Naval S&T Strategic Plan

Defining the Strategic Direction for Tomorrow

OFFICE OF NAVAL RESEARCH

Executive Summary

This Naval Science and Technology (S&T) Strategic Plan describes how the Office of Naval Research (ONR) will enable the future operational concepts of the Navy and the Marine Corps. By design, it is a broad strategy that provides strong direction for the future, but it also retains sufficient flexibility and freedom of action to allow ONR to meet emerging challenges or alter course as directed by senior Naval leadership.

ONR is the science and technology provider for the Department of the Navy (DON) and as such, is charged with providing the S&T products necessary for the operational concepts and visions for the Navy and Marine Corps of the future. While retaining an inherently long-term view, ONR can quickly redirect S&T resources to address high-priority short- or mid-term needs that emerge from our engaged Navy and Marine forces worldwide. As it has for sixty years, ONR will advance scientific knowledge to support the generation of naval technology with a vision focused on future capabilities, to hedge against the uncertainty of warfare.

Development of this strategy was undertaken with a view to engaging agencies, partners, and customers both within and outside the naval domain. This effort included review of guidance documents and other agency strategies; review of Combatant Commander's priorities; and engagement with the Naval enterprises, Marine Corps Combat Development Command (MCCDC), Office of the Chief of Naval Operations (OPNAV) and Headquarters Marine Corps (HQMC) staffs, as well as with the Naval S&T community, which includes ONR, the Naval Research Laboratory (NRL), senior systems commanders, the Naval Studies Board (NSB), and the Naval Research Advisory Committee (NRAC). This outreach and engagement has helped produce a balanced strategy that clearly points to the future and is aligned with naval missions and future warfighting needs.

This strategy outlines S&T objectives that will provide technologies for the future Navy and Marine Corps. Investments in these objectives will result in a Navy and Marine Corps that have:

- Domination of the electromagnetic spectrum and cyber space
- Implemented directed energy – fighting at the speed of light
- Achieved persistent, distributed surveillance in all domains
- Achieved comprehensive maritime domain awareness with large vessel stopping and weapon of mass destruction detection for enhanced maritime intercept operations
- Incorporated affordability into platform design and construction
- Adaptive wireless communications networks
- Decision tools to give commanders tactical advantage
- Determination of threat intent through social and cultural understanding
- Lighter, faster, more lethal Marine forces
- Accelerated team training and skill development
- Increased operational effectiveness through more efficient power and fuels
- Responsive and visible logistics to enable distributed forces
- Greater tactical advantage through superior knowledge and use of operational environments

DEPARTMENT OF THE NAVY
ASSISTANT SECRETARY OF THE NAVY
RESEARCH, DEVELOPMENT AND ACQUISITION (20350-1000)
OFFICE OF THE VICE CHIEF OF NAVAL OPERATIONS (20350-2000)
HEADQUARTERS UNITED STATES MARINE CORPS (20350-3000)
WASHINGTON, DC

JAN 19 2007

MEMORANDUM FOR THE CHIEF OF NAVAL RESEARCH

Subj: SCIENCE AND TECHNOLOGY CORPORATE BOARD DECISION MEMORANDUM

1. The Corporate Board endorses and approves the Naval Science and Technology Strategy presented at the 12 December 2006 Science and Technology Corporate Board meeting and directs the Chief of Naval Research to implement the strategy.

R. Magnus	R. F. Willard	Dr. Delores M. Etter
General, U. S. Marine Corps	Admiral, U.S. Navy	Assistant Secretary of the Navy
Assistant Commandant of	Vice Chief of Naval Operations	Research, Development and
the Marine Corps		Acquisition

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1.0 Introduction

As the Department of the Navy's (DON) science and technology (S&T) provider, the Office of Naval Research (ONR) provides S&T solutions for Navy and Marine Corps needs. Our mission, defined by law, is to "plan, foster, and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power, and the preservation of national security" [1]; and to "manage the Navy's basic, applied, and advanced research to foster transition from science and technology to higher levels of research, development, test, and evaluation." [2]

Naval S&T Vision: Sponsor scientific research and technology to:

- Pursue revolutionary capabilities for Naval forces of the future,
- Mature and transition S&T advances to improve naval capabilities,
- Respond to current critical needs
- Maintain broad technology investments to anticipate and counter potential technology surprise.

The Naval S&T Corporate Board is composed of the Assistant Secretary of the Navy for Research, Development and Acquisition (ASN-RDA), the Vice Chief of Naval Operations (VCNO), and the Assistant Commandant of the Marine Corps (ACMC). Its 3 May 2005 guidance directed the Chief of Naval Research (CNR) to develop a Naval S&T strategy. This strategy ensures that ONR's investments both respond to naval needs and support innovative naval operational concepts. Based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, OPNAV, and HQMC), this strategy has three principal goals:

- Ensure alignment of Naval S&T with Naval missions and future capability needs
- Balance and manage the S&T portfolio
- Communicate the S&T vision and approach to senior decision-makers, key stakeholders, S&T partners, customers and performers

The ONR vision and the role of S&T are discussed in the following sections. Section 2 provides background, Section 3 describes the strategy development process, and Section 4 presents derived areas of S&T focus based on Naval capability needs. Section 5 outlines the current ONR approach to providing the S&T necessary to support these capabilities. Section 6 highlights the future Navy and Marine Corps capabilities that successful implementation of this strategy enables. Section 7 provides a summary and link to the ONR website.

[1] Public Law 588 of 1946.

[2] Defense Authorization Act of 2001.

2.0 Background

To meet current and emerging warfighter needs and deliver future force capabilities, ONR invests in mid- and long-term research while allowing for limited near-term technology insertions. Figure 1 shows the key components of our portfolio and, by percentage, how S&T funds are distributed with the remaining 10% available to accelerate developments for high-priority programs. S&T's role is not to avoid risk, but to take scientifically feasible risk. ONR investigates new ideas to generate technology options and mitigate risk in acquisition. S&T also investigates a variety of technical solutions that can significantly impact the total ownership cost of military systems. These components are described in Section 5.

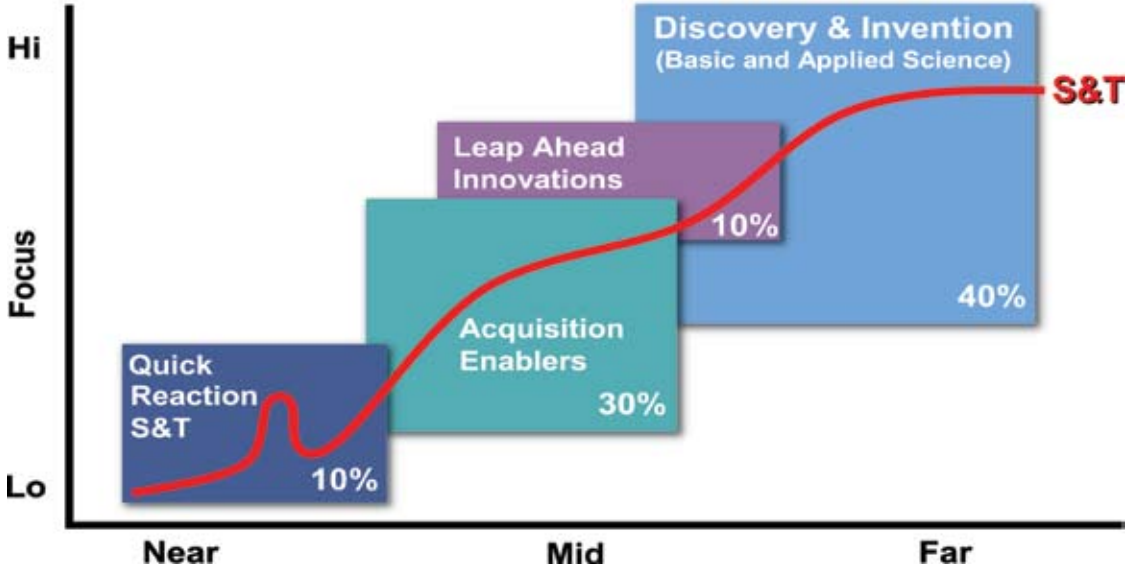


Figure 1: S&T Focus vs. Time

S&T supplies the pipeline of knowledge, concepts, and prototypes that leads to products and builds a cadre of scientists, engineers, and researchers focused on naval issues and challenges. Without this pipeline, the United States is at risk of losing its Naval forces' technological advantage. Many technologies ONR sponsored at University Affiliated Research Centers (UARC), Navy laboratories, academia, and industry have yielded solutions to emerging problems. The Fiber-optic Lightweight Wide Aperture Array for Virginia-class nuclear submarines, radar wave form and signal processing for detection of low-observable and sea-skimming targets in the AN/SPQ-9B radar, software-definable radio processes and mechanisms for the Joint Tactical Radio System, and flexible body armor technology for QuadGard Phase IV Design Marine Corps personnel protection are some excellent recent examples of this. Such successes are only possible when experienced scientists with the necessary tools and expertise are in place.

2.1 Management Approach: Selecting research for future Naval force capabilities must be balanced with fiscal realities. Naval S&T budgets have not grown in recent years, but the mission sets and capability needs they serve have expanded. This has presented a very challenging investment environment. ONR therefore manages the diverse Naval S&T portfolio to:

- Address enduring naval needs
- Maintain investments and intellectual capital in areas unique to the Navy and Marine Corps
- Encourage new researchers and stimulate competitive research with technically proficient program officers and efficient business processes
- Seek partnerships that complement or enhance S&T outputs
- Encourage informed risk-taking and learn from failure
- Provide pathways for transitioning S&T outputs, including interactions between the S&T community and potential technology users in early stages
- Counter technological surprise

2.2 S&T Outputs: S&T investments enable the technical superiority of our Naval forces by producing knowledge, transitions, and people.

