NAVAL RESEARCH ADVISORY COMMITTEE

Science and Technology for Naval Warfare, 2015--2020

Flag Officers
And
Senior Executive Service

4 October 2005
The Pentagon Auditorium

Outline

Terms of Reference
Panel Membership
Briefings & Discussions

Global S&T Trends
Military Implications
U.S. Navy-Marine Corps in 2020
Threats to U.S. Forces

Mission+Threats+Technologies Matrix
Counter-Threat Technologies Investments
Mission-Enabling Technologies Investments
Overarching Issues Requirements

Conclusion
Recommendations

Study Terms of Reference/1

Identify the science and technology in which the U.S. naval forces should consider investing to counter predicted threats and to enhance the effectiveness of U.S. naval forces in the period 2015 to 2020 while undertaking Littoral Operations.

Sponsor: Deputy Chief of Naval Operations
(Warfare Requirements and Programs) N6/7

Duration: Five Months

Terms of Reference/2

This study initially sought to identify the threat implications for three specific areas of the world; however, the issues appear to be universal because of the proliferation of weapons and systems that could threaten U.S. naval forces.

Although the geographic features of the three areas differ, the military implications for all areas appear to be similar.

Panel Membership

NORMAN POLMAR, *Chairman**	U.S. Naval Institute
RADM THOMAS A. BROOKS, USN(Ret), *Vice Chairman*	Consultant
MGEN HARRY JENKINS, USMC(Ret)	ITT Industries
The Honorable ROBIN PIRIE	Center for Naval Analyses
CAPT DENNIS RYAN, USN(Ret)	NRAC Staff
RADM THOMAS D. RYAN, USN(Ret)	Cortana Corp.
Dr. JOHN SOMMERER*	APL, Johns Hopkins University
Prof. WILLIAM WELDON*	University of Texas at Austin
JIM WOLBARSHT*	BearingPoint Inc.
Panel Secretary	
KEITH H. THOMS	NSWC Dahlgren Labs

* Member, Naval Research Advisory Committee

Briefings and Discussions

Individuals

Dr. George H. Atkinson, S&T Advisor to the Secretary of State

Dr. Alan Berman, former Technical Director, NRL

Ambassador Linton Brooks, Under Secretary of Energy

Dr. Christopher Bowie, Dep. Director, Air Force Long-Range Planning

Dr. Richard Carlin, Former Acting Chief Scientist, ONR

Tom Clancy, novelist

RADM Richard Cobbold, RN (Ret), Director, RUSI

RADM Jay Cohen, USN, Director of Naval Research

VADM James Fitzgerald, USN (Ret)

LGEN James N. Mattis, USMC, CG, Marine Corps Combat Development Command

Briefings and Discussions

Individuals (continued)

RADM William C. Miller, USN(Ret), Academic Dean, USNA

Dr. David A. Rosenberg, Director, Task Force History

CAPT Gordon Wilson, RN, former Director, Defence Studies (Naval)

Industry

Dr. Eric Horvitz, senior staff, Microsoft

George Pickett, Northrop Grumman

Dr. Scott Truver, Vice President, CSSO/Anteon

Briefings and Discussions

U.S. Government

Assessment Branch/OPNAV N81

Commander, Fleet ASW Command

Commander, Naval Special Warfare Command

Commander, Naval Surface Forces

Deep Red /OPNAV N2

DARPA (UAVs/Mechanical Bugs)

Office of Naval Intelligence (threat briefs, submarine technology)

ONR (UAVs, HI-FLY, non-acoustic ASW)

ONR Global/London (advanced air-defense concepts)

SPAWAR Systems Center (San Diego)

Strategic Studies Group (Naval War College)

Briefings and Discussions

British Government

Director of Intelligence (Maritime Systems)

Director General (Research & Technology)

Defense Science and Technology Laboratory

- Advanced radars
- Surface combatants/warfare
- Seabasing
- Electronic warfare
- Target identification
- Biological detection
- Littoral warfare
- ASW

Global S&T Trends/1

- Continued asymmetric opposition to U.S. interests
  - Non-state actors
  - Nation states
  - Military actions
  - Against U.S. critical infrastructure
  - Against U.S. civilian population
- Continued dilution of U.S. S&T base
  - Foreign students outnumber Americans in advanced engineering and science curricula
  - Technical education losing to business, arts
  - Government laboratory positions less attractive
  - Foreign investment in technical education accelerating

