DEPARTMENT OF THE NAVY
OFFICE OF THE SECRETARY
1000 NAVY PENTAGON
WASHINGTON DC 20350-1000

May 16, 2003

The Honorable Jerry Lewis
Chairman, Subcommittee on Defense
Committee on Appropriations
House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

As directed by the Fiscal Year 2003 Defense Appropriations Conference Report 107-732, the Department of the Navy's report on FORCEnet is provided.

The enclosed report describes how FORCEnet, in its first year of funding, has substantially improved Navy and Marine Corps processes and products, and how it is being implemented in coordination with transformation initiatives in the Army, Air Force, and Coast Guard to enhance Joint interoperability. It details FORCEnet's spiral development of Network Centric Warfare capability by leveraging Science and Technology investments and operational experimentation to rapidly deliver prototype capability to the Fleet. This will allow our fielding of an initial FORCEnet capability to the Forward Deployed Naval Forces in September 2003, to support its potential deployment with an Expeditionary Strike Group in Fiscal Year 2004.

Please let me know if I can be of further assistance. A copy of this report is also being provided to Chairmen Warner, Stevens, and Hunter.

Sincerely,

Hansford T. Johnson
Secretary of the Navy
Acting

Enclosure

Copy to:
The Honorable John P. Murtha
Ranking Minority Member

2003U128007376

DEPARTMENT OF THE NAVY
OFFICE OF THE SECRETARY
1000 NAVY PENTAGON
WASHINGTON DC 20350-1000

May 16, 2003

The Honorable Duncan L. Hunter
Chairman, Committee on
Armed Services
House of Representatives
Washington, DC 20515

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Secretary of the Navy
Acting

Enclosure

Copy to:
The Honorable Ike Skelton
Ranking Minority Member

DEPARTMENT OF THE NAVY
OFFICE OF THE SECRETARY
1000 NAVY PENTAGON
WASHINGTON DC 20350-1000

May 16, 2003

The Honorable Ted Stevens
Chairman, Subcommittee on Defense
Committee on Appropriations
United States Senate
Washington, DC 20510

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Secretary of the Navy
Acting

Enclosure

Copy to:
The Honorable Daniel K. Inouye
Ranking Minority Member

DEPARTMENT OF THE NAVY
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1000 NAVY PENTAGON
WASHINGTON DC 20350-1000

May 16, 2003

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Chairman, Committee on
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United States Senate
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Hansford T. Johnson
Secretary of the Navy
Acting

Enclosure

Copy to:
The Honorable Carl Levin
Ranking Minority Member

Report to Congress

on

FORCEnet

Prepared by
Director of FORCEnet
Chief of Naval Operations (N6/N7)
2000 Navy Pentagon
Washington, DC 20350-2000

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Executive Overview

FORCEnet is the operational construct and architectural framework for Naval warfare in the Information Age which integrates warriors, sensors, networks, command & control, platforms, and weapons into a networked, distributed combat force, scalable across the spectrum of conflict from seabed to space, from sea to land. It is the core of Navy and Marine Corps transformation and is the Naval vehicle to make Network Centric Warfare (NCW) an operational reality. FORCEnet is not an acquisition program; rather it is an enterprise alignment and integration initiative that serves as a change agent and an engine for innovation, potentially touching every Naval program. FORCEnet is the enabler for the Naval Transformation Roadmap and Naval Power 21 pillars of Sea Strike, Sea Shield, and Sea Basing, and for the supporting initiatives of Sea Warrior, Sea Trial, and Sea Enterprise. It is being implemented in coordination with Service transformation initiatives in the Army, Air Force, and Coast Guard and other Joint efforts such as Transformational Communications Architecture (TCA).

The Fiscal Year (FY) 2003 Appropriations Conference Report (107-732) directed: "While a solid organizational structure for the development of FORCEnet requirements has been established, the Navy must now refine the program's plan and scope. To ensure continued oversight of this important program, the conferees direct that the Secretary of the Navy submit, by May 1, 2003, a detailed report on the FORCEnet program. At a minimum, the report shall identify the five-year estimated cost of the program, describe the long term and short term objectives, define requirements, detail the spiral development and testing milestone plan, and indicate how each existing system will be integrated into the FORCEnet approach."

This report responds to that direction. It describes FORCEnet's spiral development of NCW capabilities by leveraging Science and Technology investments and operational experimentation to rapidly deliver prototype capability to the Fleet – and its concurrent implementation of supporting efforts to transform Naval processes. The report details the substantial changes already implemented in the Navy and Marine Corps due to FORCEnet, which include:

- A major re-alignment of Naval commands, closer integration of Navy and Marine Corps functions, and increased coordination with the other Services, Joint commands, the Office of the Secretary of Defense, national organizations/agencies, allies, coalition partners, and industry – which is promoting greater efficiency, synergy, and Joint interoperability.
- Implementation of a new capabilities-based approach to requirements generation and budget development – which has identified potential bottlenecks, gaps, overlaps, and duplications between systems across the Naval structure, thereby supporting enhanced operational functioning and improved investment decisions.
- Successful conduct of a major FORCEnet operational experiment (Giant Shadow) – which demonstrated and assessed transformational NCW technology and tactics in the areas of networks, data fusion, command and control, situational awareness, and platform/sensor architectures.
- Endorsement of planning by Commander Pacific Fleet for the conduct of an operational FORCEnet Integrated Prototype Demonstration (IPD) – which will result in the fielding an initial FORCEnet capability to the Forward Deployed Naval Forces in September 2003 to support potential deployment of that capability with an Expeditionary Strike Group in FY 2004.

The report further provides an in-depth discussion of the long-term FORCEnet plan to leverage and integrate related Department of Defense (DoD)/TCA efforts for development of a dynamic, multi-path survivable network which will support the integration of existing systems/applications into FORCEnet and enhance Joint, allied, coalition, and industry interoperability.

Introduction

Department of Defense and Naval Transformation

"The U.S. defense establishment must be transformed to address our new circumstance."
Secretary of Defense Donald H. Rumsfeld, Confirmation Testimony, January 11, 2001

"The need for military transformation was clear before the conflict in Afghanistan, and before September the 11th... What's different today is our sense of urgency."
President George W. Bush, Remarks at The Citadel, December 11, 2001

The President and the Secretary of Defense have clearly defined the need for transformation in the Department of Defense (DoD). In response to this need, the Chief of Naval Operations (CNO), the Commandant of the Marine Corps (CMC), and the Secretary of the Navy (SECNAV) in June 2002 forwarded the Naval Transformation Roadmap (NTR) to the Office of the Secretary of Defense (OSD). The NTR supports critical goals stated in the National Security Strategy, Quadrennial Defense Review, Joint Vision 2020, and Defense Planning Guidance. The NTR's plan for Naval transformation will support Joint transformation by delivering new military capabilities that will greatly expand the sovereign options available to Joint force commanders – with the goal of building a networked, jointly-integrated, sea-based power projection force. The NTR identifies FORCEnet as the enabler for this Navy-Marine Corps transformation.

FORCEnet Derivation

FORCEnet evolved from work done by the CNO's Strategic Studies Group (SSG) over the past four years (SSGs XVIII, XIX, XX, XXI) as the SSG examined the capabilities that the future Naval force will need to produce revolutionary improvement in operational capability. FORCEnet became the centerpiece of the Sea Power 21 vision to achieve enhanced warfighting effectiveness, the Naval Power 21 transformational vision, the CNO/CMC Naval Operating Concept for Joint Operations, and the NTR. FORCEnet enables the pillars of Sea Strike (projecting precise and persistent offensive power), Sea Shield (projecting global defensive assurance), and Sea Basing (projecting sustainable Joint operational independence), as well as the supporting initiatives of Sea Trial (accelerating enhanced capabilities to the Fleet through innovation and experimentation), Sea Enterprise (maximizing business efficiencies), and Sea Warrior (maximizing human capital). (Figure 1)

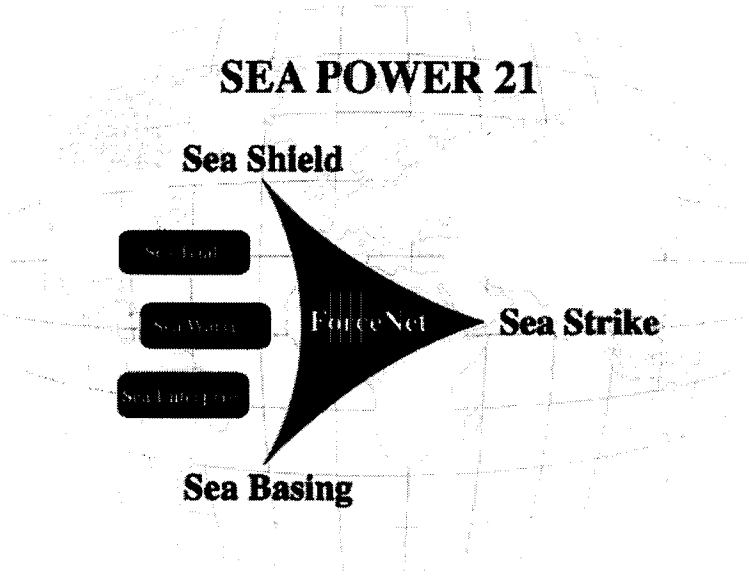


Figure 1. FORCEnet Enables Sea Power 21 and Naval Transformation

FORCEnet Need and Value

"FORCEnet will enable the Naval service to employ a fully netted force, engage with widely distributed combat power, and command with increased awareness and speed as an integral part of the joint team."
Admiral Vern Clark, Chief of Naval Operations, U.S. Naval Institute Proceedings, February 2003

The evolution of threat and technology, and an attendant increased reliance on information, has brought a concomitant change in the approach to military operations as discussed in the DoD Network Centric Warfare Report to Congress of July 27, 2001. These changes, as well as the need for improved interoperability and emphasis on the warrior and the reality of limited resources, have underscored the need for FORCEnet. SSG XX/XXI used modeling, simulation, and wargaming of selected missions to provide a first-order analysis of warfighting improvements that FORCEnet might yield. Their results showed:

- For alternative command and control structures using FORCEnet, a 50% increase in shared awareness, a 35% increase in asset efficiency, a 24% increase in speed of command, and a 16-fold increase in adaptability compared to the current force.
- For Time Critical Strike, a 50-fold improvement in the percent of land targets destroyed.
- For Mine Counter Measures, a 10-fold increase in area search rate.
- For Theater Air and Missile Defense, a 30-fold increase in maximum raid size destroyed.

FORCEnet is an enterprise alignment and integration effort. It looks across warfare mission areas to identify capabilities and efficiencies that would not otherwise be realized under the existing paradigm of individual stove-piped programs and efforts. Example benefits are as follows:

- FORCEnet analysis identifies potential synergies that could be gained by integrating individual existing/planned efforts. This benefit will be Fleet-validated in the FORCEnet Integrated Prototype Demonstration (IPD), to be conducted in September/October 2003. The IPD will build on previous FORCEnet Limited Objective Experiments (LOEs) to coordinate and integrate planned, funded installations with new, accelerated capabilities to provide increased Internet Protocol (IP) network Quality Of Service (QOS), wireless Line-Of-Sight (LOS)/Beyond-LOS (BLOS) IP networking, high bandwidth IP satellite link, and Marine Corps network connectivity to support Naval fires. Thus, with a relatively modest investment, FORCEnet is able to make substantial gains in the stated goal of providing the warfighter with a dynamic, multi-path, and survivable network core infrastructure, as well as supporting distributed, collaborative command and control with application to the Family of Interoperable Operational Pictures (FIOP), Joint fires support, Common Operational Picture (COP) distribution, and Blue Force (friendly forces) Tracking. The FORCEnet IPD also will provide supporting Tactics/Techniques/ Procedures (TTP) and Concept of Operations (CONOPS), as well as necessary sustainment, allowing this operational capability to potentially deploy with an Expeditionary Strike Group in 2004. The FORCEnet IPD approach is shown in Figure 2.

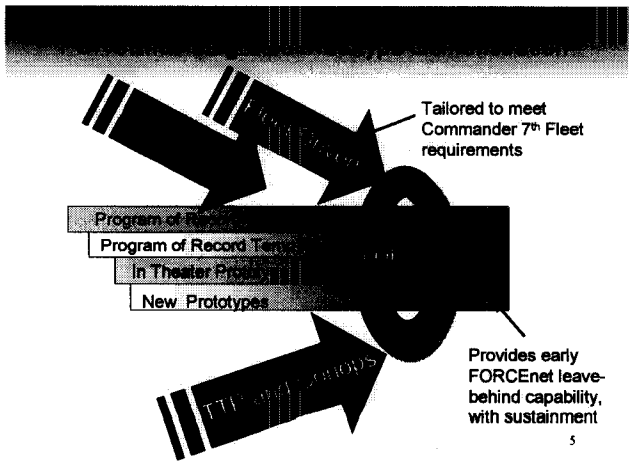


Figure 2. Integration of Individual Efforts by FORCEnet

- FORCEnet improves the identification of overlaps/gaps in legacy and planned systems/functions in a fully netted Joint warfare environment – thereby facilitating system/functionality convergence and potential efficiencies. Figure 3 shows this approach with Joint Fires Network, which will build on existing Joint capabilities to bridge the gap of legacy systems as migration to a robust Distributed Common Ground and Surface Station (DCGS) continues.

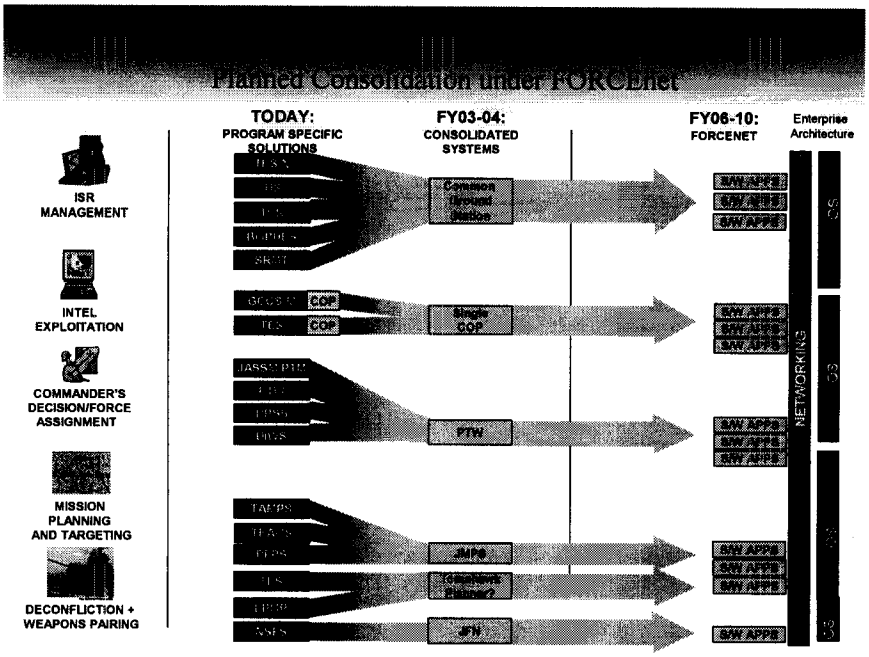


Figure 3. Example of the Consolidation of Systems under FORCEnet

- FORCEnet identifies bottlenecks between systems across the Naval structure, enhancing operational capability and optimizing investment decisions. During development of the FY 2005 budget, FORCEnet identified that the current afloat and ashore routing/ switching infrastructure is at capacity and will not support planned Program of Record (POR) improvements in effective Radio Frequency (RF) throughput. It was determined that a phased investment increase in planned FY 2005 to FY 2009 funding, to enhance the efficiency of the routing/switching infrastructure, would allow an eight-to-ten fold increase in usable bandwidth in aircraft carriers and large deck amphibious ships, and without the need for purchasing additional RF transport.
- FORCEnet leverages efforts of the Transformational Communications Office (TCO) to develop an overarching TCA within the Global Information Grid Integrated Architecture.
- FORCEnet provides the maritime input to the DoD's Family of Interoperable Operational Pictures (FIOP) – supporting DoD's FIOP effort to provide a common tactical picture to the Joint warfighter.
- FORCEnet is aligning to support the direction of the Secretary of Defense's Management Initiative Decision (MID) 912 addressing U.S. Joint Forces Command (US JFCOM) planning for Joint Battle Management Command and Control (JBMC2).
- FORCEnet provides a venue and coordinated approach to enhance Joint interoperability and collaboration between the Services, as discussed in the FORCEnet Joint, Allied, and Coalition Interoperability section.
- FORCEnet supports an improved transition of Science and Technology (S&T) initiatives to Fleet capability, as discussed in Appendix F.
- FORCEnet implements the temporal and geospatial frames of reference required to achieve a truly interoperable netted force, including World Geodetic System 1984 provided by the National Imagery and Mapping Agency and coordinated universal time provided by the U.S. Naval Observatory.
- FORCEnet leverages space capabilities for both connectivity and content, and provides a mechanism for coordination of space matters with other services and agencies. The Deputy Director of FORCEnet is a member of the Naval Space Cadre.

- FORCEnet focuses and enhances efforts to fully integrate the warrior early in the acquisition process, and in all aspects of Naval planning, as discussed below.

FORCEnet Focus on the Warrior

"FORCEnet...emphasizes the human factor in the development of advanced technologies. This philosophy acknowledges that the warrior is a premier element of all operational systems."
Admiral Vern Clark, Chief of Naval Operations, U.S. Naval Institute Proceedings, October 2002

The warrior is the key to successful implementation of FORCEnet and NCW. Manpower, personnel, training, and human factors engineering can drive as much as 60% of system lifetime costs. Fully considering the warrior from the beginning decreases costs and the probability of human error, while increasing total system performance and the probability of mission success.

FORCEnet will focus and build on existing efforts regarding warrior training and retention and will drive the application of Human Systems Integration (HSI) early in system design and in development of operational concepts and TTP. Efforts, detailed in Appendix A, include:

- Task Force EXCEL (EXcellence through Commitment in Education and Learning), Executive Review of Navy Training, and Revolution in Training: Incorporating new technologies into training, leveraging private sector opportunities, and increasing human performance factors in the acquisition process.
- Sea Warrior, the Project for Sailor Advocacy through Interactive Leadership (Project SAIL), and efforts for improving the Naval workforce: Revolutionizing career management.
- Total Ship Training Capability and Battle Force Tactical Trainer: Building on and integrating these and other key training capabilities into the overall FORCEnet plan.
- Human Systems Integration: Coordinating 21st Century Warrior efforts across the Naval Establishment.
- Development of critical expertise that crosses traditional community boundaries, including space and Information Operations.

FORCEnet Challenges

"Transforming... is about changing culture."
Secretary of Defense Donald H. Rumsfeld, Posture Statement before the 108th Congress, House Armed Services Committee, February 5, 2003

Aside from traditional challenges, transformation initiatives such as FORCEnet must confront unique obstacles in terms of cultural and procedural barriers. Organizations are generally organized and focused toward traditional stove-piped acquisition programs rather than FORCEnet's capabilities-based approach. Additionally, the Defense industry is generally configured for the competitive business environment, which has historically involved a vying between vendors to sell proprietary products to the government based on unique military specifications. That approach is often not beneficial or affordable to DoD. FORCEnet pursues a more collaborative approach, in which government and industry work together in the development and implementation of open, commercial, government-sponsored FORCEnet architectures, standards, and protocols to develop Joint, non-proprietary, open architecture systems. A similar approach has been successfully implemented in non-DoD areas of industry, such as the banking/securities sector. Lessons learned from these sectors are being studied for applicability to FORCEnet, as discussed in the Collaboration With Industry section of this report.

The undersea portion of FORCEnet, including the Common Undersea Picture, is a Navy-unique challenge that is critical to the enablement of Sea Shield. A working group has been established to assess and implement the needed end-to-end operational, technical, and system capabilities.

FORCEnet Cost and Funding

Current and projected FORCEnet costs are reflected in the President's Budget submission for FY 2004 (Program Element 0604231N, Then Year $M), shown below:

FY 2003	FY 2004	FY2005	FY2006	FY2007	FY2008	FY2009	Continuing
12.5	14.7	15.7	17.2	19.1	21.1	23.0	

FORCEnet is affordable because it is primarily an alignment, engineering, and integration effort, which leverages traditional programs and planned experimentation events to provide a more efficient and effective application of resources. A more detailed discussion and example is provided in Appendix B. FORCEnet funding levels will be reviewed annually.

Navy and Marine Corps Alignment in Support of FORCEnet

"There is another huge piece of transformation...that is the organization."
General Richard Myers, Chairman, Joint Chiefs of Staff, Defense Writers' Breakfast, January 22, 2003

"When it comes to command and control, we need to come up with a Naval solution...with Marine Corps requirements embedded into FORCEnet and Joint initiatives. There is nothing more important than for us to get this right. It is the essence of Joint transformation."
Lieutenant General Edward Hanlon, USMC, Commanding General, Marine Corps Combat Development Command (CG, MCCDC), Guidance to MCCDC staff, February 23, 2003.

