7th Annual Science and Engineering Technology Conference/
DoD Technology Exposition

18 - 20 April 2006

Lake Buena Vista, Florida

Agenda

Tuesday, 18 April 2006

Preliminary Session: *Opportunities for Collaboration*
• FY 2007 President's Budget Request for DoD S&T Program
Mr. Robert W. Baker, Deputy Director, Plans & Programs, DDR&E

• Advanced Concept Technology Demonstration (ACTD) Program
Mr. Mark Peterson, Head, Program Resources & Integration, ODUSD (Advanced Systems & Concepts)

• T&E/S&T Program
Mr. Mark Brown, Principal Scientist, Defense Test Resource Management Center, Test & Evaluation/Science & Technology Program

• DoD Basic Research Program with a Focus on Academia
Dr. William Berry, Acting Deputy Under Secretary of Defense for Laboratories and Basic Sciences

• International Collaboration
Dr. Tony Sinden, Counselor for Defence Science & Technology at the British Embassy

CONFERENCE OPENING:
• NDIA Welcome - Major General Barry D. Bates, USA (Ret), Vice President, Operations, NDIA

Session I: *Navy Future S&T Challenges*

• Naval Future S&T Challenges Overview: S&T Program Influences, Priorities and Program Rationale
Dr. Joseph Lawrence, Director of Transition, Office of Naval Research

• Future Naval Capability: FORCEnet
Dr. Bobby Junker, IPT Lead, C4ISR Department Head, Office of Naval Research

• Maritime Defense Awareness: Overview
Dr. Gary Toth, Maritime Domain Awareness Program Officer, Office of Naval Research

• Comprehensive Maritime Awareness ACTD
Mr. Ken Bruner, USPACOM J-00618

• Advanced Capability Electric Systems
Mr. Scott Littlefield, PEO Ships Science & Technology Director, Office of Naval Research

Wednesday, April 19, 2006

Session II: *Air Force Future S&T Challenges*
• Air Force Future S&T Challenges Overview, Mr. Les McFawn, Executive Director, Air Force Research Laboratory

• AF S&T Challenges for ISR
Dr. Paul McManamon, Chief Scientist, AFRL Sensors Directorate

• AF S&T Challenges for Directed Energy
Dr. Bruce Simpson, Director, AFRL Directed Energy Directorate

• AF S&T Challenges for Responsive Space
Colonel Rex R. Kiziah, Materiel Wing Director, Space Vehicles, Air Force Research Laboratory

• AF Opportunities for Basic Research
Colonel Jeffrey Turcotte, USAF, Deputy Director and Commander, Air Force Office of Scientific Research

• A DoD Perspective on S&T Areas of Emphasis
Honorable John Young, Director, Defense Research & Engineering

Session III: *Army Future S&T Challenges*

• Army S&T Challenges for Current and Future Forces
Ms. Mary Miller, Director for Technology, Office of Assistant Secretary of the Army Futures S&T Challenges Overview

• Network Enabled Capabilities
Mr. Gary Martin, Director, CERDEC, RDECOM

• Force Protection
Dr. Marilyn Freeman, Executive Director for Research and Technical Director, TARDEC

• Unmanned Systems with Net Centric Operations
Colonel Cindy Bedell, USA, Director Technology Integration Assessment and Futures, Army RDECOM

• Next Generation Capabilities: Army Basic Research
Dr. John Parmentola, Director for Research, OASA (ALT)

Thursday, April 20, 2006

Session IV: Transitioning Disruptive Technologies
• Army Approach to Disruptive Technologies and Transition
Mr. Dennis Schmidt, Director, Science & Technology Integration, Office of the Assistant Secretary of the Army for Research and Technology

• Navy Approach to Disruptive Technologies and Transition
Mr. Lewis DeSandre, Program Manager, ONR 351

• Air Force Approach to Disruptive Technologies and Transition
Colonel Mark Stephen, Associate Deputy Assistant Secretary (Science, Technology & Engineering), HQ USAF

• A New Paradigm for Technology Transfer
Dr. Greg Raupp, Director, Center for Flexible Displays, Arizona State University

• Technology Transition from an Industry Program Manager's Perspective
Dr. Malcom R. O'Neill, former Vice President & Chief Technical Officer, Lockheed Martin

Tuesday, April 18, 2006

7:00 am Conference Registration & Continental Breakfast

Preliminary Session: Opportunities for Collaboration

In this session we will present the Fiscal Year 2007 President's Budget Request for the DoD S&T program. We will also highlight specific programs that will provide conference attendees opportunities to engage in collaborative efforts with the DoD and international S&T community. Presentations will provide information on technology areas of high interest to the DoD, time lines, and points of contact for the submission of proposals. Opportunities for both industry and academia will be covered. A wide range of programs, from the larger technology demonstrations funded by the Advanced Concept Technology Demonstration program, that lead to the evaluation of military utility of advanced technology by a Combatant Commander; to the more focused technology development efforts that are funded by the Test & Evaluation/Science & Technology (T&E/S&T) program will be covered. Opportunities for proposing commercial off-the-shelf technology to meet current military needs will be addressed by the Quick Reaction Fund/Rapid Reaction Fund program presentation. Specific scientific research areas having high interest to the DoD will be highlighted along with information on the process universities should use to submit proposals. The session will be rounded out with a presentation on opportunities for collaborative international research and technology development.

Preliminary Session Chairman - Mr. Robert W. Baker, Deputy Director, Plans & Programs, DDR&E

8:15 am **FY 2007 President's Budget Request for DoD S&T Program**
Mr. Robert W. Baker, Deputy Director, Plans & Programs, DDR&E

8:45 am **Advanced Concept Technology Demonstration (ACTD) Program**
Mr. Mark Peterson, Head, Program Resources & Integration, ODUSD (Advanced Systems & Concepts)

9:15 am **T&E/S&T Program**
Mr. Mark Brown, Principal Scientist, Defense Test Resource Management Center, Test & Evaluation/Science &Technology Program

9:45 am BREAK

10:30 am **Quick Reaction Fund/Rapid Reaction Fund**
Mr. Ben Riley, Director, Rapid Reaction Technology Office/Chairman Combating Terrorism Technology Task Force

11:00 am **DoD Basic Research Program with a Focus on Academia**
Dr. William Berry, Acting Deputy Under Secretary of Defense for Laboratories and Basic Sciences

11:30 am **International Collaboration**
Dr. Tony Sinden, Counselor for Defence Science & Technology at the British Embassy

12:00 pm LUNCHEON & EXHIBITS OPEN

CONFERENCE OPENING

1:00 pm **Call to Order** - Dr. A. Louis Medin, Chairman, NDIA S&ET Division
NDIA Welcome - Major General Barry D. Bates, USA (Ret), Vice President, Operations, NDIA

1:15 pm **Keynote Address**
Admiral Edmund P. Giambastiani, Jr., USN, Vice Chairman, Joint Chiefs of Staff

Session I: Navy Future S&T Challenges

This session will address the Department of the Navy's S&T Investment Strategies with specific focus on upcoming BAAs and opportunities for alternative solutions from industry and academia. Following an overview of the Navy's S&T program, speakers will address key S&T areas, including basic research that will support the development and transition of technologies to enable the Navy to meet the uncertain and dynamic global security environment. Discussions will include overviews of the Navy's S&T efforts related to FORCEnet, the Navy's vision of Network Centric Operations, with specific emphasis on Maritime Domain Awareness and a related ACTD, and an overview of the Advanced Capability Electric Systems Program. University and DARPA involvement in these S&T initiatives will be highlighted by the speakers.

Co-Chairs: Dr. Kenneth A. Potocki, APL LWS Program Manager, Space Department, John Hopkins University
Mr. E. Terrence Dailey, Deputy Director, Program Integration, Software Engineering Institute
Ms. Cathy Nodgaard, Associate Director, SBIR, ONR

2:00 pm	**Naval Future S&T Challenges Overview: S&T Program Influences, Priorities and Program Rationale** Dr. Joseph Lawrence, Director of Transition, Office of Naval Research
2:30 pm	**Future Naval Capability: FORCEnet** Dr. Bobby Junker, IPT Lead, C4ISR Department Head, Office of Naval Research
3:00 pm	BREAK
3:45 pm	**Maritime Defense Awareness: Overview** Dr. Gary Toth, Maritime Domain Awareness Program Officer, Office of Naval Research
4:15 pm	**Comprehensive Maritime Awareness ACTD** Dr. Chris Dwyer, Maritime Domain Awareness Program Manager, Naval Research Laboratory
4:45 pm	**Advanced Capability Electric Systems** Mr. Scott Littlefield, PEO Ships Science & Technology Director, Office of Naval Research
5:30 pm - 7:30 pm	RECEPTION in Exhibit Hall

Wednesday, April 19, 2006

7:30 am	Conference Registration & Continental Breakfast

Session II: Air Force Future S&T Challenges

The Air Force is developing capabilities that are key components of DoD's joint capabilities. The Air Force future is focused on achieving persistent C4ISR, global mobility, and rapid strike. The Air Force Research Laboratory (AFRL) is the single organization within the Air Force that focuses on science and technology (S&T) to help the Air Force realize this future. The AFRL is "leading the discovery, development, and integration of affordable war fighting technologies for our air and responsive space force." This session provides a perspective on the key S&T investments the Air Force is counting on to meet the current and future mission challenges. This perspective is followed by more detailed presentations on key areas of AFRL's S&T investments: Intelligence, Reconnaissance and Surveillance (ISR), directed energy weapons, space and basic research.

Co-Chairs:	Dr. James McCormack, Technical Director (Technology Integration & Applications), Northrop Grumman Information Technology Mr. Edward Palo, Chief Engineer, Center for Air Force C2 Systems, MITRE Corporation Colonel Mark Stephen, Associate Deputy Assistant Secretary (Science, Technology & Engieering), HQ USAF
8:30 am	**AF Future S&T Challenges Overview** **AF S&T Program Influences, Priorities, and Program Rationale** Mr. Les McFawn, Executive Director, Air Force Research Laboratory (AFRL)
9:00 am	**AF S&T Challenges for ISR** Dr. Paul McManamon, Chief Scientist, AFRL Sensors Directorate
9:30 am	**AF S&T Challenges for Directed Energy** Dr. Bruce Simpson, Director, AFRL Directed Energy Directorate
10:00 am	BREAK
10:45 am	**AF S&T Challenges for Responsive Space** Colonel Mike Leahy, USAF, Director, AFRL Air Vehicles Directorate
11:15 am	**AF Opportunities for Basic Research** Colonel Jeffrey Turcotte, USAF, Deputy Director and Commander, Air Force Office of Scientific Research
12:00 pm	LUNCHEON/EXHIBITS **Luncheon Speaker:** Dr. Fred Ambrose, Intelligence Technology Innovation Center
1:30 pm	**A DoD Perspective on S&T Areas of Emphasis** Honorable John Young, Director, Defense Research & Engineering

Session III: Army Future S&T Challenges

Our Army is at war…it is engaged in a Global War on Terrorism against an enemy unlike any previously faced. Success requires the enhancement of our current forces while continuing to transform the Army. The Army's Science and Technology program strategy is to develop the technology options that will ensure that the Army is relevant and ready today and remains relevant tomorrow. In this portion of the conference, an overview will be provided of the Army S&T Program challenge to develop technologies that will enhance the Current Force while concurrently enabling the Future Force. Battle Command capabilities are paramount in order to enable the Future Force. In addition, the session emphasizes the importance of networked systems, force protection and unmanned systems. In these discussions the speakers will emphasize their work with DARPA to provide the best technology to meet our soldier's needs. The final important area to be discussed is the role of the Army's basic research program…expanding and stimulating the human imagination to extend the boundaries of the possible. Creating future Army technological advances will be discussed and the role of academia and industry will be emphasized.

Co-Chairs:	Dr. A. Michael Andrews II, VP & CTO, L-3 Communications Brigadier General R. Mark Brown, RDECOM DCG, SOSI Dr. John P. Solomond, Program Manager C4ISR, Booz Allen Hamilton
2:00 pm	**Army S&T Challenges for Current and Future Forces** Ms. Mary Miller, Director for Technology, Office of Assistant Secretary of the Army Futures S&T Challenges Overview
2:30 pm	**Network Enabled Capabilities** Mr. Gary Martin, Director, CERDEC, RDECOM
3:00 pm	BREAK / LAST CHANCE TO VIEW EXHIBITS
3:45 pm	**Force Protection** Dr. Marilyn Freeman, Executive Director for Research and Technical Director, TARDEC
4:15 pm	**Unmanned Systems with Net Centric Operations** Colonel Cindy Bedell, USA, Director Technology Integration Assessment and Futures, Army RDECOM
4:45 pm	**Next Generation Capabilities: Army Basic Research** Dr. John Parmentola, Director for Research, OASA (ALT)

Thursday, April 20, 2006

Session IV: Transitioning Disruptive Technologies

In this session, representatives from the scientific and engineering communities will provide their perspectives on which technologies possess the greatest potential to produce significant increases in military capability. However, transitioning these technologies into advanced war fighting capabilities continues to be a challenge and has long been a concern in both the DoD and industry. Technology transition is a complex undertaking with competing pressures on the system developer and government program manager to control program cost and schedule, while meeting system performance objectives that often depend upon successful application of the latest technologies. The incentives to transition the latest technology have become more intense because of rapid growth and globalization of technology developments. Potential adversaries may have access to these technologies to achieve their own disruptive capabilities. This session will also examine how the DoD and industry can work together to improve the technology transition process.

Co-Chairs:	Dr. James McCormack, Technical Director (Technology Integration and Applications), Northrop Grumman Information Technology Mr. Herb Finkelstein, Industry/Government Research Liaison Officer, Arizona State University Mr. Robert Baker, Deputy Director, Plans & Programs, DDR&E
8:15 am	**Army Approach to Disruptive Technologies and Transition** Mr. Dennis Schmidt, Director, Science & Technology Integration, Office of the Assistant Secretary of the Army for Research and Technology
8:45 am	**Navy Approach to Disruptive Technologies and Transition** Mr. Quentin Saulter, Directed Energy Project Officer, Office of Naval Research (Invited)
9:15 am	**Air Force Approach to Disruptive Technologies and Transition** Colonel Mark Stephen, Associate Deputy Assistant Secretary (Science, Technology & Engineering), HQ USAF
9:45 am	BREAK
10:30 am	**A New Paradigm for Technology Transfer** Dr. Greg Raupp, Director, Center for Flexible Displays, Arizona State University
11:00 am	**Overall DoD Perspective on Disruptive Technologies** Mr. Alan Shaffer, Director, Plans & Programs, Office of the Director, Defense Research and Engineering
11:30 am	**Technology Transition from an Industry Program Manager's Perspective** Dr. Malcom R. O'Neill, former Vice President & Chief Technical Officer, Lockheed Martin
Wrap Up & Adjourn	Dr. Raj K. Aggarwal, Vice President, Global Technology and Special Projects, Rockwell Collins Dr. A. Louis Medin, Chairman, NDIA S&ET Divsion
12:00 pm	**BUFFET LUNCHEON**

National Defense Industrial Association

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

"The Premier Defense Association!"

Vision

America's leading Defense Industry association promoting National Security

Mission

- **ADVOCATE: Cutting-edge technology and superior weapons, equipment, training, and support for the War-Fighter and First Responder**
- **PROMOTE: A vigorous, responsive, Government - Industry National Security Team**
- **PROVIDE: A forum for exchange of information between Industry and Government on National Security issues**

"If I were inviting a colleague to join, I'd say the most compelling reason is the prestige of NDIA membership." -- NDIA member

About Us……

- ✓ Non-profit, educational association
- ✓ Represents industry, government and all military Services
- ✓ 1,260+ corporate members
- ✓ @ 39,000 individual members – more than 11,700 government
- ✓ 51 Chapters provide local participation / networking opportunities
- ✓ 30 Divisions provide "area of interest" opportunities

"NDIA is one of the professional organizations that I get the most use and benefit from."
-- NDIA member

Activities

- ✓ Studies, reports, assessments, reviews for government entities
- ✓ Symposia - @ 70-80 per year – Policy, Warfighting, Logistics, Technical, Systems Acquisition, International Cooperation, Small Business, Homeland Security, etc. focus areas
- ✓ News – timely views from the Pentagon, the Administration, Congress and Industry via *National DEFENSE* magazine
- ✓ Advocacy in Washington on broad industrial base issues
- ✓ Continuous government-industry interface via industrial committees and working group activities.

"NDIA is the best organization on the block. NDIA has been able to get outside the hardware aspects of DoD." -- NDIA member

TOP ISSUES 2006

- ✓ Sustain the Defense Industrial Base
- ✓ Sustain Military Readiness While Continuing the Global War on Terrorism and Implementing Defense Transformation
- ✓ Improving the Integrity and Responsiveness of the Acquisition Process
- ✓ Improve Small Business Opportunities
- ✓ Strengthening the National Security Workforce

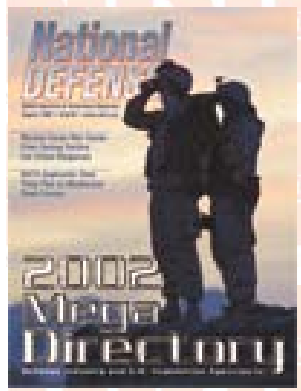
National Defense Industrial Association

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

"Your Premier Defense Association!"

Publications

- ✓ *National DEFENSE* Magazine – monthly coverage of defense developments, trends, and issues
- ✓ "Top Issues" -- published annually to outline key focus areas for NDIA efforts
- ✓ Mega Directory -- published annually in August issue of *National DEFENSE* - provides key information and POC's for corporate member companies and the DoD Acquisition community.



"I skim or read articles (in National DEFENSE Magazine)… because when dealing with clients, I like to be even or have a leg up on the (defense) industry in general." -- NDIA member

Defense Basic Research

NDIA 7th Annual S&E Technology Conference/DoD Tech Expo

Presented by

Dr. Bill Berry

Acting Deputy Under Secretary of Defense

(Laboratories and Basic Sciences)

18 April 2006

O1 OUSD(AT&L), 10/20/2003

Defense Basic Research

- ***Why do Basic Research in DoD?***
- ***Basic Research in context of Defense RDT&E***
- ***STEM Workforce/Education***
- ***Summary***

Main Purposes for Defense Basic Research

- ***Generate new knowledge and understanding as foundation for future defense technologies***
- ***Train scientists and engineers in key disciplines for defense needs***
- ***Sustain research infrastructure needed for continued performance of cutting-edge defense research***

DoD's Basic Research Program

- **Competitive, multifaceted program to enable revolutionary ideas**
  - University based, single investigators, broad areas
  - In-house laboratories for "smart buyer" and "essential capabilities"
  - Industry and services to exploit results
- **Flexible, balanced portfolio**
  - Long-term, mission orientation
  - Stable commitment to key capabilities (e.g., sensors)
- **Infrastructure support**
  - University personnel and students
  - Laboratories (lean, modern, focused)
- **Planning and oversight**
  - Link to top-down elements (S&T Strategy, DTAP, JWSTP, DTOs)
  - Basic Research Review
  - Service reviews, peer and merit reviews

FY07 RDT&E Budget Request

- All FY07 Dollars -

FY07 RDT&E request = $72.97B
(Budget Activities 1-7)

Components (All RDT&E)	$B
Army	10.86
Navy/ Marine Corps	16.91
Air Force	24.40
Def Agency & SOCOM	20.81

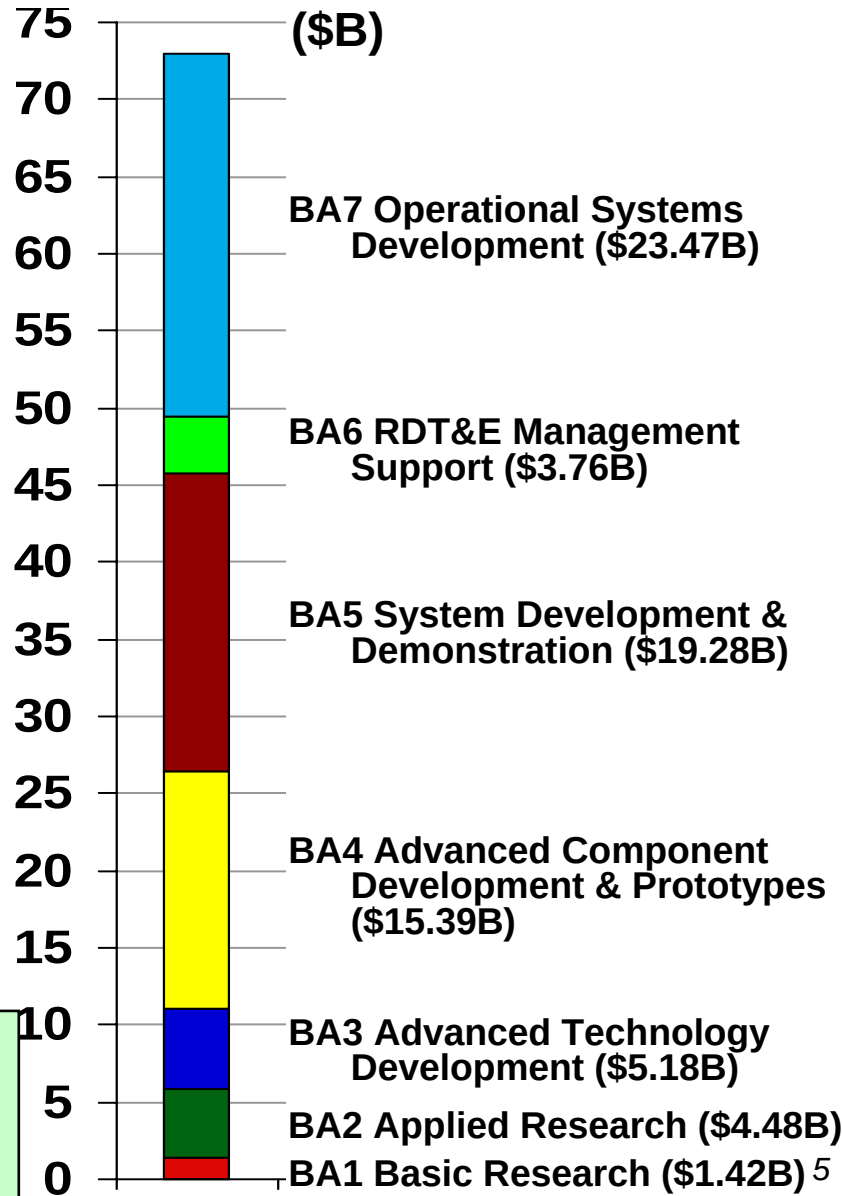
(BA6 + BA7 = $27.23B)

Development
(BA4 + BA5 = $34.66B)

Science and Technology
(BA1 + BA2 + BA3 = $11.08B)

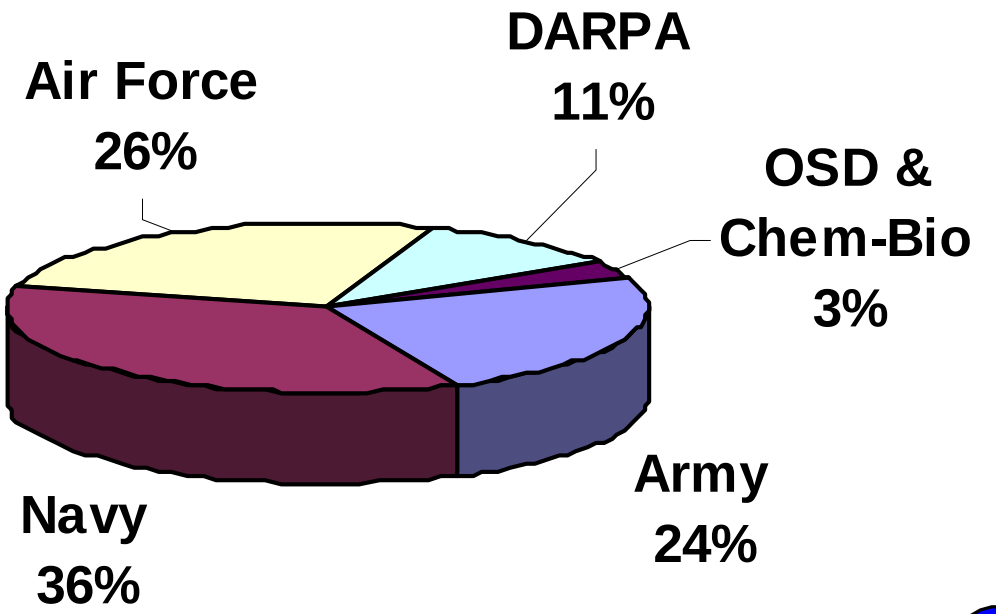
15.2% of RDT&E

Technology Base (BA1 + 2) = $5.90B)

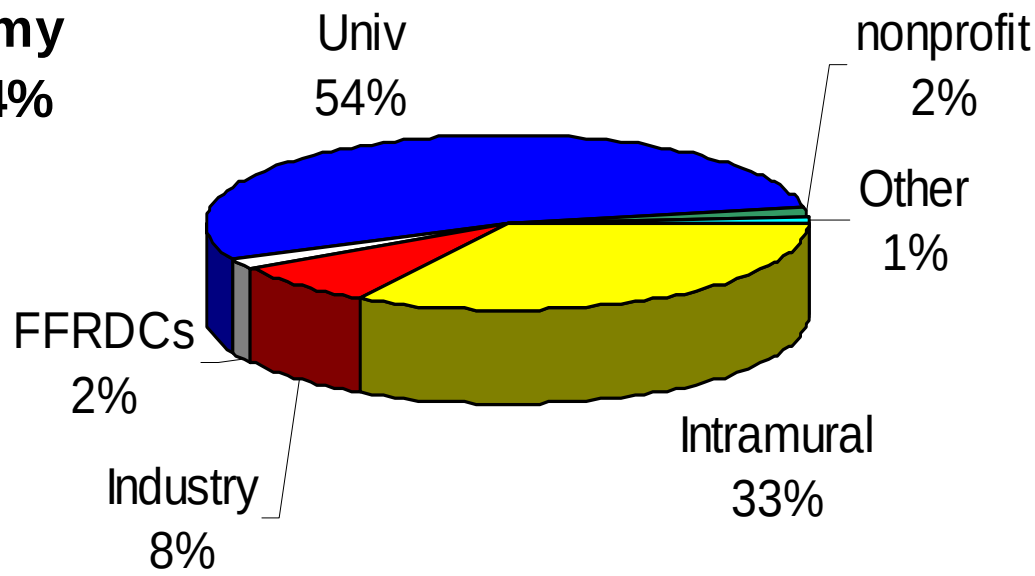


Source & Destination of Defense Basic Research Funding

←Source 86% of Defense Basic Research ($1.33B) is from Investments by Military Departments



Destination→ Performers of Defense Basic Research



Basic Research is Focused in Areas Important to Defense

- ***Invest in broad base of DoD-relevant areas across scientific and engineering disciplines***
- ***Broad base is complemented by six Strategic Research Areas, some of most exciting areas with high potential for DoD benefit:***

Bioengineering Sciences
Human Performance Sciences
Information Dominance
Multifunction Materials
Nanoscience
Propulsion and Energetic Sciences

- ***Complements other Federal agency investments. For example, while DoD provides only about 6% of total Federal investment in basic research, it provides:***

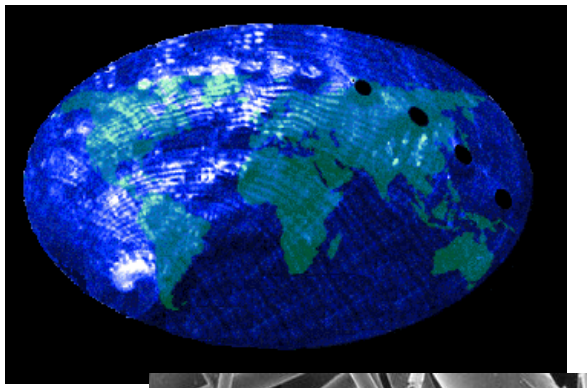
75% of Federal basic research funding in electrical engineering
66% of funding in mechanical engineering
40% of funding in mathematics and computer science

Basic Research Plan (BRP)

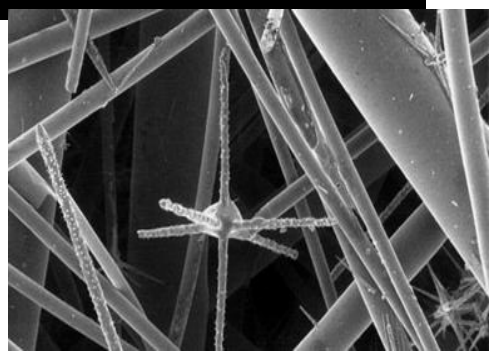
- ***Basic Research Areas***
  - **Physics**
  - **Chemistry**
  - **Mathematics and Computer Science**
  - **Electronics**
  - **Materials Science**
  - **Mechanics**
  - **Terrestrial and Ocean Sciences**
  - **Atmospheric and Space Sciences**
  - **Biological Sciences**
  - **Cognitive and Neural Science**

A Strategic plan guiding new technology development built around Basic Research Areas

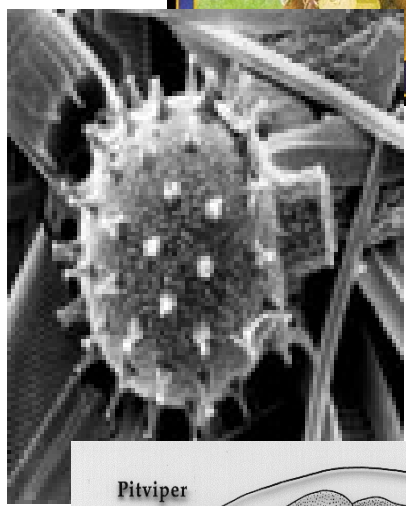
Bioengineering Sciences

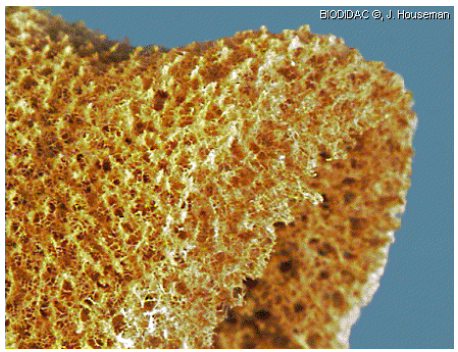


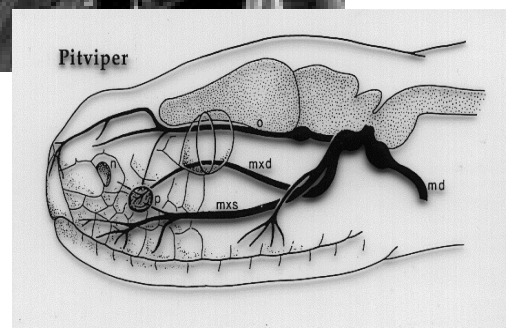
The science and technology of underlying design principles found in nature to enable the development of novel synthetic materials, processes, and sensors.



- Biomaterials
  - -Bioceramics
  - -Hybrid structures
- Bioprocesses
  - -Vision systems
  - -Auditory systems
  - -Networks
  - -Neural computation
- Biosensors
  - -Artificial nose
  - -Stochastic sensing
  - -electronic eyes



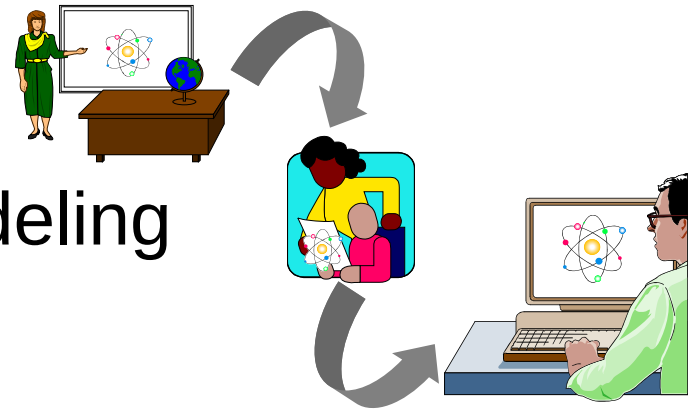




DoD Applications: Lightweight armors, Biochem sensors, smart sensors, bio-robotics

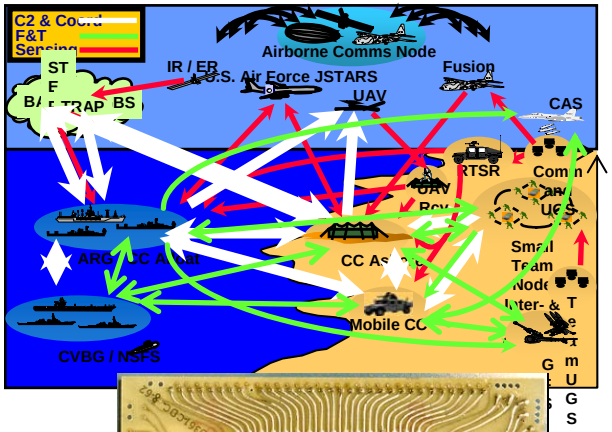
Human Performance Sciences

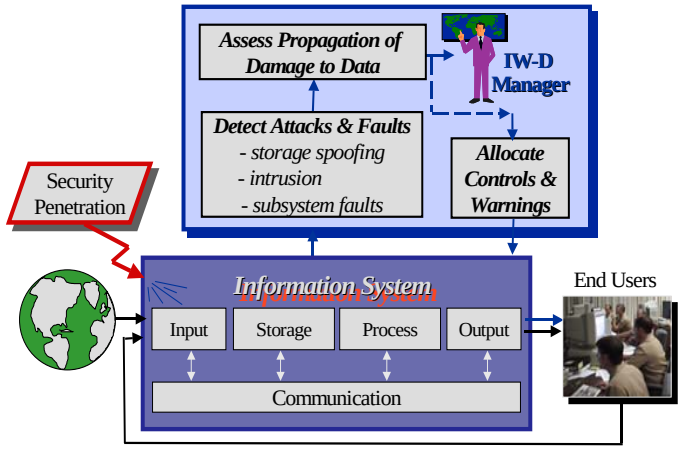
Objective: To investigate the following **Thrust Areas**:

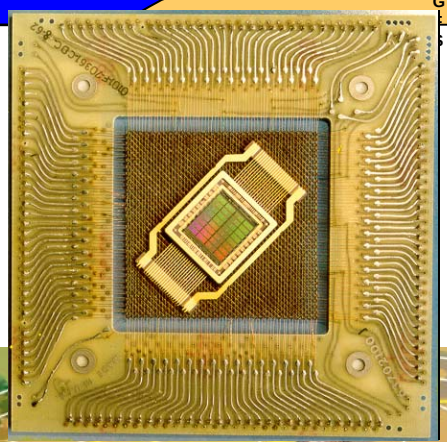


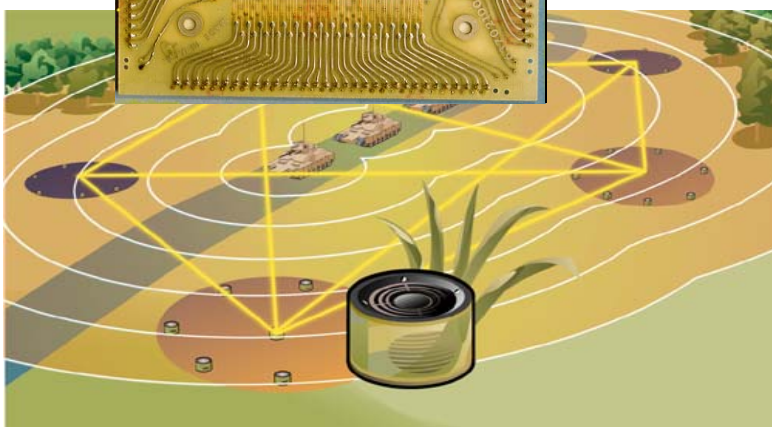
- Cognitive Performance Modeling
- Human-System Interfaces
- Physiology of Stress
- Intelligent Training
- Distributed/Collaborative Decision Making

Information Dominance







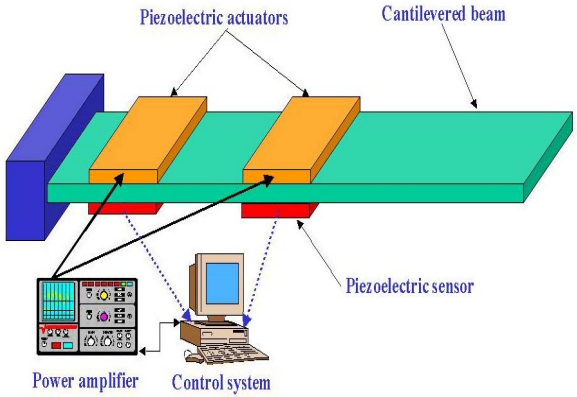


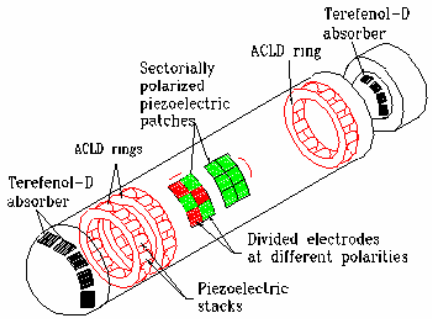
Basic science and engineering research on the fundamental principles and techniques of information acquisition, storage, processing, distribution, and display.

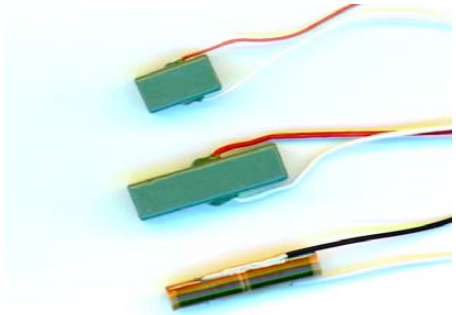
Computers, Communication, Networks, Information integration, displays, software.

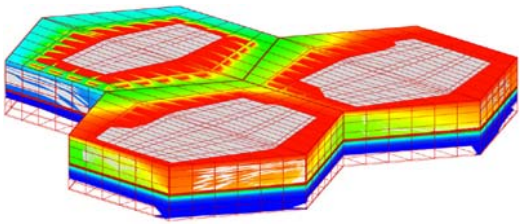
DoD Applications: C4ISR, Battle management, Surveillance, Sensors, Security, Information Assurance.

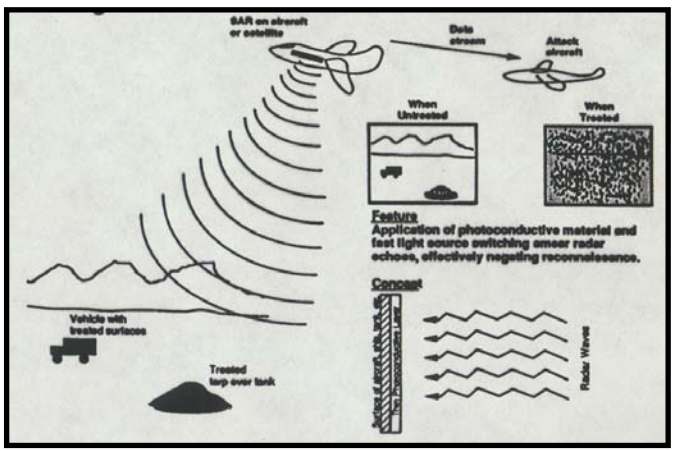
Multifunction Materials









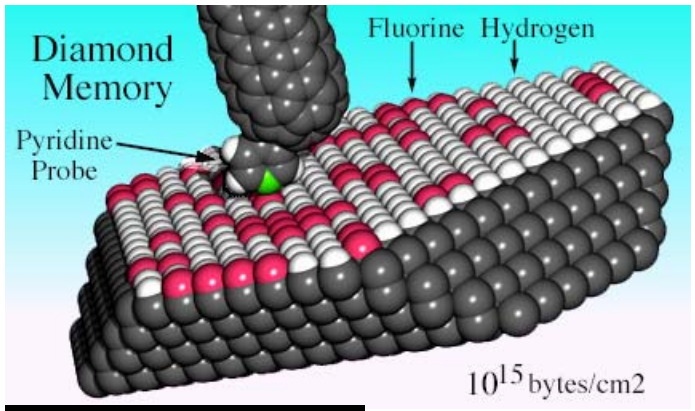


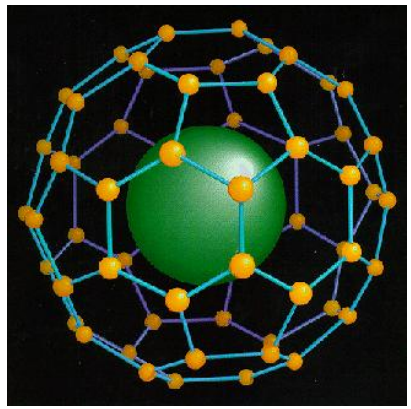
The Scientific investigation of materials and structures that can adapt to changes in the environment.

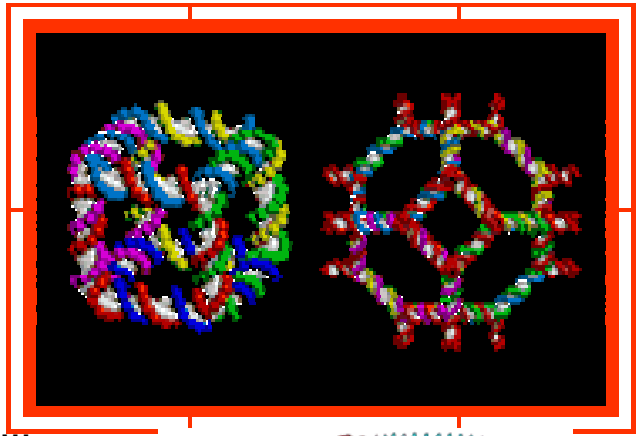
- Elastic active materials
- Smart skins and coatings
- Distributed sensors and actuators
- Armor materials by design
- Adaptive structures

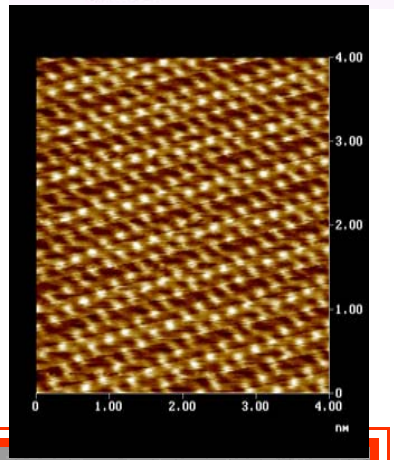
DoD Applications: Ultraquiet submarines, adaptive flight control, vibrational control, advanced stealth, armor materials.