Global S&T Trends/2

- Globalization eroding U.S. technical dominance
- Impending oil availability crisis
  - U.S. dependence on Middle East oil
  - Near-term Chinese demand for oil
  - Mid-term EU, Indian demand for oil
  - Changing situation in Venezuela
- Increasing U.S. dependence on foreign technology
- Worldwide access to advanced technology through foreign and U.S. sales and espionage
- Technological surprise is **probable!**

Military Implications of the World of 2020 for S&T /1

This study makes no attempt to define the future or to draw possible scenarios for what the world will look like in 2015-2020. However, certain trends are obvious:

- Nuclear, chemical, bio weapons continue to proliferate
- Terrorism continues
- Increasing violence and political influence by non-state actors
- Proliferation of primitive (but effective) as well as modern weapons/systems
  - Improvised explosive devices
  - Man-portable air-defense missiles
  - Sea mines
  - Surface-to-surface missiles

Military Implications of the World of 2020 for S&T/2

- Growing foreign economic power and changing politics
  - Rapidly changing demographics
  - Major emphasis on advanced S&T education
  - Advanced weapon development and sales
- Development of significant regional military powers
  - Blue water navies: China, India
  - Regional navies: Iran

Navy-Marine Corps Missions in 2020

Many missions are similar to the Cold War era

BUT with significantly different emphasis

- ↑ Provide seaborne missile defense
- ↑ Provide seaborne support for operations against terrorism (including homeland defense)
- ↑ Protect U.S.-Allied maritime areas of interest (inc. SLOCs)
- ↑ Project military power (presence/rescue/peacekeeping/ strike/assault)
- → Threaten military forces of potential enemies (especially their WMD capabilities)
- ↓ Deter nuclear attacks (Trident SSBNs)

Threats Impacting Navy-Marine Corps Missions/1

- Increased availability of long-range weapons against naval-maritime formations
  - Ballistic missiles with terminal guidance
  - High-speed, sea-skimming cruise missiles
  - EM Guns
- Proliferation of nuclear, chemical, biological weapons
- Proliferation of inexpensive delivery systems and weapons, including
  - Air (UAVs, mini-UAVs)
  - Surface (USVs)
  - Underwater (UUVs, mines, mini-submarines, SDVs)
  - Land mines, IEDs, and other low-tech systems
  - MANPADS, laser devices, and other high-tech systems