- **Knowledge:** Scientific discovery generates new technologies that expand capabilities and enable innovative concepts of operations. Knowledge (gained from both successes and failures) leads to new technology pathways and reduces technical risk in later stages of research and development. ONR Program Officers constantly evaluate the cutting-edge of science and technology for potential breakthroughs in naval capabilities, and they maintain knowledge in their disciplines of worldwide developments.
- **Transitions:** ONR strives to provide viable paths for scientific discoveries and maturing technology to transition to the DON, the broader DoD, industry, and—ultimately—the warfighter. ONR programs and business practices ease transition and bridge the "valley of death" between S&T and acquisition programs.
- **People:** ONR is dedicated to developing the S&T workforce the United States needs to maintain its technological superiority. More than half of ONR's Basic Research funding goes to university programs. In addition to grants to individual investigators, fellowship programs support faculty, graduate, and undergraduate education of U.S. citizens who plan to work in Navy laboratories. Special programs also support the education and professional development of minority students and faculty members.

3.0 Strategy Development

The strategic landscape has changed dramatically in this decade in ways that "compel the Navy…to develop a strategy that informs investments for a future marked by uncertainty, irregular and increasingly unrestricted warfare, and potentially, conventional

campaigns against technologically sophisticated adversaries."[3] This dynamism and its attendant uncertainties require a prioritized and balanced Naval S&T portfolio.

3.1 Strategy Process: The Naval S&T strategy was developed from the top down. Key guidance documents provided an underpinning of Navy and Marine Corps missions, force capabilities, and technology needs in the context of DoD goals.

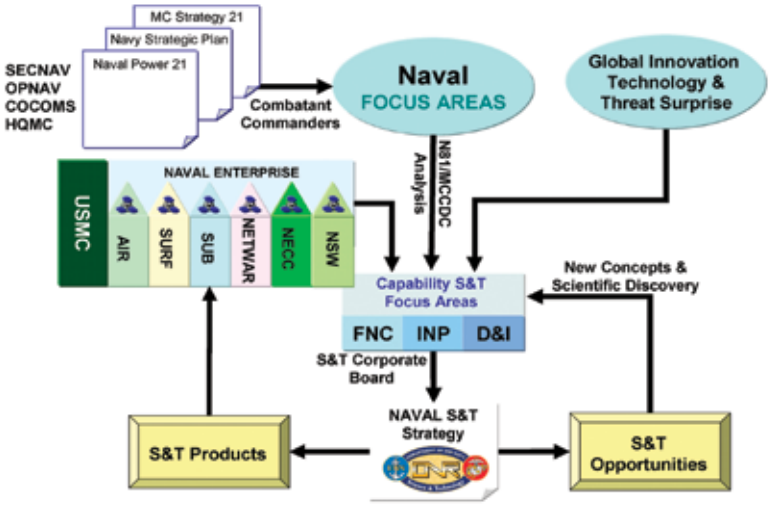


Figure 2: Naval S&T Strategy Process

The strategic planning process (Figure 2) distilled critical Naval needs from formal guidance and stakeholder input. From that input the Naval S&T focus areas (Figure 3) were developed. A list of relevant guidance considered in the development of the Naval S&T focus areas is provided in Appendix B.

- Naval Focus Areas: *Naval Power 21, the Navy Strategic Plan,* and the warfare capability analysis conducted by OPNAV N81 and MCCDC describe Naval focus areas with key elements tied to mission needs and security challenges
- Naval Enterprise and USMC Input: ONR has directly collected Naval enterprise and USMC capability needs and technology objectives. Specific S&T inputs include the Marine Corps S&T Plan, Naval Aviation Enterprise S&T Plan, as well as inputs from the other Naval enterprise technology groups (CARTECH, SURFTECH, SUBTECH and ITECH).
- Technology and Threat Surprise: The scope of the S&T that covers each Naval capability area is defined and where necessary expanded to project future security threats based on technology feasibility. Where feasible, disruptive inputs within each capability area have been considered to identify research priorities for the S&T portfolio.
- S&T Opportunities: Broad investments lead to scientific discovery and technology options applicable to naval needs. Including S&T opportunities in the planning process feeds new knowledge back into the S&T priority-setting process.

3.2 Strategy Timeframe: This strategy will be revised at two-year intervals to keep current with user needs and technology opportunities. This will allow ONR to provide current guidelines for S&T programs and focus communications between researcher and user communities.

3 *Navy Strategic Plan in Support of Program Objective Memorandum '08*, August 2006. (Unclassified)

4.0 Naval S&T Focus Areas

For each of the thirteen focus areas, we defined an S&T vision and high-level objectives. These highlight how S&T can advance naval capabilities and will guide our investments. A synopsis of the visions, objectives, and pictorial representations presented to the Corporate Board is provided in the following sections. The corresponding S&T Research Areas are listed in Appendix A. The following assumptions underlie these Naval S&T Focus Areas:

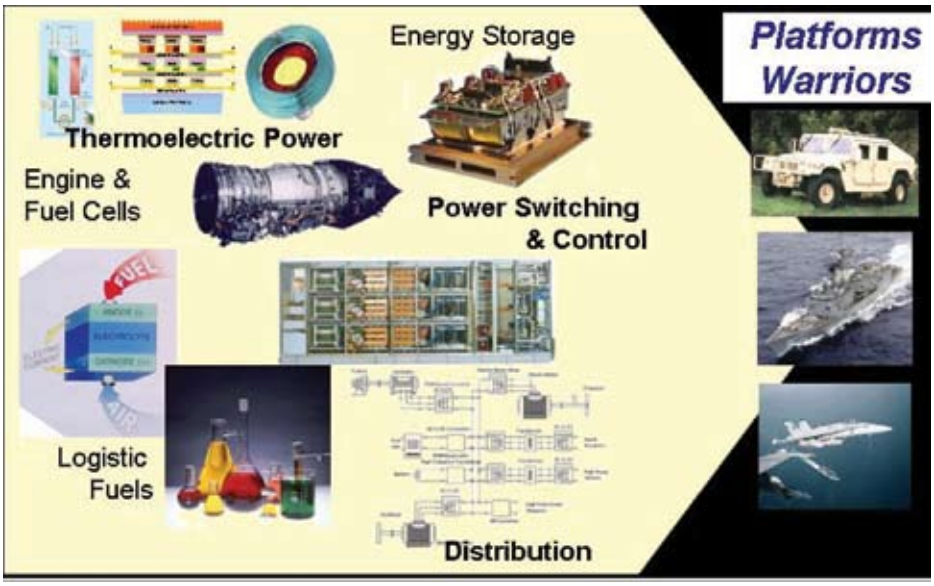
- Developed from naval needs
- Embody durable or enduring themes
- Reasonable scale and magnitude
- Traced directly from warfighting functions (Figure 3)

Naval S&T Focus Area	*Naval Warfighting and Support Functions*
Power & Energy	• Power Generation and Storage • Assured energy sources• Man Portable & Lightweight • High-Density Power
Operational Environments	• Oceanography & Survey (Ocean/Hydro/River) • Meteorology • Space Environmental Effects
Maritime Domain Awareness	• ISR collection & integration • CBRNE (Explosives & WMD Detection) • Port/Base Security • Swimmer Detection • Wide Area & Battlespace Surveillance (Including Littorals) • Social/Cultural Understanding • MIO Sensing • HLS Ship Tracking
Asymmetric & Irregular Warfare	• Operational Adaptation • Maritime Interception Operations • Expeditionary Security • Boat/Vehicle Disabling (Apply Non-Lethal Systems & Effects) • Battlefield Forensics (Near Real-Time) • Counter IED/Snipers • Riverine Operations • Tactical Tagging, Tracking, and Locating • Maritime Spec Ops • Terrorist Network Identification
Information, Analysis and Communication	• Assured and Secure Communications • Electronic Warfare • Computer Network Ops • Operations Security • Military Deception • Cross Cultural Communications • Threat Intent Determination • C4
Power Projection	• Rapid Tactical Precision Targeting • Time-sensitive strike • Neutralization (lethal/non-lethal) • Effects-scaled weapons • Integration & Control of Naval fires • Maneuver
Assure Access and Hold at Risk	• Persistent Surveillance & Monitoring • Tagging/Tracking & Locating • Shaping and Information Operations • Strategic Target ID/Tracking • Information Verification • Vessel/vehicle-stopping • MIO/Boarding • ASW & MCM • Spoof/Decoy
Distributed Operations	• Focused Logistics • Small Unit ISR/Intel Collection/Dissemination/Fusion & Engagement • Tactical Maneuver & Mobility • Control of Integrated Fires • Training Operations in Urban/Extreme Environments • Large target lethality with reduced combat loads • Control Collateral Damage • Distributed Adaptive C2 Networks
Naval Warrior Performance and Protection	• Personal Protection • Endurance • Decision-Making Tools • Decision/Training Tools • Casualty Prevention/Care • Undersea Medicine • Enhanced Human Performance • Operating in Extreme/Austere Environments • Expeditionary Security • Training Operations in Urban Environments
Survivability and Self-Defense	• Missile Defense • Torpedo Defense • LO/CLO • Tactical EW • Damage Control/Prevention • Force Protection • Time-Critical Terminal Defense
Platform Mobility	• Platform Performance & Agility • Power-Dense Propulsion • Operational Adaptation • Tactical Maneuver Mobility
Fleet/Force Sustainment	• Seabasing • Operational Logistics • Maneuver
Affordability, Maintainability, and Reliability	• Increased warfighting capacity• Reduced logistics cost optimization reduced failure rates • Automate Naval engineering • Aircraft Propulsion Design • Reduce Manning • M&S Automation • Reduce Upgrade Costs

Figure 3: Naval Warfighting Functions

For each of the thirteen focus areas, we defined an S&T vision and high-level objectives. These highlight how S&T can advance naval capabilities and will guide our investments. A synopsis of the visions and objectives follows.