The Navy and Marine Corps have substantially re-aligned and initiated closer integration to establish a more focused organizational structure to execute FORCEnet, Sea Power 21, Expeditionary Maneuver Warfare, and Naval Transformation. Critical FORCEnet roles and responsibilities are as follows:

- The CNO (N6/N7): Designated by the Chief of Naval Operations (CNO) as Director of FORCEnet. Serves as the CNO's lead for all FORCEnet activities, including Naval efforts to integrate C4ISR and network initiatives, and as focal point for space, including Naval Space Cadre. Assisted by Commander, Naval Network Warfare Command as the FORCEnet Project Coordinator and Fleet Implementer.
- The CG, MCCDC: Leads U.S. Marine Corps (USMC) Command and Control Integration (C2I), and serves as the USMC counterpart to CNO (N6/N7) for FORCEnet.
- The CNO (N61): Deputy Director of FORCEnet and FORCEnet Warfare/Resource Sponsor, as well as Deputy Department of the Navy (DON) Chief Information Officer (CIO). Responsible for validation of FORCEnet requirements and aggregation of resources among various Resource Sponsors. Co-chairs the FORCEnet Naval Capability Plan Board with CNO (N2) and Director, Expeditionary Force Development Center (EFDC).
- The CNO (N2): FORCEnet Naval Capability Plan Board Co-Chair, ensuring integration of national, theater and tactical Intelligence, Surveillance, and Reconnaissance (ISR) capabilities into Naval force planning, assessments, and programming.
- The Director, EFDC: FORCEnet Naval Capability Plan Board Co-Chair, representing USMC requirements and issues. Coordinates inputs from the Deputy Commandants/Advocates, USMC Deputy DON CIO/Director, Command, Control, Communications and Computers (C4I), Headquarters Marine Corps (HQMC), and Director Intelligence HQMC.
- The Commander, Naval Network Warfare Command (COMNAVNETWARCOM): FORCEnet Project Coordinator and lead Type Commander, responsible for Fleet prioritization/validation of Information Technology, Information Operations, Space, and related execution year resource realignments and coordinating FORCEnet Fleet implementation and related Sea Trial experimentation with Navy Warfare Development Command (NWDC). As agent for Commander, Fleet Forces Command (CFFC), generates the Integrated Priority List (IPL) for Fleet operational requirements. CG, MCCDC

established a Concepts Development and Experimentation Joint Operations Center (JOC) for CFFC/NETWARCOM liaison.

- The Commander, Space and Naval Warfare Systems Command (COMSPAWARSYSCOM): FORCEnet Chief Engineer (CHENG) and Head Assessor, and C4I CHENG to all Naval System Commands (SYSCOMs). Assesses overlaps, interoperability, technical and schedule risk, and cost, defines FORCEnet architectures and standards; integrates the FORCEnet efforts of the SYSCOMs. Coordinates with the SYSCOMs via a "Virtual SYSCOM" agreement, and with SYSCOM and ASN (RD&A) CHENGs via a "Council of CHENGs."

Additionally, Memorandums of Agreement (MOAs) are in process between Director/Deputy Director of FORCEnet and Navy/Marine Corps stakeholder commands. FORCEnet coordination is also in place with the Defense Advanced Research Project Agency (DARPA) pursuant to the MOA between the CNO and the Director of DARPA, and with TCA activities to ensure the architectural/programmatic alignment necessary for Joint interoperability.

FORCEnet and National Security Space

Space capabilities are a critical part of FORCEnet, but most national security space processes occur outside of the Department of the Navy (DON). This requires a focused effort to ensure Naval operational requirements are met and integrated into the FORCEnet construct. Key areas include space communications, ISR, precision navigation and timing, meteorological and oceanographic information, and missile warning. The Naval Space Cadre who participate in national security space organizations, as well as those integrated into the Fleet and other naval commands, are key participants in this process.

FORCEnet Connectivity with National, Theater and Tactical ISR

FORCEnet will enable better leveraging of national, theater and tactical ISR assets to support all Naval mission areas. The component of FORCEnet that will support the integration, management, exploitation and fusion of multi-source national, joint and coalition ISR data into Naval operations is the Distributed Common Ground and Surface System (DCGS). The DCGS is a family of systems that is based on standards and open architecture across the Services to support networking and processing of a variety of sensor types and data structures. Currently, each source of ISR is processed separately in different parts of a ship, e.g., signals intelligence is processed in the Ship's Signal Exploitation Space, while imagery and aimpoint derivation are processed in the aircraft carrier Intelligence Center. The DCGS will network the various data feeds into an IP-based environment, enable common displays and cross-intelligence fusion, and allow optimization/management of ISR assets. By being fully compliant with the joint DCGS standard and being a core component of FORCEnet, DCGS will ensure Naval forces can incorporate national and theater sensor-derived information with battle force organic sensor data to support time critical strike and other Naval missions--allowing battle force ISR sensors to seamlessly provide data to Joint forces.

FORCEnet Collaboration with Industry

FORCEnet does not use a prime contractor. Rather, a collaborative approach has been employed to partner with industry for FORCEnet planning and execution. In October 2002, a FORCEnet Strategy "Wargame" was held with senior government and industry personnel in order to align definitions, priorities, roles, and responsibilities concerning the implementation of FORCEnet. More than 90 executives from industry (both defense and non-defense sectors), the Navy Secretariat, OPNAV, the Naval SYSCOMs, cognizant USMC offices, and the Office of the Secretary of Defense (OSD) participated in this wargame, establishing valuable coordination and gaining critical insights. This was followed in March of 2003 by a visit to banking/financial sector offices by FORCEnet leadership to observe commonality of risk, complexity of transactions, and real- time processing. The FORCEnet Chief Engineer has continued to work with senior industry representatives in the development of FORCEnet architecture, standards, and protocols.

FORCEnet Capabilities-Based Requirements

"Forthcoming FORCEnet architecture will pull together enabling technology for the transformed Navy."
Vice Admiral Michael Mullen, Deputy Chief of Naval Operations for Resources, Requirements, and Assessments, Federal Computer Week, December 9, 2002

FORCEnet responds to strategic guidance from National and Defense leadership on NCW and the need for Joint Transformation, exemplified as follows:

- National Security Strategy of the United States of America: Need for DoD transformation, development of advanced remote sensing, long-range precision strike capabilities, transformed maneuver and expeditionary forces, innovation based on experimentation, strengthening joint operations, exploiting U.S. intelligence advantages, taking full advantage of science and technology.
- Quadrennial Defense Review: Need for a fully netted force with the agility and lethality to counter and dominate future threats.
- Joint Vision 2020: Need to effect the transformation of joint military capabilities, using experimentation and simulation to explore the shape of future operations.
- Defense Planning Guidance: Need to achieve DoD transformation in the areas of C4I/ISR, information operations, and providing persistent, timely, and accurate strike.

The FORCEnet requirements process employs a flow-down from this guidance through Navy and Marine Corps planning contained in the Naval Transformation Roadmap, to capabilities-based operational requirements. Current top-level FORCEnet capabilities/requirements are:

- Expeditionary, multi-tiered sensor and weapon information;
- Distributed, collaborative command and control;
- Dynamic, multi-path and survivable networks;
- Adaptive, automated decision aids;
- Human-centric integration; and
- Information weapons.

As detailed in Appendix C, FORCEnet capabilities-based requirements are currently being documented by NETWARCOM for forwarding via CFFC to Director of FORCEnet for final validation and resourcing. While FORCEnet is not an acquisition program, and therefore acquisition documentation is not applicable, the development of an Initial Capabilities Document (ICD) with related integrated architectures is being pursued to provide a Fleet initiated and validated requirement that will serve as a foundation for FORCEnet planning and execution and to provide a base for potential modifications to existing Programs of Record (PORs).

Supporting FORCEnet functional/system application requirements are being established by the FORCEnet CHENG via a set of FORCEnet architectures, frames of reference, standards, and protocols. In April 2003, the FORCEnet CHENG promulgated a FORCEnet Government Reference Architecture (GRA) Vision. This GRA will be followed by promulgation in July 2003 of a FORCEnet Architecture and Standards document that will provide detailed standards guidance suitable for inclusion in POR acquisition planning and execution documents. The foundation of these architectures is inherently Joint, employing key initiatives (discussed in Appendix D) such as the Global Information Grid Bandwidth Expansion (GIG-BE), Network Centric Enterprise Services (NCES), Joint Tactical Radio System (JTRS), and TCA.

Together with experimentation and S&T roadmaps, these documents form the FORCEnet "blueprint"--providing a basis for validating systems as "FORCEnet-compliant," thereby ensuring a more efficient and effective implementation of FORCEnet and NCW. FORCEnet compliance/governance will be exercised by the Director of FORCEnet in close coordination with the Acquisition Community and COMNAVNETWARCOM, via the programming and budget development process described in Appendices C and E. The Marine Corps is employing a similar capabilities-based process which will be synchronized with the Navy to identify overlaps and gaps, and develop a common set of priorities and coordinated investment strategy.

FORCEnet Joint, Allied, and Coalition Interoperability

FORCEnet Interoperability Basis

"FORCEnet is an initiative to tie together naval, joint, and national information grids to achieve unprecedented situational awareness and knowledge management...FORCEnet will be central to commanding joint operations from the sea."

Admiral Vern Clark, Chief of Naval Operations, Naval War College, June 12, 2002

"USMC Operational Concept rests on...an enhanced Joint Command and Control network we call FORCEnet."

General Michael W. Hagee, Commandant of the Marine Corps
Opening Statement for Senate Armed Services Seapower Subcommittee Hearing, April 1, 2003

FORCEnet was established on the premise of joint interoperability. A fundamental FORCEnet objective is the development of a Naval Network Information Infrastructure (NII) and integrated applications suite with full interoperability among the service components, joint task force elements, and allied/coalition partners. As discussed above, this goal will be supported by the establishment of high-level architecture tenets and standards as elements of a FORCEnet "blueprint," as part of a strong cross-program systems engineering effort under the FORCEnet Chief Engineer. These will be enforced by the Director of FORCEnet, the Acquisition Community, and COMNAVNETWARCOM to ensure that design decisions made by component programs are consistent with the FORCEnet blueprint. This blueprint will be based on joint and industry standards, with development and implementation coordinated with transformational initiatives in the Army, Air Force, and Coast Guard as well as Joint commands and allies. FORCEnet will employ within its architecture a joint standard framework for interoperability to maximize the efficient exchange of information among disparate platforms, weapons, systems, and services. This will ensure that all participants operate and communicate in the same geospatial and temporal reference frames.

Development of a Dynamic, Multi-Path, Survivable FORCEnet Network Information Infrastructure (NII) in Conformance with Joint and Industry Standards

"The truly transformational things, conceivably, might be in information technology and information operations and networking and connecting things in ways that they function totally differently than they had previously...Possibly the single most transforming thing in our force will not be a weapon system, but a set of interconnections and a substantially enhanced capability because of the awareness it provides."

Secretary of Defense Donald H. Rumsfeld, Town Hall Meeting, Washington DC, August 9, 2001

"The first steps to Network Centric Warfare have been laid out...through the CNO's vision of FORCEnet. FORCEnet is the Navy's transformational architecture for how Navy and Marine Corps elements will be linked with joint, allied, and coalition forces through seamless, interoperable integration with the DoD Global Information Grid."

Rear Admiral Kenneth D. Slaght, Commander, Space and Naval Warfare Systems Command
Testimony to the House Armed Services Committee, R&D Subcommittee, February 20, 2002

DoD is currently pursuing an expansion of the terrestrial network infrastructure worldwide through the Global Information Grid Bandwidth Expansion (GIG-BE). Current architecture plans for the GIG-BE are focusing on high speed Internet Protocol (IP) over an optical switched backbone. A near-term FORCEnet goal is to enhance the Information Technology 21st Century (IT-21) capability that has been delivered to the Fleet so that the FORCEnet NII will make the most efficient use of GIG-BE capability, using Internet Protocols to support the forward deployed warfighter with tactical information anywhere in the world.

This tactical network design will take advantage of the Standard Tactical Entry Point (STEP) sites and Teleports that are being deployed by the Defense Information Systems Agency (DISA). The Teleports will be the

SATCOM interface point for the Naval platforms to connect to the GIG-BE terrestrial network infrastructure. A transformation in satellite communication services moving toward Internet-like connectivity is also underway via the Transformational Communications Architecture (TCA). TCA will use IP addressable nodes for the delivery of content, with each platform serving as a node. Where appropriate, FORCEnet will make the Navy nodes fully IP enabled and thus reachable via the TCA.

To the maximum extent feasible, the FORCEnet transport layer will take advantage of commercial technology and networks by utilizing open-systems standards and protocols. IP will be the common standard that will facilitate moving data seamlessly among all entities in the FIOP and on the GIG. For applications where military-unique capabilities (such as anti-jam, low probability of intercept, and spread-spectrum waveforms) are required, military products will be adapted to interface with the overall architecture.

Management Initiative Decision (MID) 912 strengthens the DoD's fielding of Joint Battle Management Command and Control (BMC2) capabilities by improving the ability to provide "systems of systems" capabilities to joint warfighters. It identifies the Family of Interoperable Operational Pictures (FIOP) as the heart of Joint BMC2 effort, and assigns responsibility to the Military Departments for programming and acquisition of BMC2 systems and programs. FIOP is the Department's enterprise and integration effort and the umbrella initiative that ties together integrated air, ground, and maritime pictures with emphasis on the tactical domain. FORCEnet provides the maritime input to the FIOP.

The GIG Enterprise Services (GES) is a DoD/Defense Information Systems Agency effort to support the entire DoD and Intelligence Community in sharing information across systems via a Task, Post, Process, and Use (TPPU) approach to information resources. GES is planned to transition to Net-Centric Enterprise Services (NCES), which as been proposed as a FY04 new start program. NCES features "fast track" concept development and OSD/JCS/Service/Agency coordination to deal with transition from Common Operating Environment (COE). It will support real-time and near-real-time warrior needs (e.g., increased speed of command, enhanced collaboration, real-time battle management, global access to data, and rapid exploitation of diverse data sources), and business needs (e.g., elimination of redundant capabilities, enablement of Financial Management Modernization Program, and rapid exploitation of diverse data sources that can be customized to meet specific mission demands). FORCEnet is working collaboratively with GES/NCES, and will examine resultant products for NII applicability.

The TCA brings together DoD, the Intelligence Community, and the National Aeronautics and Space Agency (NASA) in a collaborative partnership to transform the global information infrastructure. The Deputy Director of FORCEnet is a charter member of the Transformational Communications Senior Leadership Team, supporting alignment of these two key efforts.

A "graybeard" review convened by the FORCEnet Chief Engineer (CHENG) in April 2003 with senior DoD and Industry executives recommended a Distributed Services Architecture (DSA) approach for FORCEnet. DSA uses a publish-subscribe Industry model based on Web services--an emerging Industry standard. DSA dictates that new and legacy components (e.g., applications and IT infrastructure services) be implemented in such a way that the components of DSA can be instantiated on a single computer or a collection of homogeneous or heterogeneous computing platforms (distributed computing environment). This architectural approach allows the interoperable use of new applications and legacy applications within the Joint environment. It has the advantage of allowing legacy applications to be wrapped with DSA software adapters, thereby making them quickly useable until newer services and applications replace them over time. This approach would allow many legacy systems to be interoperable without being replaced. The FORCEnet Technical Reference Model derived from this approach will make maximum use of commercial standards, as well as Joint solutions, to reduce cost and ensure interoperability. The FORCEnet CHENG will coordinate this planning with related efforts.

Coordination with Army, Air Force, and Coast Guard Transformation Initiatives

"Enhancing jointness... is a critical aspect of transformation."
General William F. Kernan, Commander, U.S. Joint Forces Command
Testimony before the Senate Armed Services Committee, April 9, 2002

FORCEnet is the designated enabler of Naval transformation and thereby is the dedicated mechanism for Navy and Marine Corps coordination with the other services and their transformation efforts. Over the past year, the Head of FORCEnet Requirements (CNO N61F) has worked closely with the Combatant Command Interoperability Program Office (CIPO) to facilitate coordination among Service representatives for each of the Service transformation initiatives--Army (Future Combat System/Objective Force), Navy/USMC (FORCEnet), Air Force (C2 Constellation), and Coast Guard (Deepwater Integration Program)--as well as with representatives of US JFCOM, Joint Chiefs of Staff (JCS), and OSD. FORCEnet sponsored the first of these CIPO-chaired Force Integration/Cross-Service Information Sharing Meetings in August 2002, and a follow-on meeting held in March of 2003. These meetings support cross-service coordination and facilitate the resolution of integration/interoperability issues identified by the Combatant Commands and Services--with US JFCOM, JCS, and OSD participation.

Allied and Coalition Interoperability

"The significant involvement of coalition forces in Operation Enduring Freedom – including over100 ships deployed in Central Asia for an extended period – has re-emphasized the requirement for improved IP data systems interoperability with allied and coalition forces."
Admiral Robert J. Natter, Commander, U.S. Fleet Forces Command, CHIPS, Summer 2002

"Developing a networked capability will be fundamental to joint and coalition war fighting in the Information Age."
Mr. Geoff Hoon, Secretary of State for Defense, United Kingdom
Aviation Week and Space Technology, December 23, 2002

FORCEnet planning is being coordinated with allies and coalition partners. In 2002 and 2003, FORCEnet discussions were held with Australia, Canada, United Kingdom, New Zealand, The Netherlands, Germany, and Italy. Significant progress has been realized with allies and coalition partners in all theaters of operations using the Combined Enterprise Regional Information Exchange System (CENTRIXS) (which incorporates Coalition Wide Area Network (COWAN)) to share IP-based information for enhanced situational awareness, C2, and communications.

Integration of Existing and Future Systems into FORCEnet

A fundamental FORCEnet concept is an open architecture approach that mandates the separation of the information infrastructure from sensor, navigation, and weapon systems, as well as applications (e.g., command and control, track correlation, target/weapon assignment). As discussed above, FORCEnet is developing a NII that will allow for integration of current and planned systems and applications onto a common information infrastructure. All FORCEnet-compliant sensors, navigation systems, weapons, and applications will be able to interface with this information infrastructure, thus allowing a broad and rapid exchange of information and the ready assimilation and use of this information by the warfighter to enhance decision-making.

This FORCEnet approach was independently recommended in a 12-month study, co-sponsored by Director of FORCEnet and CG, MCCDC, which was conducted by the National Defense Industrial Association (NDIA). This study, titled "FORCEnet: The Naval Component of the Global Information Grid--Enabling the Joint Warfighter Through Network Centric Warfare," recommended a modified Internet model for FORCEnet. As shown in Figure 4, NDIA provided the analogy of first constructing the FORCEnet architectural framework and network as "building the road," and applying information transfer standards to the development of the

applications (individual programs or capabilities) as modifying the "cars" (applications) that will ride on that network "road." In the FORCEnet approach, the FORCEnet NII provides the "road," while each of the existing and planned systems and functionalities represent the "cars".

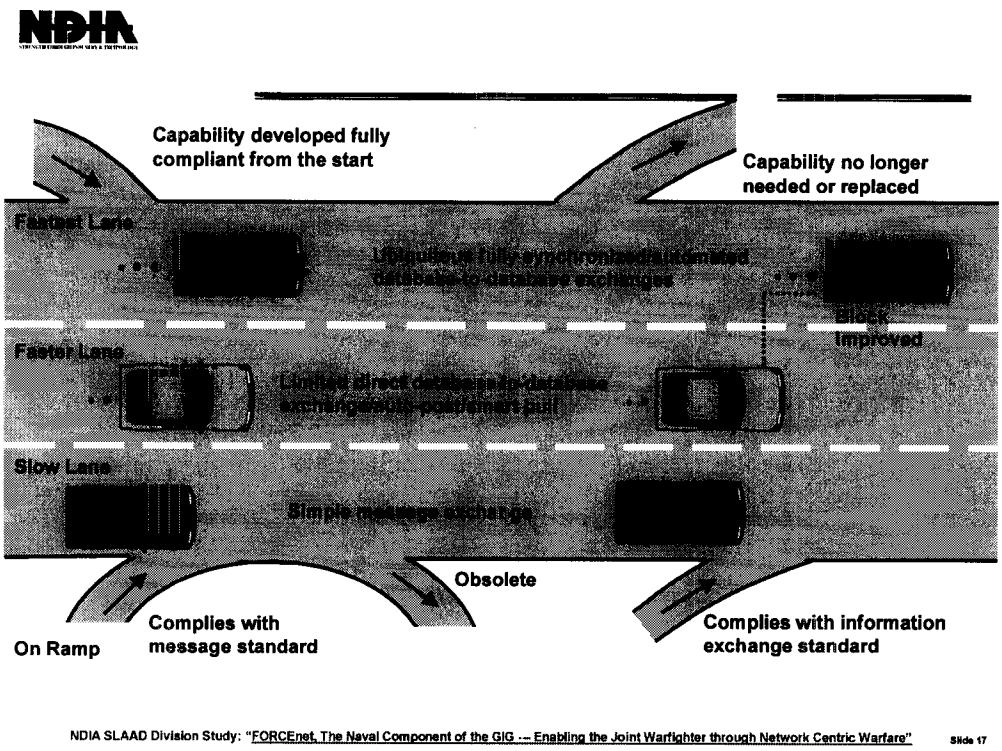


Figure 4. FORCEnet Capability Insertion/Retirement Model

FORCEnet is leveraging a number of initiatives to facilitate integration of existing and planned systems and functionalities onto the FORCEnet NII. ASN (RD&A) assigned the Program Executive Office for Integrated Warfare Systems (PEO (IWS)) the responsibility for coordinating the introduction of Open Architecture into Naval combat systems. PEO (IWS) and the PEO for Command, Control, Communications, Computers, Intelligence and Space (PEO C4I and Space) are working together to provide necessary technical support to FORCEnet by developing an Open Architecture Computing Environment which addresses combat systems and the C4I domain in accordance with PEO (IWS), PEO (C4I and Space), COMNAVSEASYSCOM (SEA 06), and COMSPAWARSYSCOM Joint Letter of 20 March 2003. The Deputy Director of FORCEnet (CNO N61) is leading an effort with these commands and other OPNAV offices for implementation of this effort as FORCEnet Open Architecture (OA). The OA will provide the computational underpinning to realize FORCEnet in both cost and performance, and will employ joint binding standards and protocols to ensure interoperability. The OA initiative follows the tenets of the Open Systems Joint Task Force and incorporates common engineering, information, protocol, computing, and interface standards across various computing environments and platforms.[1] The OA focuses attention on the need for thorough systems design and engineering to implement non-proprietary specifications for interfaces, services, and supporting formats across warfighting functions. It will enable properly engineered and partitioned hardware and software components to be used across a wide range of systems and platforms. The OA design will result in minimal system changes as either the warfare requirements or the underlying commercial computing technologies change, and will be portable and scalable to the required task.