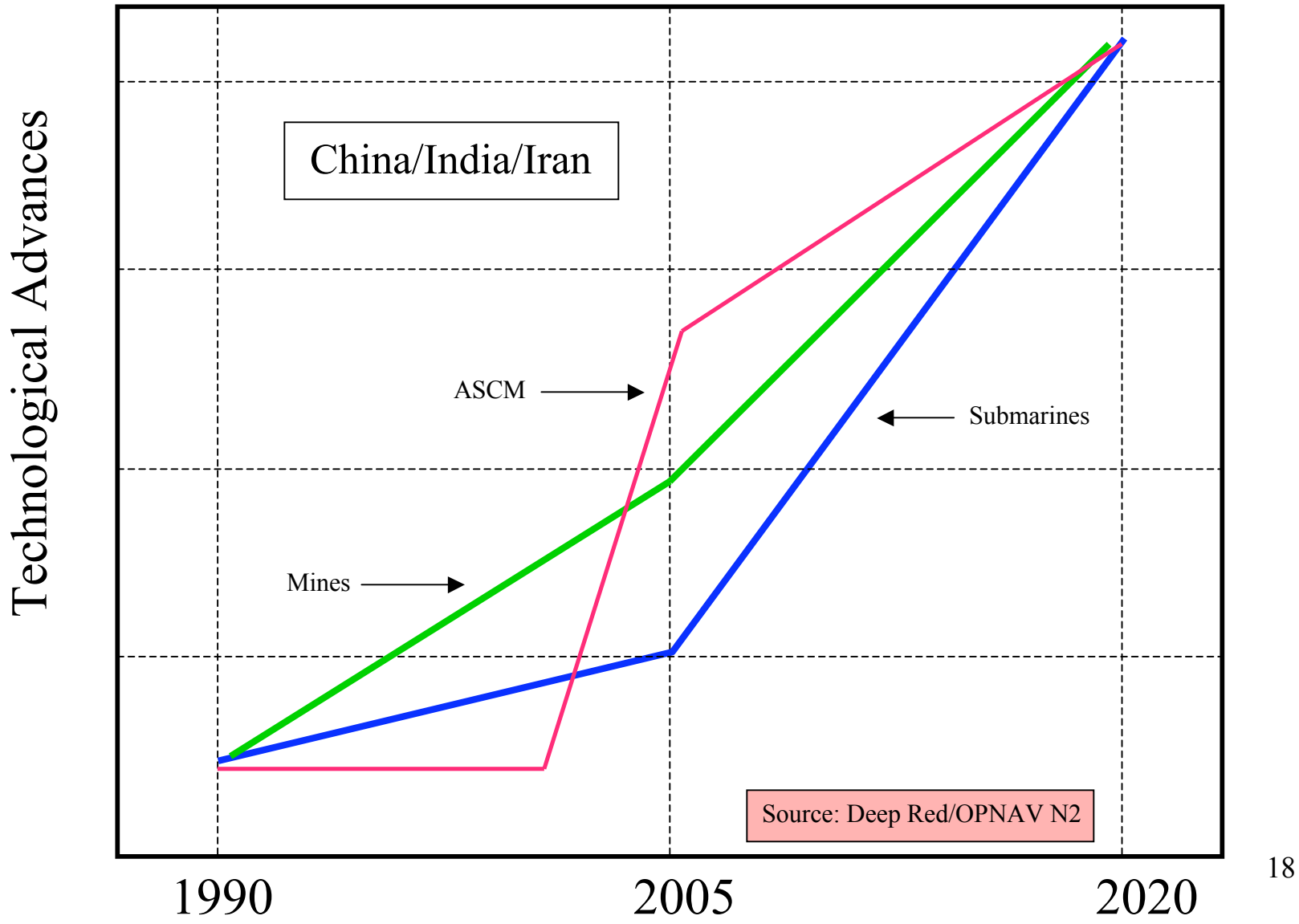
Threats Impacting Navy-Marine Corps Missions/2

- Proliferation of advanced submarine technologies *and concepts of operation*
  - Propulsion
  - Sensors
  - Stealth
  - Weapons
- Proliferation of capabilities for sophisticated information warfare
- Increase in vulnerabilities of U.S. logistics
  - Pipeline
  - Overseas procurement of goods and services