4.1 Power and Energy



Vision: Increase Naval forces' freedom of action through energy assurance and efficient power systems, to provide desired power at the platform, system, and personal level.

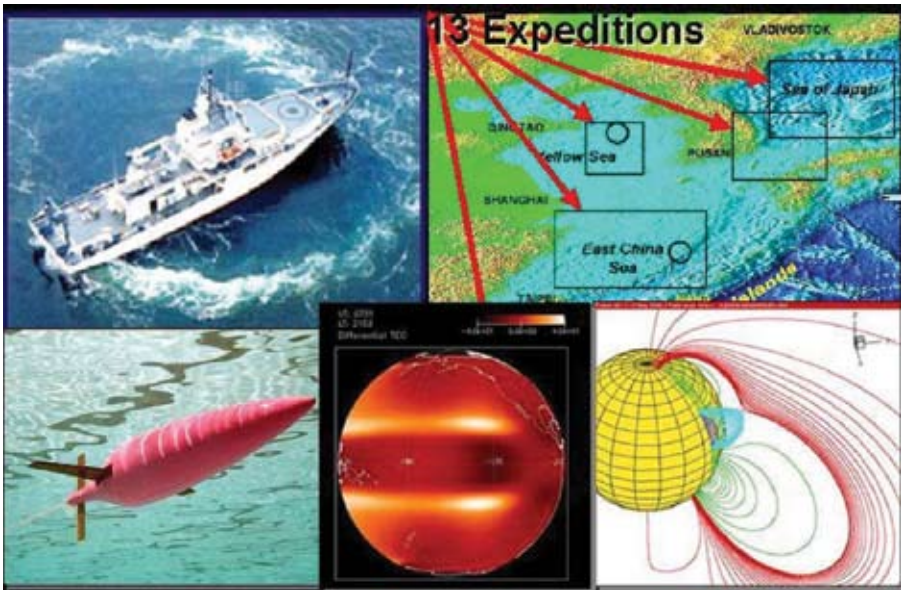
Description: Efficient power systems for Naval forces must be developed to minimize energy requirements. The characteristics for these efficient power systems include assured, regenerative, and transportable energies. The objective is to combine efficient power conversion technologies with a wide range of energy sources that will provide reliable sources of power for all non-nuclear naval ground, air, and sea systems.

Objectives

- Alternative Energy Sources
  - Use of synthetic hydrocarbons and alternative fuels
  - Wave action and bio-energy conversion
- Energy Storage
  - Portable, rechargeable, and reserve batteries
  - Personal power
- Efficient Energy and Power Conversion
  - Materials to increase efficiency and power density
  - Power distribution architectures
  - Motors and actuators
  - Technologies in lubrication, friction, and wear

- High Energy and Pulse Power
  - Energy storage power system architectures
  - Energy pulsed power switching and control systems

4.2 Operational Environments



Vision: Exploit the environment to our tactical advantage by accurately predicting the ocean, air, littoral, and riverine environments on tactical and strategic time scales.

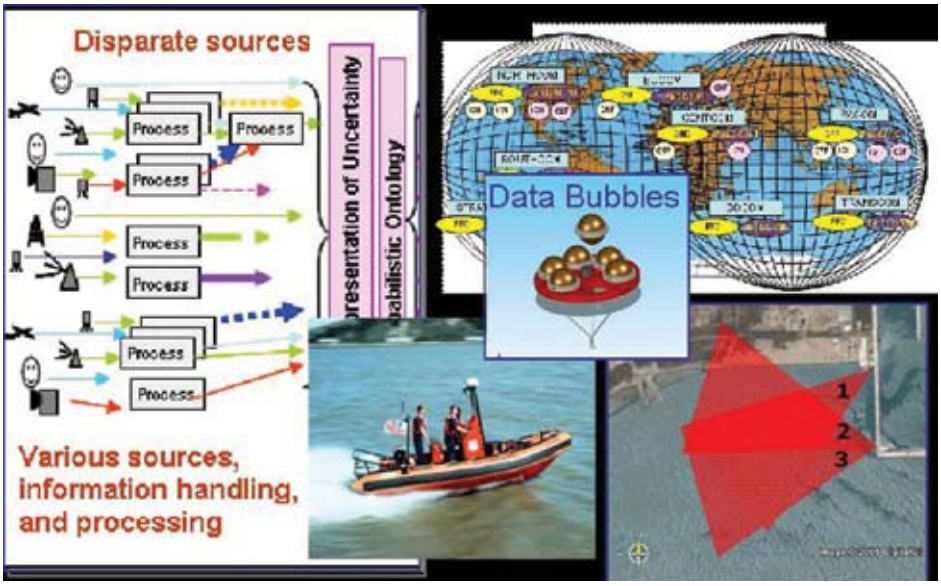
Description: Naval forces operate on, under, and above the sea, on land, and in the littoral reaches all over the world. Naval operations require precise knowledge of how the environment will impact operations in order to gain tactical advantage against adversaries who are intimately familiar with their home environments. To accomplish this objective, the Navy and Marine Corps need to exploit every aspect of the diverse environment in which they operate. Critical to their success is the development of an understanding and synthesis of littoral and selected ocean air and/or ocean processes at high resolution of space and time scales as they impact naval operations. To do this they need real-time, environmentally adaptive sensors, processing, systems, and strategies. The development and use of distributed and autonomous ocean systems is a vital aspect of this need. Innovative approaches (requiring neither complete nor perfect knowledge) to modeling and simulations of complex environments, including interactions with systems, form a key part of this challenge. Along with this, we need innovative means to evaluate assimilation, modeling, and simulation methods.

Objectives

- Mobile autonomous environmental sensing:
  - Autonomous sensing of ocean and littorals to beach exit zone
  - Actionable environmental sensing that automatically adapts sensing strategy to changing conditions

- Match predictive capabilities to tactical planning requirements:
  - Coupled ocean-atmosphere global, regional, and local modeling and prediction for operational planning
  - Forecasts for refractivity, duct heights, fog, rain, clouds, visibility, tropical cyclones at global, regional and tactical scales to increase mission planning and success
- Adapt Systems to the Environment:
  - Methods to account for acoustic and electromagnetic propagation, scattering, ambient noise, and bottom effects
  - Automated sensor and weapon performance prediction and reconfiguration
  - Impact and response for space environmental effects

4.3 Maritime Domain Awareness



Vision: Locate and track any target of interest on, under, or above the water, up to 250 nm ashore, using integrated networks of persistent sensors

Description: Successful prosecution of the Global War on Terror (GWOT) depends greatly on our situational awareness of the battlespace. For the Navy, that battlespace is the maritime domain. Today's security challenges will test our ability to gain awareness and understanding, and our ability to seize the initiative against our adversaries. Whereas our adversaries in the past have been conventional forces vulnerable to traditional means of combat, our current adversaries are elusive, widely distributed, and employ irregular tactics.

The Navy and Marine Corps must build and maintain global maritime domain awareness to generate actionable intelligence. Maritime domain awareness includes effective knowledge of all activities within the naval maritime environment–from blue water to the littorals and riverine areas—that affect the security of the United States. It also includes effective dissemination of that knowledge.

Objectives

- Sensor integration
  - Rapid, accurate, multi-source data integration
  - Automated integration of national and tactical sensors
  - Data fusion to adapt non-organic and sparse information
  - Pervasive and persistent sensors
- All domain coverage (space, air, surface, and sub-surface)
  - Affordability vs. endurance and reliability trade off
  - Fully automated (self-networking with sensor-level processing)
  - Secure and taskable data exfiltration nodes
- Tactical sensor networks
  - Autonomously interconnecting with real-time monitoring
  - Secure, survivable, self-healing, and adaptable
  - Resistant to jamming
- Homeland and port defense monitoring
  - New systems and protocols for target identification and tracking using fixed and deployable cueing systems
  - WMD detection tools
- Combat ID
  - Rugged identification technologies

4.4 Asymmetric and Irregular Warfare

Vision: Enable Naval forces to preempt and defeat adaptive non-conventional threats operating within complex physical and social terrain.

Description: Irregular warfare seeks to achieve strategic objectives by avoiding an adversary's conventional military strength while striking at the adversary's weakness, thereby eroding an adversary's power and will. This is primarily accomplished through the use of indirect, non-traditional methods of warfare. Asymmetric warfare primarily deals with unknowns and surprise in terms of ends, ways, and means. Naval forces' success against this type of warfare requires knowledge of the adversary's physical and social terrain and countermeasures to prevent as well as respond to threats.