[1] 1 An open systems approach is an integrated business and technical strategy that employs modular design and, where appropriate, defines key interfaces using widely supported, consensus-based standards that are published and maintained by a recognized industrial standards organization. See Open Systems Joint Task Force, *An Open System Approach to Weapon System Acquisition*, 2001.

Short-term and Long-term FORCEnet Objectives

To bridge the gap between legacy systems of today and the fully netted Naval forces of the future, FORCEnet will be developed and deployed incrementally through a series of blocks as part of a Spiral Development process. Short-term blocks will necessarily be populated with systems that are in the Fleet or the development pipeline, netted together using current technology. Analysis and experimentation will be conducted to decompose existing systems into functional capability components and recompose into joint network-centric capabilities. Systems that meet the FORCEnet "selection criteria" will be integrated into the first blocks.

Short-term (i.e., inside the Future Years Defense Plan (FYDP): FY03 – FY09) objectives include fielding of a Block 0 FORCEnet capability in the Fleet. Block 0 will be developed via the Integrated Prototype Demonstration (IPD) process discussed in the Experimentation section, and its prototype capability will be fielded in an Expeditionary Strike Group (ESG) in the Commander, Seventh Fleet (C7F) Area of Responsibility in the Fall of 2003. An Amphibious Ready Group (ARG), augmented with additional cruisers and destroyers to form an ESG, will deploy with the FORCEnet IPD capability in 2004. This capability will provide the ESG with a more dynamic and survivable core network capability with quality-of-service, direct ship-to-ship routing of information, and load-balancing of communications paths, integrated with enhanced Common Operational Picture (COP) applications as well as improved networking of Joint fires components (e.g., Advanced Field Artillery Tactical Data System, Naval Fire Control System, and Joint Fires Network). FORCEnet Block 0 will be based on this IPD capability, benefiting from that deployment's lessons-learned and continuing development. FORCEnet Block 1 will extend Block 0 capability via an increased netting of systems and human integration.

FORCEnet long-term (outside the FYDP: FY10 and beyond) objectives include the fielding of FORCEnet Block II capabilities, as well as follow-on Blocks that will be designed, built, and delivered to the fleet as fully netted and fully integrated--with Human Systems Integration woven into the process. FORCEnet does not have a specific end-state configuration, but rather will provide a continuing impetus to Naval Transformation.

FORCEnet Spiral Development

FORCEnet is employing spiral development (in accordance with DOD Defense Acquisition Interim Guidance issued October 30, 2002) to expedite fielding of this enhanced warfighting capability, with initial focus on development of the NII and applications as previously described. This is being executed via a parallel four-track approach, to maximize synergy, efficiency, and disciplined "speed to capability"--with each track focused on supporting the six FORCEnet required capabilities, as follows:

Track One: Integrated Capabilities-Based Requirements/Acquisition

Pursuant to the DOD Defense Acquisition Interim Guidance, FORCEnet is implementing an integrated requirements/acquisition approach. This track provides the framework within which the FORCEnet spiral development process operates and has several primary elements.

- Requirements Definition: Both operational and system requirements are being established for FORCEnet, as described in the requirements section above and in Appendix C, to serve as the basis for the development of new capabilities. These requirements will be time-phased, and iterated, to reflect insights gained from the analysis, technology transition, and innovation continuum tracks, as well as operational feedback. FORCEnet requirements are also part of the requirements base for TCA.
- System Engineering (SE): SE pervades all phases of FORCEnet developments and is led by COMSPAWARSYSCOM as the FORCEnet Chief Engineer.
- Procurement: Should procurement be necessary to support implementation of FORCEnet requirements, this will be coordinated as appropriate with DASN (Acquisition Management) and Navy Competition Advocate, as well as VCNO and CNO (N4), to ensure compliance with acquisition statute and regulation.

- Deployment: Planning and coordination of FORCEnet "leave-behind" capability to support future operational use and deployment will be guided by CFFC via NETWARCOM to ensure compliance with Fleet planning and direction.
- Support: Director of FORCEnet will coordinate with CNO (N4) for supportability and maintainability, and will work with CFFC, CG MCCDC, and the SYSCOMs to ensure systems remaining for operational use will be logistically supportable.

Track Two: Analysis and Assessment

This track provides the critical analytical underpinnings to evaluations and decisions in the other three tracks, providing support as discussed below and in Appendix E:

- Support of Resource and Requirement Decisions in the Planning, Programming, and Budgeting System: Improved identification of overlaps, gaps, and bottlenecks in legacy and planned systems/functions, to support enhanced operational capability and optimized investment decisions. Initial results were incorporated into FY 2005 budget development, with full implementation planned in budget development for FY 2006 and beyond.
- Support of Fleet FORCEnet Innovation: Provides problem definition and experiment design, development of metrics for the assessment of experimental results, preparation and execution of data collection plans required to evaluate those metrics, and generation of associated analysis reports for assessment of operational relevancy by NETWARCOM and Director of FORCEnet.
- Support of FORCEnet Architecture Selection: Provides assessment of architectural alternatives for both C4ISR and combat systems, and incorporation of such architectures into campaign simulation models. Simulation, experimentation, and wargaming are being employed to investigate the interactions between technology, architecture and CONOPS in a range of operational scenarios.
- Evaluation of Tactics, Techniques, and Procedures (TTP): Analysis and assessment of doctrine, human-machine interfaces, and collaboration and decision tools, through lab and field experiments, simulations, workshops, wargames, and operational exercises.
- Alignment of Science and Technology (S&T) and Research, Development, Test, and Evaluation (RDT&E) efforts with FORCEnet requirements: Support for development of an S&T roadmap, along with an integrated RDT&E database, to leverage by FORCEnet.
- Evaluation and selection of Modeling and Simulation (M&S) tools and scenarios: To support FORCEnet development while providing cost savings.

Two FORCEnet-developed tools will be used to facilitate analysis, as follows:

- The Collaborative Engineering Environment (CEE) allows trades across operational, technical, financial, and programmatic dimensions.
- The Virtual Warfare Environment (VWE) works in conjunction with CEE, and allows simulations, hardware and warriors to be integrated to ensure real-time, joint test events.

Analytical efforts are being supplemented by assessments conducted using a series of FORCEnet strategic "wargames," to facilitate development of policies and procedures. Three FORCEnet-related strategic war games have been conducted thus far:

- NETWARCOM Commander's Wargame: To explore how NETWARCOM-aligned commands will fulfill the intent of CNO and Fleet directed missions, functions, and tasks in operational execution of Naval network and Information Operations (IO) capabilities.
- FORCEnet Innovation and Implementation Wargame: To identify the major capability requirements and challenges, the key criteria for assessments of programs, technologies and processes, and policy/operations/acquisition changes necessary by senior decision makers for FORCEnet to succeed.
- Interoperability and Connectivity Business Case Wargame: To gain insight into the organizational dynamics related to Joint interoperability processes.

Track Three: Technology Transition

"An important first step we will take is to leverage technologies that allow us to more effectively share and expedite the flow of useful information."
General Michael W. Hagee, Commandant of the Marine Corps
Guidance as Incoming 33rd Commandant of the Marine Corps, January 14, 2003

"Emergent technologies and concepts offer a rare opportunity to dramatically increase our operational effectiveness. By implementing FORCEnet, we will seize this opportunity and leverage the full power of network-centric forces in an information age."
Vice Admiral Richard W. Mayo, COMNAVNETWARCOM, and
Vice Admiral John Nathman, CNO (N6/N7)/Director of FORCEnet,
"FORCEnet: Turning Information Into Power," Naval Institute Proceedings, February 2003.

An underlying premise of FORCEnet is ready access to and the automated processing of information necessary to make rapid, accurate decisions that lead to decisive, precise, desired outcomes in engagements. To support FORCEnet, ONR is coordinating its Science and Technology (S&T) efforts with Navy and Marine Corps Tactical Exploitation of National Capabilities (TENCAP) offices to leverage near-term through long-term research and development in network and applications technology. This supports mission responsive dispersed-force sharing of information; command and control concepts that provide for rapid, accurate knowledge and courses of action for force/battle management; pervasive, persistent sensors; and human factors and command structures that enable the warfighter to make decisive, accurate decisions and enable conflict management. The combination of ONR's long-term focus (with applications spun off during short, mid, and long-term periods), TENCAP's near-term focus, accelerated POR technologies, and coordination with Defense Advanced Research Project Agency (DARPA) initiatives, provides an outstanding integrated technology capability application by FORCEnet. For example, the Joint Task Force Wide Area Relay Network (JTF WARNET) Advanced Concept Technology Demonstration (ACTD), coupled with the TENCAP Blue Force Tracking program, the ONR Intra-Battle Group Wireless Communications effort, and SPAWAR's Expeditionary Command/Control/ Communications/Computers /Combat Systems (C5) Grid effort facilitated the FORCEnet FY03 IPD prototype – which will be used to define FORCEnet Block 0. Further discussion of technology planning is provided in Appendix F.

Track Four: Innovation Continuum

"We aren't interested in physics-based or... technical experimentation. We're interested in operational experimentation... There is the ability to obtain some very early pieces of technology, which we can then put in the operating forces and see what it means."
Vice Admiral Arthur K. Cebrowski, USN (Ret), Director, Force Transformation, DOD
Government Executive Magazine, January 21, 2003

The FORCEnet Innovation Continuum was developed by NETWARCOM in close collaboration with Navy and Marine Corps stakeholders to address the required FORCEnet capabilities. It brings together wargaming, modeling and simulation, lab and field experimentation, ACTDs, sustainable prototype development, and accelerated POR enhancements to provide operationally relevant capability to the Fleet and Fleet Marine Force. This track supports FORCEnet planning in four major areas: (1) Implementation of Spiral Development, to expeditiously provide evolutionary capability to the warfighter; (2) Feedback into the PPBS process, via insertion into the Analysis process, to support resource and requirements decisions; (3) Feedback into the concepts development and experimentation process, to support emerging concepts; (4) Feedback into the operational doctrine process to support changes in operational CONOPS and TTP; and (5) Feedback into the S&T process to support technological needs and determine technological impact on the FORCEnet CONOPS and experimentation. Spiral Development milestones are reflected in Figure 5, with key events discussed below. Because FORCEnet is an alignment initiative rather than a program, operational testing of FORCEnet is not applicable; however, assessments sponsored by the Director of FORCEnet are embedded in the Innovation

Continuum process for selected events, using operational and land-based test facilities and are in addition to planned test and evaluation of individual PORs. Discussions are in process to further enhance this FORCEnet assessment process via participation and independent observation by Operational Test and Evaluation Force.

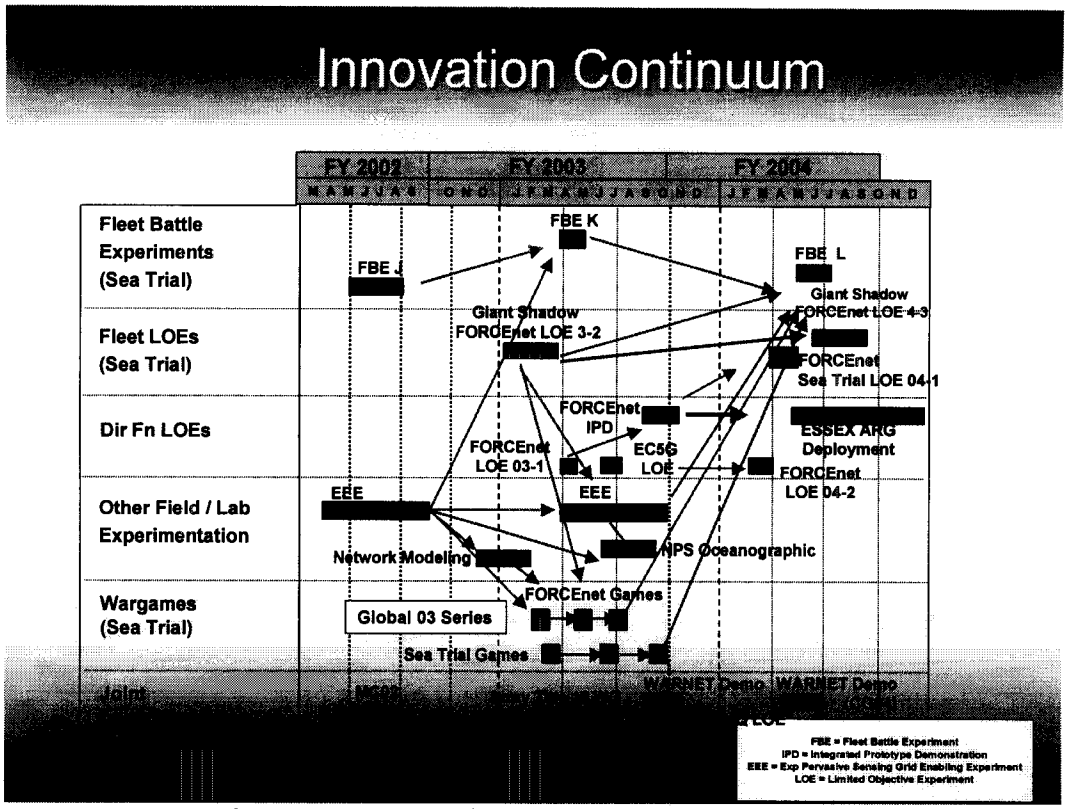


Figure 5. FORCEnet/Sea Trial Innovation Continuum

FORCEnet Limited Objective Experiment (LOE) 03-1, "Enterprise Infrastructure," November 2002 through June 2003: This LOE is a lab-based event which focuses on the infrastructure to support FORCEnet integration, to demonstrate that the "netting" and integration of selected capabilities from transformational initiatives will provide an increase in Information Knowledge Advantage and combat capability. It is a risk mitigation effort for the FORCEnet Integrated Prototype Demonstration, which is described below. The experiment will examine the operational utility of integrating Blue Force Tracking, EC5G (the Expeditionary Command, Control, Communications, Computers, and Combat System Grid), IGBWN (Intra-Battle Group Wireless Network), JTF WARNET, Web-Enabled Task Force initiatives, and Allied/Coalition information sharing enhancements in support of Naval and Joint fires.

FORCEnet LOE 03-2, "Giant Shadow," January 2003: This LOE explored how forces consisting of a stealthy undersea platform (SSGN), Special Operating Forces (SEALS), Unmanned Air/Underwater Vehicles (UAVs/UUVs), and sensors (underwater, overhead, and unattended ground sensors/UGSs, with sensor data fusion on the airborne NCW test-bed Hairy Buffalo) can use collaborative networking to rapidly clarify ambiguous intelligence related to a Weapon of Mass Destruction (WMD) threat (Figure 6). This LOE addressed the required FORCEnet capability for expeditionary, multi-tiered sensor and weapon information. Analysis of this LOE is providing information critical for evaluation of FORCEnet and NCW concepts, including assessment of the sensor information (accuracy, consistency, timeliness), quantification of the network capability (capacity, connectivity, timeliness), evaluation of the C2 tools (quality of situational awareness information, timeliness), and observation of the human factors (organizational structures, time-dependent use of ISR information/tools). This analysis can influence requirements for technology investment to support FORCEnet transformation by identifying needs in the areas of network capability and protocol, data fusion and aggregation algorithms, C2 and situational awareness tools, and platform/sensor architectures.

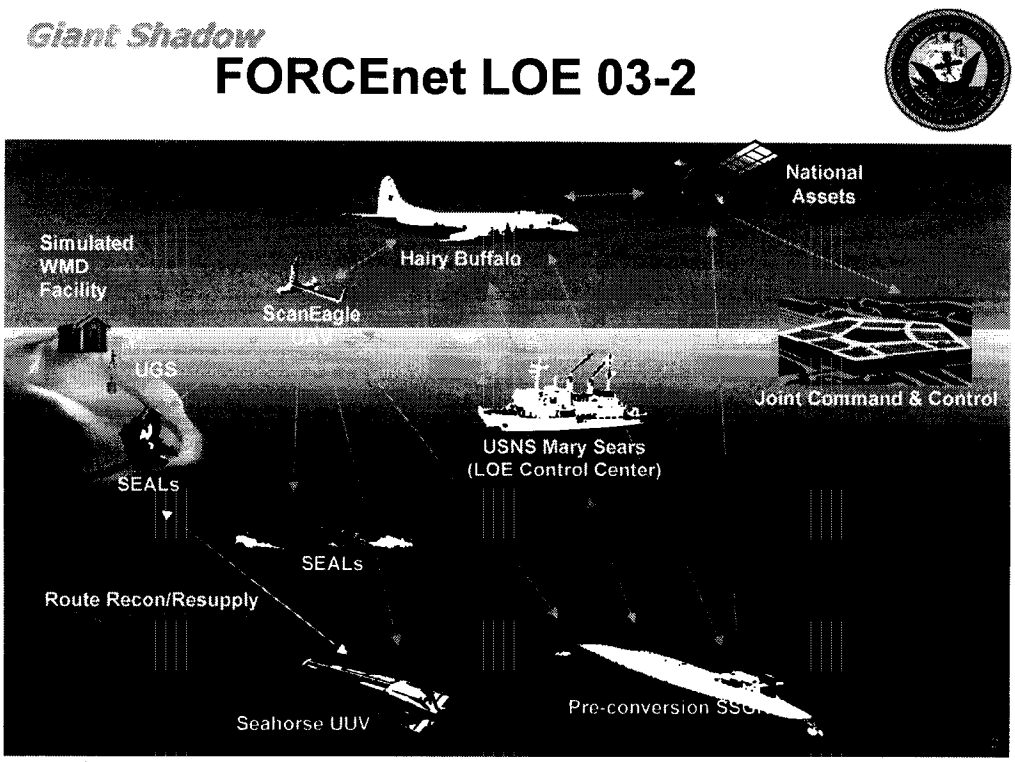


Figure 6. FORCEnet Limited Objective Experiment 03-2: "Giant Shadow"

FORCEnet Spiral 1, February to April 2003: C2F, NETWARCOM, NWDC, and Naval War College executed this concepts-based experiment to develop solutions and CONOPS for collaborative C2 of a distributed Joint Task Force Commander staff. It built on workshops and an operationally focused wargame, leading to a field experiment concurrent with a distributed C2 Staff Exercise. It will provide organizational and procedural insights to the Numbered Fleet Commanders.

Fleet Battle Experiment Kilo (FBE Kilo), April 2003: These concept-based experimentation initiatives, conducted with C7F and Forward Deployed Naval Forces (FDNF), included Information Operations for enhanced computer network defense, and C2 and operational processes of the Expeditionary Strike Group (ESG) in a legacy network environment. Its assessment will support CONOPS and TTP development for the FORCEnet IPD, described below.

FORCEnet Spiral 2, July to August 2003: This builds on and validates Spiral 1 developments, providing refined procedures and CONOPS to aid the Numbered Fleet Commanders.

FORCEnet Integrated Prototype Demonstration (IPD) (September - October, 2003):

"One of the key FORCEnet events in the near term is the FORCEnet Integrated Prototype Demonstration (IPD). This provides an excellent opportunity...to transform the Fleet."
Vice Admiral Richard Mayo, Commander, Naval Network Warfare Command
E-Mail to Admiral W.F. Doran, Commander, Pacific Fleet, January 3, 2003

The FORCEnet IPD (Figure 7) will provide a rapid fielding of improved warfighting capability to the Fleet, with full supportability and maintainability, and will develop the CONOPS and TTP on how best to use this new capability in the context of the new Expeditionary Strike Group concept. It is being tailored to meet the requirements of the operational commanders in the Western Pacific (Commander Seventh Fleet, Commander Task Force SEVEN SIX, Marine Expeditionary Unit THREE ONE), providing an initial FORCEnet capability to the FDNF to support a 2004 deployment. The IPD was endorsed by Commander, Pacific Fleet in January 2003, and will include participation of Army, Air Force, Marine Corps, and Special Operations forces.

