



## 9th Annual Science and Engineering Technology Conference/ DoD Technology Expo

15 - 17 April 2008

North Charleston, South Carolina

Agenda

**Tuesday, 15 April 2008**

### **Preliminary Session: *Opportunities for Collaboration***

- FY 2008 PB Request for DoD S&T Program, *Mr. Robert Baker*, Deputy Director, Plans and Programs Office of the Director, Defense Research and Engineering
- The Advanced Systems & Concepts Portfolio of Opportunities, *Mr. John Kubricky*, DUSD(AS&C)
- The DoD T&E / S&T Program, *Mr. Gerald Christeson*, Defense Test Resource Management Center Deputy Program Manager Test & Evaluation/Science & Technology Program
- DoD Basic Research Program with a Focus on Academia, *Dr. William S. Rees, Jr.*, Deputy Under Secretary of Defense (Laboratories and Basic Sciences) Office of the Director Defense Research and Engineering
- Strategic Initiative on Innovation & Technology Transition, *Ms. Kathleen Harger*, Assistant Deputy Under Secretary of Defense Innovation and Technology Transition

### **CONFERENCE OPENING:**

**Keynote Address:** *Mr. Alan Shaffer*, Principal Deputy Defense Research and Engineering

### **Session I: *Development and Insertion of Innovative Technologies into Army Systems***

- Recent Trends in the Army's Common Test Support Facility, *Mr. Terry Edwards*, Chief Information Officer (CIO), Chief Technology Officer (CTO), HQ Army Materiel Command, CIO-G6
- The Army Science and Technology Program, *Dr. Thomas Killion*, Deputy Assistant Secretary for Research and Technology/Chief Scientist
- CERDEC Contributions to Army Battle Command Networking Efforts, *Mr. David Jimenez*, Director, Space & Terrestrial Communications Directorate
- Software Certification and Battle Command Interoperability Issues, *BG Nick Justice*, Program Executive Officer, PEO Command, Control, Communications Tactical
- Technology Transition and Insertion Evaluation, *Mr. Brian Simmons*, Director, US Army Evaluation Center

Assault Breaching System Technologies, *Mr. Brian Almquist*, Ocean Engineering & Marine Systems, Office of Naval Research

## Wednesday, 16 April 2008

### **Session II:** *Development and Insertion of Innovative Technologies into Air Force Systems*

- Overview of Air Force Science & Technology Program, *Mr. Terry Jagers*, Deputy Assistant Secretary (Science, Technology and Engineering)
- Development and Insertion of Innovative Technologies Across the Lifecycle of a Weapon System, *Brig Gen Janet Wolfenbarger*, Brigadier General, USAF Director, Intelligence and Requirements Director, D&SWS AFSSO21 Office
- Rapid Prototyping-Leapfrogging into Military Utility, *Mr. Randall Walden*, Air Force Rapid Capabilities Office (SAF/RCO)
- Industry Perspectives on Technology Insertion, *Dr. David Whelen*, Vice President & Deputy GM, Advanced Systems & Chief Scientist, Integrated Defense Systems, The Boeing Company
- Cyberspace: New Frontiers in Technology Insertion, *Dr. John Bay*, Chief Scientist, Air Force Research Laboratory, Information Directorate

**Luncheon Speaker**– *The Challenge of Transitioning Innovative Technology*, *Dr. Malcom O'Neill, PhD, NAE LTG USA/CTO LMC (ret)*

### **Session III:** *Development and Insertion of Innovative Technologies into Naval Systems*

- Technology Insertion: Fleet / Operating Forces, *Ms. Charlene Rusnak*, ONR Science Advisor to US Fleet Forces Command

### **Innovative Technology Insertion:** *Systems Command Panel*

#### **Panelists:**

- *Mr. James Sheehy*, Chief Scientist / Technology Officer Human Systems, AIR-4.6T
- *Mr. Brian Persons*, Executive Director Naval Systems Engineering Directorate (SEA 05) & Corporate Chief Technology Officer
- *Mr. Gary Wang*, Code 73, SPAWAR Command Overview, SPAWAR S&T OPPORTUNITIES
- *Mr. David Ungar*, Director Program Engineering & Technology

## Thursday, 17 April 2008

### **Session IV:** *Manufacturing and Affordability of Innovative Technology*

- The Need for Manufacturing Innovation and Readiness, *Mr. Mark Gordon*, Director, Defense Programs National Center For Advanced Technologies
- The Navy's Mantech and Affordability Program, *Mr. John Carney*, Director, Navy ManTech
- The Air Force S&T Manufacturing Readiness Assessment, *Mr. Jim Morgan*, Manufacturing Technology Division
- Inserting Technology Incrementally, *Mr. Daniel Zanini*, LSI Deputy Program Manager, Future Combat Systems Senior Vice President, SAIC

### **Manufacturing Technology Industry Panel**

Moderator: *Mr. Gary Powell*, OUSD(AT&L)

Panelists:

- *Mr. Ed Morris*, Director, Hardware and Manufacturing, Lockheed Martin Corporate Engineering and Technology



- *Mr. Dale Iverson*, Raytheon Missile Systems
- Mr. Jim Lorenz, Manager, Advanced Industrial Engineering

# ***9<sup>th</sup> Annual Science & Engineering Technology Conference / DoD Tech Exposition***

April 15-17, 2008

Charleston Convention Center

North Charleston, SC

***Tuesday, April 15, 2008***

## ***Opportunities for Collaboration***

- 8:15am      FY 2008 PB Request for DoD S&T Program  
                  – Robert Baker
- 8:45am      The Advanced Systems & Concepts Portfolio of Opportunities  
                  – John Kubricky
- 9:15am      The DoD T&E / S&T Program – Gerald Christeson
- 9:45am      BREAK
- 10:30am     Quick Reaction Fund/Rapid Reaction Fund & JIEDDO Capability  
                  Needs – Ben Riley
- 11:00am     DoD Basic Research Program with a Focus on Academia  
                  – Dr. William S. Rees, Jr.
- 11:30am     Strategic Initiative on Innovation & Technology Transition  
                  – Kathleen Harger
- 12:00pm     LUNCHEON

***Tuesday, April 15, 2008***

## ***Conference Opening***

- 1:00pm Call to Order / Conference Opening – Dr. Raj Aggarwal  
NDIA Welcome – MG Barry D. Bates, USA (Ret)
- 1:15pm Keynote Address – Alan Shaffer

**Session I: Development and Insertion of Innovative Technologies  
into Army Systems**

**Session II: Development and Insertion of Innovative Technologies  
into Air Force Systems**

**Session III: Development and Insertion of Innovative Technologies  
into Naval Systems**

**Session IV: Manufacturing and Affordability of Innovative Technology**

***Tuesday, April 15, 2008***

## **Session I: Development and Insertion of Innovative Technologies into Army Systems**

- 2:00pm      Recent Trends in the Army's Common Test Support Facility...  
                    – Terry Edwards
- 2:30pm      The Army Science and Technology Program – Dr. Thomas Killion
- 3:00pm      BREAK
- 3:30pm      CERDEC Contributions to Army Battle Command Networking...  
                    – David Jimenez
- 4:00pm      Software Certification and Battle Command Interoperability Issues  
                    – BG Nick Justice
- 4:30pm      Army Comm. Technologies, Incl. JTRS – Tim Snodgrass
- 5:00pm      Technology Transition and Insertion Evaluation – Brian Simmons
- 5:30-7:30pm      RECEPTION (In exhibit hall)

***Wednesday, April 16, 2008***

## **Session II: Development and Insertion of Innovative Technologies into Air Force Systems**

- 8:30am Overview of Air Force Science & Technology Program  
– Terry Jagers
- 9:00am Development and Insertion of Innovative Technologies Across...  
– Brig Gen Janet Wolfenbarger
- 9:30am Rapid Prototyping-Leapfrogging into Military Utility  
– Randall Walden
- 10:00am BREAK
- 10:45am Industry Perspectives on Technology Insertion – Dr. David Whalen
- 11:15am Cyberspace: New Frontiers in Technology Insertion  
– Dr. John Bay
- 12:00pm LUNCHEON w/Speaker – Dr. Malcom O’Neill

**Wednesday, April 16, 2008**

## **Session III: Development and Insertion of Innovative Technologies into Naval Systems**

- 1:30pm      Technology Insertion: Naval Science & Technology  
– RADM William Landay
- 2:00pm      Technology Insertion: Fleet / Operating Forces  
– Charlene Rusnak
- 2:45pm      BREAK
- 3:30pm      Technology Insertion: The Anti-Torpedo Torpedo (ATT) Program  
– Brian Almquist & LtCol Tim Mclaughlin
- 4:15pm      Innovative Technology Insertion: Systems Command Panel  
– Chair: Dr. John Sommerer  
– Panelists: James Sheehy, Brian Persons, Gary Wang, David Ungar
- 5:15pm      Session Adjourned



***Thursday, April 17, 2008***

## **Session IV: Manufacturing and Affordability of Innovative Technology**

- 8:00am      Session Introduction – James Chew
- 8:10am      The Need for Manufacturing Innovation and Readiness  
– Mark Gordon
- 8:35am      The Navy’s Mantech and Affordability Program – John Carney
- 9:00am      The Air Force S&T Manufacturing Readiness Assessment  
– Jim Morgan
- 9:25am      Inserting Technology Incrementally – Daniel Zanini
- 9:50am      BREAK
- 10:25am     Best Poster Paper Winner Announcement
- 10:30am     Manufacturing Technology Industry Panel  
– Moderator: Gary Powell  
– Panelists: Ed Morris, Bob Schafrik, Al Sanders, Dale Iverson,  
Jim Lorenz
- 12:00pm     Wrap-Up & Adjournment – Alan McLaughlin
- 12:15pm     Box Luncheon

## **SUMMARY**

- ❑ Attendees will be sent a link to the proceedings within two weeks

**Join us next year!  
The 10<sup>th</sup> Annual S&E Technology  
Conference / DoD Tech Exposition will be  
held April 20-23, 2009 in the  
North Charleston Convention Center**



# Fiscal Year 2009 President's Budget Request for DoD Science & Technology

***Mr. Bob Baker  
Deputy Director, Plans and Programs  
Office of the Director,  
Defense Research and Engineering***

# The Bottom Line



***PBR09 is a continuation of the transition of S&T investment to enable growth of “non-kinetic”, non-platform specific capabilities***

***Shifting away from an emphasis on ships, tanks, and planes—to focus on protection, information, knowledge, and timely, actionable intelligence***



# DDR&E Priorities for CY 2008



- **Support Global War on Terrorism**
- **Support Urban Operations Capabilities**
- **Support WMD Detection & Response Capabilities**
- **Develop Transformational Power & Energy Technologies**
- **Develop Manufacturing Technologies**
- **Enhance Technology Transition**
- **Enhance National Security S&E Workforce**
- **Increase funding for Basic Research, plus \$270M**





# White House Guidance

- **President Bush acknowledged the importance of science and engineering development in his January 2008 State of the Union address**

***“To keep America competitive into the future, we must trust in the skill of our scientists and engineers and empower them to pursue the breakthroughs of tomorrow... I ask Congress to double federal support for critical basic research in the physical sciences and ensure America remains the most dynamic nation on Earth..”***

***President George W. Bush, State of the Union address, January 28, 2008***



# Overview



- **PBR 2009 S&T Budget**
- **Budget Changes and Historical Context**
- **Strategic foundation and Investment Focus**
- **Reliance 21 and the R&E Portal**



# PBR 2009 S&T Budget

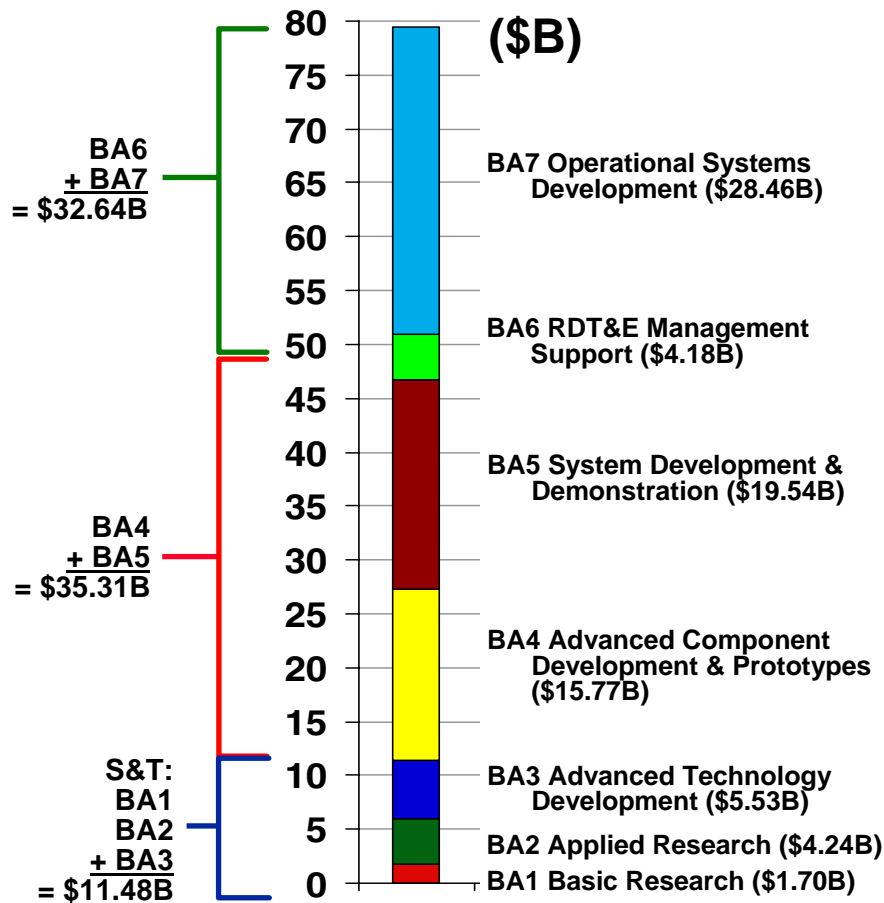
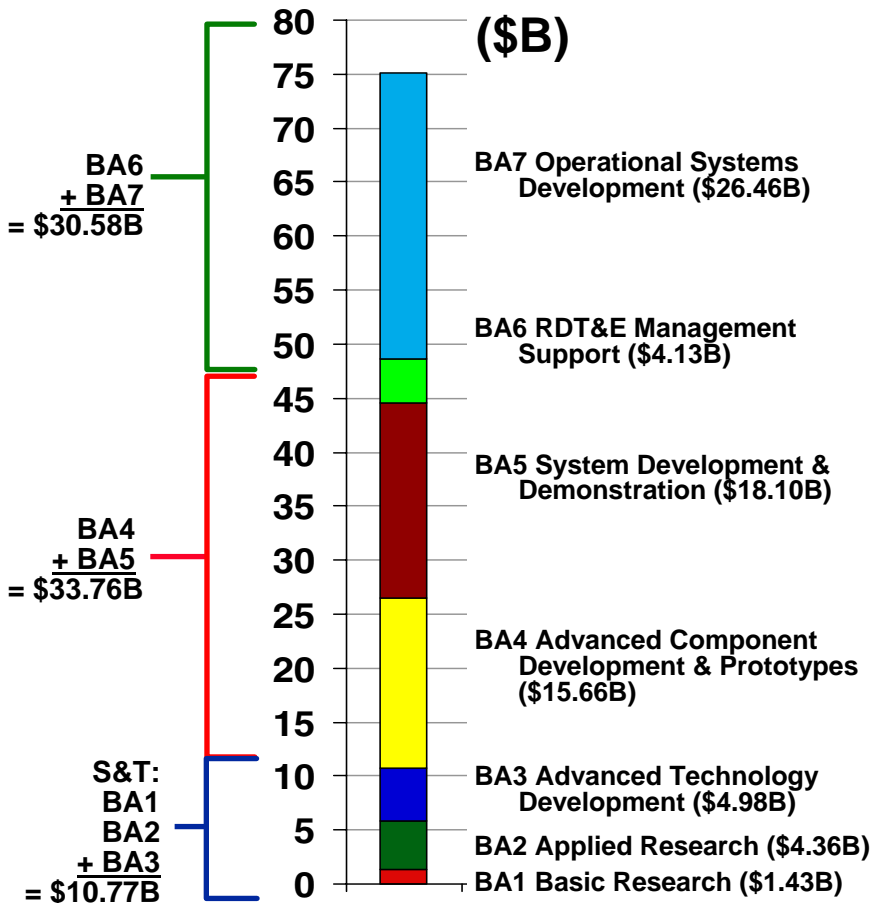
# FY08 and FY09 RDT&E Budget Request Comparison

## - in Then Year Dollars -



**FY08 RDT&E request = \$75.12B**  
(Budget Activities 1-7)

**FY09 RDT&E request = \$79.43B**  
(Budget Activities 1-7)



Technology Base (BA1 + BA2) = \$5.78B

Technology Base (BA1 + BA2) = \$5.94B

**PBR08 S&T is 14.3% of RDT&E**

**PBR09 S&T is 14.5% of RDT&E**

# FY09 DoD R&E Budget Request Comparison



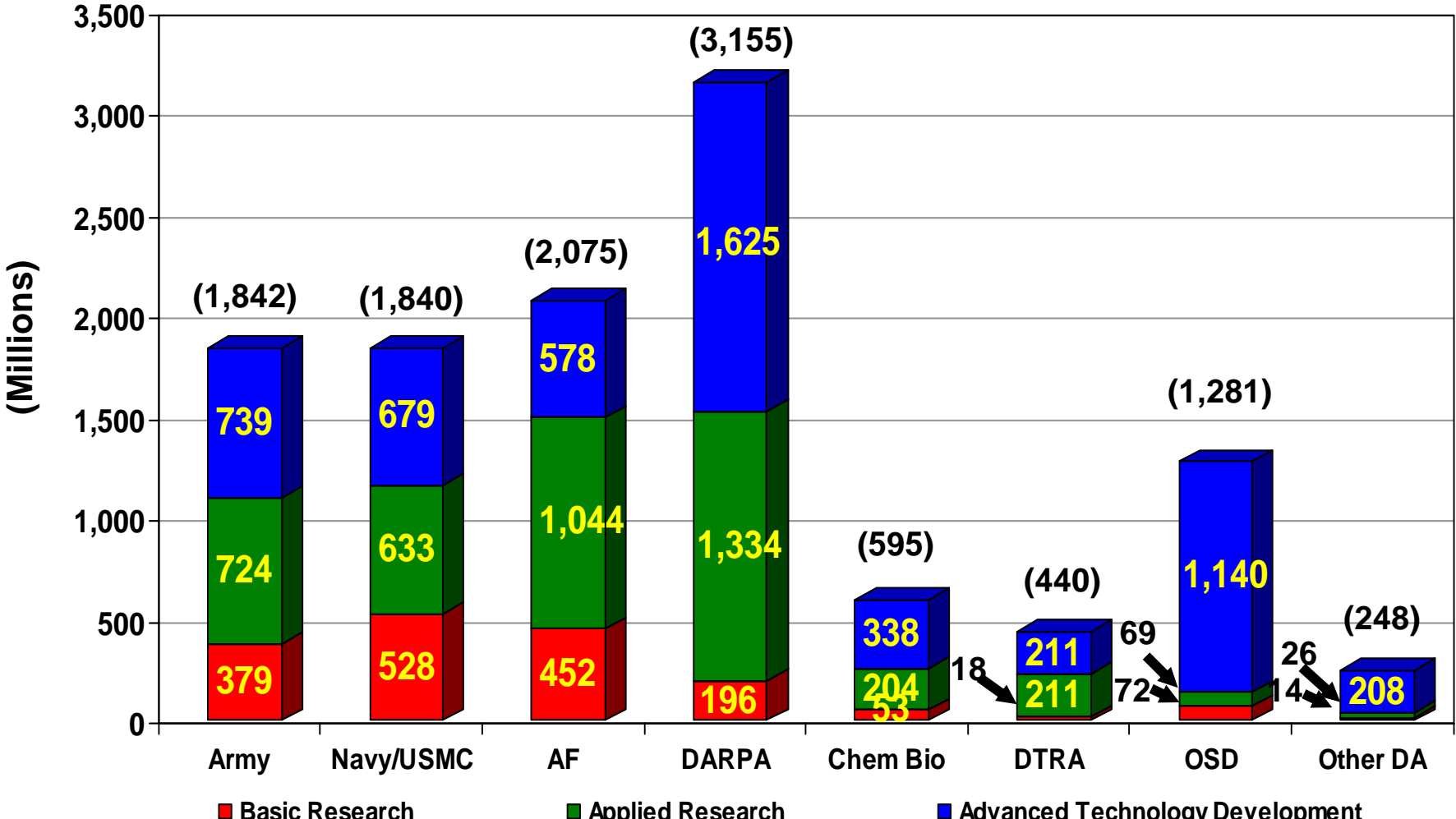
	FY08 PBR	FY08 Approp	FY09 PBR (Constant Year FY08)	Real Change from PBR (In CY \$)
Basic Research (BA 1)	1,428	1,634**	1,699 (1,662)	+16.4%
Applied Research (BA 2)	4,357	5,092	4,245 (4,153)	-4.7%
Advanced Technology Development (BA 3)	4,987	6,043	5,532 (5,412)	+8.5%
<b>DoD S&amp;T</b>	<b>10,772</b>	<b>12,768</b>	<b>11,475 (11,227)</b>	<b>+4.2%</b>
Advanced Component Development and Prototypes (BA 4)	15,662	15,947	15,774 (15,431)	-1.5%
<b>DoD R&amp;E (BAs 1 – 4)</b>	<b>26,434</b>	<b>28,716</b>	<b>27,249 (26,657)</b>	<b>+0.9%</b>
<b>DoD Topline</b>	<b>481,554</b>	<b>569,000</b>	<b>515,400 (502,486)</b>	<b>+4.3%</b>

# FY09 DoD S&T Budget Request



Total FY09 S&T request = \$11.48B

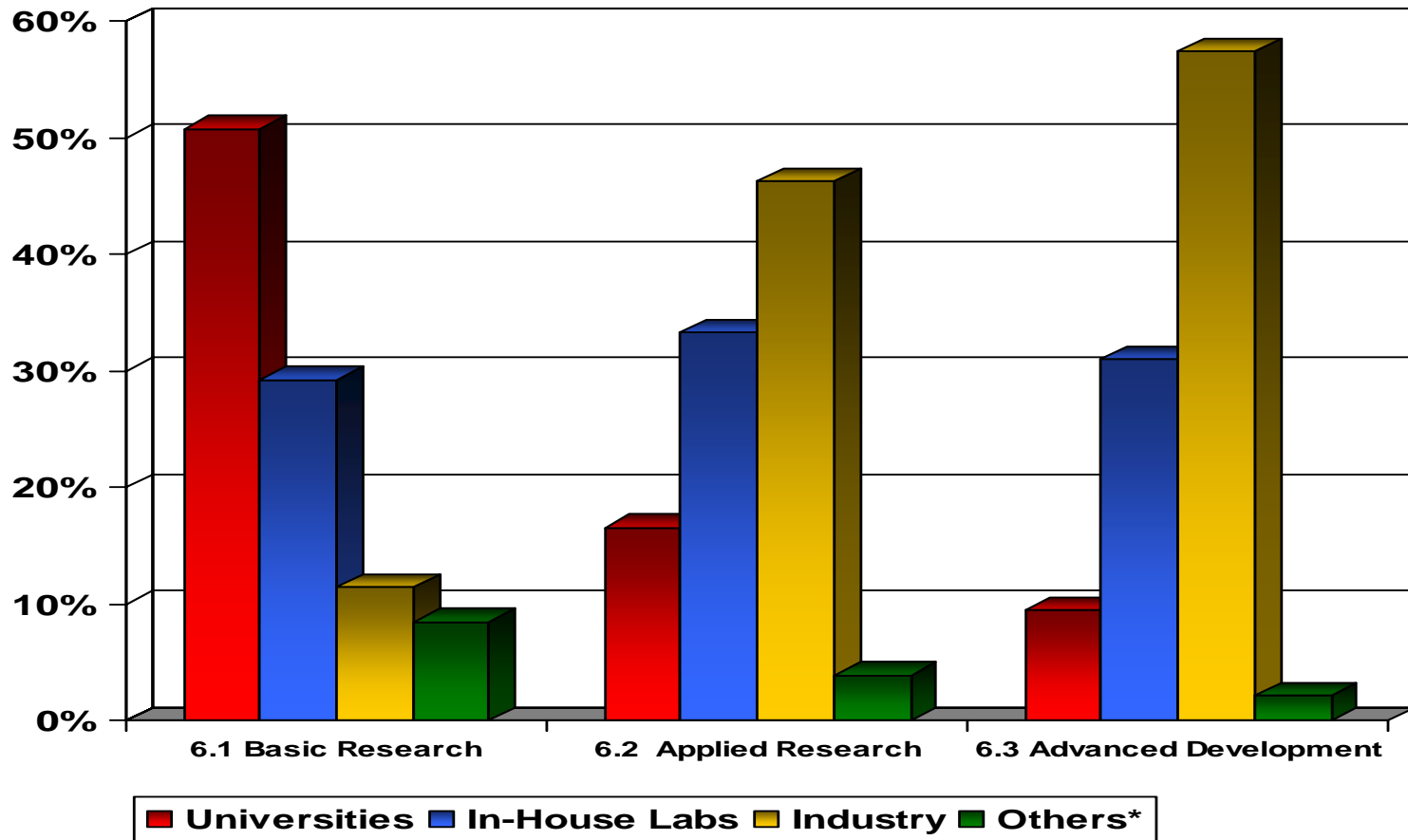
Total FY08 S&T Request = 10.77B  
 Army = 1,728 Navy = 1,667 AF = 1,964 DARPA = 3,033 ChemBio = 610 DTRA = 401 OSD = 1,166 Other DA = 201



# Recipients of DoD S&T Funds



DoD S&T Funding Recipients by Percentage (PBR08)



\*Includes non-profit institutions, State & local govt., & foreign institutions

Source: National Science Foundation Report (PBR08)



# Budget Changes and Historical Context



# PBR09 S&T Request Addresses Capability Gaps



- PBR09 S&T Request continues the realignment initiated in FY08 to address capability gaps identified in the 2006 QDR
  - Special (“non-kinetic”/enabling) technologies:
    - Clandestine Tagging, Tracking and Locating
    - Biometrics
    - Human, Cultural, Social Behavior Modeling
    - Networks
    - Persistent Surveillance

} \$183M

} \$611M
  - Technologies to decrease energy consumption and increase alternative sources of energy (\$513M)
  - Active and conventional armor technology for protection against a range of threats (\$68M)
  - Accelerating technology transition to fielded systems

***Investment is shifting away from platform-specific technologies***

# PBR09 S&T Request Addresses Capability Gaps (Cont'd)



- **New technology/emphasis areas**
  - **\$270M** increase to Basic Research
    - Enhance the science and engineering personnel base
    - Emphasis will be on research to address Grand Capability Challenges, e.g.,
      - Cyber protection and information assurance
      - Network sciences
      - Science of autonomy
      - Information fusion and decision sciences
      - Biosensors and biometrics
      - Human sciences (cultural, cognitive, behavioral, neural)
      - Software sciences and materials
      - Immersive sciences for training and mission rehearsal
      - Power and energy management
      - Counter directed energy weapons
    - Anticipate about 500 focused research efforts