Objectives

- ISR
  - Unmanned vehicles: intelligent autonomous unmanned vehicles, sensors, and communications
  - Interior and exterior imaging: rapidly reconstruct and fuse multi-aspect sensor data into 3-D tactical models of building interiors and exteriors
  - Riverine surveillance: common and persistent maritime picture on and below the surface and shore
- Intelligence Analysis
  - Image and pattern recognition tools
  - Societal, cultural, and behavioral modeling
  - Biometrics
- Active and Passive Forensics Tools
  - Field-portable forensic tools, sensors, and sensor networks, as well as spectrally-coded particulate markers and probes
- Advanced Countermeasures
  - Dominate the electromagnetic spectrum
  - Predict, detect and neutralize IEDs and P-IEDs
  - Deny adversaries the ability to hide within the civilian population
  - Phase 0 S&T in support of combatant commander's (COCOM) engagement plan
  - Electronic camouflage

4.5 Information, Analysis, and Communication

Vision: Generate options for decision making, reduce information overload, and prevent disruption-causing degradation to enable commanders decision making at the tactical and strategic levels

Description: Information, analysis, and communication involve employment of dynamic, flexible structures consisting of both current and planned national and theater assets. This focus area encompasses

automated data processing capabilities, communications and information requirements. It also provides national, geographic combatant, operational, and tactical commanders with the full range of intelligence required for planning and the conduct of operations. It includes both technical systems and processes for capturing, structuring, diffusing and re-using knowledge; roles and responsibilities for making things happen; and a culture and style that promote communication and sharing.

Objectives

- Rapid, Accurate, Decision-Making
  - Enhanced human decision-making while reducing the time-filtering of data and information
  - Automated generation and management of courses of action
  - Automated graphical representation of commander's intent
  - Knowledge and task focused human-system interfaces
  - Information assurance (authenticity, accessibility, and validity)
- Decision aids
  - Smart algorithm development for optimal action
  - Networked architecture for real-time operations
  - Rapid and reliable data access for threat-intent determination
- Communications and Networks
  - Mobile ad hoc networking
  - On-demand systems reach back
  - Quality-of-service mechanisms for commander's Intent
  - Autonomous monitoring and control of tactical communications and networks
  - Automatic alignment of sensors and networks
- Cyber Warfare
  - Cyber security and information assurance
  - Information operations

4.6 Power Projection

Vision: Precise extended range indirect fires, time-critical power on target, and control of collateral damage through electromagnetic kinetic projectiles, hypersonic missile propulsion, and scalable-effects weapons.

Description: Development and delivery of decisive effects are critical; this effort includes targeting, decision support, and precision strike by air, surface, and undersea platforms. This focus area strives for significant enhancements in naval deliberate and time-sensitive strike capabilities, combined with bold ship-to-objective maneuver operations to enhance the ability of naval forces to damage, seize, or destroy enemy forces at extended ranges in the littorals, deep inland, and on the high seas. Strike emphasizes the employment of these capabilities at a speed and rate that defeats any adversary's ability to conduct effective operations against us despite his use of mobility and deception to neutralize our efforts.

Objectives

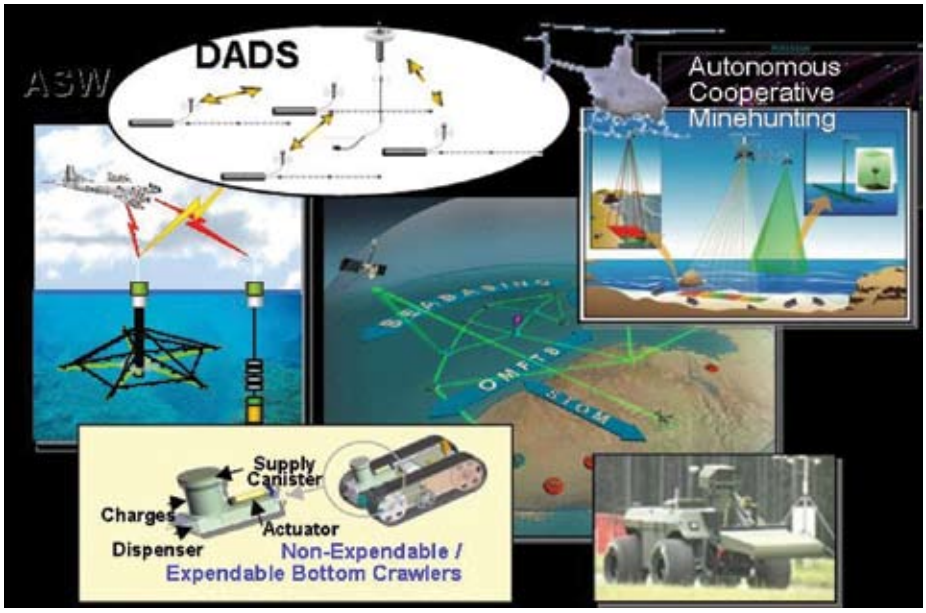
- Future Navy Fires
  - Increased volume and accuracy
  - GPS-denial compensation
  - Indirect fires to 250 miles from safe offshore locations
- Control Collateral Damage
  - Scalable-effects weapons
  - Selectable or directional lethality
- Time Critical Strike
  - Hardened target and moving target reach and destroy
  - Worldwide strike capability to meet warfighter requirements
- Small Unit Combat Power
  - Increased small unit weapon lethality
  - Neutralize larger hostile forces
- Combat Insensitive Munitions
  - Reduce system sensitivity to sympathetic detonation
  - Maintain payload range and lethality

4.7 Assure Access and Hold at Risk

Vision: Attain maritime, littoral, and riverine access to denied areas, and hold strategic and tactical targets at risk using lethal and non-lethal means.

Description: Naval forces must be able to attain maritime, littoral, riverine, and inland access (200 nm) to denied areas. They must maintain the ability to penetrate and operate in hazardous areas, where others cannot, in order to hold at-risk anti-

access targets and deny sanctuary to adversaries. To accomplish this and provide access for our forces, it is necessary to improve our anti-submarine warfare (ASW) and mine warfare (MW) technologies and capabilities. Concomitant with this is the need to have distributed and networked surface, ground, and underwater sensors capable of providing real-time date to support short-notice actions of Naval forces. All this contributes to the battleshaping task that sets the stage for successful naval operations.



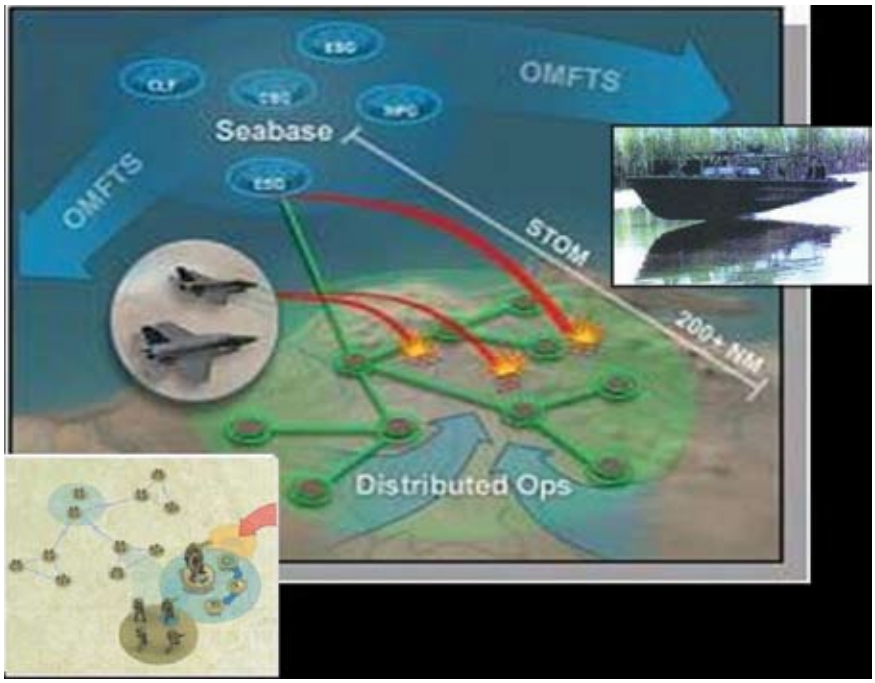
Objectives

- Anti-Submarine and Mine Warfare
  - Rapid clearing and detection of mines
  - Advanced autonomy in unmanned robotic systems to expand ground reach and reduce threat exposure
  - Next-generation data and contact fusion to expand the regional anti-submarine, mine and amphibious warfare operating picture to the theater level
- Distributed Surveillance
  - Distributed, networked surface, ground, and underwater sensors
  - Unmanned systems with onboard processing
  - Autonomous maritime reconnaissance and neutralization
- Battlespace Shaping
  - Non-lethal technologies to stop small vehicles and large ships
  - Battlespace shaping technology for enabling information operations
  - Decisive operations through a heavy electronic warfare (EW) attack area
  - Access to GPS-denied areas–alternatives to GPS technology
  - Operationally responsive use of space
  - Tagging, tracking, and locating technologies

4.8 Distributed Operations

Vision: Enable dispersed small units to dominate an extended battlespace through advanced warfighter training, unambiguous situational awareness, powerful communications, and sense-and-respond logistics.

Description: Distributed operations are an extension of maneuver warfare that employs small units dispersed throughout an extended battlespace. These units are more autonomous, more lethal, and able to operate across the full spectrum of operations and challenges, from the traditional through the irregular and disruptive to the catastrophic. This approach will create an advantage over any adversary through deliberate use of separate and coordinated, interdependent, tactical actions enabled by increased access to functional and combat support including enhanced combat capabilities at the small unit level. Warfighters will be highly adaptable to their environment, quick to respond to uncertainty, and able to deliver scaleable effects to whatever target they may need to engage.