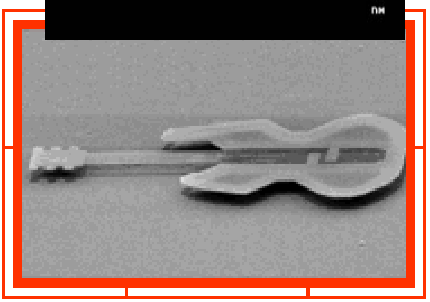
Nanoscience/Nanotechnology



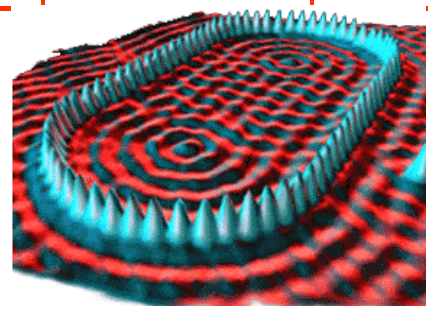






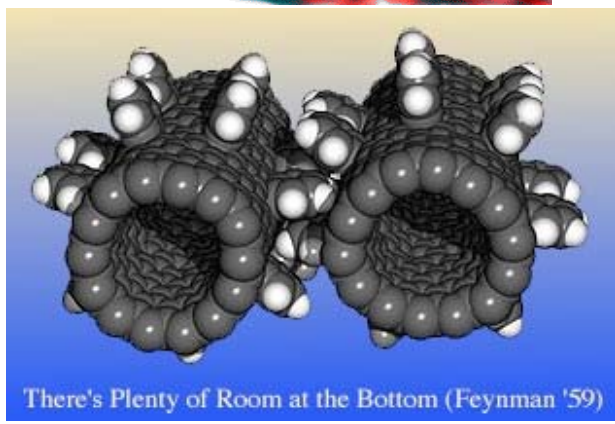


The science and technology of controlling and manipulating things at the atomic layer and nanometer (10^{-9} m) scale.



- Fabrication, synthesis, and processing of materials with predetermined properties
- Characterization, novel phenomenon, and properties for structural, electronic, and biological materials
- Nanoscale concepts and devices

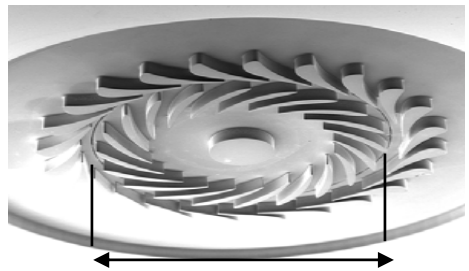
DoD Applications: Electronics, computers, Biochem sensors



Propulsion & Energetic Sciences

Exploit new concepts to achieve significant improvements in the performance of power and energy sources including compact power for portable field equipment.

- Compact Power Sources
- Energy Dense Materials and Systems
- Power Dense Materials and Systems
- Advanced Propulsion Systems



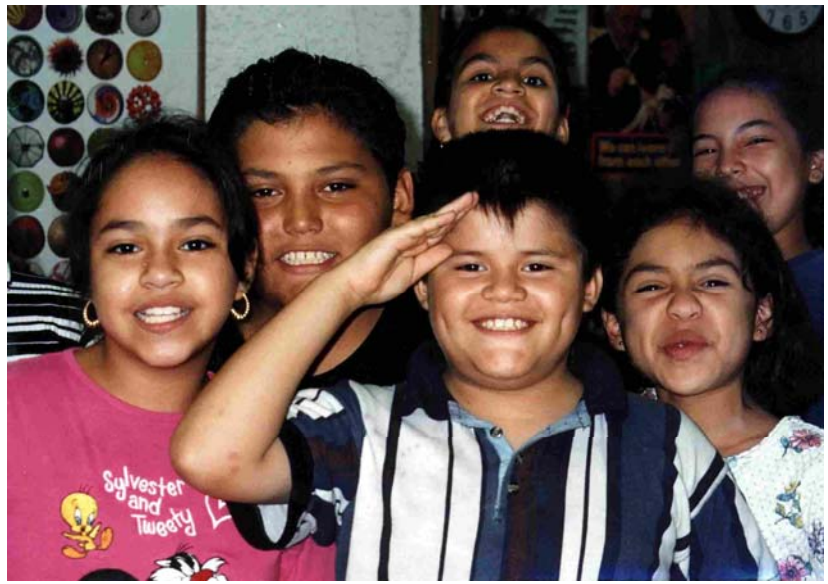
Miniaturized gas turbine

Basic Research Program Components

- University Single Investigators (3yr; < $200 K/ yr)
- Multidisciplinary University Research Initiatives (MURI)
  (3-5 yr; ~ $1-1.5 M/ yr)
- University Centers (3-5 yr; $1-2 M/ yr)
- University Affiliated Research Centers (UARCs)
  (5-8 yr; $5-10 M/ yr)
- Collaborative Technology Alliances (Industry-ARL-University)
  (5-8 yr; $5-8 M/ yr)
- Defense University Research Instrumentation Program (DURIP)
  ($50 K - $1 M)
- National Defense Science and Engineering Graduate Fellowship Program (~30 K Stipend + Tuition/Costs)
- DoD Laboratories Research (33% of Program)

DoD STEM Workforce

- **DDR&E Role: STEM**
  - **Science, Technology, Engineering and Mathematics Policy and Standards**
- ***Concern:***
  - ***Inadequate supply of clearable S&E's in areas critical to national defense.***
- ***Objective:***
  - ***Ensure the DoD Science an Engineering Workforce needs are met***
- ***Approach:***
  - ***Identify & advance effective, replicable programs***
  - ***Graduate, undergraduate, K-12***
  - ***Create pathways into mission critical S&E careers***
  - ***Build partnerships with Industry, Academia, other government***



DoD S&Es as % of Total Fed S&Es

Source: Pre-release - OPM data for NSF pub, Table B-14. Federal scientists and engineers, by agency and major occupational group: 1999-2002

	1997	1998	1999	2000	2001	2002
Total S&Es	46.6%	45.8%	44.2%	43.5%	43.1%	43.4%
All sci	28.0%	27.4%	26.1%	25.4%	25.6%	26.9%
Comp/Math sci	48.8%	47.6%	45.5%	43.9%	44.0%	45.3%
Life sci	12.2%	12.0%	11.4%	11.2%	11.0%	10.9%
Physical sci	28.2%	27.5%	26.7%	26.2%	26.1%	26.2%
Social sci	21.9%	21.4%	20.4%	20.4%	19.7%	19.6%
All eng	67.3%	67.0%	66.7%	66.4%	66.2%	66.7%
Aerospace	46.7%	45.2%	44.7%	43.6%	43.0%	42.8%
Chemical	61.3%	60.8%	62.3%	63.6%	65.7%	67.6%
Civil	62.1%	61.8%	61.8%	61.3%	60.6%	60.1%
EE&Comp	79.4%	79.4%	79.3%	79.1%	78.5%	79.1%
Industrial	83.8%	82.4%	81.1%	80.2%	79.4%	79.4%
Mechanical	88.2%	88.2%	88.2%	88.2%	88.4%	89.2%
Other eng	54.5%	54.7%	54.6%	55.1%	55.5%	55.9%

(Next NSF Publication expected February of 2007 (2003-2006 data))

National Defense Education Program

- **Enables comprehensive approach to education and training = <u>Shaped Workforce</u>**
  - Scholarship/Fellowship Pilot
  - US Citizens, Recruitment & Retention
  - Defense Critical Disciplines
  - Employment Payback requirement
  - Noncompetitive appointment authorized
  - $2.5M fully funded 30 awards in FY05 (up to 2 years of support)
- Provides both Academic and Non-Academic elements (within program $)
- Employee status while enrolled
- $10M for 2006 is expected to fully fund ~75 awards
- Planned effort expected to meet 10% of anticipated needs over 10 years
- Program Expected by Naval Postgraduate School for DoD

Defense Basic Research

- Fundamental, long-term
- Multifaceted
- Broad Based and Strategic
- “Effective” in
  - Generating new knowledge
  - Training new Scientists/Engineers
  - Sustaining research infrastructure
- Creates novel technical options/capabilities

Contact Information

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Test and Evaluation/ Science and Technology (T&E/S&T) Program

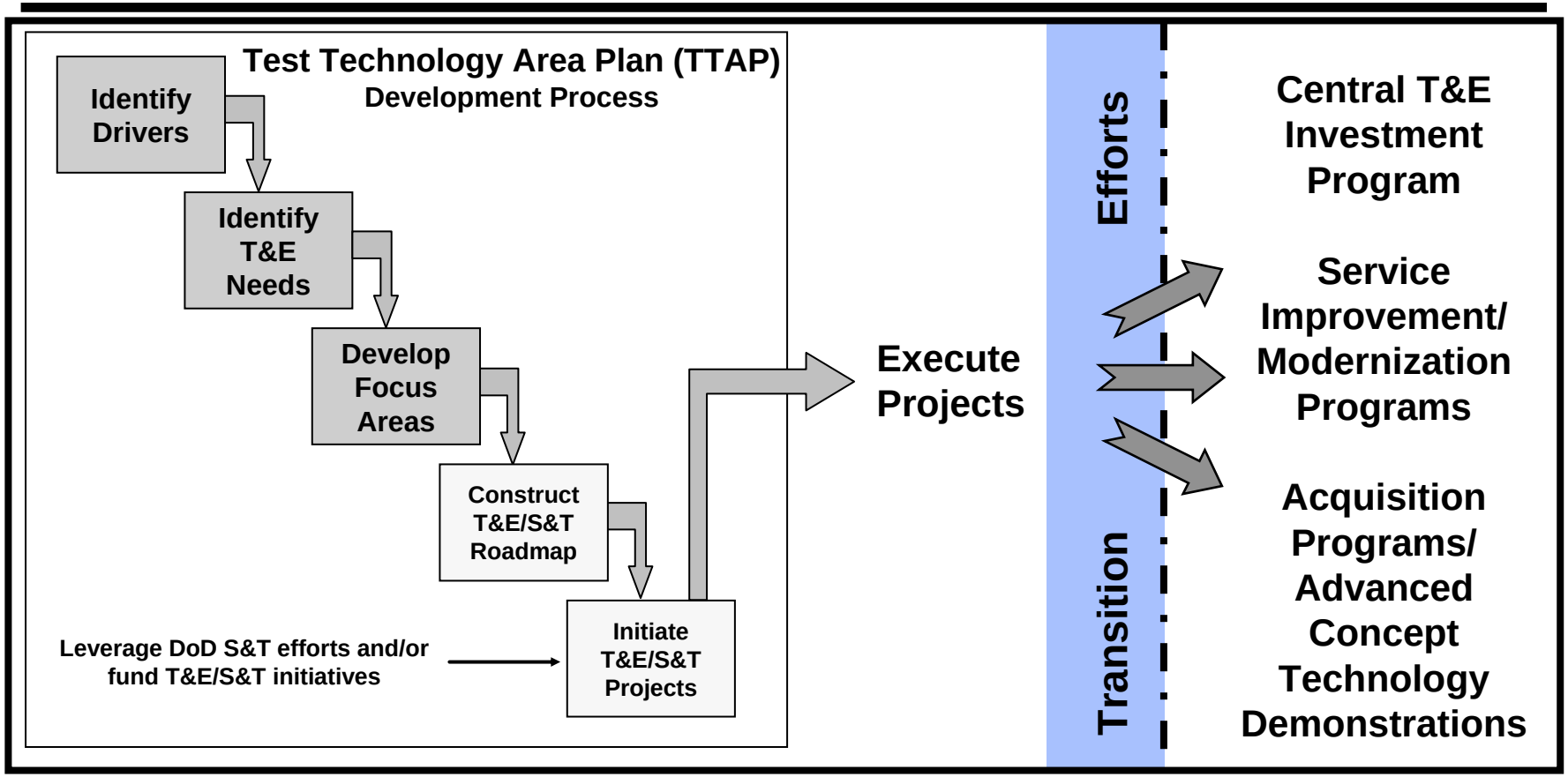
7th Annual Science & Engineering Technology Conference
18-20 April 2006

Dr. Mark Brown
T&E/S&T Principal Scientist
Test Resource Management Center
(703) 681-4166 x 126
mark.d.brown.ctr@osd.mil

T&E/S&T Program
Background

- **Program started in FY 2002**
  - Joint DDR&E/DOT&E initiative
  - Transitioned to DTRMC in Feb 2005
- **Mission**
  - Develop new technologies required to test and evaluate our transforming military capabilities
    - Includes any system that makes our warfighters more survivable and effective in combat
      - Lethal and non-lethal weapons
      - Intelligence, surveillance and reconnaissance
      - Information systems
- **Goal**
  - Transition emerging technologies into test capabilities in time to verify warfighting performance

T&E/S&T Program Process



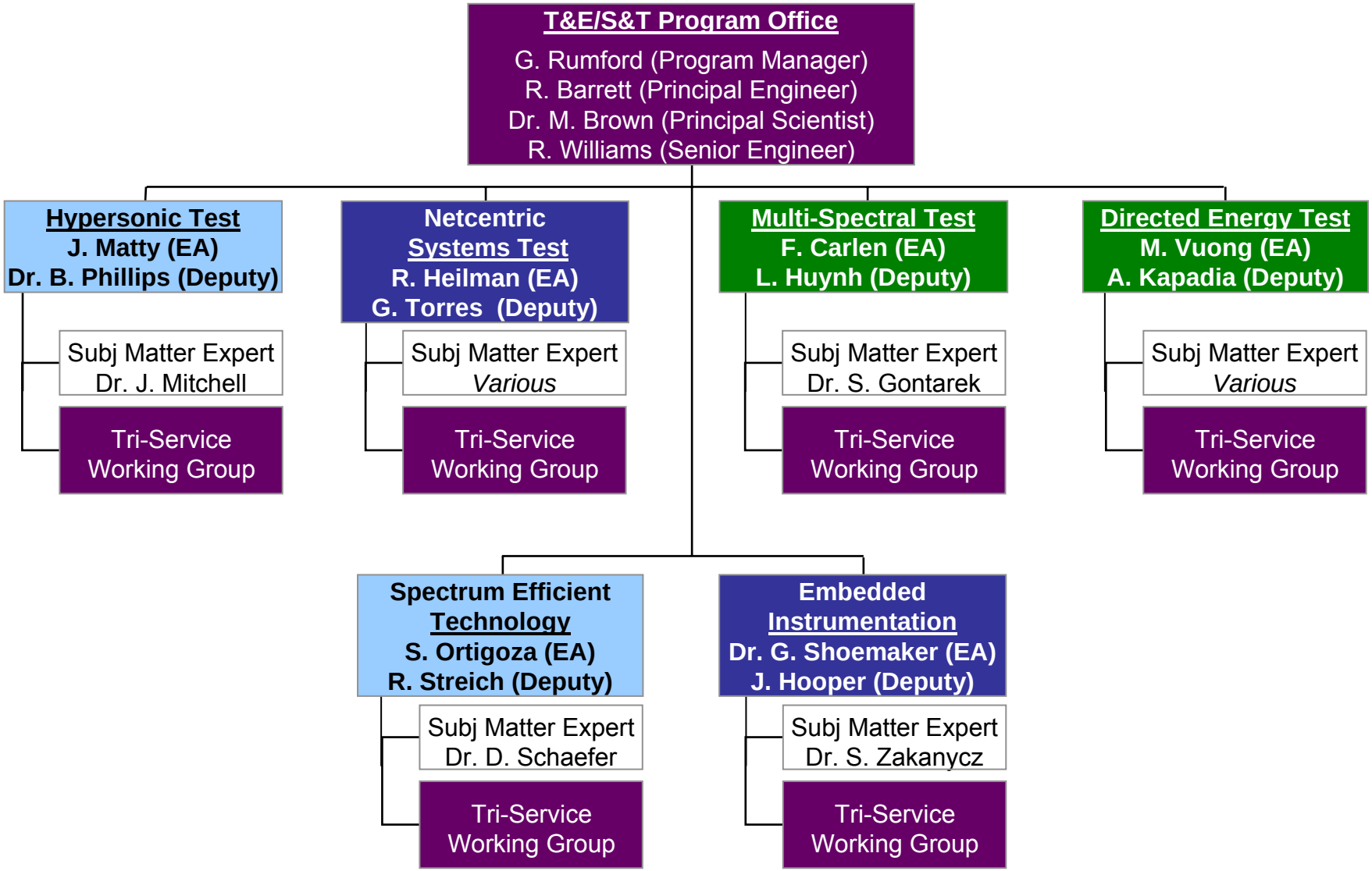
- Process used to identify focus areas
  - 6 currently active

T&E/S&T Program
Active Focus Areas

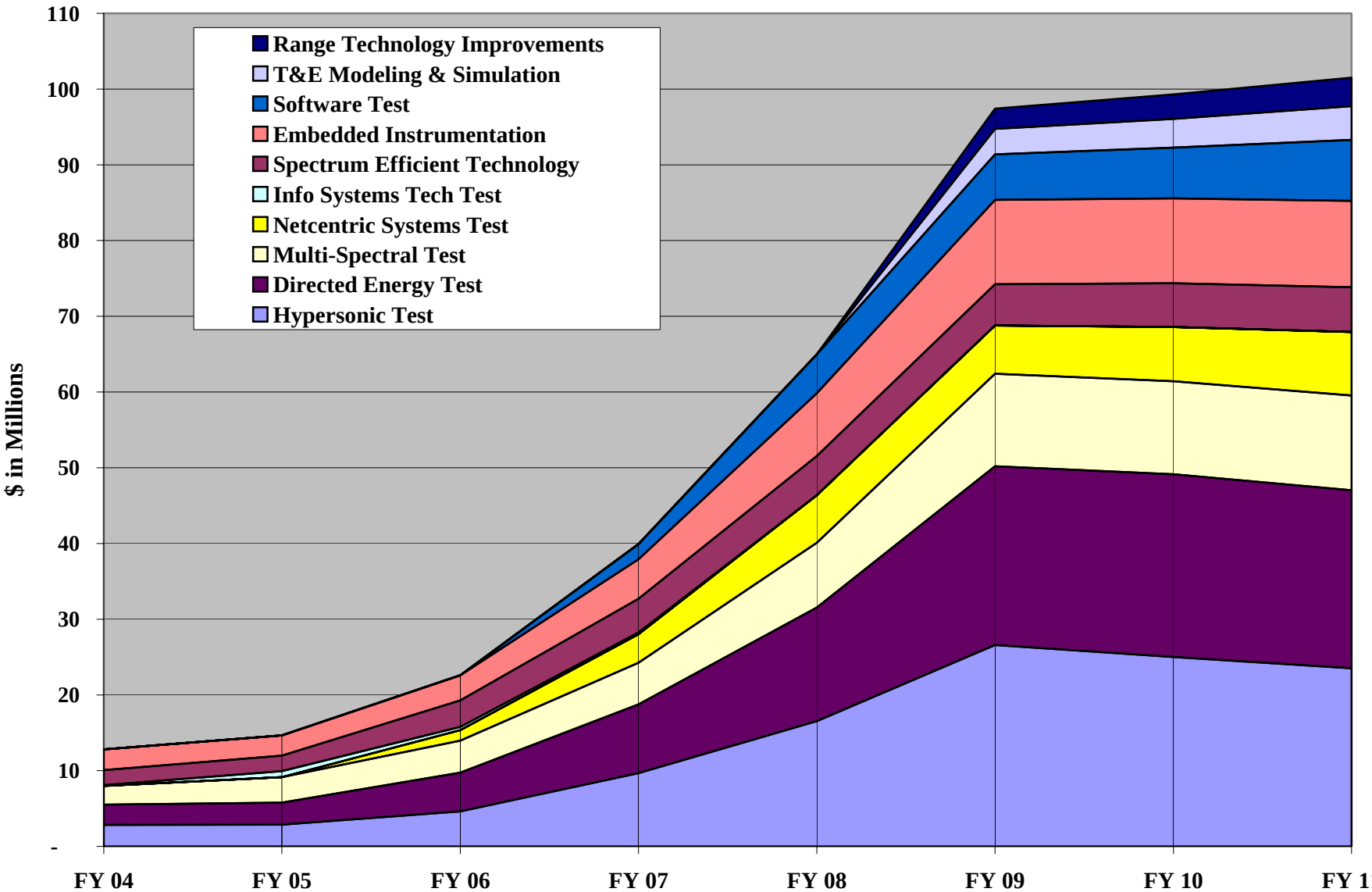
Test Technologies for

- Emerging Warfighting Capabilities
  - Hypersonic Vehicles
  - Directed Energy Weapons
  - Multi-Spectral / Hyper-Spectral Sensors
  - Net-Centric Warfare Systems
- Enhanced Test Capabilities
  - Spectrum Efficient Technology
  - Embedded Instrumentation
- 65 projects active across focus areas

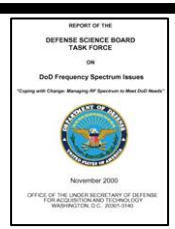
T&E/S&T Program Structure



FY 2004 – 2011 Budget Projections



T&E/S&T Program
Project Selection Process

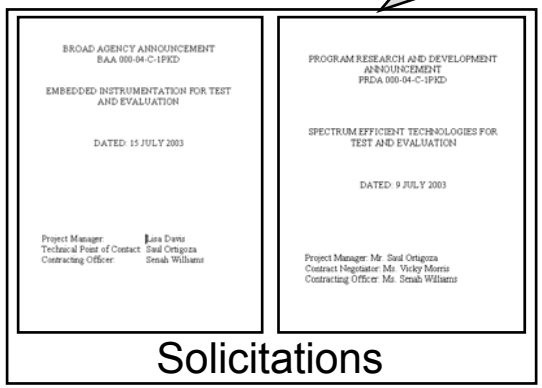


Tri-Service Focus Area Working Group

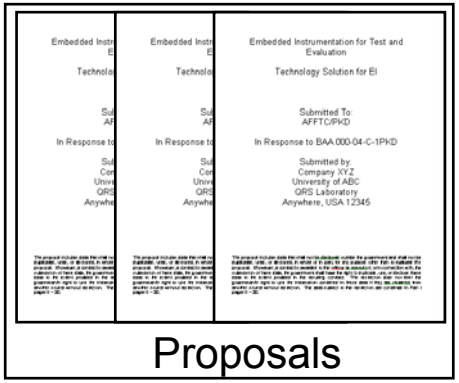
- Executing Agent
- T&E Community Reps
- S&T Community Reps
- Subject Matter Experts

Needs/Requirements

Solicitations are issued through http://www.fedbizopps.gov



Solicitations



Proposals

Source Selection Evaluation Team

- Working Group
- Subject Matter Experts
- Contracting Reps

Recommendations

Executing Agent

Final Selections

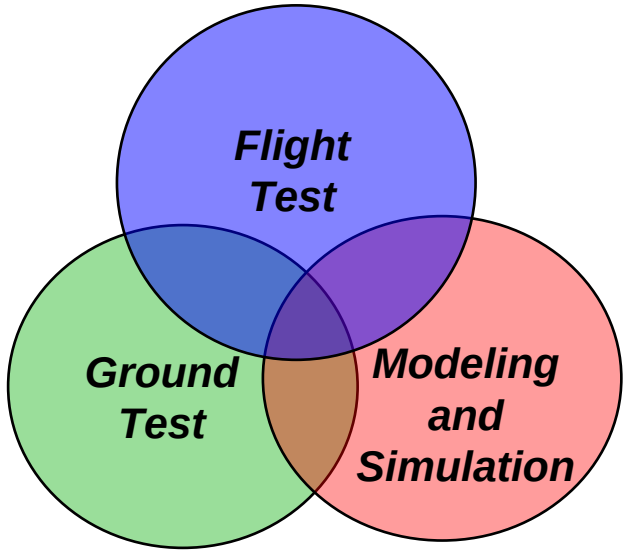
Program Manager

Focus Area Execution

Funding Decision

T&E/S&T Program
Hypersonic Test Focus Area

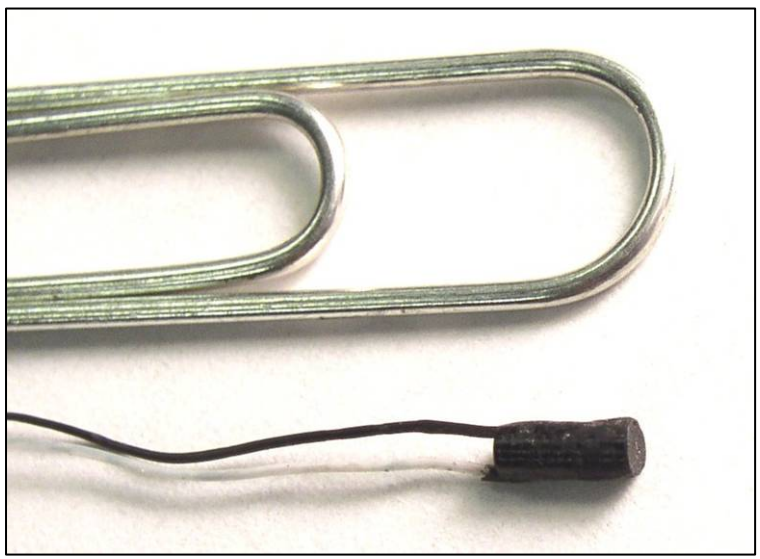
- **Hypersonic technology potential for rapid, long range targeting**
- **DoD hypersonic research efforts slated to transition technology to hypersonic weapon systems 2010+ timeframe**
  - National Aerospace Initiative
  - DARPA/Navy HyFly
  - Air Force Single Engine Demonstrator
- **Existing infrastructure inadequate to test envisioned systems**
  - Lead time away from meeting T&E needs
- **Need new T&E capabilities**
  - Ground test
  - Flight test
  - Modeling and Simulation
- **Supports T&E within DDR&E National Aerospace Initiative:**
  - High Speed/Hypersonics
  - Space Access
- **14 active projects**



Heat Flux Sensor Development for Hypersonic Aerothermal Measurements *–Hypersonic Test–*

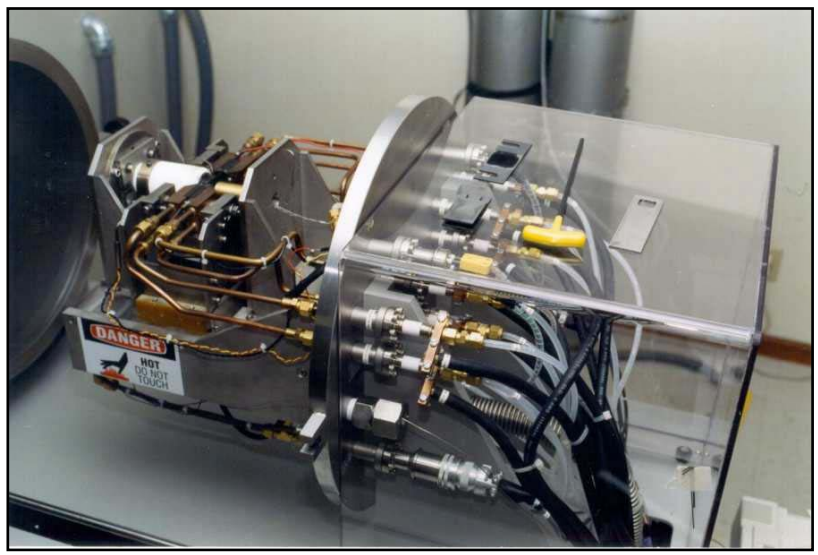
Developing miniaturized heat flux sensors with the following performance characteristics:

- Continuous operation at 700° F
- Calibration to 50 Btu/ft^2-sec
- 0.0625 inches in diameter
- Compatible with embedding in Systems Under Test



0.0625 inch diameter heat flux sensor prototype

Calibration unit



Allows measurement of heat flux to support ground and flight testing of hypersonic vehicles

T&E/S&T Program
Directed Energy (DE) Test Focus Area

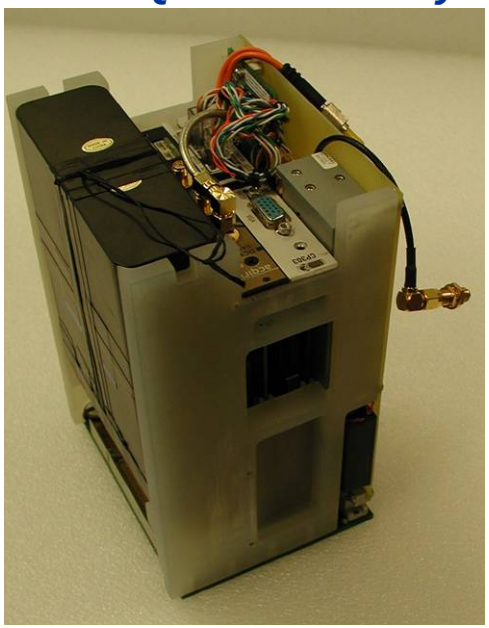
- **DE is revolutionary/transformational**
  - Focus has been on developing DE technologies, not how to test DE
  - Very little DE T&E legacy exists (infrastructure, methodology, expertise)
- **Need test technologies for:**
  - Survivable on-board instrumentation required to measure the DE beam on the target
  - Measuring the effects of DE on the target
  - Instrumentation that minimizes impacts on target performance and signature
  - Instrumentation to determine performance margins and reasons for success and failure
  - Evidence of the degree of hard kill and soft kill
  - Far field simulations in near field conditions
- **Supports T&E within DDR&E Initiative: Energy and Power Technologies**
  - Power sources for DE weapons
- **15 active projects**

Directed Energy Data Acquisition Transformation

–Directed Energy Test–

- Developed a HPM hardened Compact Remote Data Acquisition System (CRDAQ) to replace analog Fiber Optic transmitters and oscilloscopes
  - Eliminates high-maintenance analog fiber optic links
  - 10-bit resolution increases dynamic range from 32 dB to over 40 dB
  - Automatic built-in calibration
  - 110 dB total dynamic range
  - Overall dimensions: 8.375” x 4.75” x 5.25”
- Developed simultaneous trigger and a breadboard 3-axis probe for HPM testing

CRDAQ Subassembly



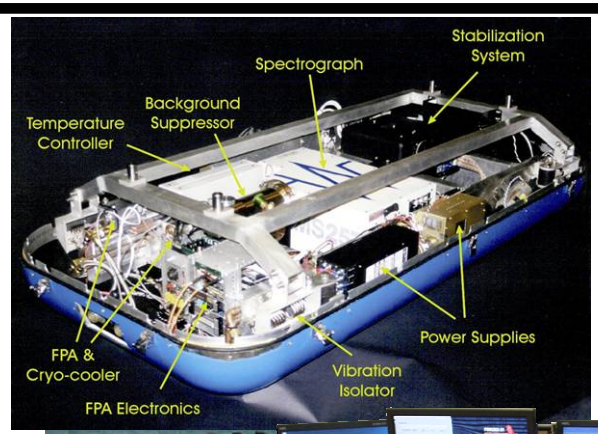
Prototype CRDAQ

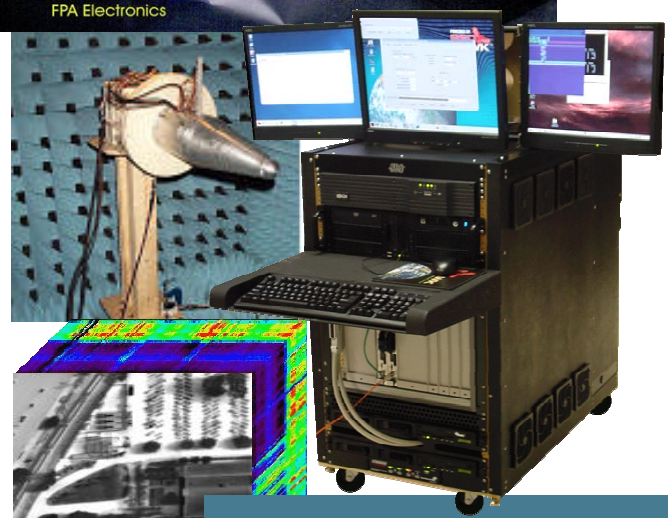
CRDAQ with open top

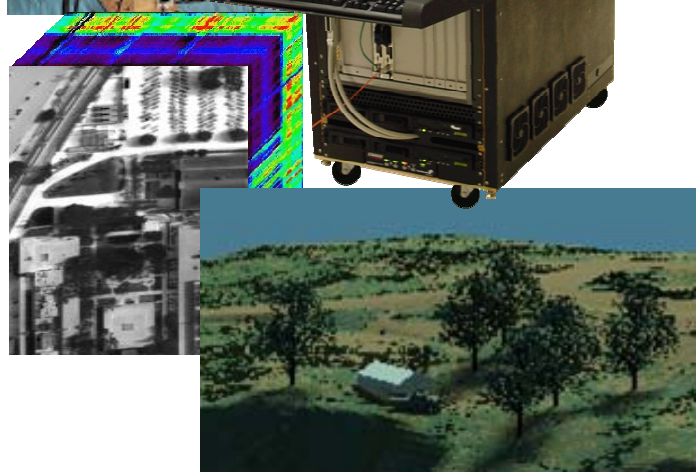
Enables T&E of High Power Microwave systems

T&E/S&T Program
Multi-spectral Test Focus Area

- **Next-generation focal plane array sensors and seekers will operate through RF, UV, visible, and IR bands**
  - Need affordable processors to create scenes for T&E
  - Presentation options require wide dynamic range, fast frame rates, and realism
  - Need performance metrics that are based on scientific analysis and describe system attributes in operational terms
- **Need an end-to-end multi-spectral test capability**
  - Robust, scalable, and affordable
- **Supports T&E within DDR&E Initiative: Surveillance and Knowledge Systems**
  - Sensors and unmanned vehicles
- **5 active projects**





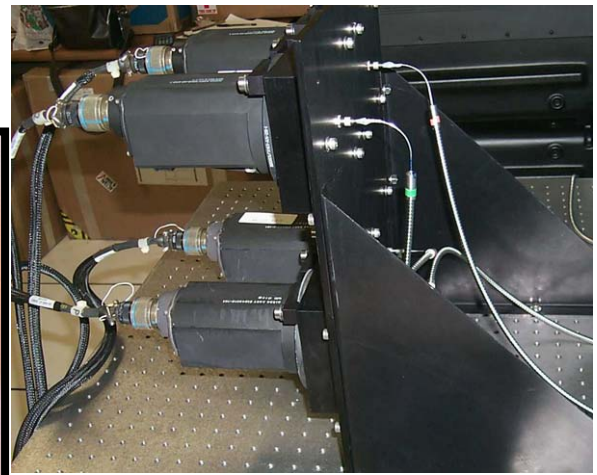


Ultraviolet (UV) Light Emitting Diodes (LEDs) for T&E

–Multi-Spectral Test–

- **Conducting a technology assessment of deep UV LED sources against the developed requirements**
  - Transition results to CTEIP's Joint Mobile Infrared Countermeasures (IRCM) Testing Systems (JMITS) project

UV-LED



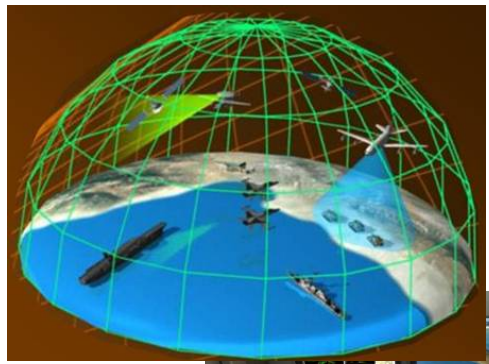
Test Rig

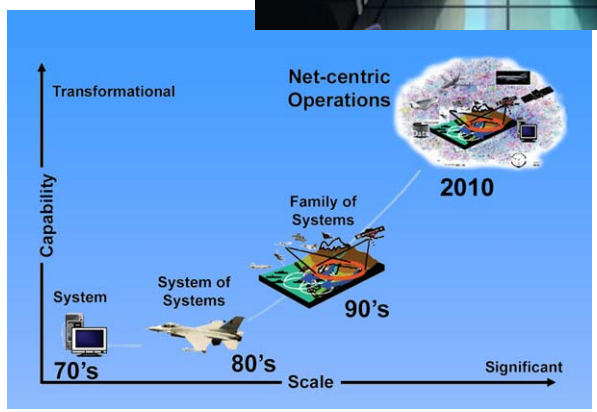
UV Output

Provides an ultraviolet source to support T&E of Infrared Counter Measures

T&E/S&T Program
Netcentric Systems Test Focus Area

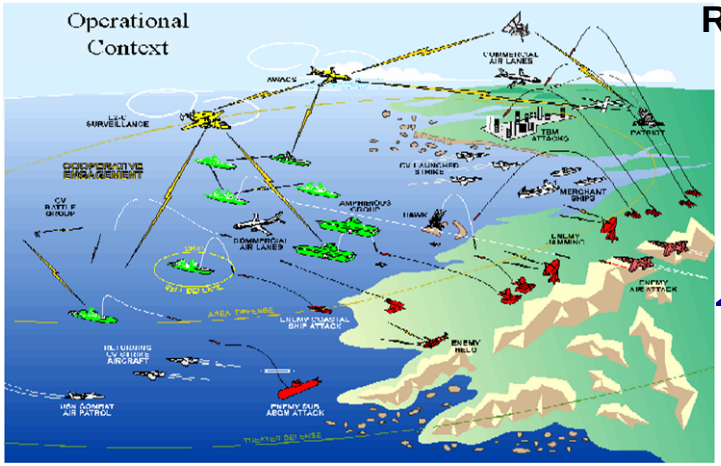
- **Information systems are a "force multiplier" in U.S. military operations**
  - Command & Control
  - Operational Pictures/Intelligence, Surveillance & Reconnaissance (ISR)
- **Emerging, powerful information systems technologies—drive toward network centric warfare**
  - Information Assurance (IA) to protect computer networks, information, and information systems
  - Seamless, secure, self-organizing, self-healing, tactical and global communications networks
- **Need non-intrusive, network centric test technologies**
  - Assess performance of networks of networks with multiplayer simultaneous activities
  - Evaluate the effectiveness of IA
  - Assess information/knowledge management
  - Test the functions of decision making systems, including the actions of intelligent agents
- **Supports T&E within DDR&E Initiative:**
  - Surveillance and Knowledge Systems
- **2 active projects**





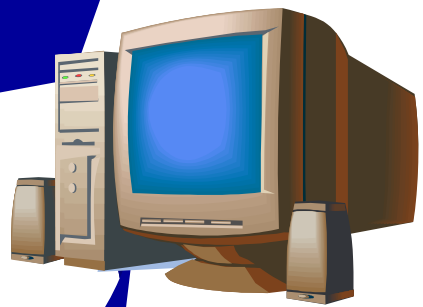
Tactical-Report Generation Test Bed

–Netcentric Systems Test–



Record Real-World Event Messages

Generate Baseline Choreographed Event "Fill in the Blanks"



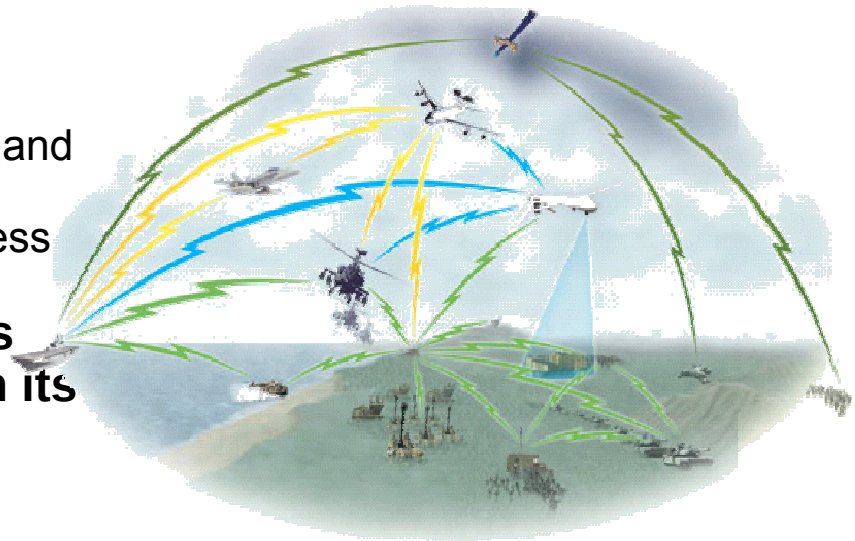
Inject Ambiguity and Uncertainty

Provide Realistic Test Input

Developing a realistic report stream generator with "generated ground truth" to enable T&E of advanced Netcentric architectures

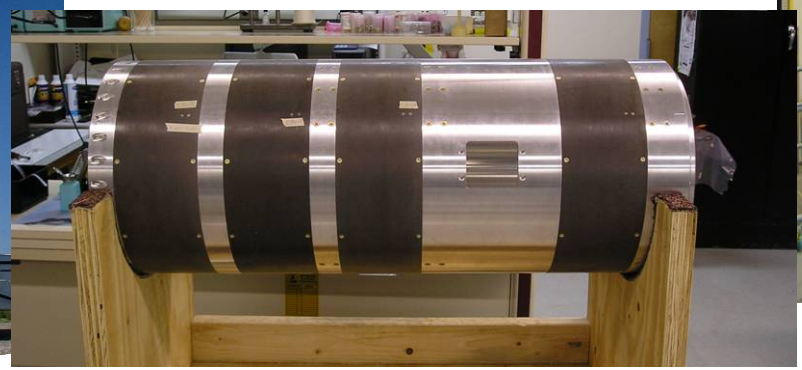
T&E/S&T Program
Spectrum Efficient Technology Focus Area

- **Growth in demand for consumer communication services**
  - Traditional bands for T&E (L and S), ideally suited for telemetry because of propagation and supportable data rates
  - Same bands desirable for commercial wireless comm
- **Each new generation of military systems generates over ten times more data than its predecessor**
  - F-15 development ~256 Kbps
  - F-22 development ~10 Mbps
- **Need more spectrum for T&E**
  - More efficient L and S band operations
  - Expand into Super High Frequency (SHF)
  - Explore Optical Band
- **DDR&E Initiative: Surveillance and Knowledge Systems**
  - High Band Width Communications/Information Assurance
- **14 active projects**



X-Band Tracking
–Spectrum Efficient Technology–

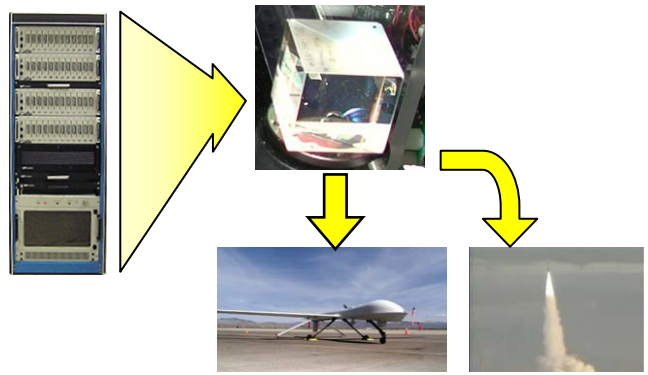
- Demonstrated ability to conduct telemetry operations in highly dynamic environment in the SHF band
  - **Modified an S-Band Telemetry Tracking System to operate in the X-Band**
  - **Incorporated an X-band payload into a rocket**
  - **Successfully tracked rocket and received telemetry at 7.975 GHz**