# PBR09 S&T Request Addresses Capability Gaps (*Cont'd*)

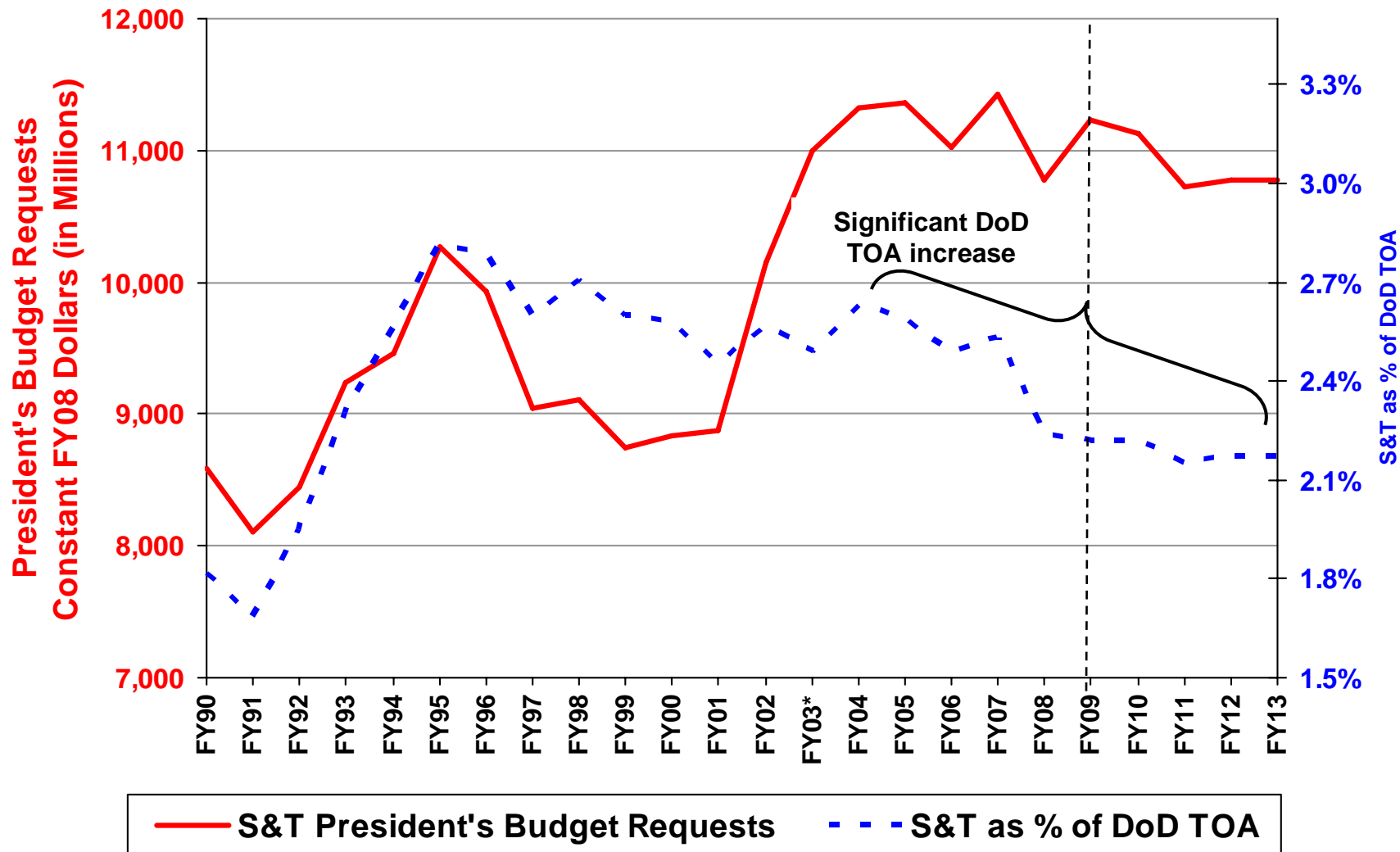


- **New technology/emphasis areas (*Cont'd*)**
  - Increased protection for dismounted troops and ground forces **(\$60M)**
  - Research in plasma and meta-materials to address emerging threats **(\$35M)**
  - Cyber protection **\*\*(\$50M)**
  - Hypersonics/Prompt Global Strike (Blackswift) – New technology prototype **\*\*(\$750M Total)**

**\*\* Note:** *Cyber protection is funded in DARPA BA 6  
Air Force funding for Blackswift is in BA 7*

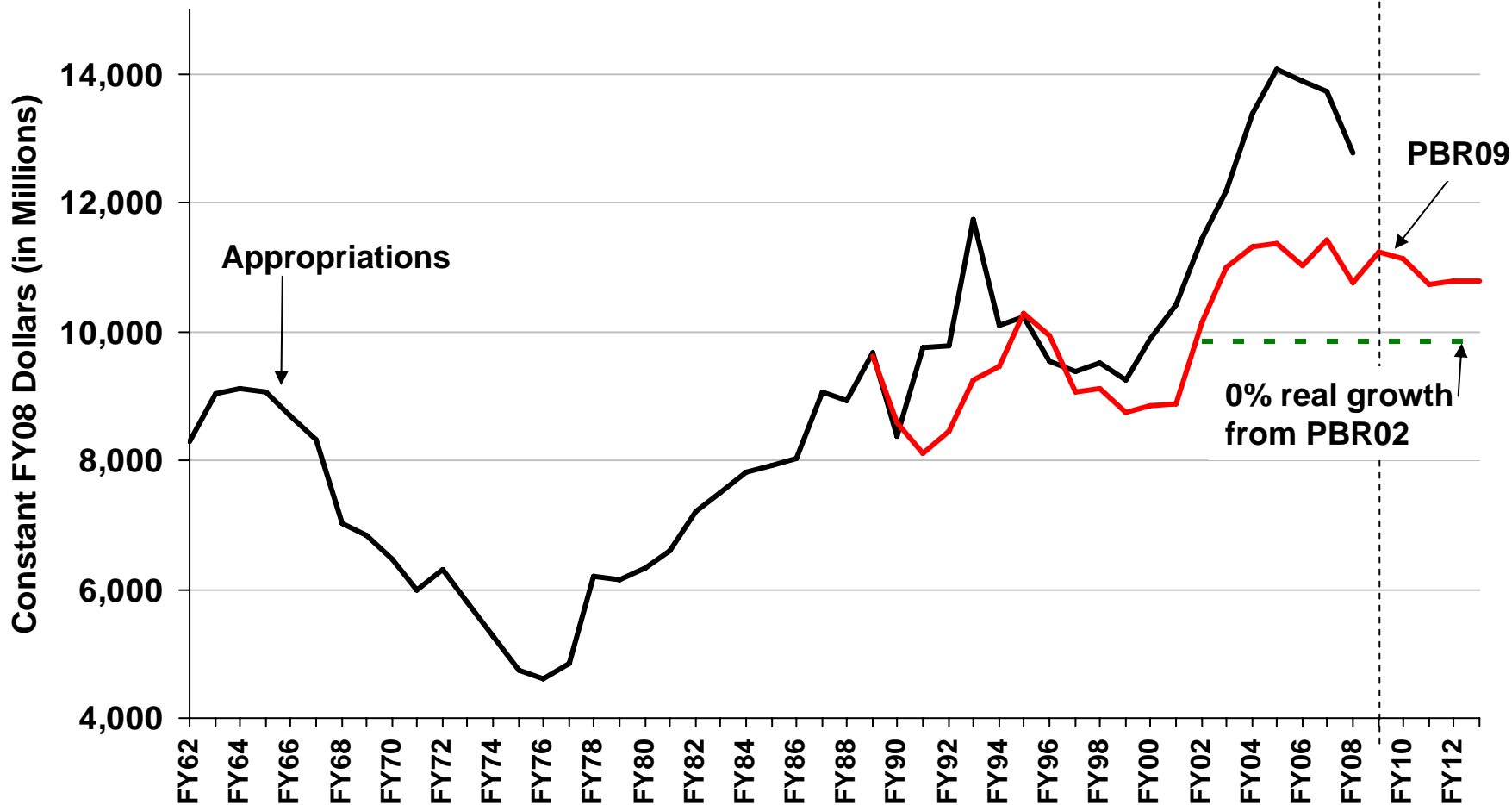
# DoD S&T - Macro Scale

- S&T Investment and % of DoD Total Obligation Authority (TOA) -



# DoD S&T – Historical Context

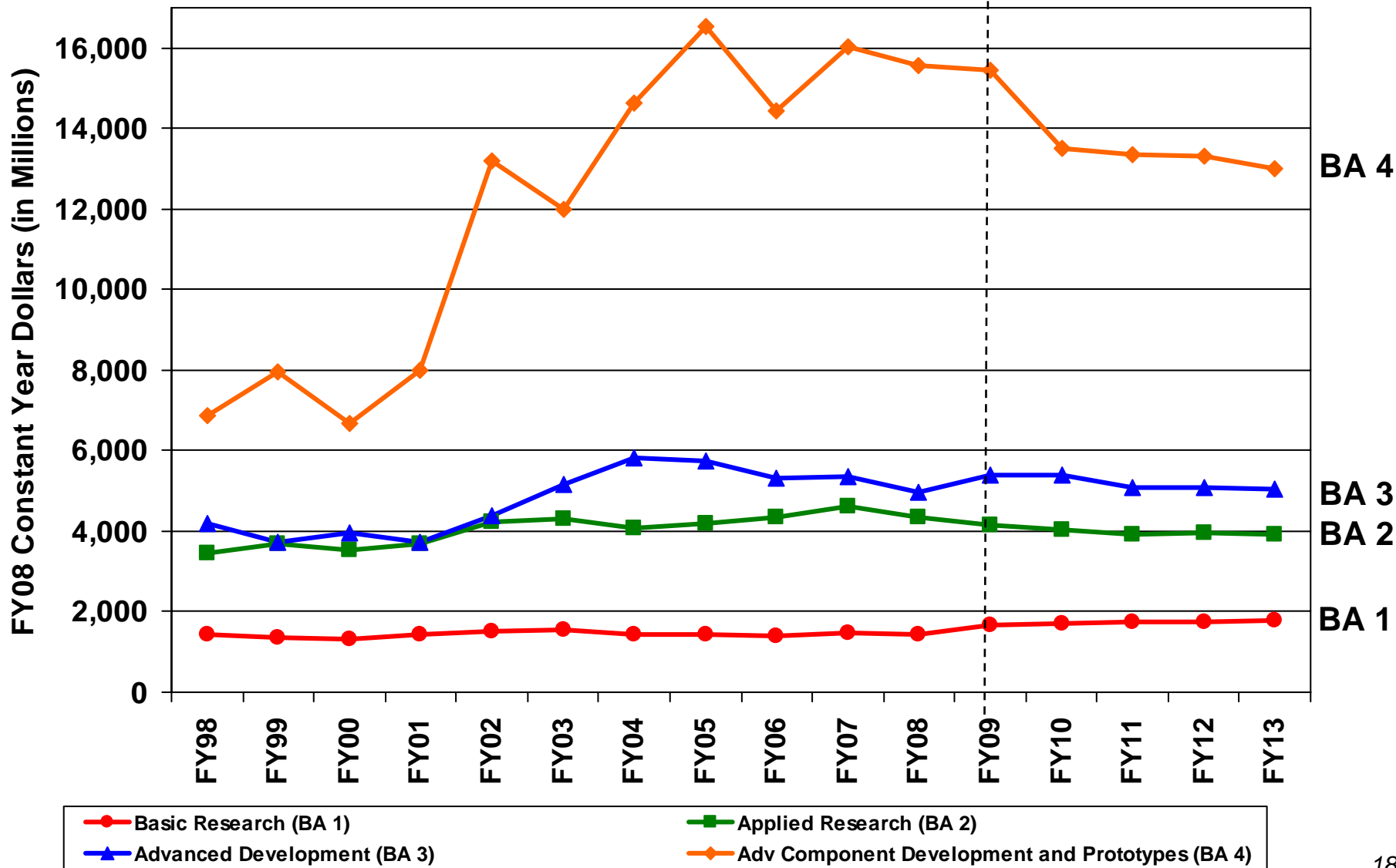
## - In FY08 Constant Dollars -



***FY09 S&T request is among the highest***

# DoD R&E Funding By Budget Activity

- President's Budget Requests  
(in FY08 Constant Dollars) -





# Strategic Context and Investment Focus



# Desert Storm



- **US dominance over Soviet-era systems “shocked” potential adversaries and combined to give US conventional superiority**
  - Precision Weapons
  - Night Vision
  - Low Observability
  - Networked Systems
- **The advent of information-based warfare feed the emergence of irregular warfare**





# Strategic Framework

- **US National Security Strategy (March 2006) set national imperative to continue the war on terrorism**
  - **2006 Quadrennial Defense Review also restated the need for DoD to balance its capabilities across four categories of challenges:**
    - Traditional
    - Irregular
    - Catastrophic
    - Disruptive
- } ***Transformational***
- **DDR&E S&T initiatives memorandum to SECDEF (24 Aug 07)**



# National Defense Strategy— Types of Programs Needing Technology



## Irregular

- *Language Translation*
- *Cultural Awareness*
- *Combating Terrorism*
- *Small Unmanned Aerial Vehicles*
- *Rapid Terrain Mapping*
- *Constant Surveillance*
- *Active & Conventional Armor*

## Catastrophic

- *Ballistic and Cruise Missile Defense*
- *Chemical Weapon Defense*
- *Bio Weapons Defense (includes research into state of genetic engineering)*
- *Remote Detection of Weapons of Mass Destruction Materials and Components*

## Traditional

- *Conventional Ground, Sea, and Air Vehicles*
- *Standard Weapons*
- *Precision Weapons*
- *Stand Alone (Single Service) Command & Control Systems*

## Disruptive

- *Nano, Bio, Information Techs.*
- *Hypersonics*
- *Directed Energy*
- *Networks on the Move*
- *Autonomous Systems*
- *Distributed Sensors*
- *Defeat of Speed of Light Weapons*
- *Metamaterials*
- *Plasma Research*

LIKELIHOOD

# QDR Priority Formulation



- **Strategic Challenges**
  - Traditional
  - Irregular Warfare
  - Catastrophic
  - Disruptive
- **Strategic Outcomes**
  - Defeat Terrorist Networks
  - Defend the Homeland in-Depth
  - Shape Choices of Countries at Strategic Crossroads
  - Prevent the Use and Proliferation of WMD

# Capabilities to Defeat Terrorist Networks



- **Persistent surveillance**
- **Locate, tag, and track terrorists in denied areas**
- **Human intelligence**
- **Capabilities to fuse intelligence**
- **Language and cultural awareness**
- **Joint coordination, processes and systems**

***Non-kinetic effects***

- **Urban warfare capabilities**
- **Prompt global strike**
- **Riverine warfare capabilities**

***Kinetic effects***

# Capabilities to Defend the Homeland In Depth



- Interoperable, joint command and control
- Enhanced air and maritime awareness
- Consequence management
- Broad spectrum medical countermeasures

*Non-kinetic effects*

- Tailored deterrence, including prompt global strike
- Air and missile defense

*Kinetic effects*

# Capabilities to Shape the Choices of Countries at Strategic Crossroads



- Improved language and cultural awareness
- Persistent surveillance (penetrate and loiter)
- Cyberspace shaping / defense
- Secure broadband communications

*Non-kinetic effects*

- Prompt, high-value global strike
- Integrated defense against all missiles
- Air dominance
- Undersea stealth

*Kinetic effects*

# Capabilities to Prevent the use of Weapons of Mass Destruction



- **Locate, tag, track, and characterize**
- **Stand off fissile material detection**
- **Wide area persistent surveillance**
- **Fusion of HUMINT, ISR, and open source information**

***Non-kinetic effects***

- **Capabilities to “render safe” WMD**
- **Non-lethal weapons**

***Kinetic effects***



# National Defense Strategy Drives S&T Investment



# S&T Enabling Technology Priorities

## --Supporting the QDR Strategic Outcomes--



- **Technology focus areas:**
  - **Biometrics and Biological exploitation**
  - **Information Technology and applications**
  - **Persistent Surveillance Technologies**
  - **Networks and Communication**
  - **Human, Social, Cultural, and Behavioral Modeling**
  - **Language Translation Technologies**
  - **Manufacturing Technologies**
  - **Cognitive Enhancement**
  - **Directed Energy Technologies**
  - **Autonomous Systems Technologies**
  - **Hyperspectral Sensors**
  - **Nanotechnology**
  - **Advanced Materials**
  - **Energy and Power Technologies**
  - **Organization, Fusion, & Mining Data**
  - **Combating Weapons of Mass Destruction Technologies**
  - **Energetic Materials**

*In Blue—Areas with Substantial Increases in FY08/09 President's Budget Request*



# **S&T Enabling Technology Priorities**

## **--Supporting DDR&E Investment Initiatives--**

- **S&T Area Investment Initiatives from 24 Aug 07 memorandum to SECDEF:**
  - **Foundational Sciences**
  - **Active & Conventional Armor**
  - **Defeat of Speed of Light Weapons**
  - **Adaptive, Interactive, Full Immersion Training for Soldiers/Marines**
  - **Metamaterials**
  - **Information Warfare**
  - **Information Assurance**
  - **Networking Technologies**
  - **Manufacturing Science Technologies**
  - **Neuro-Ergonomics**
  - **Directed Energy Technologies**
  - **Autonomous Operation of Networks of Unmanned Vehicles in Complex Envir,**
  - **Advanced Medical Research**
  - **Software Development Technology**
  - **Energy and Power Technologies**
  - **Organization, Fusion, & Mining of Large Data Sets for Enhanced Decision Making**
  - **Combating Weapons of Mass Destruction Technologies**
  - **Energetic Materials**



# Reliance 21 and the R&E Portal

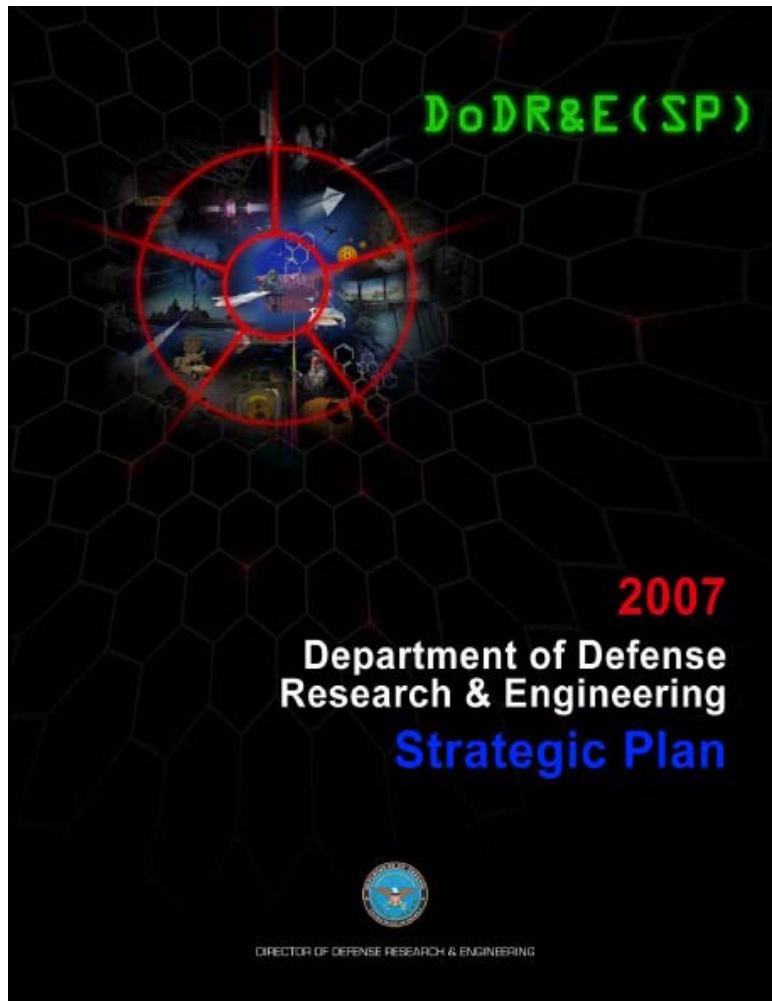
# Defense S&T Reliance



*Defense S&T Reliance provides the framework to enable the DoD S&T community to work together to enhance the Defense S&T program and eliminate unwarranted duplication. It strengthens cooperation among the Services and Agencies thereby improving responsiveness to their warfighting and acquisition customers.*



# S&T Plans and Reliance 21



## Defense Science and Technology Strategy and Plans

- *Defense S&T Strategy (Replaced with DDR&E Strategic Plan)*
- *Basic Research Plan (6.1) - BRP -(As necessary, new plan at printer)*
- *Defense Technology Area Plan (6.2, 6.3) - DTAP - (Replaced with Technology Focus Teams)*
- *Joint Warfighting Science and Technology Plan - JWSTP (Biennial, even years)*
- *Defense Technology Objectives (DTO) Volume that supports JWSTP and DTAP (Replaced by Marquee Programs in JWSTP)*

# Research & Engineering (R&E) Portal (<https://rdte.osd.mil>)



- Provide DoD R&E community (civil service, military, approved contractors) with single-point access to all current R&E information:
  - Reliance 21 S&T planning documents
  - New E-Gov database
  - R&E Points of Contact
  - Congressional budget query
  - RDT&E budget data
  - DDR&E website
  - Dialog NewsEdge (24/7 breaking news on technology)
  - DoD In-House S&T Activities Report
- Be able to intelligently search all data



# R&E Portal Access (<https://rdte.osd.mil>)



## Welcome to the DoD Research & Engineering Portal

To view a video about the R&E Portal, click [here!](#)

The R&E Portal will be the focal point for obtaining information on research and engineering activities within DoD. It is sponsored by the office of the Director of Defense Research & Engineering (DDR&E) and maintained by the Defense Technical Information Center (DTIC). Within the R&E Portal, you will find:

- Data from systems that focus on the areas of Financial Management, Strategic Planning, and Congressional Reporting.
- Information on areas of strategic importance and current initiatives within DDR&E.
- Tools to facilitate collaboration, communication, and reuse of information and artifacts.
- Robust text searching tools to query the wealth of DoD research and engineering information held by DTIC and other service agencies.

Access to the R&E Portal is controlled by the [Registration Process](#). If you are not currently registered, click [here](#) to learn more.

## Sign In

\*

or sign in using your user name and password:

User Name:

Password:

[Click here to change your password or update your profile.](#)

[Click here if you forgot your password or it has expired.](#)

If you wish to bookmark the site, please wait until you have logged in successfully before adding it to your list of favorites.

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Use of this DoD computer system, authorized or unauthorized, constitutes consent to monitoring of this system. Unauthorized use, including registering or attempting to register for access using personal identification other than your own, may subject you to criminal prosecution. Evidence of unauthorized use collected during monitoring may be used for administrative, criminal, or other adverse action. Use of this system constitutes consent to monitoring for these purposes.

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# Research & Engineering (R&E) Portal



## R&E Portal

DoD Research & Engineering

Turning Data into Knowledge

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Use the DTIC [Ask a Librarian](#) service to assist you in your research.

### R&E Data Analysis (Cognos)

Use the [R&E Data Analysis Tools](#) site to view reports and create tables and graphs of data within the R&E Portal.

[Consumer Training](#)  
[Author Training](#)

### Research Resources

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[Congressional Budget Queries](#) >>  
[R&E Database Search](#) >>  
[CSA/COS Scholars & Funding Database](#) >>  
[Knovel Reference Library](#) >>  
[Defense Science & Technology Plan](#) >>  
[Defense Technology Search](#) >>

### DoD R&E Success Story

**Heterogeneous Urban RSTA Team (HURT)**

### What's New

The 9th Annual Science and Engineering Technology Conference/DoD Technology Exposition will be held in Charleston, South Carolina from 15-17 April 2008. The conference is sponsored by the National Defense Industrial Association (NDIA). Please visit the Conference website for more details at the following link: <http://www.ndia.org/meetings/8720>.

The R&E Database Search has been updated to include 2007 submissions. The search capability has also been updated to allow more options and flexibility in searching for data. To use the search, go [here](#) or use the link under Research Resources.

The Tennessee Valley Emerging Technologies Conference will be held in Huntsville, Alabama from 25-27 March. The conference is sponsored by the Defense Intelligence Agency / Missile and Space Intelligence Center and the U.S. Army Space and Missile Defense Command / U.S. Army Forces Strategic Command. Abstracts of proposed oral presentations are requested by 15 November. Please visit the Conference website for more details at the following link: <http://smapcenter.uah.edu/ETC08>.

The [Knovel Reference Library](#) is available through the R&E Portal. Check out this useful new service.

### About the R&E Portal

The R&E Portal provides a one-stop shopping location for DoD research & engineering information. For more information about the R&E Portal and its content, click the [Help tab](#).

### Who's Who

Access these R&E Portal features to locate or learn more about people involved in research and engineering or who hold important positions in DoD R&E.

**Community of Scholars** - The CSA/COS database of researchers (contact and publication information) and funding opportunities allows users to search for people or funding opportunities by key word and narrow the results by subject area.

**R&E Community Members** - The R&E Community Members database includes directors' names and contact information for DoD R&E organizations across the Services and Agencies.