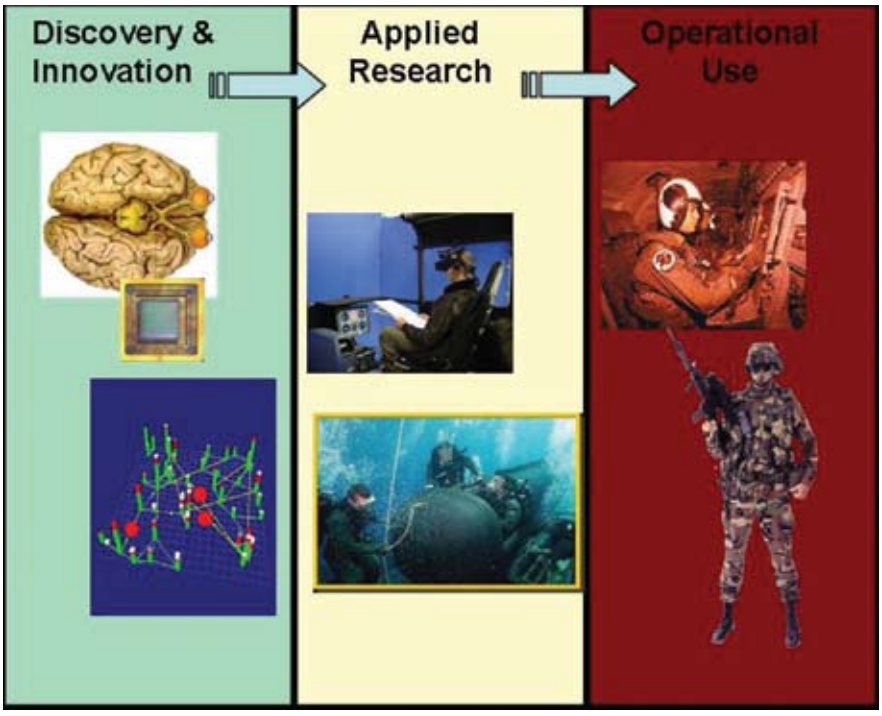
Objectives

- Training
  - Enhancement of physical and cognitive performance
  - Simulation based scenarios for enhanced training
  - Rapid assimilation of cultural environments
- Communications
  - Robust command and control networks
  - Airborne relays on manned and unmanned platforms
- Logistics
  - Rapid re-supply and medical evacuation whenever possible
  - Real time automatic supply sensors and network

  - Optimize medical self-sufficiency
- Fires
  - Integrate firepower of distributed ground, offshore, and air assets
  - Blue force tracking down to the individual
- Survivability
  - Warfighter stealth technology
  - Warfighter exoskeleton technology
- Maneuver
  - Adaptable and survivable tactical mobility systems to enhance operational tempo and extend range of vehicles and soldiers
  - Advanced materials to reduce combat load

4.9 Naval Warfighter Performance and Protection

Vision: Sustained warfighter performance and enhanced decision making in all environments through training technologies, human systems integration, and casualty management.



Description: The mission of the Naval services is to maintain, train, and equip combat-ready forces capable of winning wars, deterring aggression and maintaining freedom of the seas. To fulfill this mission, the services must develop 21st century leaders by improving manpower, personnel, training, and education programs to realize the full potential of every man and woman serving our Navy and Marine Corps. To achieve optimal system performance, the development of education and training technologies to shorten training time and maximize transfer of knowledge from the classroom to the field is key. These training tools must account for traditionally non-military scenarios that incorporate different social, political, economic, ethnic, and religious factors that may affect the operational environment. Decision-support systems are required to enable warfighters to take advantage of FORCEnet's shared situational awareness, as well as ensure effective combat identification of enemy combatants, friendly forces, and non-combatants. Technologies must protect individuals in chemical,

biological, and radiological environments with increased mission effectiveness. Improvements to helmet, body armor, and eye protection against a variety of threats while improving comfort and ease of employment are also vital technological needs. New strategies are required to mitigate the adverse effects of sleep deprivation, fatigue, extreme heat and cold, high altitude, ergonomic load, information overload, and emotional stressors.

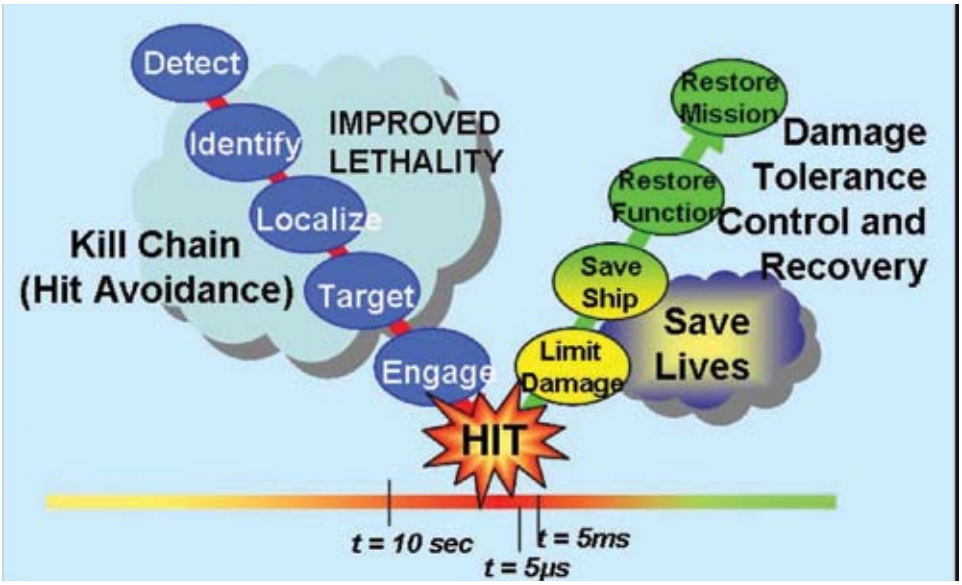
Objectives

- Training and Education
  - Technologies to shorten training time and maximize training impact
  - Computational models of human cognition applicable to tactical operations
  - Advanced decision tools for conclusive action in all operational environments
  - Risk and uncertainty in complex combat scenarios
- Casualty Care and Prevention
  - Understand combat physiological and mental stressors
  - Improve warfighter resilience in the full range of military environments and health threats
- Warfighter Protection
  - Advanced materials for lighter body armor
  - Advanced materials for lighter equipment
- Manpower management
  - Human factors and organizational design to assist in resource management

4.10 Survivability and Self-Defense

Vision: Enable manned and unmanned platforms to operate in any hostile environment and avoid/survive attack by using innovative materials, sensors, countermeasures and counter-weapons.

Description: Survivability and self-defense addresses defense against attack on U.S. and coalition forces at the individual, platform, unit, group, and theater levels. Success in this area hinges on three principles: avoid detection; if detected, avoid being hit; and if hit, minimize the effects of damage. Attack comes from many sources in the form of many different types of weapons. To avoid targeting, the entire spectrum of signatures must be considered (magnetic, acoustic, EO, IR, etc.). Stealth and own-signature suppression are critical pieces of this focus area. Incoming attack spans the range of small arms and hand-held weapons to ballistic and cruise missiles and undersea threats. They also include planted devices such as sea and land mines and IEDs. Defense will include detection and soft- and hard-kill defeat. Technologies must address a layered defense approach. Survivability will need to provide for hardened and reacting, damage-tolerant platforms and systems that may include automation to minimize the impact of a successful attack.



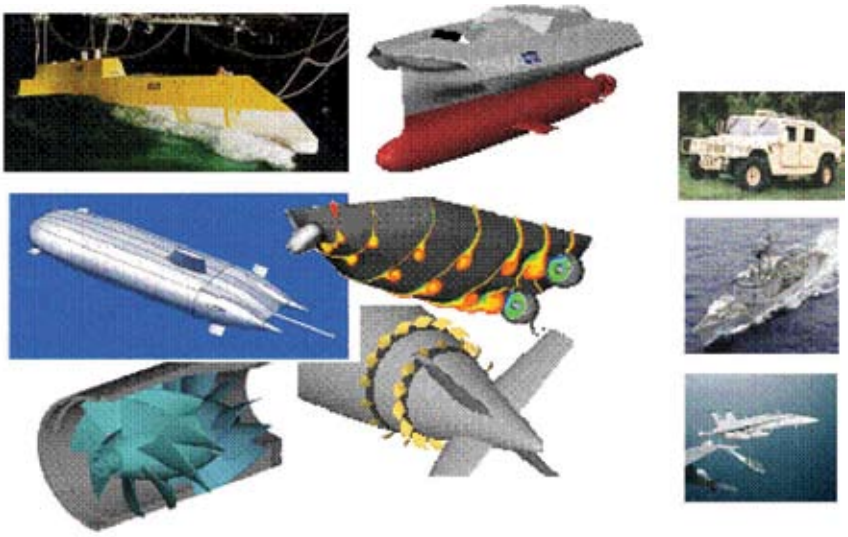
Objectives

- Platform Stealth
  - Reduce above-water and subsurface signatures
  - Multi-spectral low observable (LO) technologies
- Countermeasures & Counterweapons
  - Threat weapon tracking
  - Automated decision making
  - Low-false-alarm-rate, 360-degree detection
  - Hard kill and soft kill against threat kinetic weapons
  - Increase standoff to outside threat damage range
  - Directed energy weapons for speed of light engagement
  - Counter-LO
- Survivable Platforms
  - Advanced materials in platform construction
  - Damage tolerant platform architectures
  - Automated damage control focusing
  - Advanced materials for self-healing platforms
- Force Protection
  - Anti-swimmer technology
  - Detect and determine threat intent
  - Non-lethal response

4.11 Platform Mobility

Vision: Develop agile, fuel efficient, and modular platforms capable of operating in any environment using physics-based design tools.

