the SEW Baseline analysis. Beginning with architectural features and proceeding to system selections, the Copernicus approach is "top-down", and is designed to provide a new approach to defining, designing, and implementing C4I systems. The SEW investment strategy, based on analyses of current programs and systems, is directed at providing support for POM-94 deliberations about SEW and the Copernicus subsystems. It is a "bottom-up" approach oriented toward assessing programs individually vis-a-vis a defined set of decision points.

Both methods, which provide a check and balance against each other, have as their goal the specification of ranked sets of candidate systems and programs. As we have seen, for the Copernicus approach, the analysis is carried out separately for each of the four pillars. For each pillar a set of functions is defined that characterizes the major activities carried out under that pillar. For each function within the pillar, a set of specific services is then identified. For each of these services, a set of current and postulated systems and programs is ranked according to the degree to which each carries out the services (see fig. 9-9). There are three prioritized ranking groups, defined as: high priority systems, systems requiring restructuring, and systems requiring further investigation.

The individual service results for a given function are then "rolled up" into overall results for that function, and the results for all functions within a pillar can be "rolled up" to characterize the findings for that pillar. The overall results at any level are sets of systems, ranked by virtue of being included in one of the three groups.

The goal of the SEW investment strategy methodology is to rank candidate systems. For example, one approach is to rank systems within each of four OP-094 investment categories: tactical C3I and EW, infrastructure modernization and automation, space and surveillance, and strategic communications. The methodology works similarly in prioritizing within the four Copernicus pillars. For the SEW investment strategy methodology, candidate systems or programs are assigned to the appropriate investment category or categories. Each system is then scored in accordance with the degree to which it conforms to the Copernicus, SEW, and Programmatic decision points, shown in figure 9-10.

The scores are then combined to determine a merit value for that system within its particular investment category. The systems within each of the investment categories can then be ranked by their merit values. It is not presently planned to rank systems across investment categories. As indicated above, the

Function: Command TADIXS
Service: Voice, message, graphics, and facsimile exchanges
Quality: Nominally 1 error in 10,000 bits
Coverage: Global (through gateways)
Applications: Communication Support System, OSS, NTCS-A
Utilities: Network mgmt, Directories, Format Xlation, INFOSEC
Operating Systems: Navy Tactical Command System Afloat O.S.
Resources:

Commercial SATCOM *	Base Information Transfer System	*AN/UGC-Ixx teleprinters*	*SHF Trunking*
INSICOM	Comms Ashore	*Black Switch*	*UHF LOS*
EHF SATCOM *	COMSEC (INFOSEC)	*HF*	*VHF Meteor Burst*
SHF SATCOM *	Defense Communication System	*Red Switch*	
UHF SATCOM *	Global Positioning System		
Video teleconferencing			

* current stand-alone configuration limits usefulness

Legend

Underscore Text:	Key Contribution
Plain Text:	Considerable Contribution
Italic Text	*Little or no Contribution*
Shadow Text:	**Not a Current Program**

Figure 9-9. Example of Copernicus Program Analysis

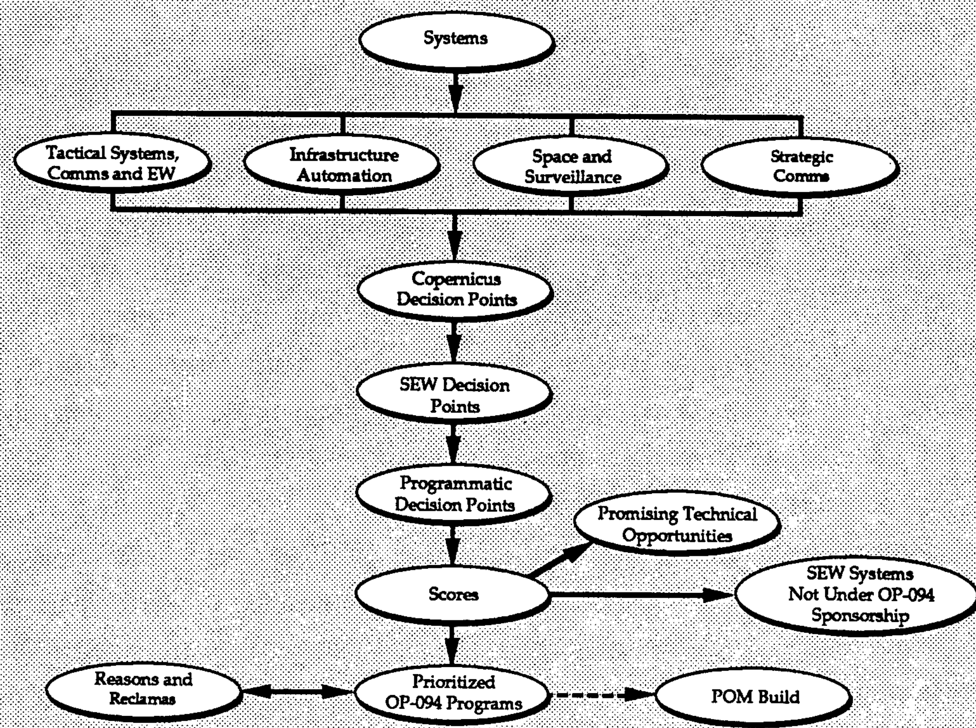

Figure 9-10. Program Review Methodology

fundamental issue is to fuse the results from both of the methods into a single overall strategy. The Copernicus strategy builds upon the 12 Copernicus decision points (fig. 9-11), and the SEW investment strategy extends these to a total of 28 decision points (figs. 9-12 and 9-13). Thus, the process of fusing the results from the two methodologies has a firm foundation. The fusion task will be completed as part of the POM 94 development.

MANPOWER, PERSONNEL, AND TRAINING (MPT) STRATEGY

An essential issue regarding the implementation of the Copernicus Architecture is the type of personnel that Copernicus will need. Technological acquisition and automation are hollow investments without supporting manpower and training. The quickest way to guarantee successful implementation of the architecture will be through advanced planning and preparation in the MPT arena.

Program evaluation, investment analysis, and acquisition spending should all take into consideration manpower, which is the Navy's most valuable resource. It is a common, though not common sense, approach to buy technology and worry later about the cost of training and manning for the system. All too often this results in a system that fails to meet performance and operational standards. The lesson learned is that manpower and training are as important to logistics as software support or spare parts programs.

A major thrust of the POM-94 Investment Strategy is developing a "new" approach in addressing this issue. The combined issue of manpower and training is now a key decision point in assessing all SEW systems. The basic assumption for MPT planning in support of SEW is that implementation of the SEW and Copernicus concepts will occur with no net-growth of manpower or training resources. Under the investment strategy, systems that are too MPN- or O&M,N - intensive will be examined for elimination over the SYDP. PIM will become one of the driving forces impacting manpower and training needs. While PIM will provide profit incentives to industry to replace obsolete equipment, it also should provide incentives to reduce MPN and O&MN.

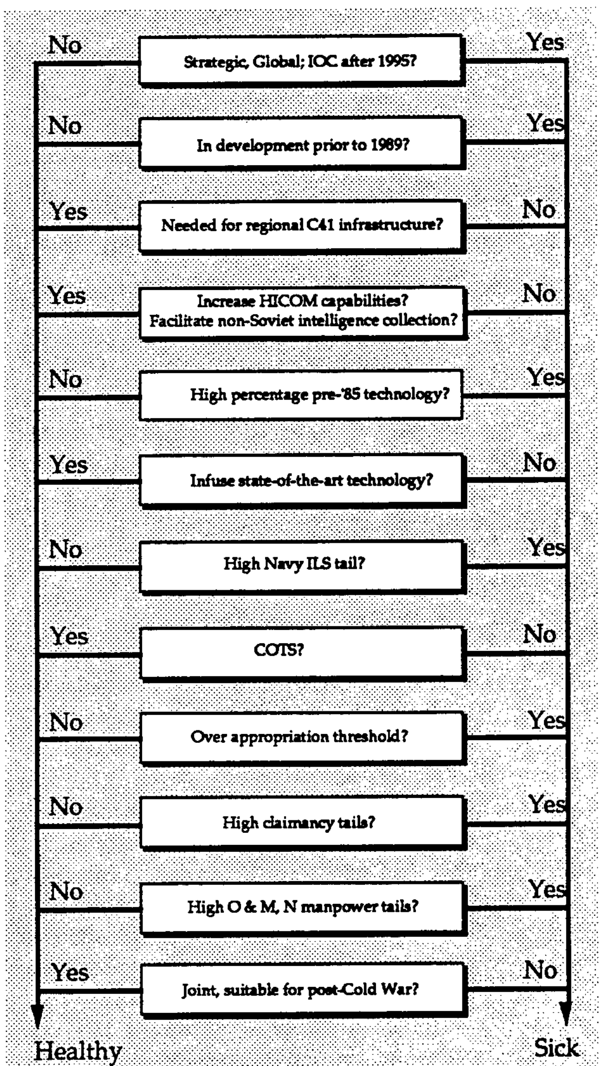

Figure 9-11. Copernicus Decision Points

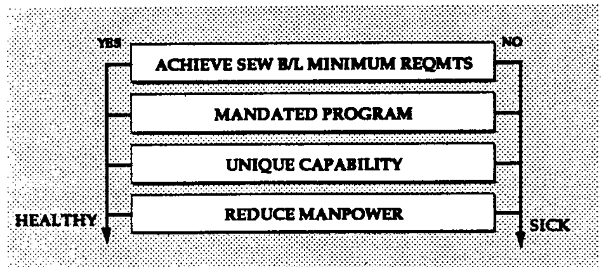

Figure 9-12. SEW Decision Points

While the quantity of our work force is always a predominant consideration in a Navy of shrinking resources, advanced technology dictates closer examination of the quality of the individuals and the training they will require. Four major manpower and training thrusts underlie the MPT strategy:

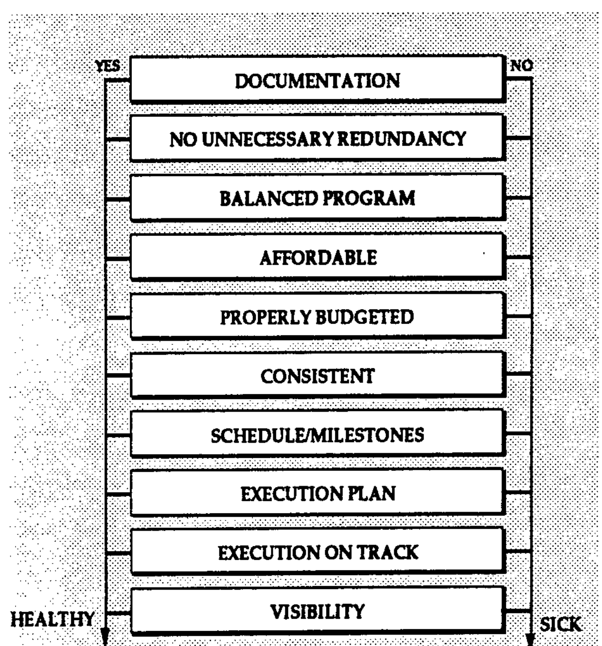

Figure 9-13. Programmatic Decision Points

- The quantity of manpower available;
- The anticipated quality of those individuals;
- Training requirements; and
- Human/systems integration.

Major Thrusts Underlying the MPT Investment Strategy

Navy manpower is being significantly reduced across the SYDP. As the number of warfare platforms decreases, the shore infrastructure supporting the fleet is also decreasing. OP-094-sponsored MPN alone has been reduced by 22 percent since FY 90. Current assessments of upcoming POM 94 provide strong indications of further manpower reductions towards the year 2000.

In such an environment, each new and existing SEW system must be evaluated in terms of manpower utilization and savings potential. Our Investment Strategy will be a no-net growth plan. A new look will be taken at MPN and O&MN intensive systems, and new technology and new manning concepts will be used when possible. Additional manning for certain components of the Copernicus Architecture, such as the CCC, will have to be realized through manpower savings in other areas.

Once the Copernicus Architecture is clearly defined in terms of actual fleet/shore implementation, modified Hardware/Manpower (HARDMAN) analyses should drive the supporting manpower requirements. Existing manpower standards will no longer apply. PIM, improved MTBF, and more "user friendly" equipment will be instrumental in achieving new, and most likely reduced, manpower requirements.

To ensure that our people have the "right stuff" for SEW we must: 1) review C4I enlisted ratings for future validity and skills overlap, 2) impose higher qualifications standards for C4I rating accessions, 3) modernize training curriculum and equipment, and 4) provide for ongoing/refresher training for our C4I professionals.

To address these training and education needs, we must start by envisioning and documenting the requirements most critical to the success of our SEW Navy professionals, including identification of needed skills, new duties, and types of knowledge required. The question of new ratings and Navy Enlisted Codes (NECs) must be examined.