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March 13, 2008

#### Security Agencies

▶ [Alleged CIA flights in Bratislava are commercial: government](#)  
BRATISLAVA, March 12, 2008 - Slovakia's foreign ministry dismissed Wednesday allegations of CIA planes landing in Bratislava airport, saying they were "commercial flights" in line with local and international regulations.  
[Agence France-Presse English Wire]  
[more headlines](#)



# Summary

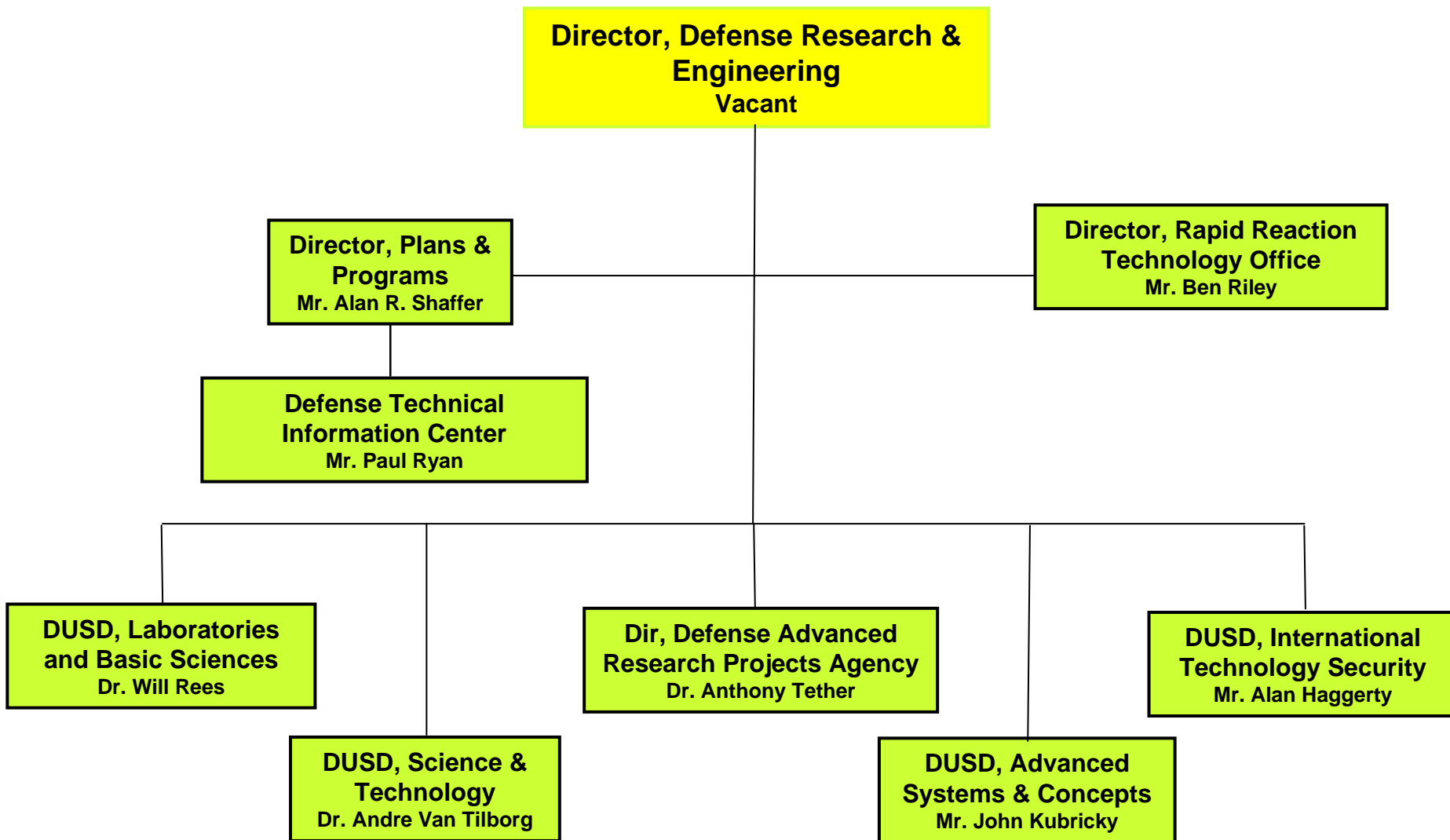
- **PBR09 S&T investment is driven by:**
  - *DoD R&E Strategic Plan (guided by National Security Strategy and the QDR)*
  - **S&T Initiatives in 24 Aug 07 memorandum from DDR&E to SECDEF**
- **PBR09 shows SecDef's commitment to a strong S&T program – especially basic research**
  - **PBR09 is 4% higher than PBR08, in real terms**
  - **PBR09 is within \$200M of highest request (PBR07), in real terms**
  - **SecDef directed increase in Basic Research is 16% higher than PBR08, in real terms**



# Backup



# DDR&E Organization



# FY09 President's Budget Request



TY\$M		FY08 Enacted	FY09	FY10	FY11	FY12	FY13
<b>ARMY</b>	Basic Research	379	379	367	383	395	424
	Applied Research	1,175	724	727	741	736	736
	Advanced Development	1,337	738	730	724	754	782
	<b>Total S&amp;T</b>	<b>2,891</b>	<b>1,842</b>	<b>1,824</b>	<b>1,848</b>	<b>1,885</b>	<b>1,943</b>
<b>NAVY/</b>	Basic Research	498	528	539	548	576	608
	Applied Research	801	633	612	660	732	787
<b>MARINE</b>	Advanced Development	722	679	649	663	6264	596
<b>CORPS</b>	<b>Total S&amp;T</b>	<b>2,021</b>	<b>1,840</b>	<b>1,800</b>	<b>1,871</b>	<b>1,935</b>	<b>1,991</b>
<b>AIR</b>	Basic Research	421	452	470	493	502	513
	Applied Research	1,170	1,044	1,103	1,059	1,096	1,112
	Advanced Development	664	578	669	632	642	659
	<b>Total S&amp;T</b>	<b>2,255</b>	<b>2,075</b>	<b>2,242</b>	<b>2,184</b>	<b>2,240</b>	<b>2,284</b>
<b>DEFENSE</b>	Basic Research	336	339	392	417	440	445
	Applied Research	1,912	1,844	1,770	1,700	1,720	1,721
	Advanced Development	3,264	3,536	3,594	3,408	3,498	3,563
	<b>Total S&amp;T</b>	<b>5,512</b>	<b>5,718</b>	<b>5,756</b>	<b>5,525</b>	<b>5,659</b>	<b>5,730</b>
<b>-WIDE</b>	Basic Research	1,634	1,698	1,768	1,840	1,914	1,990
	Applied Research	5,058	4,245	4,213	4,160	4,284	4,357
	Advanced Development	5,987	5,532	5,642	5,427	5,520	5,600
	<b>Total S&amp;T</b>	<b>12,679</b>	<b>11,475</b>	<b>11,623</b>	<b>11,428</b>	<b>11,718</b>	<b>11,947</b>

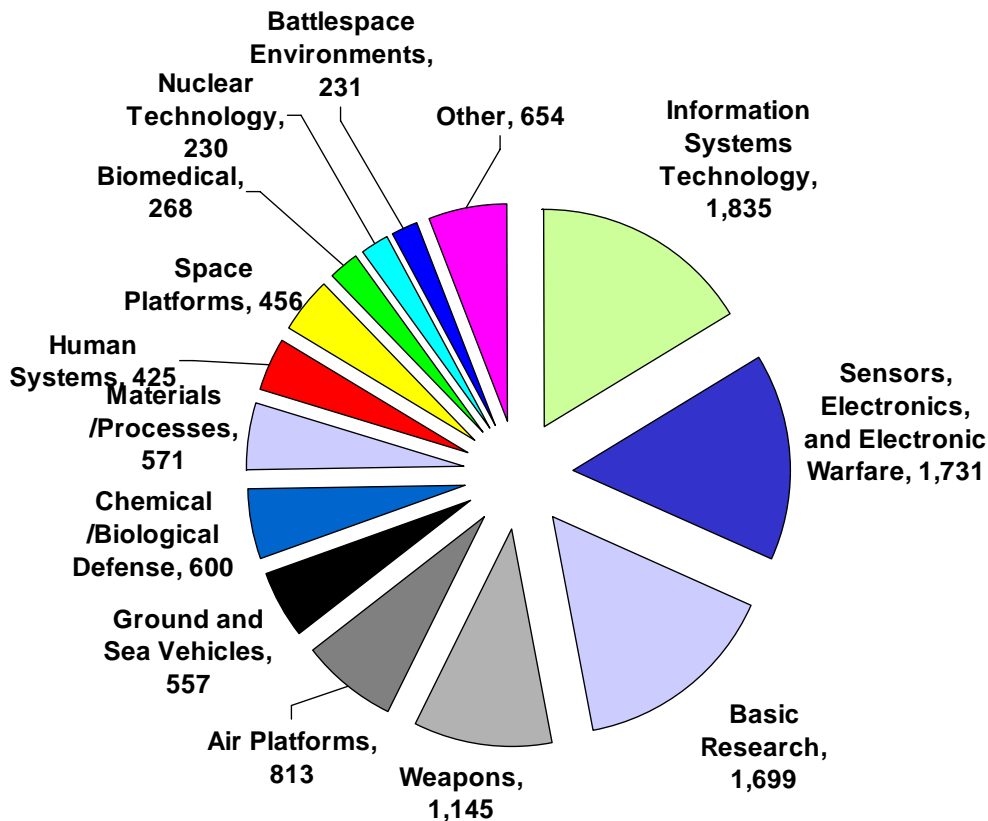
# Characterization of the FY09 DoD S&T Program



## • Funding

- Current year S&T dollars: \$10.77B FY08 to \$11.48B FY09
- Percent of DoD funding: 2.24% FY08 to 2.22% FY09
- Over 50% of total investment in 4 functional areas:

- Information Systems (1.8B)
- Sensors, Electronics / EW (1.7B)
- Basic Research (1.7B)
- Weapons (1.1B)



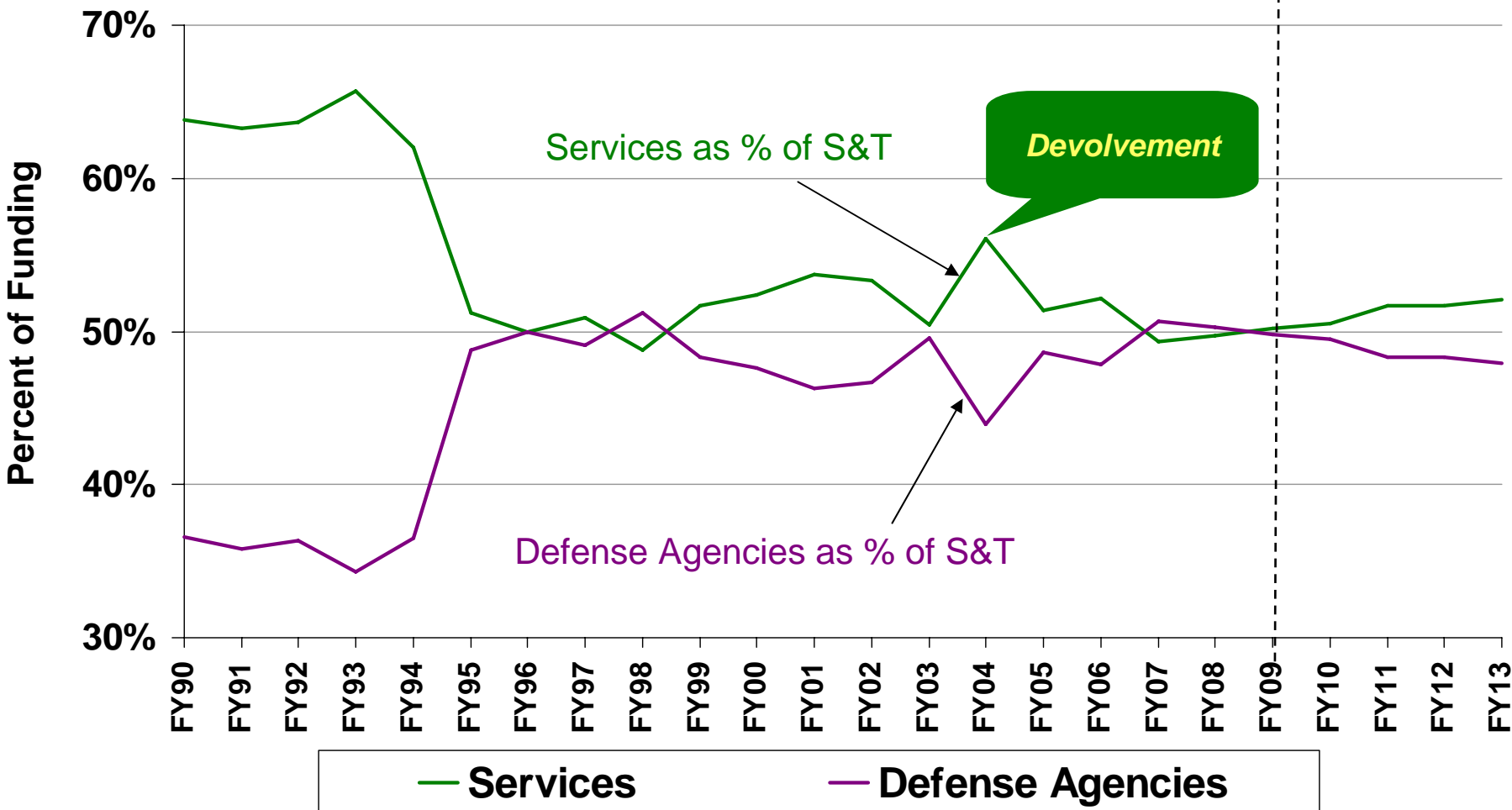
***DoD S&T program is focused on “sensing and shooting”***

# S&T Breakout

## - Services and Defense Agencies as % of Total S&T -



President's Budget Requests





# Marquee Program Count

- **Army – 25**
- **Navy – 65**
- **Air Force – 26**
- **DARPA – 44**
- **DTRA – 4**
- **MDA – 1**
- **AS&C – 28**

**Total = 193**





# The Need for Manufacturing Innovation and Readiness

Mark Gordon

Director, Defense Programs

National Center For Advanced Technologies

NDIA Science and Engineering Technology Conference

April 17, 2008



# Topics

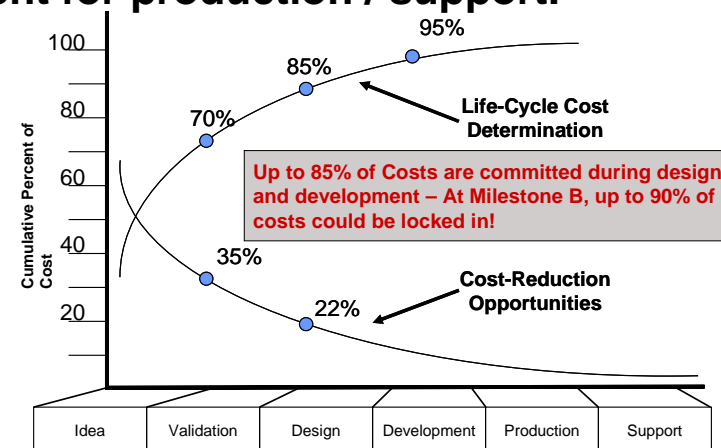
- Why Manufacturing is Key to Technology Transition
- The DoD Manufacturing Technology Program
- Current ManTech Priorities
  - Manufacturing Science and Technology
  - Manufacturing Readiness Levels
- MRL Implementation & Policy
- Questions



# Why Consider Manufacturing In Transition?

- **The ability to manufacture a component:**
  - Is not subservient to technology development cycle, but central to it.
  - Determines a large percentage of the total cost and schedule.
  - Can in itself bring about [innovative technologies](#) (MEMS, LAM, Flexible Displays, Complex Dimensional Composites, CMCs)
- **The capability to produce a technology/material is often not seen as part of technology transition or innovation, and may be ignored by the Science and Technology community.**
  - However, it is a [core focus in highly competitive commercial markets](#) (Aerospace, Automotive, IT, & Transportation.)
  - [System engineering](#) models require the maturation of technology along with the ability to manufacture, support, and test.
- **In Defense, practice is often to demonstrate the performance of complex systems, then change the design late in development for production / support.**
  - [Customer](#) priorities requirements.
  - Contracting structure [allows](#) cost increases.

The foundation of [affordable](#) transition is the access for program manager to technology with [demonstrated levels](#) of performance, producibility and support. These attributes allow for effective [design trades with knowledge about cost](#).

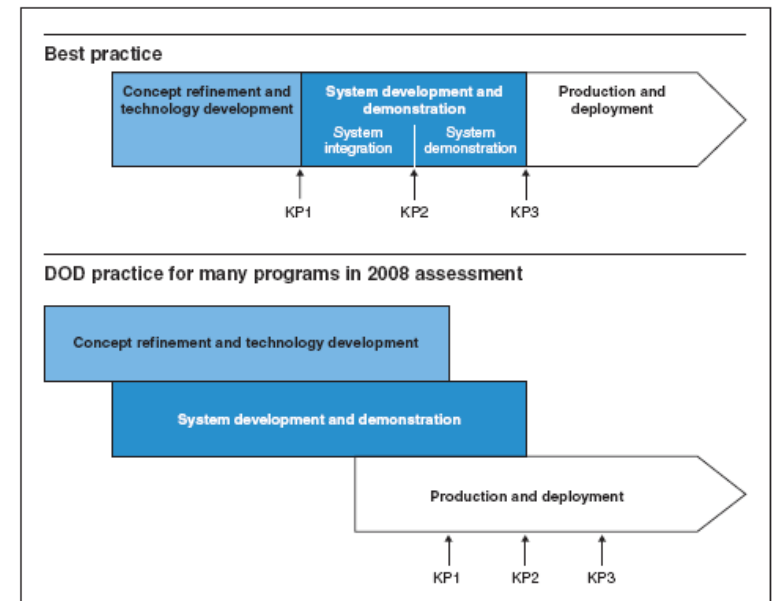




# GAO: Knowledge Based Acquisition

- During GAO assessments of Acquisition Programs, a disturbing trend of **growing cost and schedule overruns** led to a conclusion that poorly performing DoD programs did **not possess the knowledge** required to achieve a successful design at key points during development.
- **\$135B in Cost Growth (2004-2007)**
- They determined best practices in successful DoD and commercial development and defined three Knowledge Points:
  - **Knowledge point 1: Resources and needs match [Best practice: MS B]**
  - **Knowledge point 2: Product design is stable [Best practice: CDR]**
  - **Knowledge point 3: Production processes are mature [Best Practice: MS C]**
- In multiple assessments (2000-2008) of the DoD acquisition portfolio, there was found to be a **strong correlation** between delayed knowledge points and poor performance.
- In typical defense program practices, these knowledge points were achieved **significantly later** in the development process, meaning that system design changes continued far into integration and production.
- Reversing this practices resulted in a strong policy requiring **Technology Readiness at MS B**, **Configuration Control Boards** and increasing use of **Prototypes in competition**.

Figure 6: Best Practices Compared to DOD Practices for Programs in 2008 Assessment





# Finding: Most Programs Proceed With Low Levels of Knowledge Resulting in Cost/Schedule Increases

In a recent annual review of DoD programs (n=62), GAO found:

- Only 16% of programs achieved mature technology at MS B.
  - programs that demonstrated mature technologies averaged 2.6% cost growth and a 1 month schedule delay
  - programs that **did not have mature technologies averaged 32% cost growth and a 20 month schedule delay**
- At critical design review:
  - 44% of programs achieved technology maturity
  - 27% of programs demonstrated design stability (90% drawings releasable)
- At MS C, the start of Production:
  - Only 67% of programs achieved technology maturity
  - 33% of programs had still not achieved design stability
  - 10% of programs were collecting data on process control. (0% in control)
  - 47% reported they have already conducted or planned to conduct a developmental test of a production representative article (i.e., prototype)

Based on 62 programs	Technology Status at Beginning of Development	
	Mature	Immature
RDT&E Cost Increase	2.6%	32.3%
Acquisition Unit Cost Increase	<1%	>30%
Average Schedule Delay	1 month	20 months



# The DoD Manufacturing Technology Program

- ManTech is critical for moving disruptive technologies into disruptive capabilities
- If you can't build it, build it affordably, reliably, and in a timely manner, you don't have IT.
- To have true capability, must be able to move beyond the prototype "One-Off"
  - Operates Under Title 10 (Section 2521)
    - Manufacturing process investments that provide product performance, operational, & affordability improvements
  - All About Affordable & Timely Equipping of the Warfighter
    - Defense essential needs beyond normal risk / interest of industry
    - Pervasive needs across systems, platforms, or components
  - Transition of Validated Technology
    - Scale-up of processes for S&T, ATDs, IR&D, & ACTD products
    - Focus: Manufacturing process investments



# Joint Defense ManTech Panel - (JDMTP)

**ManTech Principals**  
(Army, Navy, AF, DLA, MDA)

**Ex Officio:**

- OSD, Army, Air Force Staff
- Agencies, Dept of Energy, Dept of Commerce (NIST)
- Industry

**Metals Processing & Fabrication**

- Specialty Materials
- Processing & Joining
- Inspection & Compliance

**Composites Processing & Fabrication**

- Performance Improvements
- Life Cycle Affordability

**Electronics Processing & Fabrication**

- Packaging & Assembly
- RF Electronics
- Electro-Optics

**Sustainment**

**Focus – Joint Collaboration**





# Manufacturing Technology Program Examples

## Warfighter Relevance



(U.S. Air Force)



**Solved #1 B-2 Mission Capable MX Issue**  
New capability will have the greatest impact on B-2 Fleet Availability

Developed new LO Magnetic Radar Absorbing Material (MagRAM) for B-2, reduced mx downtime for LO materials from 36 hrs to 7 hrs.

**Solved #1 C-17 MX Issue – Structural Damage to Doors on undeveloped runways**

AF – ManTech developed new stitched resin infusion process to prevent delamination.

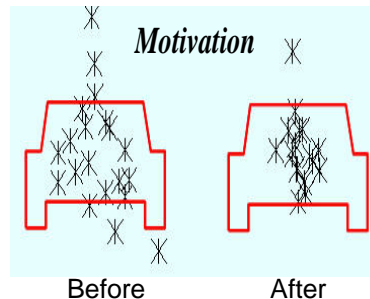
**Met Tank Tread Demand Surge for OIF**

- Vital Track component experienced accelerated failures
- Advanced casting tooling method enabled industry to meet surge and demand



**Created force multiplier for battle tanks**

- Improved Accuracy through Cannon Tube Reshaping
- 20 fold tighter tolerance; 65% reduction of shot group dispersion;
- Resulted in greatest increase in “loss exchange ratio” in 20-plus years



**Developed New Capability - New Marine Composite-to-Steel Joining Capability - Reduces Logistics Footprint and enables DD(X) to meet Program Requirements**

New Adhesive Joint replaces 5120 bolts that failed to meet technical req'ts of DD(X)





# Manufacturing Technology Program Top Priorities

- OSD Manufacturing S&T Program

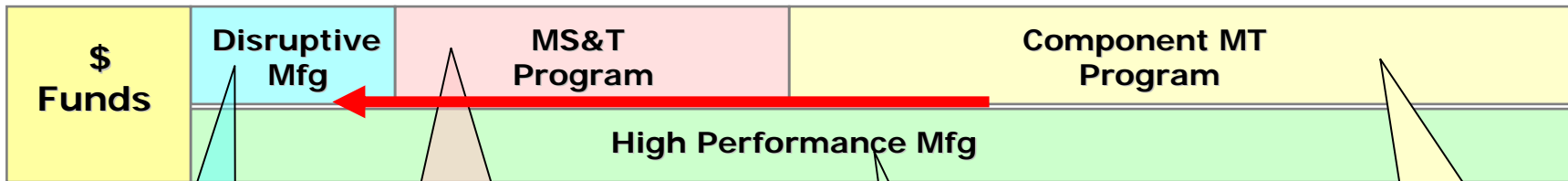
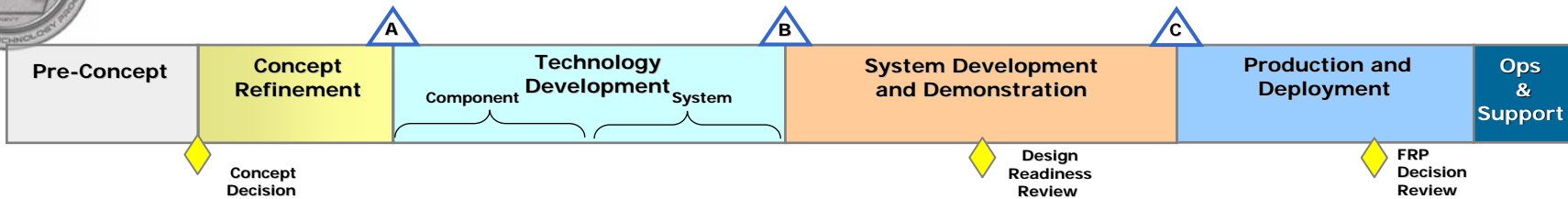
- SBIR- Manufacturing

- MRL/MRA Implementation

- Strategic Planning



# Pulling Manufacturing Back into S&T



**Manufacturing Science and Technology:**  
 Concurrently develop and mature cross-cutting manufacturing processes with new and emerging technologies.