Description: Platform mobility centers on the development and expansion of the science and phenomenological understanding of hydromechanics, aerodynamics, electrodynamics, electromechanics, materials, structural dynamics, intelligent control, and computational mechanics necessary to improve the design capability for advanced high-performance platforms, and the systems required to power and control them efficiently. Key to this is the development of design tools capable of rapidly analyzing and evaluating advanced novel air, ground, and sea/coastal/riverine platforms and system performance characteristics. The development and delivery of system and equipment technologies to improve the performance and control of air, ground, and sea platforms to meet operational requirements under all environmental conditions is the driving force for this focus area.



Objectives

- Efficient, high-endurance, high-speed platforms
  - New and novel advanced platform design supporting new directions in Naval warfare (size, agility, modularity, etc.)
  - Higher performance at reduced fuel consumption aerodynamic and hydrodynamic propulsion and power plants
  - All-terrain, lighter, more agile ground vehicle suspensions and drive trains
  - Manned or unmanned surface vessel launch and recovery
  - Lightweight and higher strength advanced composites and structural metals (cellular, lightweight alloys) building blocks
- Vertical lift operations in challenging environments
  - High performance vertical takeoff and landing/vertical-short takeoff and landing (VTOL/VSTOL)

  - High sea states launch-and-recovery technology to enable manned or unmanned air and surface platform operations
- Autonomous and unmanned vehicle mobility
  - Vehicle design technology for littoral missions and environments
  - Multi-unmanned vehicles supporting simultaneous cooperative operations
  - Advanced robotic systems for ground combat

4.12 Fleet and Force Sustainment

Vison: Provide the warfighter with supplies and equipment where and when needed for distributed operations, seabasing, and global fleet stations.

Description: Rapid resupply for mobile forces with minimal logistic burden is necessary for effective operations. The comprehensive and responsive logistics support system that includes air and sealift, replenishment ships, mobile repair facilities, and advanced logistics support hubs underpins the ability of Naval Expeditionary Forces to operate locally and worldwide. Furthermore, this ability to move and sustain Naval and other U.S. forces at great distances from our shores becomes even more crucial as we reduce our overseas base structure in response to post-Cold War realities.

Naval Power 21 transforms the Navy and Marine Corps approach from the traditional role of fleet replenishment to a completely new concept of forward presence. This new direction responds to requirements for naval forces to be strategically positioned in important regional littoral areas of the world, both as representatives of national policy in peacetime and as lead elements of national and collective international response to crises, and to enable and sustain larger joint or combined military operations when necessary. The ability to sustain ourselves on scene, for extended periods in important regions where U.S. security interests are affected, provides America with the opportunity to shape the environment with minimal dependence on the support of local foreign governments.

Objectives

- Sea Basing
  - Seabased logistics and communications operations modeling and simulation
  - Ship-to-ship and ship-to-shore logistics
  - Heavy-lift vehicle launch and recovery
  - Flexible and responsive warehousing
- Responsive and Visible Logistics
  - Point-of-delivery systems
  - Total asset visibility technologies
  - Flexible and responsive logistics
- Autonomous Re-supply
  - Intelligent re-supply agent systems
  - Sense and respond delivery system

4.13 Affordability, Maintainability, and Reliability

Vision: Reduce acquisition and lifecycle cost of Naval platforms and systems through design tools, reduced maintenance, intelligent diagnostics, and automation.

Description: This focus area is dedicated to significantly increasing the affordability of current and future naval systems by reducing the acquisition and support costs while maintaining or improving system performance and platform availability to execute assigned missions. To implement this vision, we will attack the three main cost drivers for the Navy and Marine Corps: acquisition of platforms and systems, maintenance and life-cycle, and manpower.

The cost component of affordability will be reduced by addressing platform manufacturing cost drivers and reducing manpower and material costs associated with operations and maintenance of platforms and systems. The performance component of affordability will be increased by retaining or expanding the operating envelope and reliability of systems and components. The availability component of affordability will be improved by increasing service life and reducing man-hours required for scheduled and unscheduled maintenance.

Objectives

- Platform Affordability
  - Advanced modeling and simulation for design, test and evaluation
  - Advanced composite alloys and ceramics
  - Open architecture for hardware
  - Software reliability
  - Low-cost sensors
  - Innovative manufacturing technologies
- Maintenance and Lifecycle Cost
  - Condition-based maintenance systems
  - Corrosion control technology
  - Wear resistant life-time materials
  - Energy efficient systems
  - Performance prediction modeling and simulation tools
- Automation to Reduce Manning
  - Small autonomous vehicles and systems
  - Operator action reduction technologies
  - Remote monitoring (diagnostics and correction)
  - Automated control systems

4.14 S&T Enablers: There are two underpinning enablers for Naval S&T: global technology awareness, and the science and engineering workforce and performer base. Global technology awareness is vital to avoiding technological surprise and exploiting international technology advancements. In our quest to identify the best performers and most promising technologies for the Navy and the Marine Corps, we strive to reach out and access intellectual capital worldwide. Central to our mission is ensuring the supremacy of naval technology; therefore, we must maintain the requisite U.S. S&T capacity and expertise. Naval S&T fosters the education and professional development of the science and engineering workforce in support of the NRE. These enablers will be further discussed in the next section.

5.0 Naval S&T Program Implementation

ONR must manage a balanced S&T portfolio to produce both knowledge and products that contribute to long-term DON strategic goals (See Figure 1, page 2). Strategic tenets for investment include: impact, relevance, innovation, appropriate level of risk, multidisciplinary opportunities, quality performers, critical resource level, and clearly developed programs.

5.1 Discovery and Invention (D&I): This area consists of basic research (BA 6.1) and the early stages of applied research (BA 6.2). D&I is the seed corn for future naval technologies and systems. It provides technology options, maintains critical U.S. S&T capacity, and develops the next generation of the S&T workforce. The D&I portfolio, by design, has a broad focus, and programs are selected based on Naval relevance and technology opportunity. An important aspect of ONR's D&I is the investment in unique Naval disciplines (e.g., ocean acoustics, underwater weapons, underwater medicine, naval engineering), and those areas that could benefit expeditionary warfare. To avoid sub-critical DON investment, D&I investments leverage other service, governmental department, industry, international, and general research community investments. Most of the D&I program is performed by university researchers, but both the NRL Base Program and the In-House Independent Research (ILIR) and In-House Applied Research (IAR) programs executed by the Naval Warfare Centers form key parts of the program.

5.2 Acquisition Enablers: This portion of the S&T portfolio centers on the Future Naval Capabilities (FNCs). These work to mature technology into requirements-driven, transition-oriented products in the late stages of applied research and advanced technology development (BA 6.3). FNCs provide enabling capabilities to fill gaps OPNAV and MCCDC requirements analyses identified in the Naval strategy and *Naval Power 21*. The Technology Oversight Group (TOG) determines the priorities for selecting FNC investments. FNC integrated product teams lead the management of individual FNCs to ensure close connectivity between requirements, technology development, and acquisition. In addition to the FNCs, ONR also uses Small Business Innovation Research (SBIR), Manufacturing Technology (MANTECH) programs, and Rapid Technology Transition (RTT) to foster naval acquisition programs' success.

5.3 Leap Ahead Innovations: Innovative Naval Prototypes and Swamp Works projects comprise the bulk of this S&T investment. These are technology investments that are potentially "game changing" or "disruptive" in nature.

- **Innovative Naval Prototypes** – These programs explore technologies that can change the way Naval forces fight. Programs in this category may be disruptive technologies that, for reasons of high risk or radical departure from established requirements and concepts of operation, are unlikely to survive without top leadership endorsement, and are initially too high risk for a firm transition commitment from the acquisition community. INPs should be identified based on

a balanced combination of naval need and technology exploitation. Investments should be planned with the critical mass needed to achieve a level of technology maturity suitable for transition in four to eight years. The CNR, in consultation with senior Navy and Marine Corps stakeholders, identifies candidate INPs that are then approved by the S&T Corporate Board.

- **Swamp Works** – These programs, although potentially high risk and disruptive in nature, are smaller than INPs and are intended to produce results in one to three years. Swamp Works efforts have substantial flexibility in planning and execution, with a streamlined approval process, shortening the innovation time cycle. Although a formal transition agreement is not required, Swamp Works programs should have strong advocacy outside ONR, either from the acquisition community or the fleet. Frequently, Swamp Works products are inserted into fleet experimentation, and if successful can provide the impetus for new acquisition requirements.

5.4 Quick Reaction and other S&T: This includes quick-reaction projects responsive to the immediate needs identified by the fleet, operating forces, or Naval leadership.

- **Tech Solutions** – This program addresses fleet or force input with research to provide an S&T solution that meets or exceeds the need, with short-term programs and rapid solutions.
- **Experimentation** – The NWDC and the MCWL, in partnership with ONR, explore future warfighting concepts and evaluate the capability potential of emerging technologies.

5.5 Naval Research Laboratory (NRL): NRL is the Department of the Navy's corporate S&T laboratory, performing science and technology in support of Naval needs. Since 1923, NRL's mission-oriented research and development programs have made significant contributions to the warfighting capabilities of the Navy and Marine Corps. The laboratory's work has yielded new and improved materials, techniques, equipment, systems, as well as new ocean, atmospheric, and space science and related technologies. Examples include: the Clementine spacecraft, specialized weather models in support of military operations, the "Little Buddy" ALE-50 decoy, the InfraLynx assured communications system, the Silent Guardian biosurveillance technology, and lightweight body armor.