Initiatives that will help define the career expectations for the individual officer and enlisted member are:

- Information Systems Ratings. RM 2000 is the first step towards changing not only the way we look at Radiomen, but the way in which we view all SEW ratings. It interjects into the usual rating review process additional guidance based on the technical requirements of SEW. Instead of reviewing RMs' occupational standards by assessing present tasking (which is mostly clerical in nature), the focus is on the data processing and maintenance functions they will perform by the year 2000. By developing these standards now, Navy will be able to start creating the operators and maintainers needed in the future. Concurrently, a similar data processing (DP) rating review is being conducted. The results of these projects will determine whether these two ratings should be merged into one Information Systems rating;

- The SEW Officer. We need to develop officers who are trained and educated throughout their careers with emphasis on SEW. By increasing promotion opportunities, briefing screening boards about SEW, recruiting interested junior officers and accessions, and providing a viable career path we can retain the expertise needed to support the SEW WMA; and

- General Unrestricted Line. A Process Action Team has been initiated to ensure that General Unrestricted Line SEW officers are able to advance and develop within their subspecialty community. By providing a career path with proven leadership and subspecialty tours, the Navy will be able to grow and retain expertise in this essential area. This career path would parallel that of the SEW Officer's.

The key to obtaining individuals with the knowledge and skills essential for the technology of tomorrow is to plan for their training now. Increased automation and commonality of nodes implies both a need to train fewer people and to streamline the training for those who are still required; yet, the technical nature of these systems indicates that more in-depth, advanced training will be needed than now exists. The long-term training Investment Strategy should result in no-net growth. To accommodate this strategy, curricula, training pipelines, and schools must be examined with an eye to the future. With each system acquisition, the following training issues should be considered:

- Technology. A system must be fully supported by training throughout its life cycle and future generations. By calculating the cost up front, system integrity and function are enhanced. Embedded courseware and onboard training is one of the most promising training vehicles for the future. Not only will such training reduce instructor man-hours, it could also potentially reduce refresher training and on-the-job training (OJT) needed to keep personnel fully capable. In addition to embedded and onboard training, multimedia avenues such as video training should be explored. By having the training readily available at the command, personnel can be trained while on the job vice attending a school;

- Training Economies. By viewing training requirements as a whole, we can begin to identify where individual reductions can be taken. Since many of the systems share a commonality of nodes, we should be able to eliminate or streamline a large portion of training as it exists today. Likewise, redundant, outmoded, or underused training should be eliminated. If embedded training or OJT can replace a particular curriculum, our investment strategy should incorporate these changes. Cost efficiency through use of existing interservice training should be investigated whenever feasible. Training needs to be continuously reviewed to ensure that it supports standardized fleet operating and maintenance procedures. By developing curricula in modular formats, course length and content can easily be adjusted to meet existing needs. Emphasis should be placed on overarching systems training, using systems technical manuals, to provide general knowledge, which can be transferred from job to job or equipment to equipment. Specific training initiatives that incorporate these aspects include:

  - SEW Training Continuum/Navy Training Appraisal. Copernicus systems and requirements will be driving these Navy-wide training efforts. Exposing other platform and resource sponsors and major fleet commands to this concept will assist in gaining wide acceptance and further input into training/manpower decisions;

  - Process Action Teams/Quality Management Boards. The SEW Training QMB has several PATs planned or in process to examine curricula or course content. Schools such as Communications Officer Ashore/Afloat will be evaluated to determine whether they address the Navy's current operational needs on a cost effective basis. Future efforts need to embrace a total SEW enlisted ratings review to determine manpower and training requirements;

- Reserve Training. As demonstrated by events in the Persian Gulf, Naval Reserve personnel will continue to play an important role in the Total Force structure. Their readiness is directly affected by the quality and availability of training. Each system within the Copernicus Architecture must be assessed in terms of manpower requirements. If a system would be used by mobilized forces, its associated schools and courses should be revised to a modular concept;

- RM, DP Schools Update. The "A" and "C" schools for both ratings are being updated to incorporate actual or anticipated technological advances. Course structure is being modularized in anticipation of future changes as new equipment is introduced to the fleet. To further this effort, a training analysis should be performed to consider the following: 1) When should the training come on line? 2) Will it require additional resources (instructors, Technical Training Equipment, contractors)? 3) What will the student throughput be? 4) How many modules need to be rewritten? As mentioned earlier, increased automation will mean a decrease in manpower. However, "A" and "C" schools need to be equipped to teach at a higher, more technical level to match the complexity of the equipment involved; and

- Total Quality Leadership (TQL). The analysis tools and thought processes involved in TQL lend itself to investment strategy applications. Implementing TQL methods for manpower/training issues, such as curricula and rating structures is essential to both the short term and long term success of the Copernicus Architecture.

R&D IMPLICATIONS

The objective of the R&D Investment Strategy is to provide guidance on planning the most cost-effective implementation of needed Copernicus and SEW improvements. This will be accomplished by describing the goals and visions toward which we are striving, discussing the processes needed to develop and execute the path to those goals, and providing specifics that will direct and guide the processes. The specifics will be grouped in the categories of technologies, management, and implementation.

Systems Engineering

The process to define both the Copernicus Architecture and the SEW Architecture falls both within the framework of systems engineering and operations analysis. Systems Engineering provides the tools and rationale for performing cost/performance tradeoffs to minimize lifecycle costs while providing an acceptable level of capability. The size of the universe being considered determines the outcome of the system engineering process. When one considers only a small (system) universe, the system trades become requirements-driven since there is no cost penalty for optimizing design. However, when one considers a very large universe, such as C^4I or up the hierarchy to SEW itself, the system trades become standards- and interoperability-driven because of the enormous cost savings realizable from commonality.

Technologies

Technologies can be viewed as functional areas (e.g., signature control, data fusion) definable within all categories of R&D[2]. Technology is not a "show stopper" to achieving the Copernicus Architecture. Identifying and ap-

[2] R&D categories are: 6.1 (Research), 6.2 (Exploratory Development), 6.3 (Advanced Development), 6.4 (Engineering Development), 6.5 (Management and Support), 6.6 (Operational System Development).

plying the correct technology (a function of the systems engineering process) is, however, critical. Technologies that support the systems engineering process, such as analysis, simulation and modeling, will be given high priority. Engineering development efforts will be directed toward fixing critical operational deficiencies, building the Copernicus communications "backbone" (e.g., CSS, BITS, Long Haul Architecture, Navigation Satellite Timing and Ranging Global Positioning System [NAVSTAR GPS]), and transitioning lingering existing systems (i.e., non-Copernican systems that will be available for a long time because of sunk costs, momentum, complexity, or cost to replace) to the Copernicus Architecture.

Looking to the future to determine what it will take to achieve the SEW Architecture, certain technologies are critical and will require advances to achieve desired architectural performance. These technologies include networking and network management, data fusion, signature control, distributed operating systems, and data compression. In addition to these technologies, initiatives in antennas, software producibility, simulation and modeling, AI/Expert systems, integrated optics, detection/recognition, two-way communications with submarines, and decision support should also be supported.

Management

In the area of R&D management, two initiatives should be pursued. A systems engineering consortium should be established. The consortium would develop recommended changes in the acquisition process to accommodate rapidly changing technology and work closely with OP-094 in obtaining approval from OP-91 or the Secretary of the Navy, as appropriate.

As exploratory development needs are identified, the Office of Naval Technology (ONT) should work closely with OP-094 to incorporate these needs within the ONT plans and to define transition strategies for inserting the exploratory development results into the SEW effort.

Implementation

RDT&E funds will be limited, and only the highest priority needs can be expected to be supported. Implementation will have to be orderly and timely so that no artificial roadblocks are created. (See chap. 10).

Additionally, certain specific areas in Copernicus clearly need definition and additional work. These include network requirements and distributed fusion. Network requirements must be defined in order for system interfaces can be understood. Distributed fusion is an essential element to allow the transformation of data into information. It is an extremely difficult technology area and has not yet been addressed in sufficient detail within Phase I of the architectural effort.

R&D Game Plan

The "game plan" for Copernicus R&D will be as follows, (1) use existing programs for R&D focal points as appropriate, (2) make maximum utilization of commercial R&D, (3) use DOD and other Government R&D efforts where useful, and (4) use Navy R&D to fill the gaps and aid in transition of enduring systems to Copernicus Architecture.

PROGRAMMATIC REQUIREMENTS

The following requirements are related to programmatic implementation of the Copernicus Architecture.

9-PR-1: Review and Devolve Existing Programs. There is a requirement to conduct a review and devolve all existing OP-094 C4I-related programs to determine and describe potential Copernicus building blocks currently in development.

9-PR-2: Describe Pillars as Engineering Models. There is a requirement to describe the Copernican pillars as functional engineering models based on guidance contained in Chapter 8.

9-PR-3: Develop, Publish, Use Engineering Criteria for Engineering Models. There is a requirement to develop, publish and use engineering criteria including affordability, feasibility, and suitability for the component derived from 9-PR-1.

9-PR-4: Conduct Engineering Analysis. There is a requirement to conduct an engineering analysis to determine "best of breed" of existing building blocks derived from the above analysis.

9-PR-5: Define Component ILS Strategies. There is a requirement to define component ILS strategies, including technology refreshment through the PIM concept where appropriate, for Copernican building blocks derived from the process above.

9-PR-6: Develop System-Wide ILS Strategies. There is a requirement to develop system-wide ILS strategies within the pillars of the Architecture.

9-OR-1: Establish Copernicus Architect. There is a requirement to establish, as a focal point for the effort and for all subsystems and components, a Copernicus "Architect" within OP-094 who will ensure operational and architectural continuity.

9-OR-2: Establish Copernicus Engineer. There is a requirement to establish, as a focal point for systems engineering, a Copernicus "Engineer" within SPAWAR who will ensure engineering continuity.

9-OR-3: Establish Copernicus Programmer. There is a requirement to establish, as a focal point for programmatic implementation, a Copernicus Programmer within OP-094 who will migrate existing programs across the program directorates into the Copernican mold.

CHAPTER 10
IMPLEMENTATION STRATEGY

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CHAPTER 10
IMPLEMENTATION STRATEGY

SUMMARY

Phase II will consist of three main thrusts:

- The establishment on the OP-094 staff of a Space and Electronic Warfare (SEW) Architect delegated broad architectural, managerial, and operational authority over the development of the SEW Systems, including the Copernicus Architecture.

- The establishment on the Space and Naval Warfare Systems Command (COMSPAWARSYSCOM) staff of a SEW Engineer, delegated systems integration and engineering oversight of the SEW systems, including the Copernicus Architecture.

- The establishment on the OP-094 staff of a SEW Programmer, delegated responsibility for programmatic integration of SEW systems, including the Copernicus Architecture.

The SEW Architect will be established as a staff element independent of existing division directors. His responsibilities include architectural and operational oversight of all OP-094-sponsored programs, existing and future, to ensure all compliance with Copernicus standards and applicability within the architecture.

During Phase II efforts, the Architect will focus on two broad areas: the establishment of working groups composed of fleet, claimancy, and industry personnel to produce individual operational requirements (OR) and concepts of operations (CONOP) for the four pillars and expanding the level of detail on the Architecture across Navy Department disciplines (e.g., SSN, Marine Air Ground Task Force [MAGTF], Special Operating Forces) and, if directed, up and across echelons into a joint model.

The SEW Engineer will be established in COMSPAWARSYSCOM. His responsibilities include Copernicus systems engineering, development of engineering models, "best of breed" building block selection, rapid prototyping efforts, Common Operating Environment (COE) definition, and general technical support for the SEW Architect.

During Phase II efforts, the Engineer will focus on four tasks:

- The development of a functional description document for each of the pillars;

- The development of an end-to-end, integrated, engineering model of the pillars;

- From that model, a "best of breed" building block selection recommendation to the Architect; and

- The expansion of fleet architectural and monitoring efforts (OTH-T) into SEW field engineering support.

The SEW Programmer will be established within the current programming division of OP-094. This office will effect the transition to Copernicus programmatically (versus from an engineering standpoint) from stove pipe programs of today to three basic types in the future: 1) building block programs, 2) pillar programs, and 3) research, development, test, and evaluation (RDT&E) programs.

DISCUSSION

In the preceding nine chapters, we discussed the requirements derived from Phase I (October 1990 to July 1991) working groups that are needed to implement the Copernicus Architecture. In this chapter, we describe the implementation strategy for Phase II (ending Jan. 93) of the effort.