- **Align R&D** investments
- **Accelerate** Transition

**Traditional ManTech:**  
 Develop and mature manufacturing processes for acquisition programs, and specifically for **affordable production and capacity.**

**High Performance Manufacturing:**  
 Identify and transition advanced manufacturing processes. Includes development of **test beds and prototypes**, and creation of **technology roadmaps.**

**Disruptive Manufacturing Technology:**  
 Radically alter the defense industrial base through development of “disruptive” manufacturing processes. Provide **faster and more affordable access** to low-volume production capabilities for **defense unique** technologies. Transition emerging, disruptive technologies



# MRL: Background

- *Immature technology and unstable manufacturing processes are major acquisition drivers*
- *Manufacturing Readiness Levels (MRL) Developed*
  - In collaboration with industry
  - Common Standard and framework for identifying, communicating, and managing manufacturing risks
  - Reconciled with TRLs
- *Policy Required*
  - Establish and promote manufacturing risk management as basic principal of technology development and acquisition programs
  - Plan and budget for incorporating manufacturing readiness to support successful transition
  - Establish **DoD standard** for manufacturing readiness at key milestones
    - Milestone A – MRL4
    - Milestone B – MRL 6
    - Milestone C – MRL 8
    - FRP Decision – MRL 9
  - Support the development and maintenance of necessary knowledge and skills within the DoD workforce to support this best practice already used by key U.S. defense industries
  - Provide guidance for the new DoD standard
- *MRL Process Owner: DDR&E*

# MRL Definitions & Descriptions

MRL	MRL	Definition	Description	Phase
	1		Manufacturing Feasibility Assessed	
2		Manufacturing Concepts Defined		
3		Manufacturing Concepts Developed		
4		Capability to produce the technology in a laboratory environment.		
5		Capability to produce prototype components in a production relevant environment.		
6		Capability to produce a prototype system or subsystem in a production relevant environment.		
7		Capability to produce systems, subsystems or components in a production representative environment.		
8		Pilot line capability demonstrated. Ready to begin low rate production.		
9		Low Rate Production demonstrated. Capability in place to begin Full Rate Production.		
10		Full Rate Production demonstrated and lean production practices in place.		
		Production.	monitoring ongoing. LRIP cost goals met, learning curve validated. Actual cost model developed for FRP environment, with impact of Continuous improvement.	Production (FRP) decision
	10	Full Rate Production demonstrated and lean production practices in place.	This is the highest level of production readiness. Engineering/design changes are few and generally limited to quality and cost improvements. System, components or items are in rate production and meet all engineering, performance, quality and reliability requirements. All materials, manufacturing processes and procedures, inspection and test equipment are in production and controlled to six-sigma or some other appropriate quality level. FRP unit cost meets goal, funding sufficient for production at required rates. Lean practices well established and continuous process improvements ongoing.	Full Rate Production/ Sustainment



# MRL Criteria Matrix / Threads

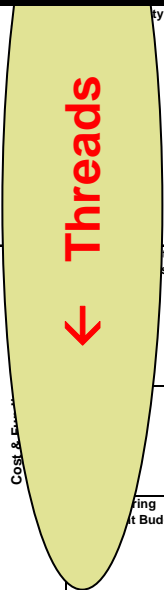
MRL Criteria Matrix Threads	
Technology and Industrial base	
Design	
Cost and Funding	
Materials (Raw Materials, Components, Sub-assemblies and Sub-systems)	
<p><b>Producibility assessments of key technologies/components and producibility trade studies completed. Results used to shape System Development Strategy and plans for SDD or technology insertion.</b></p>	

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<p style="color: red; font-size: 2em;">← Threads</p>	<p>Evaluate product lifecycle requirements and product performance requirements.</p>	<p>Systems B the Test at recognize establish manufact management risk for the Initial Key Paramete</p>	<p><b>Producibility assessments of key technologies/components and producibility trade studies completed. Results used to shape System Development Strategy and plans for SDD or technology insertion.</b></p>					<p>Major product design features are stable and LRIP produced items are proven in product testing. Design change traffic is limited to minor configuration changes. All KC's are controlled in production to three sigma or other appropriate quality levels.</p>	<p>Product design is stable. Design changes are few and generally limited to those required for continuous improvement or in reaction to obsolescence. All KCs are controlled to six sigma or other appropriate quality levels.</p>				
	<p>Technology cost models developed for new process steps and materials based on engineering details at MRL 1-2. High-level process chart cost models with major production steps identified at MRL 3.</p>	<p>Detailed process chart cost models driven by key characteristics and process variables. Manufacturing, material and specialized reqt. cost drivers identified.</p>						<p>Detailed end-to-end value stream map cost model for major system components includes Materials, Labor, Equipment, Tooling/STE, setup, yield/scrap/rework, WIP, and capability/capacity constraints. Component simulations drive cost models.</p>	<p>Cost model inputs include design requirements, material specifications, tolerances, integrated master schedule, results of system/subsystem simulations and production relevant demonstrations.</p>	<p>Cost models updated with detailed designs and features, collected quality data, plant layouts and designs, obsolescence solutions.</p>	<p>Engineering cost model driven by detailed design and validated with data from relevant environment.</p>	<p>Actual cost model developed for FRP environment. Variability experiments conducted to show FRP impact, potential for continuous improvement.</p>	<p>Cost model validated against actual FRP cost.</p>
	<p>Sensitivity, Pareto analysis to find cost drivers and production representative scenario analysis to focus S&amp;T initiatives and address scale-up issues.</p>	<p>Material, manufacturing, and specialized reqt. costs identified for design concepts. Producibility cost risks assessed and manufacturing technology initiatives identified to reduce costs.</p>						<p>Current state analysis of cost of design choices, make/buy, capacity, process capability, sources, quality, key characteristics, yield/rate, and variability.</p>	<p>Cost analysis of mfg future states, design trades, supply chain/yield/rate/SDD/technology insertion plans. Allocate cost targets. Cost reduction and avoidance contract incentives identified.</p>	<p>Costs rolled up to system level and tracked against targets. Detailed trade studies and engineering change requests supported by cost estimates. Cost reduction efforts underway, incentives in place.</p>	<p>Cost analysis of proposed changes to requirements or configuration.</p>	<p>LRIP cost goals met, learning curve validated.</p>	<p>FRP cost goals met. Cost reduction initiatives ongoing.</p>
<p>Program/ projects have budget estimates for reaching MRL of 4.</p>	<p>Program has budget estimate for reaching MRL 5. All Risk Mitigation Plans required to raise deficient elements to MRL of 4 are fully funded.</p>	<p>Program has budget estimate for reaching MRL 6 by MS B. Estimate includes capital investment for Production-representative equipment. All Risk Mitigation Plans required to raise deficient elements to MRL of 5 are fully funded.</p>	<p>Program has budget estimate for reaching MRL 7 by CDR. All Risk Mitigation Plans required to raise deficient elements to MRL of 6 are fully funded.</p>	<p>Program has budget estimate for reaching MRL 8 by MS C. Estimate includes investment for Low Rate Initial Production. All Risk Mitigation Plans required to raise deficient sub systems to MRL of 7 are fully funded.</p>	<p>Program has budget estimate for reaching MRL 9 by the FRP decision point. Estimate includes investment for Full Rate Production. All Risk Mitigation Plans required to raise deficient sub systems to MRL of 8 are fully funded.</p>	<p>Program has budget estimate for lean implementation during FRP. All Risk Mitigation Plans required to improve deficient subsystems to MRL of 9 during FRP are fully funded.</p>	<p>Production budgets sufficient for production at required rates and schedule.</p>						





# Implementation: MRL/MRA Experience in Industry

- Industry Associations and companies are supportive of DoD Manufacturing Readiness efforts and support policy
  - Participated in [Three DoD-Industry Workshops](#)
- OEMs and Second Tier Suppliers are using the first or second generation definitions, published in the Technology Readiness Assessment Guide
- Many companies have developed their own manufacturing maturity measures.
  - Rockwell Collins Manufacturing Maturity Index
  - Sikorsky Production Readiness Index
- Other companies have adopted our MRLs, and are using them within the company's gated development process.
  - **Lockheed Martin Missiles and Fire Control**
  - **Raytheon (Tuscon)**
  - **Pratt & Whitney**
  - **General Electric Power Systems**
  - **Boeing (EMRLs for MDA, MRLs for FCS)**
  - **Goodrich**
  - ... [and the list is growing](#)



# Implementation: MRL/MRA Experience in DoD

- Air Force
  - MRAs completed on 21 [Air Force Advanced Technology Demonstrations](#) using the manufacturing readiness level (MRL) criteria; additional 12 are in process
  - Used MRL criteria to perform MRAs on [two ACAT 1 Programs](#)
- Army
  - Uses MRLs on [all 6.3 Programs](#) that have manufacturing or producibility issues tied to Army Technology Objectives- Manufacturing (ATO-M)
  - Army also uses MRLs and MRAs on selected [SBIR Projects](#)
  - Army to incorporate MRLs and MRAs into the management aspect of planned [Commercialization Pilot Program](#).
- MDA
  - Applies related scale (EMRLs) to [manage high risk prototype- production technologies](#).



# Implementation – Statute and Policy

- **Manufacturing Readiness Levels**

- Definitions and framework developed, socialized with industry, Services
- Criteria Matrix developed, piloted, revised, and posted (Version 6.5, April 2008)

- **Developed AT&L Policy**

- Coordinating with DAU on Defense Acquisition Guidebook Inputs
- Signed Policy triggers 5000 updates

- **Manufacturing Readiness Guidebook** – “Why” posted 2006

- **Manufacturing Readiness Deskbook** - “How”

- Piloted under AF
- Lessons Captured
- DoD MRA Deskbook Developed
- DoD MRA Deskbook Red Teamed
  - SOO/SOW language
- DoD MRA Deskbook – Post on DAU Website – April 2008

- **Coordination with TRA**

- Incorporated MRL into TRA Deskbook Revision – Appendix I
- Mapping MRA Deskbook to TRA Deskbook – Coordinating with OSD
- De-conflicting existing policies





# Summary

- Manufacturing is a core attribute for transition of Innovative Technology, particularly for affordability!
- There is an obvious need for pacing development and demonstration of manufacturing processes concurrent with technology.
  - Targets \$135B cost growth in Defense System Costs.
- DoD ManTech Program is shifting forward to include disruptive / high performance topics.
- Manufacturing Readiness Levels represent a stable, proven tool for tracking either a technology's or system's manufacturing maturity, and will be adopted by DoD Policy this year.



# Questions?

**Mark Gordon**  
**Mark.gordon@ncat.com**  
**813-899-4545**  
**<https://www.dodmantech.com>**

# ***Headquarters U.S. Air Force***

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*Integrity - Service - Excellence*

## **USAF Science, Technology & Transition**



**Presentation to  
NDIA S&E Conference  
16 April 2008**

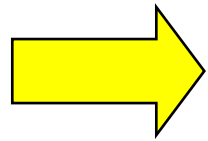
**Mr. Terry Jagers, SES  
Deputy Assistant Secretary  
(Science, Technology and Engineering)**

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# Agenda

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- **AF S&T Overview**
- **National Imperatives**
- **The AF Transition Program**
- **AF Transition Policy**
- **Summary**

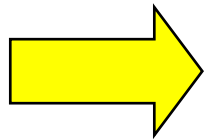


# AF S&T Overview

- AF executing \$1.7B core in FY08 with 2,200 Scientists & Engineers in 10 core technical areas
- FY09 budget on Hill is \$2.1B, increasing focus on:
  - AF Tech Vision
  - Basic Research
  - MANTECH
  - Cyber
  - Defensive Counterspace
  - Directed Energy
  - Revolutionary Propulsion
  - Thermal Management
  - Alternative Energy
  - Composites
  - Sense & Avoid for UAVs
- Improving Tech Transition is 1 of 5 guiding principles for AF S&T
  - SAE Commitment, OSD Initiatives, and JCTDs changes within AF
  - Organizing to align R&D development to 3 AF priorities, and tech transition efforts to 20-year AF roadmap
- Imperative for AF S&T tech transition to be synergized and leveraged with other tech transition efforts



- **AF S&T Overview**



- **National Imperatives**

- **The AF Transition Program**

- **AF Transition Policy**

- **Summary**



# Winning the Current War

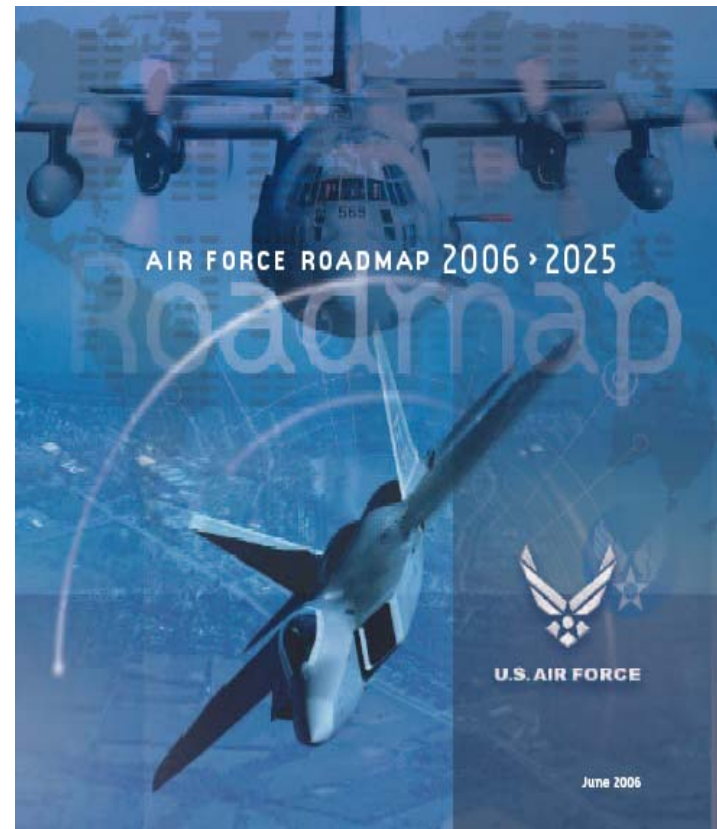
- The Nation must maintain technological superiority to win the GWOT
  - Winning the GWOT is the top priority of the AF
  - Terrorists exploit available technology faster than we can adapt and field ours
  - The AF leverages over \$200M per year in transition assistance programs aimed at rapid technology transfer
  - Effective transition of technology is needed to maintain technology superiority and win the GWOT



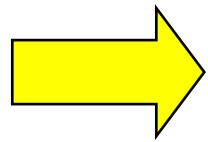


# Winning the Next War

- History has shown that Nations fail without modern militaries
  - Modernization is one of the top 3 priorities of the USAF, second only to GWOT and people
  - The AF has a 20-year modernization roadmap
  - The AF will spend over \$15B in non-system specific managed 6.3/6.4 tech development over next 20 years
  - Efficient transition of this technology is a key enabler to AF modernization success and National Security







- **AF S&T Overview**
- **National Imperatives**
- **The AF Transition Program**
- **AF Transition Policy**
- **Summary**



# AF Tech Transition Program

*Cohesive  
Tech Transition  
Policy (SAE)*

**R&D Strategic Plan**  
(AQR, AFMC & AFSPC)

**Development Planning**  
(AFMC, AFSPC)

**IRAD**  
(Industry)

**AC/JCTDs**  
(OSD & Various AF PEs, ~\$130M/yr)

**AF CSB**  
(Chief Eng)

**ManTech**  
(AQR PEM, PE0603680F, ~\$40M/yr)

**CP3**  
(AFRL  
S&T PEs,  
~\$5M/yr)

**Lifecycle Processes (D&SWS)**  
(SAE & AFMC/CC)

**WRAP**  
(AQX PEM, PE0203761F, \$15-30M/yr)

**RCO**  
(SAF/AQ)

**DAC**  
(AQP, Various PEs,  
~\$10M/yr)

**SII Fund**  
(SECAF)

**SBIR/STTR**  
(AF RDT&E PEs, ~\$370M/yr)

**AFRL ATDs**  
(S&T PEs, ~\$125M/yr)

**TTI, QRF, FCT, RR/NS, RRTO**  
(OSD & Various AF PEs, ~\$5M/yr)



# Agenda

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- **AF S&T Overview**
- **National Imperatives**
- **The AF Transition Program**
- ➔ ■ **AF Transition Policy**
- **Summary**



# AF Transition Policy

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- Tech transition office created on Air Staff to coordinate myriad of policy, processes & programs across AF
- Developing AF R&D policy for tech development *and* transition
- Key linkages to systems engineering policy for system developer insertion planning and corporate AF configuration control
- Policy recognizes differences in transition for air, space and cyber domains and adjusts for differences
- Tailored transition plans applied to achieve desired end-state for type of tech transition (to warfighter, to prime, to subtier) and life-cycle insertion point
- Tech transition requires risk identification, management, and acceptance by the customer and leadership

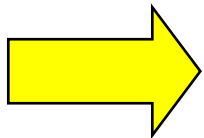
***Full spectrum of tech transition across the life-cycle including policy, people and resources***



# Agenda

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- **AF S&T Overview**
- **National Imperatives**
- **The AF Transition Program**
- **AF Transition Policy**
- **Summary**





# Summary

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- Technology transition is a key enabler to winning the GWOT, while preparing to fight and win the next war
- Technology transition program consists of multiple programs, processes and overarching policy
- Tech Transition office developing policy that aligns the right programs/processes to the right domain and end-state





# Transition Technology

---

- **Stand-up AF Technology Transition office**
- **Small Business Innovation Research (SBIR) Commercial Pilot Program (CPP) implementation**
- **Management/coordination of AF Joint Capability Technology Demonstrations (JCTDs)**
- **Policy for S&T Advanced Technology Demonstrations (ATDs)/ JCTD transition to acquisition**
- **Policy/coordination of lab urgent needs (Core Process 3) with AF Rapid Response Program**
- **Clearinghouse for Quick Reaction Funds, Technology Transition Initiatives, etc.**
- **Advanced development, prototyping, and risk reduction BA 4 initiative**





# Successful Transitions

---

- **Certified 50/50 blend of Fischer-Tropsch alternative fuel on B-52**
- **Provided PNT support to SOCOM Joint Precision Air Drop System**
- **Demonstrated Automated Air Refueling for ACC**
- **Completed all TACSAT-2 S&T experimental objectives for USSTRATCOM**
- **Transitioned Angel Fire into a USMC Operational Assessment for IED detection**
- **Deployed Spiral 2 of PANACIA to NASIC and the 480<sup>th</sup> MASINT Cell**
- **Inserted adaptive optics technology at Starfire and began transition to MSSS for AFSPC**
- **Successfully tested Focused Lethality Munitions technologies and transitioned to Small Diameter Bomb Program**

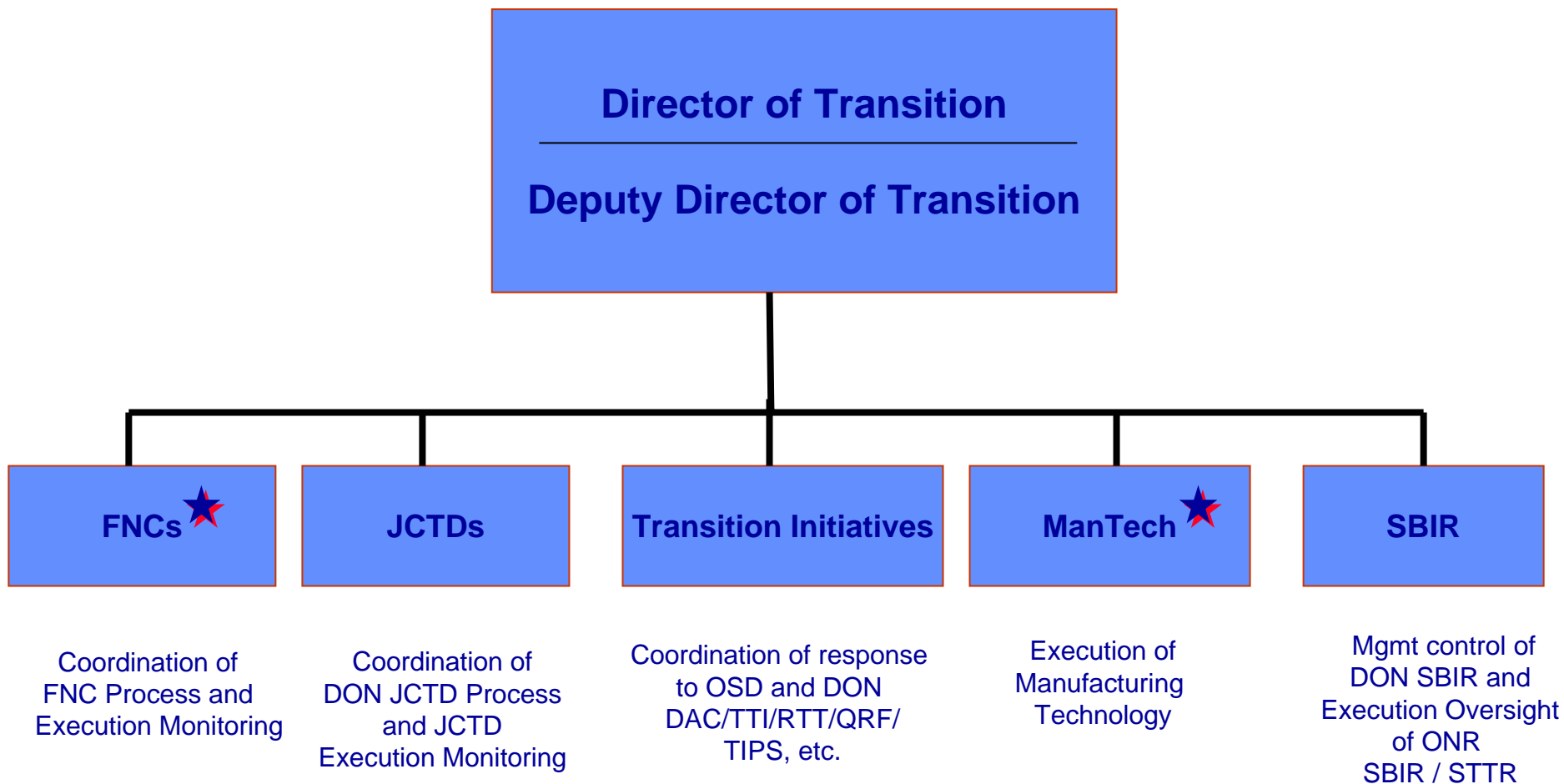
# Navy Manufacturing Technology and Affordability Programs



John Carney  
Director, Navy ManTech  
ONR 03T MT  
17 April 2008

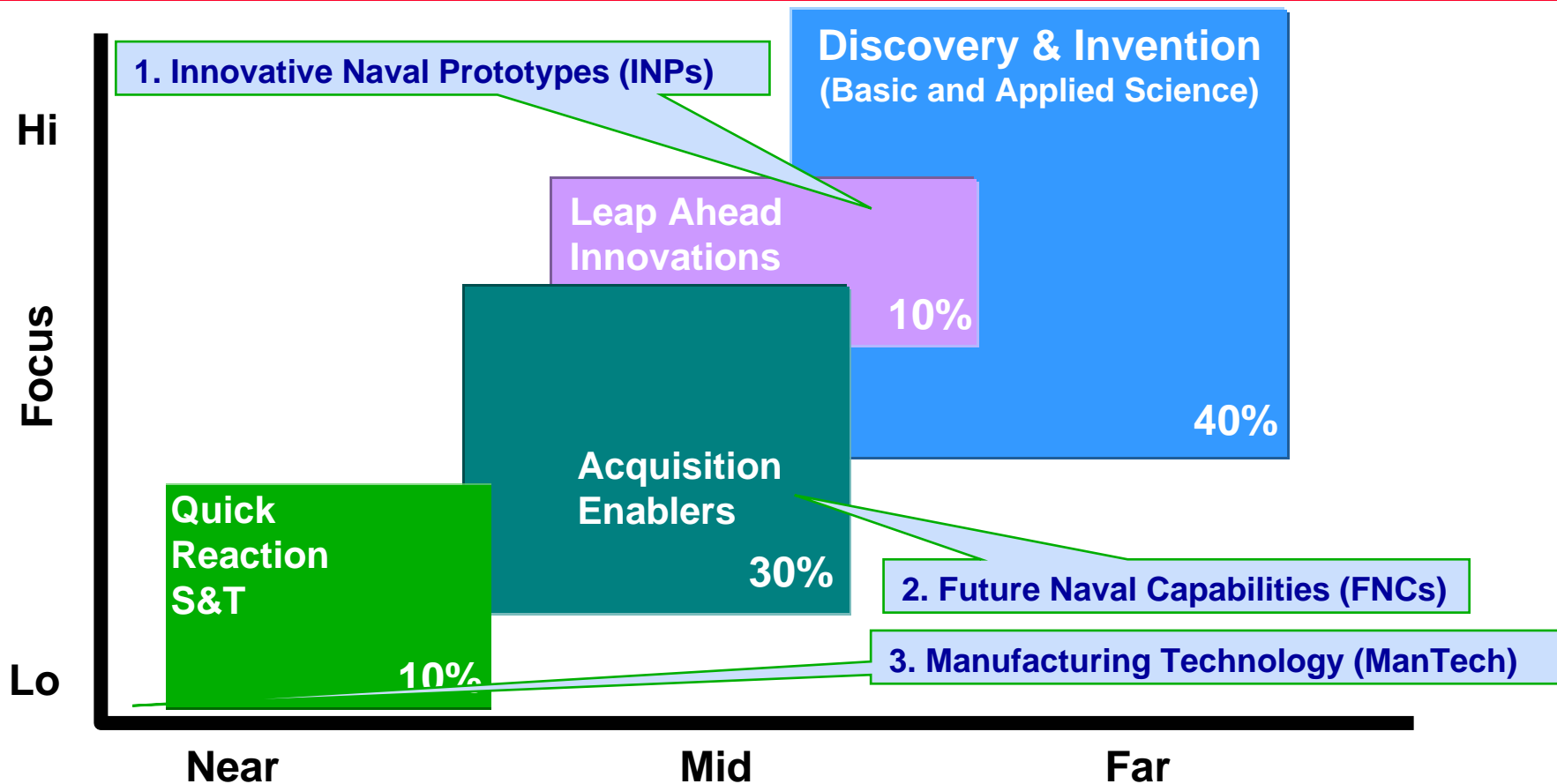


# Office of Naval Research 03T Organization





# Examples Addressing Manufacturing Early Cross ONR Spectrum



OSD Partnered / Quick Reaction S&T (\$223M, 12%)

Acquisition Enablers (\$655M, 36%)

Leap-ahead Innovations (\$197M, 11%)

Discovery & Invention (\$765M, 41%)



# Innovative Naval Prototypes (INP) Overview

- Investments planned with critical mass to achieve a level of maturity suitable for transition within 4-8 years
- Likely disruptive
- A primary goal is to move the risk from Acquisition (Billions of \$\$) back to S&T (Millions of \$\$)
- Higher technological risk than Future Naval Capabilities
- INPs are approved by the Navy Corporate Board (Assistant SecNav Research Development Acquisition, Vice Chief of Naval Operations, Assistant Commandant of the Marine Corps)
  - **INPs with a technology focus:**
    - Electromagnetic Rail Gun
    - Free Electron Laser
    - Integrated Topside
  - **INPs with a capability focus:**
    - PLUS
    - Seabasing
    - Tactical Satellite

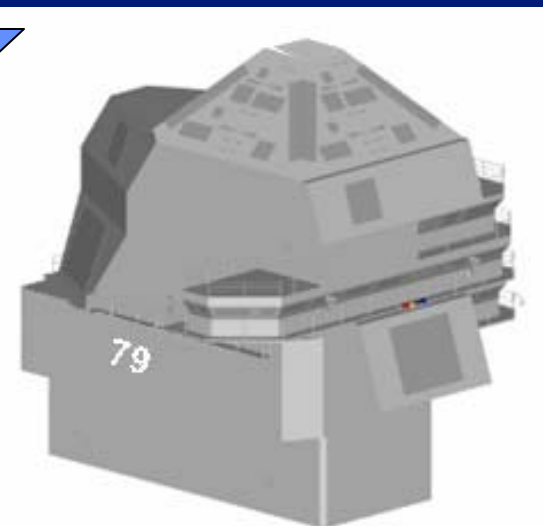
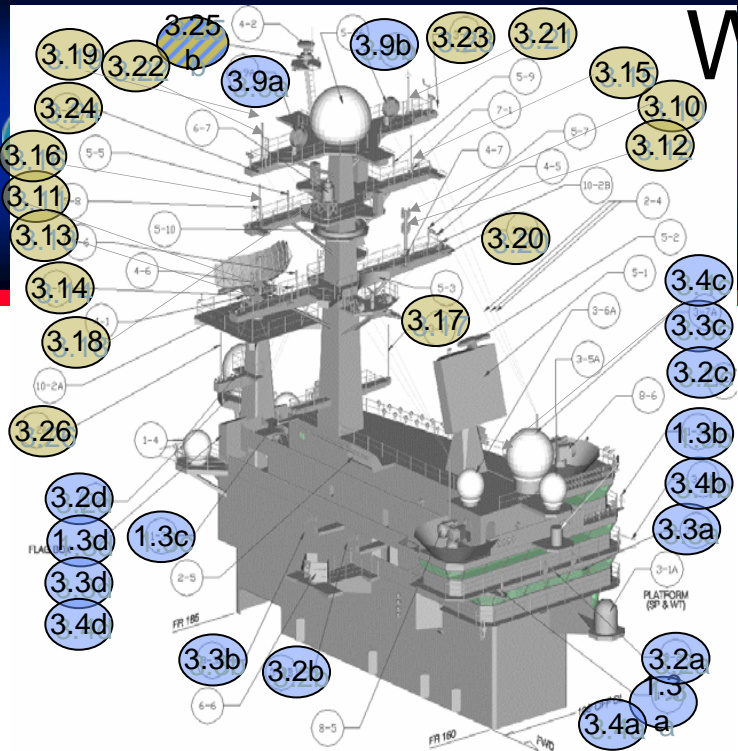


# Integrated Topside Vision

- **Dominate the RF spectrum**
- **Enable innovation through a RF Open Architecture (hardware and software)**
- **Create affordable systems that are scalable across platforms**



# What is Integrated Topside?



Current State of The Art	Integrated Topside
<b>Overcrowded</b>	<b>Combined apertures (multi-function, multi- beam)</b>
<b>Poor performance due to blockage and EMI</b>	<b>Optimally placed apertures, integration of RF functions to control EMI</b>
<b>Expensive to acquire and maintain</b>	<b>Reduced acquisition and total ownership cost</b>
<b>Significant Size, Weight and Power requirements (SWaP)</b>	<b>Significantly reduced SWaP</b>