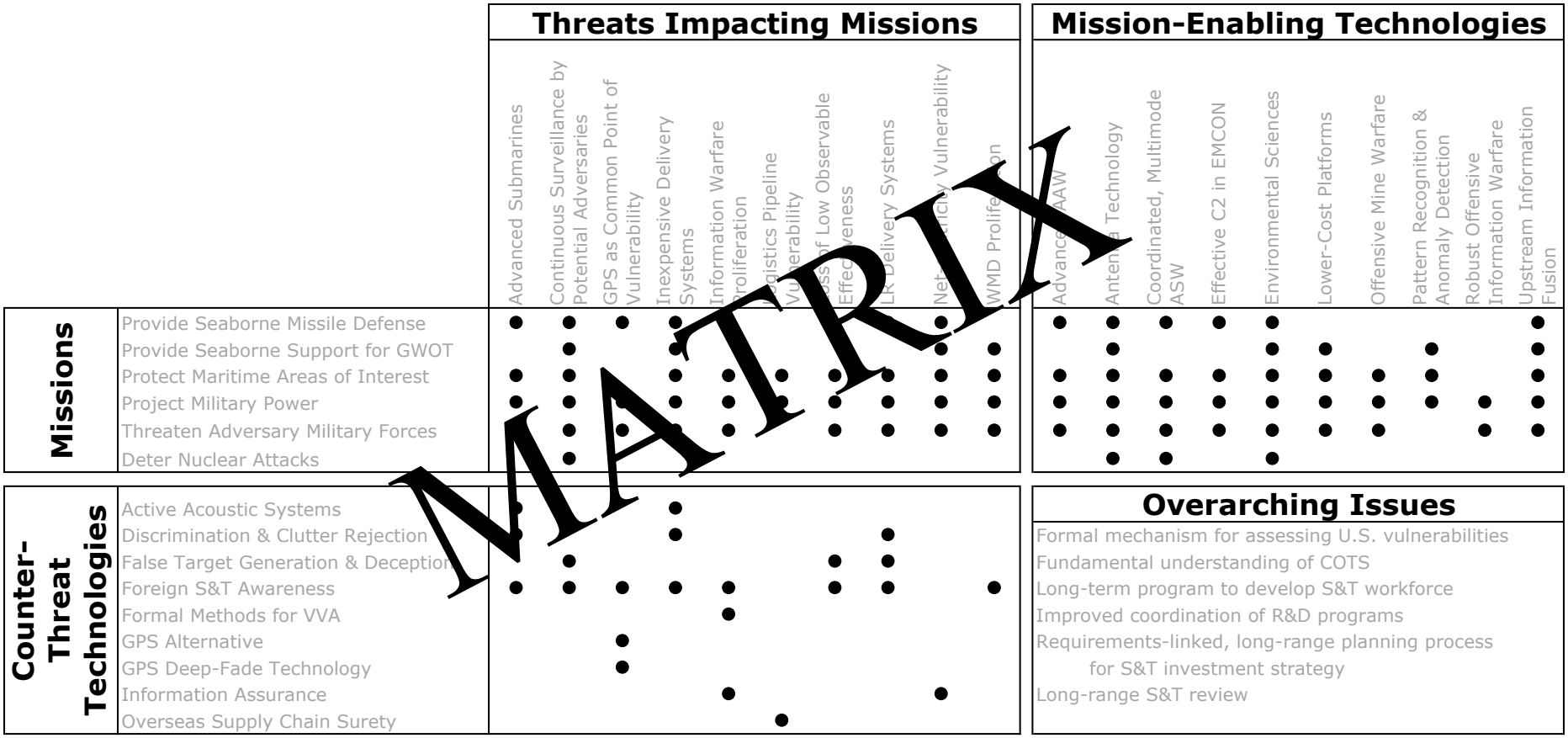
Threats Impacting Navy-Marine Corps Missions/3

- Near-continuous surveillance of U.S. land and sea forces by opposing military and commercial satellites, "cheap" UAVs, and other means
- "Network centricity" creates vulnerabilities for U.S. forces
  - Interruption/jamming
  - Effective EMCON impossible
  - Information overload
  - Over-dependence on reachback
- Loss of low-observable effectiveness
- Reliance on GPS makes it a major target

Increasing Anti-Access Capabilities



Technology Traceability to Missions and Threats



Technology Traceability to Navy Marine-Corps Missions

Missions	Provide Seaborne Missile Defense
	Provide Seaborne Support for GWOT
	Protect Maritime Areas of Interest
	Project Military Power
	Threaten Adversary Military Forces
	Deter Nuclear Attacks