Phase II will consist of three, and possibly four (i.e., joint model), main thrusts (see fig. 10-1):

- The establishment on the OP-094 staff of a Space and Electronic Warfare Architect delegated broad architectural, managerial, and operational authority over the development of the SEW System, including the Copernicus Architecture;
- The establishment on the COMSPAWARSYSCOM staff of a SEW Engineer, delegated systems integration and engineering oversight of the SEW System, including the Copernicus Architecture; and
- The establishment on the OP-094 staff of a SEW Programmer, delegated responsibility for programmatic integration of SEW systems, including the Copernicus Architecture.

Although each office will have responsibilities for all SEW systems, this document focuses on the Copernicus Architecture. For the remainder of the discussion, the responsibilities of the three positions above will center on that SEW subsystem.

SEW ARCHITECT

The SEW Architect will be established as a staff element independent of existing division directors. His responsibilities include architectural and operational oversight of all OP-094-sponsored programs, existing and future, to ensure compliance with Copernicus standards and applicability within the architecture.

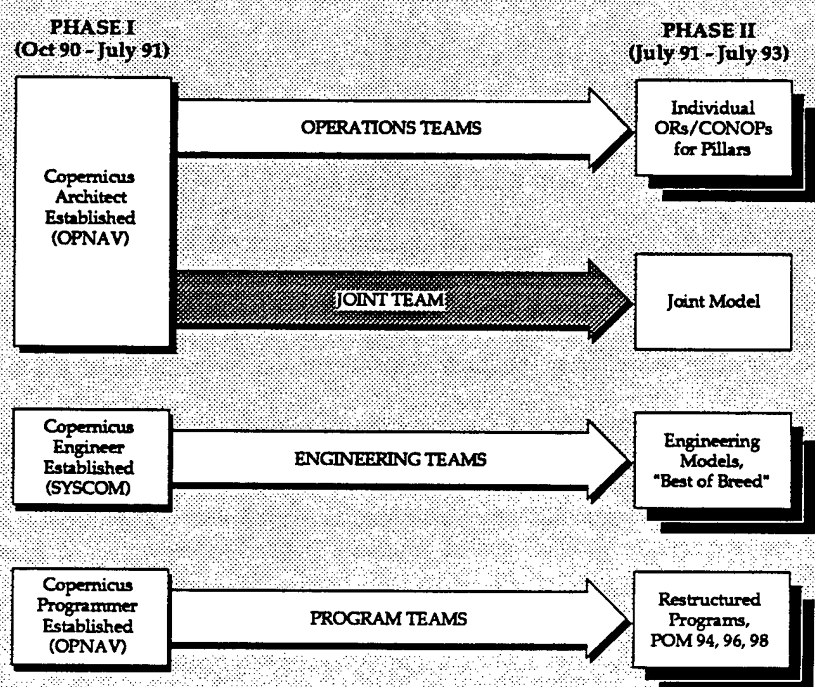

Figure 10-1. Phase II Copernicus Efforts

During Phase II efforts, the Architect will focus on two broad areas: the establishment of working groups composed of fleet, claimancy and industry working groups to produce individual operational requirements and concepts of operations for the four pillars and expanding the level of detail in the architecture across Navy Department disciplines (e.g., SSN, MAGTF, SOF) and, if directed, up and across echelons into a joint model.

Additionally, the Architect will ensure alignment of the architecture with Department of Defense plans for implementing Corporate Information Management (CIM) by blending management information systems ashore with tactical C4I systems afloat.

Methodology

To affect a more complete definition of the Global Information Exchange System (GLOBIXS) structures, the Architect will establish a series of simultaneously convened working groups to be headed by the designated claimant for each GLOBIXS. Figure 10-2 shows claimancies by GLOBIXS. Each GLOBIXS working group will be co-chaired by a designee from the Architect staff and from the claimant and will be tasked to produce an operational requirement (OR) and a CONOP that establishes GLOBIXS subscribership, information services, and operations.

Three working groups will be convened for the Tactical Information Exchange Systems (TADIXS): one each for the Carrier Battle Group (CVBG), SSN, and Marine Corps communities. Each will be tasked to produce a CONOP.

The Commander in Chief (CINC) Command Complex (CCC) and Tactical Command Center (TCC) pillars will be developed by the existing Fleet Project Team (FPT) and Fleet Requirements Working Group (FRWG) respectively. Additionally, each Fleet CINC (FLTCINC) will be requested to submit requirements for the construction of their respective CCCs. The output of these efforts will be a Program Change Approval Document (PCAD) to the Operation Support System (OSS) and Tactical Flag Command Center (TFCC) ORs. See figure 10-3.

SEW ENGINEER

The SEW Engineer will be established in COMSPAWARSYSCOM. His responsibilities include Copernicus systems engineering, development of engineering models, "best of breed" building block selection, rapid prototyping efforts, COE definition, and general technical support for the SEW Architect.

During Phase II efforts, the Engineer will focus on four tasks, shown in figure 10-4:

- The development of a functional description document for each of the pillars;
- The development of an end-to-end, integrated, engineering model of the pillars, based on a defined set of Copernicus building blocks. Definition of the Copernicus building blocks will be

GLOBIXS	Purpose	Architectural Authority	Engineering	Claimant	Operational Authority
GLOBIXS A	SIGINT MGMT	CNO (OP-094)	COMSPAWARSYSCOM	COMNAVSECGRU	FLTCINC
GLOBIXS B	ASW MGMT	CNO (OP-094)	COMSPAWARSYSCOM	COMNAVCOMTELCOM	FLTCINC
GLOBIXS C	SEW MGMT	CNO (OP-094)	COMSPAWARSYSCOM	COMNAVSPACECOM	FLTCINC
GLOBIXS D	HICOM	CNO (OP-094)	COMSPAWARSYSCOM	COMNAVCOMTELCOM	FLTCINC
GLOBIXS E	IMAGERY MGMT	CNO (OP-094)	COMSPAWARSYSCOM	COMNAVINTCOM	FLTCINC
GLOBIXS F	DATABASE	CNO (OP-094)	COMSPAWARSYSCOM	COMNAVCOMTELCOM	FLTCINC
GLOBIXS G	RDIXS	CNO (OP-094)	COMSPAWARSYSCOM	COMSPAWARSYSCOM	FLTCINC
GLOBIXS H	NAVIXS	CNO (OP-094)	COMSPAWARSYSCOM	COMNAVCOMTELCOM	FLTCINC

Figure 10-2. Proposed GLOBIXS Responsibilities

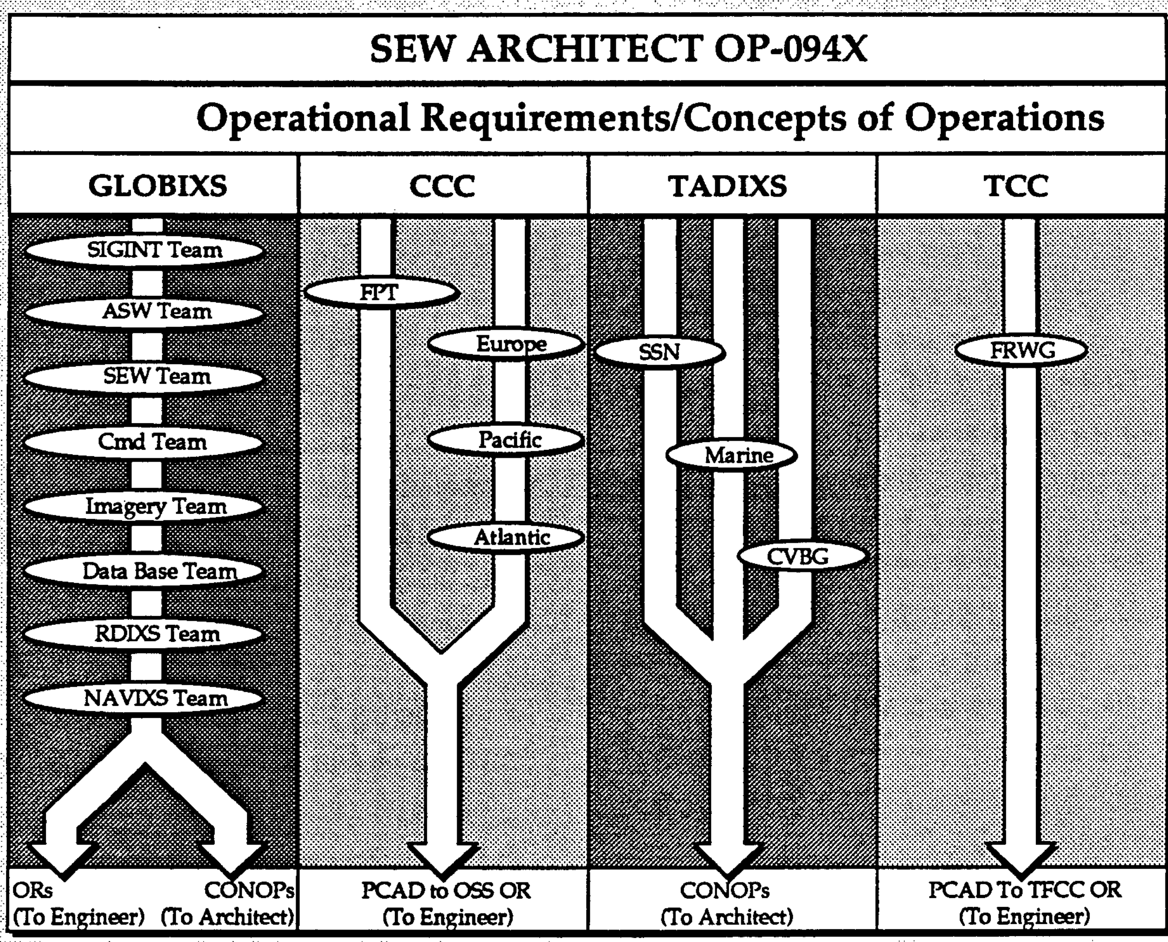

Figure 10-3. SEW Architect Phase II Efforts

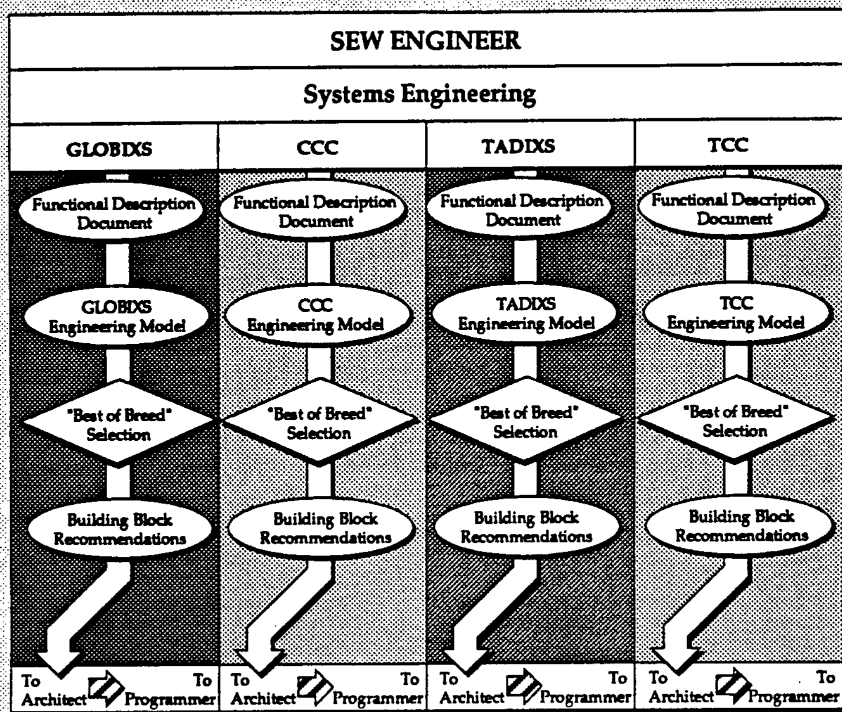

Figure 10-4. SEW Engineer Phase II Efforts

accomplished in terms of the Common Operating Environment (COE) previously described in chapter 8;

- From that model, a "best of breed" building block selection; and
- The expansion of fleet architectural and monitoring efforts (OTH-T) into SEW field engineering support.

"Best of Breed" Selection

As we saw in the preceding chapter, selection of "best of breed" building blocks will allow broad standardization throughout the architecture and make possible more affordable, tailored Integrated Logistics Support (ILS) strategies.

Figure 10-5 illustrates the anticipated "best of breed" process. Existing stove pipe programs will be mapped to pillars (e.g., programs A, B, and C in the figure) The programs will be devolved into like building blocks and compared for feasibility, suitability and affordability. In the figure, blocks A2, B3, and C1 represent all existing building blocks of a single family (e.g., communications processor, storage device, modem, terminal). From the family of three, one "species" — B3— is selected as "best of breed."