NRL provides:

- Primary in-house research in physical, engineering, space, and environmental sciences,
- Broadly based exploratory and advanced development programs in response to identified and anticipated naval needs,
- Extensive, multidisciplinary support to the Naval Warfare Centers,
- Space and space systems technology development and support

5.6 Global Technology Awareness: As the amount of research and development increases outside of the United States, and access to information and knowledge becomes more rapidly and widely available, it becomes increasingly critical that U.S. Naval S&T be closely linked with the global research and development community, both to capitalize on the global intellectual capacity and innovation for solving naval challenges, and to build awareness that allows for identification of potential technological surprise and mitigation of that risk. To take advantage of the rapid pace of global innovation, and to ensure Naval S&T challenges benefit from the broadest range of ideas and approaches available, ONR is working to build strategic collaborations between U.S. research and development organizations, such as NRL, DARPA, NASA, NSF, warfare centers, the fleet/force, international academia, industry, government laboratories, and research consortia.

Many tools are used to build these linkages to the global technology community. These include: direct scientific engagement by NRL and ONR scientists; establishment of international agreements; exchanges between government research agencies, often facilitated by the Navy International Programs Office; international governmental groups (e.g., TTCP, NATO, etc.); and, many other ad hoc arrangements. In addition to these diverse approaches, Naval S&T has an international arm, ONR Global, to enhance the development of collaborations and access.

ONR Global deploys scientists and engineers around the world to develop partnerships between the international and U.S. research communities in areas of Naval relevance; to discover leading edge scientific advances and innovation; and to communicate emerging national and regional technology trends to identify potential technology surprise. From 2003 to 2006, ONR Global engaged in more than 67 countries. Future engagement is being closely coordinated with the fleet/force to ensure that Naval S&T is positioned to assist in carrying out the theater security cooperation priorities of the combatant commands while providing scientific solutions to their needs. ONR Global also directly embeds science advisors within the fleet/force to facilitate global awareness, to ensure that operating force capability needs are quickly and effectively communicated to the Naval S&T community, and to facilitate delivery of Naval S&T solutions to the fleet/force at the right time.

5.7 Science and Engineering Workforce: The researcher base program and science and engineering workforce programs support the NRE as a whole. The D&I portfolio supports roughly 3,000 students annually. The science and engineering workforce programs educate and encourage the academic and professional development of scientists and engineers in fields relevant to national defense, provide research equipment, support multi- and cross-disciplinary research, and establish partnerships among academia, industry, and Naval laboratories. ONR works to increase minority institution and small business participation in the NRE through education programs, grants, contracts and cooperative agreements with Historically Black Colleges and Universities/Minority Institutions and Small Business Innovation Research/Small Business Technology Transfer.

5.8 Interagency Coordination and Alliance: The Naval S&T investment is coordinated though the Defense S&T Reliance program and similar cooperative programs to leverage efforts by other services and DoD agencies and achieve economies and synergies. Each year, 10-15% of the DON 6.2/6.3 program supports multi-service/agency-funded and -managed projects to develop technologies and capabilities that have DoD-wide relevancy. Key joint programs currently being funded are the Versatile, Affordable, Advanced Turbine Engine Program to develop the next generation of high efficiency, high-thrust-to-weight-ratio turbine engines and the Insensitive Munitions Program to develop new energetic materials which will meet stringent insensitive munitions (IM) requirements with equivalent or improved performance.

ONR's senior leadership and program officers routinely meet with other service counterparts to exchange information and identify opportunities to collaborate or to conduct complementary research efforts. In addition, ONR and NRL program managers reach out to the larger technical community and collaborate with non-DoD agencies such as NSF, NASA, and DOE. ONR also coordinates with the United States Coast Guard (USCG) and has two officers on-site that serve as direct Coast Guard liaison. They help coordinate ONR efforts with the Department of Homeland Security in global maritime domain awareness and in combating terrorism.

5.9 Measuring Success: Measures of S&T success should include metrics that represent key outputs: knowledge, transitions, and people. Metrics help manage high-risk revolutionary science and technology. They also communicate the value of the S&T investment to leadership.

S&T Output	Metric
Knowledge	Refereed Papers
	Patents/Licenses
	Citations
Transitions	Capability Gaps Proposed
	% Capability Gap Proposals Funded
	% at Transition Objective in 3-5 Years
	% Taken by Acquisition
	% in Fleet
People	Students Supported
	Advanced Degrees Completed
	Program Participants Entering NRE Workforce

Figure 4: Metrics to Evaluate S&T Portfolio.

5.10 Business Processes: More than 80 percent of ONR sponsored S&T is awarded to external performers in academia, industry, and the NRE; therefore, efficient and effective business processes are vital to achieving our S&T objectives. Business operations include:

- Grant and contract administration
- Contracting activities and policy
- Acquisition and research business policy
- Information and statistical reporting processes
- Human capital strategy
- Intellectual property policy with patent and trademark oversight

6.0 Execution of DON Vision from ONR Perspective

The S&T visions and objectives in Section 4 collectively represent the roadmap for our S&T investments. The future Naval force capabilities described below summarize where this S&T strategy is taking the Navy and Marine Corps of the future. They represent the intersection of Navy and Marine Corps visions, challenges, and opportunities with S&T possibilities. Our investments, when mature, will result in future Naval forces that have:

- Domination of the electro-magnetic spectrum and cyber space
- Implemented directed energy weaponry – fighting at the speed-of-light
- Achieved persistent, distributed surveillance in all domains
- Achieved comprehensive MDA with large vessel stopping and WMD detection for EMIO
- Incorporated affordability into platform design and construction
- Adaptive, wireless communications networks
- Decision tools for commanders that provide tactical advantage
- Determination of threat intent thru social and cultural understanding
- Lighter, faster, more lethal Marine Forces
- Accelerated team training and skill development
- Increased operational effectiveness through more efficient power and fuels
- Responsive and visible logistics to enable distributed forces
- Greater tactical advantage through superior knowledge and use of operational environments

7.0 Summary

The Naval S&T Strategic Plan provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. This plan reflects the current guidance and direction of our senior civilian and military leadership. It focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare. It puts us on a path

toward maturing and transitioning enhanced Naval capabilities, such as persistent ISR and dominance of the EW spectrum, and toward pursuing revolutionary advances, such as speed-of- light weapons. This strategy will be reviewed and approved by the DON Corporate Board every two years to ensure its continued relevance. It provides a means and framework to communicate with decision makers and the various external communities that interact with Naval S&T. Inside ONR, this plan will guide our investment planning and decisions. It is also intended to broaden our reach into the scientific community as well as into industry. The plan will be posted on the ONR website (www.onr.navy.mil) which provides a gateway for industry and academia into the center of Naval S&T.

Appendix A: Naval S&T Research Areas

Naval S&T Focus Area	*Objective Categories*	*S&T Research Areas*
Power & Energy	• Alternative energy sources • Energy storage • Efficient energy & power conversion • High energy & pulsed power	• Advanced Naval Power Systems • Air Platform Power • Power Electronics • Personal Power • Bio-Sensors, Materials, Processes • Manufacturing Science • Functional Materials
Operational Environments	• Mobile autonomous environmental sensing • Match predictive capabilities to tactical planning requirements • Adapt Systems to the Environment	• Unmanned Undersea Vehicle Technologies • Unmanned Air and Ground Vehicles • Intelligent and Autonomous Systems • Bio-Inspired Systems • Physical Oceanography • Marine Meteorology • Ocean Acoustics • Littoral Geosciences, Optics and Biology • Space Environmental Effects • Marine Mammals • ASW Performance Assessment • Mine Warfare Performance Assessment
Maritime Domain Awareness	• Sensor integration • Pervasive and persistent sensors • Tactical sensor networks • Homeland and Port Defense monitoring • Combat ID	• Information Processing, Discovery and Presentation • Networked Sensors • Communications and Networks • Intelligent and Autonomous Systems • Distributed Undersea Search & Surveillance • Bio-sensors, -materials, -processes & Bio-inspired Systems • Electro-Optics • ISRT - EM • Nanometer Scale Electronic Devices/Sensors • Navigation & Precision Timekeeping • Spacecraft Technology • WMD Detection
Asymmetric & Irregular Warfare	• ISR • Intelligence analysis • Active and passive forensics tools • Advanced countermeasures	• Unmanned Undersea Vehicle Technologies • Unmanned Air and Ground Vehicles • Intelligent and Autonomous Systems • Automated Image Understanding • Information Processing & Presentation • Social, Cultural & Behavioral Modeling • Biometrics • Nanoscale Electronic Devices and Sensors • EW Attack • Counter IED • Non-Lethal weapons
Information, Analysis and Communication	• Rapid, Accurate, Decision Making • Decision aids • Communications and Networks • Cyber Warfare	• Info Processing, Discovery and Presentation • Decision Support Tools • Automated Image Understanding • Human Factors Organizational Design and Decision Research • Communications & Networks • Information Assurance & Anti-Tamper • Computational Analysis • Nanometer Scale Electronic Devices/Sensors • Solid State Electronics