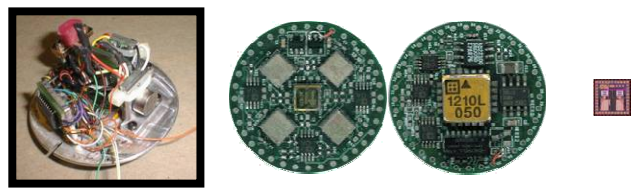


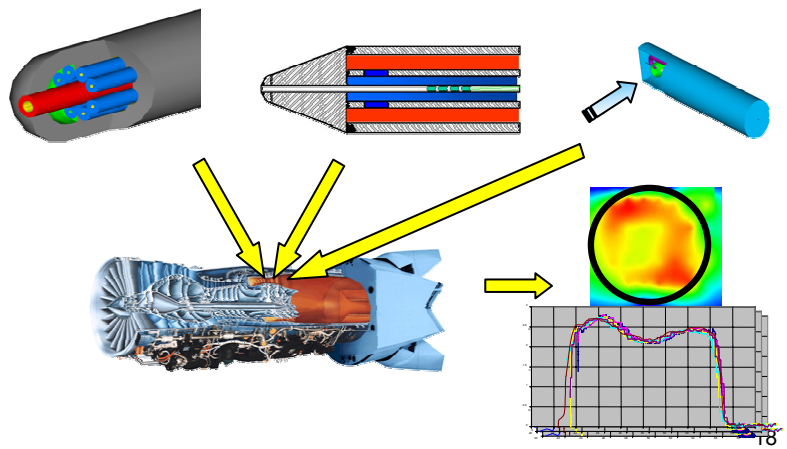
Supports DoD efforts to obtain additional telemetry spectrum

T&E/S&T Program
Embedded Instrumentation (EI) Focus Area

- **Military systems smaller, more capable, complex, interdependent, and interoperable**
  - Scarce space for sensors, wiring, and data processing and storage
  - Must minimize effects of instrumentation to the signature/ performance of the system-under-test
- **EI has the potential for providing cost savings and enhancing force readiness**
  - Key is to design EI in up front
  - CJCSI 3170.01C—The Initial Capabilities Document (ICD) and the Critical Development Document (CDD) must include consideration for EI
  - Director, J-6, Joint Staff will ensure that CDDs and Critical Production Documents (CPDs) include EI in systems tradeoff studies
- **Need technologies and architectures for non-intrusive, survivable instrumentation suites**
  - Both plug-and-play and open architectures
- **Supports T&E within DDR&E Initiatives:**
  - NAI
  - Surveillance and Knowledge Systems
  - Energy and Power Technologies
- **15 active projects**







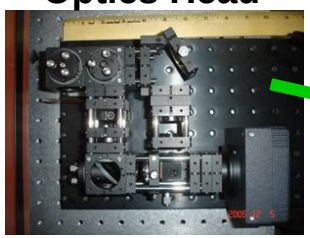
Compact Holographic Data Storage

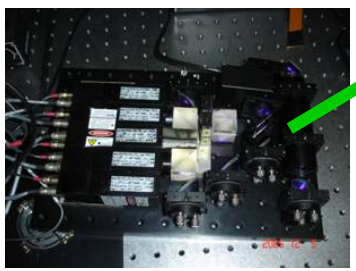
–Embedded Instrumentation–

Developed a brassboard compact holographic memory package that will support high-density, high-rate data recording. Brassboard system demonstrated:

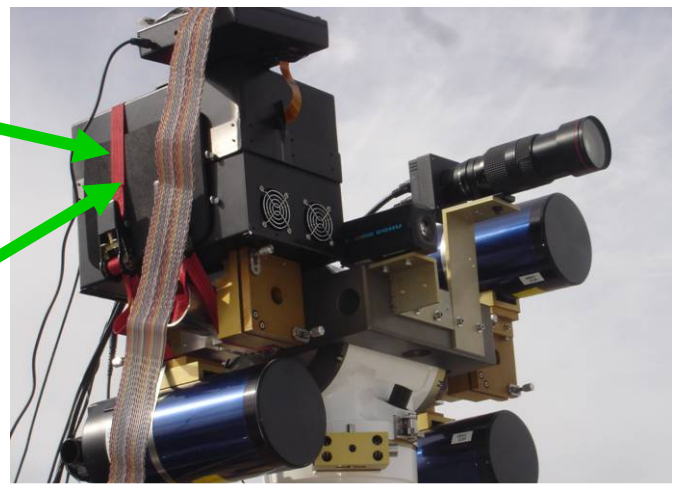
- Storage density = 767 Gigabytes
- Bit Error Rate = 1 x 10^{-9}
- Writing transfer rate = 1 Gigabits/sec
- Reading transfer rate = 1 Gigabits/sec

Optics Head





Blue diode laser source



Holographic Memory Data Storage brassboard on tracking mount

Reconstructed stored images

Enables the collection and storage of massive amounts of data required during the T&E events of advanced weapon systems

T&E/S&T Program
Wrap Up

- **T&E/S&T program initiated to address critical T&E needs, tied to S&T drivers**
  - 65 active projects across 6 focus areas
- **Sustained growth and demonstrated value**
  - Mature focus areas transitioning technology into test capabilities
- **Keys to continued success**
  - Participation of Services on Joint needs definition
  - Good mix of industry, laboratories and universities working on solutions
  - Participation of Services, industry, laboratories and universities to transition technologies to T&E capabilities

Shaping Technology into Tomorrow's T&E Capabilities

Comprehensive Maritime Awareness (CMA)

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18 Apr 2006
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The MDA Imperative

- 9/11 Commission Report
  - **“Practically every aspect of US counterterrorism strategy relies on international cooperation.”**
  - **“Coordinate the resolution of the legal, policy, and technical issues across agencies to create a ‘trusted information network’.”**

- National Security Presidential Directive NSPD-41; Homeland Security Presidential Directive HSPD-13**, December 21, 2004: Maritime Security Policy**
  - **“. . . Identify threats to the Maritime Domain as early and as distant from our shores as possible”**
  - **“Ensuring the security of the Maritime Domain must be a global effort, in which USG efforts are developed and furthered with the support of other governments . . . “**

- The National Defense Strategy of the United States of America**, March 2005**
  - **“The United States cannot achieve its defense objectives alone. Our concept of active, layered defense includes international partners.”**

The MDA Imperative (cont)

- **National Plan to Achieve Maritime Domain Awareness (Second Coordination Draft)**
  - **Plan of Action: Engage and Enhance International Partnerships, Strengthen Interagency Relationships, Remove Barriers to Information Sharing**

- **Strategy for Homeland Defense and Civil Support, DRAFT September 13 2004**
  - **"Achieve maximum awareness of potential threats."**
  - **"Together with domestic and international partners, DOD will integrate information from a wide range of sources."**

- **DoD Directive 8320.2, Data Sharing in a Net-Centric Department of Defense, December 2, 2004**
  - **Mandates application of DoD Net-Centric Data Strategy**

Comprehensive Maritime Awareness

FY06 JCTD Proposal
For
International Cooperative Development
With
Republic of Singapore (RoS)

	US	Singapore
Oversight Executive	Mr. Chris Vogt	DCE(T) / D(C4IT)
COCOM Sponsors	PACOM, EUCOM, NORTHCOM	NPLD
Lead Service	US Navy	Singapore Navy
Operational Managers	PACOM/COMPACFLT	HNO
	NORTHCOM	
	NAVEUR	HJCIS
Technical Manager	Mr. Chris Dwyer	DSTA
Transition Manager	PEO(C4I&Space)	NSuWC

Problem

Serious gaps exist in identifying and prioritizing world-wide maritime threats

- **Maritime security and defense forces lack the capabilities and capacities to provide timely and accurate maritime situational awareness**
- **Lack automatic tools to identify and prioritize relevant and actionable information to avoid information overload**
- **Inability to acquire, fuse and manage disparate information limits timely cueing and focus**
- **Information sharing (technical, cultural) barriers limit the effectiveness of partner nations**

Searching the haystack for a needle: Lack of actionable maritime information leads to missed opportunities for interdicting terrorists, WMD proliferation, piracy, trafficking and smuggling

CMA JCTD

Vision:

Track 100% maritime movements; ID which tracks are potential threats -- prioritize them for action—enabled by culture of sharing.

JCTD Objectives:

1. ***Demonstrate*** **value of information exchange to improved Maritime Domain Awareness (MDA)**
   - **Acquire, integrate, exchange relevant maritime activity information**
   - **Identify regional threats using available information**
   - **Focus limited interdiction / inspection assets on most probable threats**

2. ***Demonstrate*** **net-centric information management for improved Maritime Domain Awareness, applicable across US Govt Departments, Combatant Commands, and Coalitions**
   - **Data are visible, available, and usable when and where needed**
   - **Metadata tagging to enable discovery by users**
   - **Data posting to shared spaces, enabling "many-to-many" data exchanges (with security and policy controls)**

CMA Assessment Metrics

- **Rapid Shared Recognition of Critical Situations**
  - **Measures the improvement to cross-COCOM situational awareness**
- **Reduction in Timelines**
  - **Measures the reduction in time to provide prioritized, relevant, actionable information**
- **Rapid Coalition Information Sharing**
  - **Measures the improvement of bi-lateral information sharing and management**
- **Rapid Information Assessment**
  - **Measure the improvement in capability of integrating databases and other information providers into an MDA enterprise**

PAYOFF

- **Comprehensive maritime information sharing**….
  - Enables broader maritime domain awareness
  - Affords access to more and diverse information sources
  - Identifies and addresses capability and capacity gaps
  - Deters maritime threats
  - Provides US and partner nations with pieces of the puzzle (dots) otherwise unavailable

- **Comprehensive maritime threat detection tools …**
  - Improves probability of identifying and defeating threats
  - Expands focus beyond predetermined contacts of interest to identification of potential new threats
  - Provides agile and responsive contacts of interest prioritization
  - Increases analysts' productivity

- **Applying Net-Centric Data Strategy to MDA data management** . . .
  - Improves data visibility, accessibility, understanding, and enables discovery by unanticipated users
  - Provides interoperability at data level, enabling many-to-many exchanges vs. point-to-point interfaces

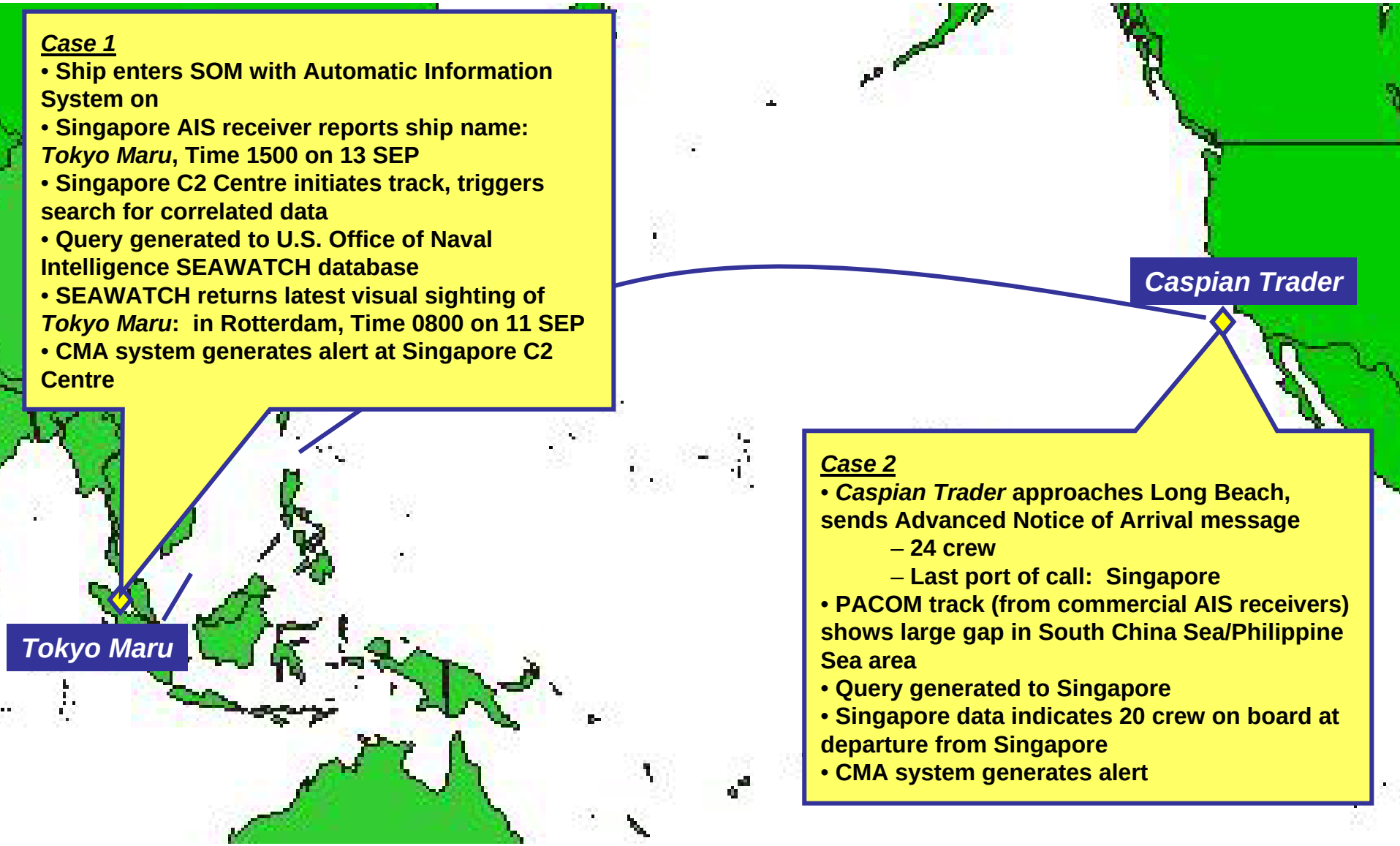
Why JCTD With Singapore?

- **Strategic position astride major shipping lanes**
- **Strong political will to ensure maritime security: Maritime Security Task Force, RMSI**
- **Good infrastructure already in place: Vessel Traffic Information System, Port Operations Command Centre, Changi Naval Base**
- **Strong US-SIN relationship in defence matters: Spartan, ex-CARAT, Southeast Asia Cooperation Against Terrorism, Proliferation Security Initiative**

SINGAPORE PORT

Year	Total Vessel
2002	187,589
2003	179,607
2004	185,131

Examples: Information Sharing, Potential Threat Detection



Case 1

- **Ship enters SOM with Automatic Information System on**
- **Singapore AIS receiver reports ship name: *Tokyo Maru*, Time 1500 on 13 SEP**
- **Singapore C2 Centre initiates track, triggers search for correlated data**
- **Query generated to U.S. Office of Naval Intelligence SEAWATCH database**
- **SEAWATCH returns latest visual sighting of *Tokyo Maru*: in Rotterdam, Time 0800 on 11 SEP**
- **CMA system generates alert at Singapore C2 Centre**

Case 2

- ***Caspian Trader* approaches Long Beach, sends Advanced Notice of Arrival message**
  - **24 crew**
  - **Last port of call: Singapore**
- **PACOM track (from commercial AIS receivers) shows large gap in South China Sea/Philippine Sea area**
- **Query generated to Singapore**
- **Singapore data indicates 20 crew on board at departure from Singapore**
- **CMA system generates alert**

CMA Program Strategy

FY06 FY07 FY08

Baseline Exchange:

- CENTRIXS extensions
- Security Guards
- GCCS Based

Operate

Develop, Evaluate And Integrate

Integrate New Capabilities

- USCG Vessel Tracking
  - Fusion
  - Anomaly Detection
  - Track Quality
- CATE Threat Assessment
- DARPA tools for Maritime COP and behavior analysis (C6F)
- Services Oriented Architecture

Operate

Develop, Evaluate And Integrate

Net-Centric Interagency Exchange

Demonstrate:

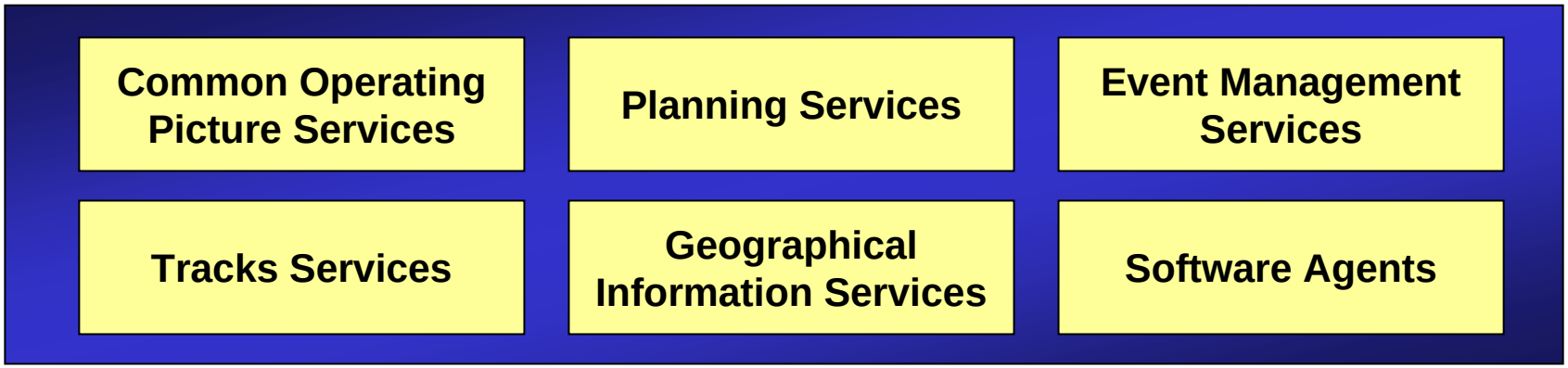
- Interagency exchange
- Net-Centric Info Mgmt
- Improved MDA

Ongoing:

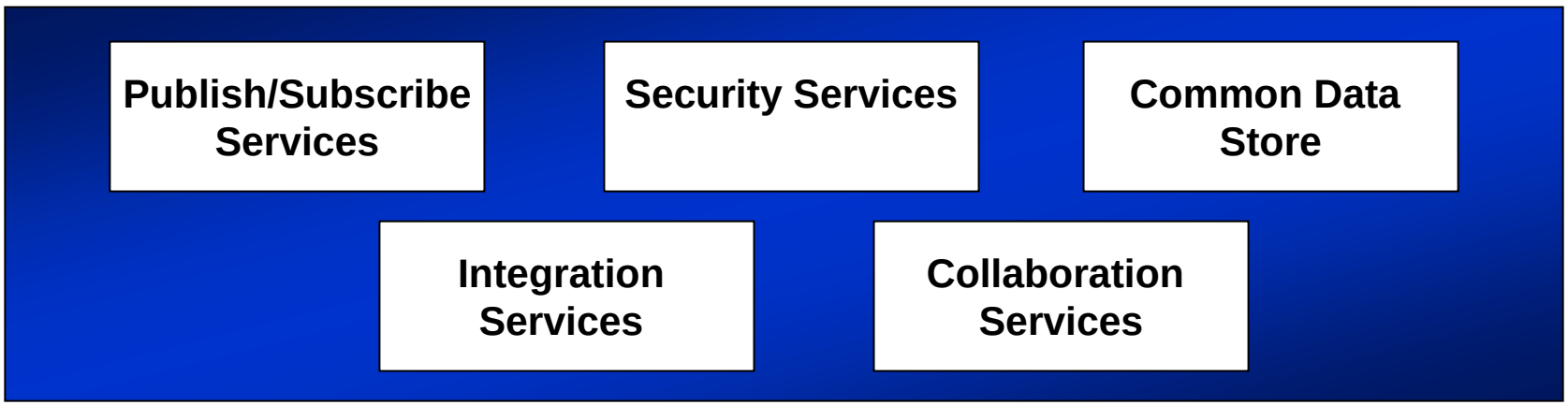
- CMA/MDA Working Group
  - MDA Data Model
  - MDA Data Exch Arch
- CONOPS/TTPS

Service Oriented Architecture

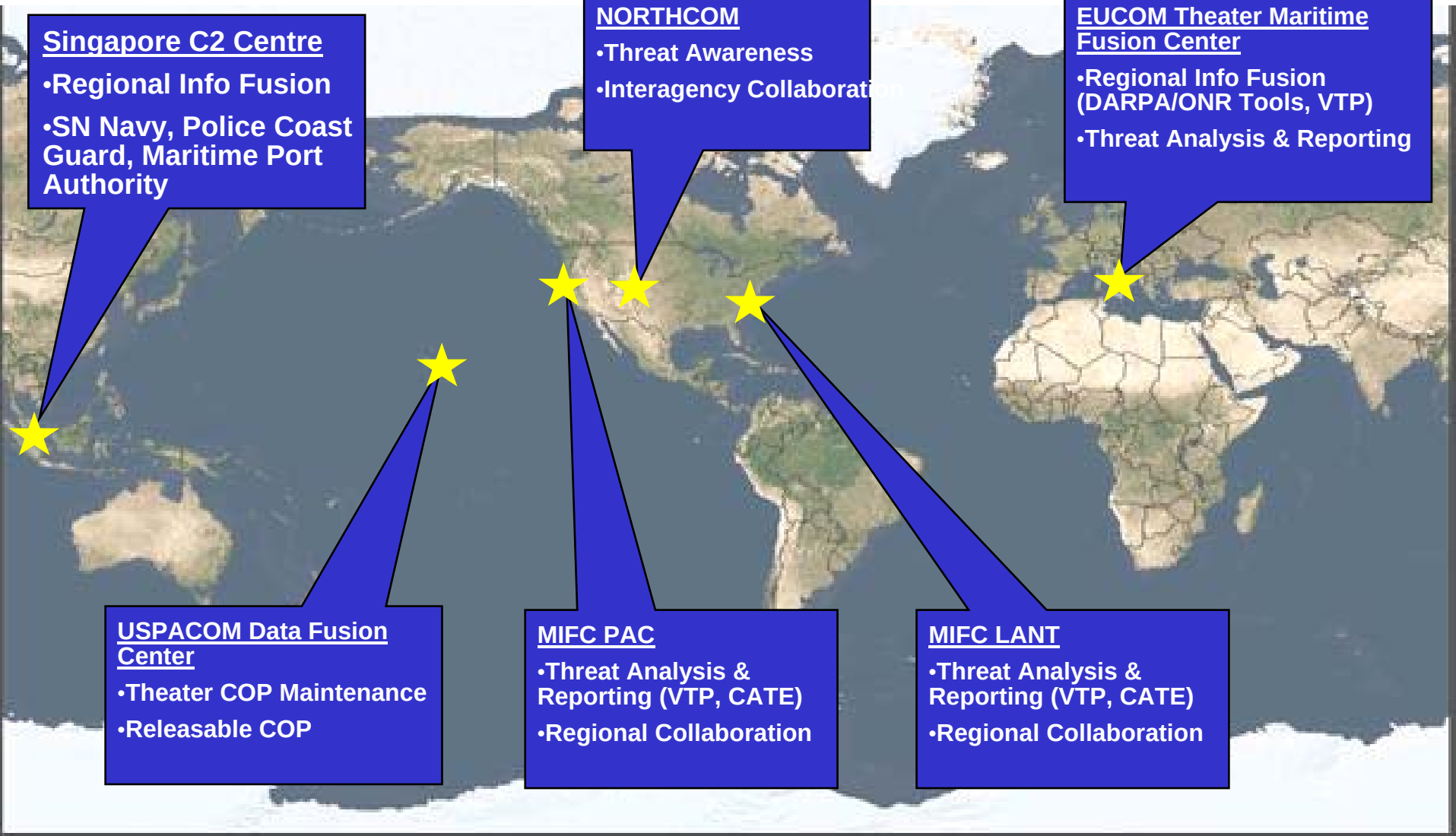
Common Business Services



Common Supporting Services

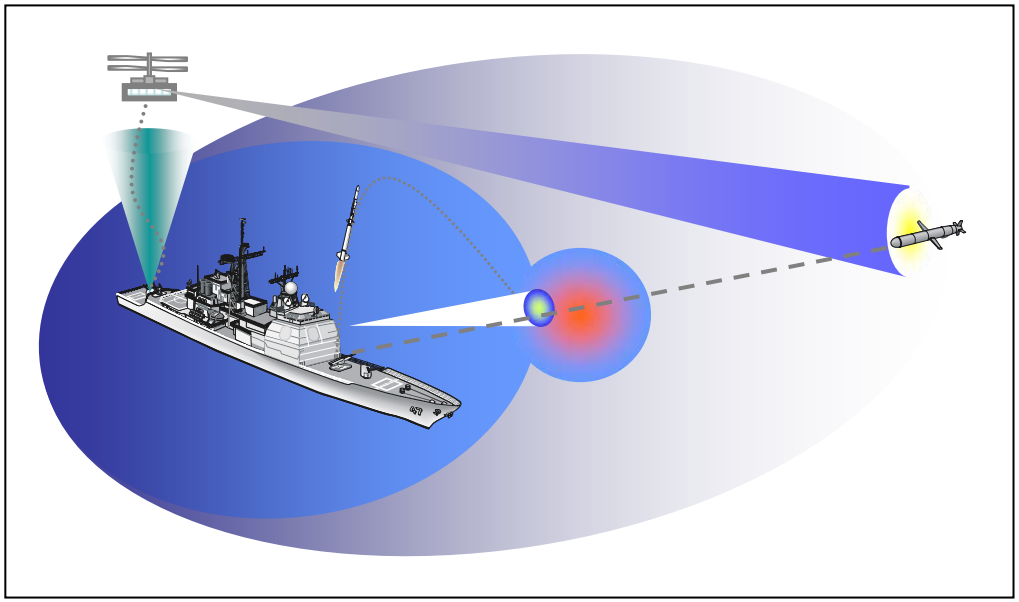


CMA Partnership Approach



Questions/Comments?

Command Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR)



Relevant Research and Results . . .Yesterday, Today, and Tomorrow

Future Naval Capability:
FORCEnet
Hard S&T Problems We Are Addressing

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Definition of FORCEnet

FORCEnet is the operational construct and architectural framework for Naval Warfare in the Information Age, integrating warriors, sensors, command and control, platforms, and weapons into a networked, distributed combat force.

Rapid, Accurate Decision-Making

- Joint Service Oriented Architectures for rapid, interoperable, Secure, sharing and discovery of mission relevant sensor data and information and joint command and control
- *Automated signal and image understanding*
- *Automated integration of disparate sensors and sources of information including metadata (e.g., information source, quality, validity, integrity, priority, degradation) to produce actionable knowledge*
- *Automated Courses Of Action with insight into uncertainty and risk particularly for specific scenarios such as urban, guerilla, and Cyber activities and port / force / base protection and application to automated generation of alternative courses of action in the future*
- *Highly flexible means of presenting complex information including uncertainty, geo-spatial, Net Topologies, etc from multiple relevant data sources for aiding in assessing intent as well as situation awareness while performing mission (31/34)*
- Means to rapidly assemble/re-configure real-time software systems for survivability to ensure security, quality of service and information for decision-making
- Certification of software-intensive systems for functional correctness and security

Italicized, red font indicates particularly difficult issues

Dynamic, Efficient, Mission-Focused Communications and Networks

- Where necessary, develop protocols and architectures for dynamic, mobile naval forces
- *Within this architecture, develop mission-driven, quality of service and secure capabilities*
- Develop tools for network automation which account for battle-space situation, battle-space environment, and commander's intent
- *Enable robust over-the-horizon connectivity*
- *Develop necessary aperture technology to ensure continuous platform participation in the network*
- *Investigate concepts for enhancing underwater communications and for rapidly moving underwater sensor information and data into overall common picture database*
- *Develop software technologies to support seamless multilevel secure real-time access to and processing of network information across domain boundaries*
- Develop Software Compliant Architecture (SCA) enabled highly adaptive tactical communications (throughput, anti-jam and LPI/LPD)

Pervasive and Persistent Sensing

- *Advanced light-weight, small, efficient sensors for variety of platforms (video, IR, SAR, chem/bio, etc)*
  - *Flexibility in search / ID*
  - *Multi-modal*
- *Automated processing at sensors and sensor networks (triage, assessment, and control)*
- Integrated modules including on-board processing and control
- Automated self-control and self-tasking of sensors and sensor networks including optimization of resources and COTP development
- *Four-dimensional navigation data with and without GPS*
  - *Jam-Resistant GPS navigation*
  - *Non-GPS navigation*
- *CONOPS and TTPs*

High Impact Technologies

- Increased speed and precision of decision making – Simply making more information available to decision-makers / warfighters doesn't help if they cannot assimilate and use that information. This requires advances in a number of technologies
  - Automated integration of disparate sensors and sources of information including metadata (eg information source, quality, validity, integrity, priority, degradation) to produce actionable knowledge and COAs with insight into uncertainty and risk
  - Integration and presentation of information to humans for maximum rate of comprehension and optimal utilization taking into account the variation in human perception . Must enable human to understand attributes of the information such as nature of source, timeliness, quality of source, rate of degradation of information, etc.
  - Automated Image Understanding – necessity to automate / speed analysis of larger amounts of image and video information which is an increasing larger component of information being made available for decisions making. Would also produce major reduction in throughput requirements as image analysis could be accomplished at sensor site and only ID and coordinate (space and velocity) need to be transmitted. Quantum jump in effective information transmission, but may require advances in nano/bio-electronics to enable sufficient, low-power computation at remote sensors. Elements of this are already spiraling into applications in the form of image compression, image deblurring, contrast enhancement, and image repair.

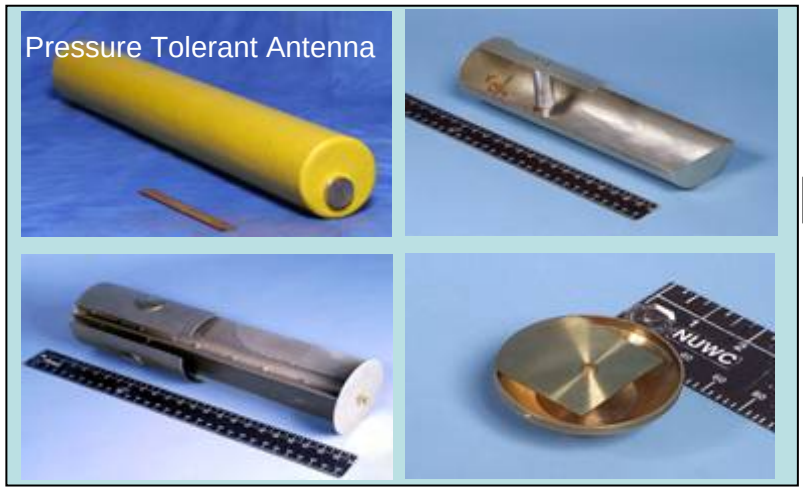
High Impact Technologies

- Multifunction/multiband/multibeam digital RF apertures – enables robust, multi-routing capability that ensures robustness of all nodes of the network and consequently inclusiveness of all resources. Could significantly enhance the functionality and thus the capability of smaller platforms.
- Low-power, high capability computer/communications technology - Nano/bio-electronics would enhance the level of capability for the small unit / Marine user, enable massive sensor nets, and significantly enhance level of computational and information storage capability for remote users/sensors/platforms. Potential for a quantum jump in information availability
- Information Assurance -- provides capability to ensure the security, integrity, trustedness, and confidentiality of shared data and information across and within coalition security enclaves, at multiple security levels, with diverse computing platforms. Technologies that will maintain security integrity across multiple servers, or in peer-to-peer collaboration, are needed.
- Flexible command structure – enables optimum (metrics: speed and precision of decision making), dynamic siting of decision making authorities based on local and non-local battle-space situation and trends and on tempo of the battle.
- Mission-focused network Quality of Service – enables automated, optimum utilization of network resources to accomplish multiple, simultaneous missions. Sets priorities based on mission(s) accomplishment as opposed to who pays the most as in commercial technology.
- Underwater communications and networks – enables the sensors, C2, and weapons systems to be tightly coupled as in the above surface case and is essential for overcoming access denial.

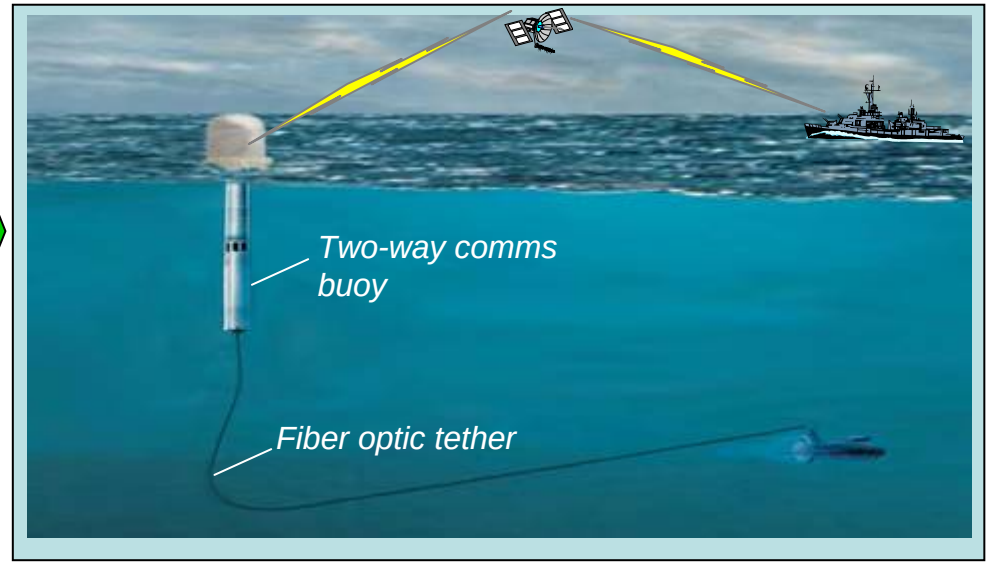
QUESTIONS

Next Generation Sub Comms at Speed and Depth

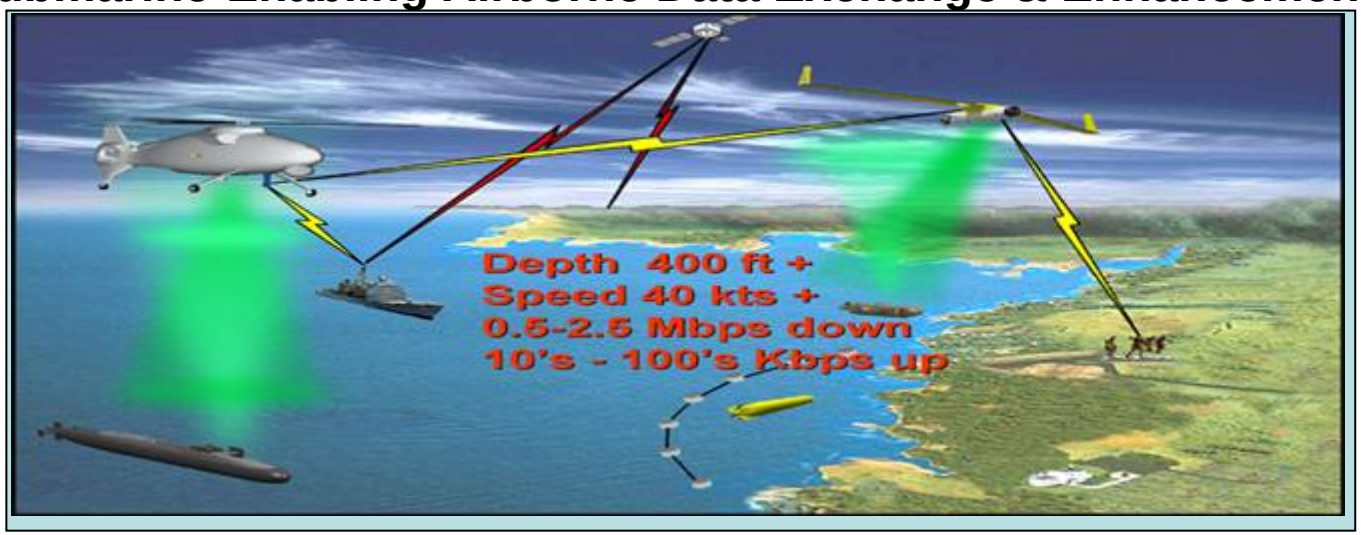
Next Generation Submarine Buoyant Cable Antenna (NGBCA)



The Expendable Communication Buoy



Submarine-Enabling Airborne Data Exchange & Enhancement Program



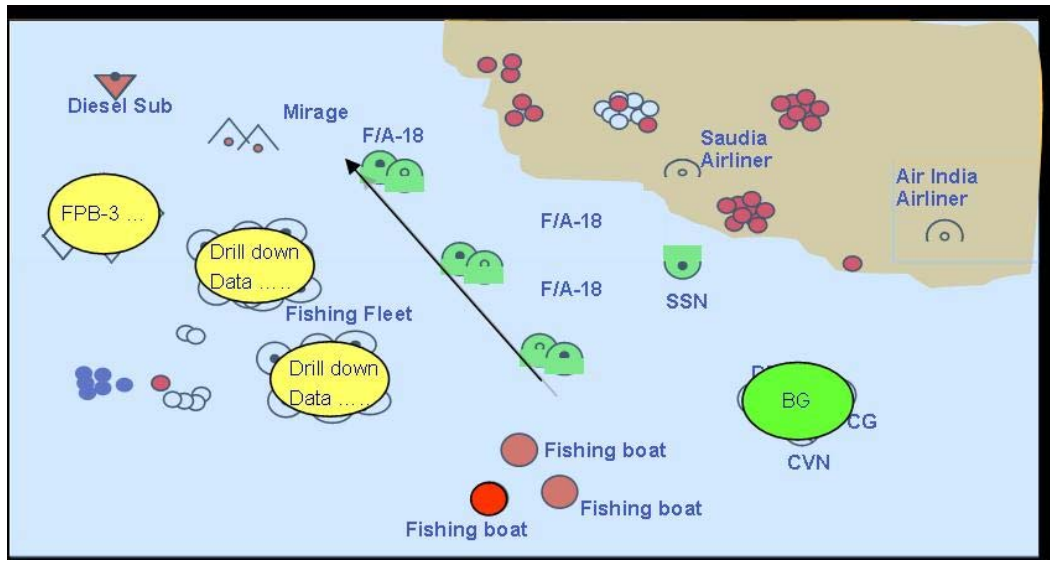
Automated Fusion Algorithms to Address Combat ID Implications of Groupings of Entities and Events

Current Capability

- Lots of data from many sources
- Little understanding about how entities and events relate
- Manual capability to manage multiple hypotheses about the meaning of
  - Groups of entities
  - Events that may potentially be related

ONR's Product Produces

- Data from many sources automatically exploited
- Warfighter-relevant understanding about how entities and events relate
- Automated capability to manage hundreds of multiple hypotheses about the meaning of
  - Groups of entities
  - Events that may potentially be related



Relationships established; Intent predicted action; Can be taken with high confidence in a timely fashion

Missile Defense S&T

Sea Shield Future Naval Capability Program

Applied Research to develop advanced algorithms for use in Navy combat systems for combat identification and sensor fusion, and supporting a common tactical air picture

- ★ Multi-Source Integration (MSI): Develop advanced data fusion algorithms for E-2C Mission Computer
  - Integrate multiple organic sensors (Radar, CEC, IFF, ES) with off-board sources (Satellite comms and tactical data links) to support Theater Air and Missile Defense (TAMD) requirements

- ★ Advanced Sensor Netting Technology (ASNT): Develop advanced algorithms for combat ID in netted sensor systems
  - Integrate electronic support (ESM) data fusion with real time tracks in the future joint / Navy track manager
  - Append ID attributes to real time netted sensor air tracks

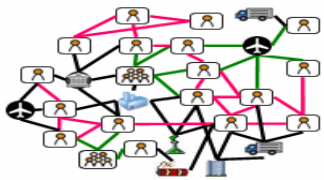
- ★ Composite Combat Identification (CCID): Develop advanced algorithms for building high confidence ID from real time and non-real time sources & sensors
  - Real time netted sensor -SIGINT integration, aircraft & surface combatants
  - Common reasoning algorithm for all naval TAMD units in theater

PALADIN- An Application of Bayesian Networks on Naval Information

DATE	BOL_NBR	CONTAINER	FPORT	USPORT	SLINE	VESSEL
40601	2154053365	TTNU4567496	SHANGHAI	LONG BEACH	CSCO	TENG YUN HE
40612	HKGRJ5021	MSKU3231647	HONG KONG	LOS ANGELES	MLSL	CLIFFORD MAERSK
40612	826120540	KKFU1180754	YANTIAN	LOS ANGELES	KLIN	YM WEALTH
40612	826120544A	KKFU7285990	YANTIAN	LOS ANGELES	KLIN	YM WEALTH

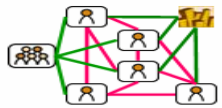
PALADIN Innovative Technologies

Link Extraction



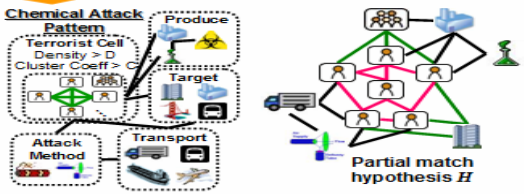
- Extract entities and links with attributes from data sources
- Use group detection to focus attention, reduce search space

Network Anomaly Detection



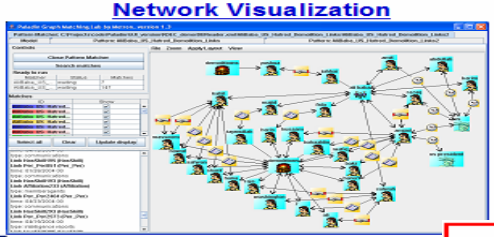
- Detect graphical anomalies to identify potential threat networks
- Use as starting points for pattern matching searches

Pattern Matcher



- Subgraph matching to find signatures
- Connect related signatures to infer organized activities

Network Visualization



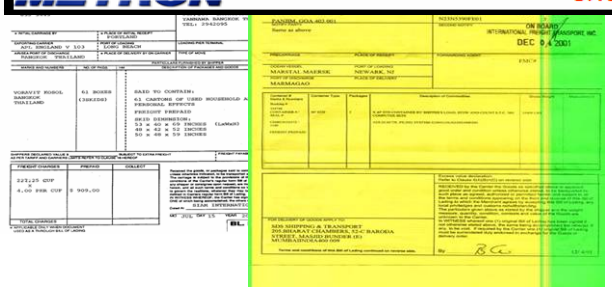
Hypothesis Scorer

$$\Lambda(H) = \frac{Pr(\text{evidence in support of } H \mid \text{threat})}{Pr(\text{evidence in support of } H \mid \text{clutter + noise})}$$