B3, however, may fall short of the desired Copernican building block E defined in the engineering models. Transition engineering will provide for improvement of B3 through either of two means. First, B3 may be improved,

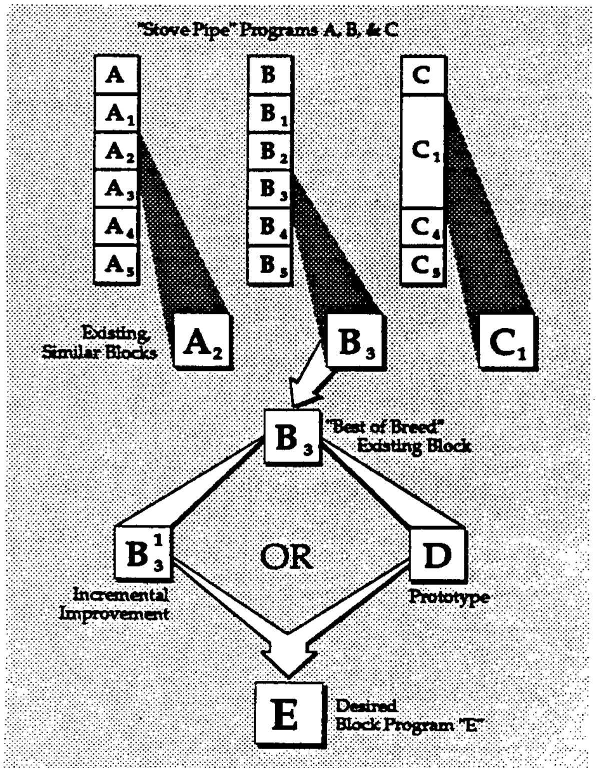

Figure 10-5. Stove Pipe Programs to Building Block Programs

producing B3[1]. Alternatively, the suitability, affordability, or feasibility of B3 may mean using B3 as an interim block even though it is far from the desired capability. In this latter case, rapid prototyping to achieve block D might be an attractive option to lead to E.

These engineering considerations necessarily will determine the length of time between today's architecture and the Copernicus Architecture and must be defined before actual implementation time can be estimated accurately. Once they are, it will be possible to map additional transitional phases— beyond definition and planning of Phase II to follow on operations and programmatic phases— over the next decade in which to implement the architecture.

SEW PROGRAMMER

The SEW Programmer will be established within the current programming directorate of OP-094. This office will effect the transition programmatically (versus from an engineering standpoint) from stove pipe programs of today to three basic types in the future: 1) building block programs, 2) pillar programs, and 3) RDT&E programs.

Building block programs exist today, but not across the board. Instead, we have a combination of building block programs (e.g., KG-84) and "stove pipe" programs (e.g., High Speed Fleet Broadcast, Officer in Tactical Command Information Exchange System, Ocean Surveillance Information System, Baseline Upgrade). The result is, we have several programs working toward the same functional building block, but producing different versions of it (and using different funding lines). In the future, we plan to pull building blocks from the stove pipe programs to build Copernicus block programs, based on the ORs derived from the Architect teams and the models and "best of breed" recommendations of the Engineer.

Pillar programs will reflect the funding lines necessary to build and operate the individual GLOBIXS, CCCs, and TCCs. Funding will have to be provided for leased bearer services to provide software and maintenance support and to construct (where necessary) the nodes and centers that make up the pillars. Although the engineering basis for an imagery GLOBIXS might be the same for Research and Development

Information Exchange System (RDIXS), locations, subscribership, existing connectivity, and other requirements will drive different budget requirements. Pillar programs will allow the claimant to operate the pillar.

Finally, RDT&E programs today are generally reflective of stove pipe efforts. The great advantage of an architecture is that it makes RDT&E shortfalls obvious. Today, to pick three examples, we have critical requirements for data compression, affordable ultra high frequency (UHF) multiplexing, and data file transmission to sea. Other examples abound: lower bit-rate voice, voice/data interleaving, electronically tunable antennas, and so on. RDT&E programs in the future will be tied to functional goals and be executed to solve clearly defined shortfalls. Figure 10-6 shows the SEW Programmer's Phase II efforts.

SEQUENCE OF TASKS

Figure 10-7 shows all three efforts in sequence. The engineering work will begin with the development of the Functional Description Documents (FDDs). These will be used to provide the engineering basis for the architectural work in the pillar teams to develop ORs and CONOPs, which will occur simultaneously. Following development of the FDDs, the Engineer will turn to development of pillar engineering models and conduct his "best of breed" analysis. From the CONOPs of the pillars, the Program Office will establish pillar

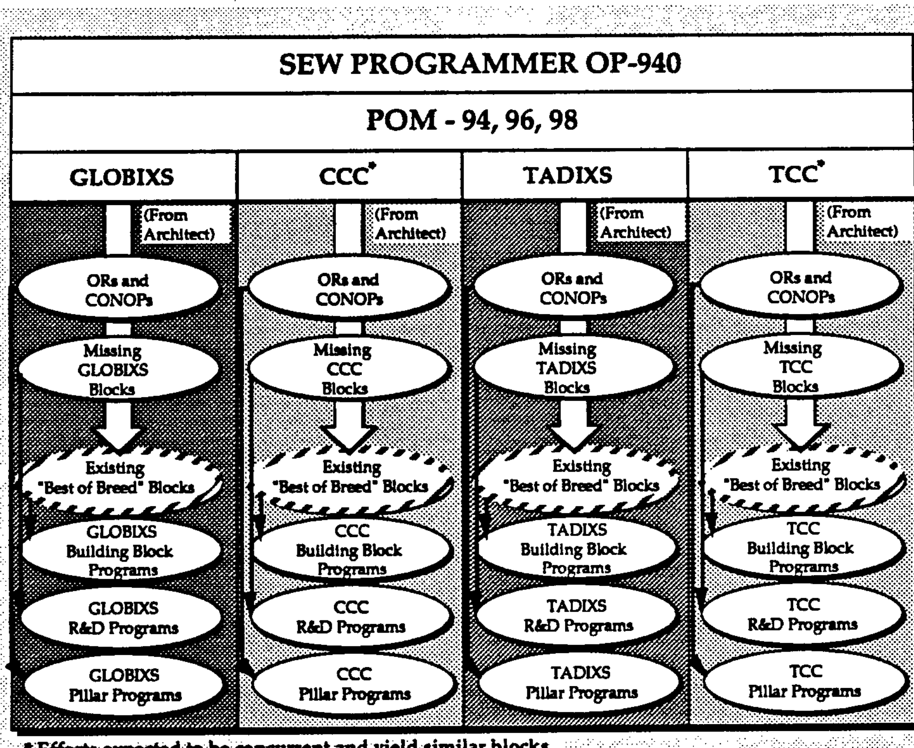

Figure 10-6. SEW Programmer Phase II Efforts

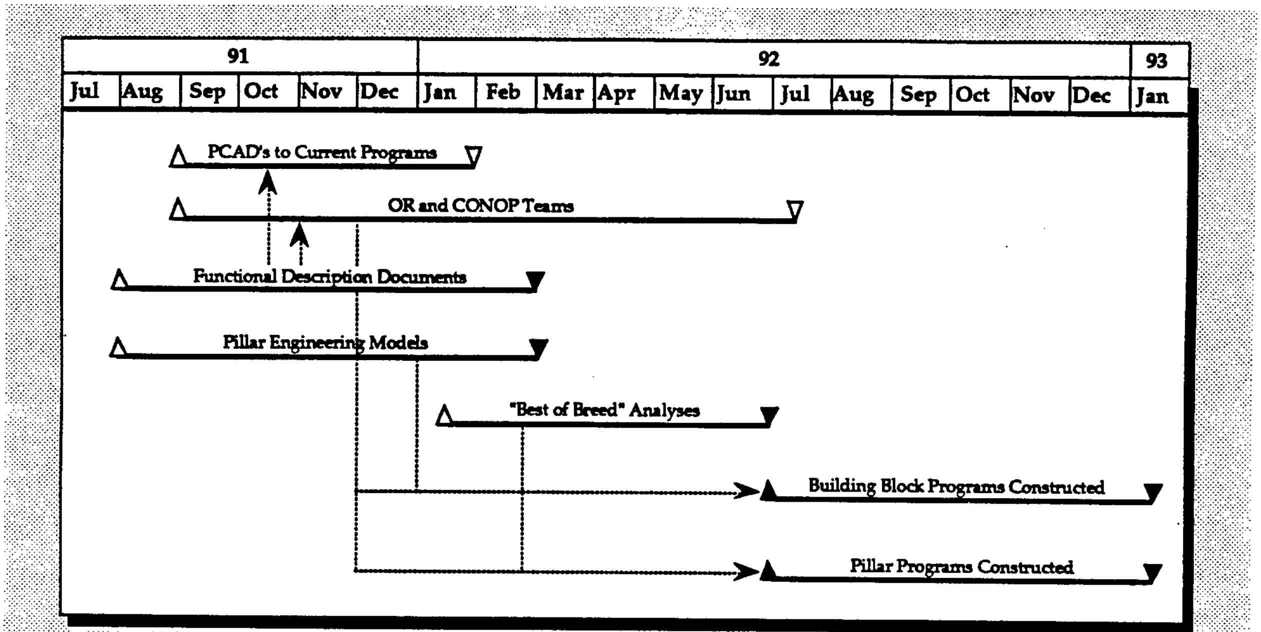

Figure 10-7. Sequence of Events for Phase II

programs for the CCCs, the TCCs, and the GLOBIXS. Similarly, from the "best of breed" analysis, the Programmer will develop building block programs from the existing stove pipes.

IMPLEMENTATION REQUIREMENTS

10-IR-1: Adminstrative Support for the Architectect and Programmer.. There is a requirement to provide administrative support for the Architect and Programmer during Phase II.

10-IR-2: Operational Requirement and Concept of Operations for GLOBIXS. There is a requirement to develop an operational requirement and an concept of operations for all GLOBIXS.

10-IR-3: Concept of Operations for TADIXS in SSN, USMC, SOF. There is a requirement to develop a concept of operations for TADIXS for the SSN, Marine, and Special Operating Force Communities.

10-IR-4: Program Change Approval Document for OSS and TFCC. There is a requirement to develop a program change approval document for the OSS and TFCC programs to reflect the Copernican requirements for CCC and TCC, respectively.

10-TR-1: Functional Description for Pillars. There is a requirement to develop a functional description document for each pillar.

10-TR-2: Engineering Model for Pillars. There is a requirement to develop an engineering model for each pillar based on a defined set of Copernicus building blocks. Definition of the Copernicus building blocks will be accomplished in terms of the Commmon Operating Environment (COE).

10-TR-3: Best of Breed Analysis for Pillar Building Blocks. There is a requirement to conduct a "best of breed" analysis for the pillar building blocks and make recommendations for those building blocks to the Architect.

10-TR-4: Identify Missing Building Blocks. There is a requirement to identify missing building blocks and make recommendations to the Architect.

10-PR-1: Develop Pillar Programs for GLOBIXS, CCC, TCC. There is a requirement to develop pillar programs to implement the GLOBIXS, the CCC, and the TCCs.

10-PR-2: Develop Building Block Programs. There is a requirement to develop building block programs based on the "best of breed" selection process.

10-PR-3: Develop RDT&E Programs for Building Blocks. There is a requirement to develop RDT&E or other appropriate programs for building blocks required by the architecture but not currently in being.