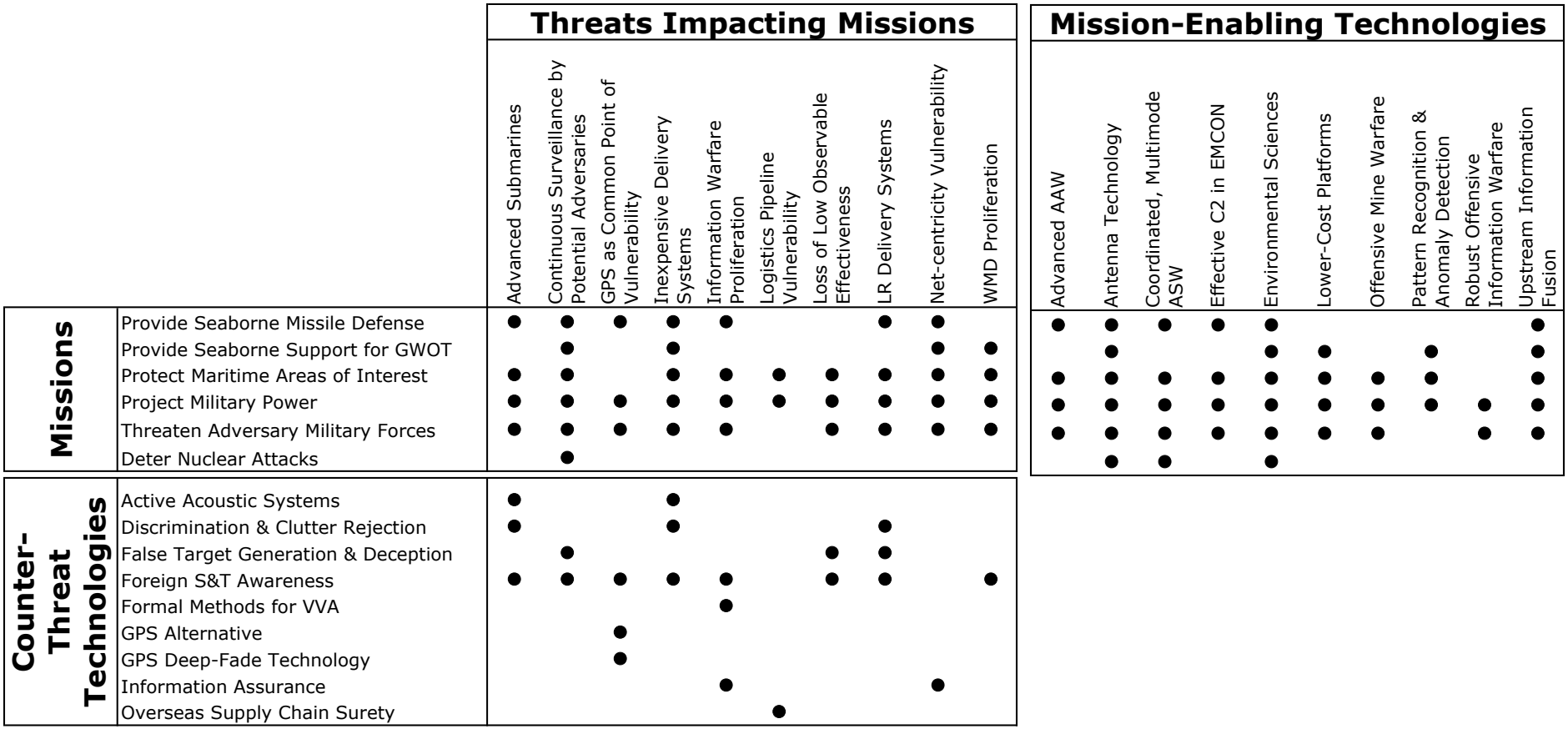
Technology Traceability to Missions Indexed by Threats

Missions	Threats Impacting Missions										
	Advanced Submarines	Continuous Surveillance by Potential Adversaries	GPS as Common Point of Vulnerability	Inexpensive Delivery Systems	Information Warfare Proliferation	Logistics Pipeline Vulnerability	Loss of Low Observable Effectiveness	LR Delivery Systems	Net-centricity Vulnerability	WMD Proliferation
Provide Seaborne Missile Defense	●	●	●	●	●			●	●	
Provide Seaborne Support for GWOT		●		●					●	●
Protect Maritime Areas of Interest	●	●		●	●	●	●	●	●	●
Project Military Power	●	●	●	●	●	●	●	●	●	●
Threaten Adversary Military Forces	●	●	●	●	●		●	●	●	●
Deter Nuclear Attacks		●								

Technology Traceability to Counter-Threat Technologies

		Threats Impacting Missions										
		Advanced Submarines	Continuous Surveillance by Potential Adversaries	GPS as Common Point of Vulnerability	Inexpensive Delivery Systems	Information Warfare Proliferation	Logistics Pipeline Vulnerability	Loss of Low Observable Effectiveness	LR Delivery Systems	Net-centricity Vulnerability	WMD Proliferation
Missions	Provide Seaborne Missile Defense	●	●	●	●	●			●	●	
	Provide Seaborne Support for GWOT		●		●					●	●
	Protect Maritime Areas of Interest	●	●		●	●	●	●	●	●	●
	Project Military Power	●	●	●	●	●	●	●	●	●	●
	Threaten Adversary Military Forces	●	●	●	●	●		●	●	●	●
	Deter Nuclear Attacks		●								
Counter-Threat Technologies	Active Acoustic Systems	●			●						
	Discrimination & Clutter Rejection	●			●				●		
	False Target Generation & Deception		●					●	●		
	Foreign S&T Awareness	●	●	●	●	●		●	●		●
	Formal Methods for VVA					●					
	GPS Alternative			●							
	GPS Deep-Fade Technology			●							
	Information Assurance					●				●	
	Overseas Supply Chain Surety						●				