- Compute likelihood ratio for each hypothesis
- Filter and rank hypotheses

METRON

UNCLAS

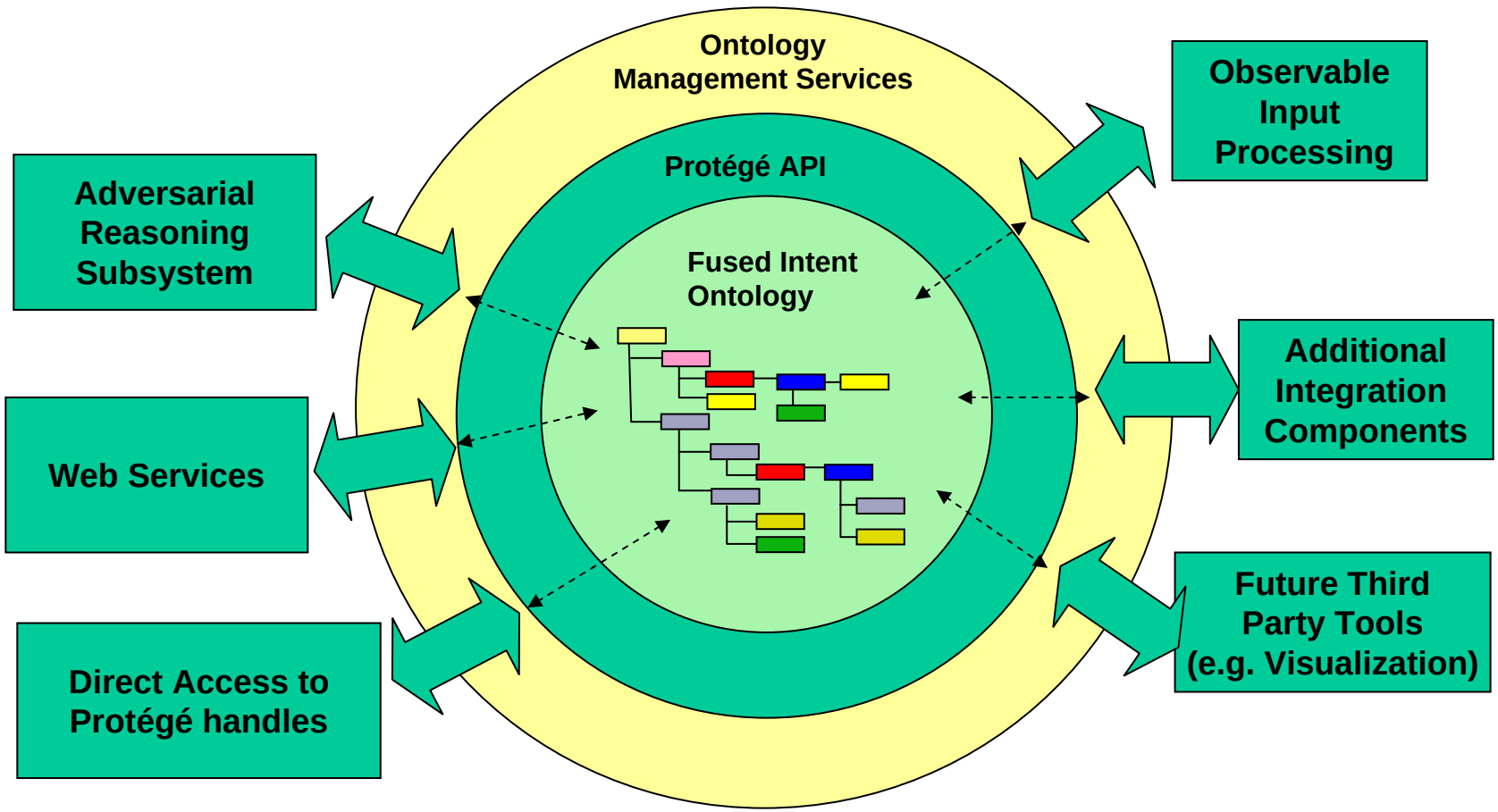


Theorem [Lo, Ferry]: For $m, n \to \infty$ with constant μ, the expected number of subgraphs of $\mathcal{B}^*(n,m,\mu)$ isomorphic to H is given by

$$\frac{E[X_H(\mathcal{B}^*)]}{X_H(K_n)} = \frac{\mu^{v(H)}}{m^{r(H)}} \prod_{i=1}^{c(H)} \sum_{s=1}^{b_i} \left\{ \begin{matrix} b_i \\ s \end{matrix} \right\} \mu^{s-1} + O\left(\frac{1}{m^{r(H)+1}}\right)$$

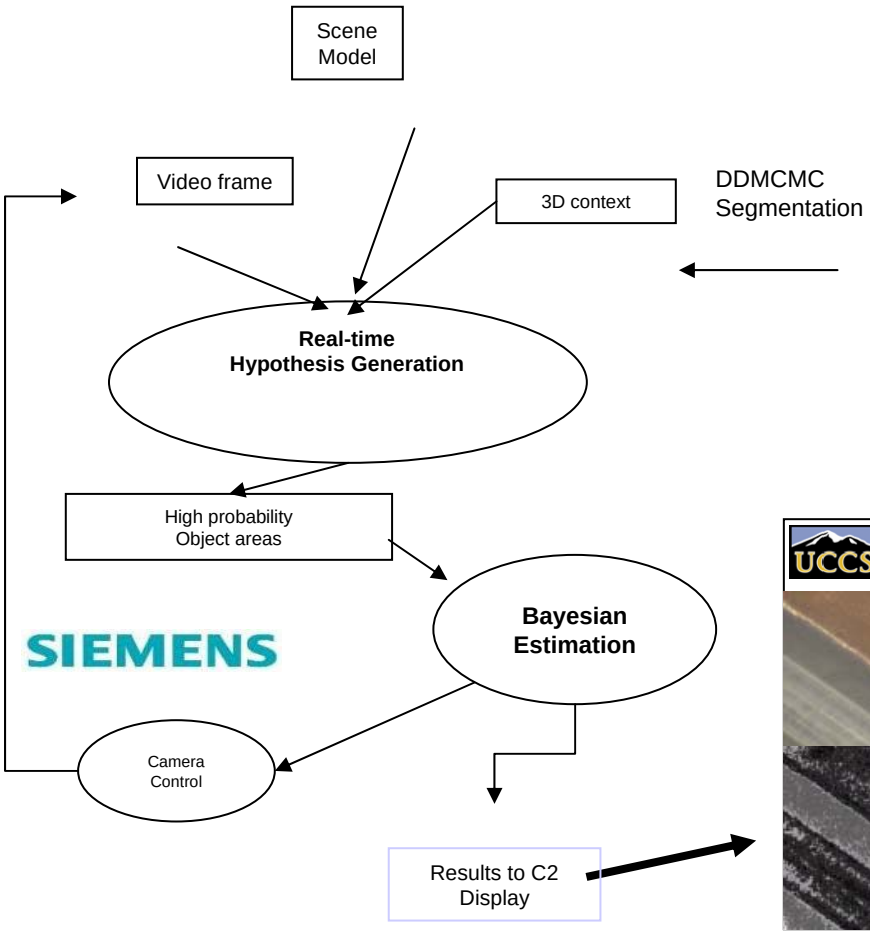
- H represents a threat activity obscured by noise model $\mathcal{B}^*$
- Formula used to detect whether H arises by chance or by design

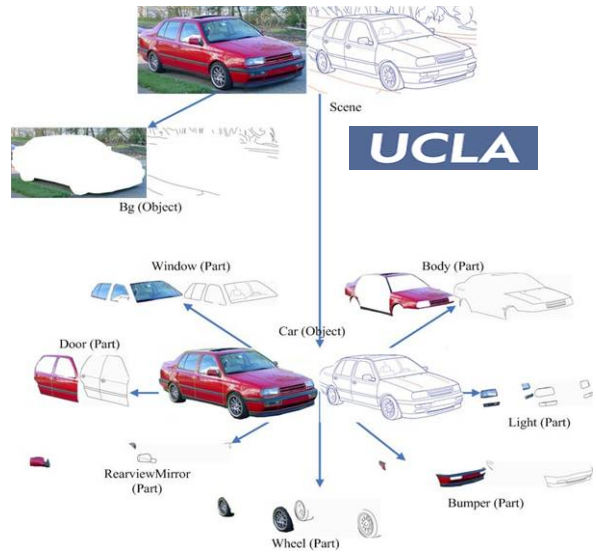
Ontology Management Services

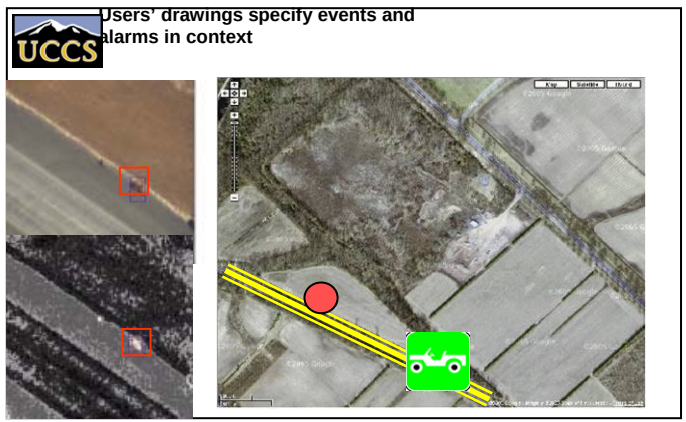


The bottom line: if the ontology isn't right, the integration cannot supported.

C2Fuse:
Supporting UAV-based Change Detection and IED





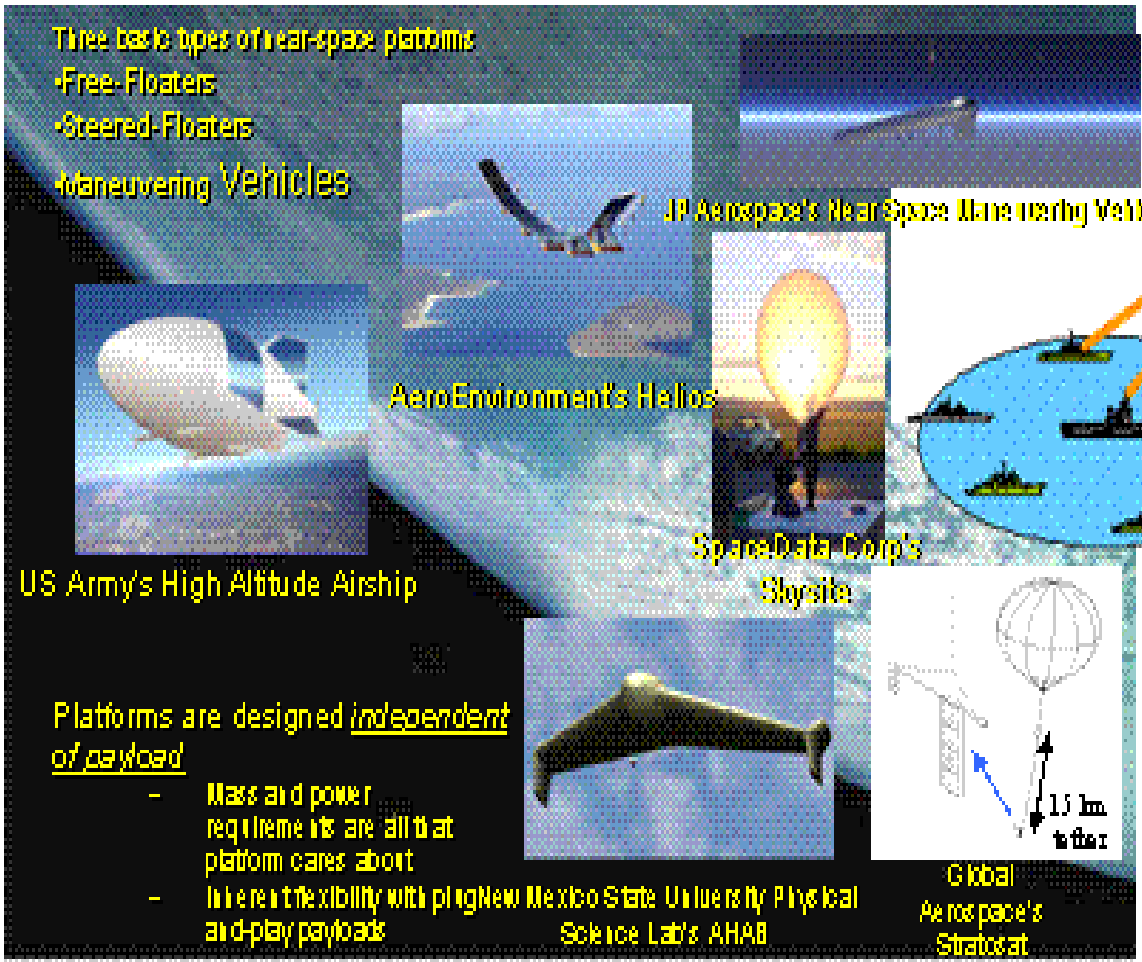


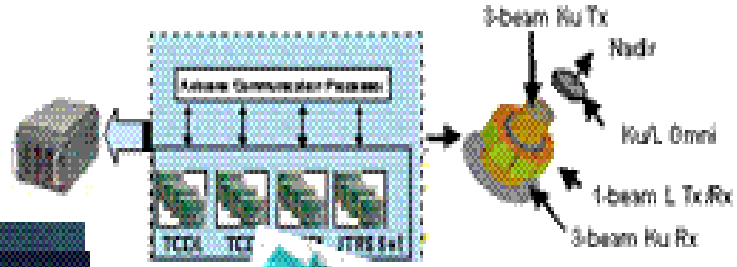
Live C2 Interface Event recognition

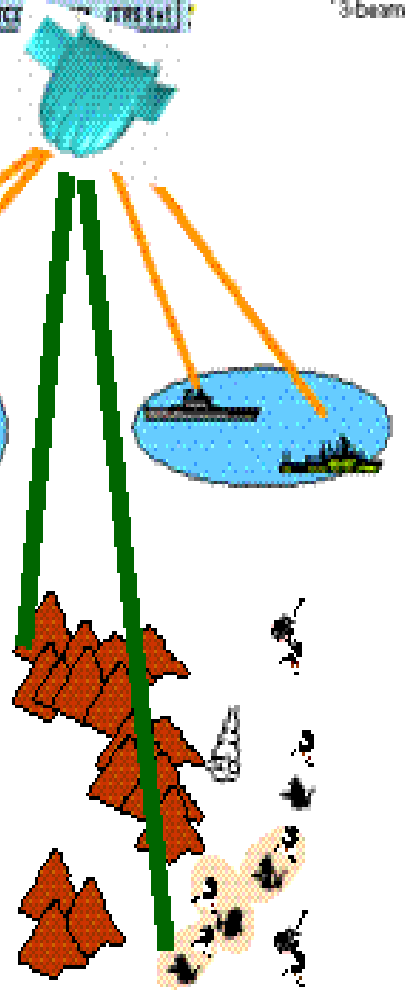
Developed novel methods for segmenting images into meaningful regions

Automated Object Recognition

High Altitude Airborne Relay and Router Package







Integrated Digital Apertures and Array Radars Foundation (CY)

04 05 06 07 08 09 10 11 12

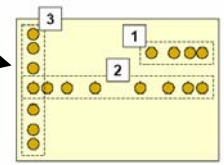
◆ Demonstrated multiple simultaneous beams doing multiple comms, EW, and radar functions

▲ Delivered and demoed three simultaneous beam S-Band receive aperture on Lake Erie

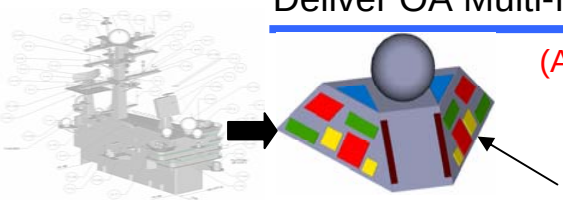
▲ Demonstrated multi-beam X-band and Ku-band TCDL apertures and delivered Ku TCDL to DDX for EMI topside testing and subsequent selection for DDX

▲ MDA taking delivery of multi-beam C-band transmit and receive apertures based on S-band architecture

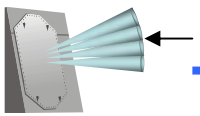
Deliver OA Multi-function (HPOI, PDF, SEI) ESM Interferometer to DDX



(Analysis this year lead DDX to remove the top-hat from the topside)



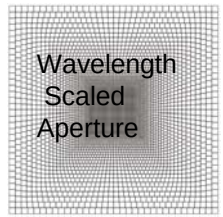
Deliver multifunction UHF / L – Band Line of Sight and SATCOM Aperture suitable for CVN21 or DDX

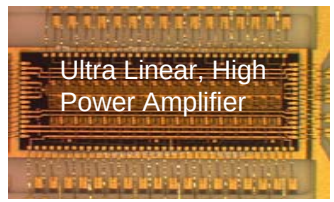


Open Architecture Digital Array Radar

Cost Avoidance Aperture Architectures and Electronics

-Motivated $225M DARPA High Power Amplifier Program
-Motivated $40M DARPA High Speed Electronics Program

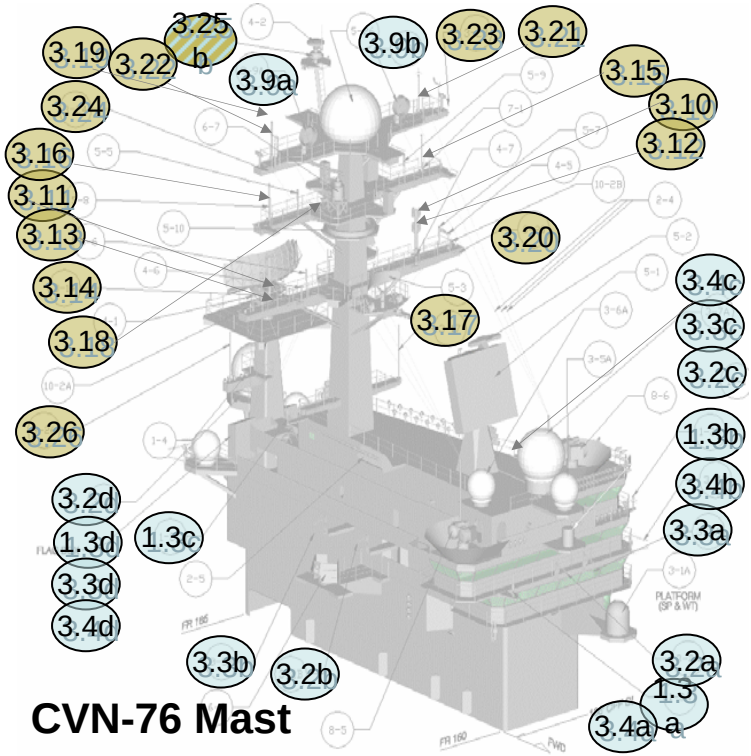




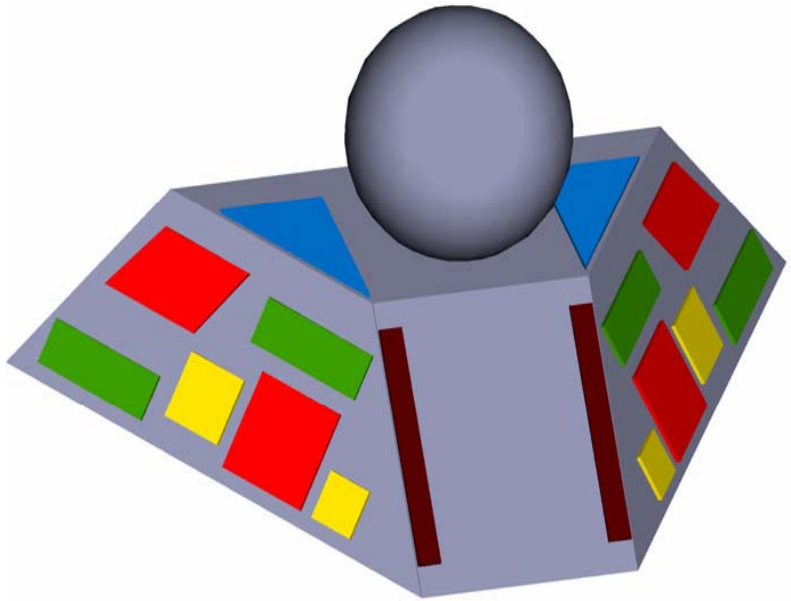
Industry-Navy Partnership on RF Open Architecture Definition

Significant Experience Base and Transitioned Products

UHF/L SATCOM/LOS Aperture



CVN-76 Mast



46 to 51 antennas
> 3500 pounds (Ant. Only)

NEW

4 panels , 20 meters ^{2}
< 1800 pounds

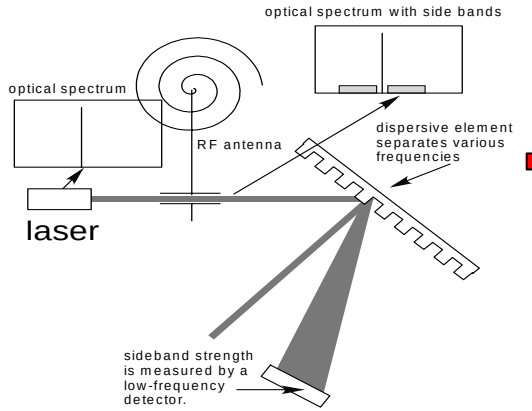
Multi-beam, Multi-SATCOM, Trainable Array

(Replaces five apertures with one)

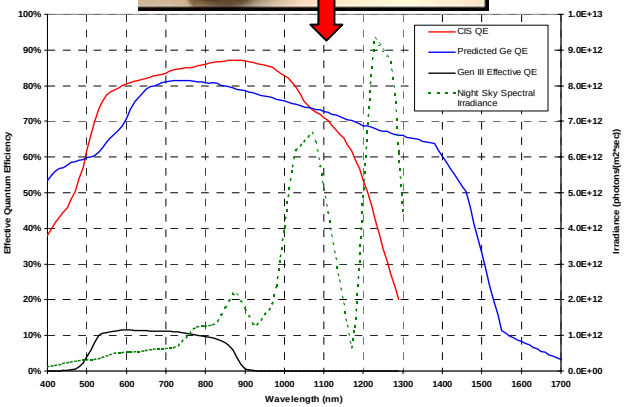
Miniaturized UAV Sensors

Silver Fox fielded In Operation Iraqi Freedom with 1MEF and Navy SPECOPS in 60 Days

Passive Millimeter Wave Imager

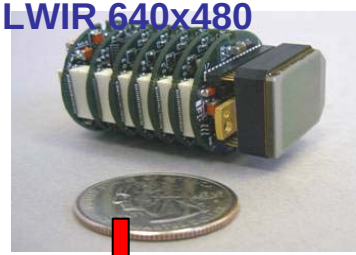


Quad HDTV 1920x1080 Electronic Zoom + JPG2000



Color 640x480 120 dB Dynamic Range

LWIR 640x480

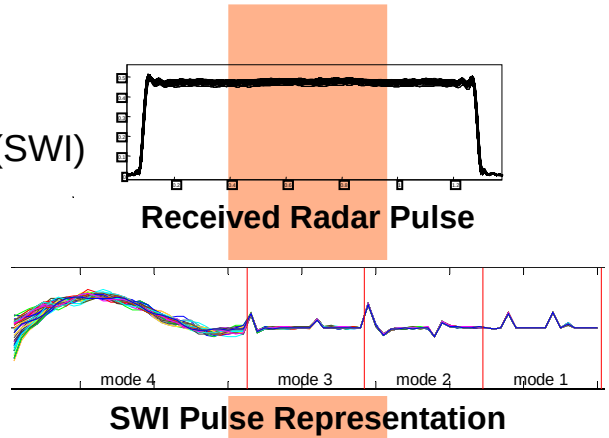


Specific Emitter Identification Capabilities Extension

Specific Emitter Identification Extended Multi-processor

Develop, evaluate and test algorithms to address known shortfalls

- Cross Mode Radar Matching - Sample window independent (SWI)
- Low SNR operation - Tree Structure Representation (TSR)
- Align effort with Specific Emitter Identification Program Office (SEIPO) at the National Security Agency
- Address database design



Received Radar Pulse

SWI Pulse Representation

Implement algorithms in WinSEI Software and SEI Field Programmable Gate Array hardware

- Algorithms will be hardware independent
- Available for community use

Transition to fielded SEI systems

IFD-120 Next Generation SEI Processor mounted on VME Pentium card

Missile Defense S&T

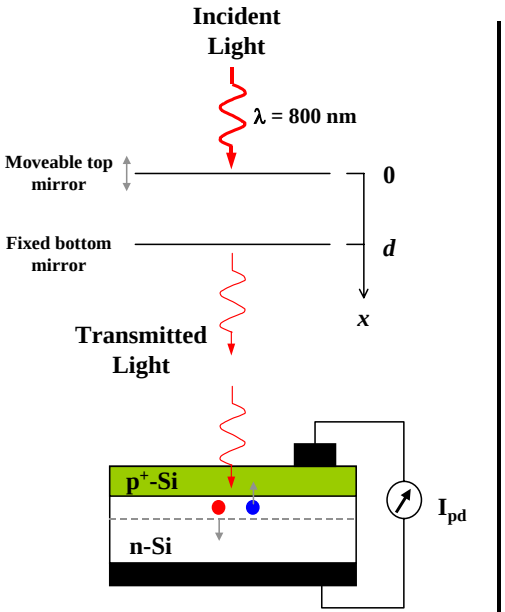
Sea Shield Future Naval Capability Program

Advanced Technology to test and demonstrate advanced algorithms developed in PE 0602235N for use in Navy combat systems for combat ID and sensor fusion, and supporting a common tactical air picture

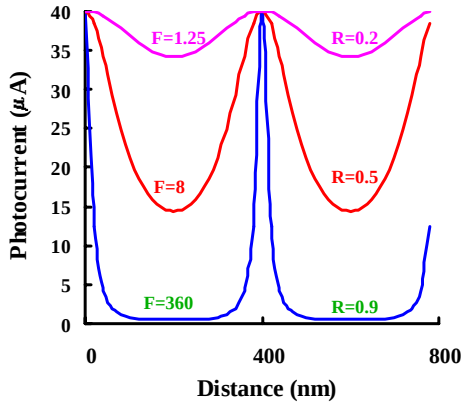
- **<u>Multi-Source Integration (MSI):</u> Test & demonstrate data fusion algorithms for E-2C Mission Computer**
  - **Integrate multiple organic sensors (Radar, CEC, IFF, ES) with off-board sources (Satellite comms and tactical data links) to support Theater Air and Missile Defense (TAMD) requirements**
- **<u>Advanced Sensor Netting Technology (ASNT):</u> Test & demonstrate algorithms for combat ID in netted sensor systems**
  - **Integrate electronic support (ESM) data fusion with real time tracks in the future joint/Navy track manager**
  - **Append ID attributes to real time netted sensor air tracks**

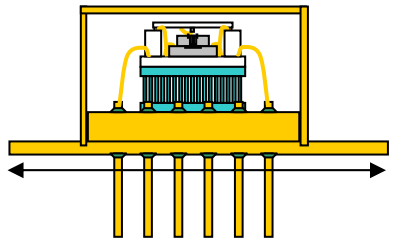
- **<u>Composite Combat Identification (CCID):</u> Test & demonstrate advanced algorithms to build high confidence ID from real time and non-real time sources & sensors**
  - **Real time netted sensor -SIGINT integration, aircraft & surface combatants**
  - **Common reasoning algorithm for all TAMD units in theater**

Electro-Optic Accelerometer



- Inherent 3-terminal Device
- Possesses "Transistor" Action



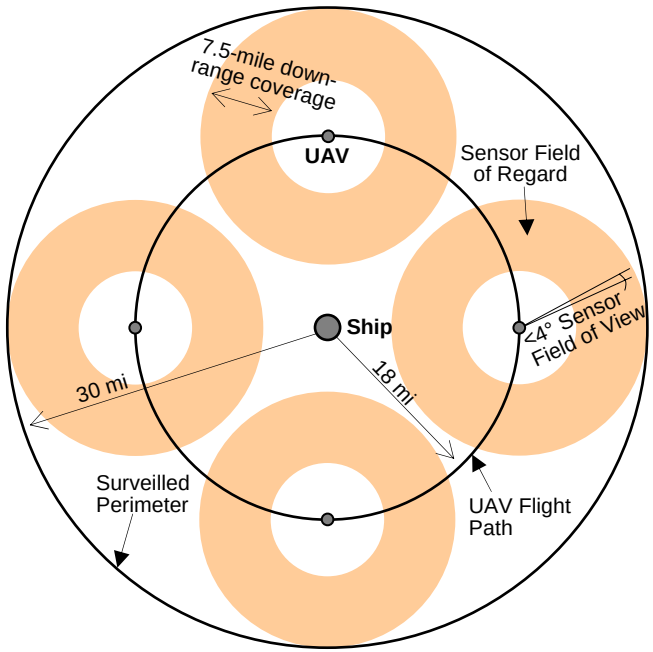


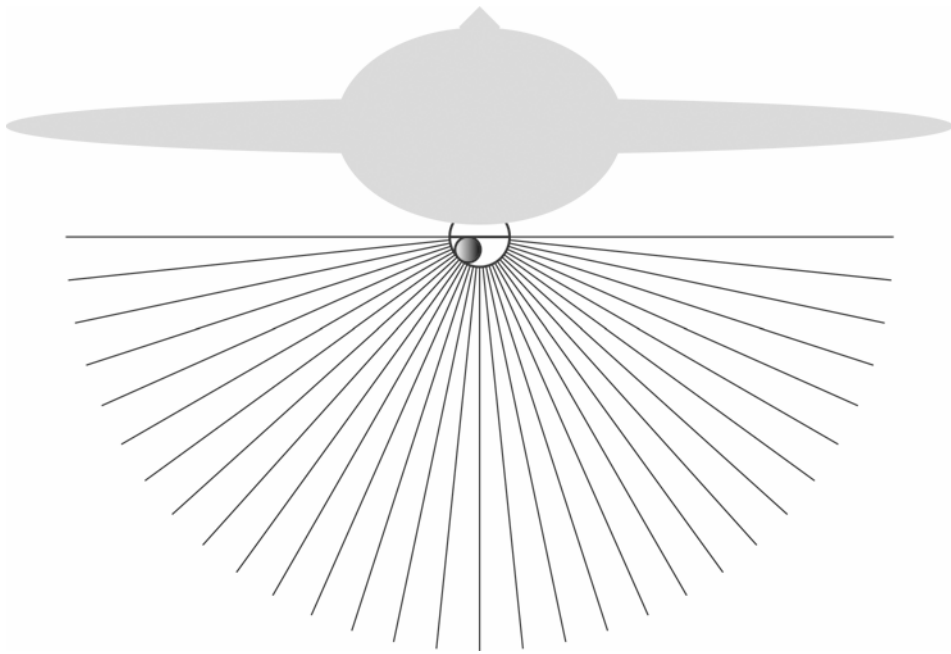
Design and Fabricate Small, Lightweight MEMS Ultra Sensitive Accelerometers for Navigation Systems.

PI: Dr. T. Jones (SSC-SD)

CONOPS

- An IR camera with a narrow field of view is scanned through 360º, down-looking approx. 4.5º into an annular footprint that covers from within 5 miles of the ship out to 30 statute miles.
- Four UAVs each flying at 70 mph update the inner perimeter in approx. 10 minutes, and update the outermost perimeter in approx. 20 minutes. Points in-between have a graduated update rate.





Office of Naval Research

Naval Future S&T Challenges Overview: S&T Program Influences, Priorities, and Program Rationale

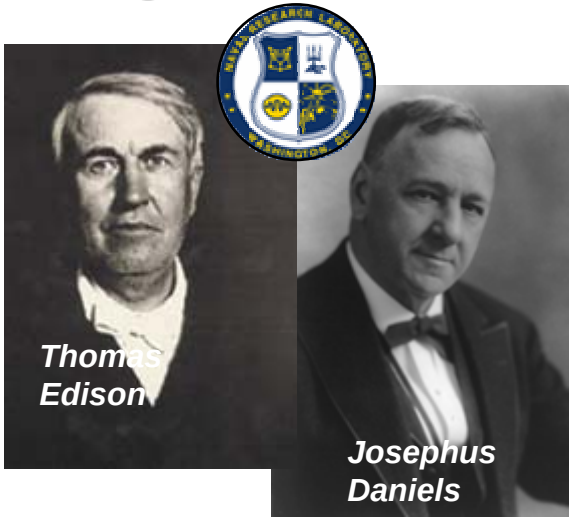
Dr. Joseph Lawrence
Director of Transition
18 April 2006

Presentation Agenda

- ONR and Its Mission
- Future Naval Capabilities Program
- Advanced Concepts Technology Demos
- Manufacturing Technology Program
- Small Business Innovative Research Program
- Technology Transition Initiatives
- Our Weblinks
- Questions?

Naval Research: An Enduring and Evolving Mission

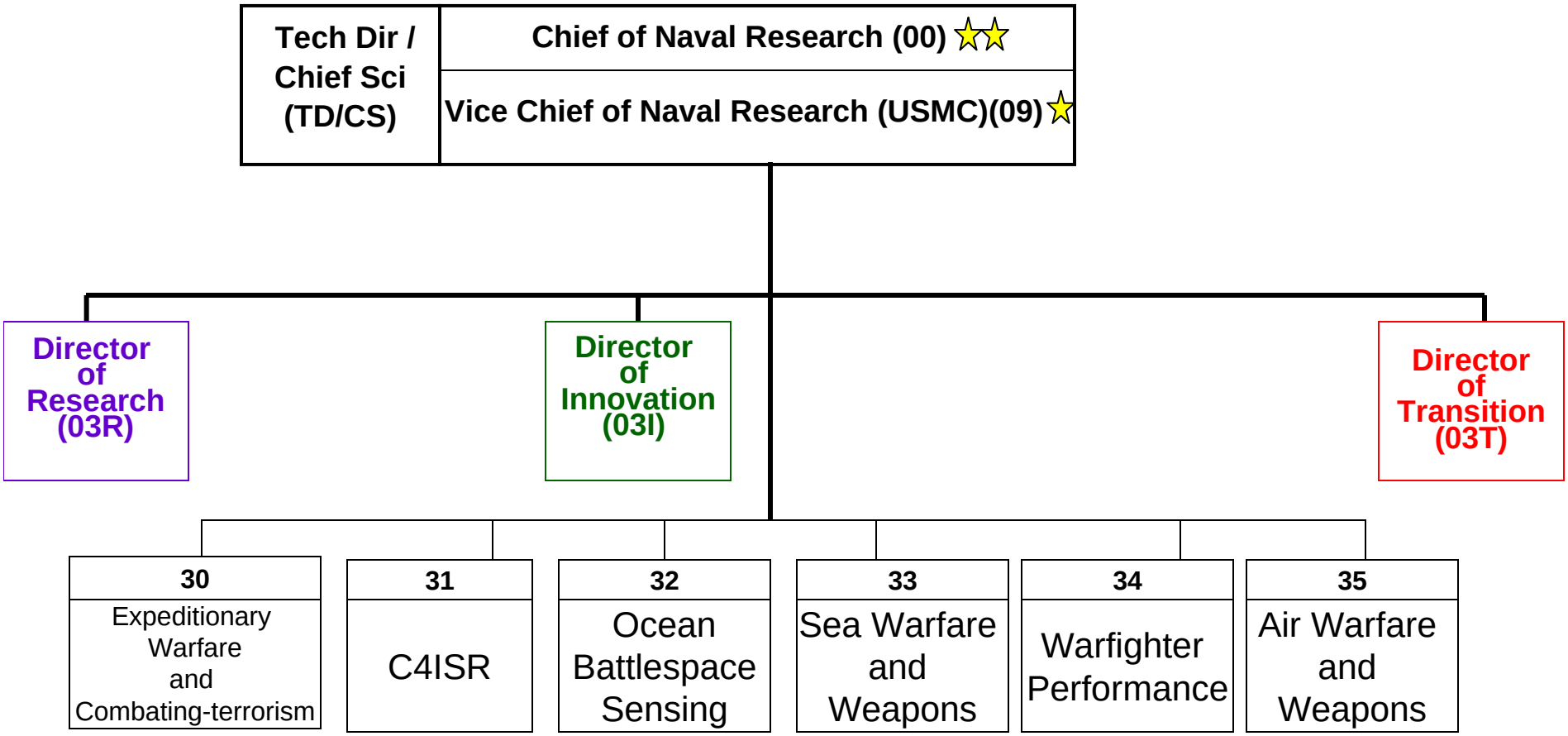
Naval Research Laboratory *(Appropriations Act, 1916)*: *"[Conduct] exploratory and research work … necessary… for the benefit of Government service, including the construction, equipment, and operation of a laboratory…."*



Office of Naval Research *(Public Law 588, 1946)*:
"… 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…. "

Transitioning S&T *(Defense Authorization Act, 2001)*:
"…manage the Navy's basic, applied, and advanced research to foster transition from S&T to higher levels of research, development, test, and evaluation."

S&T Directorate Organization



S & T Departments: Customers & Portfolios

EMW	FORCENet	SEA SHIELD	SEABASE	SEA WARRIOR	SEA STRIKE
MCLW MARCORSYSCOM MARFOR, NAVFAC NCIS, DTRA, DHS SOCOM SPECWARCOM JNLW Directorate Army Research Lab	SPAWAR NETWARCOM ONI NRO NSA CIA NAVSEA NAVAIR	FLT ASW COM N7C N096 NAVMETOC CORE NOPP NOAA UNOLS TFASW FASWC COMMINEWARCOM	NAVSEA NAVSURFOR NAVSUBFOR NAVAIRFOR (for ship systems) USCG DOE	Surgeon General Medical Officer of the USMC CNET CNP NIH	NAVAIR NAVAIRFOR Air Force Research Lab AMRDEC, Redstone AATD, FT Eustis NASA MCHQ AVN
DASN LMW	DASN IWS/LMW/ AIR/C4I	DASN LMW/ IWS/AIR	DASN SHIPS/LMW	DASN SHIPS/C41/ LMW	DASN SHIPS/ IWS/AIR
30 – Exp. Warfare & Combating Terrorism	31 – C4ISR	32 – Ocean Battlespace Sensing	33 – Sea Warfare and Weapons	34 – Warfighter Performance	35 – Air Warfare and Weapons
Exp. Man. Warfare USMC STOs in multiple warfighting areas – C4; ISR; Logistics; Human Perf, Trng & Surv; Maneuver MCM Warfare (w/32) Ground-based firepower Non-lethal weapons Combating terrorism Joint EOD Naval Specwar	Electronics Computer & Info Sciences Radar/EO/IR Maritime sensors EM propagation & interaction Signal & image processing C3 Networking Surveillance EW Navig/Timekeeping	Oceanography Ocean Acoustics Coastal Geosciences Marine Geology & Geophysics Marine metrology Space MCM (w/30) ASW (w33,31) Signal Processing Maritime Sensing ASW & UUV's (w/33) Ocean eng. & marine systems	Chemistry Power & energy conversion Naval materials Non-linear dynamics Ship Structures Ship HM&E ASW & UUV's (w/32)	Cognitive science Neural science Behavioral science Social org./science Manpower, personnel & training Human factors Medical science Bimolecular science Biosystems Biomaterials CBWD	Physics Aerospace materials Energetics Surface & Air launched weapons Kinetic & Directed energy weapons Robotics UAV's Air Vehicles

DON FY06 S&T Portfolio (FY06 - $1,776M)

Acquisition Enablers ($551M – 31%) • FNC's (TOG Oversight) • Warfighter Protect • Capable Manpower (N1/N00T) • LO/CLO (PMR 51)	**Discovery & Invention ($713M - 40%)** • Naval scientific disciplines • NRL/Warfare Centers • National Naval Responsibilities • Technical workforce sustainment • High impacts/surprises
Directed/Passthrough ($330M – 19%) • JFCOM's Joint Experimentation • POM-04 PDM (except EM Rail Gun) • PBD's and earmarks	**Leap-ahead Innovations ($182M -10%)** • Innovative Naval Prototypes • SwampWorks • Tech Solutions • SEA TRIAL • Fleet/Force Response Programs

ONR manages an additional $400M of non-S&T funds and approximately $500M of Congressional Adds.

Future Naval Capability Program

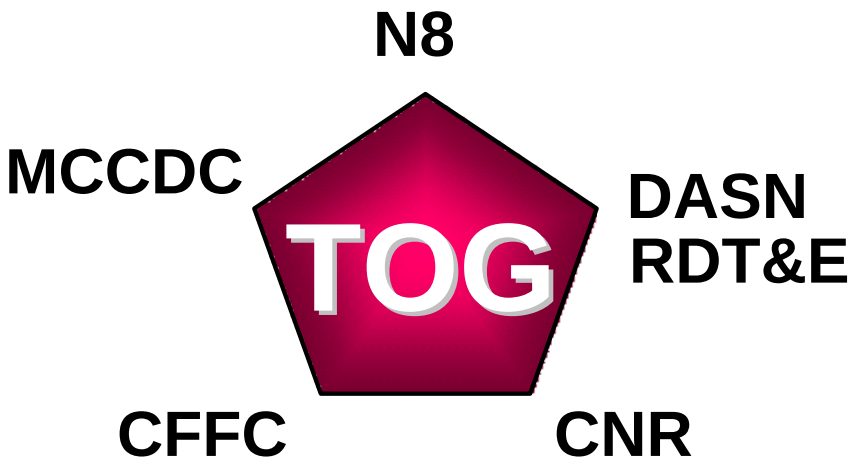
The FNC program is composed of Enabling Capabilities (ECs) which develop and deliver quantifiable products (i.e., prototype systems, knowledge products, and technology improvements) for insertion into acquisition programs of record after meeting agreed upon exit criteria within five years.

- The ECs are currently aligned with four of the pillars of Naval Power 21, a vision for the U.S. Navy and Marine Corps of the future (Sea Shield, Sea Strike, Sea Base, and FORCEnet) with an additional group for crosscutting technology improvements (Enterprise and Platform Enablers) for operations and maintenance cost savings.