APPENDICES

APPENDIX A
TECHNOLOGY TEAM OUTBRIEF

The Copernicus Architecture

Technology Team
OUTBRIEF

Technology Team — Technical Team Findings

- Copernicus concept judged technologically sound!
- GLOBIXS are virtual (vice physical) nets
  - GLOBIXS will be operated on DCS backbone
  - DDN and DCTN plus available commercial
- DDN time will be significant cost to subscribers
- GLOBIXS/TADIXS media:
  - Text, voice, data files, imagery and video
  - Expense/subscriber drives media mix among nodes
  - Full motion video/studios are unnecessary
- Some GLOBIXS require little to implement
- Navy implementation will be OSI and GOSIP standards
  - GLOBIXS will be 100% GOSIP (possible one exception)
  - Objective for TADIXS (EMCON/Protocol overhead ↓)
  - Message service implementation will be DMS

Navy's C^4I Post Cold War Architecture: OP-094

The Copernicus Architecture

Technical Team Findings

- Four basic computer building blocks
  - A desktop series
  - A tactical workstation series
  - Communication servers
  - File servers
- "PIM" block intervals <6 but >4 years
  - Prime mover to maintain industry competition
- Do not constrain file/COMM/message servers to DTC-2
  - DTC-2 can be interface device
  - CCC file server functions were described
  - Separate file servers for encyclopedic/track data

Technical Team Findings

- Evolve a commonly structured Copernicus tactical software (e.g. spreadsheet application) tailored to many warfare areas
  - Truncate the training pipeline
  - Junior personnel are generic terminal operators specializing later in their careers
- The concept of COTS/GOTS is good but more rapid movement in that direction is required
- A veneer software is required
  - Fast standardization with industry hooks
  - Flexibility enough for unique industry interface
- Functional description of FASTT produced
- Accomplish transliteration/sanitization as close to the source as possible

Technical Team Findings

- Functions of C2 center processor established
- Must evolve common contact/track format for FASTTs
- Common track number methodology is required
- MLS is not mature but critical to full implementation
  - Will greatly streamline architecture/data flow
  - Radiant Mercury endorsed as interim transliterator/sanitizer
- Common message format desired
  - Bit-oriented preferred
  - OPNOTES in BOM BUT
    - Some text messages must be character-oriented
    - Machine-machine formats desired

Technology Team

Technical Team Findings

- Need algorithms for GLOBIXS-TADIXS sensors plus data fusion strategy for cross-sensor correlation at CCC/TCC
- Need multiple FOTC doctrine in order to address enabling technology (trips to CINCS should provide)
- Validated need of dynamic bandwidth management
  - CSS is viable option for CCC>TADIXS>TCC interface but concerns exist
    - Early commitment to VME
    - MLS certification risk
    - No $ yet spent on voice integration
    - Video not in the current architecture
    - Limited work evident on COMMS mgt functionality
    - Potential for costly retrofit if necessary

Navy's C^4I Post Cold War Architecture: OP-094
The Copernicus Architecture

Technology Team — **Technical Team Findings**

- Copernicus architecture will implement Navy ITDN
- Need joint management control interface for military COMMS equipment
  - JTC3A develop:
    - -- Management information base (MIB)
    - -- Use DDN standard protocol (SNMP, CMP)
    - -- Applicable to CSS
- Interface with COMMS PAT for loading and pipe data characterization for technology applications

Navy's C^4I Post Cold War Architecture: OP-094 — The Copernicus Architecture

Technology Team — **Technical Team R&D Findings**

- Low rate voice (<2.4 KBS/desired 300 BPS)
- Distributed DBMS
- Distributed operating systems
- Decision support tools
- Display technology to include large screen display
- AI applications for COMMS management
- Video-teleconferencing at 32 KBS
- Multi-freq, multi-aperture SATCOM antenna to include commercial SATCOM applications
- MUX voice plus voice on virtual circuit (COMSEC)
- MUX voice with data on virtual circuit (COMSEC)
- Investigate fractal's for long term voice and video applications
- Consider MODS to NKDS to include frequency management

Navy's C^4I Post Cold War Architecture: OP-094 — The Copernicus Architecture

Technology Team

Summary

- Unique government-industry teamwork
- Expanded awareness and acceptance of Copernicus in the industrial and development communities
- Many emerging technologies will assist implementation of Copernicus provided COTS and GOTS are pushed
- Care must be taken not to accept commercial standard until it is truly adopted industry wide
- End to end commercial standards where applicable could significantly reduce implementation costs as well as "PIM"

Navy's C^4I Post Cold War Architecture: OP-094

The Copernicus Architecture

APPENDIX B
COMMUNICATION TEAM OUTBRIEF

The Copernicus Architecture

Communication Team OUTBRIEF

Communication Team — Team Goals

- Define and prioritize communication infrastructure for the Copernicus Architecture
  - What kind of HF, UHF SATCOM, SHF, EHF, and CommSAT?
  - What proportions of HF, UHF SATCOM, SHF, EHF, and CommSAT?
  - Where in the architecture do we use each?
  - What are our priorities?
  - When should we invest in each?
- What existing programs must be cancelled, modified, and/or accelerated to build this infrastructure?

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The Copernicus Architecture

Communication Team

Findings

- Delphi analysis of transmission media completed, comparing Copernicus service requirements with attributes needed for these services.
- Detailed analyses summed into top level ranking of transmission media.
- Bottom line: UHF SATCOM, SHF SATCOM, and modernized HF have greatest potential for near-term contribution.
- Affordability may constrain extensive HF modernization.

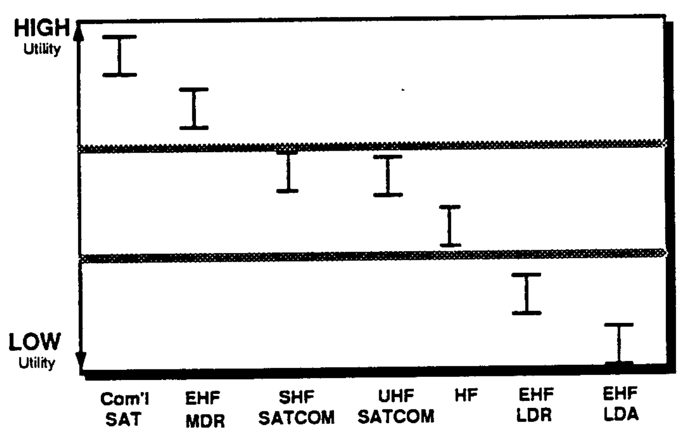
Navy's C⁴I Post Cold War Architecture: OP-094

The Copernicus Architecture

Communication Team

Recommendations

- Re-evaluate programs during Investment Strategy Team session. Identify the Contribution each makes toward a Copernican RF capability.



Navy's C⁴I Post Cold War Architecture: OP-094

The Copernicus Architecture

Communication Team

A Slice through the Volume: Copernican Record Services

HF	Suitable
UHF SATCOM	Good, although there is no anti-jam capability
SHF SATCOM	Good, although anti-jam data rate is limited (as low as 75 bps)
Milstar Low Data Rate	Good. Current validated uses oriented toward tactical message exchanges. Access to limited space segment is a problem.
Milstar Medium Data Rate	Applicable (future system now being designed)
EHF on UHF Follow-On	Good. Current validated uses oriented toward tactical track message exchanges. Access to limited space segment is a problem.
Commercial SATCOM	Good

Coverage Throughput Survivability Growth Operation & Maintenance Limitations Cost Physical Characteristics

Navy's C^4I Post Cold War Architecture: OP-094

The Copernicus Architecture

Communication Team

A Slice through the Volume: Copernican Data Base Exchange Services

HF	Not suitable, due to poor error rate of medium
UHF SATCOM	Good, although there is no anti-jam capability
SHF SATCOM	Good, although anti-jam data rate is limited (as low as 75 bps)
Milstar Low Data Rate	Good. Current validated uses oriented toward tactical message exchanges. Access to limited space segment is a problem.
Milstar Medium Data Rate	Applicable (future system now being designed)
EHF on UHF Follow-On	Good. Current validated uses oriented toward tactical track message exchanges. Access to limited space segment is a problem.
Commercial SATCOM	Good

Coverage Throughput Survivability Growth Operation & Maintenance Limitations Cost Physical Characteristics

Navy's C^4I Post Cold War Architecture: OP-094

The Copernicus Architecture

Communication Team

A Slice through the Volume: Copernican VoiceServices

HF	Suitable, but not optimum due to poor error rate of medium
UHF SATCOM	Good, although there is no anti-jam capability
SHF SATCOM	Good, although voice may not be supportable in some extreme radio electronic combat scenarios
Milstar Low Data Rate	Good, although getting access to the limited space segment is a problem
Milstar Medium Data Rate	Applicable (future system now being designed)
EHF on UHF Follow-On	Good, although getting access to the limited space segment is a problem
Commercial SATCOM	Good

Coverage Throughput Survivability Growth Operation & Maintenance Limitations Cost Physical Characteristics

Navy's C4I Post Cold War Architecture: OP-094

The Copernicus Architecture

Communication Team

A Slice through the Volume: Copernican Graphics Data Exchange

HF	Suitable, but not optimum due to poor error rate of medium
UHF SATCOM	Good, although there is no anti-jam capability
SHF SATCOM	Good, although anti-jam data rate is limited (as low as 75 bps)
Milstar Low Data Rate	Good, although getting access to the limited space segment is a problem
Milstar Medium Data Rate	Applicable (future system now being designed)
EHF on UHF Follow-On	Good, although getting access to the limited space segment is a problem
Commercial SATCOM	Good

Coverage Throughput Survivability Growth Operation & Maintenance Limitations Cost Physical Characteristics

Navy's C4I Post Cold War Architecture: OP-094

The Copernicus Architecture

Communication Team

A Slice through the Volume: Copernican Facsimile Services

HF	Suitable, but not optimum due to poor error rate of medium
UHF SATCOM	Good, although there is no anti-jam capability
SHF SATCOM	Good, although anti-jam data rate is limited (as low as 75 bps)
Milstar Low Data Rate	Good, although getting access to the limited space segment is a problem
Milstar Medium Data Rate	Applicable (future system now being designed)
EHF on UHF Follow-On	Good, although getting access to the limited space segment is a problem
Commercial SATCOM	Good

Coverage Throughput Survivability Growth Operation & Maintenance Limitations Cost Physical Characteristics

Navy's C^4I Post Cold War Architecture: OP-094

The Copernicus Architecture

Communication Team

A Slice through the Volume: Copernican Imagery Transmission

HF	Not suitable
UHF SATCOM	Limited due to current 32 kilobit per second data rate
SHF SATCOM	Applicable, although anti-jam data rate is limited (as low as 75 bps)
Milstar Low Data Rate	Suitable, although 2,400 bps rate is not optimum
Milstar Medium Data Rate	Applicable (future system now being designed)
EHF on UHF Follow-On	Suitable, although 2,400 bps rate is not optimum
Commercial SATCOM	Applicable, but high band width satellites may not cover ocean areas

Coverage Throughput Survivability Growth Operation & Maintenance Limitations Cost Physical Characteristics

Navy's C^4I Post Cold War Architecture: OP-094

The Copernicus Architecture

Communication Team

A Slice through the Volume: Copernican Video Teleconferencing

HF	Not suitable
UHF SATCOM	Limited due to current 32 kilobit per second data rate
SHF SATCOM	Applicable, although shore-ship-shore quality may not be good
Milstar Low Data Rate	Not suitable
Milstar Medium Data Rate	Applicable (future system now being designed)
EHF on UHF Follow-On	Not suitable
Commercial SATCOM	Applicable, but high band width satellites may not cover ocean areas

Coverage Throughput Survivability Growth Operation & Maintenance Limitations Cost Physical Characteristics

Navy's C^4I Post Cold War Architecture: OP-094

The Copernicus Architecture

Communication Team

Recommendations (Continued)

- Establish a single OP-094 point of contact for all OP-094 architectural efforts.

- Analyze backbone architectures in comparison to Copernicus Architecture requirements. Other architectures affecting OP-094 programs should be consolidated into Copernicus, or modified to be consistent with it.

Current Architecture Paradigm

Tactical Data Link	Secure Voice and Data Systems	Radio Frequency Systems

Objective Architecture Paradigm

Copernicus Architecture		
SEW System Description		
Tactical Data Link	Secure Voice and Data Systems	Radio Frequency Systems

Navy's C^4I Post Cold War Architecture: OP-094

The Copernicus Architecture

Communication Team

Recommendations (Continued)

- CSS should be used to implement the Copernicus TADIXS structure afloat and ashore.
- Investigate political and legal implications of using Commercial SATCOM in CALOW situations that do not involve U.S. operating in support of U.N. resolutions.
- Consider how to invest to take best advantage of Commercial SATCOM. Possible alternative approaches may include:
  - Modular antenna systems.
  - Integrated, modular SATCOM terminals that can plug-in, plug-out capabilities (both military and commercial) for individual missions and Copernican services.
- De-emphasize Milstar LDR and EHF on UHF Follow On investment when it is economical to do so.

Navy's C^4I Post Cold War Architecture: OP-094

The Copernicus Architecture

Communication Team

Recommendations (Concluded)

- Minimize investment in Milstar Low Data Rate (LDR).
  - Procure and install terminals for flagships and capital ships.
  - Go slow with procurement & installation for smaller ships while Milstar Medium Data Rate (MDR) clarifies.
  - Participate in definition of Milstar MDR.
- Use UHF Follow On EHF capability, but don't invest in buying more.