RF functions simultaneously share apertures and signal processing  
 Topside continually optimized to meet highest priority needs



# Integrated Topside (INTOP) Objective

- **Develop and demonstrate an integrated, multi-function, multi-beam top-side aperture construct that has:**
  - **A scalable family of EW, RADAR (not high power) & communications capability to support multiple classes of ships**
  - **Modular open RF design (apertures and electronics) to facilitate best of breed technology and cost effective upgrades**
  - **Shared apertures for multiple functions**
  - **Software defined functionality**
  - **Cost effectiveness up front and over the life cycle**
  - **Increased operational capability**
  - **Spiral development to reduce risk and costs and have high probability for transition of technology to the fleet**





# Future Naval Capabilities (FNCs) Overview

- **The FNC Program:**
  - Composed of Enabling Capabilities (ECs) which develop and deliver quantifiable products (i.e., prototype systems, knowledge products, and technology improvements)
  - In response to validated requirements
  - For insertion into acquisition programs after meeting agreed upon exit criteria within five years
- **ECs**
  - Currently aligned with four of the pillars of Naval Power 21 (Sea Shield, Sea Strike, Sea Base, and FORCEnet)
  - Additional group for crosscutting technology improvements (Enterprise and Platform Enablers) for operations and maintenance cost savings

**Aligns requirements, acquisition, Fleet, and S&T Communities  
to increase impact of S&T investment**



# FNC Overview (cont)

## Keys to Transition

- S&T passes mature technology to acquisition into development and production programs
- Agreement must exist on the maturity and readiness at the stage this happens (Technology Transition Agreement or TTA)
- Key components agreed upon in a TTA:
  - Description of Product
  - Completion/Transition Year
  - Level of Risk (Technology Readiness Level)
  - Demonstration of TRL
  - Exit Criteria

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

### Annual Transition Assessment

FNC Product: K/Ka/Q-Band Phased Array								
<ul style="list-style-type: none"> <li>• <b>EC Number/Title:</b> FNT-FY04-08: Advanced Communication for FORCENet</li> <li>• <b>EC Manager:</b> Adrian Eley / 311 / 703 588 2812 / aleya@onr.navy.mil</li> <li>• <b>Gap Number/Title:</b> Gap 15 - Ubiquitous, Secure Communications and Network Infrastructure</li> <li>• <b>FY&amp; TRL Start - Stop:</b> FY03 (TRL 3) - FY05 (TRL 6)</li> <li>• <b>Acquisition Program:</b> SSN 600 and Trident Modernization, PEO C4I and Space, PMW 173, Ruth Youngs Law</li> <li>• <b>Resource Sponsor:</b> N77 and N76/DOO Design Agent (Raytheon)</li> <li>• <b>Transition Status:</b> Signed TTA PMW 173 Transition FY05</li> <li>• <b>Deliverables:</b> Ka/Q-band transmit arrays, K-band Receive Array design utilized by OXX</li> </ul>							<b>Assessment</b> Cost <span style="color: green;">●</span> Schedule <span style="color: green;">●</span> Technical <span style="color: red;">●</span> Transition <span style="color: red;">●</span>	
	<b>Funding</b>	<b>PE Number</b>	<b>FY05</b>	<b>FY06</b>	<b>FY07</b>	<b>FY08</b>	<b>FY10</b>	<b>FY11</b>
S&T # 3-6.3			\$2,500					
		00W313V Project X0740	\$10.1M	\$16.7M	\$34.0M	\$14.0M	\$13.9M	
<b>Transition (\$46.5)</b>								
<b>Comments/Issues</b> - Both the K and Q band arrays had technical difficulties which required schedule slip, resulting in a yellow score above. - There are two major risks for the Q band array: cost and performance. However, Q band arrays can be developed at cost less than \$100 million, successful transition of K&Q band arrays, utilization on program. - Both the K and Q band arrays are under for production. Schedule and cost design are being used for AICAD program.								
<b>*S&amp;T Cost/Schedule/Technical</b>				<b>*Transition</b>				
Green: S&T On Track for Delivery				Green: Adequate Funds Programmed				
Yellow: Identified Delivery Issues/Risk but Manageable				Yellow: Funds Planned/PT Committed				
Red: S&T Delivery Unlikely or at High Risk				Red: No Funding Plan				
* Requires recommendation on continuation in comments box.								

Transition is the responsibility of all stakeholders



# FNC Project Highlight

## Affordable Common Radar Architecture

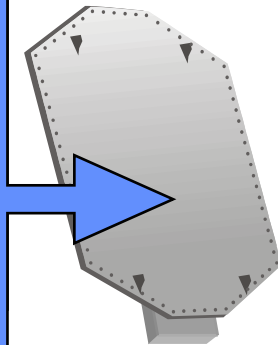


### Objectives

- Common scalable architecture for:
  - USMC HELRASR/USAF KMDS
  - Integrated SPN-43, SPS-48, SPS-49 retrofit.
- Emphasize scalability and open architecture for procurement and life cycle affordability

### S&T Design Issues

- Affordable OA core relevant to afloat & expeditionary systems
- Extended reliability by design
- Address permanent and near-land use prohibitions from spectrum loss
- Address mid-latitude ducting limitations
- Fixed or rotator TBD depending upon procurement and life-cycle costs
  - If rotator, address Doppler resolution limitations
- ECCM
- High resolution for NCID and closely spaced objects
- Affordable scalable architecture meeting joint needs



### Budget (\$M)

	FY09	FY10	FY11	FY12	FY13	Total
ACRA	2.75	7.26	8.25	5.39	3.3	26.95

**AFFORDABLE, RELIABLE, MOBILE**



# Manufacturing Technology (ManTech) Overview

- **Mission:**

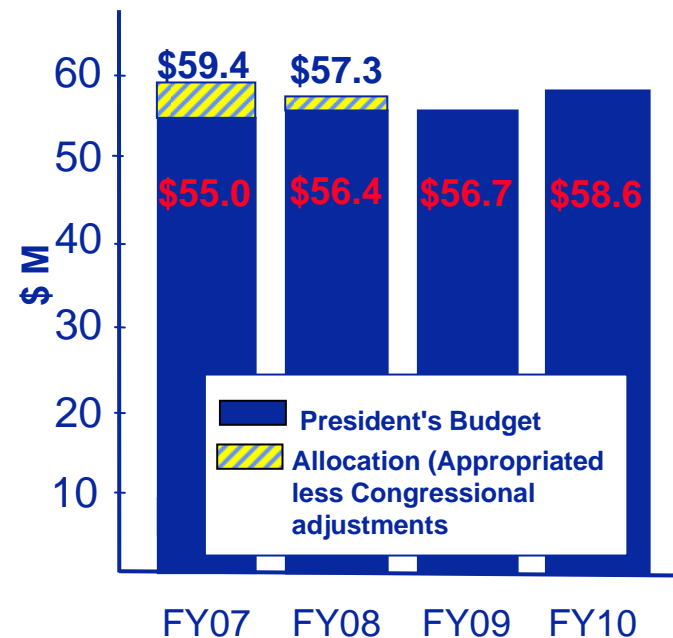
- Develop enabling manufacturing technology -- new processes and equipment -- for implementation on DoD weapon system production lines
- DoD 4200.15 states investments should:
  - Transition emerging S&T results to acquisition programs
  - Improve industrial capabilities in production, maintenance, repair 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



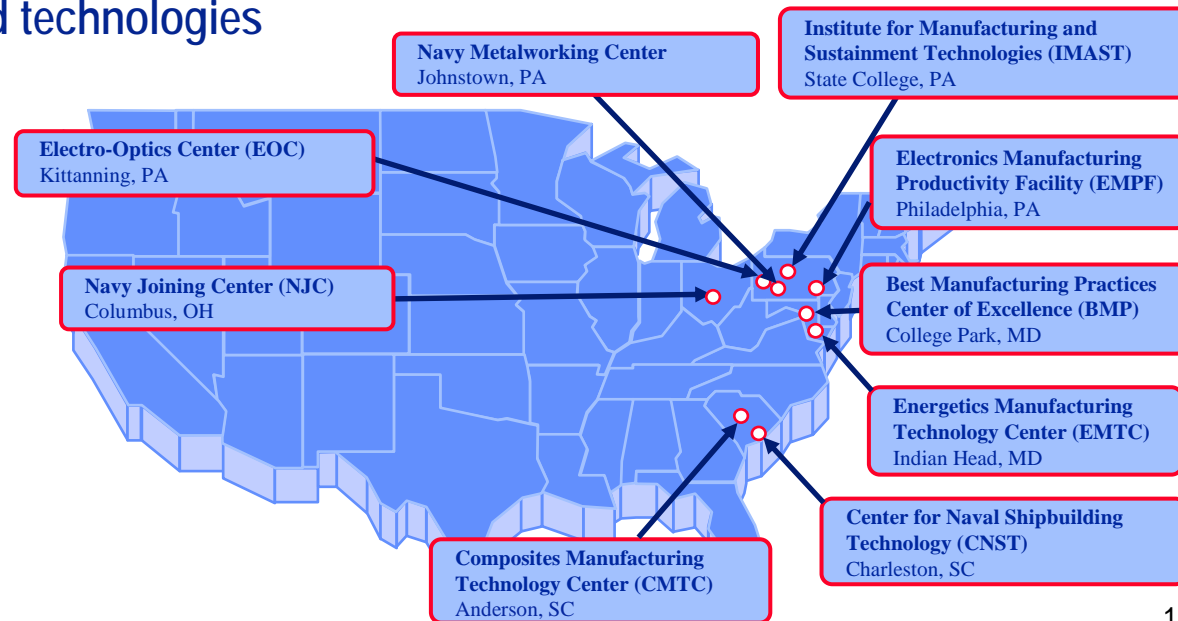


# ManTech Overview (cont)

## Execution

Navy ManTech is executed through nine Centers of Excellence (COEs):

- Execute projects; manage project teams
- Serve as corporate expertise in technological areas
- Collaborate with acquisition program offices / industry to identify and resolve mfg issues
- Develop and demo mfg technology solutions for identified Navy requirements
- Provide consulting services to Naval industrial activities and industry
- Facilitate transfer of developed technologies





# ManTech Overview (cont)

## FY09 Investment Strategy

- **Focused Shipbuilding Affordability Initiatives**
  - Concentrate resources on few high priority naval platforms for maximum benefit
  - Working with Program Offices and industry to select and execute projects to reduce acquisition cost
  - Acquisition Program Office prioritizes projects for platform portfolio
  - Platform IPTs oversee platform portfolios (ONR, COEs, Program Office, industry)

### Primary Emphasis - Affordability



PEO (Ships)  
DDG 1000



PEO (Carriers)  
CVN 21



PEO (Ships)  
LCS



PEO (Subs)  
SSN



PEO (Ships)  
LPD 17  
DDG 51



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



PEO (IWS)  
Missiles  
Weapons  
Munitions



PEO (W)  
N-UCAS





# LCS Build Strategy (LCS)

- **LCS Program Office asked ManTech for suggestions for improving acquisition process for Littoral Combat Ships**
  - Recommendation - LCS bidders be required to include a Build Strategy in proposal
- **LCS Program Office agreed and requested that ManTech develop -**
  1. Draft build strategy requirements that could be included in the LCS solicitation and
  2. Evaluation criteria that the Navy could use to assess strategies submitted
- **CNST teamed with First Marine International (internationally recognized leader in providing specialist services to marine industry) to develop requested documents**
  - Delivered to ONR and **forwarded to LCS Program Office on 10 Jan 08**

## Build Strategy should:

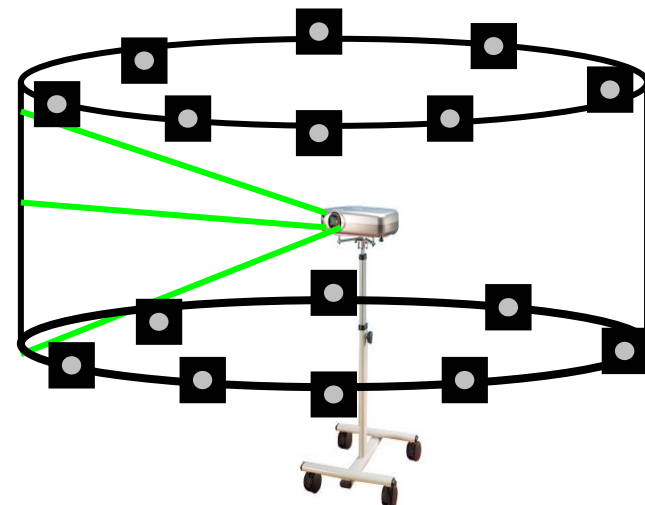
- Describe how the ship is going to be built:
  - Block and unit definition
  - Outfit module definition
  - Interim product definition
  - Assembly methods and processes
- Demonstrate that there are sufficient resources to the build the vessel as described:
  - Labor, facilities and infrastructure
- Demonstrate that the shipyard has the capability to carry out project as proposed:
  - Realistic schedule
  - Alignment of resources to schedule
  - Material acquisition plan
- Describe overall plan:
  - From principal product breakdown and supply chain plans to test and commissioning plans

Done properly, build strategies will reduce cost by matching the production approach to the shipyard process capabilities and will reduce risk to Navy and industry



# ManTech Project Highlight Laser Image Projection (VCS)

- **Goal:** Automate the layout of attachments during early outfitting
- **Benefits:**
  - Automate layout process
  - Eliminate paper templates and string measurements wherever possible
- **Background:**
  - Technology made possible by EB's One-Stop tool, developed under CNST's Product Centric project
  - One-Stop enables extraction of attachment data from EB's 3-D Product Model
- **Impact**
  - Partially implemented on Hull 781 (8 cylinders)
    - ~2000 hangers (~4000 studs) for Electrical & HVAC attachments
    - 2,910 hours saved (**~84% savings**) on partial use
    - \$650,000 saved per hull (conservatively estimated at \$65/hour)
    - **Project cost (\$622K) re-couped in one hull**
    - Additional application being evaluated



• Retro-reflective targets placed on already marked ship's grid system points can be used to position projection system.



Projector marks center-point location of stud (green laser light dot). Technician punch-marks & labels attachment point on face of frame flange.





# ManTech Project Highlight HSLA-115 Eval / Implementation (CVN)

## • Background:

- CVN 78 requires improved performance and higher strength for reducing weight and to meet application requirements
- Implement HSLA-115 at higher strength level and acceptable protection, toughness, welding and structural performance for weight reduction and increased factors of safety

## • Payoff:

- Potential weight savings of 100 - 200 long tons per hull for one application
- Cost neutral to \$1M savings impact anticipated
- Reduced top-side weight, lower center of gravity 0.2-ft
- Potential for additional future applications that require high strength and toughness

## • Achievements:

- NAVSEA / PMS 378 issued official letter to NGNN approving the use of HSLA-115 in baseline design and requiring successful completion of this project
- NNS Management and Technical Review Board (TRB) officially approved incorporation of HSLA-115 into CVN 78 design (2 Nov 2007)

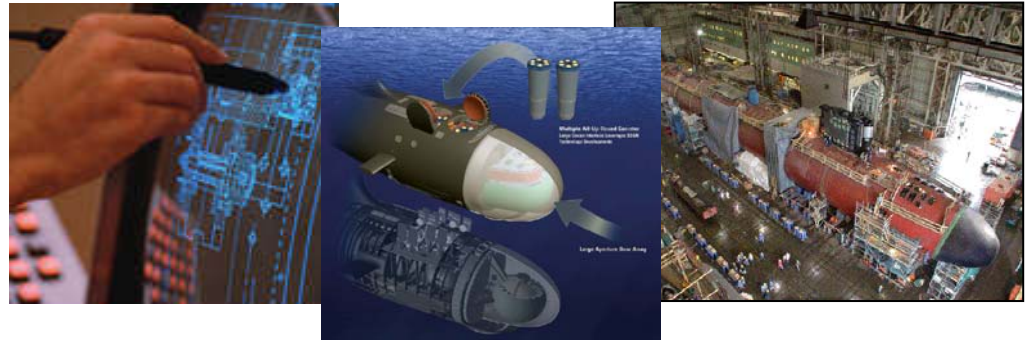




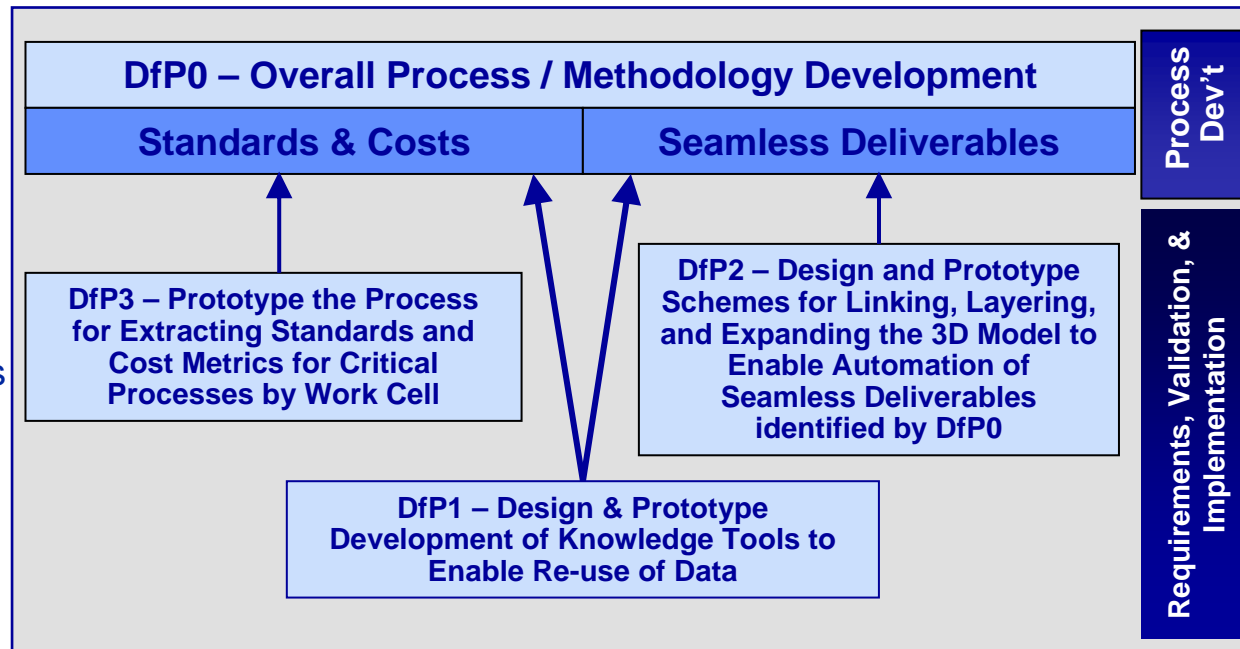
# ManTech Project Highlight

## Design for Production (DfP) Projects (VCS)

- **Goal:** Develop and implement Design for Production (DfP) techniques for VIRGINIA Class submarine construction cost reduction
- **Background:**
  - 4 inter-related DfP projects at Electric Boat
- **Payoff:**
  - Reduced design costs
  - Improved configuration management
  - Ability to consider design alternatives based on mfg costs
  - Standardized best mfg practices for re-use in design
  - Improved build sequencing
  - Reduced construction costs
  - **Total est. cost savings of \$4.8M/hull**



Identifying design / process drivers to reduce construction costs





# Summary

- **Affordability is a key Navy theme**
- **Navy Science and Technology programs starting to address affordability and manufacturability**
- **Affordability needs to be addressed while developing next generation capability**
  - Affordability as part of the technology development concept (open systems, modular)
  - Difficult to insert affordability once technology has been developed
- **Navy ManTech addressing shipbuilding affordability**
  - High return on investment from areas such as Design for Production and Outfitting Process Improvement

***Deputy Under Secretary  
of Defense***

***Advanced Systems &  
Concepts***

~

***9th Annual Science  
& Engineering Conference***

~

***The Advanced Systems  
and Concepts Portfolio  
of Opportunities***

~

**OSD/AT&L/DDR&E/AS&C**

**UNCLASSIFIED**



***John J. Kubricky***

***DUSD(AS&C)***

***15 April 2008***

**UNCLASSIFIED**



# OSD/AT&L/DDR&E/AS&C Mission

OSD/Advanced Systems & Concepts



- **Find, Integrate, Demonstrate, and Transition** operational concepts and technologies for **multi-Service, Joint & Coalition Warfare Needs**
- Leverage RDT&E Defense-wide resources through partnerships with Services and Agencies to meet the **Most Critical Needs** of the joint warfighter as defined by **Combatant Commanders (COCOMs)**
- **Induct Innovative Technologies** inside the traditional Planning, Programming, Budgeting, and Execution (PPBE) process that result in an enduring **Capabilities-based Portfolio** to defeat asymmetric threats

*Thrusts: Agile, Adaptive, Affordable, Relevant, Urgent, Enduring, Transition*





# How Advanced Systems & Concepts Functions

OSD/Advanced Systems & Concepts

- **Multi-Service Needs-Driven**
  - Monthly meetings with COCOMs - Progress on Deliverables
  - Frequent meetings with Intel Community
  - Participation in JCIDS and in JS/StratCom/DDR&E-sponsored studies
- **Technological Awareness**
  - Formal searches, pursuits and harvests of specified critical technologies
  - Briefings from industry (Domestic and International)
  - Intimate with technology development and assessment organizations
    - Services, Agencies, Intel Community, DHS, DOE, etc.
- **Program Oversight**
  - Organize, vet, select, and defend programs and projects
  - Validated Service and CoCom Priorities; IPLs and Most Pressing Needs
  - Wholly or partially funding projects – a core function
  - Closely monitor program and project execution
- **Transitioning Capabilities and Transferring Technologies**
  - Identify transfer and transition partners, pathways, PORs and POMs
  - Oversee transition process and progress; stimulate as necessary
  - Fund select game-changing technology enablers and transformation



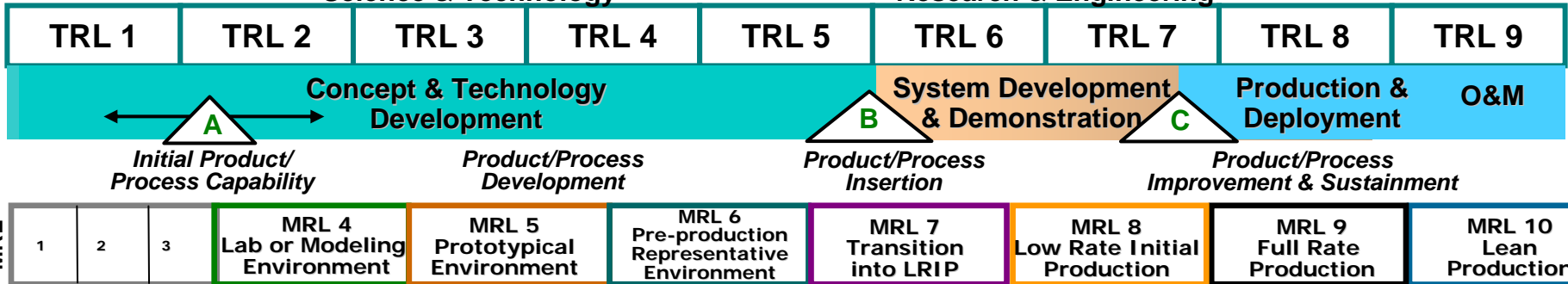
# Advanced Systems & Concepts Portfolio

OSD/Advanced Systems & Concepts

6.1                      6.2                      6.3                      6.4                      6.5                      6.7                      Proc                      O&M

Science & Technology

Research & Engineering



**COCOM /Joint/Coalition focused**

**Joint Capability Technology Demonstrations**

**Demo 1-3 yrs**

**AC/JCTDs Transition Enabler – “joint peculiar” capabilities**

**JCTD Transition & DAE Pilot Program**

**Industry “On” Ramp – Test to Procure Tech Refresh**

**Defense Acquisition Challenge**

**Service, SOCOM Nominated - Test to Procure**

**Foreign Comparative Testing**

**DOD S&T Push**

**Tech Transition Initiative**

**DoD Technology Transfer**

**Formerly TechLink**

**to Private Sector**

**Domestic Technologies Critical to National Security**

**Defense Production Act (Title III)**

**ManTech Joint Investments**

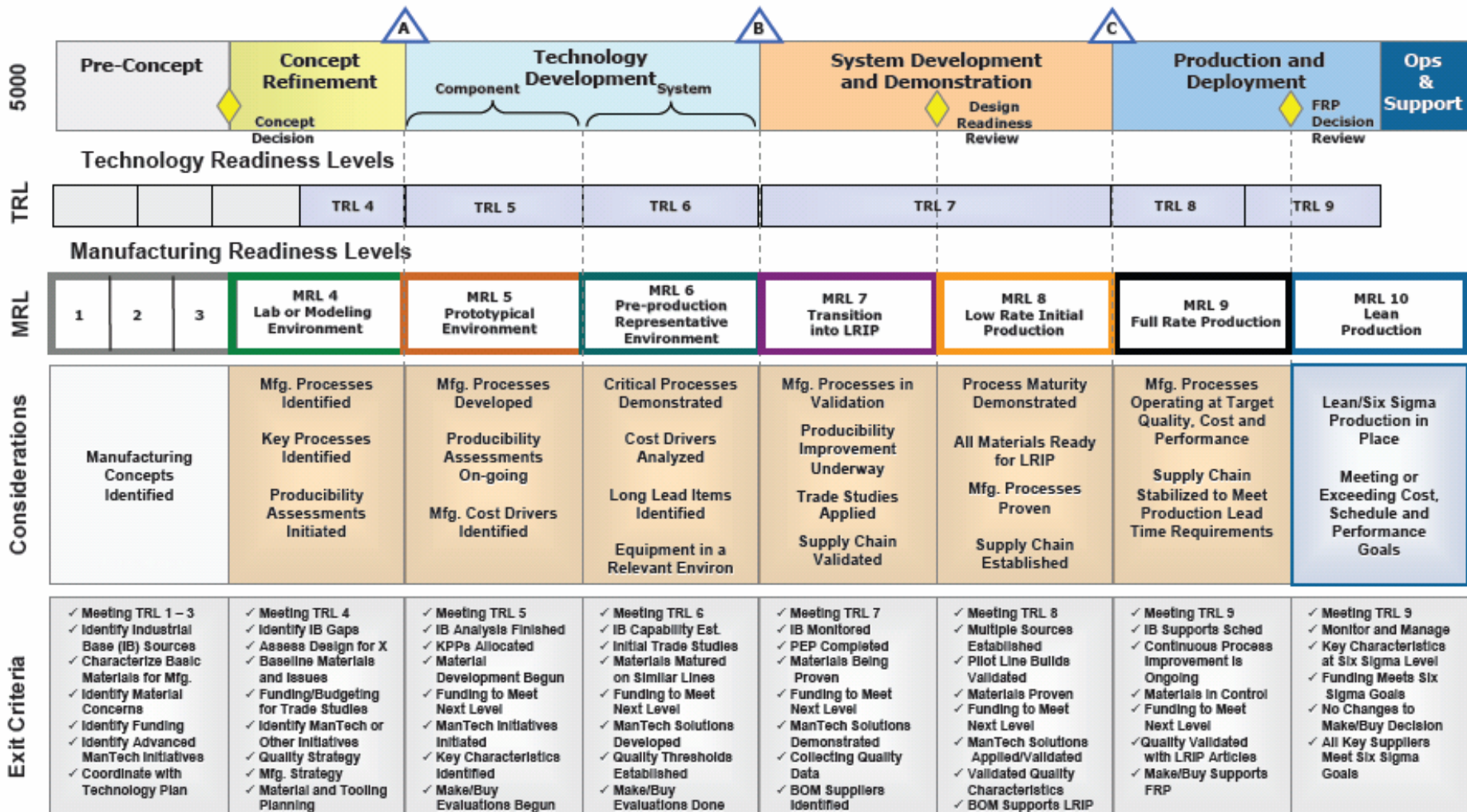
**Defense Manufacturing Technology – Next-Gen Multi-Service Enablers**