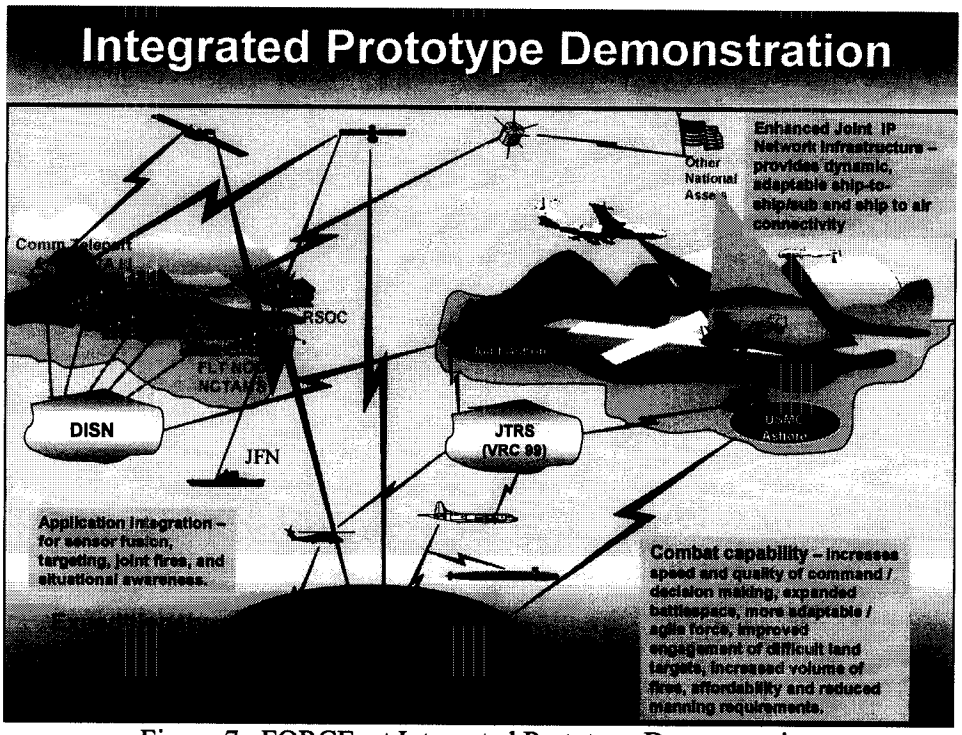


Figure 7. FORCEnet Integrated Prototype Demonstration

FY04 FORCEnet innovation and experimentation will build on FY03 efforts:

- Giant Shadow 2004 (GS 04): Will leverage lessons learned in GS 03 and further explore organic deployment of UAVs by SSGN in support of forces ashore.
- Sea Viking 2004 (SV 04): A coordinated event between the Director of FORCEnet and the Marine Corps, SV 04 is the first step in an experimentation program designed to transform the Ship-to-Objective Maneuver (STOM) concept into an operational reality. Preliminary events consist of technical assessments, workshops, war games, and modeling and simulation Command Post Exercises (CPXs), culminating in a live force experiment conducted in the Fall of 2004 by West Coast operating forces.

Summary

"Transformation is not an event-- it is a process... Our goal is to set in motion a process of continuing transformation."

Secretary of Defense Donald H. Rumsfeld,
Posture Statement before the 108th Congress, House Armed Services Committee, February 5, 2003

"FORCEnet is the Department of the Navy's catalyst for operational transformation. In the realm of network centric warfare and operations, it will enable orders of magnitude increases in combat power to ensure decisive influence and warfighting success across the full spectrum of military operations in the information age."

Honorable Hansford T. Johnson, Secretary of the Navy (Acting)
Statement before the House Armed Services Committee, February 26, 2003

FORCEnet is the enabler for transformation of the Naval services. Through FORCEnet and its application of Network Centric Warfare capabilities, the Navy and Marine Corps forces will be able to achieve profound improvements in areas ranging from Power Projection to Ship-to-Objective Maneuver to Homeland Defense--while promoting increased coordination and Joint interoperability with the other services, departments, allies, and coalition partners. In its first year of funding, and with a relatively modest investment, FORCEnet has already achieved dramatic improvements in organizational structures, processes, and products--and is rapidly providing enhanced operational capability to the warfighter.

Appendix A: Warrior Focus and Enablement

Introduction: Warrior enablement is key to FORCEnet success, with human-centric integration one of the six required capabilities of FORCEnet. A warrior focus is particularly critical in the dispersed, networked, mobile, complex, and rapidly changing FORCEnet/Network Centric Warfare environment. To optimize total system performance and minimize total ownership cost, the warrior must be considered as an integral component of the system. Human performance cost trades must be made in conjunction with hardware and software cost trades at each step of the acquisition process. The Director of FORCEnet is working with cognizant commands to coordinate and focus efforts that will maximize the efficiency and effectiveness of human centric design and development. Foundation efforts that FORCEnet will leverage, and related planning, are addressed below.

Human Systems Integration (HSI): HSI is a systems engineering discipline that considers the human as part of the system. It's component elements are manpower, personnel, training, human factors engineering, system safety, occupational health, personnel survivability, and habitability. Design alternatives balance human performance and cost as part of determining the final function and task allocations among hardware, software, and people. Warfighter evaluations ensure that operational lessons-learned are incorporated. A primary HSI objective is to ensure these considerations are addressed early in the engineering and acquisition process, when it is most cost effective. HSI initiatives include:

- Manning Affordability Initiative: Office of Naval Research (ONR) teamed with the acquisition community in an experiment demonstrating that application of HSI principles reduces workload and manpower requirements while improving system performance.
- Integrated Command Element: Use of a web-enabled model to track FORCEnet effectiveness metrics. A notional display is shown in Figure 1, where each circle represents a snapshot status at various times. This robust assessment model allows for concurrent monitoring and in-depth analysis of multiple factors, with Measures of Effectiveness (MOE) and Measures of Performance (MOP) roll-up to show overall combat effectiveness.

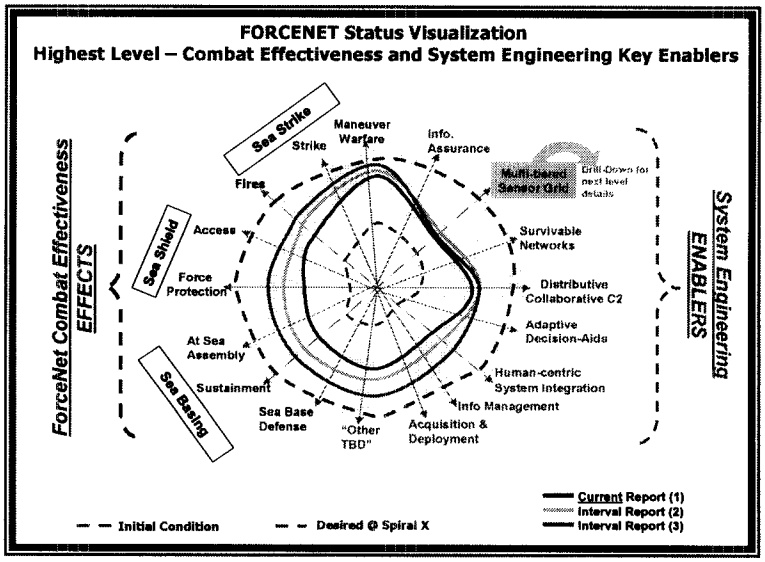


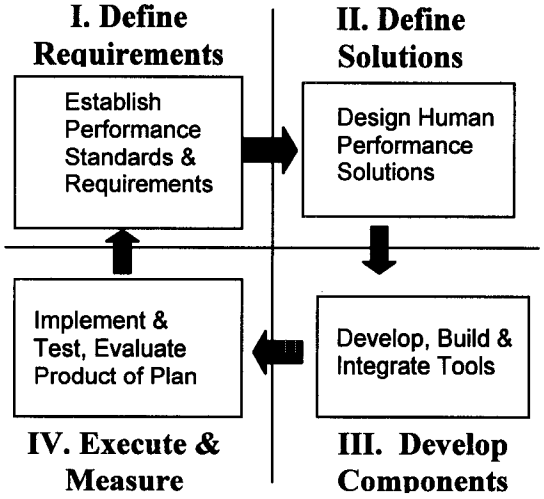
Figure 1: FORCEnet Status Visualization

- Augmented Cognition Research Initiatives: Demonstrates that advanced models of human learning styles, mental models, and cognitive workload could be used to tailor the results of HSI to the individual warrior for application to FORCEnet. Principles and instrumentation are emerging that: (1) Translate information into specific actions required of the human; (2) Reduce cognitive load; (3) Structure tasks and integrate information into actions of systems; (4) Promote self-synchronization and focus on the warrior rapidly achieving and maintaining a common operational picture of the battlespace; (5) Ensure subordinate personnel are fully aware of commander's objective and intent; (6) Optimize distributed decision-making; (7) Facilitate multimodal communications channels.

- Task-Centered (TC) Technologies: TC Design focuses the integration of FORCEnet components on the goal of warfighter task support. It includes the analysis of tasks during requirements development and design, and inclusion of tasks in the final design approach. This reduces the burden from the warfighter to collect, integrate, and manage information that is not task sensitive. Task products allow operators the ability to distribute mission workload effectively, not being bounded by network or information barriers. TC Decision Aids allow users to support the mission process with rapid decision-making.
- Information Architecture: Focuses the development of tools on the requirements of information management and supply to the Human-Computer Interface from legacy software components to modern web-based applications. The multi-tier architecture approach allows the modular development and maintenance of large-scale software systems without the complexity of design, through the use of reusable components. This is critical to FORCEnet, as it allows the integration of information and capabilities from both legacy and newly developed system components and supports system evolution.
- Navy Aviation Simulation Master Plan (NASMP): Launches future distributed mission training programs to effect the seamless integration and modernization of all Naval aviation simulation assets in a tactically relevant environment. NASMP will provide a common infrastructure, including standards, tools, and networks--thereby promoting interoperability, instructional efficacy, and cost effectiveness. Exemplifies plans FORCEnet will leverage.

Task Force EXCEL (TFE) and Training: TFE is a CNO initiative to bring a revolution in training, which is one of the HSI elements. A cornerstone of TFE is the Human Performance System or Four Quadrant Model (FQM), shown in Figure 2, which integrates human performance into every phase of activity and provides a feedback loop to facilitate continuous improvement.

Figure 2: TFE FQM



The FORCEnet training requirements process will identify highly interoperable and flexible training capabilities that will be analyzed and validated using intuitive interfaces, intelligent aids, and integrated training methodologies to ensure warrior readiness. TFE and training initiatives include:

- Training Research and Development: Delivering advanced human-centric training technology products for assessing, diagnosing, and debriefing teams to rapidly develop Naval Mission Essential Task List (METL)-based competencies.
- TFE Revolution in Training Development and Delivery: A Naval Education and Training Command (NETC)-led effort to develop effective and efficient delivery methods, dramatically increase the use of onboard training/simulation capabilities, and apply rapid learning techniques to training, supporting disciplined "Speed to Capability."
- Integrated Battle Force Training: The primary tool used by deploying carrier and expeditionary strike groups to manage C4ISR training. It is being expanded to include Combat Systems, making it the C5 training management tool.

- Afloat Training: Unit or multi-unit training conducted by simulation, netted multi-unit virtual exercises and fleet readiness assessments, applying embedded knowledge management and user performance support features to enable self-training and skill refresh.
- Total Ship Training System (TSTS) and Battle Force Tactical Training (BFTT): The FORCEnet Requirements Branch (N61) is working with PEO (IWS) to integrate these key initiatives into FORCEnet implementation. TSTS is developing a standardized training open architecture that will integrate BFTT/Combat System Onboard Training systems with engineering, navigation, ship handling, damage control, combat system casualty control, and afloat training systems. BFTT is an integrated team trainer that provides a scenario-based mission rehearsal capability. TSTS and BFTT will be linked with NASMP.

Sea Warrior and Career Planning: Sea Warrior is one of the initiatives directly supporting the NTR pillars, providing a foundation of warfighter effectiveness by ensuring the right skills are in the right place at the right time. Project SAIL (Sailor Advocacy through Interactive Leadership) uses web-based technologies and intelligent software agents to revolutionizes career management by matching the warrior's capabilities and preferences against service needs, while the Improved Navy Work Force project is an automated tool that utilizes Knowledge, Skills and Abilities (KSA) of job and warrior aptitudes, personalities, and interests to link warriors to optimum jobs.

Organizational Alignment: As with the broader FORCEnet initiative, Navy organizations have been realigned and partnered to more effectively and efficiently execute human-centric design and engineering goals, as illustrated by the following examples:

- Establishment of an HSI Directorate (SEA 03) in NAVSEASYSCOM. SEA 03 is working closely with CNO (N00T) and NETC to ensure a systematic approach to training and institutionalize HSI principles in system acquisition. Similarly, SPAWARSYSCOM has established a Director of Manpower, Personnel, and Training (SPAWAR 04H1) to lead HSI efforts, and NAVAIRSYSCOM has designated personnel to lead HSI efforts.
- The CNO (N125) is leading an OPNAV effort to ensure that acquisition programs consider HSI early and throughout the system acquisition process.
- The CNO (N00T) is performing significant revisions to Navy training policy, instructions, and guidance to emphasize HSI.
- The FORCEnet Requirements Branch, CNO (N61F), has established a designated HSI lead and is partnering with NETC and the Center for Information Technology to facilitate the rapid delivery of training to realize FORCEnet human-centric integration goals. N61F has initiated discussions with USMC HQ and MCCDC to ensure warrior development and training standardization as well as interoperability across the Naval service, and is also coordinating with the Naval Postgraduate School and the United States Naval Academy to support their implementation of Network Centric Warfare related curriculum.

Acquisition: Inclusion of the human element in acquisition planning is necessary to achieve rapid deployment of highly advanced, human-centric systems. Proper acquisition requirements will define the requisite system scope to full address operator and maintainer issues, and human performance issues to be tested and evaluated. Documentation of procedures for including HSI early in system development provides the framework for successful warrior enablement and the structure to enforce requirements. The CNO (NOOT) is also performing significant revisions to Navy training policy, instructions, and guidance to emphasize human performance and restructure the approach to training development and delivery. This new guidance will be applied to FORCEnet with each SYSCOM providing increased influence and emphasis on HSI during each phase of the acquisition process, from requirements definition to system retirement. The foundation of requirements definition will be based on Top-Down Functional Analysis that includes descriptive requirements analysis, system analysis, and mission/task analysis. In addition, the SYSCOMs will function as advocates for resourcing HSI and will provide a focal point for best practices and solutions.

Appendix B: FORCEnet Funding

FORCEnet funding falls under PE 0604231N, Tactical Command System, Project W9123, FORCEnet. Funding across the Future Years Defense Plan (FYDP) is as follows:

FY 2004 President's Budget; Appropriation: RDT&E, N (Then-Year $M)

FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	Continuing
12.5	14.7	15.7	17.2	19.1	21.1	23.0	

FORCEnet is affordable because it is primarily an alignment, engineering, and integration effort, which leverages all programs and planned experimentation events across the Navy and Marine Corps to provide a more efficient and effective application of resources. Attached Figure B-1 provides an example. FORCEnet funding supports the efforts described below.

Limited Objective Experiments (LOEs): Integration of tactics, techniques, and procedures with rapid prototyping and Science & Technology (S&T) to develop innovative operational concepts. Experimentation roadmaps are developed to align with emerging initiatives and Fleet Battle Experiments.

FORCEnet Collaborative Engineering Environment (CEE): Allows trades across operational, technical, financial and programmatic dimensions. Analytically defendable investment plans and mission capability platform and equipment roadmaps are established through qualitative and quantitative analysis. Cost vs. combat capability trades will be executed in conjunction with the FORCEnet Virtual Warfare Environment.

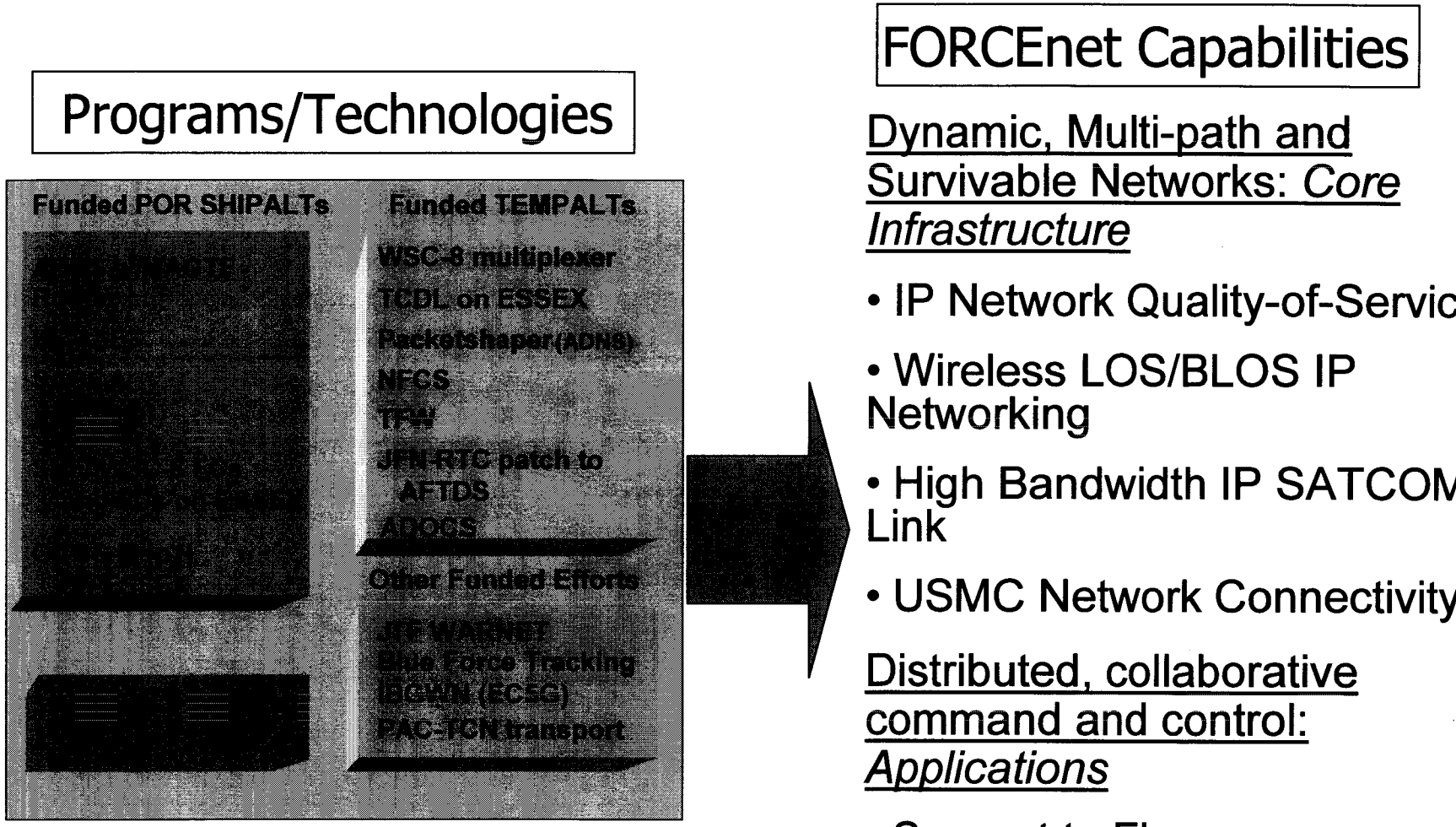
FORCEnet Virtual Warfare Environment (VWE): Integration of simulations, hardware and warriors to ensure real-time, joint test events and analytical products are captured as part of a disciplined implementation of NCW requirements. Used in conjunction with CEE to develop cost vs. combat capability trades and roadmaps.

Integration Analysis: Provides a common thread of support to all activities with final results to the decision makers. Analytical feedback refines subsequent LOE definitions, concepts, capabilities and budget alignment to drive capability introduction to the Fleet through spiral development using a decision support system that aligns existing programs, emerging initiatives, experimentation, and S&T.

FORCEnet Products: Flowing from the above efforts, these products include:

- Validated FORCEnet requirements,
- FORCEnet plans/roadmaps integrating Navy and Marine Corps planning for S&T and experimentation,
- A dynamically reconfigurable set of metrics required to manage FORCEnet,
- Software models to support investment trade-offs, and
- A collaborative capability to demonstrate and study the various concepts of integrated warfare and combined force effects provided by FORCEnet.