Navy's C^4I Post Cold War Architecture: OP-094

The Copernicus Architecture

APPENDIX C
INVESTMENT STRATEGY

The Copernicus Architecture

Copernicus/SEW Investment Strategy

Investment Strategy OBJECTIVES

- REFINE COPERNICUS INVESTMENT STRATEGIES
- PROVIDE FOCUS FOR POM-94

Investment Strategy — *PHASES OF PANEL WORK*

REQUIREMENTS

COPERNICUS (TOP DOWN) — SEW (BOTTOM UP) — SPAWAR (WSA&E)

RECOMMENDATIONS
- CUT/FIX UP
- INVEST IN FOLLOW-ON OR NEW START
- ASSOCIATE PROGRAMS WITH PILLARS

→ **TRANSITION TRADEOFFS**
- SIZE PROGRAMS VS COST
- REVALIDATE REQUIREMENTS FOR TIMING AND UTILITY

→ • POM

← PHASE I →

← PHASE II →

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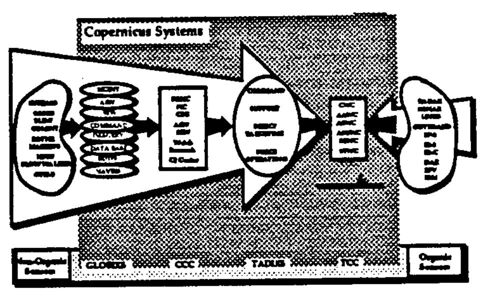
Investment Strategy — *TOP-DOWN ANALYSIS*



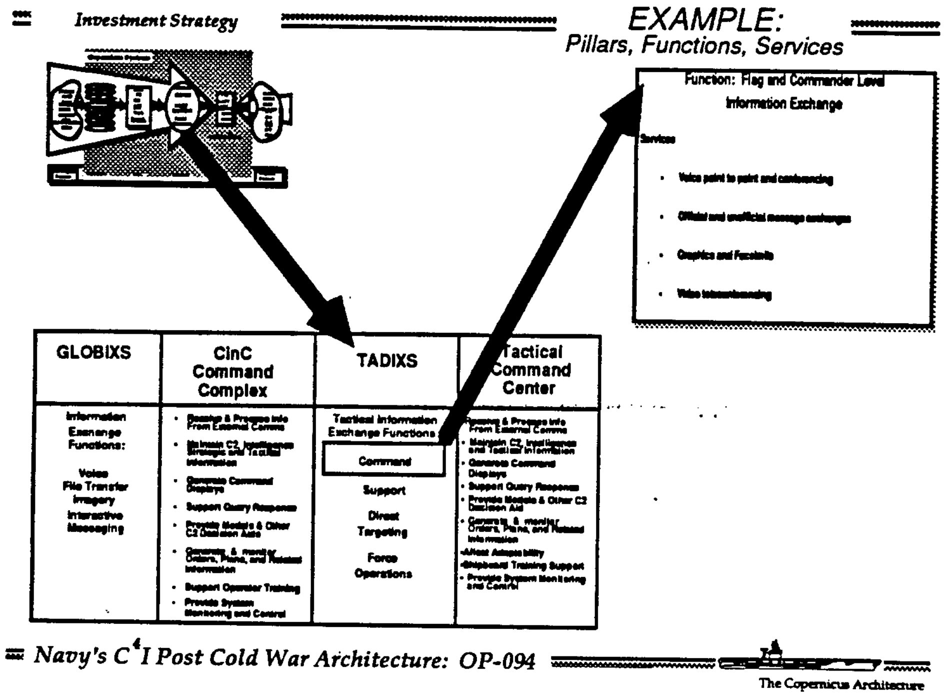
1. Allocate programs and functions to pillars

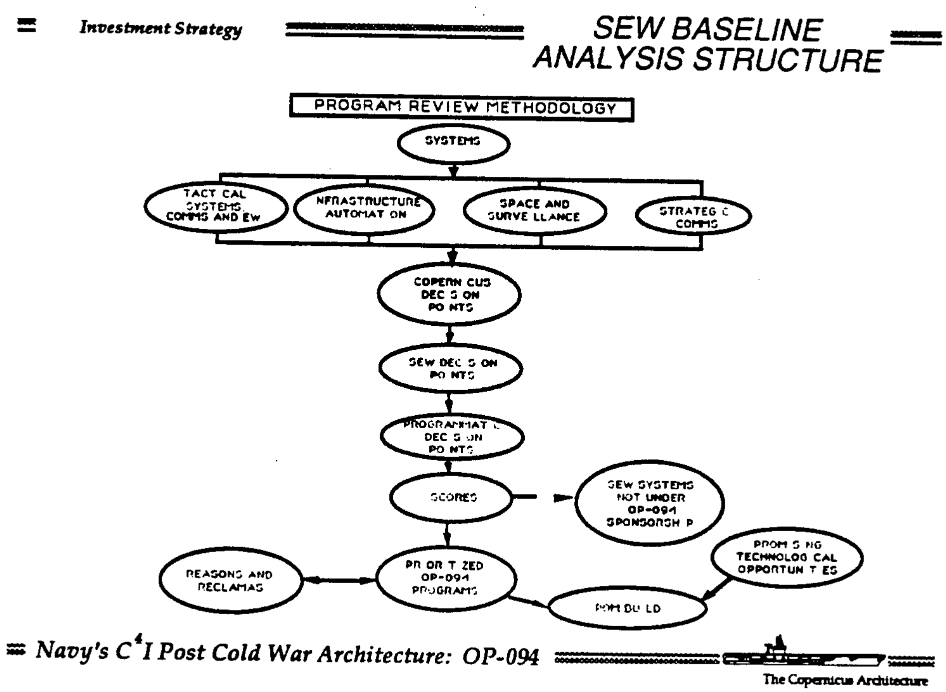
2. Analyze functions and services required to make the pillar real

3. Analyze utility of programs for functions and services

4. Make recommendations:
   - a. Priority Requirements
   - b. Restructure
   - c. Requires Further Investigation

Navy's C⁴I Post Cold War Architecture: OP-094 — The Copernicus Architecture


Investment Strategy
EXAMPLE:
Pillars, Functions, Services
Function: Flag and Commander Level Information Exchange
Services
GLOBIXS
CinC Command Complex
TADIXS
Tactical Command Center
Information Exchange Functions:
Voice
File Transfer
Imagery
Interactive
Messaging
Tactical Information Exchange Functions
Command
Support
Direct Targeting
Force Operations
Navy's C4I Post Cold War Architecture: OP-094
The Copernicus Architecture


Investment Strategy
SEW BASELINE
ANALYSIS STRUCTURE
PROGRAM REVIEW METHODOLOGY
SYSTEMS
TACT CAL SYSTEMS COMMS AND EW
NFRASTRUCTURE AUTOMAT ON
SPACE AND SURVE LLANCE
STRATEG C COMMS
COPERN CUS DEC S ON PO NTS
SEW DEC S ON PO NTS
PROGRAMMAT C DEC S ON PO NTS
SCORES
SEW SYSTEMS NOT UNDER OP-094 SPONSORSH P
PROM S NG TECHNOLOG CAL OPPORTUN T ES
PR OR T ZED OP-094 PROGRAMS
REASONS AND RECLAMAS
POM BU LD
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The Copernicus Architecture

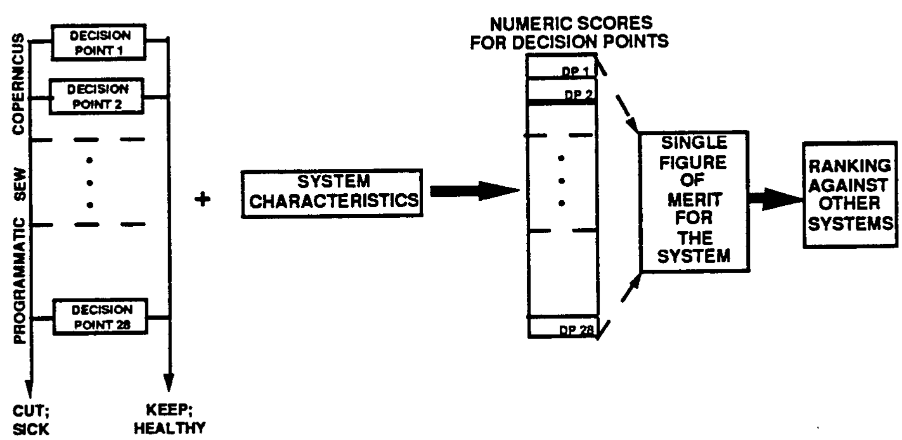
Investment Strategy

SEW BASELINE INVESTMENT STRATEGY (BOTTOM-UP APPROACH)

- PROGRAM DATA COLLECTED AND VERIFIED
- MODEL LOADED WITH QUANTITATIVE MEASURES
  - CONFORMANCE TO COPERNICUS DECISION POINTS
  - CONTRIBUTION TO SEW BASELINE REQUIREMENTS
  - PROGRAMMATIC HEALTH OF PROGRAM
  - 28 DECISION POINTS, 90 SPECIFIC QUESTIONS
- LINKS CURRENT PROGRAM REQUIREMENTS TO COPERNICUS BUILDING BLOCKS
- WILL BE USED TO HELP DERIVE PROGRAM RANKINGS

Investment Strategy

SEW BASELINE INVESTMENT STRATEGY METHODOLOGY



METHODOLOGY REPRESENTED AS AN EQUATION:

SYSTEM FIGURE OF MERIT = i(COPERNICUS) + j(SEW) + k(PROGRAMMATIC)

Investment Strategy — *MANPOWER , PERSONNEL, AND TRAINING*

- MPT INVESTMENT ASSUMPTIONS:
  - NO NET-GROWTH IN MPN
    - MODERNIZATION SHOULD REQUIRE LESS MANPOWER
    - TQL APPROACH TO INVESTIGATE RESTRUCTURE OF ALL SEW ENLISTED RATINGS
  - NO NET-GROWTH IN TRAINING
    - HUMAN/SYSTEM INTEGRATION, EMBEDDED AND ONBD TRAINING = LESS EMPHASIS ON SCHOOLHOUSE TRAINING
    - INCREASED COMMONALITY OF NODES MEANS GENERALIST, SYSTEMS INSTRUCTION APPROACH

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Investment Strategy — *MANPOWER, PERSONNEL, AND TRAINING, CONT'D*

- FOUR PRINCIPAL FACTORS
  - QUANTITY
  - QUALITY
  - TRAINING
  - HUMAN/SYSTEMS INTEGRATION

Navy's C⁴I Post Cold War Architecture: OP-094 — The Copernicus Architecture

Investment Strategy **MANPOWER, PERSONNEL, AND TRAINING, CONT'D**

- QUANTITY
  - OVERALL NAVY DOWNSIZING
  - SEW MPN DECREASED SINCE FY 90
  - COPERNICUS MPN REQUIREMENTS MUST COME FROM WITHIN (NO NET GROWTH)

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Investment Strategy **MANPOWER, PERSONNEL, AND TRAINING, CONT'D**

- QUALITY
  - TO ENSURE OUR PEOPLE HAVE THE "RIGHT STUFF" FOR COPERNICUS:
    - SEW CONTINUUM
    - REVIEW C4I ENL RATINGS (TQL, QMB)
    - IMPOSE HIGHER QUALIFICATIONS FOR C4I ENLISTED/OFFICERS
    - MODERNIZE TRAINING AND PROVIDE REFRESHER TRAINING
  - ONGOING INITIATIVES INCLUDE:
    - RM 2000/DP RATING REVIEW
    - SEW OFFICER PROFESSIONAL DEVELOPMENT
    - GEN URL SEW PAT
    - SEW CENTER
    - SEW COMMANDER

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Investment Strategy

MANPOWER, PERSONNEL, AND TRAINING, CONT'D

- TRAINING--TO MEET ASSUMPTION OF NO NET GROWTH, STRATEGY MUST EMPHASIZE:
  - TECHNOLOGY
    - LIFE CYCLE TRAINING COSTS
    - EMBEDDED COURSEWARE
  - TRAINING ECONOMICS
    - SCHOOLHOUSE AND CURRICULUM CONSOLIDATION
    - STREAMLINING OF PIPELINE TRAINING
    - EMPHASIS ON OVERARCHING SYSTEMS TRAINING

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The Copernicus Architecture

Investment Strategy

MANPOWER, PERSONNEL, AND TRAINING, CONT'D

- HUMAN/SYSTEM INTEGRATION
  - EMBEDDED AND ON-BOARD TRAINING
    - WILL PROVIDE REDUCED TRAINING COSTS
  - BUILT-IN TESTS AND USER-FRIENDLY DIAGNOSTICS
    - FASTER, LESS EXPENSIVE MAINTENANCE
  - GENERAL SYSTEMS INSTRUCTION
    - COMMON WORK STATIONS
    - WILL PROVIDE PERSONNEL FLEXIBILITY
  - SIMPLER MAINTENANCE
    - RECOGNIZING BENEFITS OF THROW-AWAY PARTS

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The Copernicus Architecture

Investment Strategy

TECHNOLOGY/RESEARCH

- TECHNOLOGY IS NOT A SHOW STOPPER
- SYSTEMS ENGINEERING IS ABSOLUTELY ESSENTIAL
- ENABLING TECHNOLOGIES FOR THE NEXT GENERATION OF SEW SYSTEMS:
  - Networking and Network Management
  - Distributed Fusion
  - Signature and Emission Control
  - Distributed Operating Systems
- SEPARATE R&D BRIEF TO BE PRESENTED

Navy's C^4I Post Cold War Architecture: OP-094

The Copernicus Architecture

Investment Strategy

INSTITUTIONAL FINDINGS

- INSTITUTIONALIZE COPERNICUS GOAL ARCHITECTURE
  - EXPAND TO INCLUDE ALL OF SEW
  - CONTINUE TO SUPPORT COPERNICUS AND SEW BASELINE PROJECTS FOR SHORT TERM
  - MERGE INTO SEW/COPERNICUS TEAM UNDER A SINGLE SEW/COPERNICUS ENGINEER
    - DUTIES AND RESPONSIBILITIES
      - EXPAND ARCHITECTURE
      - SELECT AND ENFORCE STANDARDS
      - REVIEW ALL C4I PROGRAMS FOR CONFORMANCE TO COPERNICUS AS A NORMAL PART OF ACQUISITION REVIEW PROCESS
      - FOSTER COTS/GOTS
      - NAVY SPOC FOR ARCHITECTURAL ISSUES WITH DOD, DCA, ET AL.