FNC Oversight Process

The Technology Oversight Group (TOG) provides oversight for key milestones:

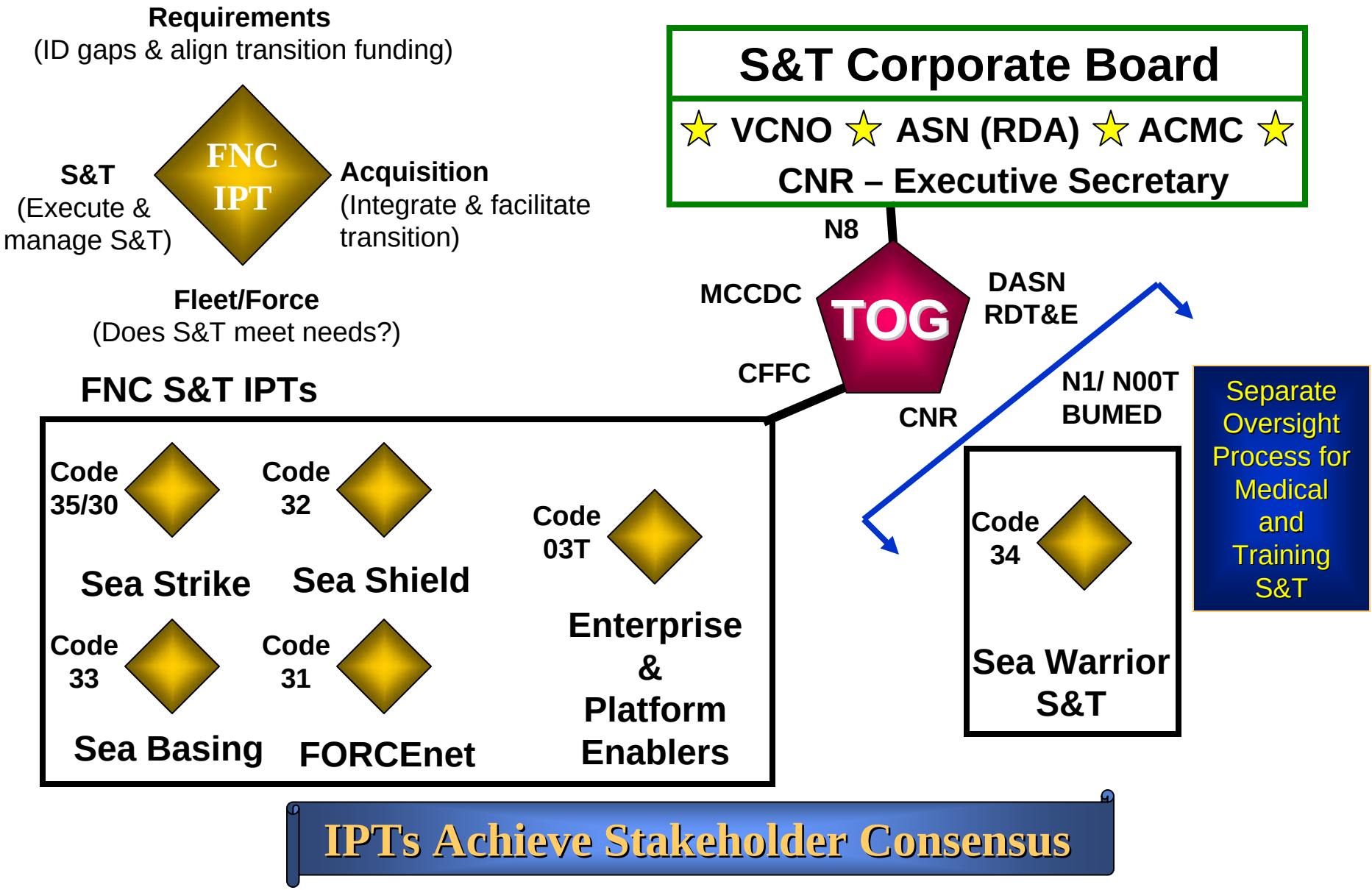
- NCDP Gap analysis and prioritization
- ONR development of new start EC proposals
- IPT and TOG WG assessment of proposed new start ECs
  - Competitive process based on gap priorities
  - Many proposals go unfunded
- TOG review and approval of new start ECs
- N6/N7 and N091 budget submissions
- IPT transition status reports to CNR for ongoing ECs
- CNR status report to the TOG for ongoing ECs
- CNR annual review of on-going ECs



Voting Members

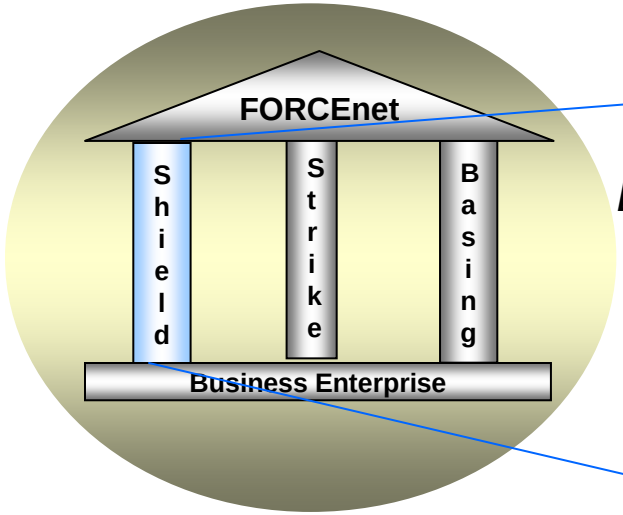
N8, MCCDC	(Co-Chairs, Requirements)
N091/CNR	Resources/S&T
DASN, RDT&E	Acquisition
CFFC	Fleet/Force

FNC IPT Structure



Sea Shield

Ensuring Maritime Dominance but Taking Measured Risks



Ensuring Strategic Resources Flow

Building Regional Confidence

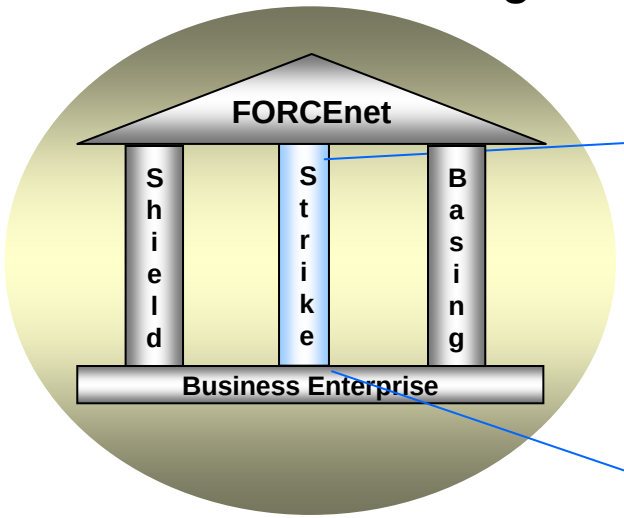
S&T Gaps

- Shipboard force protection against asymmetric threats
- Capacity to clear large areas of mines without cued ISR
- Rapid submarine cueing, detection and localization in shallow to deep water
- Sea-based missile defense of ships & littoral forces
- Platform defense against undersea threats, including ship self-defense against multi-salvo torpedo attacks
- Destruction of mines in areas through which Marine Corps and joint forces must maneuver, ranging from deep water through the objective
- Adequate detection and engagement of terrorist and Special Operations Force threats to ship inport and transiting restricted maneuverable choke points

Project Global Defensive Assurance

Sea Strike

Ensuring Maritime Dominance but Taking Measured Risks



Naval and Air Strength

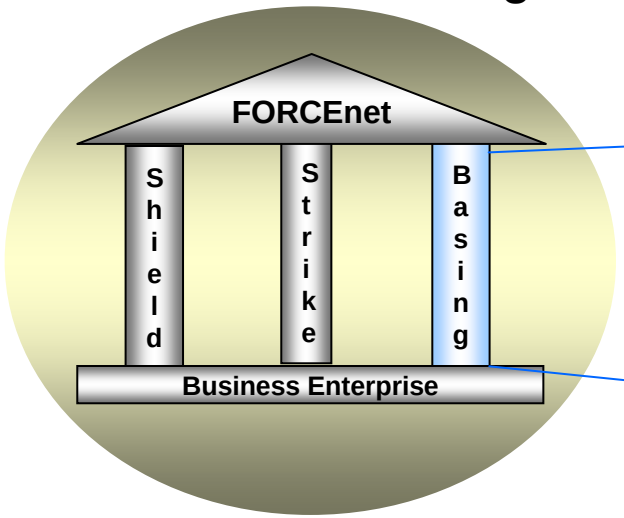
S&T Gaps

- Urban/Littoral Operations
- Rapid movement of mobile/emergent target data to shooters
- Survivability of aircraft operating at low altitudes
- Persistent high speed strike weapon to engage time critical targets
- Weapons with standoff and fire and forget capability against moving targets
- Common and persistent maritime picture on/below the surface
- Naval fires to support speed/depth of Marine Corps and joint maneuver

Project Precise and Persistent Offensive Power

Sea Basing

Ensuring Maritime Dominance but Taking Measured Risks



Right Capabilities for the Right Price

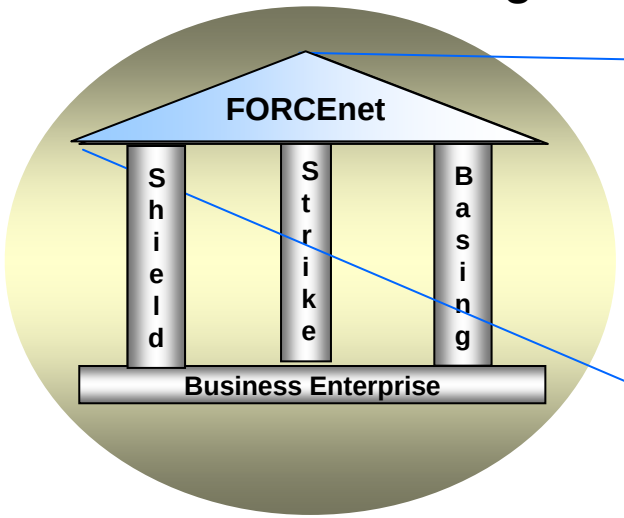
S&T Gaps

- Rapid closure and sea based operations of ground forces
- Tactical lift platforms for ship-to-objective maneuver from “beyond horizon”
- Aviation capacity on the sea base to conduct MEB level and special operating forces operations
- Connectors and interfaces to support the transport of personnel, equipment and logistics to/from the base and to/from objective

Project Joint Operational Independence

FORCEnet

Ensuring Maritime Dominance but Taking Measured Risks



Ensuring Strategic Resources Flow

Building Regional Confidence

S&T Gaps

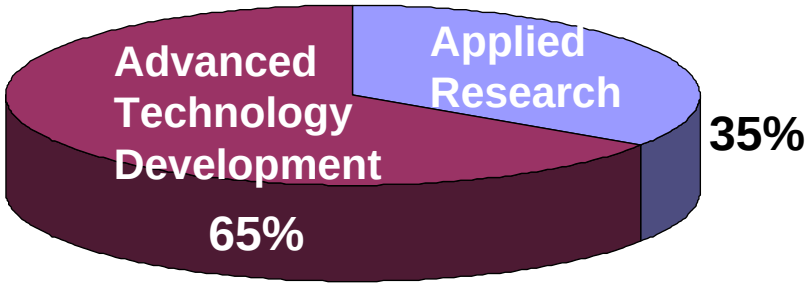
- Urban/Littoral Awareness
- Maritime domain awareness, homeland defense and interdiction of terrorist threats
- Joint combat ID
- Persistent ISRT for accurate target discrimination and location
- Computer network defense and information assurance
- Information operations
- Ubiquitous, secure communications and network infrastructure

Projecting a networked and distributed combat force

FNC Investment

Investment by Research Type

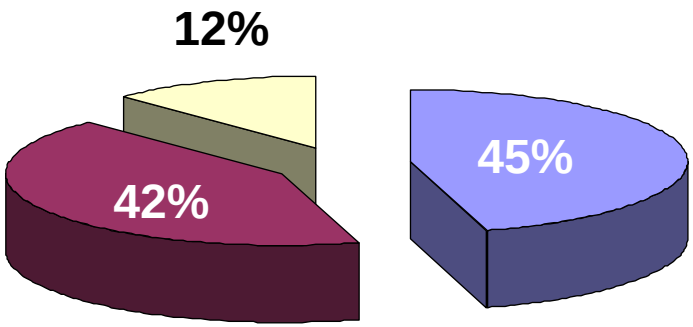
6.3



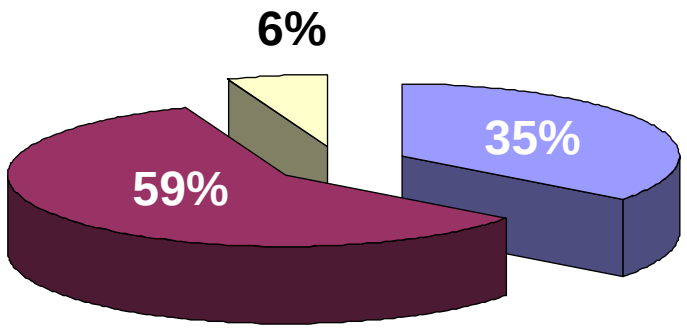
6.2

Investment by Performer

6.2



6.3



- FNCs leverage technologies that can be matured over the FYDP.
- FNCs are delivery oriented.

Transition Commitment Level

Transition Commitment Level (TCL)					
Strength of Transition Commitment / Years remaining in approved S&T development program	1	2	3	4	5+
A TTA Level A - Committed Fully executed final TTA. Including integration strategy. Transition funding programmed.	A1	A2	A3	A4	A5
B TTA Level B - Working Detailed Exit Criteria. Acquisition Program Interested. Transition TRL established. Proposed Transition Budget, PE Line identified/targeted	B1	B2	B3	B4	B5
C TTA Level C - Initial Initial Exit Criteria. Target Acquisition Program Identified and Program Manager is watching with interest as technology is developed. PE Line identified/targeted. Key stakeholders identified	C1	C2	C3	C4	C5
D No TTA IPT and TOG commitment.	D1	D2	D3	D4	D5

Annual ONR FNC Schedule

- Mid Aug — IPT Transition Assessments Due
- End Aug — Proposed New EC Proposal Abstracts Due
- Sept — Proposed New ECs Selected for Internal Review
- Sept — TOG Review of CNR Transition Status Report
- Oct –Nov — Internal Review of Proposed New ECs
- 30 Nov — ONR Endorsed Proposed New ECs to TOG WG
- Dec – Mid Jan — IPT Reviews of Proposed New ECs
- Jan – Mar — Release of BAAs/RFPs for New FY Contract Starts
- End Jan – Mid Feb — TOG WG Review of Proposed New ECs
- Mid Feb — CNR Review of ECs in Execution
- Feb — Proposed New EC Budget Balancing
- Early Mar — TOG Decision Meeting on New Start ECs
- Apr — FNC Budget Current POM Submission
- July — New EC Briefs to the R&D Partnership Conference
- July — EC Business Plan Updates Due
- Oct – Dec — Initiation of New FY Contracts

Red denotes New
Blue denotes Approved
Green denotes Executing/On-going

ACTDs

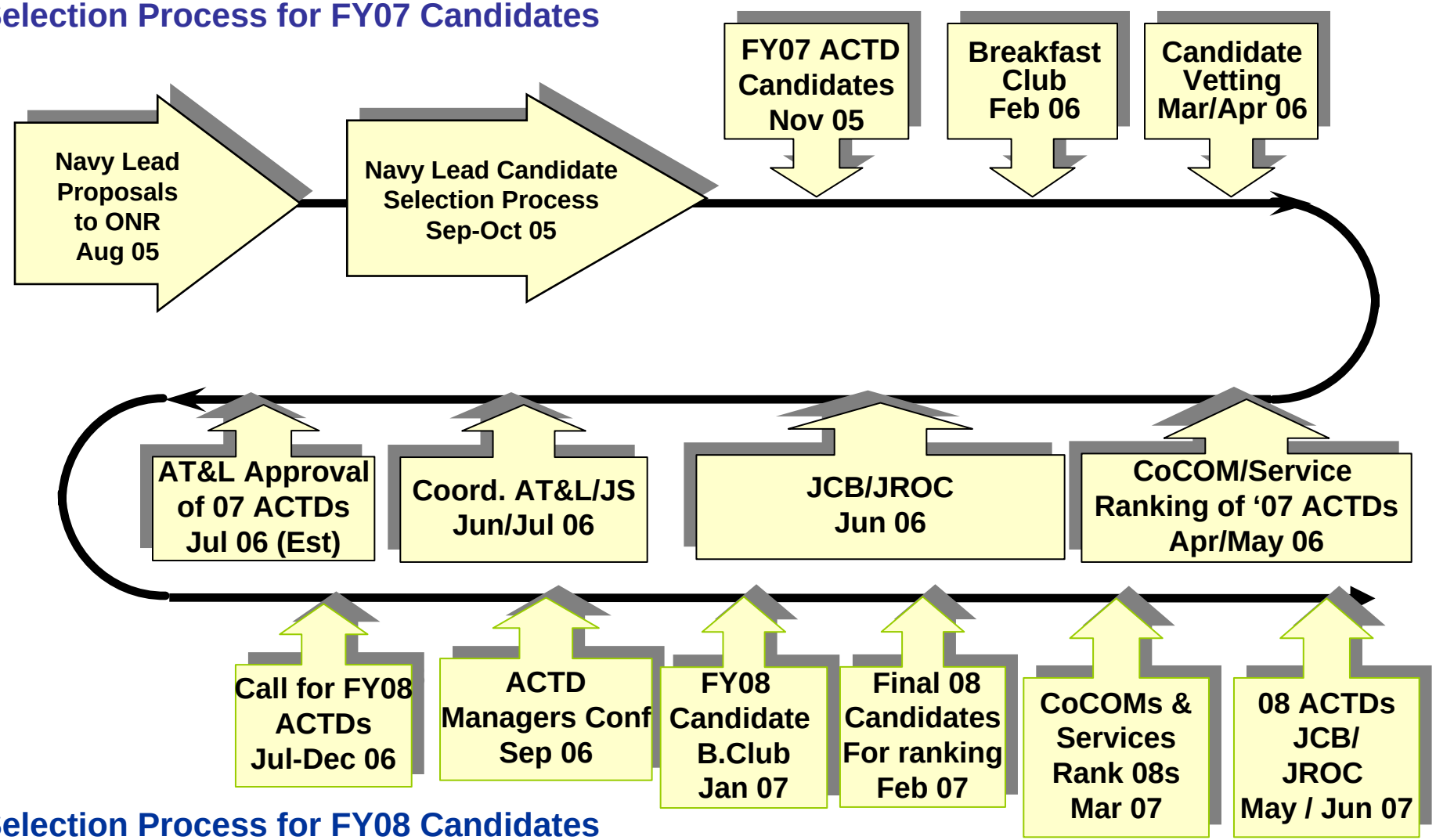
Advanced Concept Technology Demonstrations (ACTDs) exploit mature and maturing technologies to solve important military problems.

The Navy Led ACTD program is a structured process established to assure that proposals submitted to OSD transition successfully to a Program of Record. The successful ACTD will:

- Address a ***joint warfighting*** need with a ***mature technology (TRL 5+)***
  - ***Joint***, often includes coalition partners and other U.S. Government
- Have Multiple Funding Sources - OSD routinely provides ***10-30%*** funding
- Be Managed by an ***integrated team***
  - Lead Service/Agency: Transition Manager
  - Developer Service /Agency: Technical Manager
  - Sponsoring Combatant Commander: Operational Manager
- Provide a technical solution with demonstrated ***CONOPS***
- Evaluate solutions in field demonstrations by warfighters
- ***Is Rapid:*** 1-3 Years – or less - to Final Demonstration/Prototype
- Leaves residuals with warfighter with 2 years support

DUSD AS&C ACTD Program Timeline

Selection Process for FY07 Candidates

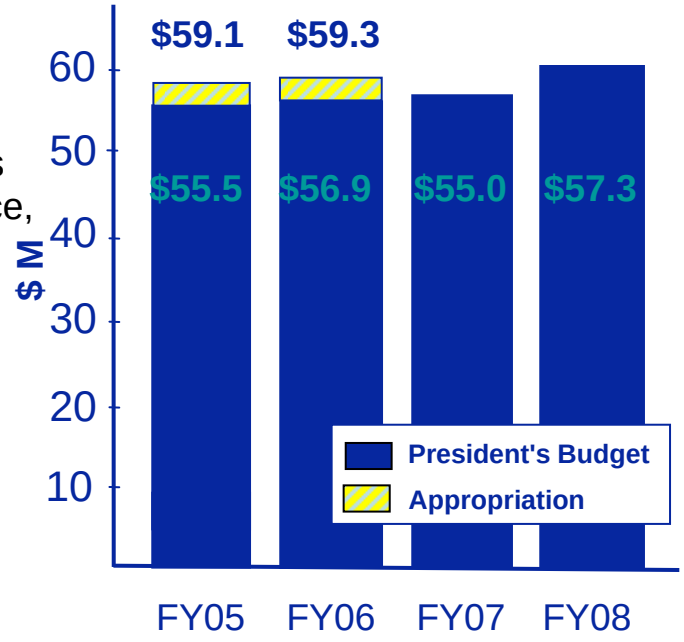


Selection Process for FY08 Candidates

JCTD Timeline TBD

Navy ManTech Program Mission, Budget, and Roles

- Mission:
  - Develop enabling manufacturing technology -- new processes and equipment -- for implementation on DoD weapon system production lines
  - DoD 4200.15 states investments should:
    - Transition emerging S&T results to acquisition programs
    - Improve industrial capabilities in production, maintenance, repair and industrial base responsiveness
    - Advance manufacturing technology to reduce cost, improve performance, and responsiveness
- Budget:
  - Stable at approx. $60M
- Execution:
  - Nine Centers of Excellence (COEs)
    - 8 Contracted
    - 1 Government
- ONR Roles:
  - Budgeting
  - Investment Strategy – platforms for investment
  - Program Planning
  - Contracting – COEs (competed every 5 years) and projects
  - Program Execution
  - Technology Transfer



FY06 Investment Strategy
Platform-Centric Focused Initiatives

Primary investment strategy supports key naval assets

Primary Emphasis

PEO (Ships)
DD(X) Family

PEO (Carriers)
CVN 21

PEO (Ships)
LCS

PEO (Ships)
LPD 17
DDG 51

PEO (T)
F-18 Family
EA-18G

PEO (IWS)
Missiles
Weapons
Munitions

PEO (Subs)
SSN
SSGN

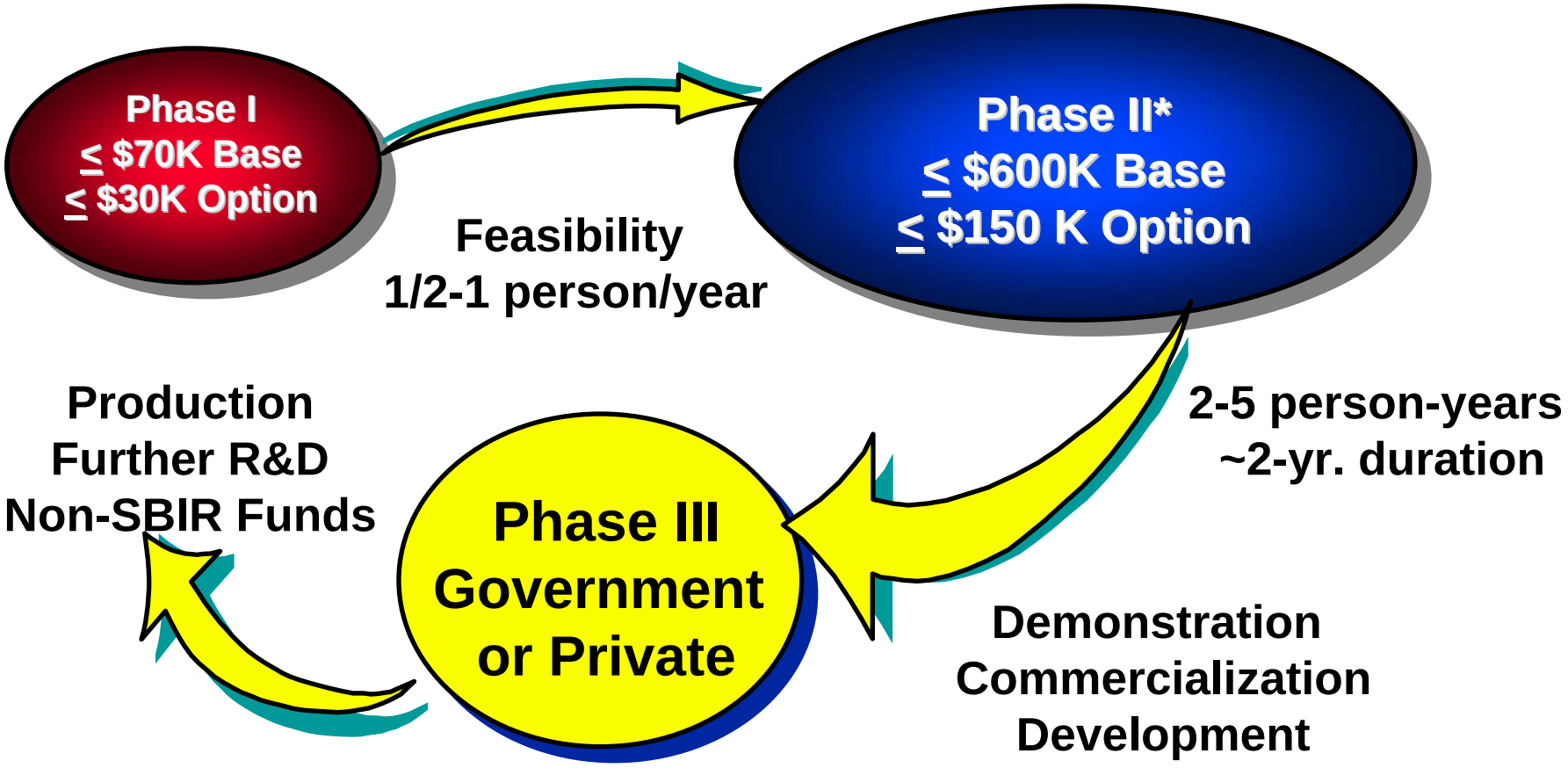
SBIR Congressional Program Goals

15 USC 638 SBIR Reauthorization, December 2000

1) Use small business to meet federal R/R&D needs.
2) Stimulate technological innovation.
3) Foster and encourage participation by socially and economically disadvantaged SBCs, and by SBCs that are 51 % women -owned & controlled, in technological innovation; and
4) Increase private sector **commercialization** of innovations derived from federal R/R&D, thereby increasing competition, productivity and economic growth.

What is meant by "commercialization"?

Program Phases



*varies by component

Technology Transition Programs

Program	Purpose
Defense Acquisition Challenge Program (DACP)	Identify and introduce innovative and cost-saving technology or products from within DOD's science and technology community as well as externally into existing DOD acquisition programs.
Technology Transition Initiative (TTI)	Facilitate the rapid transition of new technologies from DOD science and technology programs (TTI).
Quick Reaction Fund (QRF)	Identify and rapidly field-test promising new technologies from DOD's budget execution years.
Rapid Technology Transition (RTT)	Rapidly transition technology from any source into Department of Navy (DoN) programs of record (PoRs) to meet emergent/urgent Naval Needs.
Domestic Technology Transfer	Mandate by Federal Technology Transfer Act of 1986 to effectively use national S&T to benefit the public and private sector.

Characteristics of Transition Programs

Transition Program	Scope	Duration	Funding	TRL Level 1-9	Topic Call
DACP	Any person or activity inside or outside DoD	1 to 3 years	Up to $2M	6	Annually
TTI	DoD S&T Programs	1 to 4 years	Up to $3M	6-7	Annually
QRF	Any S&T Programs	6 to 12 months	Up to $3M	6-7	Annually
RTT	Any person or activity inside or outside DoD	2 years	Up to $2M	6-9	Sep/Mar
Domestic T2	Congressionally mandated by Federal Technology Transfer Act of 1986	Ongoing	None		

Office of Transition Program Website Links

Office of Naval Research
www.onr.navy.mil

Future Naval Capabilities
http://www.onr.navy.mil/sci_tech/3t/fnc/

Advanced Concept Technology Demonstrations
http://www.onr.navy.mil/actd

Manufacturing Technology
http://www.onr.navy.mil/sci_tech/3t/mantech/

Small Business Innovation Research
http://www.onr.navy.mil/sci_tech/3t/sbir_sttr/

Transition Initiatives
http://www.onr.navy.mil/sci_tech/3t/transition/

Questions

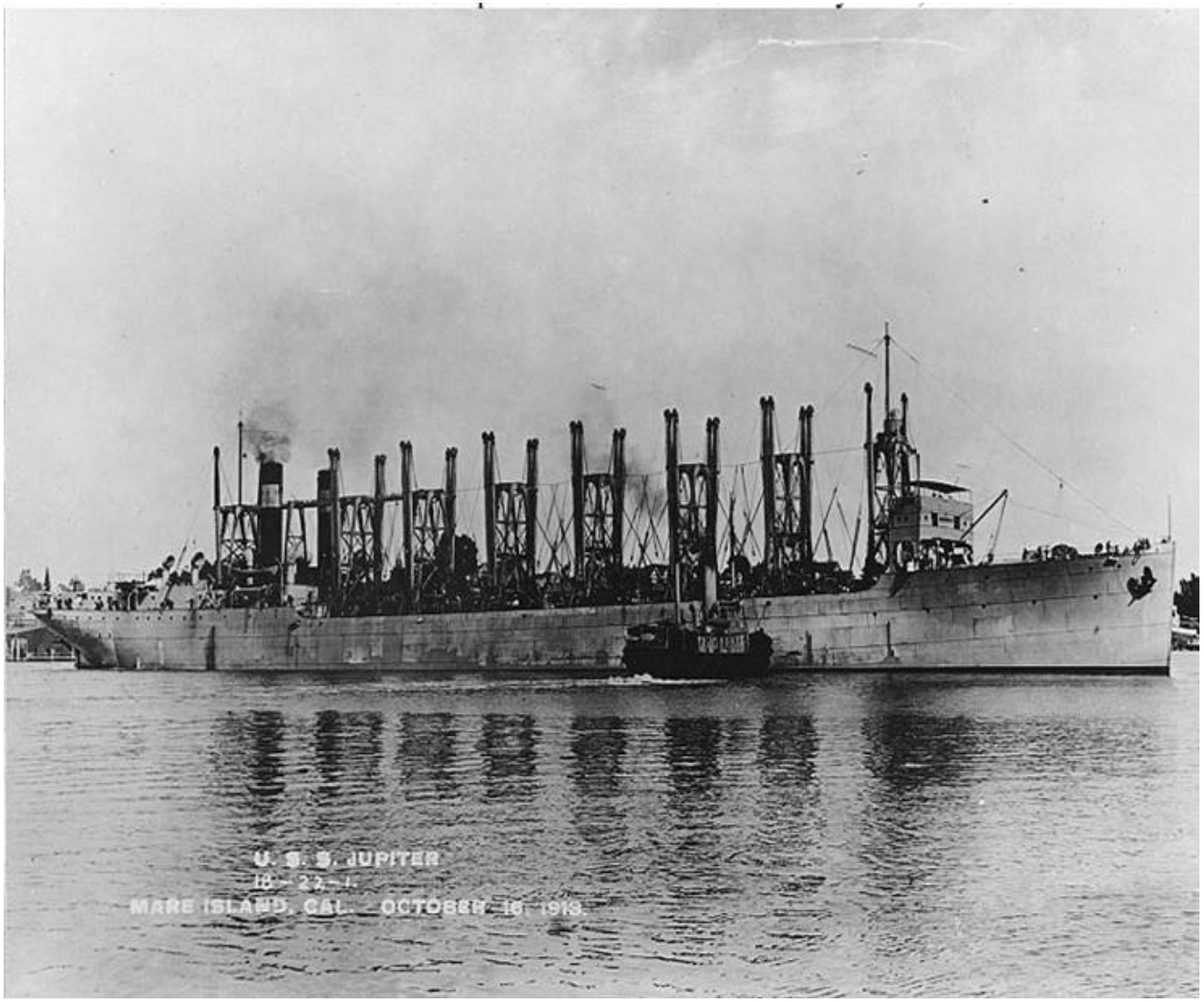
Advanced Capability Electric Systems

April 2006

Scott Littlefield
Office of Naval Research

USS Jupiter- 1913

Early example of Electric Drive



Navy is going electric

- T-AKE (Cargo Ship) – Diesel-electric system, with in-hull electric motors.
  - Enabled improved internal arrangements, with room for more cargo.
- LHD-8 (Amphibious Ship) – Hybrid system, with diesel-electric low speed mode and gas turbine mechanical drive at higher speeds.
  - Enables very efficient low-speed cruise.
- DD(X) Destroyer
  - First attempt at a power-dense, modern, militarized electric drive system.

Why is the Navy Going Electric?

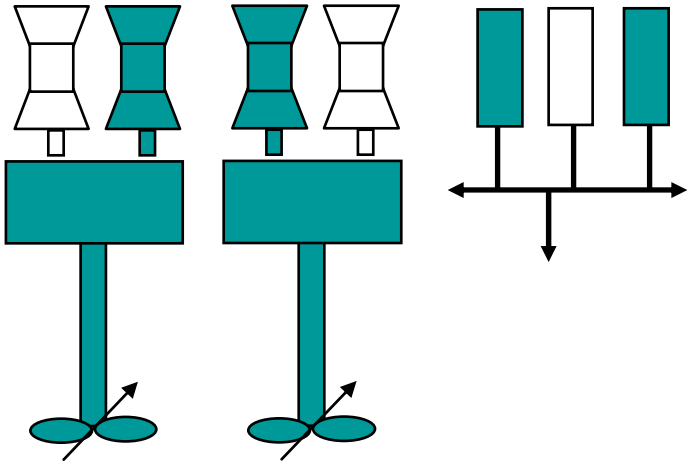
- Enable Transformational Weapons Systems
  - Electromagnetic Guns
  - Shipboard Laser Systems
  - Advanced Sensors

- Improve Survivability
  - Rapid and anticipatory Reconfiguration of Power and systems
- Reduce Signatures
  - Eliminates propulsion gear noise
  - Enables lower speed propellers
  - Enables silent watch capabilities

- Reduce Life Cycle Costs
  - Reduction in Number of Prime Movers
  - Significantly Greater Fuel Efficiency
  - Eliminate high maintenance hydraulic systems

Integrated Power System leads to Reduced Number of Prime Movers

Mechanical Drive

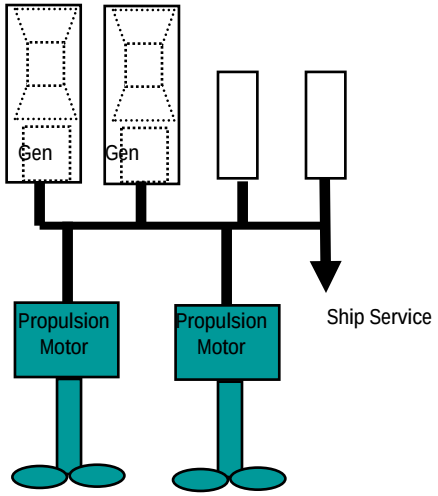


Current DDG-51 class has seven gas turbines

Life Cycle Cost Drivers:

- Initial Acquisition Cost
- Manning
- Maintenance
- Fuel Consumption

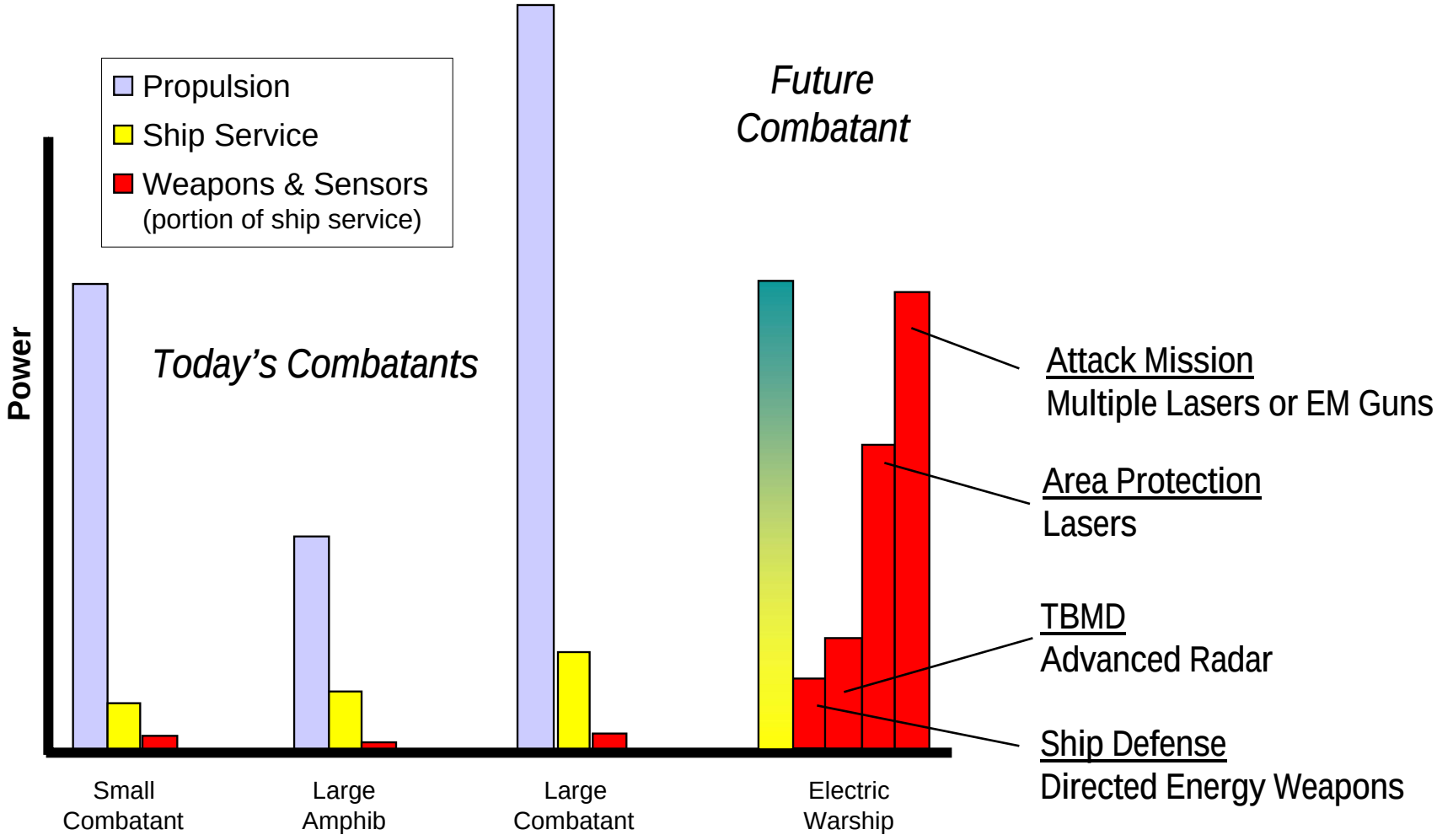
IPS



DD(X) will have four gas turbines

Thus lower Life Cycle Costs!

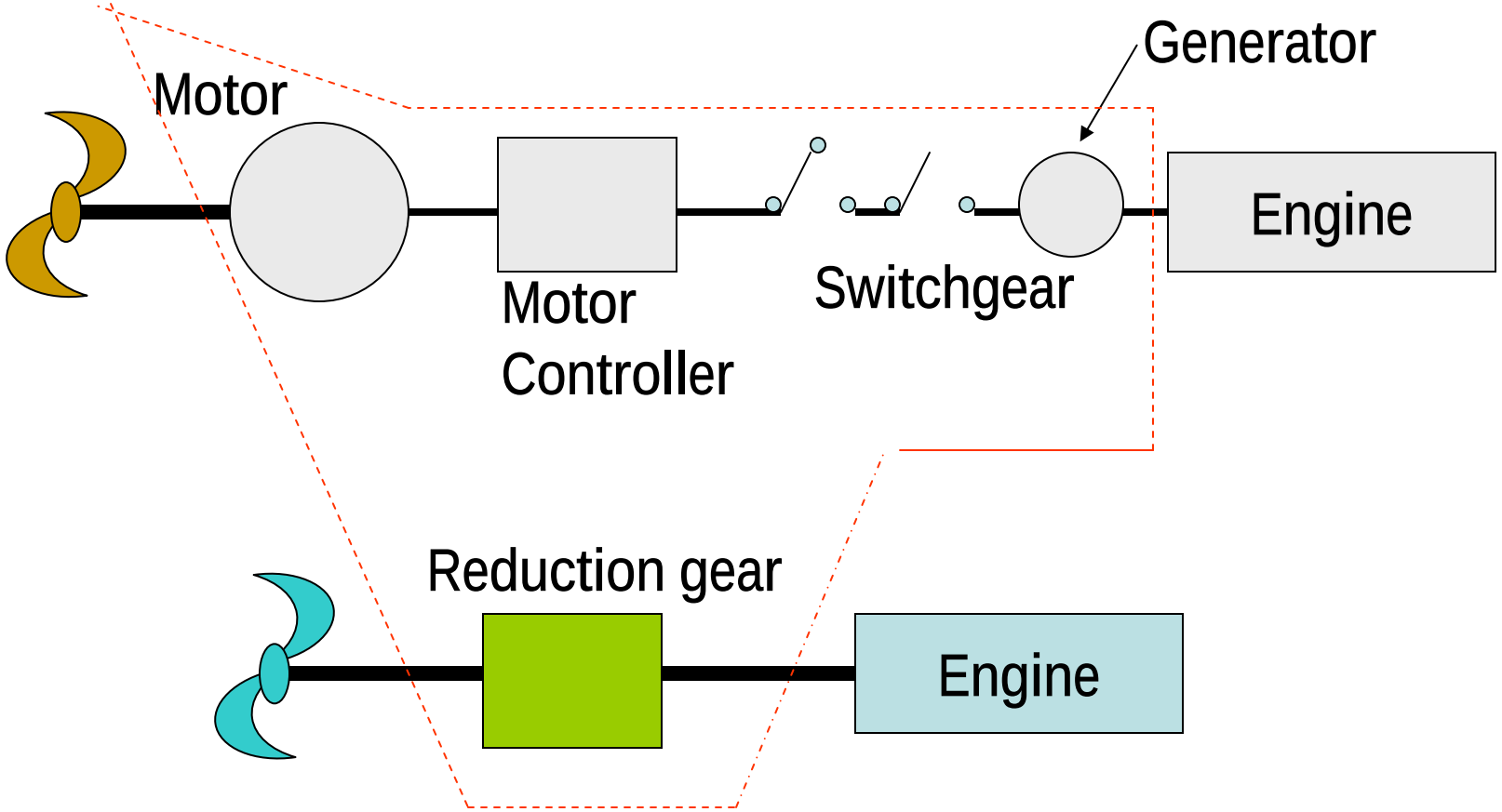
Expected Growth in Power Requirements



Key Issues for Navy

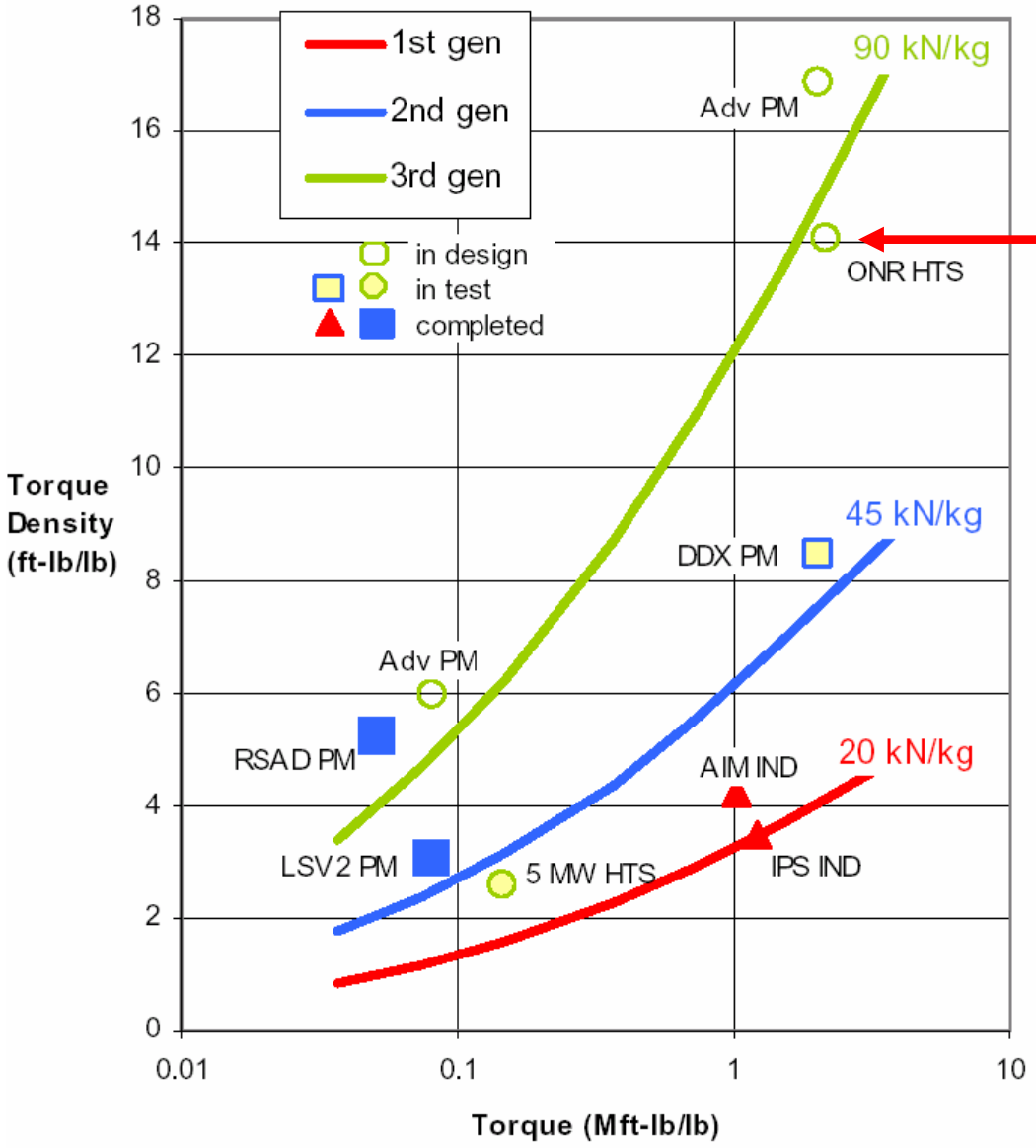
- Power Density
  - Components
  - Distribution Architecture
- Fuel Efficiency
- Pulsed Power
- Signatures

Power Density Issue



Mechanical Drive still beats Electric Drive on Power Density.