Figure B-1: The FORCEnet Integrated Prototype Demonstration (IPD) Leverages Planned Program, Technology, and Experimentation Investments to Bring Critical New Warfighting Capabilities to the Fleet



POR: Program of Record
SHIPALT: Ship Alteration
TEMPALT: Temporary Alteration
(Note: Program acronyms are listed in Appendix G)

Appendix C: FORCEnet Capability-Based Requirements

Introduction: This appendix provides additional detail on the flow-down from National and Defense strategy via the Naval Transformation Roadmap (NTR) and related guidance to FORCEnet requirements, as well as how the Navy will manage FORCEnet compliance. Figure C-1 highlights this flow from the Joint and Service vision statements to Operational Concepts that are validated via the FORCEnet/Sea Trial Innovation Continuum process of experimentation and wargaming. The warfighting capabilities needed to support these operational concepts are then analyzed for solutions across the range of doctrine, organization, training, material, leader development, personnel, and facilities (DOTMLPF) options. For those warfighting needs for which material solutions are warranted, a Fleet-validated requirement is generated. It is envisioned that FORCEnet requirements will guide POR material solutions.

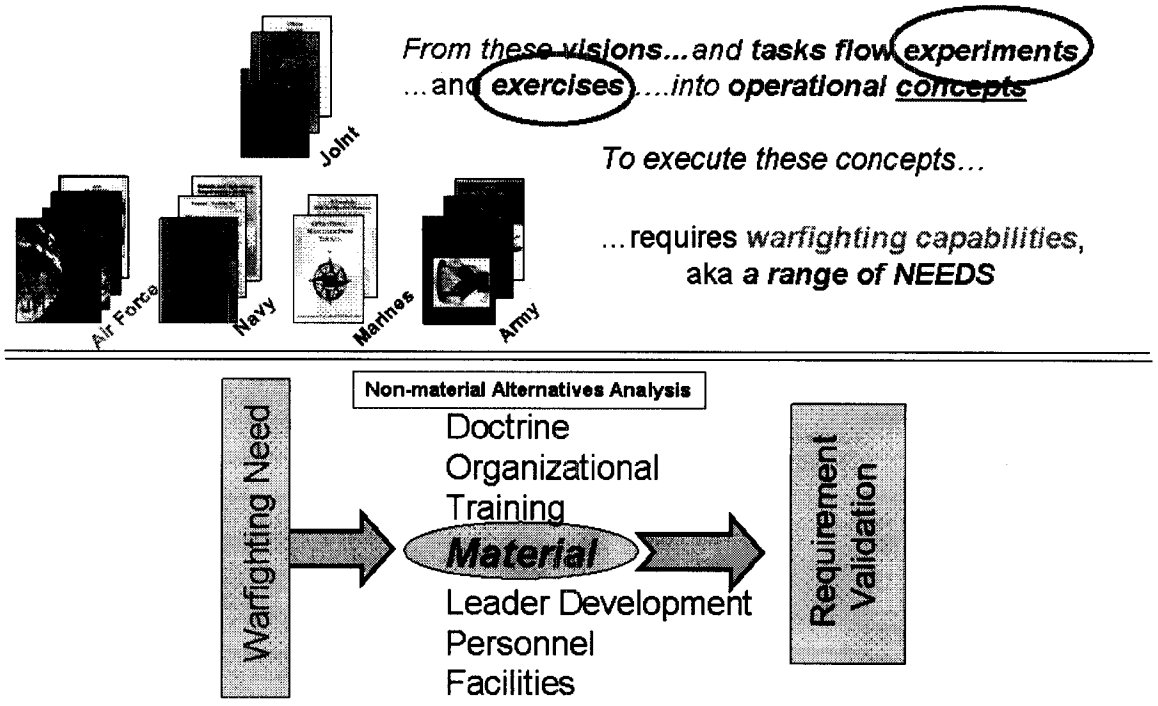


Figure C-1: Translating Vision to Requirements

Required FORCEnet Capabilities

To support the transformational capability documented in the NTR and related guidance, FORCEnet must enable capabilities in the following six broad areas:

- Expeditionary, multi-tiered sensor, and weapon information,
- Distributed, collaborative command and control,
- Dynamic, multi-path, and survivable networks,
- Adaptive, automated decision aids,
- Human-centric integration, and
- Information weapons.

For each of these FORCEnet capability areas, a set of required attributes are being defined. A coordinated set of warfighting concepts is being developed by Navy Warfare Development Command (NWDC) and Marine Corps Combat Development Command (MCCDC). These concepts will be validated through the FORCEnet/Sea Trial Innovation Continuum process of experimentation and wargaming. When validated, these concepts and the

underlying experimental hypotheses provide the traceability from FORCEnet capabilities and attributes to specific measures of enhanced warfighting capability in Sea Strike, Sea Shield, and Sea Basing.

The Fleet-generated FORCEnet Baseline Initial Capabilities Document (BICD) under final review by NAVNETWARCOM summarizes these high-level requirements and supporting capabilities. This BICD will also provide the linkage between the higher-level Joint and Naval strategies, the FORCEnet top-level requirements, and the more detailed capability taxonomy elements.

FORCEnet Capabilities-Based Requirements Process

The military capabilities required by Naval Forces to support Joint transformation and Network Centric Warfare (NCW) are identified and Fleet-validated through a Fleet-led requirements integration and experimentation process. To manage and direct this requirements generation and validation process, the Navy and Marine Corps have substantially realigned organizations and procedures affecting concept development, experimentation, requirements generation and integration, planning/programming/budgeting, systems engineering, acquisition, and configuration control. These alignments, summarized in the main body of this report, transform how FORCEnet requirements flow from the Fleet through the Planning, Programming, and Budgeting System (PPBS) and the acquisition process. Added to these Naval re-alignments are recent actions by the Joint Chiefs of Staff and Office of the Secretary of Defense (OSD) that affect DOD requirements and acquisition processes.

FORCEnet capabilities are captured in a strategy-to-task framework that guides FORCEnet planning, providing programmatic structure and serving as FORCEnet top-level operational requirements. Figure C-2 shows the current FORCEnet capabilities; these are constantly being reviewed and refined to reflect additional feedback from the innovation and assessment process.

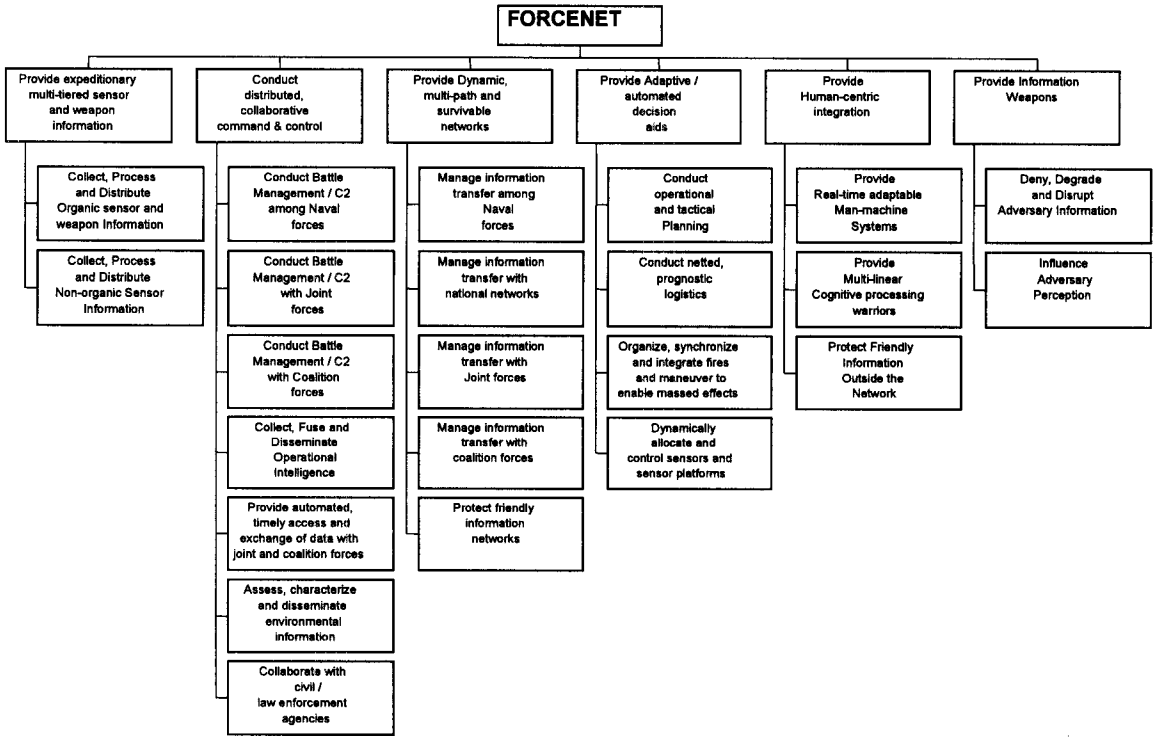


Figure C-2: Current FORCEnet Top-Level Capabilities/Requirements

Emerging operational needs are assessed, along with emerging operational concepts and CONOPS, results from modeling and simulation, experiments, technology demonstrations, prototyping, exercise and operational lessons learned, via interdisciplinary Warfare Innovation Development Teams (WIDTs) coordinated by NWDC. The output of these teams is captured in a taxonomy that represents the set of required capabilities, warfighting concepts, and technologies necessary to achieve Naval operational objectives in the near term (FYDP) and beyond. This constantly evolving, concepts-based capability taxonomy is the foundation for the FORCEnet/Sea

Trial Innovation Continuum, and forms the interface between the strategy-to-task, top-level capabilities/requirements framework that guides the FORCEnet Director's (CNO N6/N7) assessment, validation, and planning/programming processes, and the acquisition and R&D communities' specific technical solutions. Figure C-3 is a notional view of that process.

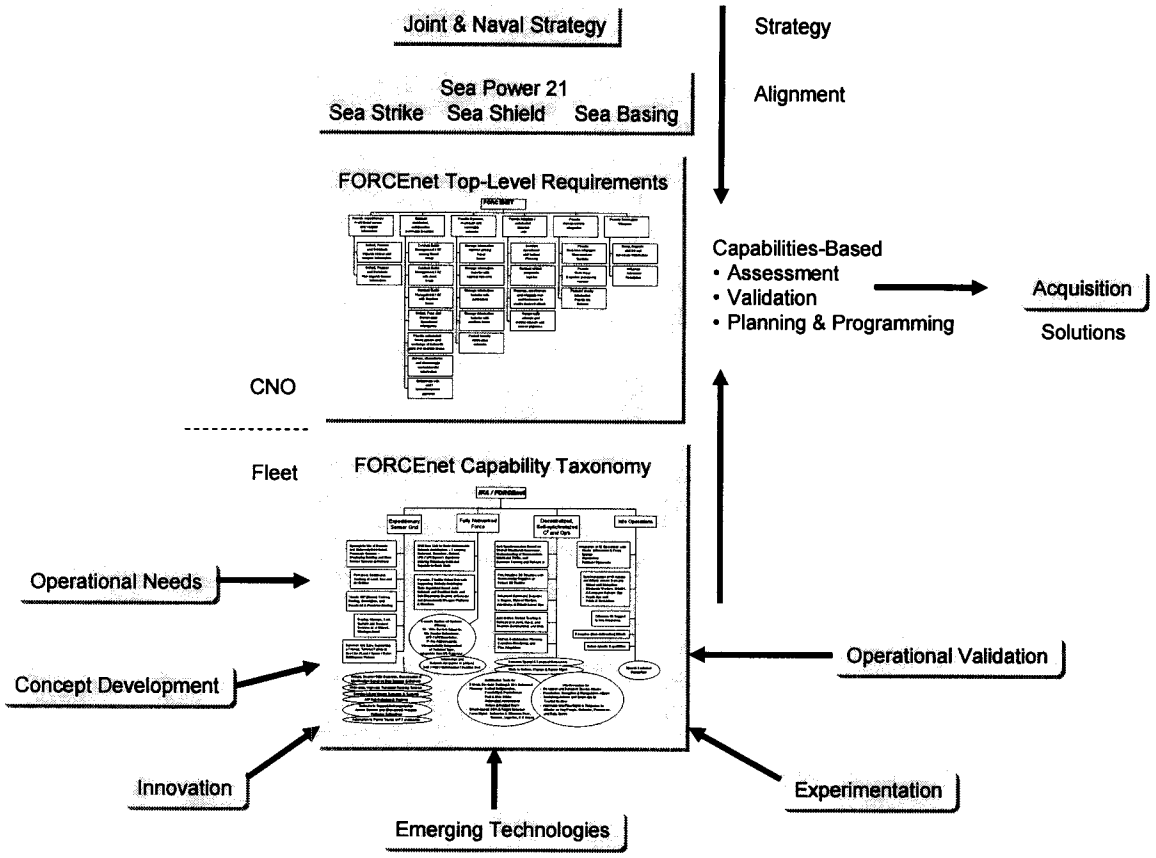


Figure C-3: FORCEnet Capabilities-Based Requirements Linkage

FORCEnet operational needs and FORCEnet/Sea Trial Innovation Continuum results are validated through Fleet-led Integrated Product Teams (IPTs). The products of these IPTs are integrated and submitted by NAVNETWARCOM through CFFC to CNO as the Fleet's input to the PPBS. The FORCEnet BICD and integrated architectures will develop these Fleet requirements in accordance with emerging DoD requirements and acquisition policy.

Capabilities-Based Requirements Analysis

The FORCEnet requirements process assesses the National/Defense strategy and Joint/Naval vision to identify the challenges to implementing the FORCEnet transformation, and the opportunities to be seized to leverage Naval asymmetric advantages. In response to those challenges and opportunities, a range of future strategies is reviewed through functional analyses, modeling and simulation, wargaming, and experimentation. The requirements process begins with reviewing Naval missions and tasks in the context of the current Defense Planning Guidance scenarios, through Naval employment scenarios and validated threats, towards identification of a prioritized list of any mission shortfalls or function performance gaps. The results of this body of work have been corroborated in several competitive analyses, including a recent national intelligence estimate.

Challenges and Opportunities

To effectively support the National and Defense strategies, Naval forces must address challenges to providing sustained forward presence, as well as to seizing the opportunities for U.S. asymmetric advantage. Potential adversaries are increasingly capable of developing or purchasing multi-dimensional anti-access capabilities to

keep Naval forces out of the littoral environment. There has been a worldwide proliferation of military systems, information sources, processing and communication technologies, and a development of disruptive technologies.

The Office of Naval Research (ONR) is developing technology that will help counter the anti-access threat, including enhanced situational awareness and collaborative planning, communication and networking, and time-sensitive decision-making technology. The ONR develops technology by co-evolving technology products with experimentation that refines concepts into tactics, techniques, and procedures. A more detailed summary of ONR initiatives and processes in support of FORCEnet is included in the body of this report and Appendix F.

Management of FORCEnet Capabilities-Based Requirements In System Alignments

An essential element of FORCEnet is the alignment of Programs of Record, new efforts, and Science and Technology initiatives to an integrated set of Naval warfighting requirements, architectures, and associated standards. Compliance with this FORCEnet "blueprint" is being managed via a capabilities-based analysis process by the Director of FORCEnet in close coordination with his Marine Corps counterpart (CG, MCCDC), ASN (RD&A), COMNAVNETWARCOM, and COMSPAWAR. For Program Review 05 (PR05), the Navy is piloting a FORCEnet Naval Capabilities Plan (NCP) approach, realigning assessments around the four pillars of NTR/SP 21. Navy and Marine Corps "Flag" level lead and co-lead warfare sponsors have been designated for FORCEnet, Sea Strike, Sea Shield, and Sea Basing. Each warfare sponsor is responsible to the Director of FORCEnet for assessing the end-to-end warfighting capabilities in their area. FORCEnet compliance and interoperability will be supported by Space and Naval Warfare Systems Command (SPAWARSYSCOM) as the designated lead SYSCOM for FORCEnet and Chief Engineer for FORCEnet and Naval C4I. The results of these assessments will also be used by COMNAVNETWARCOM, the Fleet's operational agent for FORCEnet, to evaluate the performance risk and advisability of installing or implementing specific solutions. COMNAVNETWARCOM also serves as the configuration control authority and Designated Approval Authority for Naval networks, and approves all IT and network related shipboard and shore installs.

Appendix D: FORCEnet Network Information Infrastructure Development

Introduction: The FORCEnet vision, as stated by the SSG-XX[1], was FORCEnet would provide a fully netted force. As detailed in Appendix C, this is now one of the six fundamental FORCEnet top-level capabilities/requirements: "Provide dynamic, multi-path, and survivable networks."

The FORCEnet fully netted capabilities will be realized through the creation of a FORCEnet Network Information Infrastructure (NII) fully integrated into the evolving DOD-wide network infrastructure including Transformational Communications Architecture (TCA), Teleports, Defense Information System Network (DISN)/Global Information Grid - Bandwidth Expansion (GIG-BE) and the Joint Tactical Radio System (JTRS). The broad and rapid exchange of information and the ready assimilation and use of this information are at the heart of the FORCEnet NII. The FORCEnet NII will provide not only dynamic and robust connectivity among dispersed forces but also the information dissemination management services required to support the warfighter's decision-making and engagement process. The NII will be fully integrated with the DOD-wide network infrastructure to ensure that the Naval information infrastructure is interoperable with Joint, Army, Air Force and Special Forces information infrastructures--supporting use of Naval forces as an integral part of a Joint team. The FORCEnet NII will also integrate the Combined Enterprise Regional Information Exchange System (CENTRIXS) (which incorporates former Coalition Wide Area Network (COWAN)) with the Naval network infrastructure and provide an interface to NATO and other coalition systems to maximize interoperability with allies and coalition partners. The FORCEnet NII provides the Navy's tactical component of the Global Information Grid (GIG).

The FORCEnet NII will give the 21st Century warriors access to information from a wide variety of sources and will operate in an effective, coordinated manner by exchanging information, even if the force elements are widely dispersed. As a result:

- Decision making will be better informed;
- Collaborative planning among dispersed forces will be more timely and complete;
- Distributed engagements involving sensors, fire control authority and weapons at separate locations will be more readily executable.

The FORCEnet NII in conjunction with the DoD-wide infrastructure (TCA, DISN/GIG-BE, JTRS and Teleport) will provide:

- Connectivity among fixed and mobile nodes located anywhere on the globe;
- Capacity with more efficient links , particularly "sensor and shooter" platforms;
- Control through an autonomously-managed and self-configurable communications network;
- Capability to manage information dissemination with Quality-Of-Service (QOS).

GIG Enterprise Services (GES) is a Defense Information Systems Agency (DISA) effort to support the entire DOD and Intelligence Community in sharing information across systems via a Task, Post, Process, and Use (TPPU) approach to information resources. GES is planned to transition to Net-Centric Enterprise Services (NCES), which as been proposed as a FY04 new start program. NCES features "fast track" concept development and OSD/JCS/Service/Agency coordination to deal with the transition from Common Operating Environment (COE). It will support real-time and near-real-time warrior needs (e.g., increased speed of command, enhanced collaboration, real-time battle management, global access to data, and rapid exploitation of diverse data sources), and business needs (e.g., elimination of redundant capabilities, enablement of Financial Management Modernization Program, and rapid exploitation of diverse data sources that can be customized to meet specific mission demands). FORCEnet in working collaboratively with GES/NCES, and will examine resultant products for FORCEnet/NII applicability as they mature.

The FORCEnet NII will provide improved flexibility and adaptability over the mission-specific information and communications systems of today. FORCEnet will employ a hierarchically layered open architecture to build

[1] CNO SSG XX, FORCEnet and the 21st Century Warrior, November 2001

the transport services that support the information dissemination service. Under this concept, an architectural layer is a logical grouping of closely associated functions or protocols. The layers can be visualized as a vertical stack, each layer sharing well defined interfaces with its upper and lower adjacent layers. The adoption of architectural layering in the design of military systems will provide the basis for an open architecture while significantly improving the ability to keep pace with technology and lowering life cycle costs. The layered protocol suite is illustrated by Fig. D-1.

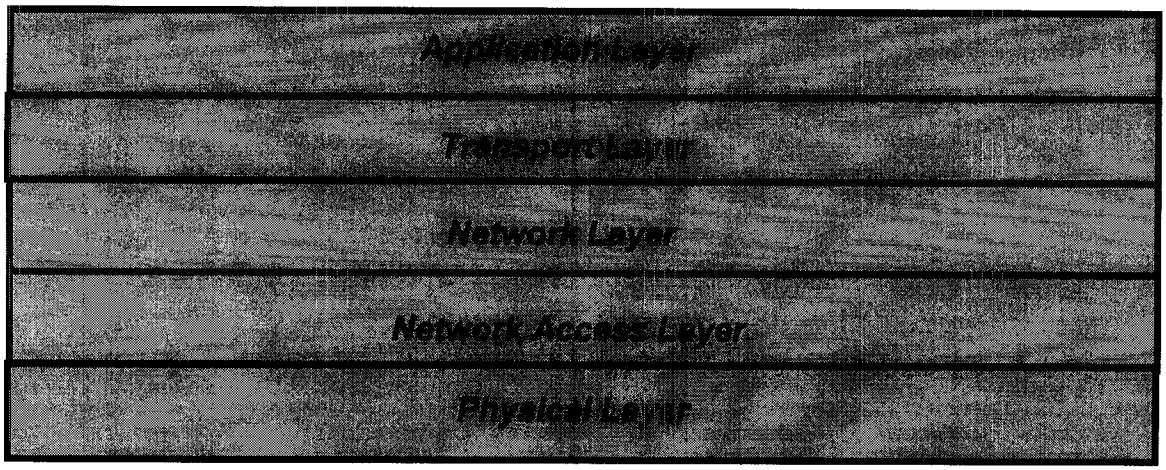


Figure D-1: The Open Systems Layered Protocol Suite

End State for the FORCEnet Network Information Infrastructure (NII):

The end state for the FORCEnet NII is a fully netted force capable of engaging with distributed combat power and C2 with increased awareness and speed as an integral part of a Joint team. The NII contains the communications, networking and computing assets necessary to accomplish two objectives: (1) Effect the exchange of information among information repositories, sensors, command elements, forces and weapons, and logistic and support elements; (2) Allow this information to be used for human decision- making and automated processes pertaining to command and execution.