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The Copernicus Architecture

Investment Strategy

INSTITUTIONAL FINDINGS, CONT'D

- ACQUISITION PROCESS
  - "TRAIL BOSS" ANALOG FOR SEW
  - INSTITUTIONALIZE EVOLUTIONARY DEVELOPMENT WITHIN THE ACQUISITION PROCESS
    - REVISE DOD/JOINT/SECNAV DIRECTIVES
  - REQUIRE SEW/COPERNICUS ENGINEER APPROVAL FOR ALL SEW PROGRAMS

Navy's C^4I Post Cold War Architecture: OP-094

The Copernicus Architecture

Investment Strategy

OUTLINE

- EXAMINATION OF REQUIREMENTS (PHASE I OF II)
  - TOP DOWN, BOTTOM UP
  - ARCHITECTURE ASHORE AND AFLOAT
  - IDENTIFICATION OF HIGH PRIORITY PROGRAMS
- MANPOWER, PERSONNEL, AND TRAINING
- TECHNOLOGY AND R&D FINDINGS (SEPARATE BRIEF)
- **INSTITUTIONAL ISSUES AND REQUIREMENTS**
- CONSOLIDATED PRINCIPAL RECOMMENDATIONS

Navy's C^4I Post Cold War Architecture: OP-094

The Copernicus Architecture

Investment Strategy SUMMARY

- USE THE PILLAR PRIORITY REQUIREMENTS AS A POM-94 STARTING POINT.
- TECHNOLOGY IS NOT A SHOW STOPPER
- CHARTER SEW/COPERNICUS SYSTEM ENGINEER
- ESTABLISH AND ENFORCE ARCHITECTURE STANDARDS
- FOSTER STREAMLINING OF THE ACQUISITION PROCESS (THROUGH TRAIL BOSS, SYSTEMS ORIENTATION, ETC.)
- MPT MUST BE THE CORNERSTONE FOR THE SEW/COPERNICUS INVESTMENT STRATEGY

Navy's C^4I Post Cold War Architecture: OP-094 The Copernicus Architecture

The Copernicus Architecture

Investment Strategy
R&D Panel

Investment Strategy

DEFINING TERMS

R&D Categories

- Research (6.1) - ONR
- Explortory Development (6.2) - ONT
- Advanced Development (6.3A) - OAT +

- Advanced Development (6.3B) OP-094
- Engineering Development (6.4)

Technology

- Functional Areas Covering All R&D Categories

Architecture

- Broad Definition - A Structural Description of a System or Activity
- More Specific Definition - The Physical, functional, and Organizational Arrangement of a Given Set of Related Entities for a Given Composition of Forces

System Engineering

- The Process Needed to Define Architectures
  - Small Universe - Requirements Driven Design
  - Large Universe - Standards and Interoperability Driven Design

Navy's C⁴I Post Cold War Architecture: OP-094

The Copernicus Architecture

Investment Strategy

DEFINING TERMS

C4I Architecture

The Physical, Functional, and Organizational Arrangement of C4I for a Given Composition of Forces

- Physically - Hardware/Software Elements (What the Elements are)
- Functionally - What the Elements Do
- Organizationally - Chain of Command, Structure and Responsibility
- Compositionally - What Set of Forces/Platforms are Being Considered

Copernicus Architecture

The Physical, Functional, and Organizational Arrangement of C4I

- Physically - Specifies and Defines the Consistent Set of Rules for the Development and Combining of Hardware/Software (NFC, JOINT, COMBINED)
- Compositionally - Open Architecture, within Bounds
- Achievable within the State-of-the-Art

Copernicus Goal Architecture

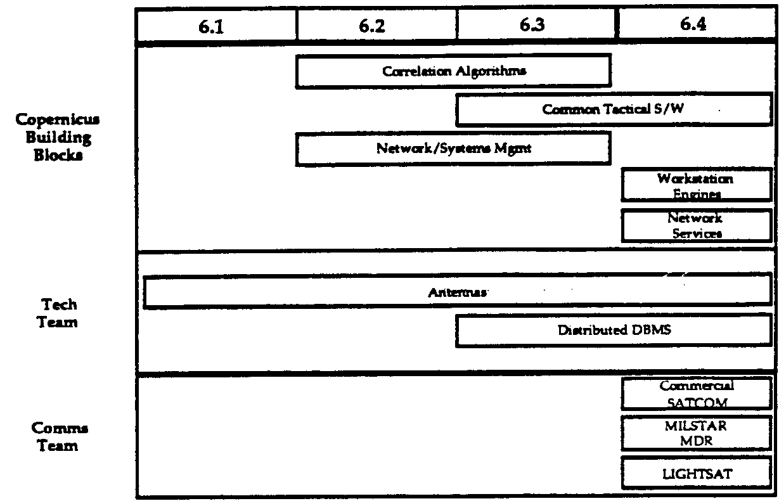
- The Implemented Copernicus Architecture

Navy's C⁴I Post Cold War Architecture: OP-094

The Copernicus Architecture

Investment Strategy

Top Down GAME PLAN FOR COPERNICUS R&D



Investment Strategy

TECHNOLOGY CONCLUSIONS

What's Important - *Now*

- Copernicus Architecture Needs System Engineering and Expansion to the Total SEW Architecture
- Engineering Development Needs to Concentrate on:
  - Fixing Critical SEW Deficiencies
  - Applying Technologies to the Copernicus Communications Backbone
  - Transitioning Enduring Systems to New Goal Architecture

Investment Strategy

MANAGEMENT CONCLUSIONS

- Work Closely with ONT on Expl Dev investments, Establish Transition plans for SEW Efforts
- Promote the Changing of Acquisition Rules to Accomodate rapidly Changing Technology
  - Work with OP-91 to Change OPNAVINSTRs
  - Work with ASN to Change SECNAVINSTs
  - Promote Evolutionary Acquisition in all Instructions

Navy's C^4I Post Cold War Architecture: OP-094

The Copernicus Architecture

Investment Strategy

IMPLEMENTATION CONCLUSIONS

Copernicus Architectural Details Need To Be Specified
And Expanded So That R&D Deficiencies Can Be Fully Addressed

- Establish dedicated OPNAV/SYSCOM team supported by Navy labs
- POA&Ms required

SEW Concept Needs To Be Defined

- Establish a team to develop "The SEW Concept"
  - Top down integrated sense
  - Near and far term objectives and implications
  - Address both warfare mission area (investment strategy) and SEWC (CWC) aspects

Navy's C^4I Post Cold War Architecture: OP-094

The Copernicus Architecture

TOP DOWN R&D COPERNICUS BUILDING BLOCKS

Copernicus Building Blocks	Examples of R&D Focal Points	Navy R&D "Roadmap"		
		Commercial Utilization	DOD Government Utilization	Navy R&D Investments (Recommended)
Correlation Algorithims	NTCS-A, SGS/AC, OSS, IUSS, CS@SE(AACT), F-14, P-3C, Aegis, ASWOC, etc.	Use civil and commercial products	Use Air Force, SDI, Army algorithms. High availability, must make correct choce	Low (6.1) High (6.2, 6.3) Med (6.4)
Copernicus Common Tactical Software	NTCS-A, AUTO ID, OSS, CS@SE(CSDS), IUSS	Use, e.g., Data Base, Spreadsheet, Office Automation programs	Don't pursue due to low availability	Need DBMS development High (6.3, 6.4)
Network/Systems Management	NTCS-A, OSS	Leverage Standards (e.g., SNMP)	Use Commercial standards, not local inventions.	High (6.2, 6.3)
Workstation Engines	NTCS-A, AUTO ID, OSS, TDA, NGCR, NIPS, CS@SE	Leverage Standards, use ruggedized systems where applicable	Settle on Navy Requirements and leverage commercial.	High, to transition systems and packaging of commercial technology
Network Services	DCS, DDN, DTCN, FTS-2000	Leverage Standards	Strongly pursue due to high availability	Program Specific. High, to integrate current enduring systems.
INFOSEC	System by System	Use industrial security products as applicable	NSA, High Availability (UNIGUARD COTS, TC/IP)	Med (6.3)
Common Decision Support Software	NTCS-A, OSS, IUSS, ASWOC, TAMPS, TDA	Leverage MMI Standards (e.g., MOTIF)	Don't pursue due to low availability	Med (6.2, 6.3)
Data File Servers	OSS	Leverage Standards (e.g., NFS)	Settle on Navy Requirements and leverage commercial.	Med to integrate existing enduring systems.
Desktop Engines	SNAP, NST Ashore	Leverage Standards	Settle on Navy Requirements and leverage commercial.	Develop as Part of Programs
Comm Servers	NAVCOMPSRS/LDMX* NAVMACS/CUDIXS* NTCS-A, Integrated SI Comms* Long Haul Comms*, DDS	Leverage Standards	Settle on Navy Requirements and leverage commercial.	Develop as Part of Programs
Sensor Specific Application	System by System	Don't pursue, no utilization expected	Don't pursue due to low availability	Develop as Part of Programs
Data Compression	TRAP	Leverage Standards	Strongly pursue due to high availability	Low (6.1, 6.2)
Data Robots	None Known	Leverage Standards (e.g., SQL)	Don't pursue due to low availability	Low (6.2)
Environmental Analysis	PMW 161 Programs, TESS-3, TAMPS, ASWOC, etc.	Don't pursue, no utilization expected	Strongly pursue due to high availability	Low (6.1, 6.2) Med (6.3)
Tran-Sanitization Software	TENCAP	Don't pursue, no utilization expected	Pursue with NSA, low availability	Low (6.3)
Display Devices	OSS, NTCS-A, Aegis ADS	Leverage Standards	Settle on Navy Requirements and leverage commercial	Low (6.2, 6.3) For rugged packaging of commercial technology
Modular Embedded Crypto	Classic Lightning	Don't pursue, no utilization expected	Pursue with NSA, low availability	Low (6.2, 6.3)
STU-III		Don't pursue, no utilization expected	Influence OSD to support MANTECH to reduce costs	Low (6.4)
Interchangable Modems	None Known	Leverage Standards	Settle on Navy Requirements and leverage commercial	None. Use as approprite. Not an R&D issue.
Standard Storage Devices	None Known	Leverage Standards	Strongly pursue due to high availability	None. Use as approprite. Not an R&D issue.