Motor Torque Density



To be demonstrated at full scale in 2007.

Figure courtesy of Peter Mongeau, ASNE Electric Machines Technology Symposium, Philadelphia PA, January 2004

NRAC Summer Study – Future Fuels

- National Petroleum Usage – 16M BPD
- DOD Usage – 300K BPD (about 2% of national usage).
- DOD Usage:
    - Aircraft 73%
    - Ground 15%
    - Ships 8%
    - Installations 4%
- Recommendation – DOD catalyze manufactured hydrocarbon liquid fuels infrastructure through long term purchase contracts.

Future S&T Directions:

- High Speed / High Frequency Generators
- Advanced Distribution Architecture
- Innovative Ship Propulsion
- Compact Power Electronics and Energy Storage to Support Pulsed Power Weapons and Sensors.

Relevant Research and Results . . .Yesterday, Today, and Tomorrow

Questions?

UNCLASSIFIED

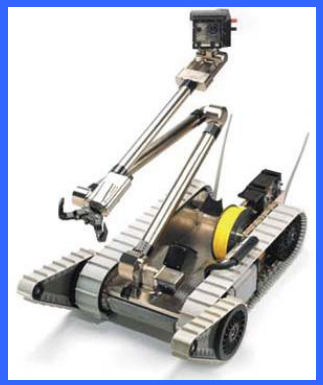
Advanced Concept Technology Demonstration (ACTD)

And transition to the…

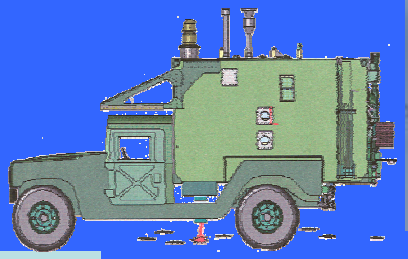
Joint Capability Technology Demonstration (JCTD)

business model

Vision: Through oversight and partnerships, accelerate cutting-edge technologies & concepts to sustain and improve warfighting capabilities.



CUGR ACTD
NDIA Jan 2006



MICRO UAV ACTD
NDIA March 2006

Mark Peterson

Director, Program Resources & Integration

Office of the Secretary of Defense

DDR&E/AS&C

(Advanced Systems & Concepts)

April 18, 2006

www.acq.osd.mil/asc

Deputy Under Secretary of Defense (Advanced Systems & Concepts)

- Military Assistant
- Program Resources & Integration
- Joint & Coalition Operations Support
  - Joint Warfighting Program
  - USJFCOM Joint Experimentation and Integration
- ACTD/JCTD Office
  - ACTD Program
  - JCTD Program
- Office of Technology Transition
  - Tech Transfer, Tech Link, TechMatch
  - Independent Research and Development (IR&D)
  - Small Business Innovation Research (SBIR)
  - North American Technology and Industrial Base Organization (NATIBO)
  - Manufacturing Technology (ManTech)
  - Defense Production Act Title III
  - Technology Transition Initiative (TTI)
- Special Capabilities Office
  - Special Capability Projects
- Comparative Testing Office
  - Foreign Comparative Testing (FCT)
  - Defense Acquisition Challenge (DAC)

USD (AT&L)
Honorable Ken Krieg

DDR&E
Honorable John Young

DUSD (AS&C)
Ms. Sue Payton

ACTD/JCTD Support to Joint Combatant Commanders

- **ACTDs rapidly field emergent mature technologies to joint warfighters** (TRL level 5-6).
  - Balanced emphasis on tailoring technology with associated Tactics, Techniques, & Procedures (TTPs) to user needs
- **Primary customers for ACTDs are joint Combatant Commanders**
  - Joint, Coalition, & transformational opportunities are priorities
  - ACTDs require a Lead Service/Agency and a CoCom Sponsor
- **ACTDs are not an acquisition/procurement program**
  - Charter is to minimize processes that delay rapid fielding of demonstrations
  - Overcoming resistance to transformational concepts
  - "Rack & Stack" voting process used to select Candidate slate inside the Planning, Programming, Budgeting & Execution (PPBE) process
    - Example: FY 2007 selection is in process now

Since 1995, Over hundred and fifty ACTDs have been initiated. 70 Ongoing today!

ACTD/JCTD Objectives

Formal Success Objectives

- ✓ Rapid transition to Defense Program of Record
- ✓ Satisfaction of operational requirement with residuals
- ✓ Confirmation that technology/op concept appropriate for joint military use

- or not !

Informal Success Objectives

- ✓ Develop operational concepts (DOTMLFP) employing proposed technologies
- ✓ Contribute technical elements into existing/new programs

Informal Failure Indicators

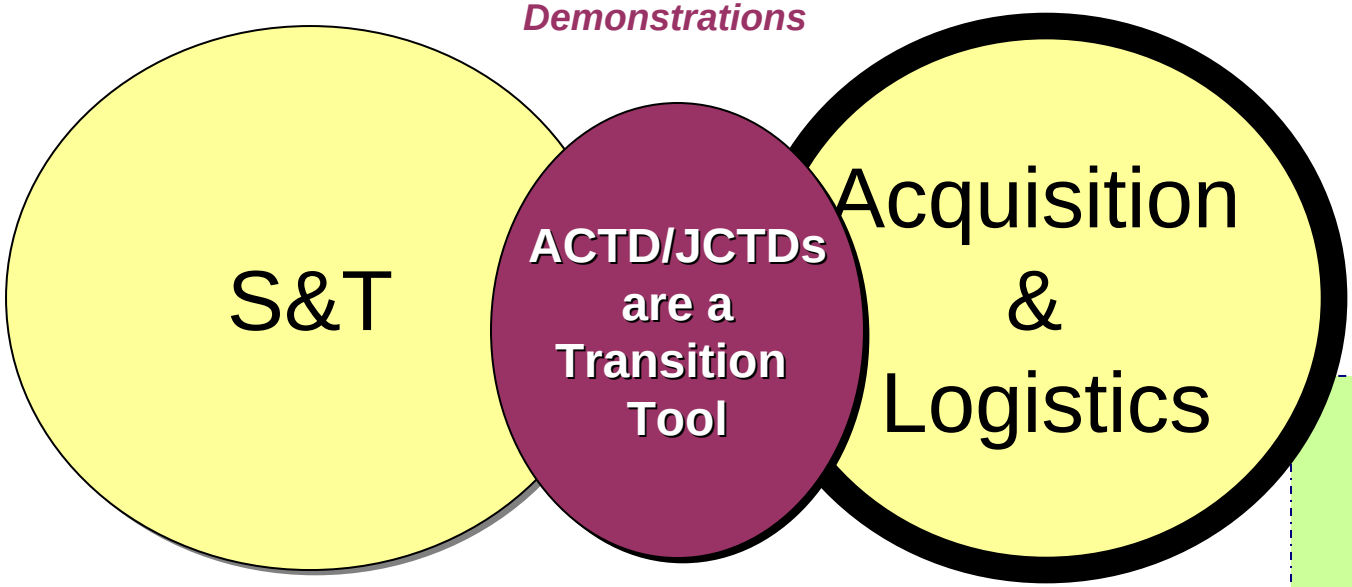
- Overlook technologies to solve known military problems
- Allow spiraling technologies/requirements to postpone transitions
- Pursuing low risk technologies to ensure successful demonstrations
- Focus on popular single-service ACTDs at expense of tough joint efforts

ACTD/JCTDs Projects Positioned between S&T & Acquisition

Filling the Joint Gap between S&T and Acquisition for the CoCom Customer

Advanced Concept Technology Demonstrations

"Try before you buy"



"The 80% Solution"

Deliverables:

- Concept of Operations
- Military Utility Assessment
- Residual Capability leave behind
- **Business Case**

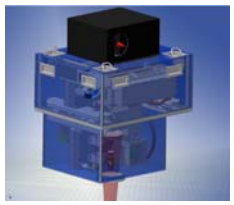
76% of all ACTDs transition at least one product into a warfighting capability

Transition programs are not acquisition programs, and should not be science projects

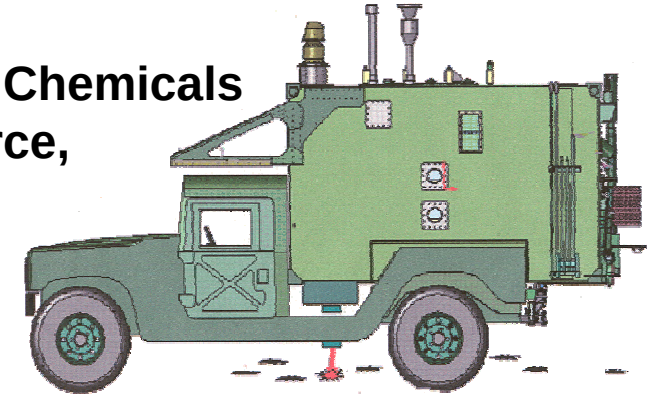
CUGR ACTD Description

Joint Contaminated Surface Detector (JCSD)

- **Mounted in a modified Joint Service Light NBC Reconnaissance System**
- **Detect Traditional and Non-Traditional Chemical Warfare Agents and Toxic Industrial Chemicals**
- **Recon routes at the speed of the maneuver force, independent of terrain**



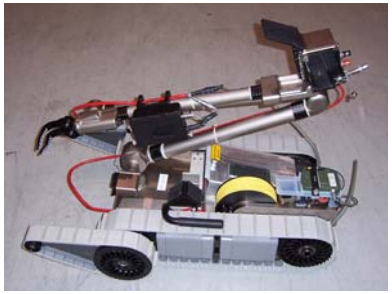
Joint **C**ontaminated **S**urface **D**etector



CUGR **A**CTD **H**MMWV **V**ariant **S**ystem

CBRN Unmanned Ground Vehicle (CUGV)

- **Keep crew out of contamination and direct fire**
- **Keep contamination out of the Recon Vehicle**
- **Integrate CBRN detection joint mission specific modules**



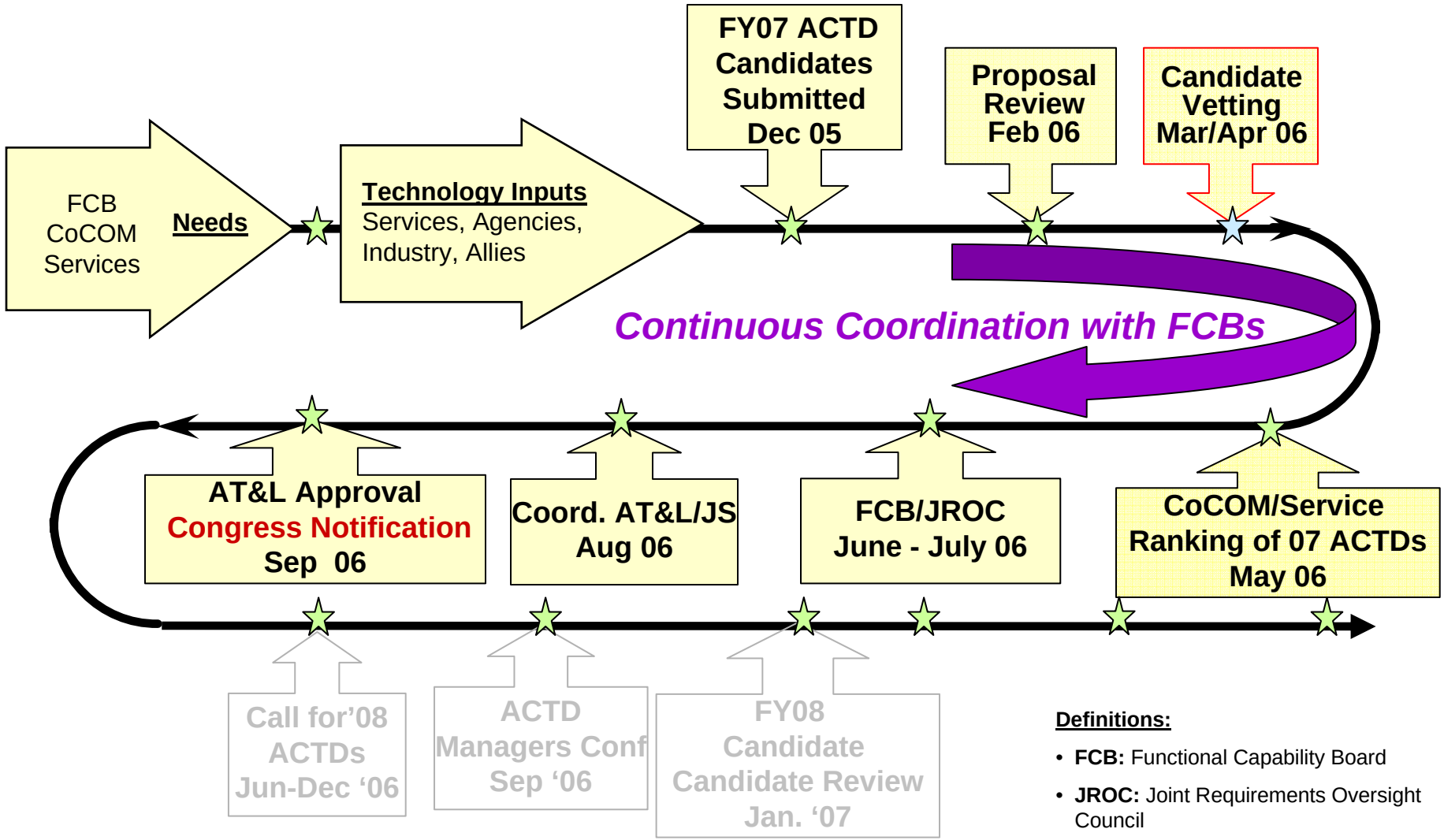
CBRN **U**nmanned **G**round **V**ehicle

Transition: **Two Programs of Record (PoRs) identified to receive CUGR Thrusts**

- **STYKER Nuclear Biological Chemical Reconnaissance Vehicle (NBCRV)**
- **Joint Nuclear Biological and Chemical Reconnaissance System (JNBCRS**

ACTD FY-2007 ACTD/JCTD Program Timeline

Selection Process for the FY 2007 ACTD/JCTD Candidates



Definitions:

- **FCB:** Functional Capability Board
- **JROC:** Joint Requirements Oversight Council
- **CoCOM:** Combatant Commander

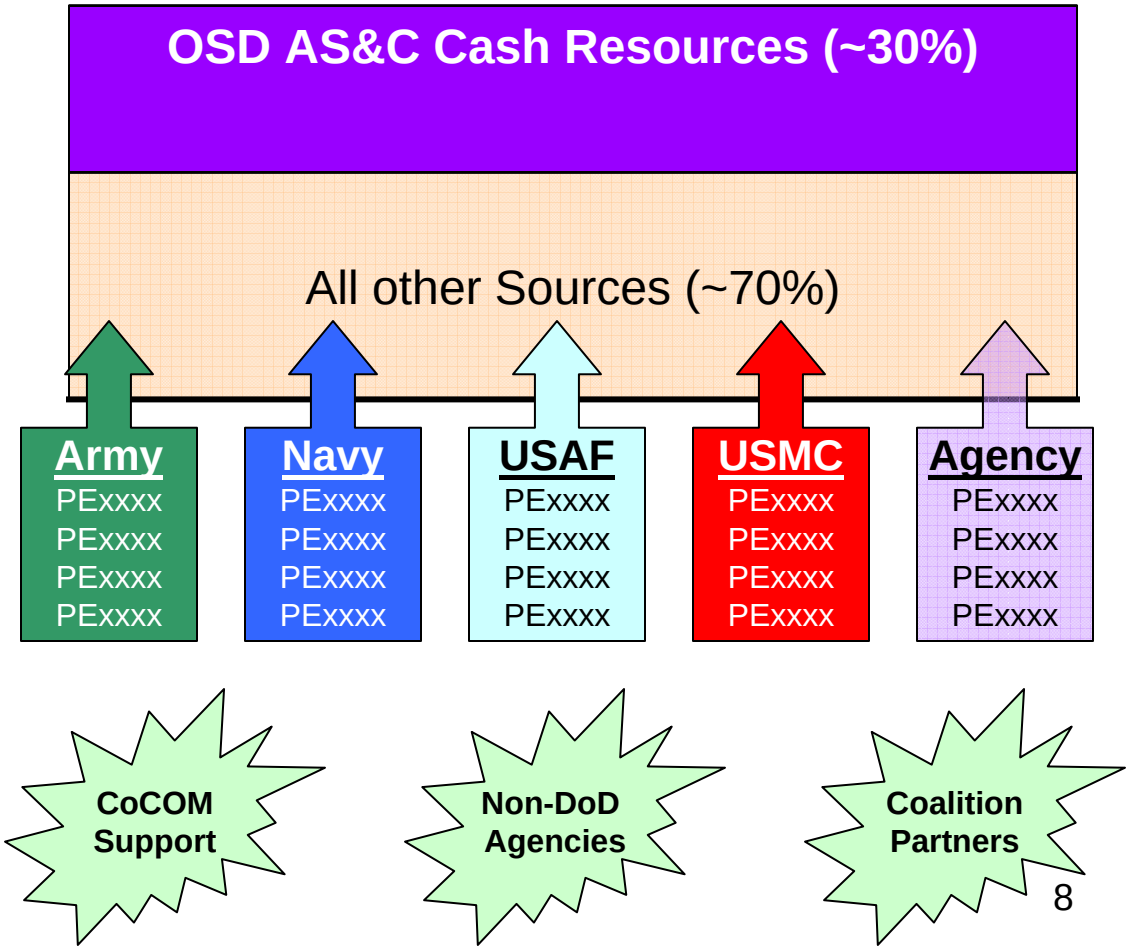
ACTD to JCTD conversion occurs after JROC validation

Current ACTD Funding Model
"Lets talk Money"

Goal is to initiate ACTDs within months of a JROC approval. However, two year PPBE process creates Service challenge in funding new ACTDs.

Challenges:

- **Front-end (start-up) and tail-end (transition) funding issues create serious PPBE challenges.**
- **Little incentive for Service participation as New ACTDs create immediate unfundeds.**
- **Significant start-up and demonstration delays after JROC decision: Average 6 month delay waiting for Implementation Agreements.**
- **Many different Program Elements fund ACTDs (Little visibility at Service level—accountability challenges)**
- **Projects require sustained commitment of resources once initiated.**
- **Unfunded Requirements (UFRs) during execution cause significant risk and disruption as OSD tries to "share" the UFRs with stakeholders.**
- **Even successful demonstrations risk waiting 2 years (or more) for resources to be programmed via rigid PPBE process.**



Joint Capability Technology Demonstration (JCTD)
Defense Acquisition Executive Pilot Program
(Four parts to the 3-5 year initiative to transform the ACTD program to JCTDs)

1. **Front-end incentive funds** create fair-share partnership. Significantly more of the Services JCTD resources fenced in OSD Defense Wide Lines. (JCTD budget line will eventually replace ACTD line in the budget)

   - **Incentive to participate without breaking Service core programs. Also provides stability of funding. The Best JCTDs defined by the CoCom sponsor will be initiated.**

2. **New Defense Wide Program elements and creation of new JCTD specific Component Program Elements (TBD)** (New JCTD PE's RDT&E BA-3/4)

   - **Visibility and Accountability of funds**
   - **Allows time for Services to POM for outyears (OSD assumes more resource "risk")**

3. **One year of Transition funding** (New OSD JCTD PE in RDT&E BA-4)
   - **Bridge the S&T capability "Valley of Death" – DoD prepared to "catch" successful capabilities without destructive delays. ANTICIPATE JCTD SUCCESS rate ~80%.**

4. **DAE Pilot program** – Transition "Joint Peculiar" systems into a fielded capability (New OSD PEs: RDT&E BA-5, OSD Procurement).

   - **Tracking joint capability through acquisition into initial sustainment**
   - **A new way of doing business for difficult transitions.**

JCTD First introduced in the FY 2006 President's Budget

JCTDs Offer Significant Benefits

ACTDs

- Innovative & joint efforts
- Partnerships serving CoCom needs beyond core Military capabilities
- Unique perspective on challenges of transitioning proven joint capabilities into acquisition

JCTDs

- Tailors solutions to CoCom needs
- Yields faster starts, faster deliveries
- Structures funding to permit Service participation without “breaking” programs
- Pilots “top-down” DAE process for joint acquisition
- Provides “window on joint investment”

Joint S&T focused on Capabilities from “Cradle-To-Grave”

Performance Metric Comparison
ACTD vs. JCTD

Performance Metric	ACTD	JCTD
Project Selection Focus	**Threat Based:** Shared Military Service and CoCom influence	**Capability Based:** Greater CoCom influence looking at nearer term **joint/coalition** needs..
Spiral Technologies	No Metric currently established	**Spiral Technology** available within **one year** of JCTD initiation
Final Demonstration Completed (Starting Point: Approved ID)	3 to 4 years after initiation (Implementation Directive (ID) Signed)	**50% completed final demo** by the end of the 2nd year. Goal - All JCTDs completed inside 3 years.
Shared Funding and Visibility of resources	OSD provides no more than 30% of the budgeted resources. Funding provided from many different program elements.	**OSD provide significantly more funding** (often greater than 30%, in some cases a majority of project funding), especially in the first two years.
Military Utility Assessment (MUA) conducted by an independent activity	MUA traditionally tied to a specific planned exercise for evaluation	**JCTDs not necessarily tied to an exercise**. Greater flexibility to establish military utility via operational "real-world" demonstration or specifically designed test/venue
Transition of technology	70% of ACTDs transition at least one product to sustainment	**80% of JCTDs transition at least 50% of their products to sustainment**

Source: FY 2007 President's Budget

– NEW –

Joint Capabilities Technology Demonstration (JCTD)

PE: 0603648D8Z (BA-3) and PE: 0604648D8Z (BA-4)

- ***COCOMs*** **remain the Customer – enhanced customer "capabilities pull"**
- **Builds on historically successful ACTD process**
  - **Balance "tech push" with "capabilities pull", focus on CoCom emerging needs**
  - **Maintains strong technical focus: work with services/agencies to push technology solutions**
- **Designed to increase speed of transformational, joint and coalition capabilities**
  - **Increase number of rolling/mid year project starts**
  - **Aim to introduce 1st spiral of new capability into field within first 12 months**
  - **Goal: final demo phase starts w/in 2 years, project complete in 3 years**
- **Increased focus on transition to long term warfighter support**
  - **Goal: 80% of JCTDs transition 50 percent of products (POR, residual support, GSA, etc.)**
- **Accelerate time to demonstration by increasing OSD funding in the first two years – with Transition funds!**

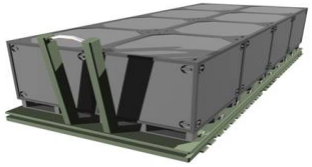
Four JCTDs Initiated in 2006

- CHAMPION
- JMIDS
- CMA
- LARGE DATA

Transformational

Counter-intelligence Human-intelligence Advanced Modernization Program/Intelligence Operations Now (CHAMPION) will demonstrate timely CI and HUMIT from the tactical to the strategic level.

Joint



Joint Modular Intermodal Distribution System (JMIDS) will demonstrate a seamless logistics system that will improve true joint Service and commercial interoperability.

Coalition

Comprehensive Maritime Awareness (CMA) will include coalition partners in extensive maritime sharing demonstrations. Includes tracking, tagging, and collaboration technologies. USNORTHCOM is also participating for homeland security application.

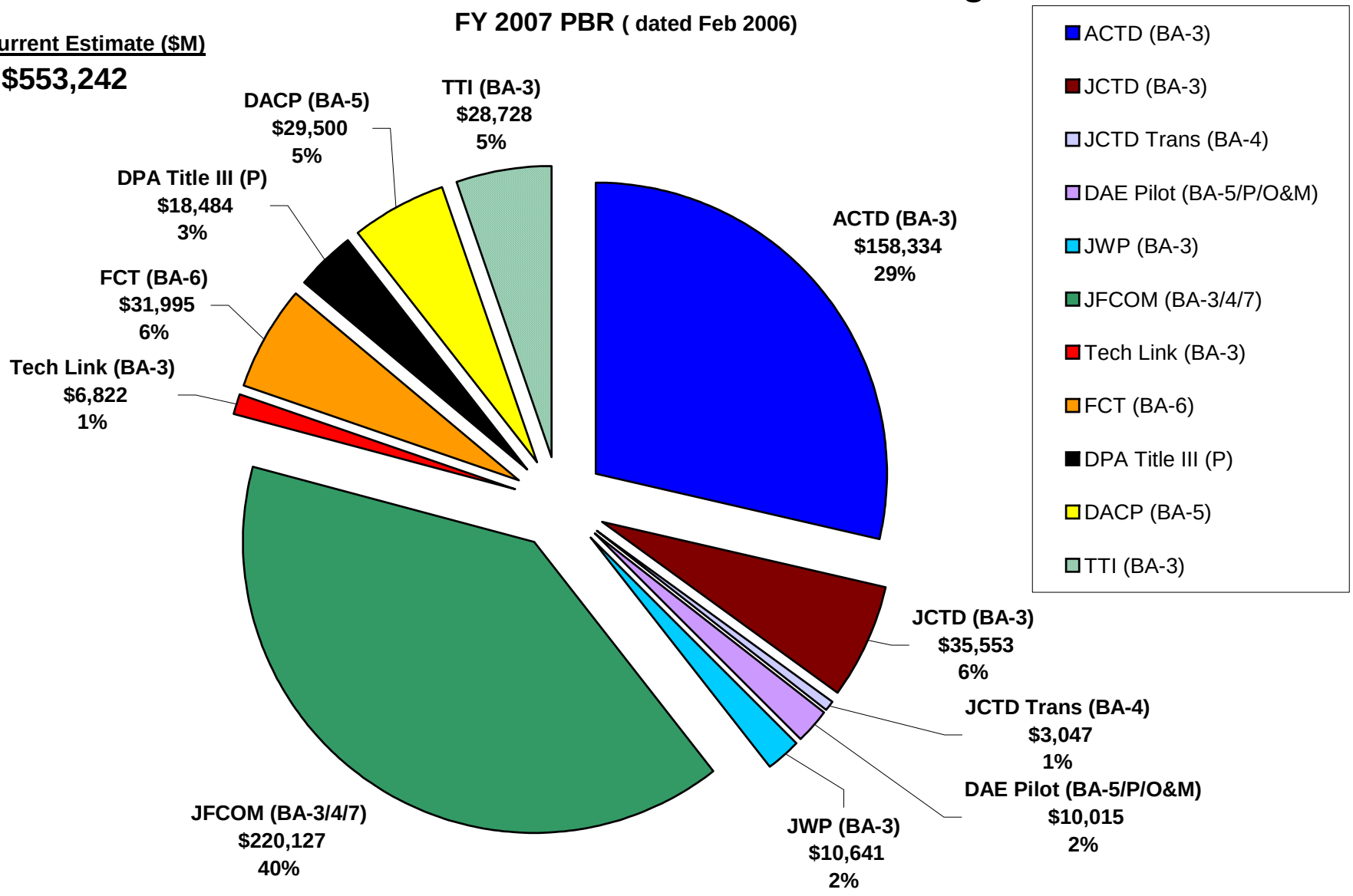
GAO's Michael Sullivan before House Armed Services Tactical Air and Land Forces Subcommittee, March 9, 2005: ***"We are encouraged by recent actions taken by DOD to initiate a Joint Capabilities Technology Demonstration {JCTD} business process as it is intended to meet joint and coalition forces needs…"***

FY 2007 DDR&E/AS&C Resource Oversight

FY 2007 PBR (dated Feb 2006)

Total Current Estimate ($M)

$553,242



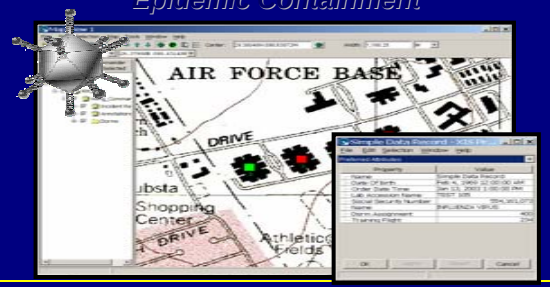
Source: FY 2007 PresBud

In FY 2007, USJFCOM funding is transferred from Navy to Defense-Wide Program Elements

"The Advanced Concept Technology Demonstration (ACTD) Program is helping to establish an agile, rapid, and adaptive acquisition process. This program partners with science and technology producers to rapidly insert technology into the appropriate phase of the deliberative acquisition process, with the goal of providing on-ramps for acceleration. The new Joint Capability Technology Demonstration Program (JCTD) furthers this concept by developing and maturing technologies to support the unique needs of the joint community in an even more adaptive and responsive process."

USD (AT&L) HASC Testimony, November 2, 2005
"Improvements and Excellence in Acquisition"

Epidemic Containment



Epidemic Outbreak Surveillance (EOS) FY 2005 ACTD integrates advanced diagnostics and informatics with surveillance system concept of operations to rapidly detect, identify, and distinguish natural and hostile biological pathogens. **Accelerated with Army/USAF responding to threat of the Avian flu threat.**

UNCLASSIFIED

BACK-UP SLIDES

UNCLASSIFIED

International Technology Cooperation

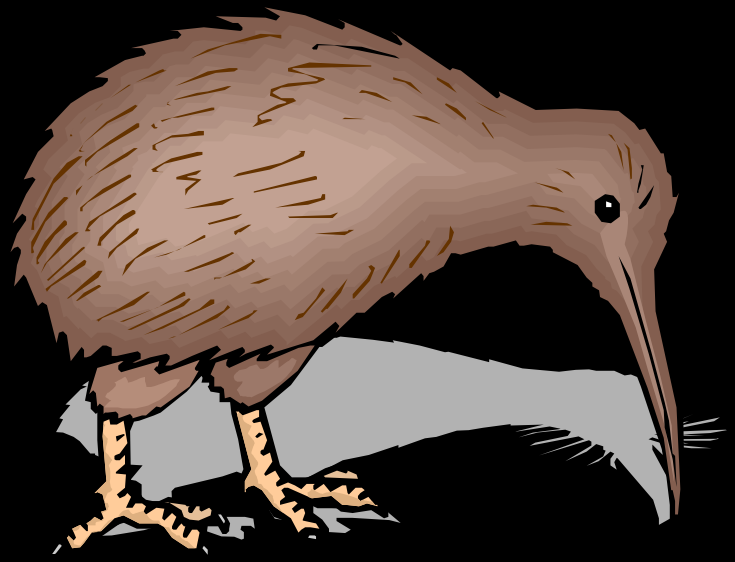
Dr Tony Sinden

Defence Science and Technology Counsellor, British Embassy

Outline

- **Why Collaborate**
- **How to Collaborate**

Why Collaborate?



Why Collaborate?

Why Collaborate?

More effective pursuit of military goals

More capable national equipment

More capable Allies

Coalition technological interoperability

Collaborative Development & Procurement

Access to new **TECHNOLOGY**

Access to new **EXPERTISE**

Access to new **FACILITIES**

Long-term personal **RELATIONSHIPS**

PROVIDED THROUGH COLLABORATION

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US benefits
from
overseas
equipment
development

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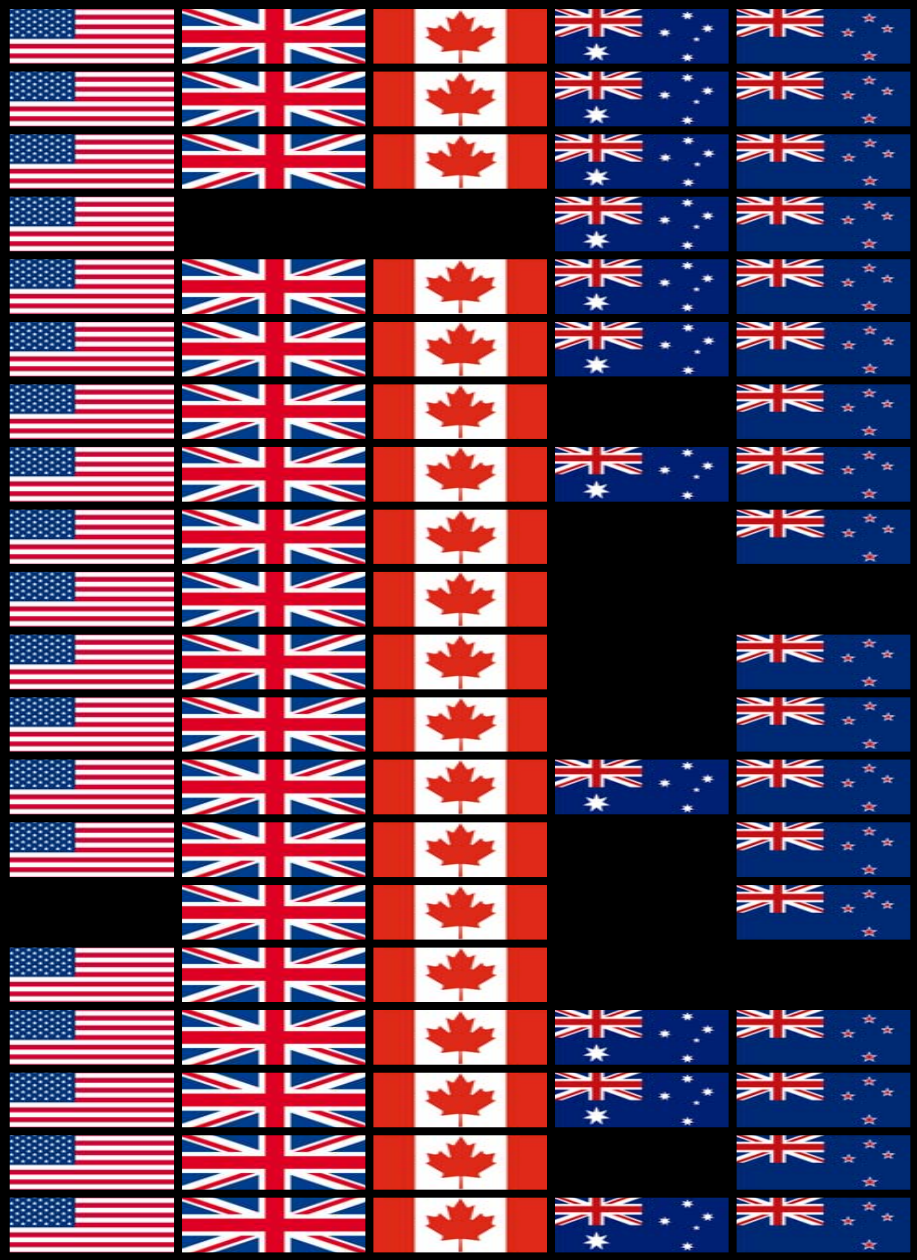
Long-term personal **RELATIONSHIPS**

PROVIDED THROUGH COLLABORATION

Examples of Coalition Operations



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PROVIDED THROUGH COLLABORATION

We operate
side-by-side
around the world

Iraq - 2003

1 Marine Expeditionary Force

3 Commando Brigade

15 Marine Expeditionary Unit

Why Collaborate?

More effective pursuit of military goals

More capable national equipment

More capable Allies

Coalition technological interoperability

Collaborative Development & Procurement

Access to new **TECHNOLOGY**

Access to new **EXPERTISE**

Access to new **FACILITIES**

Long-term personal **RELATIONSHIPS**

PROVIDED THROUGH COLLABORATION

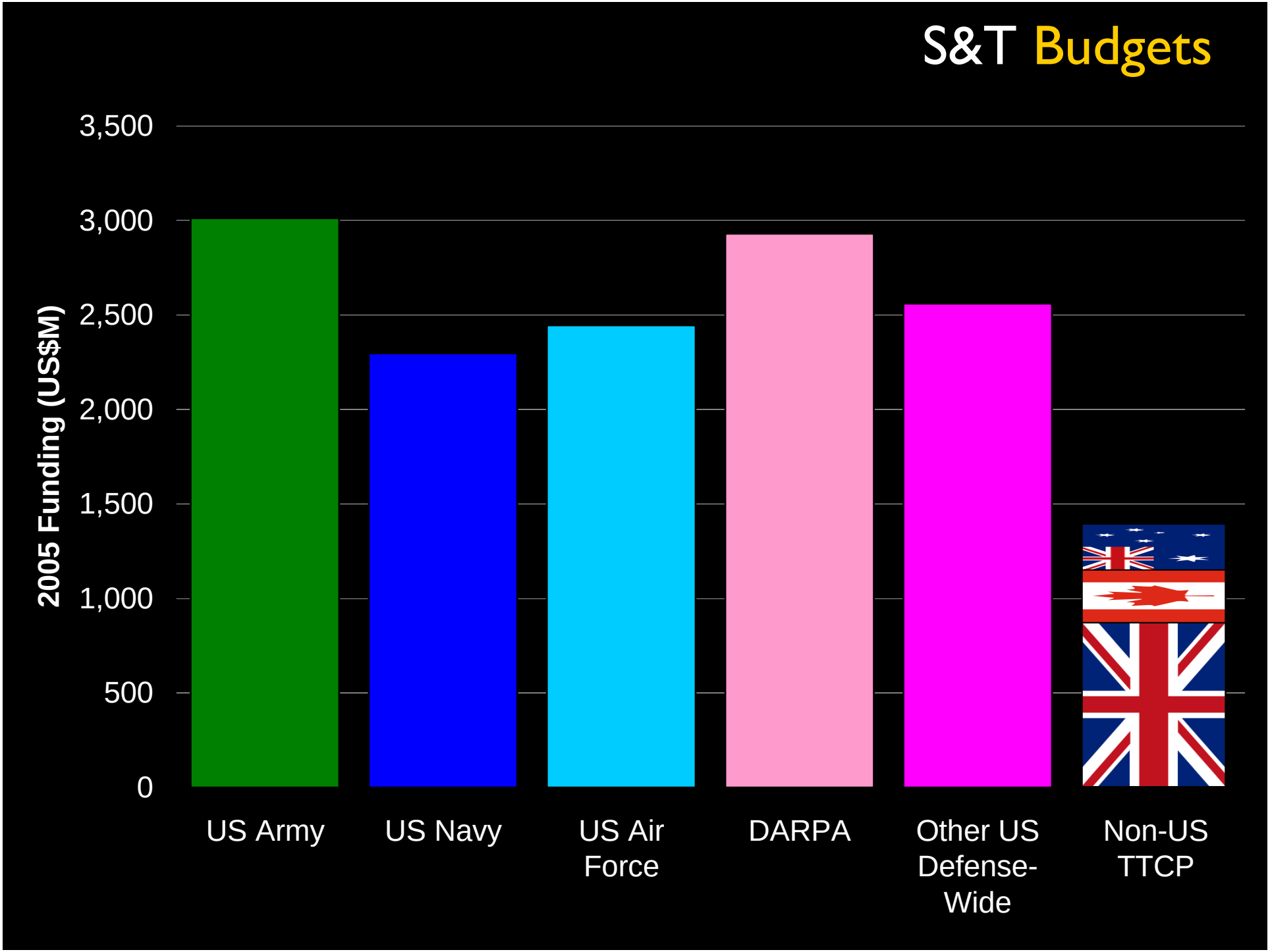
Top National Research Priorities

					
Automation & Unmanned Systems	X	X	X	X	X
CBR Mitigation	X	X	X	X	X
Combat Identification	X	X	X		
Counter-IED	X	X	X	X	X
Force Protection	X	X	X	X	X
Hard & Buried Targets	X	X			
ISR	X	X	X	X	X
Modelling & Simulation	X	X	X	X	
Nanotechnology	X	X	X		
Networks & IT	X	X	X	X	X
Through-Life Costs	X	X	X	X	X
Urban Operations	X	X	X	X	

Implications for:

- Government program managers – other people are working on the same problems as you…
- Industry managers – there are other markets for your ideas…

S&T Budgets


2005 Funding (US$M)
3,500
3,000
2,500
2,000
1,500
1,000
500
0
US Army
US Navy
US Air Force
DARPA
Other US Defense-Wide
Non-US TTCP

Why Collaborate?