The FORCEnet NII design tenets are:

- Information assurance in conjunction with the GIG Capstone Requirements Document for availability, integrity and security,
- Alignment and integration with the DISN, GIG-BE terrestrial infrastructure, TCA space-based infrastructure, Teleports and Navy Marine Corps Intranet,
- Internet Protocol (IP)-based transport with QOS over multiple radio frequency (RF) paths and gateways to Tactical Data Links (Link 11, Link 16),
- Jointly interoperable network services (e.g., data base access, collaboration, security, directories), and
- Open standards based architecture (intra-platform, inter-platforms).

Compatibility with the FORCEnet NII architecture vision can be achieved by migrating to a core set of protocols, based on Transport Control Protocol (TCP) and User Datagram Protocol (UDP) over the Internet Protocol (IP). Since many existing networks and applications do not support IP, some will be migrated to IP and some will be extended to IP by a gateway capability. The use of a common networking protocol, as planned for FORCEnet, will significantly reduce the gaps in connectivity and interoperability among military systems.

Creating the Fully Netted Force: The FORCEnet NII will consist of two user-significant services: The information dissemination service, and the information transport service. The information dissemination service is the interface to the command and control (C2) applications (e.g., mission planning, collaboration, decision support, engagement), sensors, weapons and support systems. The information transport service provides the

quality-of-service capable network connectivity inter-platforms, intra-platforms, and between warfighters. Figure D-2 illustrates how the sensors, C2 applications, weapon and support systems interface to the information dissemination service.

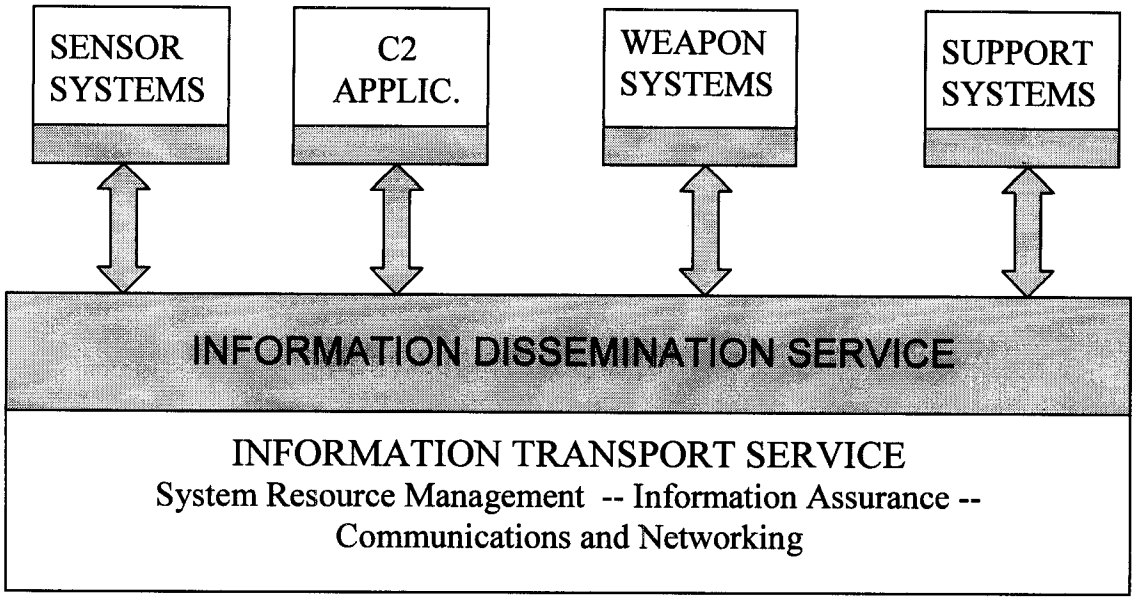


Figure D-2: The Information Transport and Information Dissemination Services

Naval systems have a unique mobility requirement; as a result, despite the rapid advancement of communications and networking technology, continuing limits are anticipated on the network capacity available to most Naval systems. The FORCEnet vision includes the utilization of multiple communications paths for all networks along with a common set of transport services to manage their capacity to the user services. The FORCEnet NII will support integrated voice, video and data communication services. In the FORCEnet NII vision, everything is communicated as digital data (e.g., packet data at the network layer) that includes appropriate quality-of-service parameters established by the applications and/or policy.

In order to bridge the gap between legacy systems of today and the fully netted future Naval force, FORCEnet will be developed and fielded incrementally through a series of blocks. As discussed in the Experimentation and Testing section of the main report, prior to fielding FORCEnet Block I, a FORCEnet Block 0 will be defined via the FORCEnet Integrated Prototype Demonstration. Block I will build on Block 0 to achieve a greater degree of network federation. Block I will be built upon high payoff systems already operating in the fleet today or in the development pipeline that contribute to supporting a number of warfare mission areas. The goal of Block I will be the netting together of those high payoff networking systems to form a federation of networks which will become a global secure interoperable network. Figure D-3 illustrates at a top-level the federation of networks proposed for FORCEnet. The centerpiece of this federation of networks is the family of IT-21 (Information Technology for the 21st Century) afloat and ashore IP networks. The allied and coalition networks are part of the federation through connectivity via various gateways and guards both afloat and ashore. The non-IP Tactical Digital Information Links (TADILS) networks are included in the federation through the creation of a gateway between the TADILS and the IT-21 networks. Critical warfighting information, such as track data, will be able to flow seamlessly between the IP network infrastructure and the TADILS.

Figure D-3 illustrates the relationship between the various components that make up the FORCEnet NII and the DOD-wide network infrastructure. The FORCEnet NII contains two major components: The afloat infrastructure and the tactical shore infrastructure. When deployed, the afloat forces maintain connectivity to the shore infrastructure via SATCOM through the Teleports[2] and STEP[3] sites. When pier-side, connectivity is

[2] Operational Requirements for DoD Teleport, 31 July 2000

maintained through NMCI for Continental United States (CONUS) piers and through the Base Level Information Infrastructure (BLII) for Outside CONUS (OCONUS) piers. In all cases, terrestrial connectivity between the major tactical shore components is maintained via the DISN/GIG-BE network infrastructure. In the future, FORCEnet will be positioned to make maximum use of the TCA space-based network system that is currently under development as well as the significantly enhanced terrestrial network infrastructure being implemented under the GIG-BE initiative.

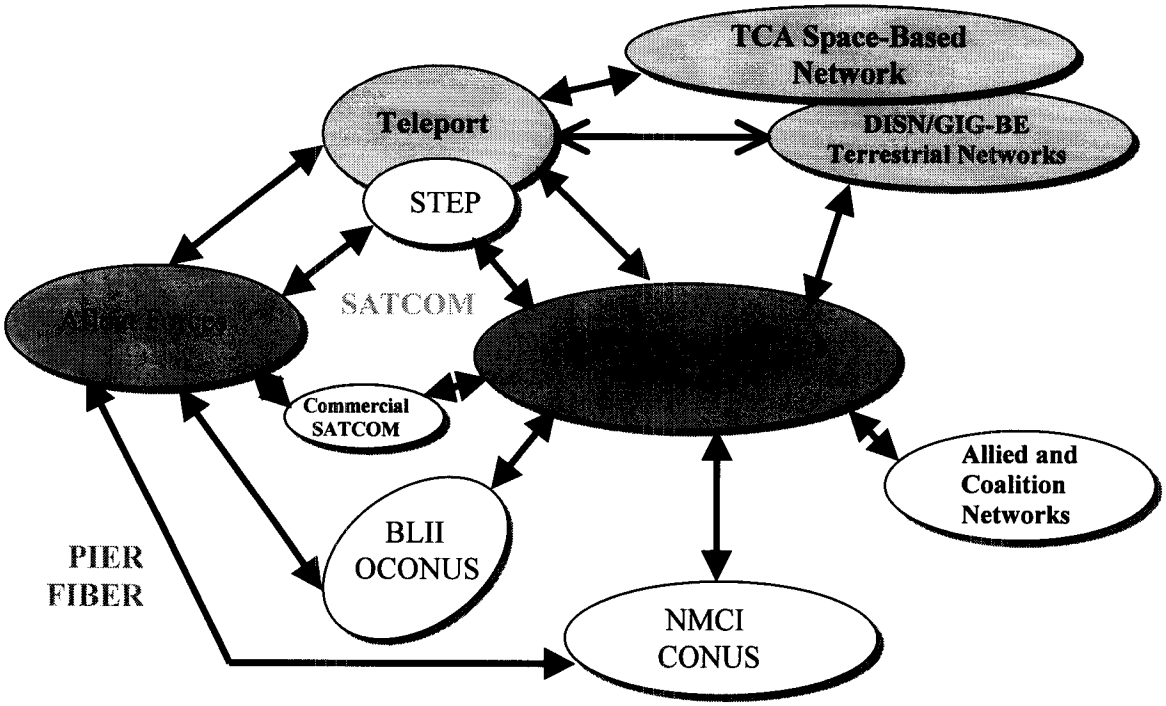


Figure D-3: FORCEnet NII integrated with DOD Network Infrastructure

Due to the extent that the Internet and IP satisfy FORCEnet NII requirements, the pervasiveness of and user familiarity with its protocols, and the reliance on a layered, extensible architecture, IP will be used as the basis for the NII. This can be accomplished by extending the IP infrastructure that has been established under IT-21 and NMCI. The challenge of the IP requirement for the NII is that many of the Naval tactical warfighting systems do not currently support IP-based communications or are not connected to the IP networks (e.g., most Naval aircraft). Block I requirements for the implementation of the NII will be focused on extending the IP-based information infrastructure to all platforms and providing an IP-based interface to all FORCEnet compliant user application systems.

The information transport service for the FORCEnet NII is under development through the Expeditionary C5 Grid (EC5G) initiative. Since FORCEnet demands a netted force with real-time shared understanding of the battlespace at all levels of warfare, a solid information transport service is required. Current Naval networks pose many challenges that must be overcome for the Navy to fully achieve the FORCEnet NII. These challenges include lack of QOS, inefficient use of bandwidth, lack of dynamic networking, shore infrastructure near saturation levels, inability to prioritize traffic, and inefficient use of SATCOM links ship-to-shore. The EC5G fundamentally addresses the integration and enhancement of a number of the existing Naval and Joint programs focused on improving IP connectivity and services for mobile Naval forces: The Advanced Digital Network System (ADNS), the Integrated Shipboard Network System (ISNS), the Joint Tactical Radio System (JTRS) and the Joint Fires Network (JFN).

[3] Standarized Tactical Entry Point (STEP), JCS Operating Circular, 30 March 2001

An open architecture initiative was formed to support significant improvements in afloat operational effectiveness and efficiency through development, implementation and management of a common shipboard network and applications services architecture that includes Hull, Mechanical, and Electrical (HM&E), C4ISR and combat system networks. The goals are improved network reliability, improved operational efficiency through standardization, and more efficient logistical and training requirements. This effort will provide afloat upgrades in seven functional areas: applications services (web portal), servers, storage, afloat networks, resource management, allied/coalition interoperability, communication services, computer network defense, and combat survivability.

The FORCEnet approach includes a Distributed Services Architecture (DSA). The DSA is based on a publish/subscribe industry model that utilizes web services, an emerging industry standard. The term "web services" describes a standard way of integrating web-based applications using the XML, SOAP, WSDL, and UDDI open standards over an IP backbone. The XML is used to tag the data, SOAP is used to transfer the data, WSDL is used for describing the services available, and UDDI is used for listing what services are available on the IP backbone.

The Navy Marine Corps Intranet (NMCI) and Base Level Information Infrastructure (BLII) efforts provide the base level infrastructure for CONUS and OCONUS on which the tactical networks (IT-21) depend to maintain connectivity to the shore infrastructure.

The process for developing guidance and standards that determine the evolution of FORCEnet Block II will include on-going reviews of commercial and military efforts in protocol development as well as assessments of evolving military communications and data sharing requirements. This will include the Joint Technical Architecture (JTA), Internet Engineering Task Force (IETF) standards and protocol feature lists of major information technology vendors. Block II will focus on the integration of the combat systems, potentially applying developments such as FORCEnet Open Architecture, discussed in the body of this report.

Appendix E: FORCEnet Analysis

Introduction: Baseline Challenges with Network Centric Warfare (NCW) Analysis. FORCEnet analysis guidelines respond to findings by the Studies Board Committee on Naval Forces regarding challenges in implementing NCW warfighting mission analysis. These include:

- Inadequate output Measures Of Effectiveness/Measures Of Performance for NCW
- Lack of system trade-off analyses
- Lack of cross-platform and cross-mission analyses
- Lack of reference points for use as measurement baseline
- Lack of common geospatial and temporal frames of reference among current systems.

Evolving and accelerating transformational capabilities in distributed netted forces CONOPS, technology development, and capabilities-based acquisition requires new and creative analytical capabilities that go beyond today's platform-centric and often heuristic methods and evolve toward those that address the requisite new relationships (physical, informational, and cognitive). Various assessment approaches consonant with distributed networked forces are needed in support of concept development, experimentation, technology and requirements. Examples include articulation of warfare drivers and needs; assessment of concepts of operation and shaping of tactics, techniques and procedures; formulation of investment strategies for acquiring block capability-based increments; managing a framework of sufficient flexibility, fidelity and rigor for experimentation at various scales (wargaming, modeling and simulation, and field experiments); designing systems interfaces optimized around the warrior; integrating end-to-end systems engineering, including logistics and training. The ability to quantify or assess with rigor "effects-based operations", information warfare operations, and tradeoffs between achieving non-lethal versus lethal effects is needed.

Validated modeling and simulation tools are essential to understand and drive information engineering, and assist in interpretation of the complex, dynamic interactions among distributed netted Naval/military forces in terms of warfighting value-added. Developing the necessary people, tools and analytic processes, and empirical knowledge to achieve the underlying rigor for the various assessments enumerated is a major challenge. Identifying potential weaknesses and vulnerabilities inherent in net-centric operations must be done at an early stage to better understand risks and devise appropriate mitigation strategies. An accelerated, sustained, and coordinated effort to explore and apply novel techniques is needed, and it must be closely tied and driven by the requirements, acquisition, and experimentation communities needs.

Analysis Objectives. FORCEnet analysis and assessment provides a critical link between the innovation and experimentation process and the requirements and budget process. The analysis function is critical to bridging an understanding of the warfighter requirements with the resources that are needed to provide the right capabilities. The FORCEnet Analysis Team is a collaborative body composed of representatives from the acquisition, requirements, and warfighter communities, as well as specialized Subject Matter Experts (SMEs). The FORCEnet Requirements Branch, CNO (N61F), provides overall guidance and direction to the Team. In the interest of efficiency, the analysis team operates as a virtual team, although individual task leaders have the latitude for organizing, scheduling, and conducting task group meetings. Table E-1 below summarizes the Team's tasks, functional responsibilities and deliverables.

Table E-1: FORCEnet Analysis Team Tasks

Task	Function	Deliverables
Support of Resource and Requirement Decisions in the Planning, Programming, and Budgeting System.	Identification of overlaps, gaps, and duplication in legacy and planned systems/functions, to optimize investment decisions and operational capability. Initial results have been incorporated into	➢ Support POM-06 development ➢ Substantive input to the FORCEnet Naval Capability Plan (NCP)

	FY 2005 budget development; full implementation is planned for the FY 2006 budget.	
Support of FORCEnet Fleet Experiments	Provides problem definition and experiment design, development of metrics for the assessment of experimental results, and preparation and execution of data collection plans required to evaluate those metrics	➢ Reports to synthesize studies and analysis results for LOEs, IPD. ➢ Metrics used to assess the FORCEnet impact on warfighting effectiveness ➢ Annual summary report
Support of FORCEnet Architecture Selection	Provides assessment of evolving architectural alternatives for both C4ISR and combat systems, and incorporation of such architectures into campaign simulation models. Simulation, experimentation, and wargaming are being employed to investigate the interactions between architecture and CONOPS in a range of operational scenarios.	➢ Provide an analysis of alternative architectures that summarizes the business case for FORCEnet
Alignment of Science and Technology (S&T) and Research, Development, Test, and Evaluation (RDT&E) efforts with FORCEnet requirements	Development with ONR of an S&T roadmap, along with an integrated RDT&E database, to leverage by FORCEnet. Ensure continued close coupling of FORCEnet capabilities and ONR Future Naval Capabilities (FNC) products	➢ Relational data base for studies, analysis, S&T, POR and FORCEnet capabilities ➢ Comprehensive roadmap of technology insertion ➢ FNC projects responsive to FORCEnet capabilities
Evaluation and selection of Modeling and Simulation (M&S) tools and scenarios.	Support FORCEnet development for Naval and Joint requirements.	➢ Selection and implementation of a federation of tools for assessing the impact of FORCEnet on warfighting effectiveness ➢ Development of associated metrics ➢ Establish an environment for M&S analysis now and in the future

Framework for Assessment. Before any capability measurement can be addressed, it is essential to derive common definitions of a capability. A hierarchical capability taxonomy was developed and refined over the past year. FORCEnet has aligned itself with OSD (ASD/C3I), which has developed a number of NCW concepts and analytical resources useful in linking newer concepts with existing metrics and systems performance assessment criteria associated with the Universal Joint Task List (UJTL) and service-based Mission Essential Task Lists (METLs). A number of traditional measures and metrics may be applied to the FORCEnet core capabilities. Table E-2 describes the assessment criteria for each of the six required FORCEnet capabilities, reflecting the

mapping of C4ISR operational attributes to notional metrics. These evolving metrics have been drawn from an initial review of C4ISR research efforts, the Joint C4ISR Battle Center's Assessment Methodology, the OSD (ASD/C3I) Architecture Working Group, the NSA/DISA sponsored Information Assurance Technical Framework and Defense Planning Guidance.

Table E-2 FORCEnet Capability Descriptions and Metrics

1. Provide expeditionary, multi-tiered sensor and weapon information: The expeditionary, multi-tiered sensor and weapons grid capability uses a full spectrum of manned and unmanned vehicles, platforms, sensors, and weapons to provide the Force Commander with what is needed to locate targets and attack them across the depth and breadth of a theater-sized battlespace. Sensors must determine their position, time, and movement at the precise time they are reporting their target or other intelligence information. The time and position information of the track provided by sensors in the grid must be properly attributed (e.g., linked to a standard reference frame with uncertainty (error) and confidence level) for it to be accurately understood, represented, and fused with other data/information. Many modern weapons are also dependent on precise time and position (including uncertainty) for effective operation.

Attribute	Notional Metric
Accuracy	Correspondence with ground truth-correlation coefficient (0=no correspondence with ground truth, 1=full correspondence with ground truth). Data matrix comprised of relevant information items estimates (e.g., detection, ID, velocity, location, heading).
Consistency	Degree of lack of ambiguity with previous information.
Completeness	Percentage of ground truth relevant and necessary for ongoing task.
Precision	Error and confidence level for time and position information compared to a standard reference.
Timeliness	Degree to which currency matches what is needed (0=no match, 1=high degree of matching between currency level needed and available).

2. Conduct distributed, collaborative Command & Control: To collaboratively manage land, air, sea, and space operating forces in time, space, and purpose to produce maximum relative combat power and minimize risk to own forces. This activity ensures all elements of the operational force, including supported agencies' and nations' forces, are efficiently and safely employed to maximize their combined effects beyond the sum of their individual capabilities.