GLOSSARY

GLOSSARY

Abbreviations/Acronyms

AAW	Anti-Air Warfare
AAWC	Anti-Air Warfare Commander
ABN	Airborne
ACDS	Advanced Combat Direction System
ACP	Allied Communications Publications
ACS	Afloat Correlation System
ADP	Automated Data Processing
AIC	Atlantic Intelligence Center
AJ	Anti-jam
AMW	Amphibious Warfare
ANCC	Automated Network Control Center
ANDVT	Advanced Narrowband Digital Voice Terminal
AOR	Area of Responsibility
AREC	Air Resources Element Coordinator
ASUW	Anti-surface Warfare
ASUWC	Anti-surface Warfare Commander
ASW	Anti-submarine Warfare
ASWC	Anti-submarine Warfare Commander
ASWIXS	ASW Information Exchange System
ASWM	ASW Module
ASWOC	ASW Operations Center
ATF	Amphibious Task Force
ATP	Advanced Tactical Protype
AUTODIN	Automatic Digital Network
AWACS	Airborne Warning and Control System
BDA	Battle Damage Assessment
BF	Battle Force
BG	Battle Group
BGPHES	Battle Group Passive Horizon Extension System
BITS	Base Information Transfer System
BLOS	Beyond Line-of-Sight
BOM	Bit Oriented Message
C&D	Command and Decision
C&P	Characteristics and Performance
C^3CM	Command, Control, Communications Countermeasures
C^4	Command, Control, Communications and Computers
C^4I	Command, Control, Communications, Computers and Intelligence
C^4ICM	C^4 I Countermeasures
C^4S	Command, Control, Communications, and Computer Systems
CAL	Computer Aided Logistics
CALOW	Contingency and Limited Objective Warfare
CAS	Close Air Support

Abbreviations/Acronyms

CATF	Commander, Amphibious Task Force
CCC	CINC Command Center
CDBS	Central Data Base Server
CDC	Combat Direction Center
CDS	Combat Direction System
CIA	Central Intelligence Agency
CIC	Combat Information Center
CIM	Corporate Information Management
CINC	Commander in Chief
CINCLANTFLT	Commander in Chief U.S. Atlantic Fleet
CINCPAC	Commander in Chief U.S. Pacific Command
CINCPACFLT	Commander in Chief Pacific Fleet
CINCUSNAVEUR	Commander in Chief U. S. Navy Europe
CLF	Commander Landing Force
CLNP	Connectionless Network Protocol
CMSA	Cruise Missile Support Activity
CNO	Chief of Naval Operations
COE	Common Operating Environment
COM	Character Oriented Message
COMNAVSECGRU	Commander Naval Security Group
COMNAVSPACECOM	Commander Naval Space Command
COMOPTEVFOR	Commander, Operational Test and Evaluation Force
COMPUSEC	Computer Security
COMSEC	Communications Security
COMSPAWARSYSCOM	Commander, Space and Naval Warfare Systems Command
CONOP	Concept of Operations
CONUS	Continental United States
COOP	Continuity of Operations Planning
COPCOM	Copernicus Common
COSL/P	Commander Oceanographic Systems, Atlantic/Pacific
COTS	Commercial Off-the-Shelf
CPA	Closest Point of Approach
CPE	Consumer Premise Equipment
CSG	Cryptologic Support Group
CSRF	Common Source Routing File
CSS	Communication Support Service
CTO	Communication Technician Operator
CUDIXS	Common User Data Information Exchange System
CV	Carrier
CVBG	Carrier Battle Group
CVIC	Carrier Intelligence Center
CWC	Composite Warfare Commander

Abbreviations/Acronyms

DAMA	Demand Assigned Multiple Access
DCA	Defense Communications Agency
DCS	Defense Communication System
DCTN	Defense Commercial Telecommunications Network
DDN	Defense Data Network
DECCO	Defense Commercial Contracting Office
DF	Direction Finding
DIA	Defense Intelligence Agency
DISN	Defense Information Systems Network
DISNET	Defense Integrated Secure Network
DMS	Defense Message System
DOD	Department of Defense
DP	Data Processing
DSCS	Defense Satellite Communications System
DSSCS	Defense Special Security Communications System
DTC-2	Desktop Computer 2
EC	Electronic Combat
ECCM	Electronic Counter-countermeasure
ECM	Electronic Countermeasure
EDI	Electronic Data Intelligence
EHF	Extremely High Frequency
ELINT	Electronic Intelligence
ESM	Electronic Support Measures
EW	Electronic Warfare
EWC	Electronic Warfare Coordinator
EWCM	Electronic Warfare Coordination Module
FASTT	Fleet All-Source Tactical Terminal
FCC	Fleet Command Center
FDD	Functional Description Document
FDDI	Fiber Distributed Data Interface
FDM	Frequency Division Multiplex
FEP	Fleet Satellite Communications Extremely High Frequency Package
FIC	Fleet Intelligence Center
FIPS	Federal Information Processing Standards
FIST	Fleet Imagery Support Terminal
FLTCINC	Fleet Commander in Chief
FLTSATCOM	Fleet Satellite Communications
FMP	Fleet Modernization Program
FNOC	Fleet Numerical Oceanographic Center
FOSIC	Fleet Ocean Surveillance Information Center
FOSIF	Fleet Ocean Surveillance Information Facility
FOTC	Force Over-the-Horizon Track Coordinator

Abbreviations/Acronyms

FOT&E	Follow-On Test and Evaluation
FPT	Fleet Project Team
FRWG	Fleet Requirements Working Group
FSC	File Server Control
FTAM	File Transfer, Access, and Management
FTC	Force Track Coordinator
FTD	Foreign Technology Directorate
FTS2000	Federal Telephone System 2000
GENSER	General Service
GLOBIXS	Global Information Exchange System
GOSIP	Government Open Systems Interconnection Profile
GOTS	Government Off-the Shelf
GSA	General Services Administration
HARDMAN	Hardware/Manpower
HDTV	High Definition Television
HF	High Frequency
HFMR	HF Modem Replacement
HIT	High Interest Track
HMI	Human Machine Interface
HSFB	High Speed Fleet Broadcast
I & W	Indications and Warning
ICA	Integrated Communications Architecture
IEEE	Institute for Electrical and Electronic Engineers
ILS	Integrated Logistic Support
INSICOM	Integrated Special Intelligence Communications Architecture
INTELCAST	Intelligence Broadcast
INTELNET	Intelligence Network
IOC	Initial Operational Capability
IS - IS	Intermediate System - to - Intermediate System
ISDN	Integrated Services Digital Network
ITDN	Integrated Tactical-Stategic Data Network
IUSS	Integrated Undersea Surveillance System
JANAP	Joint Army Navy Air Force Publication
JCS	Joint Chiefs of Staff
JIC	Joint Intelligence Center
JINTCCS	Joint Interoperability Tactical Command and Control Systems
JOPES	Joint Operations Planning and Execution System
JOTS	Joint Operational Tactical System
JTF	Joint Task Force
JTIDS	Joint Tactical Information Distribution System
JVIDS	Joint Visually Integrated Display System
LAMPS	Light Air Multi-Purpose System

Abbreviations/Acronyms

LAN	Local Area Network
LEC	LAMPS Element Coordinator
LEIP	Link Eleven Improvement Program
LF	Low Frequency
LOS	Line of Sight
LPI	Low Probability of Intercept
M^2C^2	Multi Media Communication Control
MAGTF	Marine Air Ground Task Force
MAN	Metropolitan Area Network
MDR	Medium Data Rate
MEB	
MEV	
MEC	Main Evaluation Center
MHS	Message Handling System
MIDS	Multifunctional Information Distribution System
MILSATCOM	Military Satellite Communications
MLS	Multilevel Security
MPA	Marine Patrol Aircraft
MPN	Manpower Personnel, Navy
MPT	Manpower and Training
MTBF	Mean Time Between Failure
MTBO	Mean Time Before Obsolescence
NATO	North Atlantic Treaty Organization
NAVCOMMSTA	Naval Communications Station
NAVIXS	Navy Information Transfer System
NAVNET	Navy Network
NAVSTAR GPS	Navigation Satellite Timing and Ranging Global Positioning System
NAVSTKWARCEN	Naval Strike Warfare Center
NCA	National Command Authorities
NCCS	Navy Command and Control System
NCO	Net Control Outstation
NCSO	Naval Control of Shipping Organizations
NCTAMS	Naval Computer and Telecommunications Area Master Station
NCTC	Naval Computer and Telecommunications Command
NDI	Non-developmental Item
NEC	Navy Enlisted Codes
NESP	Navy EHF Satellite Program
NFC	Numbered Fleet Commander
NGFS	Naval Gun Fire Support
NOIC	Naval Ocean Intelligence Center
NIPS	Naval Intelligence Processing System
NMC	Network Management Centers

Abbreviations/Acronyms

NMCS	National Military Command System
NOPF	National Oceanographic Processing Facility
NSA	National Security Agency
NSOC	National Signals Intelligence Operations Center
NST	Navy Standard Teleprinter
NSWC	Naval Surface Weapons Center
NTCC	Naval Telecommunications Center
NTCS-A	Naval Tactical Command System Afloat
NTIC	Naval Technical Intelligence Center
NWOC	Navy Weather and Oceanographic Center
NWP	Naval Warfare Publication
NWTDB	Naval Warfare Tactical Data Base
OBU	Ocean Surveillance Information System Baseline Upgrade
OCR	Optical Character Reader
ODA/ODIF	Office Document Architecture/Office Document Interchange Format
OED	OSIS Evolutionary Development
OJT	On-the-Job Training
OM&N	Operations and Maintenance, Navy
ONT	Office of Naval Technology
OPDEC	Operational Deception
OPINTEL	Operational Intelligence
OPLANS	Operation Plans
OPN	Other Procurement, Navy
OPNAV	Office of the Chief of Naval Operations
OPSEC	Operational Security
OPTEVFOR	See COMOPTEVFOR
OR	Operational Requirement
OS/IPC	Operating System/Inter-process Communications
OSI	Open Systems Interconnection
OSIS	Ocean Surveillance Information System
OSP	Ocean Surveillance Product
OSS	Operations Support System
OTC	Officer in Tactical Command
OTCIXS II	Office in Tactical Command Information Exchange System Phase II
OTCIXS	Officer in Tactical Command Information Exchange System
OTH	Over-the-Horizon
OTH-T	Over-the-Horizon Targeting
P^3I	Pre-planned Product Improvement
PAT	Process Action Team
PCAD	Program Change Approval Document
PIM	Plamned Incremental Modernization
PLRS	Position Location Reporting System

Abbreviations/Acronyms

PMO	Project Management Office
POA&M	Plan of Action and Milestones
POM	Program Objective Memorandum
POST	Prototype Ocean Surveillance Terminal
Q A	Quality Assurance
QMB	Quality Management Board
R&D	Research and Development
RACC	Regional ASW Command Centers
RDIXS	Research and Development Information Exchange System
RDT&E	Research, Development, Test, and Evaluation
RF	Radio Frequency
RFC	Request for Comment
RFI/EMI	Radio Frequency Interference/Electromagnetic Interference
RM	Radioman
RRC	Regional Reporting Centers
SACC	Shore ASW Command Center
SACEUR	Supreme Allied Commander Europe
SACLANT	Supreme Allied Commander Atlantic
SAG	Surface Action Group
SAR	Search and Rescue
SATCOM	Satellite Communications
SCE	Standard Communication Environment
SCI	Sensitive Compartmented Information
SDLS	Satellite Data Link Standard
SDS	Surveillance Direction System
SEW	Space and Electronic Warfare
SEWC	Space and Electronic Warfare Commander
SHF	Super High Frequency
SI	Special Intelligence
SIC	Subscriber Interface Control
SIGINT	Signal Intelligence
SIGSEC	Signal Security
SINCGARS	Single Channel Ground and Air Radio System
SMTP	Simple Mail Transfer Protocol
SOC	Sector Operations Center
SOCC	Submarine Operations Command Center
SOE	Standard Option Equipment
SOF	Special Operations Forces
SOSUS	Sound Surveillance System
SSA	Software Support Activity
SSC	System/Site Control
SSES	Ship Signals Exploitation Space

Abbreviations/Acronyms

SSGN	Guided Missile Submerine, Nuclear
SSIC	Standard Subject Identification Code
SSIXS	Submarine Satellite Information Exchange System
STU-III	Secure Telephone Unit III
STW	Strike Warfare
STWC	Strike Warfare Commander
SUBOPAUTH	Submarine Operating Authority
SUPPLOT	Supporting Plot
SURTASS	Surface Towed Array Surveillance System
SVS	Secure Voice System
SYDP	Six Year Defense Plan
SYSCOM	System Command
TACAIR	Tactical Air
TACMEMO	Tactical Memo
TACREP	Tactical Report
TACTASS	Tactical Towed Array Surveillance System
TAD	Temporary Assigned Duty
TADIXS	Tactical Data Information Exchange System
TAMPS	Tactical Air Mission Planning System
TARPS	Tactical Airborne Reconnaissance Pod System
TASS	Towed Array Surveillance System
TCC	Tactical Command Center
TDA	Tactical Decision Aids
TDBM	Tactical Data Base Manager
TDP	Tactical Data Processor
TEAMS	Tactical EA-6 Mission Planning System
TENCAP	Tactical Exploitation of National Capabilities
TERPS	Tactical Electronic Reconnaissance Processing and Evaluation System
TFCC	Tactical Flag Command Center
TIMS	TFCC Information Management System
TP	Transaction Processing
TP2	Transport Protocol Class 2
TQL	Total Quality Leadership
TRE	Tactical Receive Equipment
TTE	Technical Training Equipment
TTY	Teletype
UFO	UHF Follow On
UHF	Ultra High Frequency
USA/USAF	U. S. Army/U.S. Air Force
USCINC	U. S. Commander in Chief
USCINCPAC	Commander in Chief U.S. Pacific Command
USMC	United States Marine Corps

Abbreviations/Acronyms

USMTF	U.S. Message Text Format
VHF	Very High Frequency
VT	Virtual Terminal
WAM	WWMCCS ADP Modernization
WIN	WWMCCS Intercomputer Network
WMA	Warfare Mission Area
WWMCCS	Worldwide Military Command and Control System