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More capable national equipment

More capable Allies

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Access to new **TECHNOLOGY**

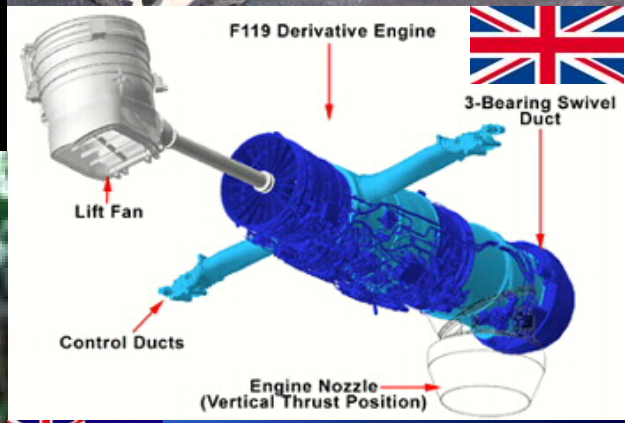
Access to new **EXPERTISE**

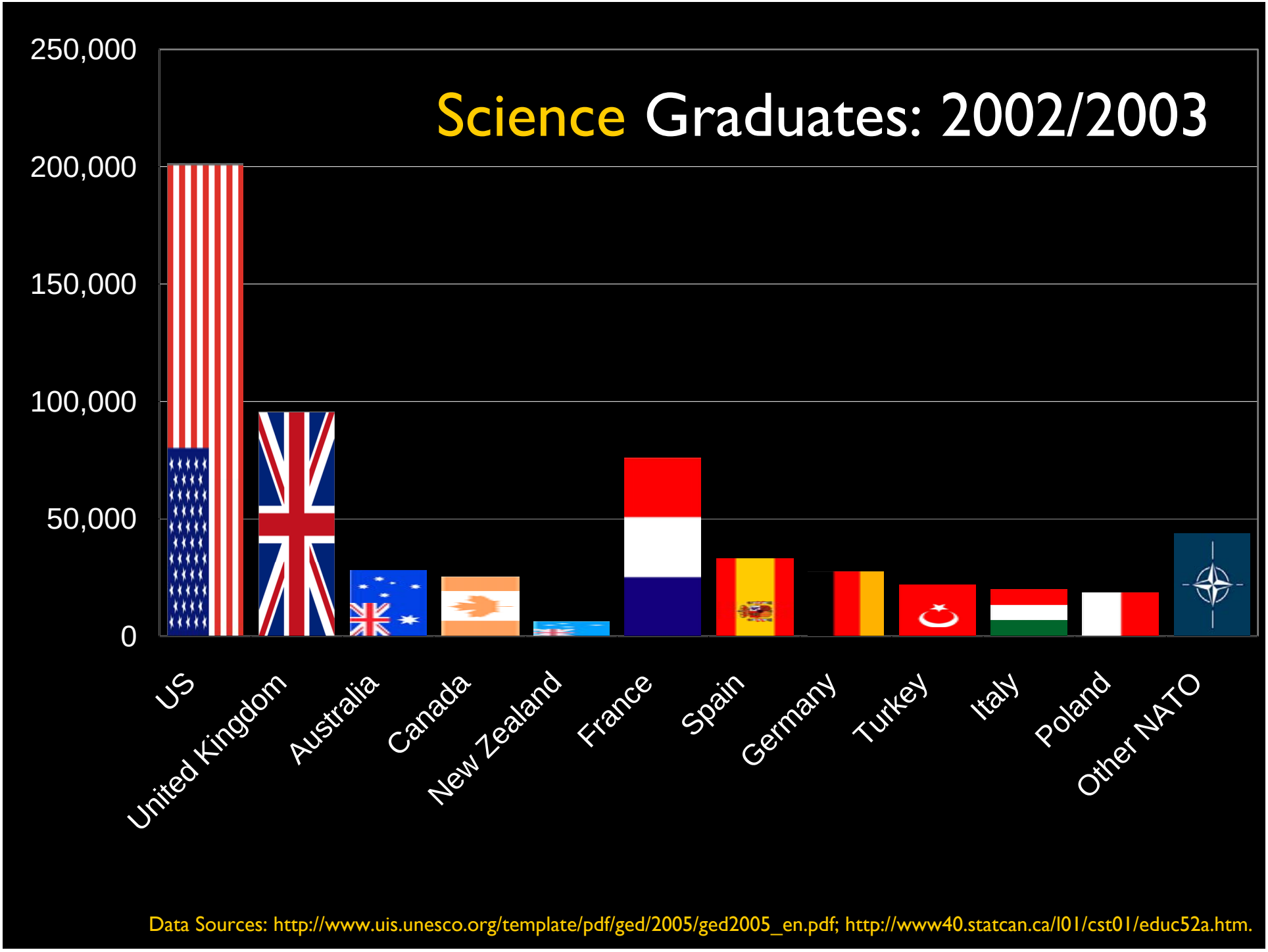
Access to new **FACILITIES**

Long-term personal **RELATIONSHIPS**

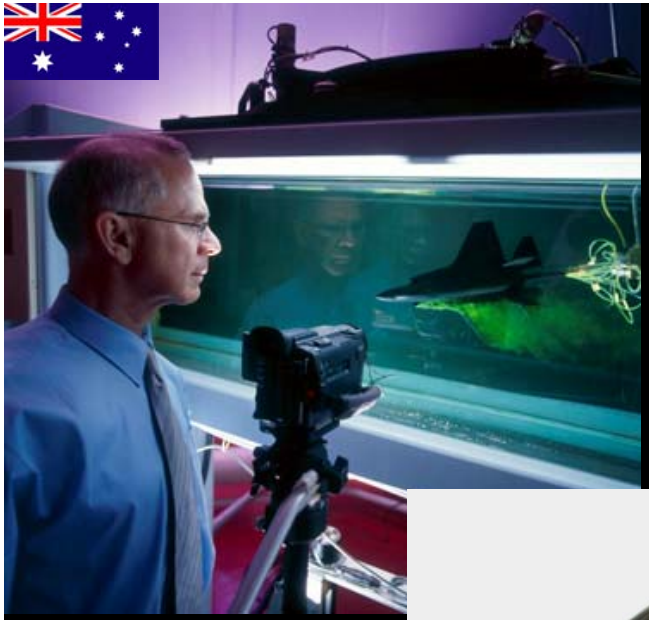
PROVIDED THROUGH COLLABORATION

US benefits from overseas technology




Science Graduates: 2002/2003
250,000
200,000
150,000
100,000
50,000
0
US
United Kingdom
Australia
Canada
New Zealand
France
Spain
Germany
Turkey
Italy
Poland
Other NATO
Data Sources: http://www.uis.unesco.org/template/pdf/ged/2005/ged2005_en.pdf; http://www40.statcan.ca/l01/cst01/educ52a.htm.

US benefits from overseas facilities



More effective pursuit of military goals

More capable national equipment

More capable Allie…

…ity

Why …rate?

OR – SHARED RESEARCH & DEVELOPMENT COSTS

T…

Access to new **EXPERTISE**

Access to new **FACILITIES**

Long-term personal **RELATIONSHIPS**

PROVIDED THROUGH COLLABORATION

Outline

- **Why Collaborate**
- **How to Collaborate**

How to Collaborate

US Program

US Government

US Industry

Allied Program

Allied Government

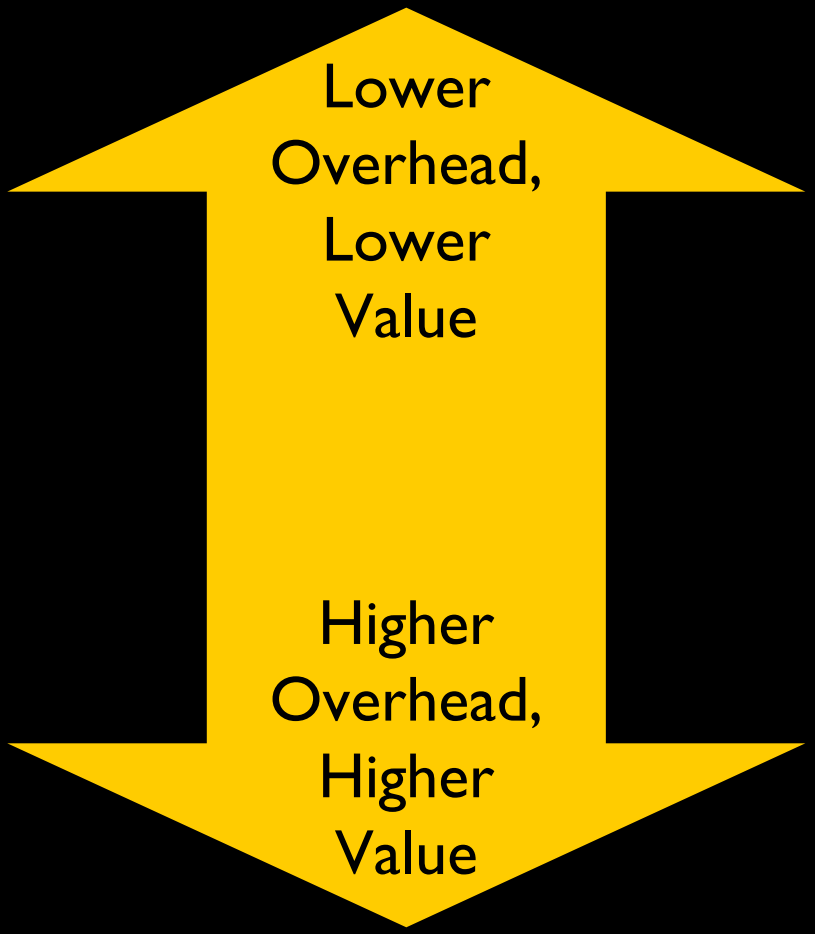
Allied Industry

Government – Government

Information Exchange: share results of national programs

Cooperative Development: coordinate & share results of national programs

Collaborative Development: mutually dependent, shared programs



Government – Government

Sources of Information (for US Government staff):

- **US National Representatives to collaborative fora** (e.g. TTCP, NATO) – for advice on Allied programs and collaborative channels
- **Overseas US S&T Staff** – for advice on Allied programs, collaborative channels and processes
- **DDR&E International Technology Programs staff** – for advice on collaborative channels and processes
- **DoD International Agreements staff** – for advice on collaborative processes
- **Defense S&T staff in Allied Embassies** – for advice on Allied programs, collaborative channels and processes

Government – Government

Wide range of existing collaborative arrangements (bilateral and multilateral), including:

NATO

The Technical Cooperation Program (TTCP)

Chemical, Biological & Radiological (CBR) MoU

UK/US Master Information Exchange MoU (MIEM)

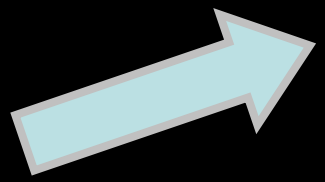
UK/US Research & Development Projects (RDP) MoU

How to Collaborate

US Program

US Government

US Industry



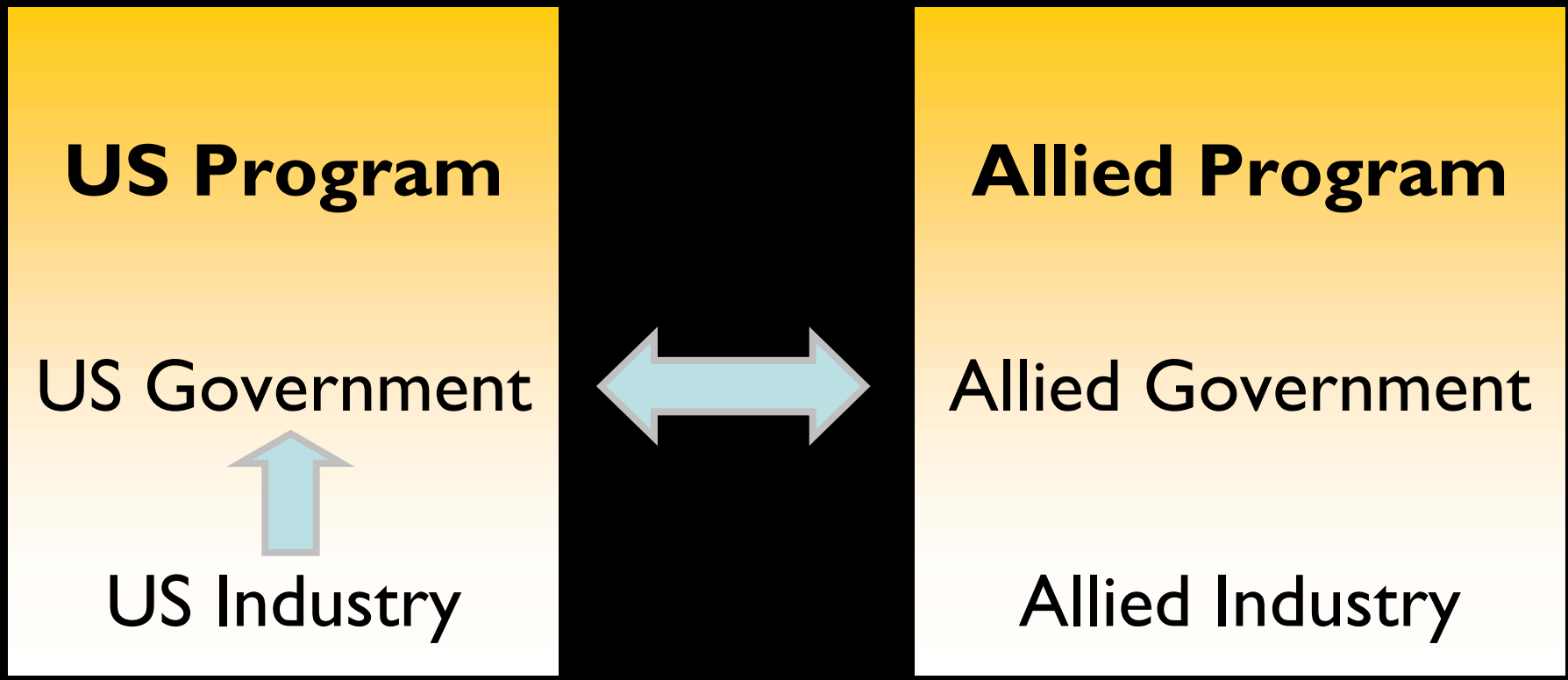
Allied Program

Allied Government

Allied Industry

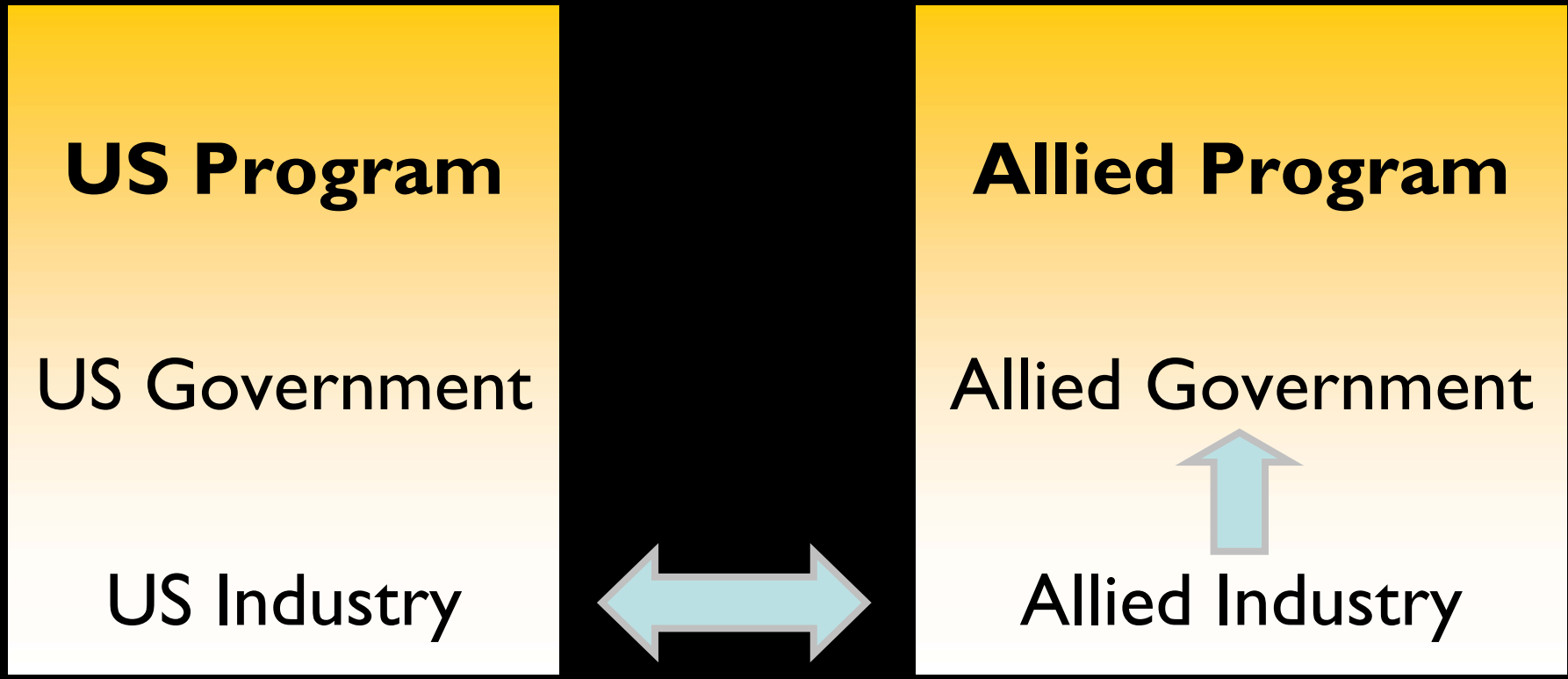
Contract directly with Allied Government via normal commercial channels (not true collaboration)

How to Collaborate



Use Government-Government collaboration to exchange outputs of complementary national programs

How to Collaborate



Use Industry-Industry collaboration to obtain a share of Allied program work

How to Collaborate

US Program		**Allied Program**
US Government		Allied Government
US Industry		Allied Industry

Multinational Government–Industry Partnership, e.g. JSF, Network & Information Sciences International Technology Alliance

Industry – Industry

Sources of Information (for US Industry staff):

- **Allied S&T Managers** – for advice on Allied programs and opportunities
- **Trade Associations** – Advice on opportunities and processes, fora (conferences, workshops …)
- **Allied Contracts Bulletins, etc.** – for advice on Allied programs and opportunities
- **Defense S&T staff in Allied Embassies** – for advice on Allied programs and processes

Questions?

For further information please contact:

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British Embassy
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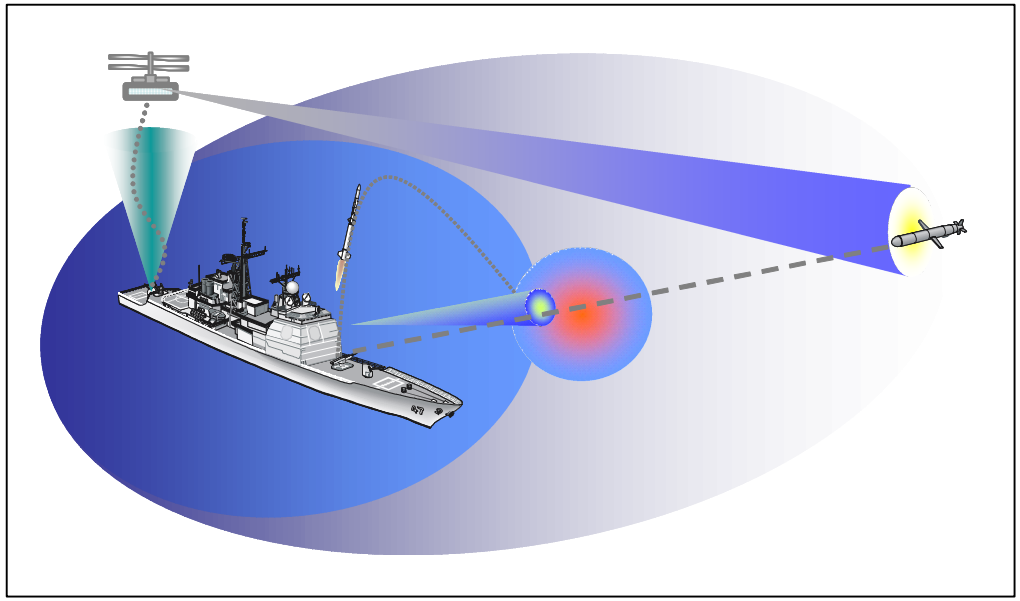
Washington
DC 20008

tony.sinden@moduk.org
Phone: +1 202 588 6724

Maritime Domain Awareness

The Information Integration Challenges and Responses

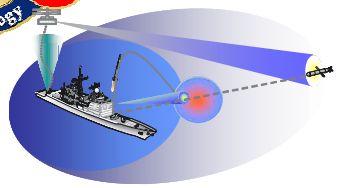


Gary Toth

Information Integration Program Officer

Office of Naval Research

April 18, 2006

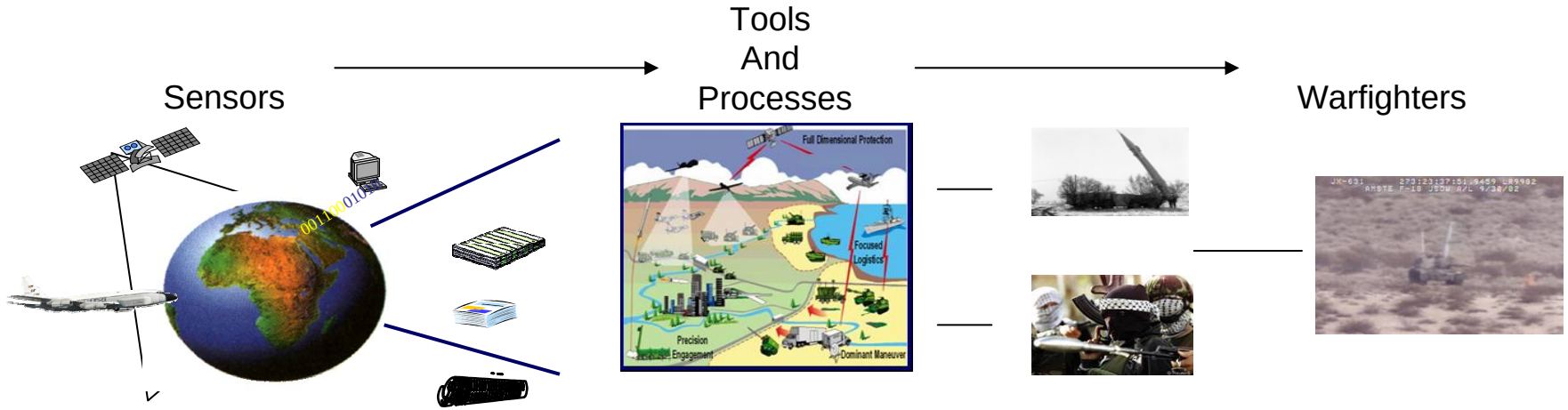


Global War on Terrorism (GWOT) / Maritime Domain Awareness (MDA)

- The enemies of yesterday were predictable, homogeneous, rigid, hierarchical, and resistant to change
- ***Today's enemies are dynamic, unpredictable, diverse, fluid, networked and constantly evolving leading to complex problem sets***
- In the context of GWOT, MDA takes on a strategic dimension and must:
  - Collect, fuse, and disseminate enormous quantities of data drawn from U.S. joint forces, U.S. government agencies, international coalition partners and forces, and commercial entities to understand the behavior of all entities in the battlespace
  - Complexity is compounded by:
    - Threats have no formal doctrine
    - Fewer analysts are available to work more data and more problems
    - Required reaction times have decreased from days to minutes

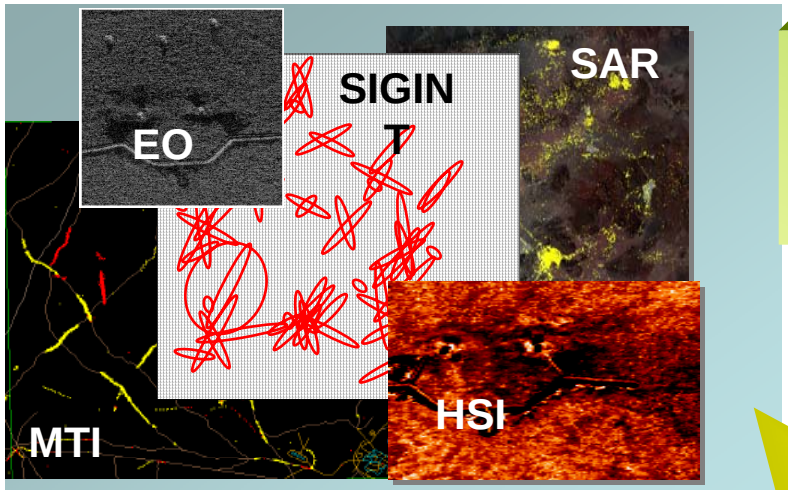
Warfighting Requirements

- Future operational environments - *Global War on Terrorism (GWOT) and Maritime Domain Awareness (MDA)* – require technologies to support information needs:
  - Regardless of location
  - Consistent with the user's level of command or responsibility and operational situation
- Navy FORCEnet will achieve this in part by relying on Discovery and Invention (D&I) projects and Enabling Capability products



Develop knowledge through the fusion and contextualization of information from disparate sources and domains

The Challenge

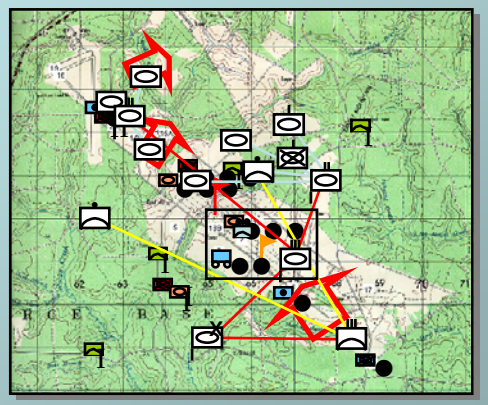


What I see?

Make sense of what I see, only to find out that I need a little more.

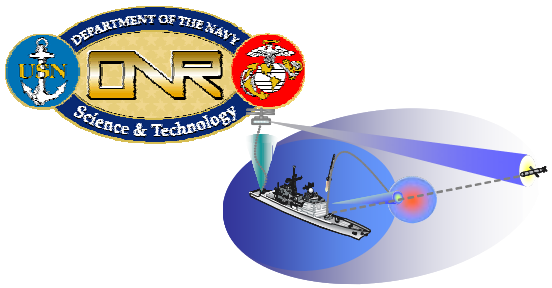
GOAL:
Reduce uncertainty enough to support effective decision making!

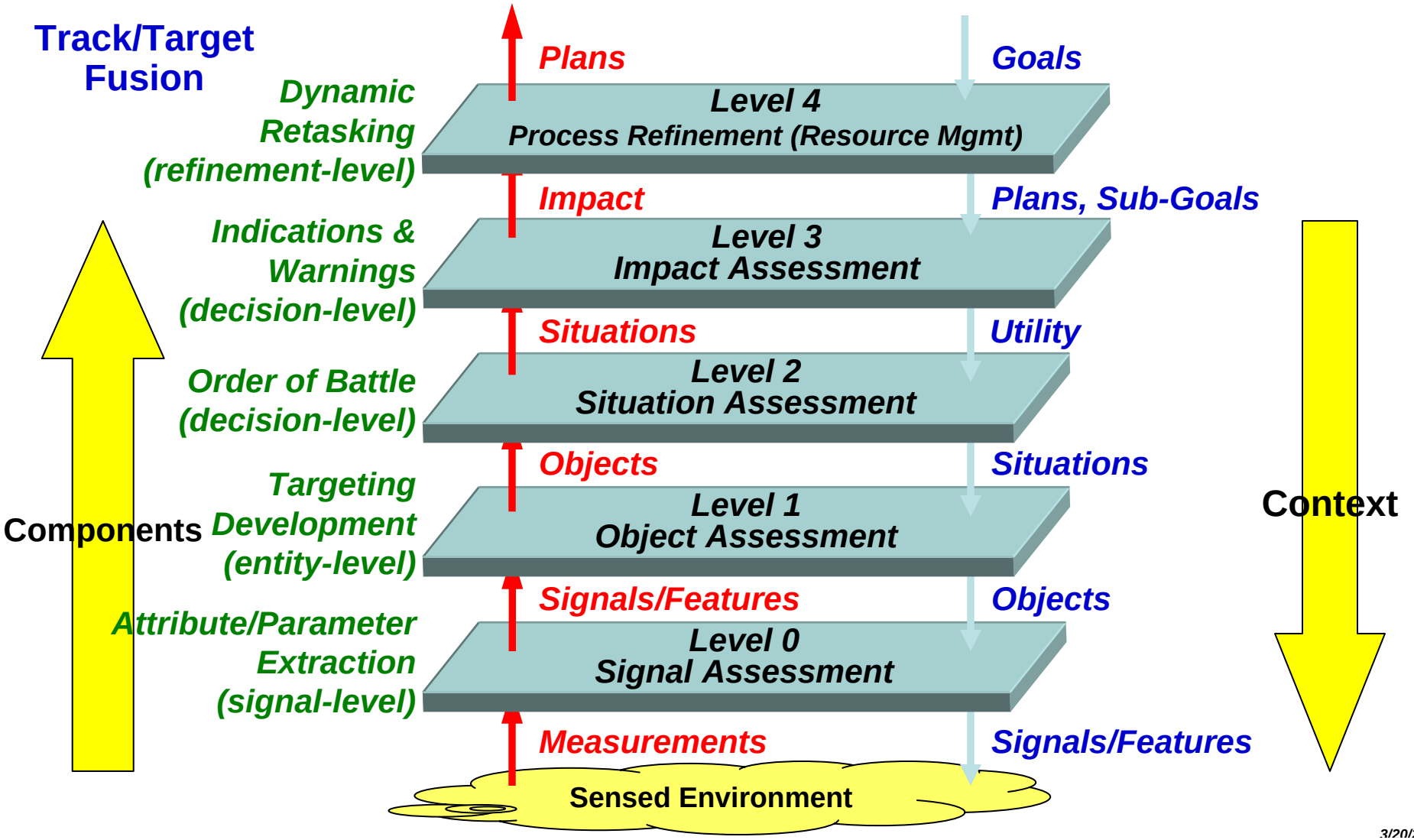
What I need to know!



How can I get the data that will tell me what I want to know?

Logical Flow Across the JDL Data Fusion "Levels"





Linking Fusion and Operational Challenges

Level 3 - Threats

Intentions:

Red Plans, Objectives

Context Examples:

Red: Past methods, training, feasible objectives

Blue: vulnerabilities, opportunities to deter

Level 2 - Situations

Activities:

Motion, Routes, Comms,

Context Examples:

Terrain, Wx, Trafficability, White traffic, Where/when to look, for what

Units:

Capability, mobility

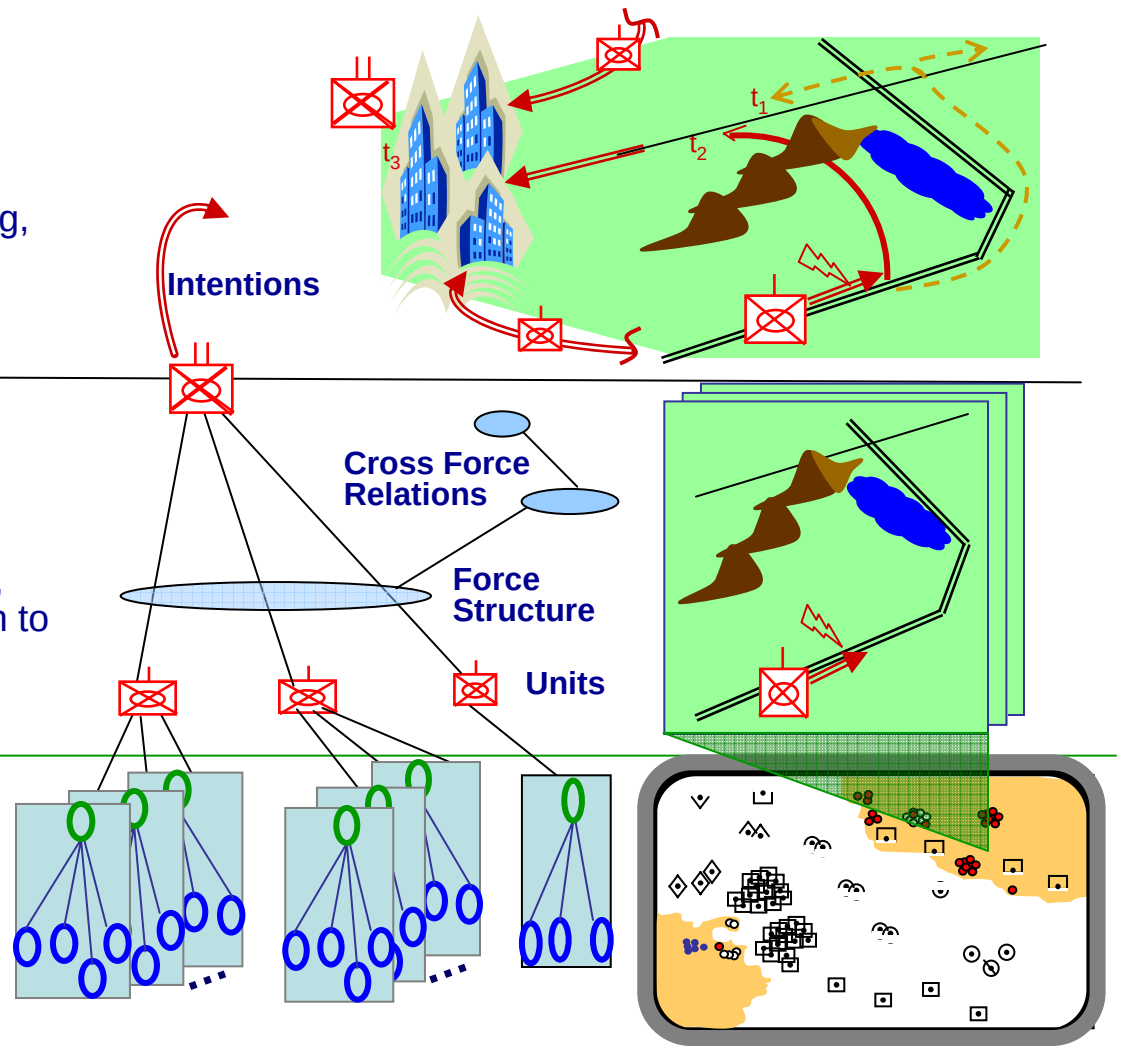
Level 0 / 1

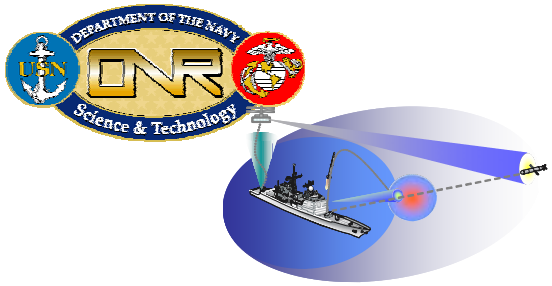
Objects:

position, kinematics, ID

Observations:

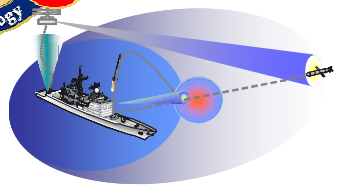
multiple sensors





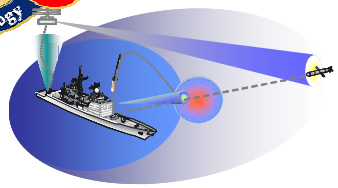
Today's Limitations

- **Operating pattern data is not linked to the picture**
  - Warfighters depend on heavy manpower intensive interpretation to understand the relationships affecting the operational situation
- **Integration of national and tactical sensor data processes (e.g., COMINT, HUMINT, ELINT, IMINT, etc.) are manually established**
  - Warfighters struggle in the volume of unassociated raw multi-int data and are incapable of understanding or extracting relationships between battlespace objects in a timely fashion.
- **Warfighter cannot drill-down to see what data was used to create the track**
  - Contact pedigrees are not preserved and often stripped as the information is fused.
  - Warfighters face ambiguities and inconsistencies in the Combat ID picture resulting from multiple collects and conflicting data reports
- **Sensor data that doesn't "add up" to a track is lost**
  - Valuable information from multi-media formats including imagery are manually integrated to track information.



Today's Technical Challenges

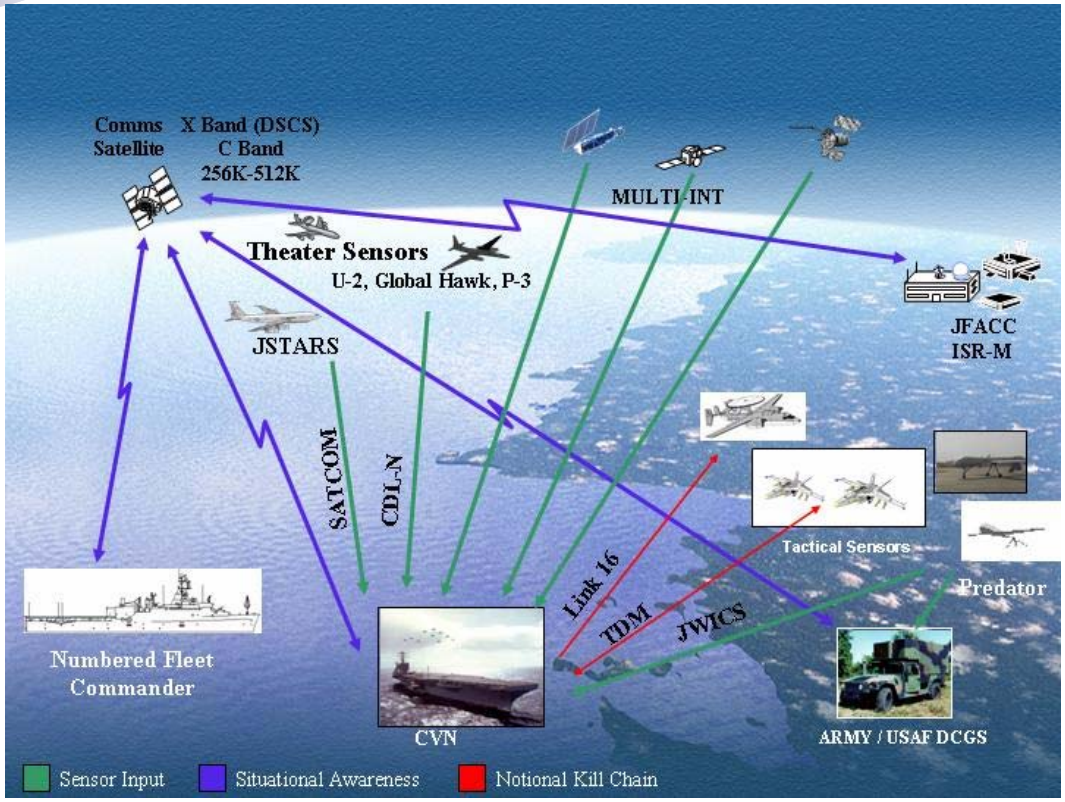
- Networks do not address semantic interoperability
- Levels 2 & 3 must be addressed globally in terms of resource priorities and allocations
- Technology to support ways to represent higher levels of abstraction and information aggregation
- Different Levels of Confidence are derived from different sources
- Identification of techniques for representation of knowledge uncertainty
- Identifying techniques for aggregating and managing hypotheses about battlespace activities/behaviors
- Environments for M&S are not mature enough to support sound, scientific experimentation needed to develop fusion systems
- Environments that allow analysts to develop and modify knowledge bases to perform automated analysis and interpretation are not adequate to meet knowledge representation and reasoning requirements nor fast enough to make timely changes during operations



Current Navy S&T Effort

- Current programs examine critical S&T needs for
  - Automatic association and merger of information for unified presentation
  - Automated recognition and cueing for significant patterns of information, computer-aided reasoning for task-oriented information dissemination
  - Timely, accurate information and sensor fusion from heterogeneous sources
- Specific Goals
  - Automated image understanding: 40% of imagery collected not screened due to availability of analysts
  - Automated integration of disparate sources of information
    - Minimizing uncertainty of information; Maximizing its expected value
    - Ability to uncover trends in activity, links among objects, and hidden models of behavior/activity
    - Preservation of data integrity
  - Level 2 / Level 3 Information Fusion
    - Understanding technical relationships and future developments

Level 1/ Entity Based Fusion



Naval Relevance

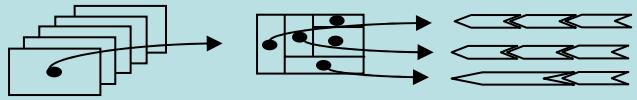
— Maintain Track and ID consistent with commander's priorities – increased confidence in the ground and maritime picture

— ID of significant military entities (reduced fratricide, higher certainty about the target engaged) and fewer false recognition and Timely sensor information shared with combat systems

— Smart management of tactical sensors

Multivariate Spatial-Temporal Data Conditioning

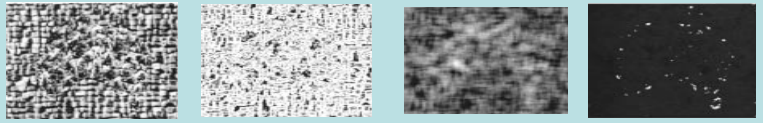
- Capturing and conditioning data from multiple sensors and sources
  - Processing over multiple fusion levels and multiple levels of data mining and discovery processes
    - Multi-level attribute characterization within a consistent mathematical framework
    - Represents behavior for individuals and groups and model behavior of targets and events in a commonly understood framework
  - Coarse-to-fine grain resolution
    - Spatial, Temporal, Spectral, Informational, Knowledge Extraction
  - Focuses on preparation and mapping of data from all source types into a mathematically commensurate framework.