# MRLs - - a Technology Transition Risk Reducer

OSD/Advanced Systems & Concepts

## Manufacturing Readiness Levels







# FY08 Emerging Defense-Wide ManTech Initiatives

OSD/Advanced Systems & Concepts

## Current D-ManTech Program Drives 6 New Initiatives (examples):

- **Ceramic Matrix Composites Manufacturing Initiative:** to reduce cost and establish manufacturing technologies needed to develop and sustain advanced turbine engines
- **System-on-Chip Manufacturing Initiative:** advance manufacturing processes for packaging of system-on-chip systems; initial applications in communication and precision guided weapons
- **Prosthetics and Orthotics Manufacturing Initiative:** to integrate advanced manufacturing processes and materials that result in custom composite orthotics and prosthetics for wounded warrior amputees

## Out-year and Potential FY08 D-wide ManTech Rolling Starts:

- **Identify/transition advanced manufacturing processes/technologies** to create significant productivity/efficiency in defense manufacturing base
- Radically alter defense industrial base through “disruptive” manufacturing
- Examples: solder-free electronics, advanced fixed and rotary wing aircraft structures, ballistic protection, conformal load bearing antennas

# Defense Acquisition Challenge (DAC)...

## ...DoD's On-Ramp to Industry



### OSD/Advanced Systems & Concepts

#### • Scope:

- Allows anyone to propose innovations that could quickly improve -
  - ✓ Affordability, manufacturability, performance, or capabilities at a system, subsystem or component level
- Competitive: Annual BAA in Federal Business opportunities and unsolicited proposals
- Proposals “challenge” existing technology
  - ✓ Evaluated for merit & feasibility
  - ✓ If testing successful, innovations inserted into a program of record
  - ✓ Provides industry entry into DoD acquisition

#### • Metrics & Measures

- Over 1200 proposals submitted
- 68 projects awarded & ongoing
- 70 companies from 26 states
- 70% are small / medium enterprise technology providers
- ROI (14 completed projects) is > 9:1

**Spray Cool Technology: Electronics Sprayed with Non-Corrosive Coolant in a Hermetically Sealed Housing**



**Before SprayCool: 482 Pounds & 17 Cubic feet**





**After SprayCool: 100 Pounds & 2.6 Cubic feet**

Employed in Counter Targeting System - Part of OVERWATCH ACTD  
4 units deployed to Iraq

**Mini Combat Trauma Patient Simulation System: Training medics at Camp Pendleton**



Casualty simulator improves skills of medical personnel in mass casualty & triage - over 3500 medics trained & deployed to Iraq; attrition rate of trainees reduced from over 20% to 6%

**Enhanced Performance Location Report System Tactical Data Network: Replaces manual network planning with automated system**

Reduces complexity and need for manpower redundancy, deployed to 900 users (MEF II) in Iraq, enabling rapid and accurate information flow and data priority on the joint/coalition battlefield



# CTO\* FY08 Emerging Opportunities

## Defense Acquisition Challenge (DAC) Program



OSD/Advanced Systems & Concepts

**Current DAC (Examples) - - Supports 13 continuing projects (\$13M)**

- ***Omni-directional Antenna for M156 Magneto-Inductive Remote Activation Munition System (MI-RAMS)***...Test 3-Axis Antenna for Army/SOF MI-RAMS allows placement of demolition charges and their initiator in any attitude (vice vertical only)
- ***Mobile IP Interface to Tactical Data Links (TDL)***..Test TDL to enable uninterrupted and real-time coordination/re-tasking of combat missions, challenging current system that requires manual reconfiguration
- ***Sinuuous Spiral Antenna for AN/ALQ211 EW System*** ...Test antenna candidate that may enable warfighter to better identify enemy transmission signals, improving threat geo-location and threat detection and defeat in all aircraft attitudes

**Out-year / Potential DACs: Estimate 8 to 12 new start FY09 projects (\$15M)**

- **Address warfighter operational issues / functional capabilities (effectiveness, employment, survivability, force protection, and/or sustainability)**
  - How: 'Challenge' existing legacy systems/equipment by testing mature technology for use in acquisition programs-of-record
  - Examples: Improved medical trauma simulation equipment; rapid armor or composites repair kits at unit level; better chemical / biological protective clothing; improved, lighter-weight, longer-lasting sources of power

\*Comparative Testing Office

# Foreign Comparative Testing (FCT)...

## ...the search for world-class technologies



OSD/Advanced Systems & Concepts

### • Scope:

- Seeks international technologies for US warfighting needs
- Leverages mature technologies for economic/speedy buys
- Provides US Forces with new capabilities
- Technologies assessed for use, bought from foreign source or manufactured under license in US



UK system can refuel two aircraft at once, avoiding \$40 million in R&D

### • Program Measures & Metrics (1980-2007)

- OSD investment of \$1.1B has avoided \$7B in costs
- 567 projects started, 488 completed, 266 met test req's
- 184 projects resulted in procurements worth about \$8B
- Accelerated fielding averaging 5–7 years
- Participation from 27 allied and coalition partners
- Vendor partnerships in 33 U.S. states
- Past 5 years: Transition rate from test-to-procure > 80%



South-African developed Buffalo mine clearing vehicle probing & clearing mines & IEDs in Iraq



Russian erosion-resistant coating triples life of compressor blades in MH-53 helicopter, avoiding \$1.6 million annually



Korean fiber optic mesh detects breaks and enhances perimeter security



Italian venture, the Joint Service Combat Shotgun, used in Iraq as a "door-buster"



Swedish bunker buster system fired from confined spaces, used in Afghanistan and Iraq



# CTO\* FY08 Emerging Opportunities

## Foreign Comparative Testing (FCT) Program



OSD/Advanced Systems & Concepts

### Current FCTs (Examples) - - Supports 12 continuing projects (\$17M)

- ***Fire Control System for SOF Combat Assault Rifle (SCAR) Grenade Launcher***  
- Test fire control and ammunition programming systems for enhanced grenade launch module for SCAR, improving range and suppressing hostile fire and other threats
- ***A/C Arresting System for F-22 and JSF*** - Test computer-controlled caliper-disk aircraft arresting system that increases functionality and capability to arrest both heavy aircraft and lightweight fighters
- ***Advanced Airborne Expendable Infrared Countermeasures (IRCM)*** - Test the effectiveness of expendable IR countermeasures to counter emerging advanced infrared Man-Portable Air Defense Systems

### Out-year / Potential FCTs - - Support 8 to 12 new start FY09 projects (\$16M)

- **Address warfighter operational issues / functional capabilities (effectiveness, employment, survivability, force protection, and/or sustainability)**
  - How: Test mature, non-development allied equipment and technology for use in acquisition programs-of-record
  - Examples: Light-weight, high-energy density batteries; health monitoring systems; improved active and passive armor protection; real-time, persistent surveillance

\*Comparative Testing Office



# The Technology Transition Initiative (TTI)

OSD/Advanced Systems & Concepts

## ➤ Objectives

- Accelerate transition of new technologies from DoD S&T programs into acquisition for production and deployment to US Armed Forces
- Demonstrate new technologies in relevant environments

## ➤ Partners and Processes

- Technology Transition Council
- Technology Transition Working Group

### Countermeasures Protection System



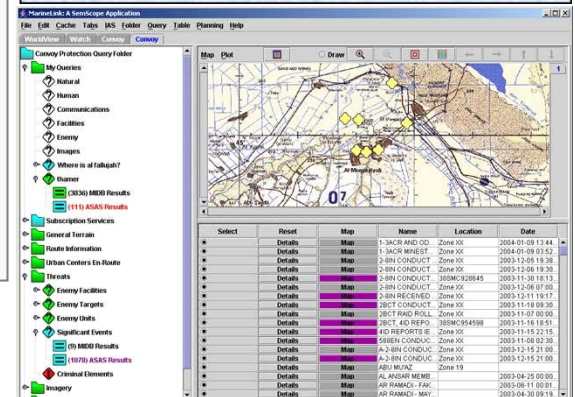
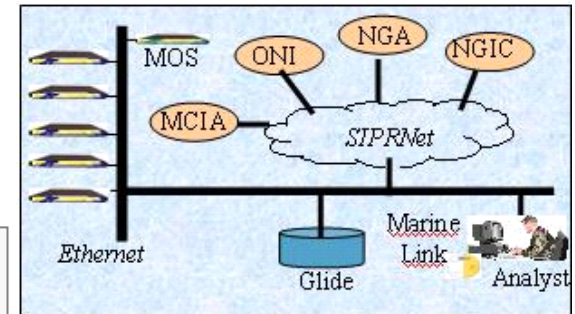
- Improves force protection against radio-controlled IEDs
- Deployed in GWOT

### Water Purification Pen



- Eliminates risk of exposure to diseases and bio-chemical pollutants
- Deployed in IRAQ with each of the Services
- Sent as part of Tsunami relief effort in S.E. Asia

### Semantic Web Network



- Incorporated into Marine Link
- Deployed w/1st and 2d MEF in Iraq
- Saves Analyst 4-5 hours per manual query



# Technology Transfer Programs

OSD/Advanced Systems & Concepts

## ➤ Objectives

- Ensure full use of the Nation's investment in R&D (15 USC 3710)
- Rapidly enhance warfighter capabilities via technology exploitation

## ➤ Benefits

- Clear path from DoD S&T to application of technology
- Commercial source for DoD items using DoD-developed technologies
- Speed to deployment and cost-saving advantages

## ➤ Partners

- US Industry (as opposed to contractual relationship)
- Funds to support joint R&D efforts (funds from CRADAs)
- Royalties on licensed inventions to reward inventors and perform R&D





# FY08 Technology Transfer & Transition Initiatives

OSD/Advanced Systems & Concepts

## Current TTI Projects (Examples): 12 continuing projects (\$20M)

- ***Accelerate Extremely Insensitive Detonating Substances (EIDS) and Insensitive Munitions (IM) Solution in 155mm Artillery Ammunition:*** Greater soldier survivability and reduced ammo storage/relocation detonation risk while retaining weapon lethality
- ***Improved Heating Technology (IHT) for the Unitized Group Ration:*** Self-heating group ration that sustains warfighters in remote, austere locations
- ***Joint Service General Purpose Mask (JSGPM) Filter End-of-Service-Life Indicator:*** \$10M/yr savings in reducing unnecessary filter exchanges
- ***Solid State Laser Igniter for Artillery Applications:*** Safer, cheaper, more reliable means of firing 155mm artillery
- ***Tactical Idle Reduction Equipment for Heavy Tactical Vehicles:*** Saves 15M gallons/year in fuel with associated reduced fuel convoy personnel risks

## Out-year/Potential TTI Projects: 6 to 8 new start FY09 projects (\$10M)

Focus on TTI projects that enable affordable and decisive military superiority

- Address the following high-level mission areas: Battlespace Awareness; Stability of Operations; Cultural Awareness; Force Management; Command, Control and Information Management; Net-Centric Operations; Protection; Joint Training; Tailored Force Application





# FY08 Defense Production Act Title III Initiatives

OSD/Advanced Systems & Concepts

## Current DPA/T3s:

**Atomic Layer Deposition Hermetic Coatings:** ...domestic ALD for electronic components; transition to fabrication process for DDG-1000.

**ALON/ Spinel:**...domestic source of durable ceramics for transparent armor and apertures used in IR equipment and ballistic windows.

**Beryllium Production:** :...domestic source of high purity beryllium for defense sensors, missiles and satellites, avionics, weapon applications.

**Boron Fiber:** ...modernizing manufacturing processes of sole domestic source of boron fiber.

**Coal-based Carbon Foam:** ...establishing high-volume production for carbon foam materials in light weight tooling & non-structural components.

**Reactive Plastic CO2 Absorbent:** ...expanding production of reactive plastic CO2 absorbent to reduce hazards/increase diver mission duration.

**Lithium Ion Batteries for Space:**...long-life cells for space systems using assured domestically produced materials.

**Military Lens Systems:** ...advanced optics for multi-spectral fused imagery.



# FY08 Defense Production Act Title III Initiatives

OSD/Advanced Systems & Concepts

## Emerging/Imminent DPA/T3s:

**Armstrong Titanium Production** ...project aims to develop capabilities that lead to domestic production of low-cost titanium (**RFP in-process**).

**Methanol Fuel Cells:** ...components for soldier-portable equipment power.

**SWORDS Safety Confirmation Testing and Production** ...establish capability to produce a modified robotic system for confirmation testing.

**Life Cycle Support Center for Unmanned Systems** ...expanded capacity to support unmanned systems upgrade and repair for DoD and first responders.

**Light-Weight Ammunition & Armor**...establish production capacity for rigid polymer ammo cartridges to reduce weight for warfighters and transportation.

## Out-year/Potential DPA/T3s:

### **Gallium Nitride (GaN) Radar Monolithic Microwave Integrated Circuits**

S-Band radar: affordable production capability for GaN MMICs on SiC (fy09)

X-Band radar: affordable production capability for GaN MMICs on SiC (fy10)



# Joint Capability Technology Demonstrations

OSD/Advanced Systems & Concepts

- Enable Combatant Commanders to fill seams and gaps in core warfighting capabilities...particularly multi-Service operations
- Deliver new and *relevant* technology to warfighters *quickly*
  - *The JCT Demonstration Program is not a procurement program*
  - *JCTDs provide options that can lead to accelerated procurement*
- Overcome resistance to transformational concepts (eg, tech risk)
- Integrate technology, joint doctrine and coalition operations
- Chartered to bypass delays in fielding innovative capabilities...  
...requires Transition Planning upfront.

*A Deliberate Technology Transition Strategy is Required to Begin a JCTD*

# *JCTDs are not developmental projects...*

- ~~Development~~ (Integrate to Demonstrate)

...JCTDs integrate, demonstrate and deliver new capabilities for urgent COCOM needs within 1 - 3 years and become enduring warfighter resources.

- Adaptation, Modification, Refinement, Prototype, Tech Insertion, Improvement, Revision, etc. to enable Joint, Coalition or multi-Service operations

JCTDs apply, integrate, prototype, modify, adapt and deliver new capabilities to satisfy validated COCOM urgent needs.



# FY08+ JCTD Initiatives & Emerging Opportunities

OSD/Advanced Systems & Concepts

## Current JCTDs:

***Communications Air-Borne Layer Expansion (CABLE) (STRATCOM/USAF):***

Airborne communications backbone network for IP-based, high capacity data transfer with secure gateways to interconnect data links and voice

***Joint Force Protection Advanced Security System (JFPASS) (STRATCOM / USN / USAF):*** Integrated system protects expeditionary military installations

***Hard Target Void Sensing Fuze (HTVS) (STRATCOM / USAF):*** Competitive prototype of survivable, void sensing fuze to destroy deeply buried targets

***Shadow Harvest (SOUTHCOM / USAF):*** Demonstrate a rapidly configurable non-traditional ISR pod on a C-130 aircraft to find obscured targets

## Out-year/Potential JCTDs:

***Net Zero Plus (CENTCOM / USA):*** Utilizes alternative energy technologies to reduce energy footprint at military facilities and forward operating bases

***Cross Domain Collaborative Information Environment (CD-CIE) (JFCOM / DISA):*** Open standards, non-proprietary, secure, scalable, cross domain collaborative info environment for multinational information exchange

***Collaborative Security Environment (CSE) (SOUTHCOM / JFCOM):*** Integrated decision and assessment tool to support coalition security

***Joint Recovery and Distribution System (JRADS) (TRANSCOM / Army):*** Integrates joint cargo handling system for intermodal load and recovery ops



# Strategic Initiative on Innovation and Tech Transfer

OSD/Advanced Systems & Concepts

- Technology access has changed throughout the world; proliferation of potentially disruptive technologies is the new way of global competition and economic success; DoD is no longer at the forefront of most tech research; fewer sources for growing numbers of warfighter-relevant technologies with shorter threat/refresh/support cycles
- The Strategic Initiative for Innovation and Technology Transition is tasked to create an action plan that will accelerate the movement of technology to Warfighters
  - particular emphasis on global outreach, flexible contracting, and strategic linking of the Department's agile acquisition initiatives to set conditions for an "outward looking" culture ... a transformation!



# References and Discussion

OSD/Advanced Systems & Concepts

<b>Advanced Systems &amp; Concepts (AS&amp;C)</b>	<a href="http://www.acq.osd.mil/asc">www.acq.osd.mil/asc</a>	<b>703-695-5036</b>
<b>Joint Capability Tech Demo (JCTD)</b>	<a href="http://www.acq.osd.mil/actd">www.acq.osd.mil/actd</a>	<b>703-697-5558</b>
<b>Comparative Test Office (FCTs)</b>	<a href="http://www.acq.osd.mil/cto">www.acq.osd.mil/cto</a>	<b>703-602-3740</b>
<b>Office of Technology Transition</b>	<a href="http://www.acq.osd.mil/ott/tti">www.acq.osd.mil/ott/tti</a>	<b>703-607-5316</b>





# Considering Warfighter R&D Investments...

OSD/Advanced Systems & Concepts

...questions should be answered affirmatively:

1. Does the action address the COCOM's needs<sup>1</sup>?
2. Is a significant Joint capability or military advantage gained?
3. Do we have a clearly stated and attainable goal/outcome?
4. Have risks and costs been fully and frankly analyzed?
5. Have all other DOTMLPF<sup>2</sup> means been fully explored?
6. Is there an exit strategy to avoid endless development?
7. Have consequences of inaction been fully considered?
8. Can support be garnered from the Services<sup>3</sup> and Congress?
9. Are experienced people available to execute the effort?
10. Can results be demonstrated to project champions (<PCS)<sup>4</sup>?

<sup>1</sup> Integrated Priority Lists and Most Pressing Military Issues – as validated by JCS J8

<sup>2</sup> DOTMLPF: Doctrine, Organization, Training, Materiel, Leadership, Personnel and Facilities

<sup>3</sup> Enduring outcomes are all about timely transition to an affordable and sustainable capability

<sup>4</sup> Demonstrate 80% capability before CoCom champion/sponsor moves to next assignment



# Air Force Materiel Command

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**Development and  
Insertion of Innovative  
Technologies Across  
the Lifecycle of a  
Weapon System**

**Janet C. Wolfenbarger**  
Brigadier General, USAF

Director, Intelligence and Requirements  
Director, D&SWS AFSSO21 Office

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*Integrity ★ Service ★ Excellence*



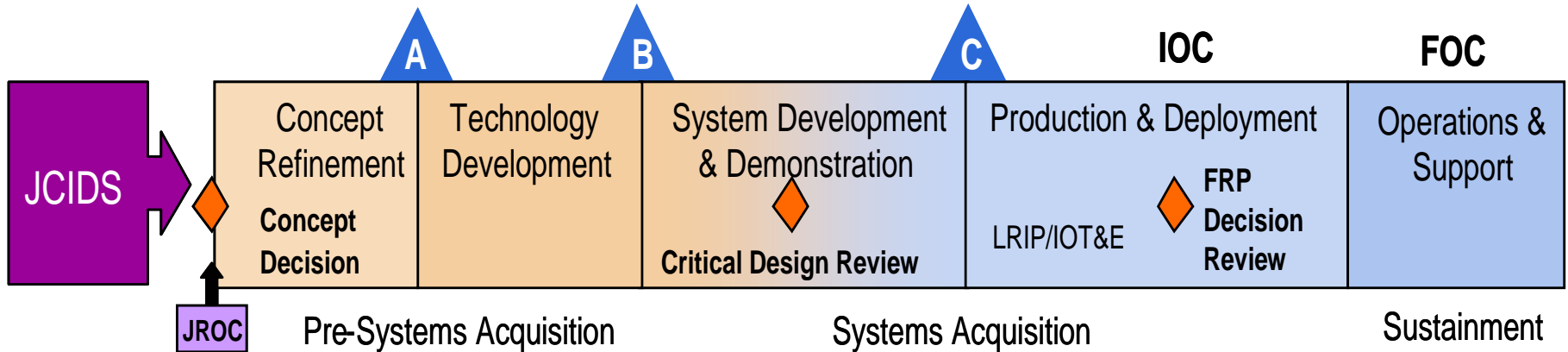
# Overview

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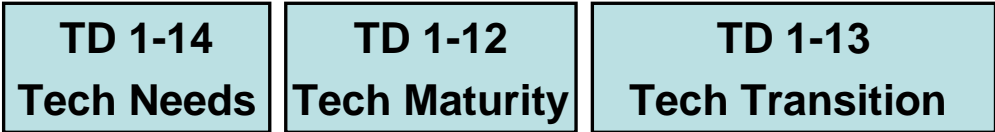
- **Ongoing AF/AFMC initiatives to improve technology insertion:**
  - **Pre-MS B: AFSO21 Develop and Sustain Warfighting Systems (D&SWS) Technology Development (TD) Initiatives**
  - **Sustainment: Sustainment Technology Process (STP) to develop focused sustainment technology investments**



# Integrated Life Cycle Management



## Development and Sustainment of Warfighter Systems “Technology Development Process”



Sustainment Technology Process



# Air Force Special Operations for the 21<sup>st</sup> Century (AFSO21)/D&SWS

*Part of the Answer*



## Funding Our Priorities

“We will fund transformation through ... **organizational efficiencies, process efficiencies, reduction of legacy systems and manpower** while sustaining GWOT and ongoing operations in support of the Joint Fight.”

- Michael W. Wynne, SECAF

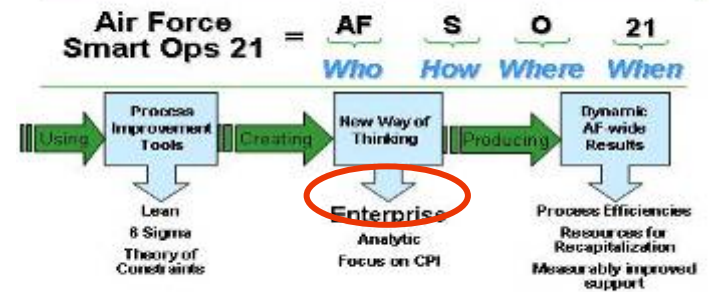


*Integrity - Service - Excellence*

1

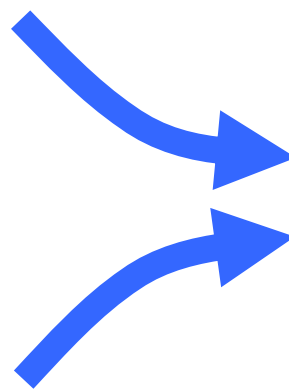


## AF Smart Ops 21



*Integrity - Service - Excellence*

2



## The Status Quo is Out

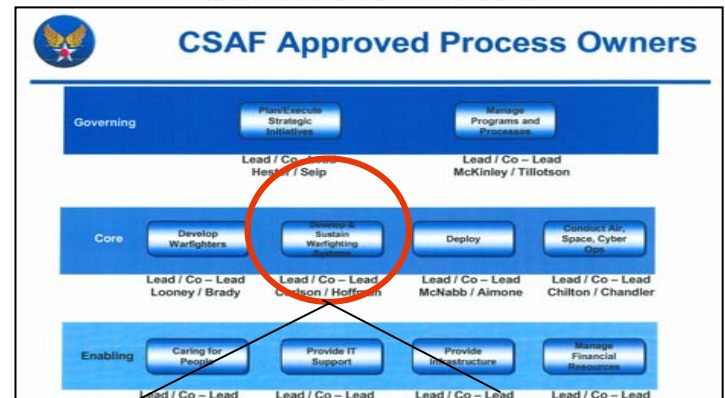


### AFSO21

- *The USAF will do less with less*
- *Do what is valued by our customers*
- *Employ tools and techniques smartly to reduce waste and non-value-added work, to maximize value to the warriors*

*Integrity - Service - Excellence*

4



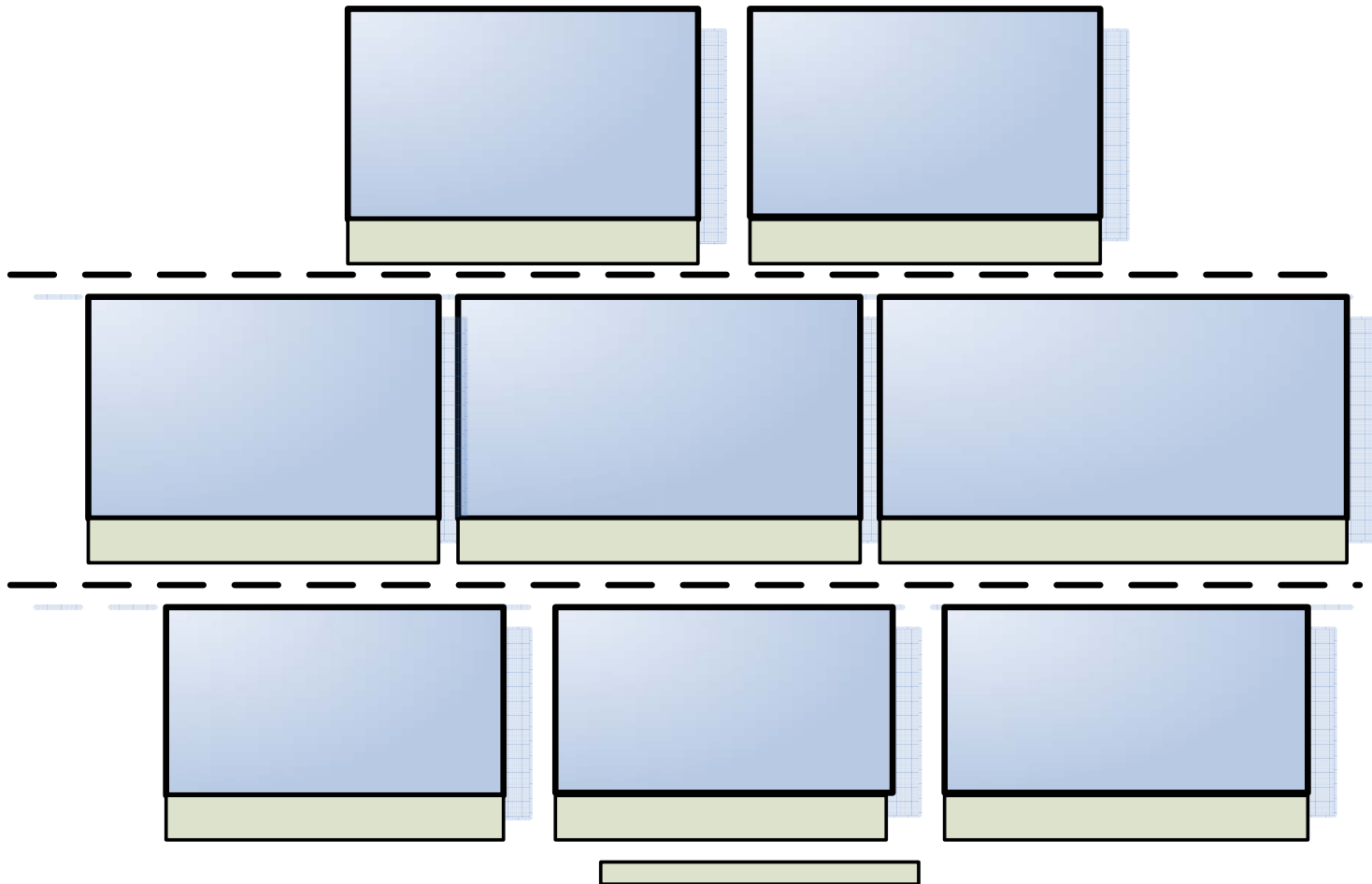
**Develop and Sustain Warfighting Systems (D&SWS)**