Naval S&T Focus Area	*Objective Categories*	*S&T Research Areas*
Power Projection	• Future Navy Fires • Control Collateral Damage • Time-Critical Strike • Small Unit Combat Power • Combat Insensitive Munitions	• Advanced Energetics • Directed Energy • Electromagnetic Guns • High Speed Weapons Technologies • Precision Strike • Undersea Weaponry • ASW Rapid Attack • Mining • Non-Lethal Weapons • Signature Control & Sensors (LO/CLO) • EW Attack • Expeditionary Firepower
Assure Access and Hold at Risk	• Anti-Submarine & Mine Warfare • Distributed Surveillance • Battlespace Shaping	• Anti-Submarine Warfare Surveillance • Mine Hunting • Unmanned Vehicles • Intelligent and Autonomous Systems • Networked Sensors • Space Technologies • Nanoscale Electronic Devices & Sensors • Solid State Electronics • Functional Materials • EW – Attack • ISRT - EM • Large Vessel Stopping • Non-Lethal Weapons • Navigation and Precision-Timekeeping
Distributed Operations	• Training • Communications • Logistics • Fires • Survivability • Maneuver	• Training, Education & Human Performance • Expeditionary C4 • Communications and Networks • Expeditionary Logistics • Expeditionary Firepower • Precision Strike • Expeditionary ISR • Unmanned Air and Ground Vehicles • Special Warfare / EOD • Land Mine Countermeasures • Expeditionary Maneuver/ Individual Mobility
Naval Warrior Performance & Protection	• Training and Education • Casualty Care/Prevention • Warfighter Protection • Manpower Management	• Training Education & Human Performance • Information Presentation • Decision Support Tools • Undersea Medicine • Casualty Care & Management • Casualty Prevention • Functional Materials • Human Factors, Organizational Design & Decision Research

Naval S&T Focus Area	*Objective Categories*	*S&T Research Areas*
Survivability & Self-Defense	• Platform Stealth • Countermeasures & Counterweapons • Survivable Platforms • Force Protection	• Signature Control (LO/CLO) • Undersea Weaponry • Torpedo Defense • Directed Energy • Survivable Platforms Structures • Functional Materials • Electro-Optics • Solid State Electronics • EW Attack • ISRT – EM • Expeditionary Force Protection • Non-Lethal Weapons
Platform Mobility	• Efficient, high endurance, high speed platforms • Vertical lift operations in challenging environments • Autonomous and unmanned vehicle mobility	• Advanced Sea Platforms • Air / Ground Vehicles • Air Propulsion • Advanced Naval Power Systems • Expeditionary Maneuver • Advanced Naval Materials (Structural, Functional) • Naval Engineering/Naval Architecture • Unmanned Undersea Vehicle Technologies • Unmanned Air and Ground Vehicles
Fleet/Force Sustainment	• Sea Basing • Responsive and Visible Logistics • Autonomous Resupply	• Advanced Sea Platforms • Seabase Enablers • Expeditionary Logistics • Intelligent & Autonomous Systems • Human Factors, Organizational Design, & Decision Research
Affordability, Maintainability, and Reliability	• Platform Affordability • Maintenance and Life Cycle Cost • Automation to Reduce Manning	• Advanced Sea Platforms • Air / Ground Vehicles • Complex Software System Tools • Anti-Tamper • Manufacturing Science and Technologies • Affordability / Reduced Platform Life Cycle Cost • Advanced Naval Power Systems • Power Electronics • Bio-Sensors, Materials, Processes • Structural Materials • Materials Prediction and Simulation • Environmental Quality • Intelligent and Autonomous Systems

Appendix B

References

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Naval Operations Concept (2006)

Navy Technology Strategic Plan (May 2006)

Marine Corps S&T Strategic Plan (Nov 2006)

Naval Enterprise Input (Nov 2003 – July 2006)

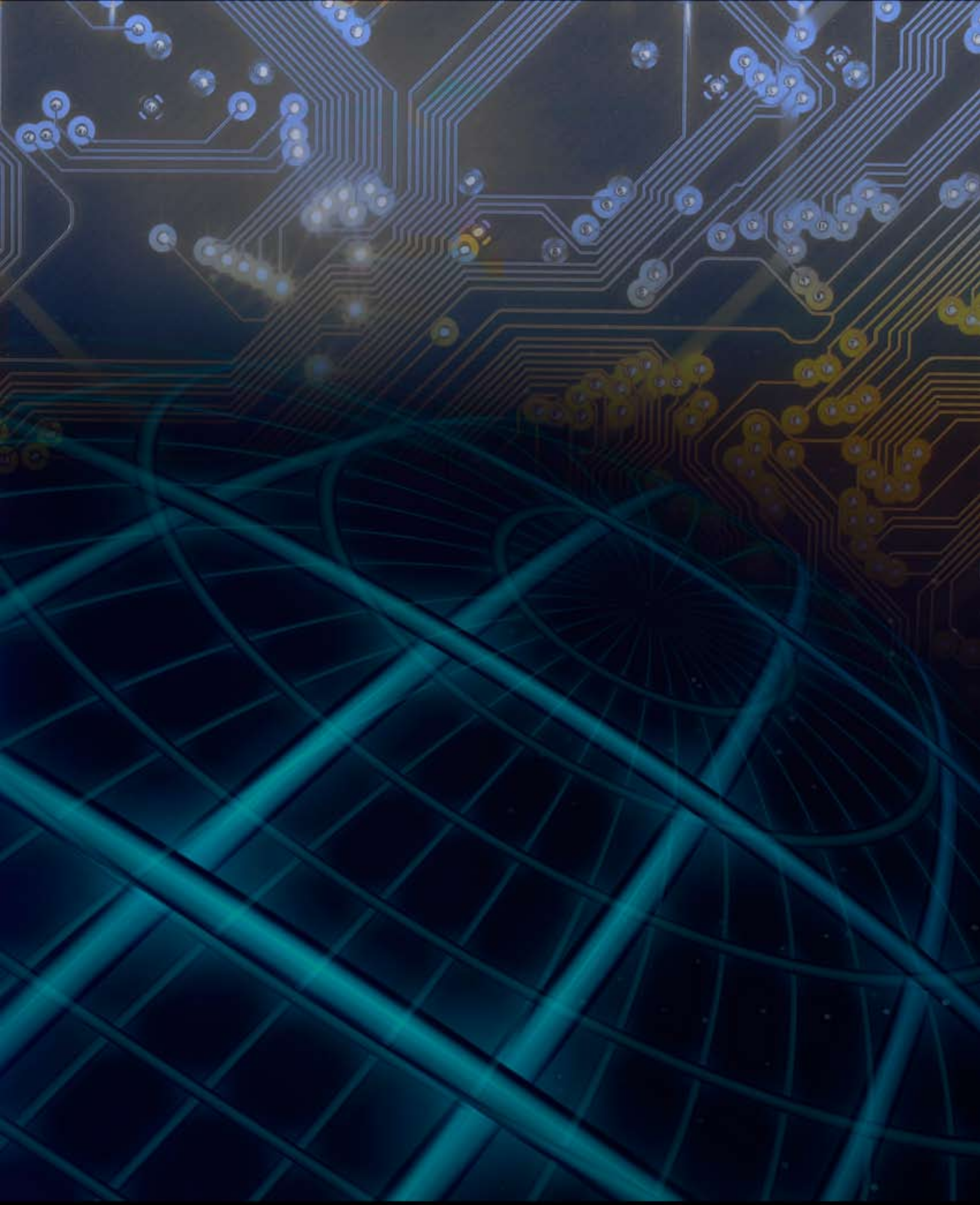
CNR Fleet Engagement (Spring 2006)

Appendix C

List of Acronyms

ACMC	Assistant Commandant of the Marine Corps
ASN	Assistant Secretary of the Navy
ASW	Anti-Submarine Warfare
BA	Budget Activity
C4	Command, Control, Communications, and Computers
CBRNE	Chemical, Biological, Radiological, Nuclear, and High-yield Explosive
CNR	Chief of Naval Research
D&I	Discovery and Innovation
DoD	Department of Defense
DOE	Department of Energy
DON	Department of Navy
EC	Enabling Capability
EMIO	Enhanced Maritime Intercept Operations
EO	Electro-optical
EOD	Explosive Ordnance Disposal
EW	Electronic Warfare
FNC	Future Naval Capabilities
GPS	Global Positioning System
GWOT	Global War on Terror
HQMC	Headquarters Marine Corps
IAR	In-House Applied Research
IED	Improvised Explosive Devices
ILIR	In-House Independent Research
IM	Insensitive Munitions
IR	Infrared
ISR	Intelligence, Surveillance, and Reconnaissance
ISRT - EM	Intelligence, Surveillance, Reconnaissance, and Targeting -Electromagentic
LO/CLO	Low Observable/Counter Low Observable
ManTech	Manufacturing Technology
MCCDC	Marine Corps Combat Development Command
MCM	Mine Countermeasures
MCWL	Marine Corps Warfighting Laboratory
MDA	Maritime Domain Awareness
MIO	Maritime Interception Operation
M&S	Modeling and Simulation
MW	Mine Warfare
NAE	Naval Aviation Enterprise
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NM	Nautical miles
NRAC	Naval Research Advisory Committee

NRL	Naval Research Laboratory
NRE	Naval Research Enterprise
NSB	National Science Board
NSF	National Science Foundation
NWDC	Navy Weapons Development Command
ONR	Office of Naval Research
OpNav	Office of the Chief of Naval Operations
P-IED	Projected Improvised Explosive Device
RDA	Research Development and Acquisitions
RTT	Rapid Transition Technology
SBIR	Small Business Innovation Research
S&T	Science and Technology
STOM	Ship to Objective Maneuver
TOG	Technology Oversight Group
TTCP	Technology Transfer Control Plan
USMC	United States Marine Corps
VCNO	Vice Chief of Naval Operations
VTOL	Vertical Take-off or Landing
VSTOL	Vertical/Short Take-off or Landing
WMD	Weapons of Mass Destruction



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