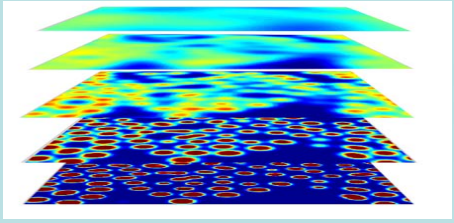
Coarse-to-Fine Grain Conditioning

Knowledge

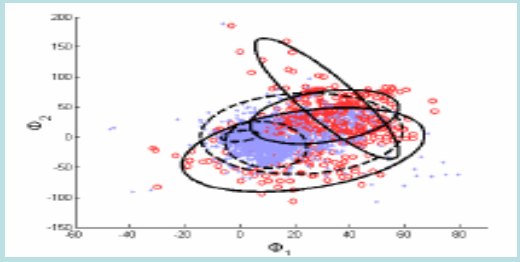
- Domain
- Representation
- Development Processing
- Specification



Texture **Edges** **Texture Energy** **Texture Points**

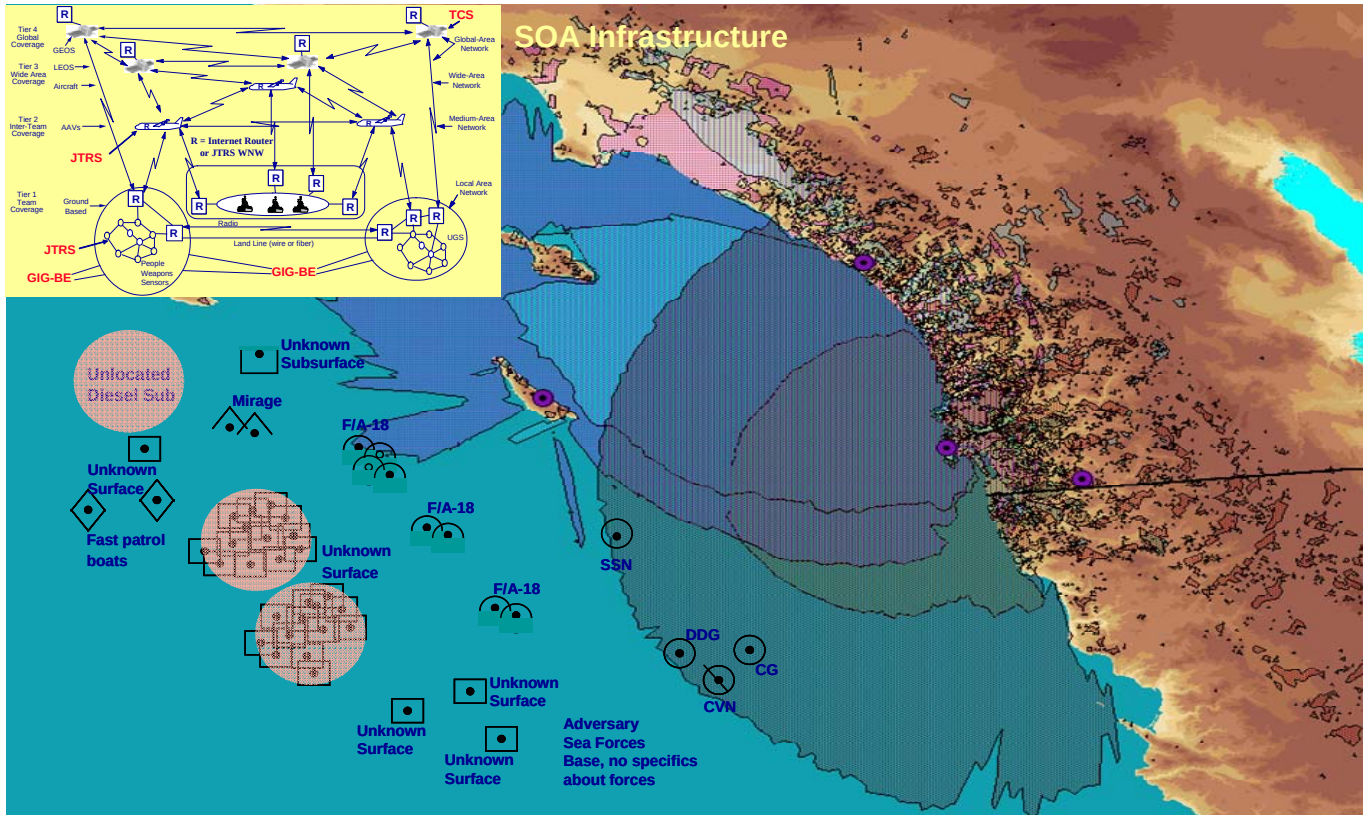


Environmental Impact on Target Location



Mixed Gaussians

Level 2/3 Fusion Approach



Naval Relevance

- Automated capability to recognize anomalies that indicate hostile intent in the maritime / littoral domain.
- Improved decision support through automated production of decision-quality information
- Reduces manpower requirements

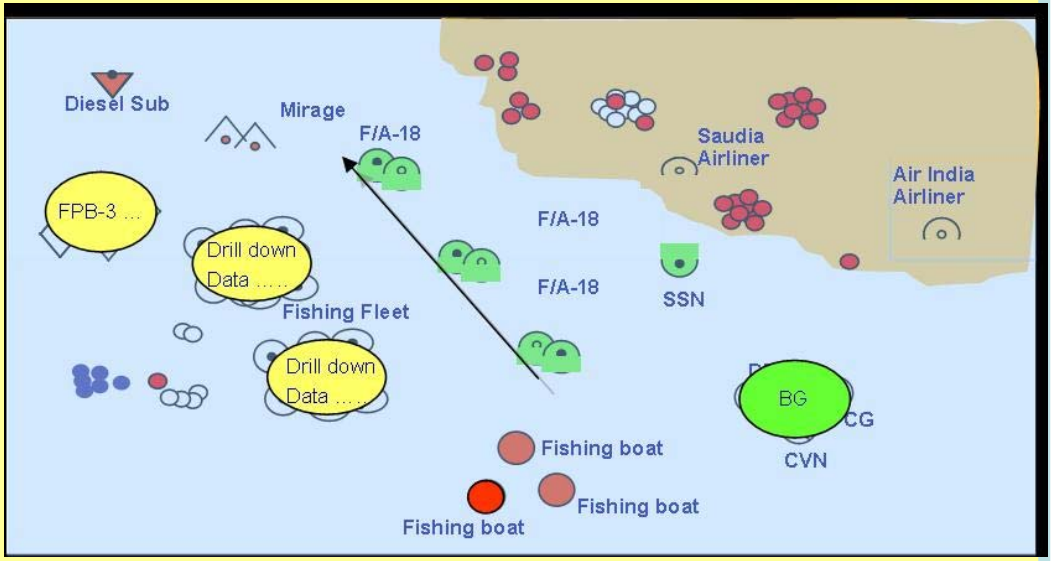
Level 2/3 Fusion: Combat ID Implications

Current Capability

- Lots of data from many sources
- Little understanding about how entities and events relate
- Manual capability to manage multiple hypotheses about the meaning of
  - Groups of entities
  - Events that may potentially be related

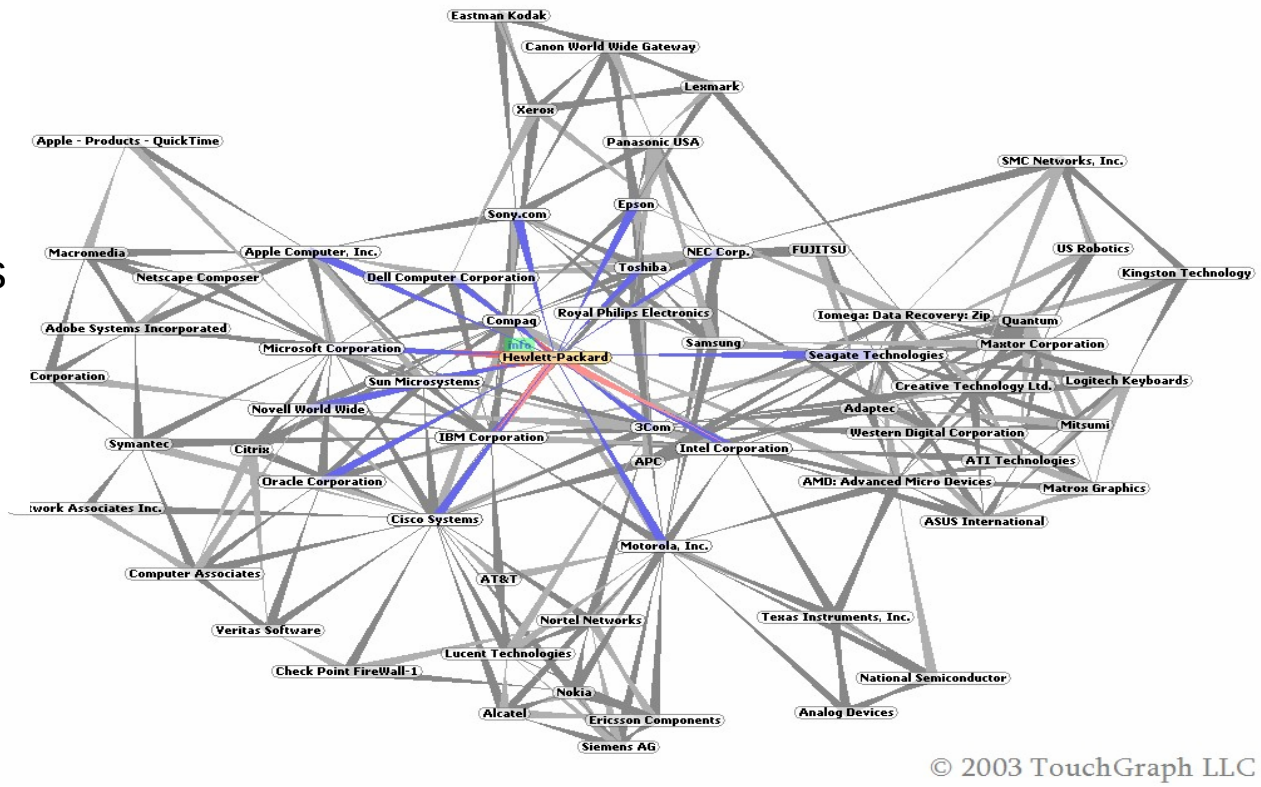
ONR's Products Produce:

- Data from many sources automatically exploited
- Warfighter-relevant understanding about how entities and events relate
- Automated capability to manage hundreds of multiple hypotheses about the meaning of
  - Groups of entities
  - Events that may potentially be related



Context-Aided Inferencing

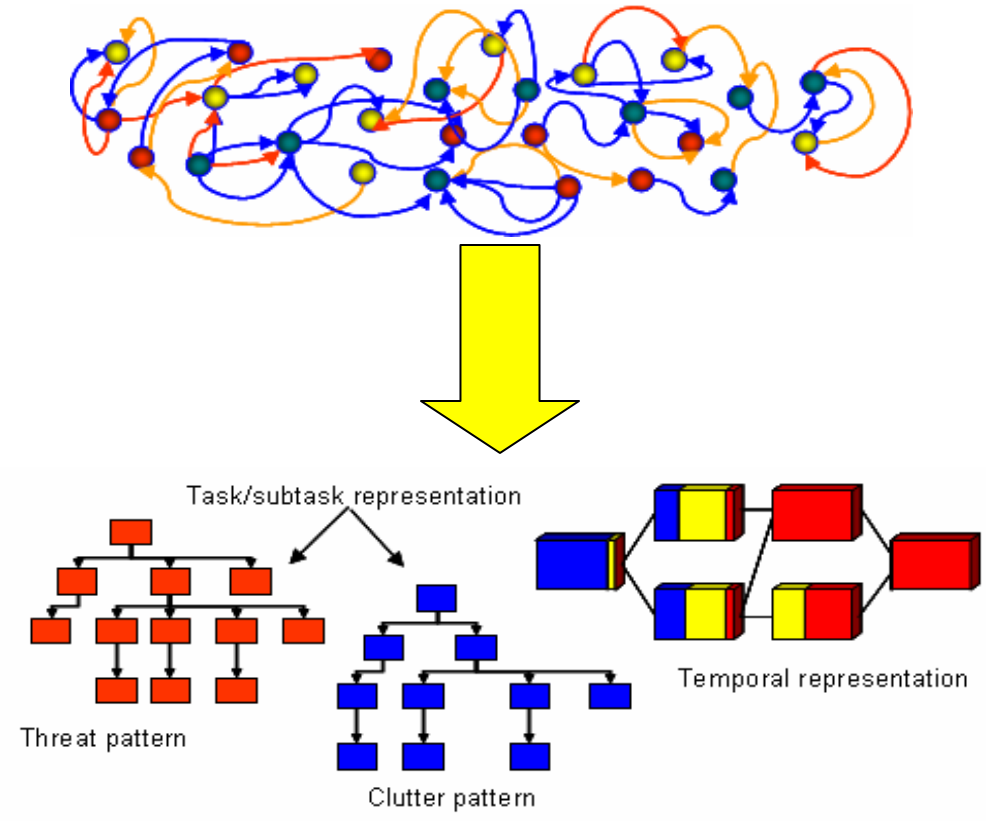
- Inferences to support fusion processing
  - Underlying components of a situation
    - Elemental relations, behavior dependencies
- Models capture constraints
  - Physical properties
  - Political, economic conditions
  - Relationships (not necessarily directly observable)
- For example
  - High Tech Companies
  - Relationships with foreign Governments
  - Efforts to sell to adversary groups



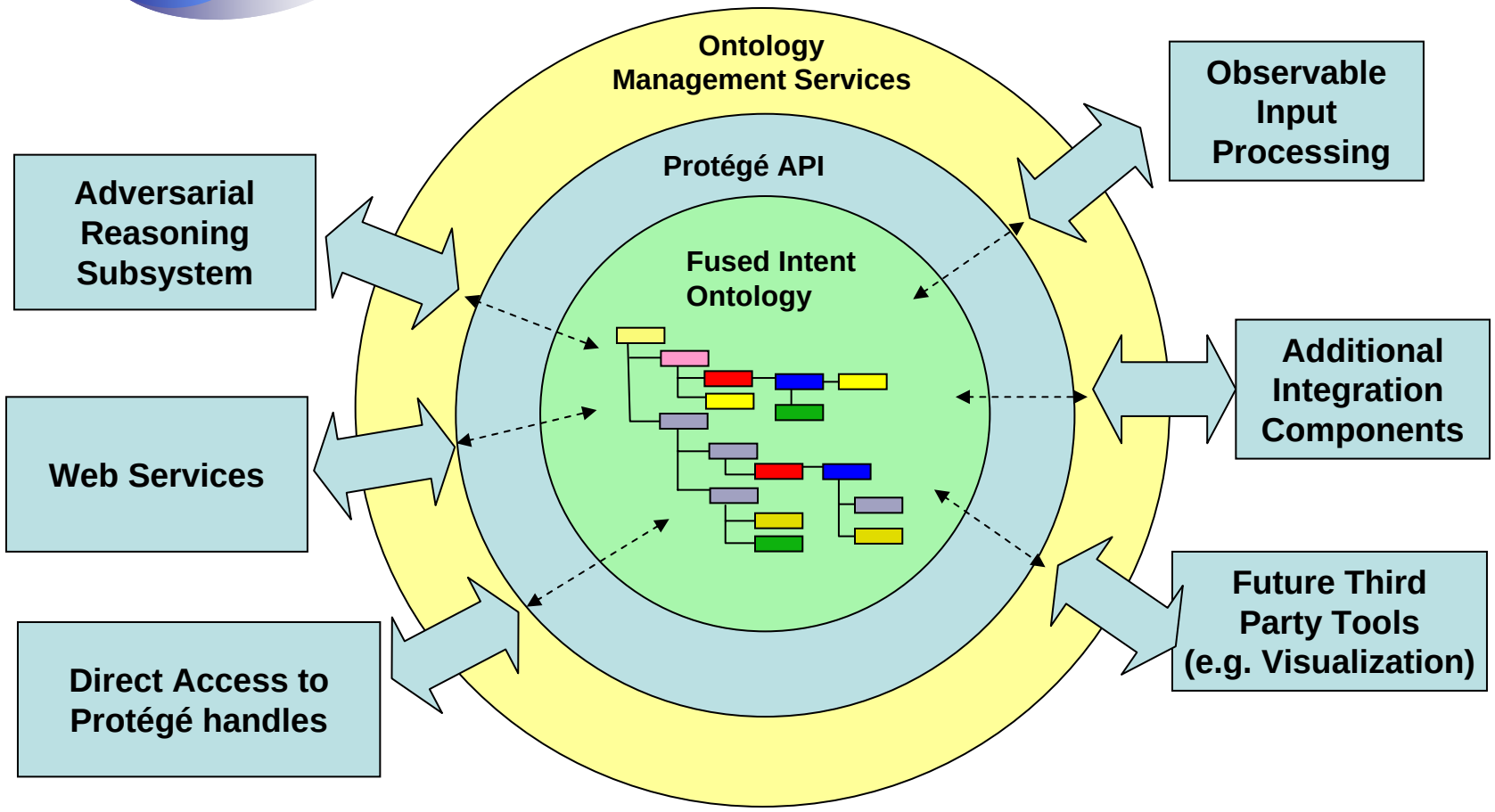
Theory of Detection for Naval Targets Using Transactional Networks

Naval Relevance

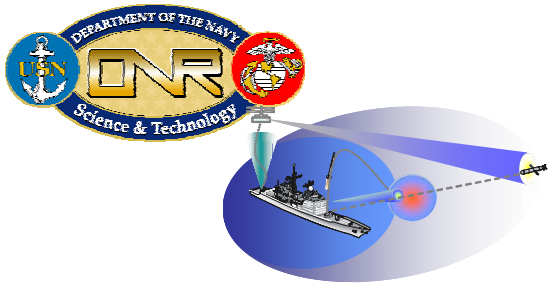
- Detecting, classifying, and tracking potential hostile activities in massive amounts of transactional noise
  - –Important in GWOT
  - –Complements MDA ship tracking
- Ability to detect threat events and organizations prior to attack
  - –Supports precision strike (Sea Strike)
  - –Enhanced common tactical picture
  - –Detection of shipping anomalies for Naval Intelligence
  - –Commander has increased confidence in intelligence information



Ontology Management Services are Critical to Level 2/3 Fusion



The bottom line: if the ontology isn't right, the integration cannot supported.



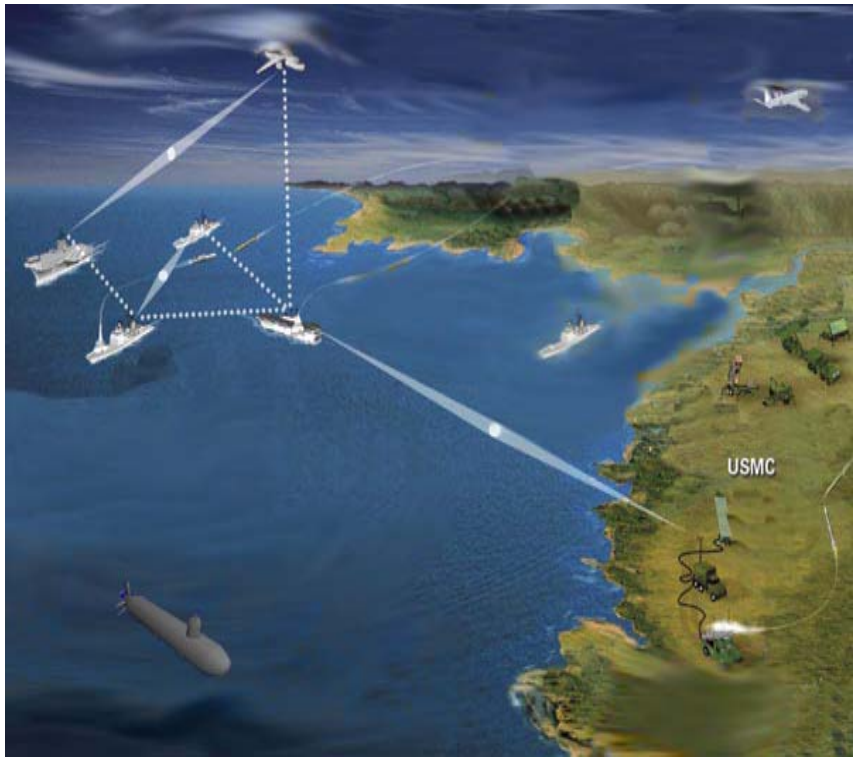
Level 2/3 Framework
JDL Model Extensions

		Traditional Fusion Levels			
		Objects ID Tracking (1)	**Situation Assessment (2)**	**Threat Assessment (3)**	**Process Refinement (4)**
Context	**Perception**	Element Acquisition Common Referencing	Element Acquisition Common Referencing	Capability	
	Comprehension	Contextual Analysis Object Classification and Recognition Object Interpretation/ Assessment Explanation	Contextual Analysis Situation Classification and Recognition Situation Interpretation/ Assessment Explanation	Opportunity	**Performance Assessment**
	Projection (Anticipation)	Estimate Future State Expectation Matching	Estimate Future State Expectation Matching	Intention Worst Case Most Likely Relevance	
		Uncertainty, Confidence & Pedigree Management			*Internal* / *External*
		Fusion Performance Management			
		HCI	Sources	Products	Main

3/20/2005

Goal and Context for Combat ID in the Maritime Domain to Reveal Contact Intent

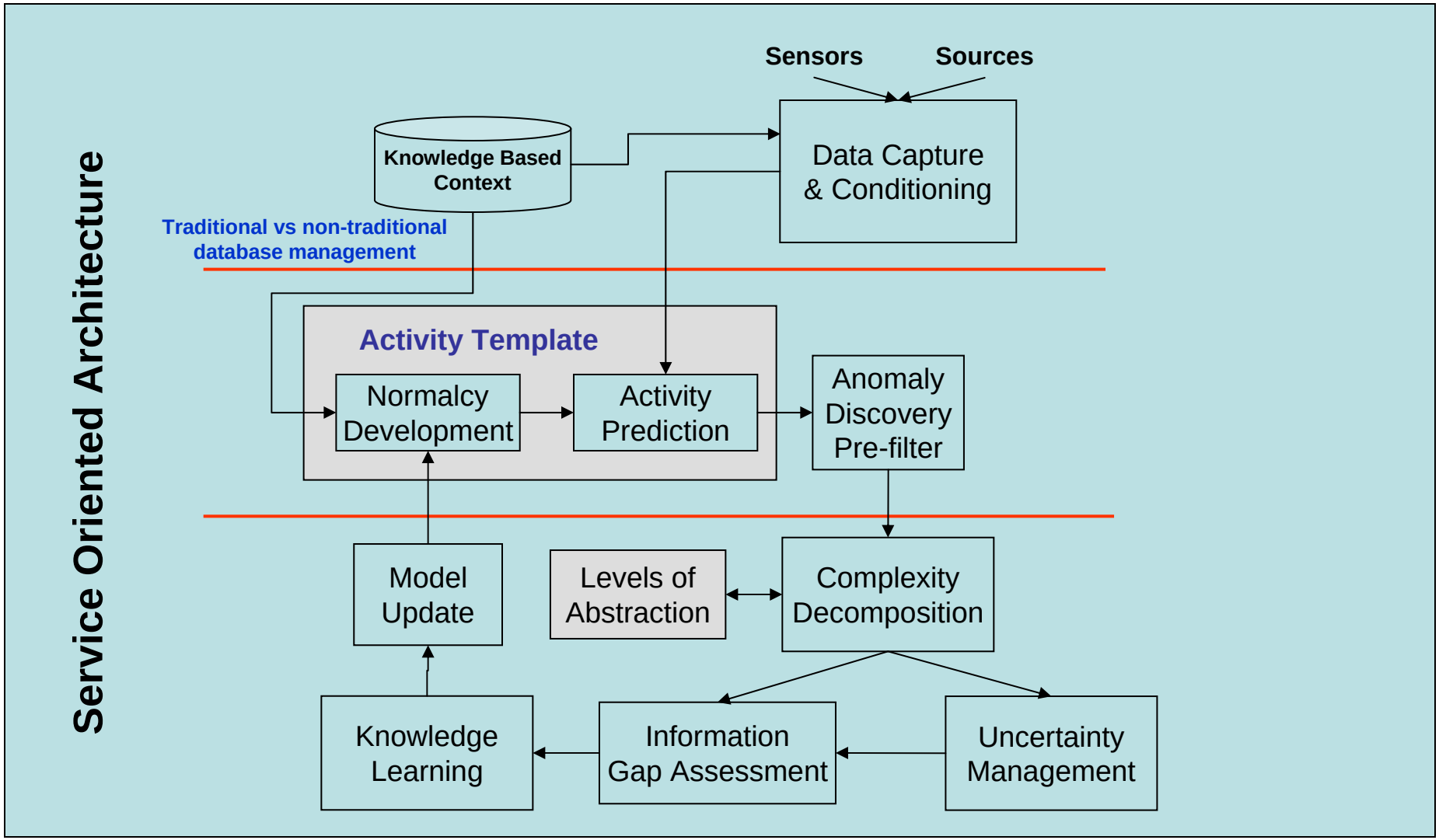
- **GOAL:**
  - Develop proof-of-principle demonstration of (semi) automated machine reasoning Level 2 / Level 3 fusion within an MDA environment
  - Develop relationships among such entities as sea surface, subsurface, and ground-borne objects, events, and the situation
  - Understand situations (e.g. routine activity/behavior, adversary capabilities and dependencies, own force vulnerabilities), and
  - Anticipate threats (e.g. adversary options, enabling events/activities)
- **CONTEXT**
  - Weather, terrain, topology, traffic flow
  - Activity patterns, open source records, market demands, hostile actions
  - General influences: Political, economic, cultural
  - Non-standard transactional data: Financial records, cargo manifest, etc.



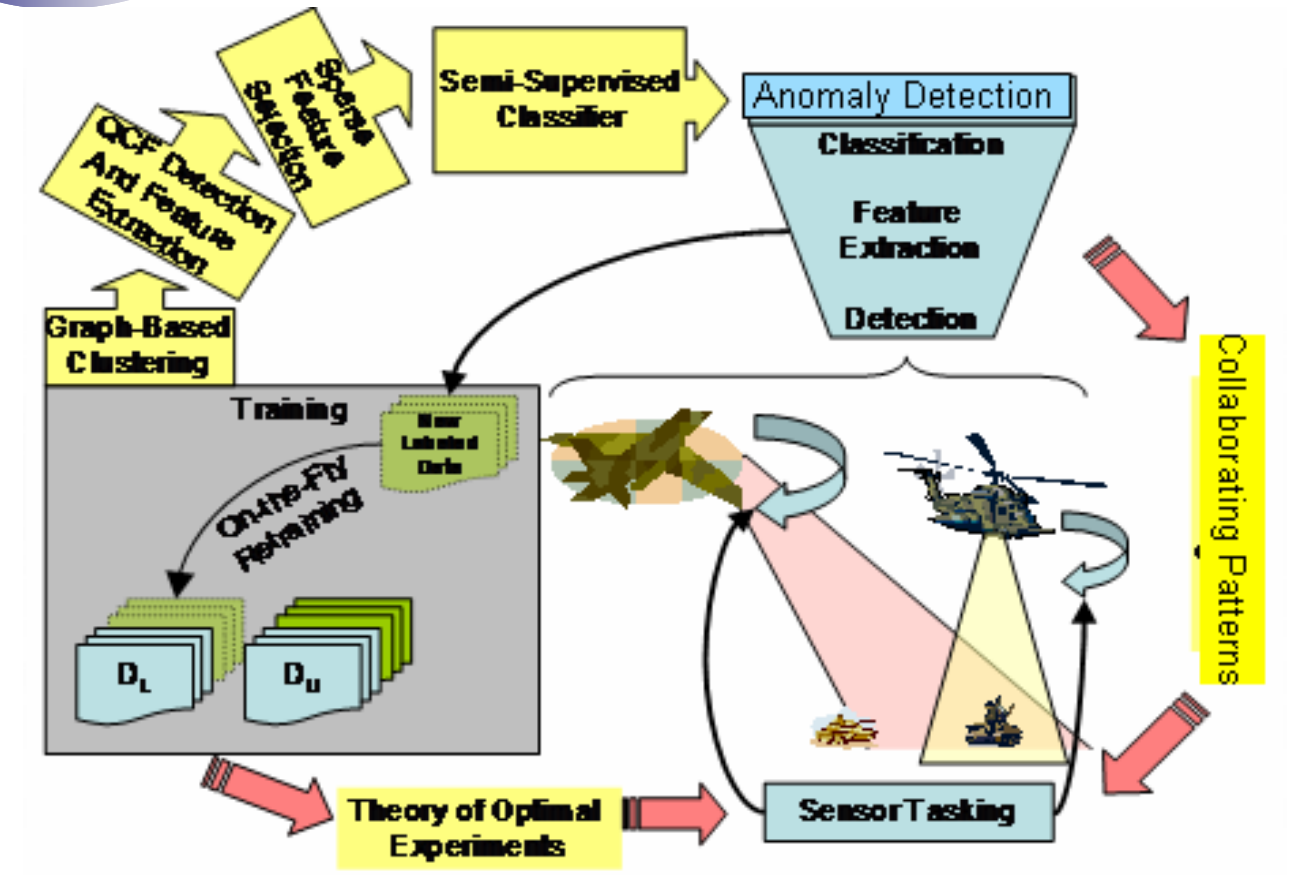
Naval forces (surface, subsurface, air, ground) operating in the maritime domain.

Start Date: FY07

Combat ID in the Maritime Domain to Reveal Content Intent Conceptual Architectural



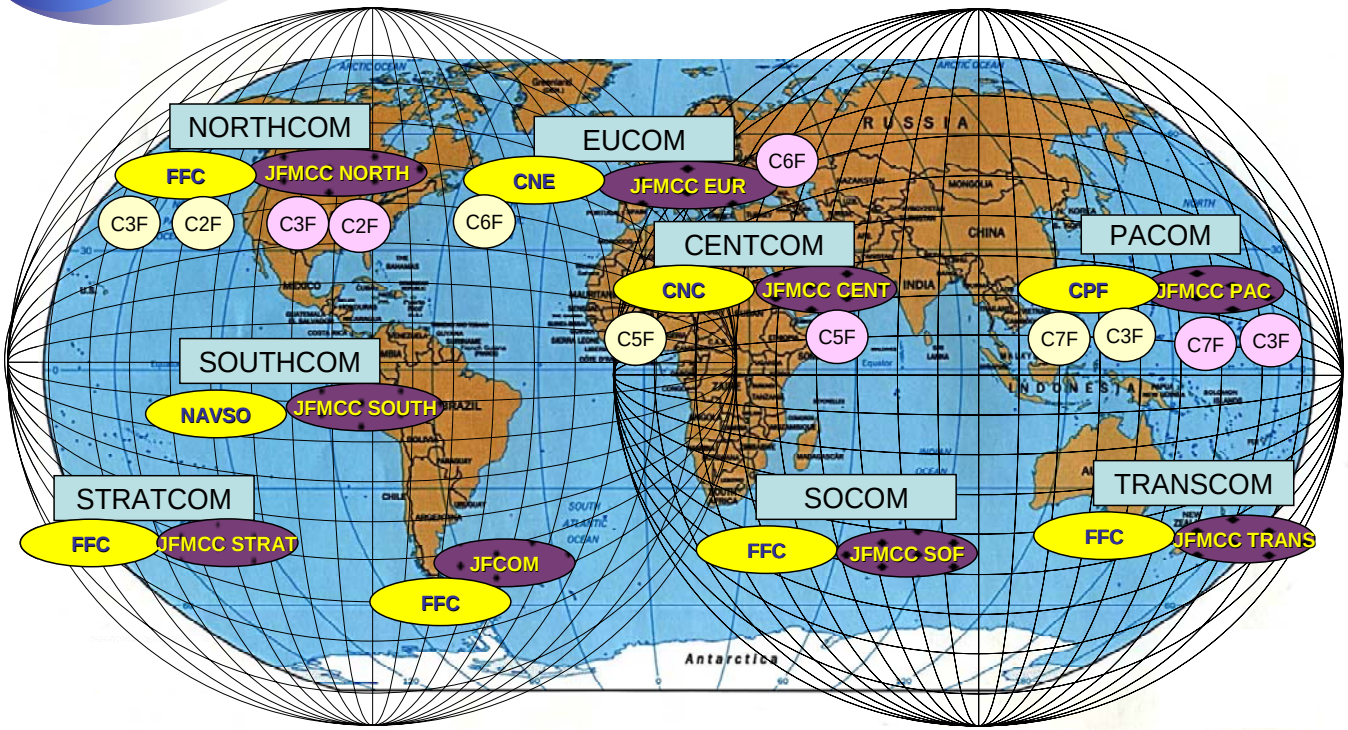
Multi-Sensor Information Integration



Naval Relevance

- Improved urban and base security through ability to detect anomalous behavior
- decisions/control using multi-sensor imagery, video and intelligence, consistent with FORCEnet objectives
- Reduced shipboard workload: system designed to ease the burden of the military analyst

Globally Netted Joint/Coalition Force Maritime Component Commander



New Operational Capability

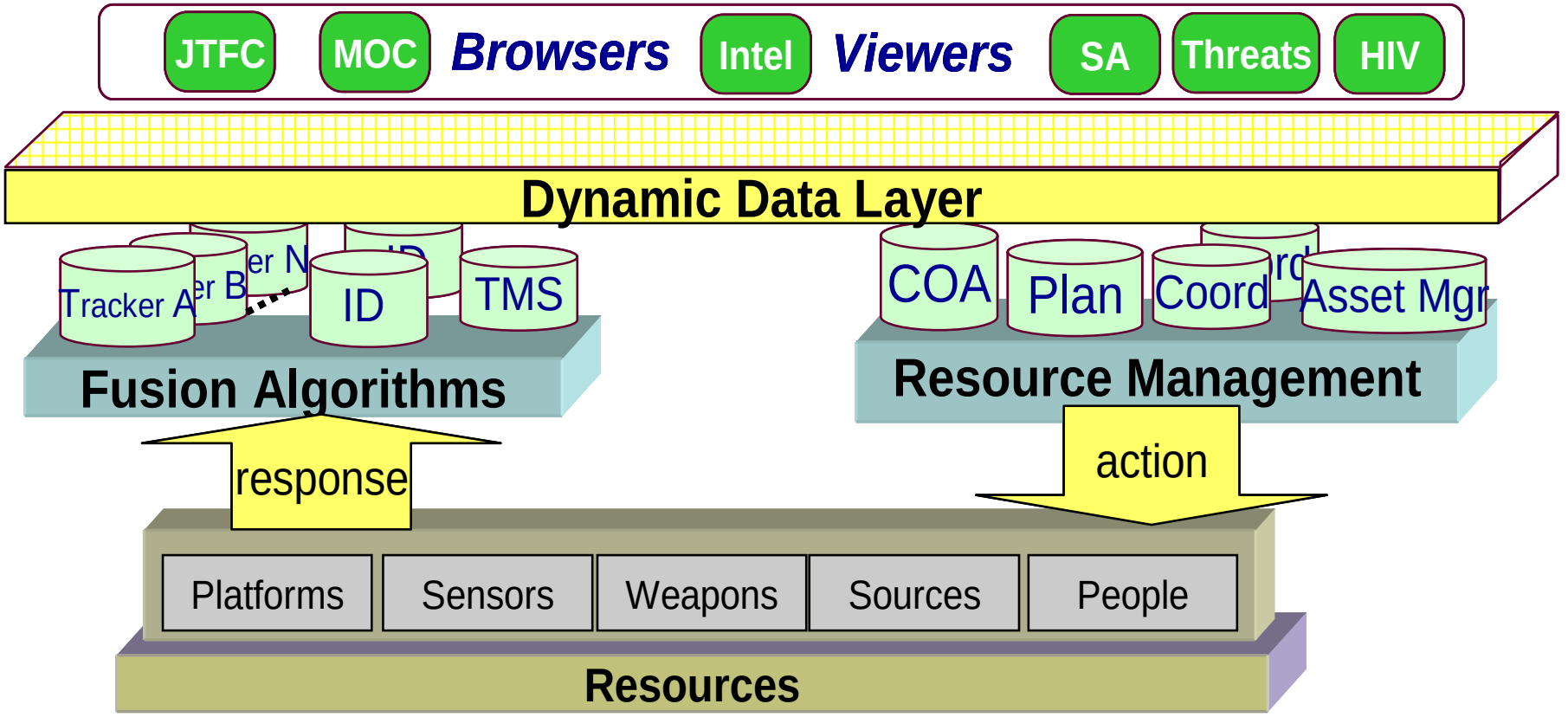
New technologies and processes to perform global monitoring of maritime activity across Joint / Coalition Force Maritime Component Commanders (J/CFMCC) to develop a Global Maritime Domain Awareness (MDA) that supports Regional COCOM Maritime missions.

– Dynamic Virtual Data Layer

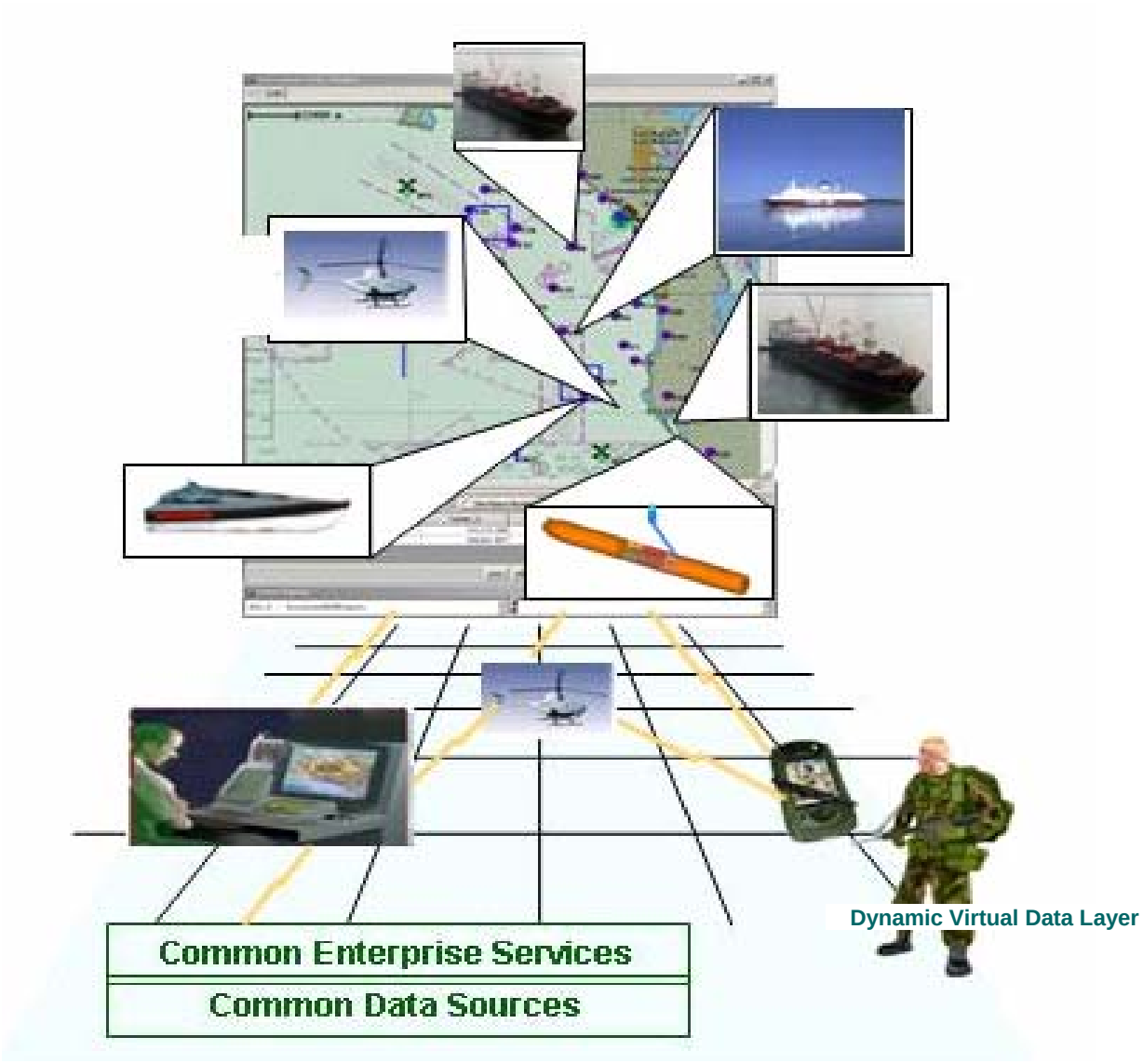
– Role Relevant Visualization

– Collaboration Assistant

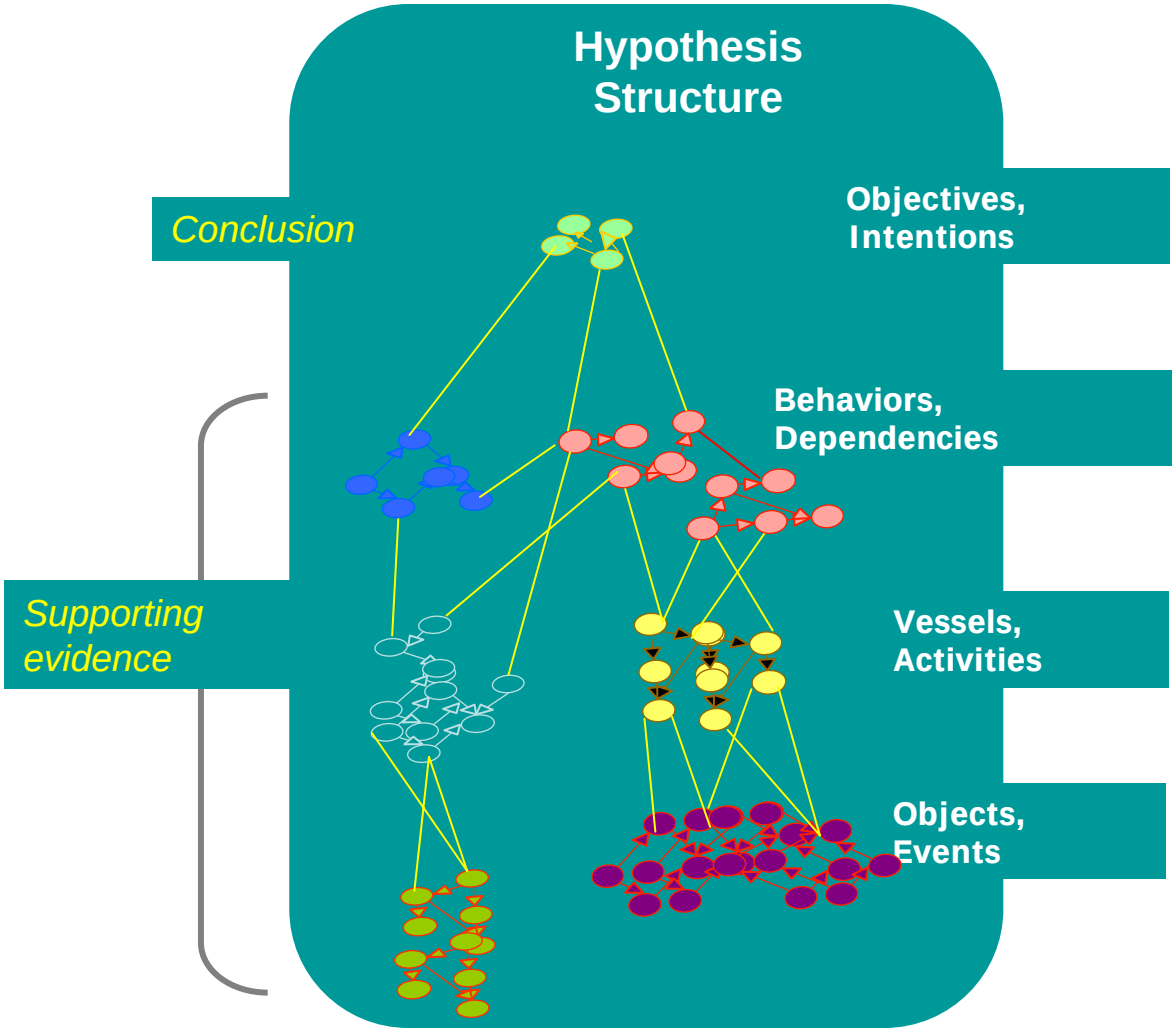
Dynamic Virtual Data Layer

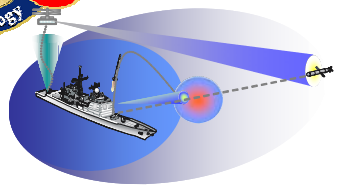


Role Relevant Visualization



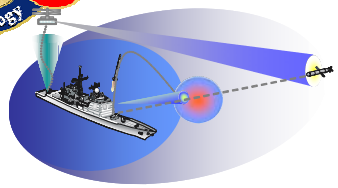
Collaboration Assistant





Why Now?
Several DoD/NSF Relevant Efforts

- Knowledge Discovery and Data Dissemination (KDD)
  - Learning:
    - Using prior knowledge bases / SMEs
    - Actively; request new data and analyses to improve inferencing
    - Incrementally and cumulatively; make full use of knowledge
  - Data mining is “finding a needle in a haystack”
  - KDD help analysts “reassemble” needles hidden in many haystacks
    - Knowledge based inference and relational patterns
    - Temporal and Spatial relationships
    - Heterogeneous data sources and Fragmented knowledge
- Predictive Analysis for Naval Deployment Activities (PANDA)
  - Identify high risk vessels by observing patterns of behavior
    - Patterns are complex and hidden in noise
    - Identify significant deviations from normal behavior
  - Four areas of study
    - Motion based pattern learning
    - Prediction and activity monitoring
    - Anomaly processing and presentation
    - Adaptive context monitoring



Why Now?
Several Promising Technologies

For Example

- Blackboard methods/tools are now more robust including commercially available generic blackboards
  - Enables both *relational* structure to maintain alternate hypotheses and *control* structure to satisfy decision maker and computational constraints
  - Leverages new capabilities in agent based computing, semantic annotation, and knowledge representation
- Bayesian reasoning and other inferencing technologies have advanced to allow practical approximation algorithms
  - Structure of Bayes nets supports control reasoning for “anytime” algorithm solutions
  - Trades-off quality and complexity allowing potential “design-to-time” control
  - Variety of inductive (e.g., Fuzzy algebra, Dempster’s combination) and abductive methods
- Techniques for visualization of complex information have advanced to aid humans in hypothesis management and solution visibility.
  - Hybrid continuous / discrete probabilistic prediction for intelligent simulation of threat activity under real physical constraints (e.g. terrain, weather, lightning)

Final Thoughts

- MDA consists of two key components: information and intelligence
- Both combine in the COP to create a substantive, layered presentation of the global maritime environment
- There are many programs that include a COP
- No single one source captures all of the maritime information warfighters need — or that is currently available
- S&T programs are addressing the need to effectively integrate and fuse inputs to achieve the synergies offered by a comprehensive situational awareness picture
- The goal monitor vessels, people, cargo and designated missions, areas of interest within the global maritime environment, access all relevant databases, and collect, analyze and disseminate relevant information

Questions