# D&SWS Sub-Processes

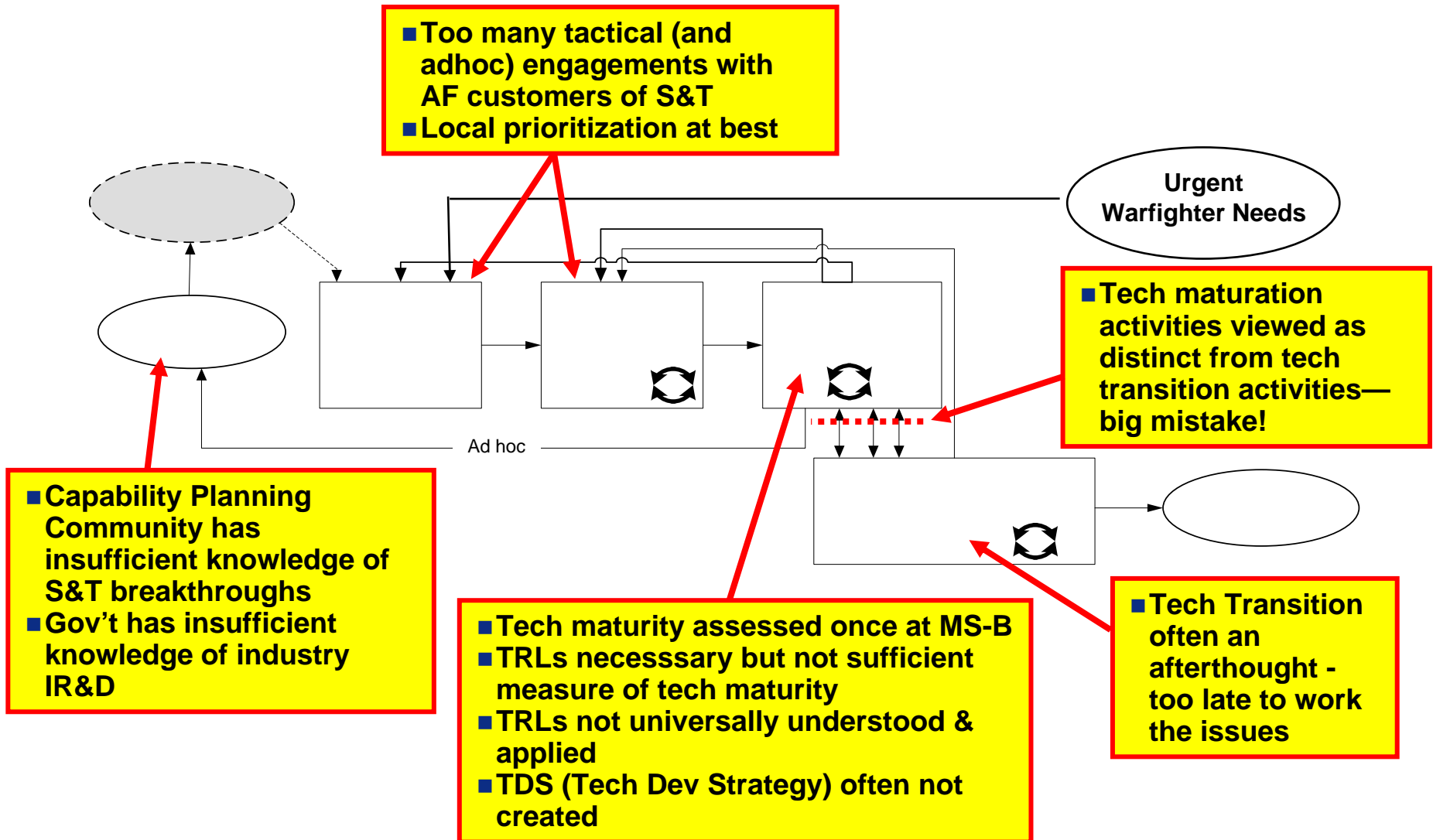
*\*Sub-Process Owners,\* Co-Leads, Design Team Leads*

Process Owner/Co-Lead **Gen Carlson/Lt Gen Hoffman**  
Chief Process Officer **Brig Gen Janet Wolfenbarger**





# As-Is Technology Development Process





# D&SWS Technology Development Initiatives



**AF-wide process to identify and prioritize tech needs linked to capability gaps and program requirements**

**Benefits: Best technologies needed to achieve AF's highest priorities receive highest investment priority.**

**"Tech Push" better influences capability planning.**

**Establish comprehensive "yardstick" to assess maturity of technologies (more than technology readiness levels: include testability, manufacturability, integratability, supportability, etc)**

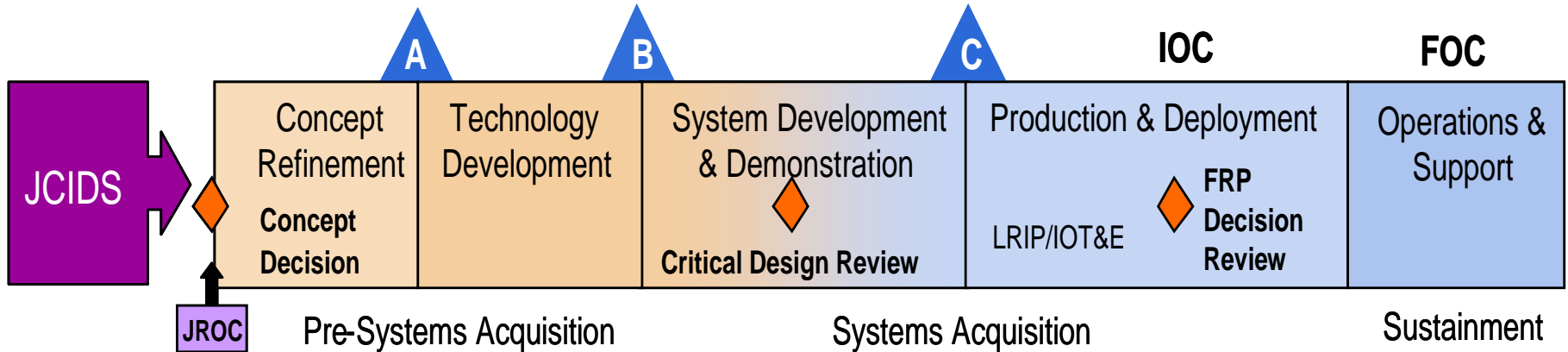


**Establish disciplined and collaborative "stage-gating" process to ensure highest confidence in successful technology transition**

**Benefits: Reverse the trend of starting SDD with immature technologies which cause RDT&E and production cost growth and schedule slips**



# Integrated Life Cycle Management



## Development and Sustainment of Warfighter Systems “Technology Development Process”



## Sustainment Technology Process





# Strategy Development

## Top Down Capability Driven Process to Support Strategic Sustainment Technology Investments

### Strategic Drivers

#### **E-Log21**

- Reduced O&S Costs and increase system availability

#### **AFMC Balance Scorecard**

- Sustain Weapon Systems
- Improve equipment availability at reduced cost
- Enhance Sys Reliability

#### **Customer Needs**

- MAJCOMs
- AFMC

#### **AFRL FLTC**

- Affordable Mission Generation & Sust

#### **Agile Combat Support**

- Agile, Responsive & Effective Sustainment

### Strategic Thrusts

• Improve the sustainability of weapon systems, and influence the sustainability of new systems in development

• Improved Inspection, Fault Detection, Prognostics and Diagnostics Capability (Sense and Respond)

• Apply Advanced Practices for Maintenance, Repair & Overhaul, Production Processes, and Supply Chain management

### Focus Areas

- Crack & Corrosion Detection
- Coat/Decoat
- NDI
- LO Maintainability
- CBM + Integrity
- Maintenance Shop Improvements
- Aircraft Subsystem Diagnostics
- AGE, Test Equip & Avionics
- Obsolescence Management
- Supply Chain Enhancements

### Technology Working Groups

Airframe Sustainment - TWG

Propulsion Sustainment - TWG

MRO&P Sustainment - TWG

Combat Sustainment - TWG



# Governance Structure

Strategic Vision & Sustainment Thrust

**Senior Sustainment Steering Committee (S3C)**  
 Chair: AFMC/A4  
 Co-Chair: AFMC/A2/5

**GO & SES**

Members		
AAC/CA	AFRL/CA	NWC/CC
ACC/A4/A8	AFSOC/A4	OC-ALC/CA
AEDC/CA	AFSPC/A4	OO-ALC/CA
AETC/A4	AMC/A4	SAF/AQR
AF/A4 M/A4RC	ASC/CA	SAF/IEL
AFMC/A3/A8/EN/FM	ESC/CA	WR-ALC/CA

**Guidance** →

**Internal Resources**

- AFRL
- AFMC Centers
- AFMC Corporate Process
- AFMC CMPs

**Advocacy** →

**External Funding Sources**

- MAJCOM, OSD
- Programs

**AFMC CMPs**

**Sustainment Review Group**  
 Chair: AFMC/A4D  
 Deputy: AFMC/A5S

**O-6 & GS-15**

**Members**

SAF/AQRC, AQRT, IEL AF/A4MM, HQ AFMC/A2/5, A3, A4, A8, EN, FM, AFMC Centers EN, XR, XP AFRL/PR MAJCOMs A4, A8

**Requirements Generation/Transition Agents**

<b>Technology Working Groups</b>	<b>AFMC Centers</b>	<b>MAJCOMS</b>	<b>Outputs</b> <ul style="list-style-type: none"> <li>• High Priority Sustainment Tech Needs</li> <li>• Planning Documents</li> <li>• ID Funding Source</li> </ul>
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# Accomplishments

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- **Expanded S3C membership to include MAJCOMs**
- **S3C approved sustainment technology needs:**
  - **Submitted for OSD transition/sustainment funding sources, i.e., Quick Reaction Funds, Reduction in Total Ownership Cost (RTOC)**
  - **Guided FY09 APOM and FY10 POM (Aging Aircraft and S&T supporting Affordable Mission Generation & Sustainment)**
    - **Funded projects include: Condition Based Maintenance Plus, Non-destructive Inspections, LO Maintainability, and Improved Depot Processes**



# STP Next Steps

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- **Leverage Industry Research & Development (IR&D) and Small Business Innovation Research (SBIR) Commercialization Pilot Program (CPP)**
- **Technology Roadmap Development**
  - Provides a WBS structured approach to acquire, test, and implement critical sustainment technology to meet a specified capability
  - Utilizing A2/5 modified Capability Based Roadmap Tool
- **STP Performance measures being developed and implemented ECD: Jun 08**
- **Finalizing governance document: AFMCI 61-103; S&T and Technology Transition Planning**



# Summary

**Objective is to develop and insert innovative technologies across the lifecycle of a weapon system**

- **Pre-MS B: D&SWS initiatives focus on identifying highest priority needs, improved technology maturity assessments and establishing high confidence gated technology transition**
- **Sustainment: Strategy-to-task driven process to support cross-cutting sustainment technology investments**

**AFMC and the AF are pressing forward with revolutionary initiatives to  
*Develop & Insert Innovative Technologies into AF Weapons Systems***



**JANET C. WOLFENBARGER**  
**Brigadier General, USAF**  
**Director, Intelligence and Requirements**  
**Director, D&SWS AFSO21 Office**  
**HQ AFMC/A2/5 and CCO**  
**937-257-3024 or DSN 787-3024**  
**janet.wolfenbarger@wpafb.af.mil**



# The DoD T&E / S&T Program

**Gerry Christeson**

**Defense Test Resource Management Center  
Deputy Program Manager  
Test & Evaluation / Science & Technology Program**

**NDIA 9<sup>TH</sup> Annual Science & Engineering Technology Conference**





# **Test Resource Management Center (TRMC)**

## **Sec. 231, FY 2003 National Defense Authorization Act**

### **DoD Directive 5105.71, March 8, 2004**

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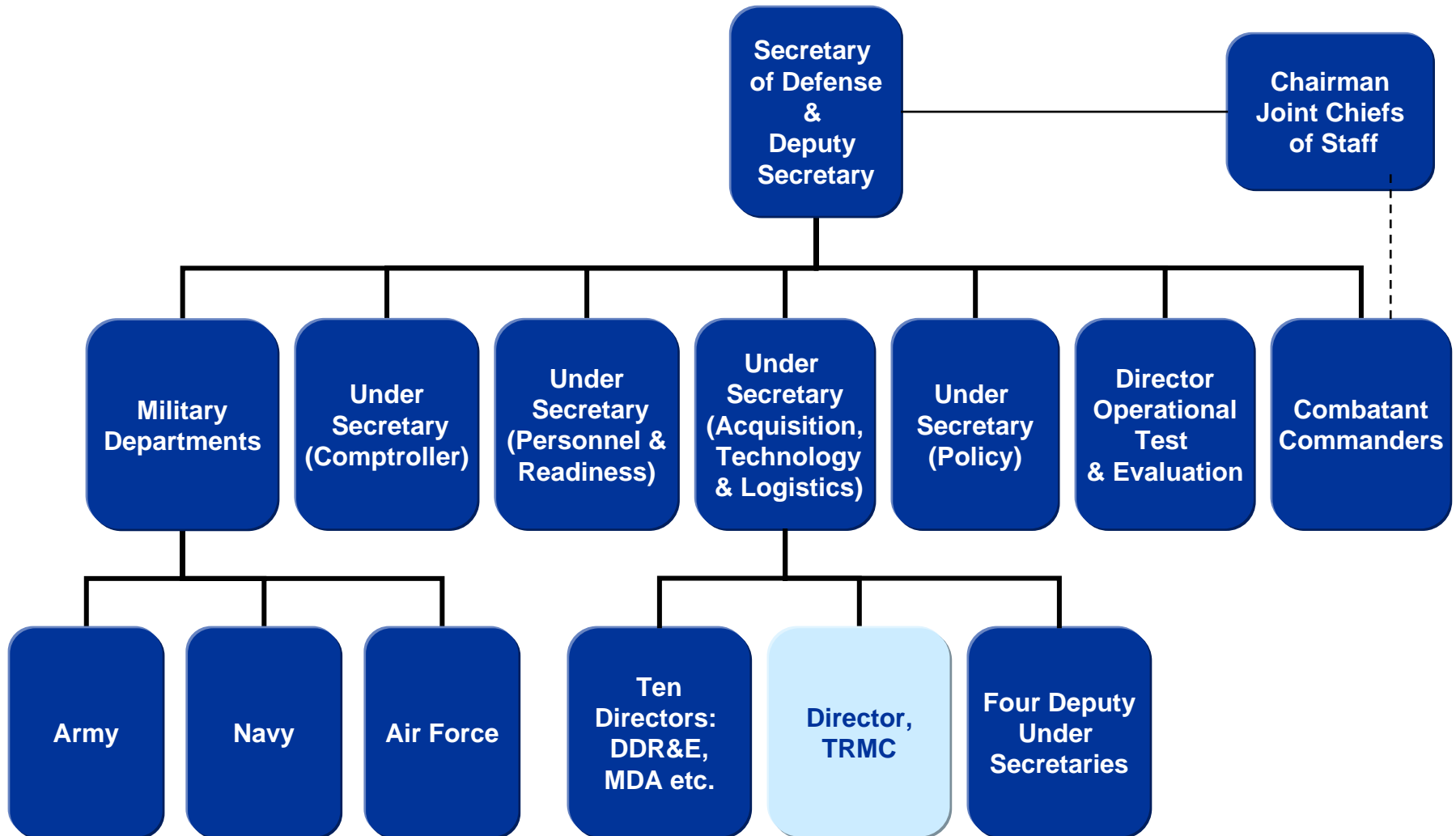


- **DoD Field Activity**
  - Established to ensure that the DoD T&E infrastructure is adequate to support the development and acquisition of defense systems
- **Annually certify that the T&E budgets of the military departments and defense agencies are adequate**
- **Develop a biennial strategic plan that assesses T&E requirements for a period of ten years and identifies required T&E infrastructure investments**
- **Responsible for T&E infrastructure policy for DoD's Major Range and Test Facility Base (MRTFB)**
- **Administer three major T&E investment programs:**
  - **Joint Mission Environment Test Capability Program (JMETC)**
  - **Central Test and Evaluation Investment Program (CTEIP)**
  - **Test and Evaluation/Science and Technology (T&E/S&T) Program**



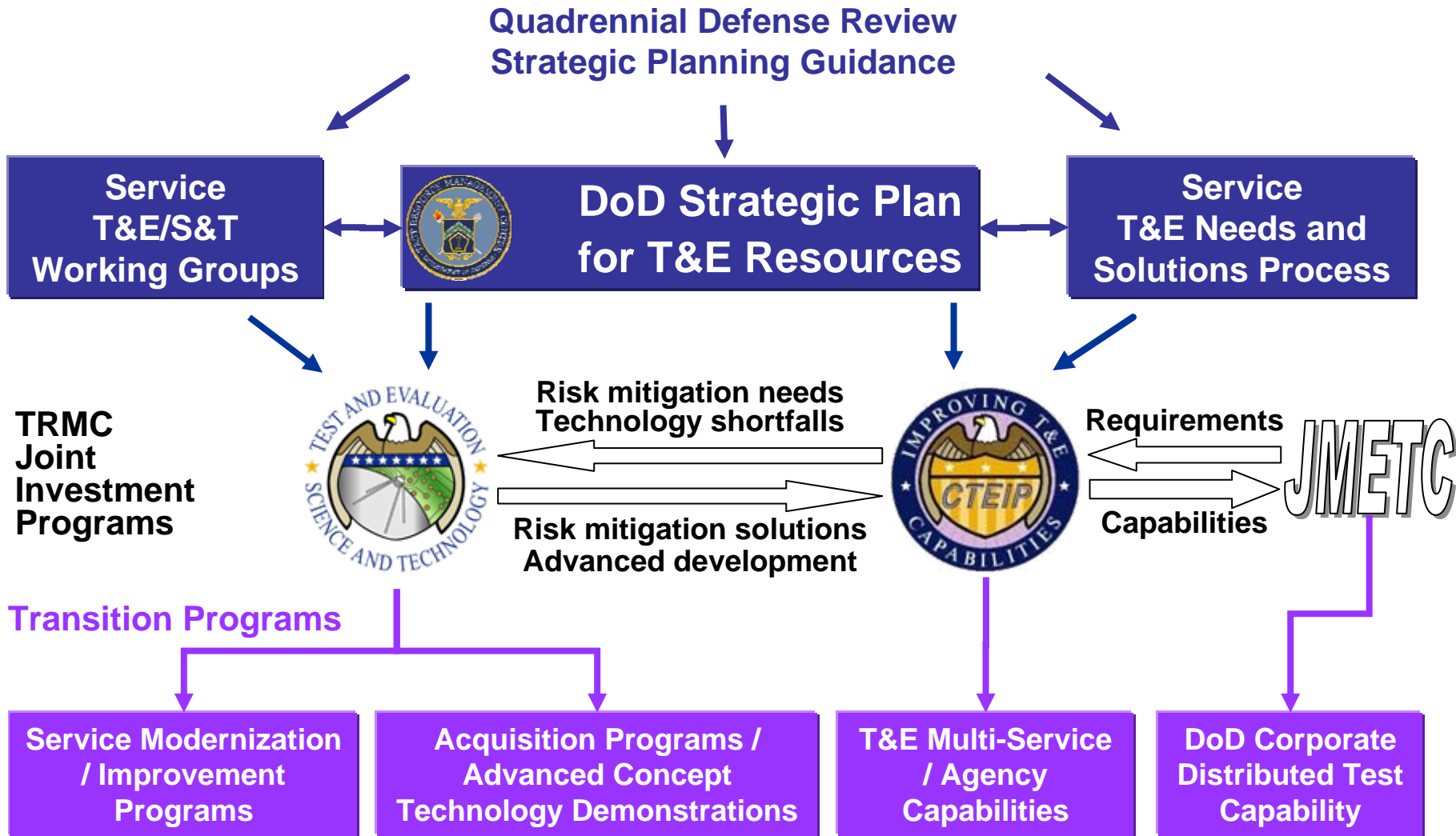
# TRMC T&E/S&T

## Direct Report to USD(AT&L)





# Synergy through Aligned Investment





# T&E/S&T Program

## Overview

- **Test & Evaluation / Science & Technology (T&E/S&T) Program started in FY 2002**
  - Joint DDR&E / DOT&E initiative
- **Mission**
  - Investigate and develop new technologies required to test and evaluate our transforming military capabilities
    - Include any system that makes our warfighters more survivable and effective in combat
    - Mature test technologies from TRL 3 to 6
- **Goal**
  - Transition emerging technologies into test capabilities in time to verify warfighting performance

**Shaping Technology into Tomorrow's T&E Capabilities**



# Why a T&E/S&T Program?

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- **Nanotechnology**
- **Biometrics**
- **Genetic algorithms**
- **Microelectromechanical systems**
- **Adaptive optics**
- **High power microwaves**
- **High energy lasers**
- **Synthetic instrumentation**
- **Multispectral seekers**
- **Autonomous systems**
- **Hypersonics**
- **Intelligent agents**



# T&E/S&T Program Office

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- **What We Do?**

- Fund high risk / high pay-off T&E R&D projects
- Foster technology transition to MRTFB and other DoD T&E field activities

- **How We Do It?**

- Issue annual Broad Agency Announcement (BAA)
- Tri-Service working groups draft BAAs and participate in proposal evaluation
- Award T&E R&D projects starting at TRL3 and mature to TRL6
- Executing Agents (EA) manage test technology Focus Areas

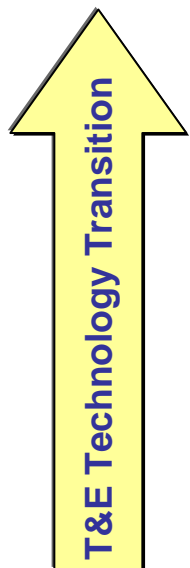
- **Who Do We Fund?**

- Academia
- Industry
- Government laboratories
- Teams of academia / industry / government labs

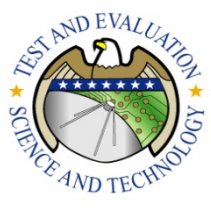


# Technology Readiness Level

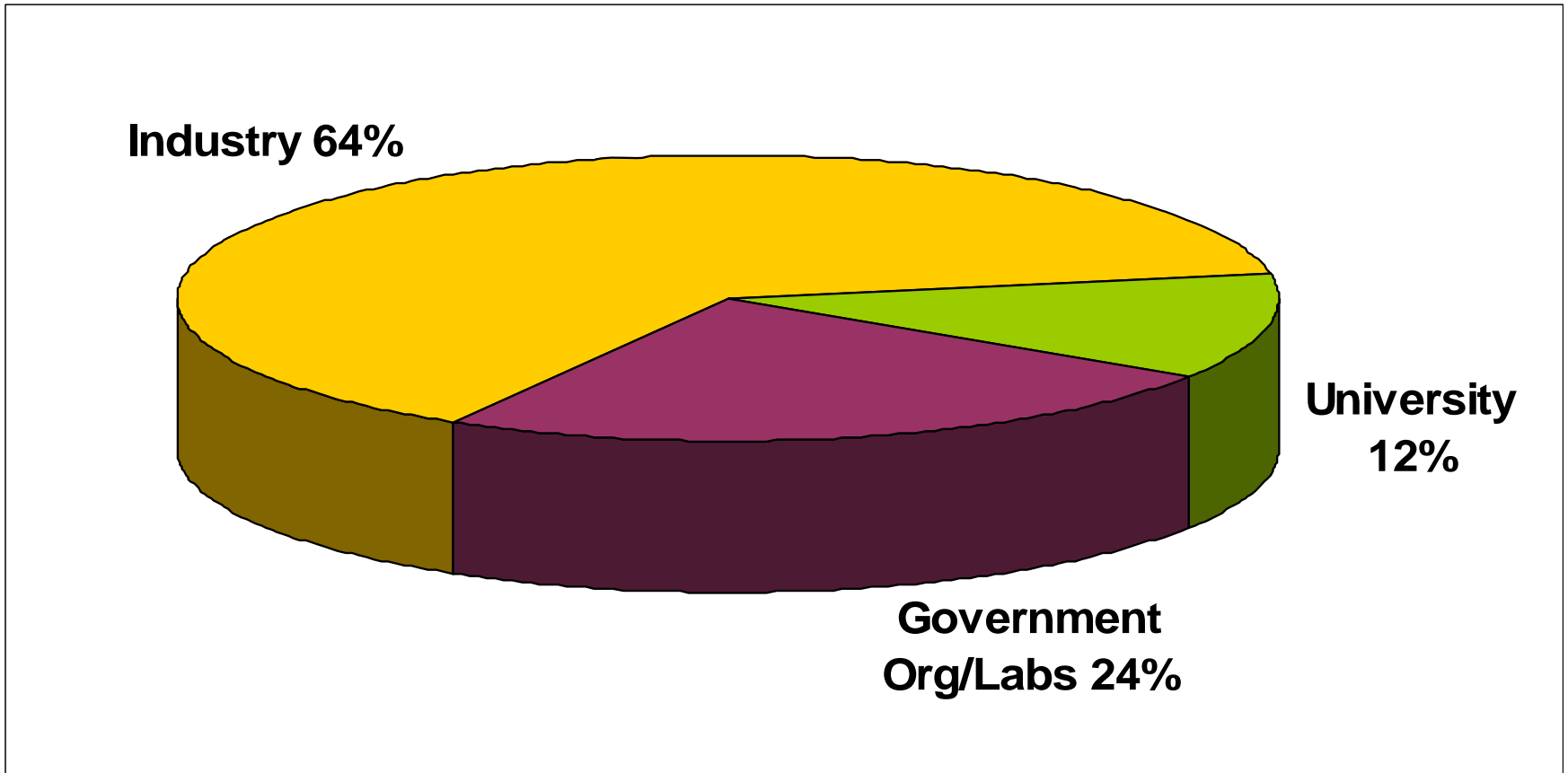
TRL 9	Actual system 'flight proven' through successful mission operations
TRL 8	Actual system completed and 'flight qualified' through test and demonstration
TRL 7	System prototype demonstration in an operational environment
TRL 6	System/subsystem model or prototype demonstration in a relevant environment
TRL 5	Component and/or breadboard validation in relevant environment
TRL 4	Component and/or breadboard validation in laboratory environment
TRL 3	Analytical and experimental critical function and/or characteristic proof of concept
TRL 2	Technology concept and/or application formulated
TRL 1	Basic principles observed and reported