Technology Traceability to Mission-Enabling Technologies



Technology Traceability to Missions and Threats

		Threats Impacting Missions										
		Advanced Submarines	Continuous Surveillance by Potential Adversaries	GPS as Common Point of Vulnerability	Inexpensive Delivery Systems	Information Warfare Proliferation	Logistics Pipeline Vulnerability	Loss of Low Observable Effectiveness	LR Delivery Systems	Net-centricity Vulnerability	WMD Proliferation
Missions	Provide Seaborne Missile Defense	●	●	●	●	●			●	●	
	Provide Seaborne Support for GWOT		●		●					●	●
	Protect Maritime Areas of Interest	●	●		●	●	●	●	●	●	●
	Project Military Power	●	●	●	●	●	●	●	●	●	●
	Threaten Adversary Military Forces	●	●	●	●	●		●	●	●	●
	Deter Nuclear Attacks		●								
Counter-Threat Technologies	Active Acoustic Systems	●			●						
	Discrimination & Clutter Rejection	●			●				●		
	False Target Generation & Deception		●					●	●		
	Foreign S&T Awareness	●	●	●	●	●		●	●		●
	Formal Methods for VVA					●					
	GPS Alternative			●							
	GPS Deep-Fade Technology			●							
	Information Assurance					●				●	
	Overseas Supply Chain Surety						●				

Mission-Enabling Technologies										
	Advanced AAW	Antenna Technology	Coordinated, Multimode ASW	Effective C2 in EMCON	Environmental Sciences	Lower-Cost Platforms	Offensive Mine Warfare	Pattern Recognition & Anomaly Detection	Robust Offensive Information Warfare	Upstream Information Fusion
Provide Seaborne Missile Defense	●	●	●	●	●					●
Provide Seaborne Support for GWOT		●			●	●		●		●
Protect Maritime Areas of Interest	●	●	●	●	●	●	●	●		●
Project Military Power	●	●	●	●	●	●	●	●	●	●
Threaten Adversary Military Forces	●	●	●	●	●	●	●		●	●
Deter Nuclear Attacks		●	●		●					

Overarching Issues

- Formal mechanism for assessing U.S. vulnerabilities
- Fundamental understanding of COTS
- Long-term program to develop S&T workforce
- Improved coordination of R&D programs
- Requirements-linked, long-range planning process for S&T investment strategy
- Long-range S&T review

Findings/1
Counter-Threat Technologies Investments

- Tactical/Operational
  - Active acoustic systems
  - Discrimination and clutter rejection
  - False target generation for deception
  - GPS deep-fade technology
  - GPS alternative
- Logistics
  - Security for overseas supply chain
- Capabilities/Systems Development
  - Foreign S&T awareness
  - Formal, automated methods for Verification, Validation, and Accreditation
  - Information assurance

Findings/2
Mission-Enabling Technologies Investments

- Tactical/Operational
  - Advanced AAW
  - Coordinated, multimode ASW
  - Effective C^2 in EMCON
  - Offensive mine warfare
  - Pattern recognition and anomaly detection
  - Robust offensive information warfare
  - Upstream information fusion
- Capabilities/Systems development
  - Antenna technology
  - Environmental sciences (specific areas)
  - Low-cost platforms technologies

Findings/3
Overarching Issues Requirements

- Formal mechanism for assessing U.S. vulnerabilities
- Fundamental understanding of COTS
  - Business models
  - Technology drivers
  - Standards
  - Internal structure, functionality, vulnerabilities
- Long-term program to develop S&T workforce
- Improved coordination of R&D programs
- Requirements-linked, long-range planning process for S&T investment strategy
- NRAC long-range S&T review should be a continuing responsibility

Conclusion/1

The **bottom line** is that

While the Navy has a productive S&T program today….

The rapidly changing threat and the rate of world technological development demands change in the Navy-Marine Corps investment strategy for S&T over the next 15 years to insure that the naval services can continue to effectively carry out their missions.