Attribute	Notional Metric
Shared Situational Awareness	Degree to which the different individual mental models of the situation are integrated into a common operational picture.
Quantity of Posted Information	Percent of collected information posted
Quantity of Retrievable Information	Percentage of nodes that can retrieve various sets of information.
Understandability	Degree to which information is easy to use (0=low degree of ease of use, 1=high degree of ease of use)
Precision	Error and confidence level for time and position information compared to a standard reference
Timeliness	Degree (speed of effect) to which currency matches what is needed (0=no match, 1=high degree of matching between currency level needed and available)

3. Provide dynamic, multi-path and survivable networks: To provide data and information flow seamlessly and transparently to the warfighter across a fault tolerant, adaptable, self-organizing, holistically engineered

continuously available network. The data and information flows across a wide range of transmission paths in an interoperable manner with naval, joint, coalition and civil/law enforcement agencies. Platforms and vehicles are able to communicate freely and autonomously with other elements of the architecture thus the existence and functions of the underlying network are transparent to the warfighter.	
Attribute	**Notional Metric**
Capacity	Throughput (1) effective systems capacity = maximum data rate - system overhead rate (2) bandwidth utilization = available data rate / effective systems capacity.
Reach	Percentage of nodes that can communicate in desired access modes, information formats, and applications.
Connectivity	Percentage of time that all required nodes are connected to the network.
Information Assurance	Extent to which node supports the assurance of information in the areas of privacy, availability, integrity, authenticity, and non-repudiation
Quality of Service	Measures of jitter, packet loss, and latency.
Timeliness	Degree (speed of effect) to which currency matches what is needed (0=no match, 1=high degree of matching between currency level needed and available).
Agility	Extent to which the network can maintain QOS in response to environmental changes (incorporates robustness, responsiveness, flexibility, innovativeness and adaptation).
Robustness	Number of differing conditions/environments over which network is capable of operating at a given level of effectiveness (baseline level determined by SME, simulation, analysis, empirical analysis, etc.). Effectiveness of network across varying levels of attack/degradation (baseline level determined by SME, simulation, analysis, empirical analysis, etc.). Number of tasks/missions, which the network is capable of operating at a given level of effectiveness (baseline level determined by SME, simulation, analysis, empirical analysis, etc.).
Responsiveness	The timeliness of the response to an environmental change (baseline level determined by SME, simulation, analysis, empirical analysis, etc.).
Flexibility	Number of options for responding to an environmental change. Compatibility of different responses (0=not compatible, 1=fully compatible; determined by SME, simulation, analysis, empirical analysis, etc.).
Innovativeness	Number of novel responses developed and implemented (baseline determined by SME, simulation, analysis, empirical analysis, etc.).
Adaptiveness	Number and timeliness of changes to network structure and processes (baseline determined by SME, simulation, analysis, empirical analysis, etc.).

4. Provide adaptive/automated decision aids: To support warfighter decision making by providing recommended courses of action that are adaptive and based upon knowledge of the operational context, commander's intent, rules of engagement, order of battle, etc., and evolution of the battlespace landscape.	
Attribute	**Notional Metric**
Robustness	Degree to which decision aids support decision making across a range of situations and degradation conditions.
Responsiveness	Degree to which decision aids support decision making which is relevant and timely.
Innovativeness	Degree to which decision aids support decision making that reflects novel ways to perform known tasks.
Adaptability	Degree to which decision aids support a decision making process with the flexibility to alter decision making in response to the evolution of the battlespace landscape.
Consistency	Extent to which decision aids support decision making are internally consistent with prior

	understanding and decisions.
Currency	Extent to which decision aids support decision making that minimizes latency (e.g. Notification - Time of detection = Cueing Time, Time of detection – receipt of refined positional estimate = Update rate, Time of cueing data – time of weapon firing = weapons release time, Firing report received by group commander – weapons firing time = Firing report time).
Precision	Error and confidence level for time and position information compared to a standard reference.
Fitness for Use	Relative quality in reference to criteria that are determined by the situation.
Appropriateness	Extent to which decision aids support decisions that are consistent with existing understanding, command intent, and values.
Completeness	Extent to which decision aids support relevant decisions that encompass the necessary: • Depth: range of actions and contingencies included; • Breadth: range of force elements included; • Time: range of time horizons included.

5. Provide human-centric integration: Enhance the ability of warriors to multi-task through all phases of warfare while taking advantage of improved Human-Computer Interfaces which leverage the best of humans and computers.

Attribute	Notional Metric
Competence	Distribution of members' knowledge, skills, abilities, and attitudes.
Trust	Extent to which members are willing to rely on one another.
Confidence	Extent to which members have expectations of the reliability of the organization.
Size	Number of team members involved adequate to support mission.
Experience	Degree to which team members have interacted in the past on the same task.
Diversity	Degree to which team members are heterogeneous or homogeneous across exogenous variables: experience, age, gender, etc.
Autonomy	Extent to which organization is externally or self-directed.
Structure	Numbers of layers of authority, and functional differentiation effectiveness.
Interdependence	Extent to which members depend on one another for resources.
Cooperation	Extent to which member(s) are willing and able to work together.
Efficiency	Extent to which members utilize one another's resources so as to minimize costs and maximize benefits.
Synchronization	Extent to which organization is conflicted, deconflicted, or synergistic.
Engagement	Extent to which all members actively and continuously participate.
Risk Propensity	Extent of risk aversion.

6. Provide information weapons: To integrate the use of military deception, psychological operations, electronic warfare, and physical destruction, mutually supported by intelligence, in order to deny information, influence, degrade, or destroy adversary information, information-based processes, and information systems. (Metrics are under development).

Attribute	Notional Metric
Lethality	Extent of capability to precisely deliver desired Non-Kinetic (NK) Information Operations (IO) effects.
Coverage	Extent of capability to accomplish IO effects.
Persistence	Extent of capability to sustain IO effects.
Timeliness	Extent of capability to deliver desired NK IO effects at a desired time.

Survivability	Extent of capability to avoid enemy threats, counter ISR, and employ IO techniques to reduce targeting of adversary kinetic systems allowing increased secure maneuvering by ASMD/Deny ISR/SEAD/Networks.

Summary. FORCEnet has developed an analysis approach and metrics to support requisite tasks, capabilities, and actions. By maintaining strict adherence to the above assessment criteria, FORCEnet will substantially improve Naval processes and products.

Appendix F: Science and Technology in Support of FORCEnet

Introduction. Military transformation is enabled by the warfighter's ability to access and utilize battlefield knowledge and situational understanding to an unprecedented degree. Digital networks and information transfer standards such as the World Wide Web (WWW) now make it possible for a very large number of participants to exchange a substantial amount of information at the same time. FORCEnet takes the concept of the WWW and applies it to military systems and operational missions. FORCEnet allows individual participants to augment simultaneously data and information available from their own platform's systems with data and information from other platforms and systems. This fusion of critical information from other locations well beyond one's own individual platform provides a significant enhancement in the knowledge and understanding of the tactical situation for each participant. In addition, collaboration technologies are being developed that enable dispersed commanders and forces to cooperate and synchronize in an environment not constrained by their spatial location. Full application of these capabilities necessitates robust interoperability and information assurance.

Due to the large amounts of data available from diverse sources via the FORCEnet information grid, information integration techniques must be developed that will assist the individual naval operators to rapidly understand the battlespace situation and the options available to the warfighter. In such an information-rich environment, it will also be necessary to improve our understanding of the cognitive capabilities of individuals to maximize the rapid, accurate assimilation of this information.

Science and Technology (S&T) supporting FORCEnet will be drawn from numerous sources including service S&T organizations such as Office of Naval Research (ONR), Navy TENCAP, Marine Corps TENCAP, and service laboratories, as well as non-Naval sources such as Defense Advanced Research Projects Agency (DARPA), Defense Information Systems Agency (DISA), other national organizations/agencies, and industry. The ONR, Navy TENCAP, and Marine Corps TENCAP work directly with Naval requirement, acquisition, and Fleet communities to support development of technology to fill identified shortfalls in FORCEnet capability. Naval S&T also works closely with non-Naval technology organizations to accelerate the development and reduce the cost of technology needs.

Navy TENCAP and Marine Corps TENCAP are research and development efforts that employ rapid-prototyping techniques to improve tactical support to combat commanders provided by national-level intelligence, surveillance, and reconnaissance systems. Navy TENCAP and Marine Corps TENCAP develop innovative solutions to emerging fleet and joint operational requirements within 12-24 months from project start to completion of a Fleet-ready prototype capability. Navy TENCAP, which was incorporated into FORCEnet under CNO (N61F) as part of the Navy and Marine Corps Alignment detailed in the main body of this report, works closely with Marine Corps TENCAP to ensure maximum synergy within the Naval establishment.

The ONR S&T program, conducted in collaboration with the Director of FORCEnet, NETWARCOM, NWDC, Naval laboratories, other DOD commands, academia, and industry, is pursuing near-through-long-term research and development in areas such as non-COTS networking technology that provides mission-responsive, dispersed-force sharing of information; command and control concepts that provide for rapid, accurate knowledge and courses of action for force/battle management; human factors and command structure concepts that enable the warfighter to make decisive, accurate decisions and enable conflict management; and sensors that provide continual and pervasive situation awareness. These programs will be able to be introduced in FORCEnet through spiral development via the FORCEnet Innovation Continuum as discussed in the body of this report. Transitions span the time scale from the near-term efforts such as the Joint Task Force Wide Area Relay Network Advanced Technology Concept Demonstration (JTF WARNET ACTD), which is providing the venue for the FORCEnet IPD, to long-term research such as automated image understanding to speed image analysis and processing.

Because the Naval planning must address and include current ("legacy") systems, there must be a phasing plan in which early realizations of FORCEnet result from integrating current systems to optimally achieve a networked force while new, more effective network capabilities and architectures are phased in over time.

Therefore, most of the near-term and many of the mid-term efforts are focused toward improving the networking of current capabilities and providing interoperability between legacy systems. Long-term research is addressing the technologies needed to enable an optimized architecture and supporting applications for a netted force.

Required Military Capabilities, Naval S&T and Development Investment Strategy.
The requirements section and Appendix C of this report identified the six required FORCEnet capabilities. Efforts within Navy TENCAP, Marine Corps TENCAP, and ONR align with these FORCEnet capabilities, with other ONR/TENCAP programs supporting the related NTR/SP21 pillars of Sea Strike, Sea Shield, and Sea Basing.

Technology will develop and transition in the context of concept development and the experimentation that refines concepts; develops Tactics, Techniques, Procedures (TTP); and interfaces with diverse organizations. ONR, Navy TENCAP, and Marine Corps TENCAP contribute prototype technologies to the FORCEnet/Sea Trial Innovation Continuum by actively participating in the process of planning, conducting, evaluating and monitoring experiments. For example, several ONR projects in the Knowledge Superiority and Assurance (KSA) Future Naval Capability (FNC) initiative had progressed sufficiently to allow early implementation during Operation Enduring Freedom. These projects included Real-time Execution Decision Support for retargeting of in-air assets; Image Processing and Exploitation Architecture to support automated image registration for geo-locating targets and providing battle-damage assessment; Knowledge Web Technology which significantly increased the speed at which situational awareness and operation metrics could be maintained; and Cryptologic Management and Analysis Support System.

Navy TENCAP and Marine Corps TENCAP have worked together to develop a successful rapid-prototyping process comprising the following steps to bring National information to the warfighter:

Step #1. Identify the requirement with Fleet commanders.
Step #2. Formulate a research and development concept with cognizant organizations.
Step #3. Organize a government/academia/industry research team.
Step #4. Develop a project plan, identifying schedule, milestones, risks, budget.
Step #5. Conduct technical tests and operational demonstrations.
Step #6. Conduct spiral development using a "Develop-Test-Refine-Test" approach.
Step #7. Transition from a robust prototype capability to a Program of Record.

The ONR uses a phased approach to technology development, particularly in the case of information technologies. FORCEnet technology requirements evolve rapidly. Both industry and DOD capabilities change quickly. The ONR coordinates closely with operational requirements, experimentation, and acquisition communities to ensure technology projects meet critical warfighter needs, have good transition potential, are worth the cost of developing technology, and are co-evolved with doctrine, organization, training, materiel, leader development, personnel, and facilities (DOTMLPF).

The KSA FNC provides an example of how near-term contributions to FORCEnet capability areas are currently in execution. Figure F-1 provides an overview of the six Enabling Capabilities approved by the KSA FNC Flag and Senior Executive Service Integrated Product Team. Other FNCs provide technology products for FORCEnet.

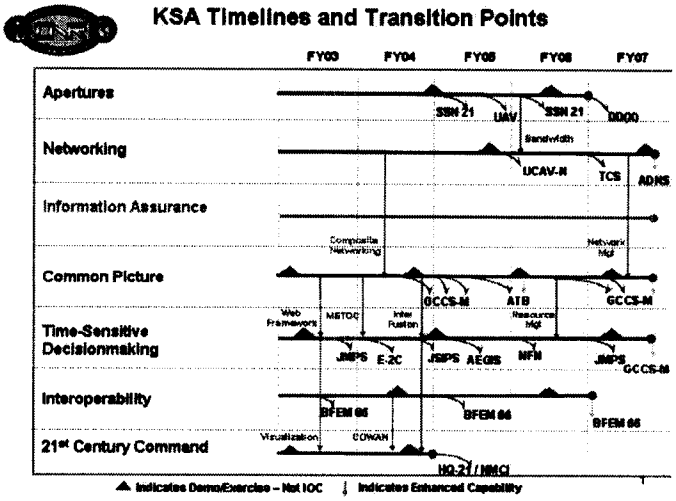


Figure F-1: KSA Planning

S&T Contributions to FORCEnet Capability Requirements: The Director of FORCEnet is working with ONR, Navy and Marine Corps TENCAP, and other cognizant organizations to develop a S&T planning in support of FORCEnet. The ONR, as lead for this effort, has developed an initial FORCEnet S&T roadmap (Table F-1); this roadmap will be further reviewed and refined during FY03 and FY 04 for potential implementation in FORCEnet, and updated annually thereafter.

Table F-1: Science and Technology Roadmap in Support of FORCEnet

Program Title	Description	Transition Target	Transition Year (FY)	Start Date (FY)	End Date (FY)	FNC or Program
Capability: Distributed, Collaborative Command and Control						
Joint Task Force WARNET	Provides interoperability for various Joint legacy fire control systems; organic, airborne network relays and CONOPS / TTP development; integrates Navy TENCAP Radiant Blue for Blue Force tracking and battle-space awareness; provides venue for FORCEnet Block 0	FORCEnet IPD	04	02	04	Navy / OSD ACTD
Course of Action Analysis Tool (CAAT) for Identification of Mobile Time-Sensitive Targets	Provides the capability for optimizing the detection and tracking of time sensitive targets for US Marine Corps forces.	CAC2S	05	02	05	KSA
Integrated Marine Multi-Agent Command Control System (IMMACCS)	Improves quality of the common tactical picture for the Ground Combat Element of Marine Air Ground Task Force	MAGTF COCs	04	98	04	KSA
Multi-National Virtual Operations Capability (MVOC)	Provides radio frequency and security solutions to implement multiple, concurrently operating coalition networks whose participants span a wide range of technical capability and trust.	BATTLE FORCE EMAIL 66	04, 06	02	06	KSA
Composite Combat Identification (CCID)	Develops a Signals Intelligence correlation algorithm and a common identification-reasoning algorithm to enhance Intelligence Surveillance and Reconnaissance exploitation, dissemination and multi-sensor fusion within a battle force	EP3 StoryMaker SSEE AEGIS TCAC	04 06 07	02	07	MD
Timeliness and Quality of Command Decision Making	Exploratory development products that will mature in the mid-term include: a four-stage neural network and production rule model for processing air/surface contacts (identification, elaboration, planning and execution); strategies for communicating commander's intent across echelons of command; decision support systems for monitoring mission execution and dynamic re-planning; and strategies for achieving self-synchronization and shared awareness	CVBG Tactical Command Centers USMC UOC	06	00	06	ONR 6.1
Long-Term S&T: Flexible Command Structure	Enables optimum (metrics: speed and precision of decision making), dynamic citing of decision making authorities based on local and non-local battle-space situation and trends and on tempo of the battle					ONR 6.1

Table F-1: Science and Technology Roadmap in Support of FORCEnet

Program Title	Description	Transition Target	Transition Year (FY)	Start Date (FY)	End Date (FY)	FNC or Program
Capability: Adaptive / Automated Decision Aids						
Communications and Navigation *Acoustic/RF Communication Module* for Undersea Search and Survey	Provide rapid autonomous search and survey of large shallow water areas using cooperative multiple vehicles, mobile navigation and communication nodes and multi-vehicle networked LPI spread spectrum acoustic and RF communications.	ONI-34 SP, EOD SCM/RIN, SAHRV Blk 2, MRUUV	04 05 05 05	02	05	AO
Communications and Navigation *Aids Autonomous Connect /Locate Controller* for Undersea Search and Survey	Provide near real-time RF networked connectivity for underwater vehicles at depth and speed by providing GPS quality navigation fixes to UUVs while they continue to perform their mission at depth.	ONI-34 SP, SAHRV Blk 2, EOD SCM/RIN	04 05 05	02	05	AO
Environmental Visualization (EVIS)	Provides rapid forecasting tools and processes to provide atmospheric information to support rapid mission planning	NITES-2000	04/05/06	02	06	KSA
Image Processing & Exploitation (IPEX)	Provides automated recognition of features such as human movement within imagery frames and automatically mosaics frames of streaming video	JSIPS-N TEG	05	02	04	KSA
Integrated Decision Support System (IDSS)	Supports special warfare planning by utilizing template instructions for Course of Action analysis	SPECWAR MPS, JMPS	04 04	01	03	KSA
Distributed Weapons Coordination (DWC)	Develops advanced combat system algorithms for common threat evaluation and preferred shooter recommendations	AEGIS B/L, OPEN ARCH	05 07	01	07	MD
Radiant Garnet	Automated ELINT pattern recognition algorithms	GCCS-I3, GALE-Lite	05 05	02	04	TENCAP
Radiant Glass	Provides 4-D visualization of network-centric air picture	JFN, TES-N	04 04	00	03	TENCAP
Long-Term S&T: Automated Information Integration	Develops actionable information and automated courses of action with associated risks and uncertainty through technologies that integrate disparate sensor and other sources of information. Also promotes technology research that enables humans to to understand attributes of the information such as nature of source, timeliness, quality of source, rate of degradation of information, etc.					ONR 6.1

Table F-1: Science and Technology Roadmap in Support of FORCEnet

Program Title	Description	Transition Target	Transition Year (FY)	Start Date (FY)	End Date (FY)	FNC or Program
Capability: Dynamic, Multi-path and Survivable Networks						
Wearable Antennas	Develops a wearable broadband Very High Frequency and Ultra High Frequency communications antenna that will allow a dismounted user to take advantage of most future handheld and backpack Joint Tactical Radio System versions bandwidth availability in a single antenna	JTRS Manpack	04	99	02	CECOM
Advanced Multifunction Radio Frequency Concept (AMRF-C)	Provides multiple, simultaneous beams each of which has independent control over the beam function (communications, EW, and radar), power, direction, etc to significantly reduce real estate requirements for antenna replacement and reduced electromagnetic interference	SubNextGenAnt, SEWIP, DD(X), LCS	04 04 07 07	99	07	F/FP
End User Terminal ++	Integrates weapon, sensor, and communication capabilities into backpack system, including infrared and individual weapon scope	D-DACT IOW	06	02	06	F/FP
Dynamic Reconfiguration of Link 16	Dramatically improves Link 16 networks by enabling network reconfiguration in the deployed environment and dynamic allocation of time slots	LINK 16 Platforms	05	03	04	KSA
NBN-Airborne Communication Package	Develops a UAV package that integrates Tactical Common Data Link and Joint Tactical Radio System surrogate into a small package	UAV TCS	06	02	05	KSA
NBN-Intra-Battle Group Wireless Networking	Provides ad-hoc dynamic self configuring packet switched radio frequency networking through use of a JTRS Wideband Networking Waveform surrogate technology and is integrated into the JTF WARNET project	ADNS	05	02	04	KSA
Expeditionary Maneuver Warfare Communications Networking	Develops a scaleable software-based capability to roam between subnets within the battlespace while maintaining applications sessions, enable peer-to-peer networking to extend networks to nodes that do not have access to a communications gateway, and allow integration of existing radio networks in Joint Tactical Radio System networks	JTRS	06	03	05	LC

Table F-1: Science and Technology Roadmap in Support of FORCEnet

Program Title	Description	Transition Target	Transition Year (FY)	Start Date (FY)	End Date (FY)	FNC or Program
Advanced Sensor Netted Technology	Provides advanced algorithms to integrate Electronic Surveillance sensor data into the Cooperative Engagement Capability and help facilitate positive identification of air contacts	CEC, NIFC-CA	06 07	01	07	MD
Radiant Emerald	Provides near-real-time connectivity between fleet SIGINT resources and national SIGINT systems	NAVSECGRU, SPAWAR (GBS)	03 03	98	03	TENCAP
Radiant Ether	IP-based distribution that give smaller ships/bases access to national system data	ISNS (IT21), GCCS-M	03 03	01	03	TENCAP
Long-Term S&T: Robust, Distributed Network Management	Provides high-performance, low-power computational capability for sensor, network control and reduced throughput requirements since information vice raw signals, images, and videos would be transmitted. Also provides mission focused network Quality of Service, enabling automated, optimum utilization of networked resources to accomplish multiple, simultaneous missions. Could significantly enhance the functionality and thus the capability of smaller platforms					ONR 6.1
Long-Term S&T: Underwater Networks	Provides enhanced throughput and connectivity for underway submersibles enabling major advances in common undersea picture allowing rapid, effective ops against technically sophisticated adversaries					ONR 6.1 / 6.2
Long-Term S&T: Information Throughput	Technologies that enable mission-focused information reduction / compression; provide mission-focused vice cost-focused quality of service; produce efficient protocols and modulation schema; etc					ONR 6.1 / 6.2
Long-Term S&T: Information Assurance	Technologies that will maintain security integrity across multiple servers, or in peer-to-peer collaboration; technologies that aid detecting insider attacks from within our information networks and detecting attempts at deception					ONR 6.1