Conclusion/2

Failure to change the investment strategy for Navy-Marine Corps S&T will make technological surprise on the battlefield **likely**…and success in executing naval missions will be **problematic.**

Recommendations/1

- **Develop Long-Term S&T Planning Process**

The ASN(RDA) should direct that his staff, the Chief of Naval Research, and appropriate OPNAV codes develop a long-term S&T planning process to help guide the future of Navy-Marine Corps S&T investment. Such a process should address (1) probable missions, (2) related systems capabilities, (3) related platform type requirements, and (4) related S&T requirements for required capabilities.

Further, it is proposed that the study sponsor, N6/7, recommend that this ongoing effort be made responsible to the Department of the Navy's S&T Corporate Board.*

*Note: The S&T Corporate Board consists of the Vice Chief of Naval Operations, the Assistant Commandant of the Marine Corps, and Assistant Secretary of the Navy (RDA), with the Chief of Naval Research as board secretary.

Recommendations/2

- **Develop Long-Term S&T Workforce Plan**

  .

  The ASN(RDA) should determine the extent to which the NRAC report of 2002 has been implemented and remains valid with respect to the civilian S&T workforce, And, in collaboration with the Commander Naval Education and Training Command, the Chief of Naval Personnel, the appropriate Navy and Marine Corps systems commands, determine those actions to be recommended for retaining uniformed personnel in the S&T workforce.

Recommendations/3

- **Accelerate Lower-Cost Platform Technologies**

The ASN(RDA) should determine in conjunction with the Naval Sea Systems Command the means to initiate a comprehensive analysis based on the above cited concepts to review the above cited concepts for ships design and their implementation to date, and insure that they are adopted to the maximum extent practical in the "next" Navy ship design. In particular, the extended service lives of contemporary warships demands that high priority be given to transition to these concepts prior to initiation of the next major surface ship or submarine design.

Recommendations/4

- **Assess and Mitigate Long-Term COTS Vulnerabilities**

  The ASN(RDA) should form a joint task force representing the Office of Naval Research and the appropriate systems commands that would be empowered to develop a business model for assessing the potential vulnerabilities of COTS insertion into naval systems. Such an assessment should address technology drivers, standards, internal structure, functionality, and supportability. Develop a program to enable mitigation of potential vulnerabilities.

Technology Traceability to Missions and Threats

		Threats Impacting Missions											Mission-Enabling Technologies										
		Advanced Submarines	Continuous Surveillance by Potential Adversaries	GPS as Common Point of Vulnerability	Inexpensive Delivery Systems	Information Warfare Proliferation	Logistics Pipeline Vulnerability	Loss of Low Observable Effectiveness	LR Delivery Systems	Net-centricity Vulnerability	WMD Proliferation		Advanced AAW	Antenna Technology	Coordinated, Multimode ASW	Effective C2 in EMCON	Environmental Sciences	Lower-Cost Platforms	Offensive Mine Warfare	Pattern Recognition & Anomaly Detection	Robust Offensive Information Warfare	Upstream Information Fusion	
Missions	Provide Seaborne Missile Defense	●	●	●	●	●			●	●			●	●	●	●	●						●
	Provide Seaborne Support for GWOT		●		●					●	●			●			●	●		●			●
	Protect Maritime Areas of Interest	●	●		●	●	●	●	●	●	●		●	●	●	●	●	●	●	●			●
	Project Military Power	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●		●
	Threaten Adversary Military Forces	●	●	●	●	●		●	●	●	●		●	●	●	●	●	●	●		●		●
	Deter Nuclear Attacks		●											●	●		●						
Counter-Threat Technologies	Active Acoustic Systems	●			●								**Overarching Issues**										
	Discrimination & Clutter Rejection	●			●				●				Formal mechanism for assessing U.S. vulnerabilities										
	False Target Generation & Deception		●					●	●				Fundamental understanding of COTS										
	Foreign S&T Awareness	●	●	●	●	●		●	●		●		Long-term program to develop S&T workforce										
	Formal Methods for VVA					●							Improved coordination of R&D programs										
	GPS Alternative			●									Requirements-linked, long-range planning process for S&T investment strategy										
	GPS Deep-Fade Technology			●																			
	Information Assurance					●				●			Long-range S&T review										
	Overseas Supply Chain Surety						●																