Table F-1: Science and Technology Roadmap in Support of FORCEnet

Program Title	Description	Transition Target	Transition Year (FY)	Start Date (FY)	End Date (FY)	FNC or Program
Capability: Expeditionary, Multi-tiered, Sensor & Weapon Information						
Maritime Reconnaissance *ISR Sensing Module*	Enable automated Surveillance and reconnaissance in all environmental conditions through the use of miniaturized, low energy sensors/payloads (and platforms) in unmanned undersea vehicle (UUV) systems.	ONI-34 SP, MRUUV BLK 1, EOD SCM/RIN, SAHRV BLK2	04 04 05 05	02	05	AO
Maritime Reconnaissance *Autonomous Reconnaissance Controller*	Provide all-condition access for Unmanned Undersea Vehicles (UUV) that can be dynamically retasked to perform reconnaissance, surveillance, target acquisition, target designation, tactical oceanography, and battle damage assessment.	ONI-34 SP MRUUV SAHRV BLK 2	04 04 05	02	05	AO
Situational Awareness, Sensor Data Processing	Improved algorithms to enhance single Unmanned Air Vehicle ability to detect, see, and avoid obstacles; navigate; and automatically detect and recognize targets. Software will be demonstrated in real UAVs in FY04, 05, and 06. Software will transition to the Tactical Control System	UAV/TCS GCCS-I3	06	02	05	AO
Visualization Based Training and Support Systems	Provides battlegroup and theater-level visualization systems to support multi-platform Anti-Submarine Warfare senor employment training, tactical planning, tactical support and reconstruction and feedback	Numbered Fleets, CNETC, CSL/CSP, CLF, CPF, CFFC	07	02	07	CM
Electronic Support (ES) Detection of Low Probability of Intercept Periscope Detection Radar	Provides submarines capability to passively detect emerging threat radars, enhancing covert submarine operations in the littoral	AN/BLQ-10(V) Adv. Sub ES System	04,06, 07	02	06	F/FP
Electronic Warfare Integrated System for Small Platforms (EWISSP)	Enhances small platform survivability by providing detection, identification, and targeting of radio frequency, infrared, and laser designated munitions. Provides multi-vehicle cooperative functionality to enhance performance	AAAV, LCAC	07 07	02	07	F/FP
Missile Warning System (MWS)	Tactical aircraft ability to operate below 20,000 ft enhanced by improving false alarm and giving more missile warning time, improved missile classification information will improve effectiveness of pilot response and countermeasures	AN/AAR-47, TADIRCM, MV-22, JSF	04 04 04 04	02	04	F/FP

Table F-1: Science and Technology Roadmap in Support of FORCEnet

Program Title	Description	Transition Target	Transition Year (FY)	Start Date (FY)	End Date (FY)	FNC or Program
Shipboard Electro-Optical and Infrared Closed Loop Self Protection	Algorithms, software and pulsed chemical laser hardware to counter optically guided missiles with low radar cross-section, non-radio frequency system requiring minimum human intervention	SEWIP	07	02	07	F/FP
Cryptologic Management Analysis and Support Segment	Provides enhanced capability for the Shipboard Information Warfare and Cryptologic System to deal with a greater volume and wider variety of electronic signals and more effectively use sensor and weapon information	SSEE (Incr E), MCS-21 TCAC	05	02	04	KSA
Extensible Tactical C4I Framework	Provides an extensible data management framework and tactical management system that will support a wide range of mission applications through facilitated sharing of a broad spectrum of information (coordinated with DISA and AF JBI as NCES infrastructure option)	GCCS-M GCCS-I3	05	02	04	KSA
Deployable Autonomous Distributed System	Produces a rapidly deployable autonomous distributed underwater sensor field of acoustic and electromagnetic sensors without physical links	IUSS	07	02	06	LASW
Interactive Scenario Builder	Provides a modeling capability for electronic warfare to enable a real-time interface to threat receivers and classified databases	EW Platforms	06	02	05	NRL 6.2, F/FP
Autonomous Undersea Vehicle Technologies for Clandestine Reconnaissance	Provides rapid and accurate mine detection in order to find mines faster and covertly in the Very Shallow Water Zone without exposing divers or marine mammals to mines	VSW MCM UUV	03 07	01	06	OMCM
Image Exploitation Techniques	Develops new imagery exploitation and collection techniques for existing technology to give the Mine Counter Measure (MCM) Commander better intelligence needed to cue the use of tactical MCM assets	NAVOCEANO COBRA	04	96	04	OMCM
Multi-Source Integration	Provides algorithms and software for fusion of non-real time data received through satellite communication links into a single track in the E-2C Hawkeye 2000 mission computer	E2C HE2000, E2C RMP	04 07	99	04	ONR 6.2

Table F-1: Science and Technology Roadmap in Support of FORCEnet

Program Title	Description	Transition Target	Transition Year (FY)	Start Date (FY)	End Date (FY)	FNC or Program
Mobile Direction Finding	Provides wavelet-based signal characterization and compression algorithms that allows personal computer-equipped users to share and distribute Signals Intelligence information over low-bandwidth data links	USMC Team Portable Collection System	03	00	02	ONR 6.2
Long-Term S&T: Nanoelectronics (computing for situational awareness and image understanding)	Provides enhanced warfighting effectiveness of dismounted Marines and small platforms by reducing power and volume requirements needed to provide the rich situational awareness and the decision support aids now only available to large command centers. Nanoelectronic computers also enable image understanding capabilities eliminating the need to transmit raw data by recognizing significant objects and events, transmitting only their identity, location & motion					ONR 6.1
Capability: Human-Centric Integration						
Augmented Cognition	Supports the measurement of human cognition and conduct of experiments in to information representation that most effectively results in cognitive gains. The program will develop and demonstrate technologies to enhance the performance of operational users in perceptual, cognitive, memory, and decision tasks. The goal is to enhance operational capability currently beyond reach (e.g., the control of multiple entities by one operator), support the reduction in the numbers of persons required to perform current functions, and improve human performance in stressful operational environments	USA Objective Force Warrior, UCAV, Aegis Combat System, USMC COMBATT2	07	01	06	DARPA 6.2/3
CINC-21	Supports Combatant Commanders and Joint Command and Control decision making through interoperable, standards-based knowledge infrastructure	GCCS-M, DJC2	04 04	00	04	ACTD
Knowledge Web Technologies	Facilitates continuous situation awareness summary and common knowledge base	GCCS-M	03	02	03	KSA

Table F-1: Science and Technology Roadmap in Support of FORCEnet

Program Title	Description	Transition Target	Transition Year (FY)	Start Date (FY)	End Date (FY)	FNC or Program
Agile and Adaptive Organizational Architectures	Mid-term research will concentrate on the investigation of network and heterarchical forms of C2 organizations as alternatives to hierarchies and will specify strategies for enabling dynamic reconfiguration for C2 structures. Algorithms for generating mission-optimal C2 architectures and computational/executable models of organization designs for evaluation in simulations of CJTF operations are also expected in the mid-term	Naval Warfare Development Command	06	00	05	KSA D&I
Human-Centric Interfaces for Command and Control	Mid-term products include guidelines for use of augmented/annotated video for collaborative transfer of shared understanding; principles of attention management for multi-tasking environments and algorithms for threat assessment and models for geo-plot decluttering and deconfliction	SPAWAR	06	99	05	KSA
Long-Term S&T: Human Cognition	Rapid, accurate comprehension of the information and knowledge to enable rapid, accurate decision-making					ONR 6.1

Appendix G: Acronym List

Acronym	Definition
AAAV	Advanced Amphibious Assault Vehicle
AAM	Air-to-Air Missile
ACTD	Advanced Concept Technology Demonstration
ADNS	Advanced Digital Network System
ADOCS	Artillery Deep Operations Coordination System
AFATDS	Advanced Field Artillery Tactical Data System
AF JBI	Air Force Joint Battlespace Ionosphere
AO	Autonomous Operations (FNC)
AODS	Air Operations Decision Support
AN/BLQ-10(V)	Advanced Submarine ED Electronic Support System
ARG	Amphibious Ready Group
ASA	Analytical Support Architecture
ASM	Anti-Ship Missile
ASN (RD&A)	Assistant Secretary of the Navy (Research, Development and Acquisition)
ATO	Air Tasking Order
ATT	Anti-Torpedo Tripwire
AWBS	Advanced Warfare Baseline System
BDI	Battle Damage Information
B/L	Baseline
BLOS	Beyond Line of Sight
BFTT	Battle Force Tactical Training
BMC2	Battle Management Command and Control
CA	Challenge Athena
C2F	Commander Second Fleet
C3F	Commander Third Fleet
C7F	Commander Seventh Fleet
C4I	Command, Control, Communications, Computers and Intelligence
C4ISR	Command, Control, Communications, Computers and Intelligence, Surveillance and Reconnaissance
C5I	Command, Control, Communications, Computers and Combat Systems
CAAT	Course of Action Analysis Tool
CAC2S	Common Aviation Command and Control System
CADRT	Computer Aided Dead Reakoning Tracer (AN/SSQ-53D)
CARTE	Comprehensive, Analytic, Real-time Execution
CCID	Composite Combat Identification
CCS Mk2	Combat Control System Mk2
CEC	Cooperative Engagement Capability
CECOM	Communications Electronics Command
CEE	Collaborative Engineering Environment
CENTRIXS	Combined Enterprise Regional Information Exchange System
CFFC	Commander, Fleet Forces Command
CG, TECOM	Commanding General, Training and Education Command
CG,MCCDC	Commanding General, Marine Corps Combat Development Command
CG, MCWL	Commanding General, Marine Corps Warfighting Laboratory
CHENG	Chief Engineer
CIO	Chief Information Officer
CIPO	Combatant Commander Interoperability Program Office
CJTF	Commander Joint Task Force
CLF	Commander, Atlantic Fleet

Acronym	Definition
CM	Capable Manpower (FNC)
CM	Countermeasures
CMASS	Cryptologic Management Analysis and Support Segment
CMC	Commandant of the Marine Corps
CNETC	Commander, Naval Education and Training Command
COBRA	Coastal Battlefield Reconnaissance and Analysis
COE	Common Operating Environment
COMBATT2	Commercial Based Tactical Truck Version 2
CNO	Chief of Naval Operations
COMNAVAIRSYSCOM	Commander, Naval Air Systems Command
COMNAVNETWARCOM	Commander, Naval Network Warfare Command
COMNAVSEASYSCOM	Commander, Naval Sea Systems Command
COMSPAWARSYSCOM	Commander, Space and Naval Warfare Systems Command
CONOPS	Concept of Operations
CONUS	Continental United States
COP	Common Operational Picture
COTP	Common Operational Tactical Picture
COTS	Commercial Off The Shelf
COWAN	Coalition Wide Area Network
CPF	Commander, Pacific Fleet
CPXs	Command Post Exercises
CSL	Commander, Submarines Atlantic
CSP	Commander, Submarines Pacific
CV-TSC	Aircraft Carrier Tactical Support Center
D&I	Discovery and Invention
DADS	Deployable Autonomous Distributed System
DARPA	Defense Advanced Research Project Agency
DAS	Distributed Aperture System
DASN	Deputy Assistant Secretary of the Navy
DC, M&RA	Deputy Commandant for Manpower and Reserve Affairs
DCGS	Distributed Common Ground and Surface Station
D-DACT	Dismounted-Digital Automated Communications Terminal
DISA	Defense Information Systems Agency
DISN	Defense Information Systems Network
DJC2	Deployable Joint Command and Control
DMSP	Defense Meteorological Satellite Program
DoD	Department of Defense
DON	Department of the Navy
DOTMLDPF	Doctrine, Organization, Training, Material, Leader Development, Personnel, & Facilities
DSA	Distributed Services Architecture
DSP	Decision Support Package
DWC	Distributed Weapons Coordination
E2C RMP	E2C Radar Modernization Program
EA	Electronic Attack
EC5G	Expeditionary Command, Control, Communications, Computers and Combat Systems Grid
EFDC	Expeditionary Force Development Center
EMCON	Emission Control
EO/IR	Electro-Optical/Infrared
EOD SCM/RIN	Explosive Ordnance Detachment Search, Classify, Map/Reacquire, Identify, Neutralize
ES	Electronic Support

Acronym	Definition
ESG	Expeditionary Strike Group
EVIS	Environmental Visualization
EW	Electronic Warfare
EWISSP	Electronic Warfare Integrated System for Small Platforms
EXCEL	Excellence Through Commitment in Education and Training
FDNF	Forward Deployed Naval Forces
F/FP	Fleet/Force Protection (FNC)
FIOP	Family of Interoperable Operational Pictures
FLT NOC	Fleet Network Operations Center
Fn	FORCEnet
FBE	Fleet Battle Experiment
FNC	Future Naval Capability
FQM	Four Quadrant Model
GALE-LITE	Generic Area Limitation Environment
GBS	Global Broadcast System
GCCS-13	Global Command and Control System - Integrated Imagery and Intelligence
GCCS-M	Global Command and Control System - Maritime
GES	Global Information Grid Enterprise Services
GIG-BE	Global Information Grid - Bandwidth Expansion
GOES	Geostationary Operational Environmental Satellite
GRA	Government Reference Architecture
HAIL-SS	Human Alerting Interruption Logistics - Surface Ship
HF ALE	High Frequency Automatic Link Establishment
HK/EW	Hard Kill/Electronic Warfare
HM&E	Hull, Mechanical and Electrical
HSI	Human Systems Integration
IA	Information Awareness
IA	Intelligent Autonomy
IAS	Intelligence Analysis System
IBFT	Integrated Battle Force Training
IBGWN	Integrated Battle Group Wireless Network
ICD	Initial Capabilities Document
IDSS	Integrated Decision Support System
IETF	Internet Engineering Task Force
IMMACCS	Integrated Maritime Multi-Agent Command and Control
INF	Improving Naval Workforce
IO	Information Operations
IOW	Intelligence Operations Workstation
IP	Internet Protocol
IPD	Integrated Prototype Demonstration
IPEX	Image Processing and Exploitation
IPL	Integrated Priority List
IPTs	Integrated Product Teams
ISNS	Integrated Shipboard Network Systems
ISR	Intelligence, Surveillance, Reconnaissance
IT	Information Technology
IT-21	Information Technology 21st Century
IUSS	Integrated Underwater Surveillance System
IVUL	Integrated VHF, UHF, L Band Antenna System
IWS	Integrated Warfare Systems

Acronym	Definition
JCS	Joint Chiefs of Staff
JOC	Joint Operations Center (Concepts Development and Experimentation)
JFN	Joint Fires Network
JMPS	Joint Mission Planning System
JSF	Joint Strike Fighter
JSIPS-N	Joint Services Imagery Processing System - Navy
JTA	Joint Technical Architecture
JTF WARNET	Joint Task Force Wide Area Relay Network
JTRS	Joint Tactical Radio System
KSA	Knowledge, Skills and Abilities
KSA	Knowledge Superiority and Assurance
KWWK	Knowing What We Know
LACS	Land Attack Control Suite
LASW	Littoral Anti-Submarine Warfare (FNC)
LC	Littoral Combat (FNC)
LCAC MPS	Landing Craft Mission Planning System
LCS	Littoral Combat Ship
LID	Low Observable Integrated Deckhouse
LMS EMD	Low Observable Multi-function Stack, Engineering, Manufacturing and Development
LO	Low Observable
LOE	Limited Objective Experiments
LOS	Line of Sight
LPI	Low Probability of Intercept
M&S	Modeling & Simulation
MAGTF	Marine Air Ground Task Force
MAGTF COCs	Marine Air Ground Task Force Combat Operations Center
MCM	Mine Control Measures
MCS-21	Maritime Cryptologic System-21
MD	Missile Defense (FNC)
METLs	Mission Essential Task Lists
MID	Management Initiative Decision
MOA	Memorandum of Agreement
MOE	Measure of Effectiveness
MRUUV	Mission Reconfigurable Unmanned Underwater Vehicle
MV-22	Osprey V-22
MWS	Missile Warning System
NASA	National Aeronautics and Space Agency
NASMP	Naval Aviation Simulation Master Plan
NATO	North Atlantic Treaty Organization
NAVOVEANO	Naval Oceanographic Office
NAVSECGRU	Naval Security Group Command
NBC	Nuclear, Biological, Chemical
NBN	Naval Battlegroup Networking
NCES	Net-Centric Enterprise Services
NCP	Naval Capabilities Plan
NCTAMS	Naval Computer Telecommunications Area Master Station
NCW	Network Centric Warfare
NDIA	National Defense Industrial Association
NEP	Navy Enterprise Portal
NETC	Naval Education and Training Command

Acronym	Definition
NTEW	Network
NFCS	Naval Fires Control System
NGBCA	Next Generation Buoyant Cable Antenna
NGCM	Next Generation Countermeasures
NGN	Next Generation Network
NIFC-CA	Naval Integrated Fire Control - Counter Air
NITES-2000	Naval Integrated Tactical Environmental System
NII	Network Information Infrastructure
NK	Non-Kinetic
NMCI	Navy and Marine Corps Intranet
NSA	National Security Agency
NPES	Non-propulsion Electronics System
NTR	Naval Transformation Roadmap
NWC	Naval War College
NWDC	Navy Warfare Development Command
OA	Open Architecture
OCONUS	Outside CONUS
OMCM	Offensive Mine Counter Measures (FNC)
ONI	Office of Naval Intelligence
ONR	Office of Naval Research
OPNAV	Office of the Chief of Naval Operations
OPTEVFOR	Operational Test and Evaluation Force
OSD	Office of the Secretary of Defense
OSPF	Open Shortest Path First
OV	Operational View
PAC-TCN	Pacific-Telecommunications Network
PEO	Program Executive Office
POR	Program of Record
PPBS	Planning, Programming, and Budgeting System
QOS	Quality Of Service
R&D	Research and Development
RAM	Radar Absorbing Material
RCS	Radar Cross Section
REDS	Real-Time Execution and Decision Support
RDT&E, N	Research, Development, Test and Evaluation - Navy
RF	Radio Frequency
RMP	Radar Modernization Program
ROE	Rules of Engagement
RSOC	Regional Security Operations Center
RSTA	Reconnaissance, Surveillance and Target Acquisition
S&T	Science and Technology
SA	Situational Awareness
SACCA	Strategic Air Command Communications Area
SAHRV	Semi-Autonomous Hydrographic Reconnaissance Vehicle
SAIL	Sailor Advocacy through Interactive Leadership
SAM	Surface-to-Air Missile
SATCOM	Satellite Communication
SCCM	Sea Combat Commander Module
SEALs	Sea Air Land
SECNAV	Secretary of the Navy

Acronym	Definition
SEWIP	Surface Warfare Electronic Improvement Program
SHF/CA III FCs and ECs	Super High Frequency/Challenge Athena Field Changes and Engineering Changes
SIAP	Single Integrated Air Picture
SIGP	Single Integrated Ground Picture
SLAM-ER	Stand-Off Land-Attach Missile - Expanded Response
SMEs	Subject Matter Experts
SOF	Special Operating Forces
SP	Special Projects
SPAWAR	Space and Naval Warfare Systems Command
SPECWAR MPS	Special Warfare Mission Planning System
SP21	Sea Power 21st Century
SSEE	Ships Signal Exploitation Equipment
SSG	Strategic Studies Group
SSGN	Nuclear Powered Submarine (Guided Missile)
STEP	Standard Tactical Entry Point
STOM	Ship to Objective Maneuver
SYSCOM	Systems Command
TADIL	Tactical Digital Information Link
TADIRCM	Tactical Air Defense Infrared Countermeasures
TAMPS/JMPS	Tactical Aircraft Mission Planning System/Joint Mission Planning System
TBD	To Be Determines
TC	Task Centered
TCA	Transformational Communications Architecture
TCAC	Tactical Common and Analysis Center
TCDL	Tactical Common Data Link
TCO	Transformational Communications Office
TCS	Tactical Control System for UAVs
TCP	Transport Control Protocol
TDS	Tactical Display System
TENCAP	Tactical Exploitation of National Capabilities
TES-N	Tactical Exploitation System - Navy
TFE	Task Force EXCEL
TIDS	Tactical Integrated Digital System
TFW	Task-Force Web
TSTS	Total Ship Training System
TTP	Tactics, Techniques, and Procedures
TV	Technical View
TPPU	Task, Post, Process and Use
TTWCS	Tactical Tomahawk Weapons Control System
TUAV	Tactical Unmanned Air Vehicle
TUGV	Tactical Unmanned Ground Vehicle
UAV	Unmanned Air Vehicle
UCAV-N	Unmanned Combat Air Vehicle - Navy
UDEM	Universal Data Exchange Manager
UDP	User Datagram Protocol
UGS	Unattended Ground Station
UJTL	Universal Joint Task List
UOC	Unit Operations Center
USJFCOM	United States Joint Forces Command
USMC	United States Marine Corps

Acronym	Definition
UUV	Unmanned Underwater Vehicle
VA Class	Virginia Class Submarine
VCNO	Vice Chief of Naval Operations
Victor II	Virtual Information Center Technologies for Open-Source Requirements Phase II+B36
VSM	Very Shallow Water
VWE	Virtual Warfare Environment
WIDTs	Warfare Innovation Development Teams
WILNK	Weapons/Image Link
WMD	Weapon of Mass Destruction
WWW	World Wide Web
XTCF	Extensive Tactical; C4I Framework