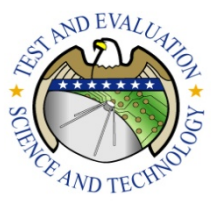




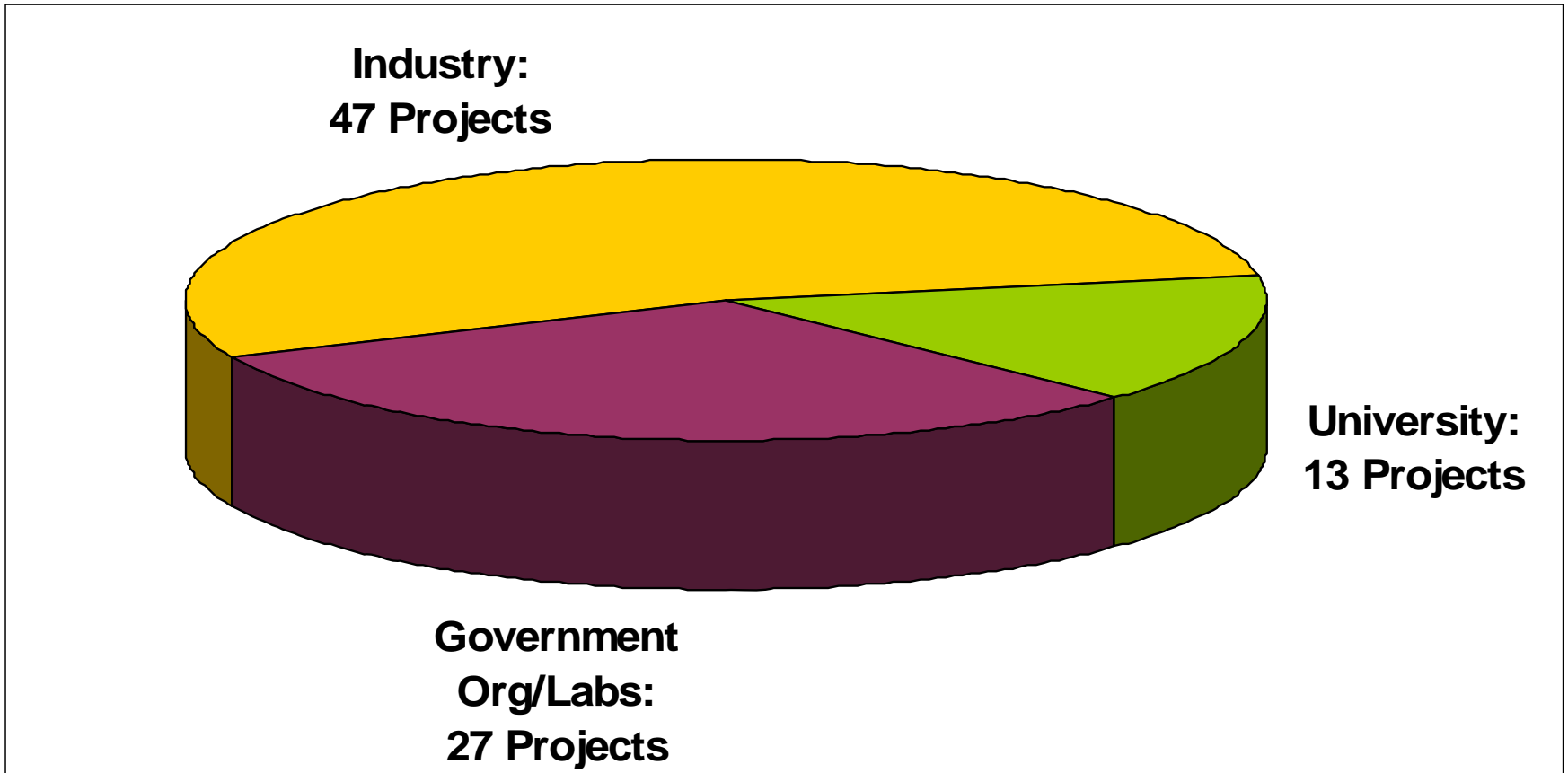
# FY 2008 Funding Distribution



Note: numbers apply only to FY08 funding profile



# FY 2008 Project Distribution



Note: numbers apply only to FY08 funding profile



# FY08 T&E/S&T Focus Areas

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- **Directed Energy Test (DET)** – On-board and off-board technologies to assess performance of high energy laser and high power microwave weapon systems
- **Hypersonic Test (HST)** – Technologies to provide high fidelity environments, M&S and instrumentation for testing of air breathing hypersonic vehicle propulsion and flight systems
- **Multi-Spectral Test (MST)** – Technologies to enable real-time, realistic T&E of multi-spectral and hyperspectral seekers and sensors through scene injection and projection
- **Non-Intrusive Instrumentation (NII)** – Technologies for non intrusive sensors, data storage, and power sources to provide continuous, non-obtrusive T&E



# FY08 T&E/S&T Focus Areas

## (cont.)

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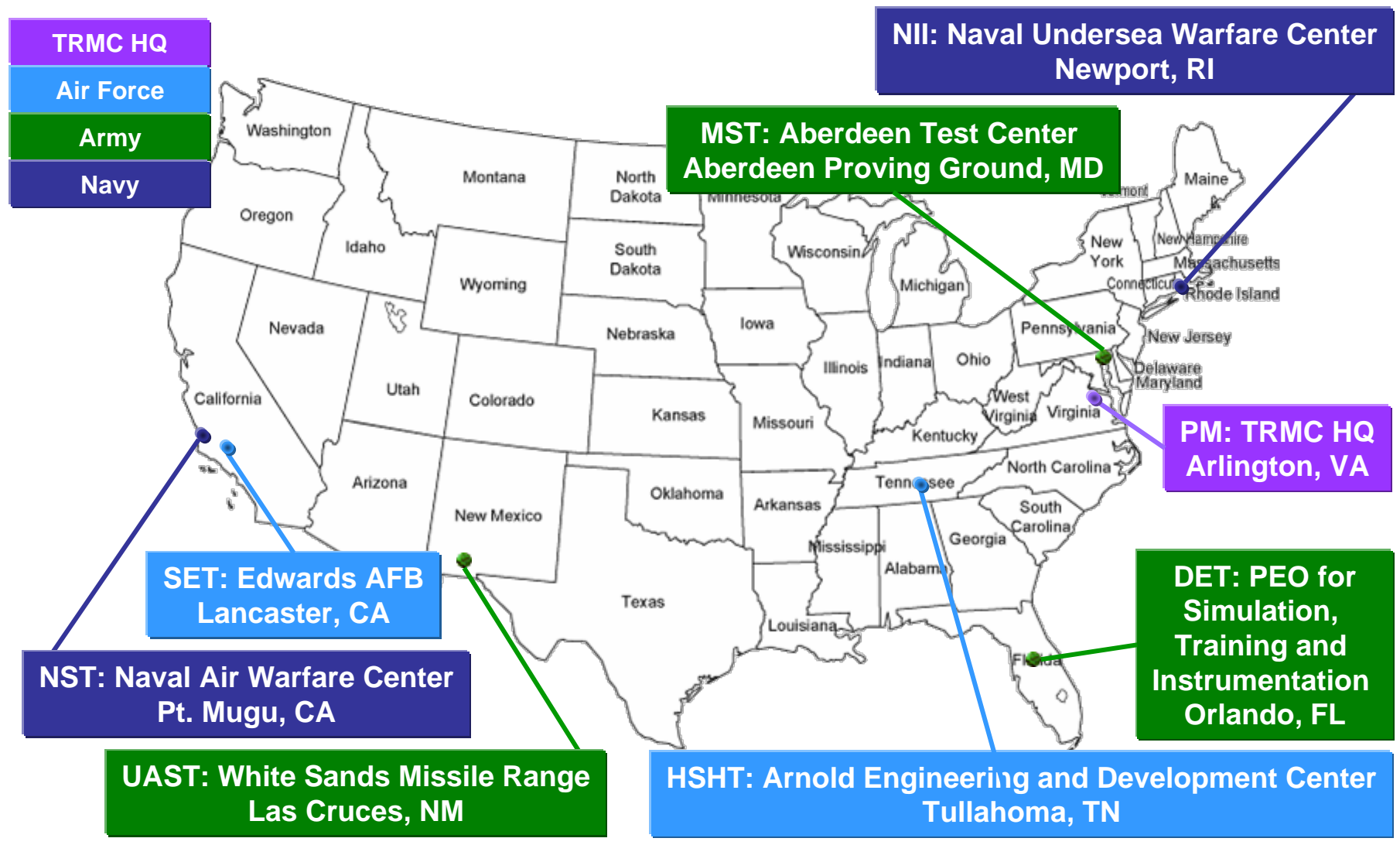


- **Netcentric Systems Test (NST)** – Technologies to measure and assess the performance of the physical, information and cognitive domains of Joint, integrated architectures
- **Spectrum Efficient Technology (SET)** – Technologies to enable more efficient use of legacy telemetry bands and expand into non-traditional areas of the RF spectrum and the optical spectrum
- **Unmanned Autonomous Systems Test (UAST)** – Technologies for T&E of unmanned systems ranging from full tele-operation to totally autonomous, learning performance

**111 active projects**



# T&E/S&T Program Management



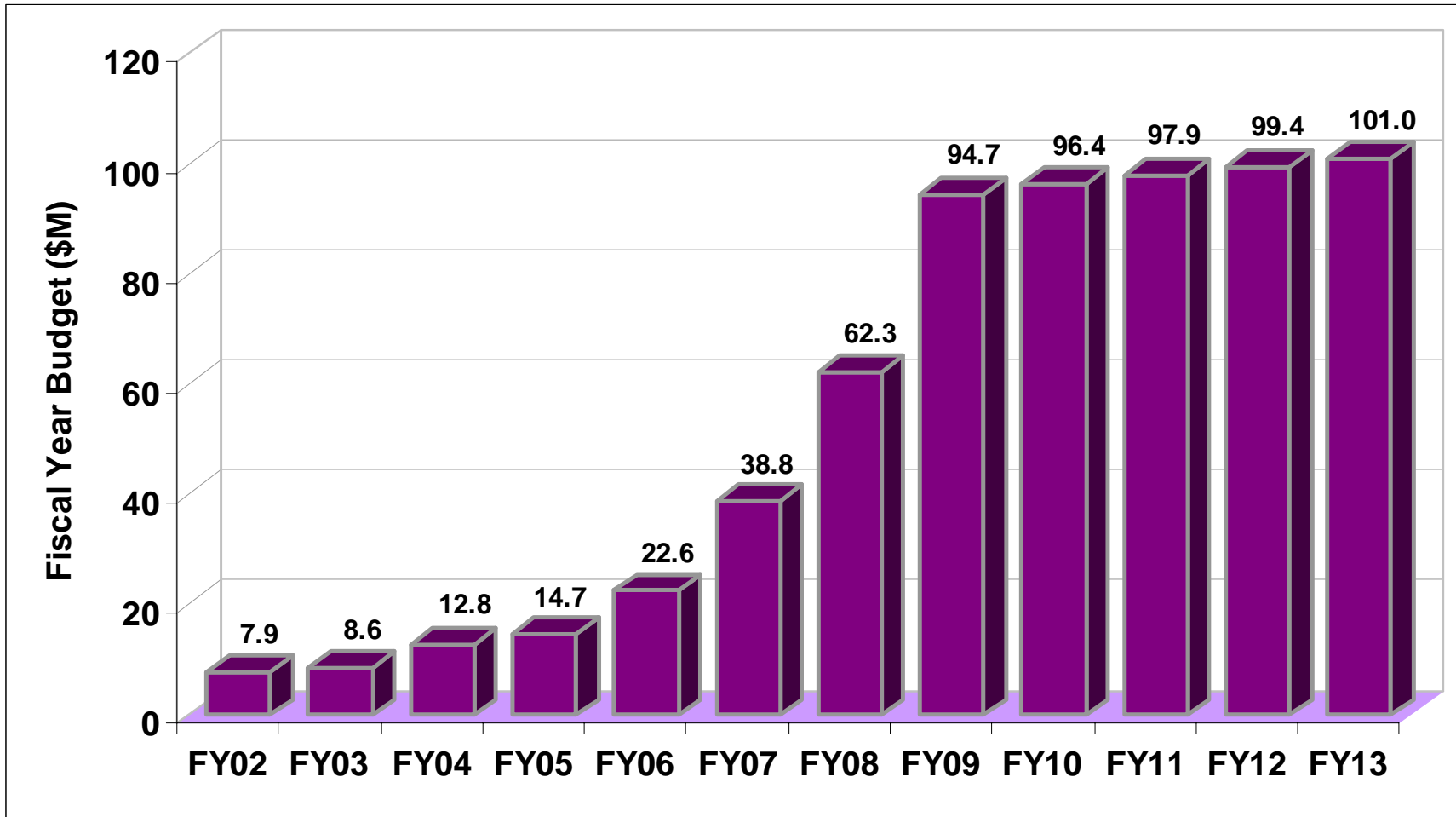


# Working Groups

Army	AMRDEC	IEW
	AMSAA	NVESD
	ARL	OTC
	ATC	PEO STRI
	ATEC	RDEC
	ATTC	RTTC
	HELSTF	TRADOC
Navy	NAVAIR	NAWC
	NAVSEA	NUWC
	NRL	SPAWAR
Air Force	AEDC	AFRL
	AFEWES	AFWDC
	AFFTC	46 <sup>th</sup> TW
	AFOTEC	452 <sup>nd</sup> FLTS
DoD	DDR&E	JCS
	DISA / JITC	JFCOM
	DOT&E	



# T&E/S&T Program Annual Budget







# T&E/S&T Program Project Selection Process



## Drivers



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

**Tri-Service Focus Area Working Group**

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

**Needs/Requirements**

**Roadmaps and Solicitations**

**Proposals**

**Source Selection Evaluation Team**

- Working Group
- Subject Matter Expert
- Contracting Reps

**Executing Agent**

**Program Manager**

**Funding Decision**



# BAA Schedule

Activity	Govt FY 2008									Govt FY 2009		
	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08
FY09 Project and Study Selection												
EA's Draft BAA Topic Areas	[Grey bar with arrowhead at Mar-08]											
Industry/Academia Days		[Green diamond]										
PMO Topic Area Approval			[Grey bar with arrowhead at Mar-08]									
EA's Issue Solicitations				[Blue diamond]								
Offeror White Paper Submissions					[Blue diamond]							
EA WG's White Paper Review					[Grey bar with arrowhead at May-08]							
PMO/EA Coordinate Selected White Papers / Develop Clarifications						[Grey bar with arrowhead at Jun-08]						
Letter RFP Issued to Selected Offerors							[Blue diamond]					
Offeror Proposal Submissions								[Blue diamond]				
EA WG's Proposal Review & Recommendations to PMO								[Grey bar with arrowhead at Aug-08]				
PMO Proposal Recommendations Review & Decisions									[Grey bar with arrowhead at Sep-08]			
Clarifications, Negotiations & Contract Awards										[Grey bar with arrowhead at Oct-08]		

BAA – Broad Agency Announcement  
 PMO – Program Management Office

EA – Executing Agent  
 RFP – Request for Proposal

WG – Working Group  
 FY – Fiscal Year



# The Proposal — Key Criteria

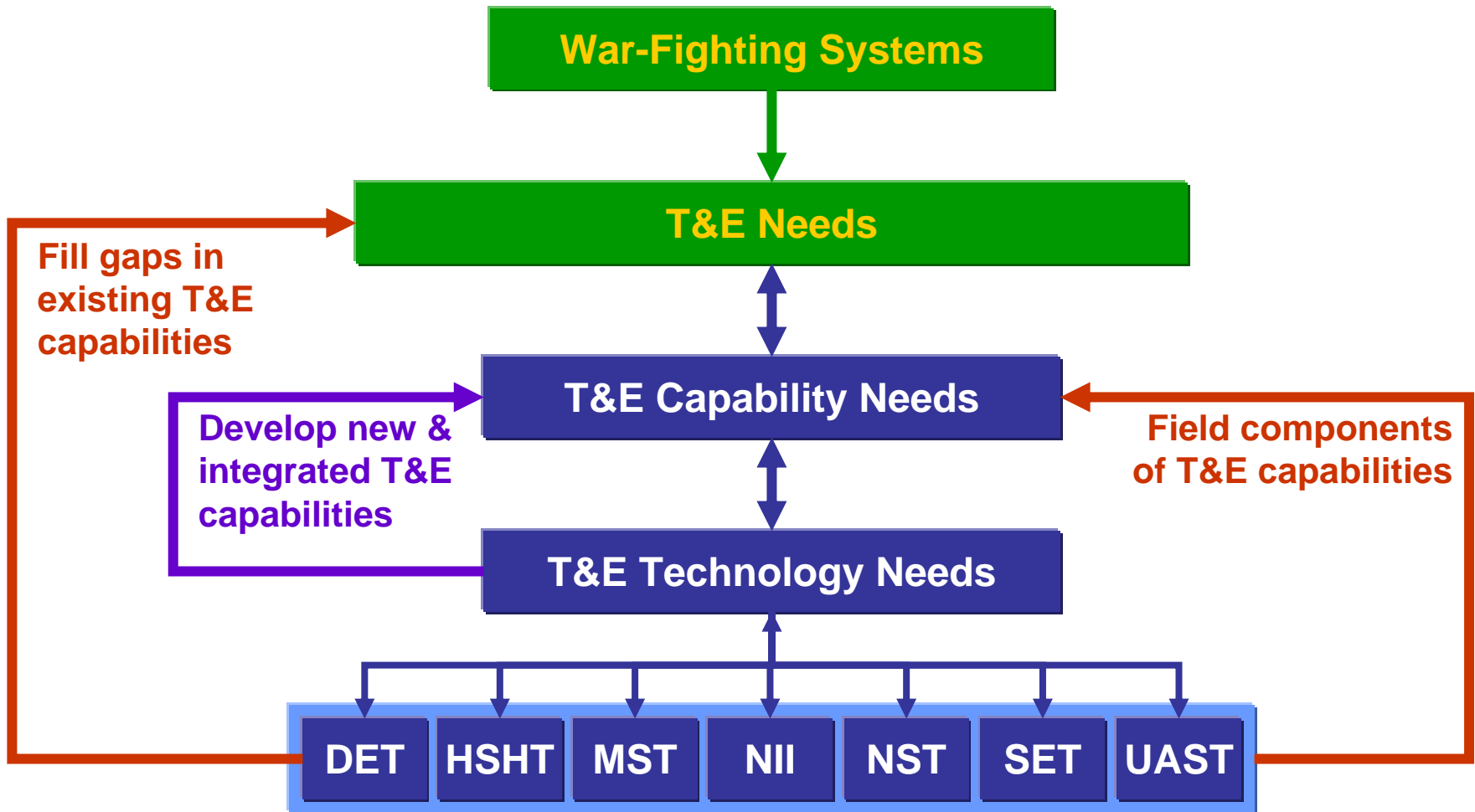
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- **Meets a T&E Need**
- **Requires S&T work**
- **High Risk / High Payoff**
- **Broad application (more than one DoD test activity)**
- **High potential for transition to development of a test capability**



# Technology Development Framework





# Partnerships

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- **Partnerships between universities, industry & DoD laboratories**
  - Form the best research teams possible
- **Collaborate to pursue bigger opportunities**
  - Leverage each others' core competencies
  - Share resources
- **Increase transition opportunities through increased involvement in the T&E/S&T Program**



# Success Stories

---

- **In-Situ Pressure Measurement**
  - Transitioned to the hypersonic HyFly program which is sponsored by the Office of Naval Research and the Defense Advanced Research Projects Agency
- **Tactical-Report Generation Test Bed**
  - Transitioned to the CTEIP Interoperability Test and Evaluation Capability (InterTEC) program and to Joint Forces Command for automated netcentric test planning and scenario development
- **Steerable Beam, Directional Antenna Concepts**
  - Transitioned technology to the CTEIP integrated Network Enhanced Telemetry (iNET)



# Success Stories (cont.)



- **Heat Flux Sensor**
  - Transitioned to Arnold Engineering Development Center for aerothermal measurements by miniaturized heat flux sensors at high temperatures—used in the Shuttle Return-to-Fly Program
- **Directed Energy Data Acquisition Transformation**
  - Transitioned to Naval Surface Warfare Center, Dahlgren for conducting T&E of High Power Microwave Systems
- **Multi-Spectral Stimulator Injection Test Method**
  - Transitioned to U.S. Army Redstone Technical Test Center Future Force/Future Combat Systems for hardware-in-the-loop testing of multispectral systems





# Summary

---

- **Only DoD S&T program for T&E**
- **Tri-Service participations**
- **Focus on transition**
- **Partnerships**
  - **Government labs / ranges**
  - **Industry**
  - **academia**



# Questions?

---



## Contact Information:

**Mr. Gerry Christeson**  
**Defense Test Resource Management Center**  
**Deputy Program Manager**  
**T&E / S&T Program**  
**Gerald.Christeson@osd.mil**



# Back Up



# T&E Needs

## The R&D project:

- Addresses the T&E requirements
- Fills known T&E gaps
- Articulates how the above are to be achieved

### Example: T&E Need

Ground test facilities generally use combustion processes to create representative flight conditions for hypersonic engine testing. The effects of vitiation on the engine performance is not well known. Ground test facilities need a clean air test capability to more realistically simulate actual flight conditions to accurately predict engine performance in flight.



# S&T Challenges

## The R&D project:

- Develops new test & evaluation capabilities that do not currently exist
- Utilizes /develops beyond state-of-the-art technologies that can be high-risk
- Pushes technology to new limits

### Example: S&T Challenges

- Develop resistively heated elements to routinely operate between 2200 to 2400 Kelvin (4535 to 4927 deg F)
- Develop electrical interface materials that can maintain high current (60 Amp or greater) electrical and mechanical connection at extreme temperatures
- Develop element materials and shapes that can withstand temporal temperature cooling gradients of at least a thousand degrees a minute and maintain air seal to prevent internal cooling air from leaking into external airflow and cooling it

# *Manufacturing Readiness Levels (MRLs) Manufacturing Readiness Assessments (MRAs) In an S&T Environment*



**Jim Morgan**  
Manufacturing Technology Division  
Phone # 937-904-4600  
[Jim.Morgan@wpafb.af.mil](mailto:Jim.Morgan@wpafb.af.mil)

---

*Integrity - Service - Excellence*



# Why MRLs?



***“Advanced weapon systems cost too much, take too long to field, and are too expensive to sustain” -- Congress, OSD, CSAF, GAO***

- Production/manufacturing processes are major contributor
  - A GAO study of core set of 26 programs: RDT&E costs up by 42% and schedule slipped by 20%
    - \$42.7B total cost growth
    - 2.5 years average schedule slip
  - Characteristics of successful programs:
    - *Mature technologies, stable designs, **production processes in control***
    - **S&T organization responsible for maturing technologies**, rather than *program or product development manager*
- Need way to mitigate impact of diminishing manufacturing infrastructure
  - People, policy, programs gutted
  - Lost recipe on how to manage manufacturing risk
  - Won't get infrastructure back but still need to manage manufacturing risk



# Technology Readiness Levels (TRLs)



Provide a common language and widely-understood standard for:

- Assessing the *performance maturity* of a technology and plans for its future maturation
- Understanding the level of performance risk in trying to transition the technology into a weapon system application

TRLs leave major transition questions unanswered:

- Is the technology producible? Reproducible?
- What will these cost in production?
- Can these be made in a production environment?
- Are key materials and components available?





# Manufacturing Readiness Levels (MRLs)



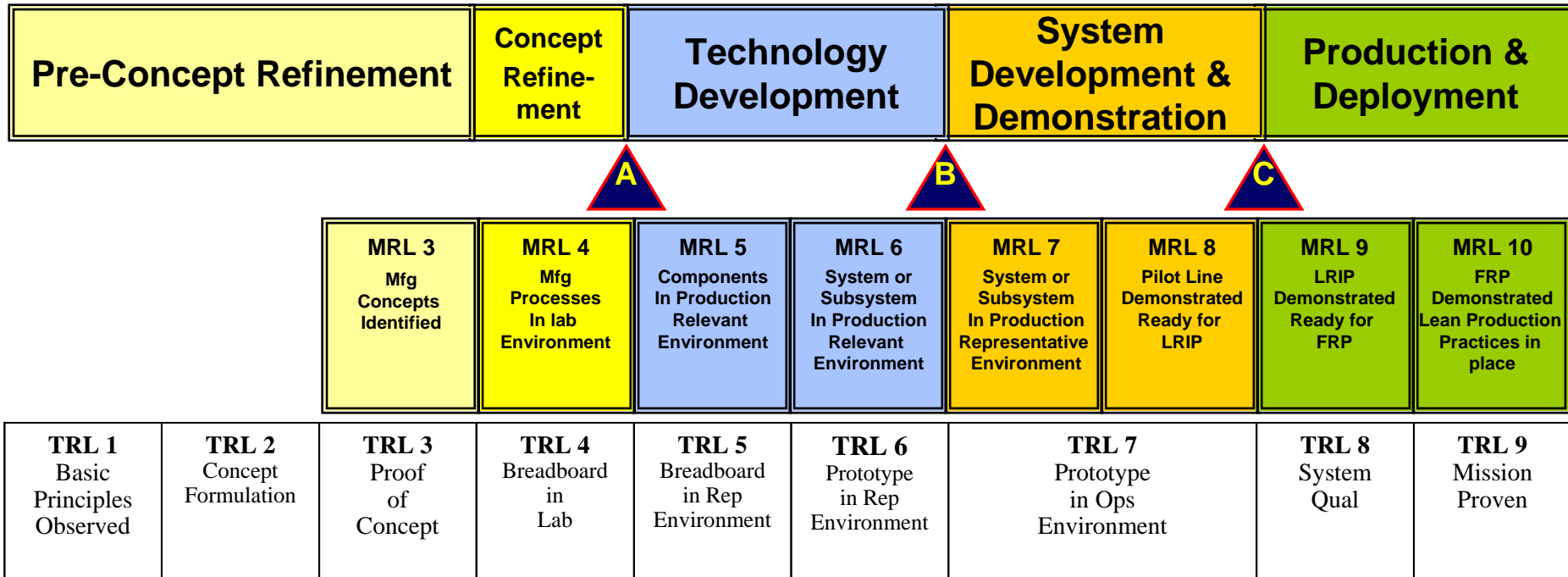
- Common language and standard for
  - Assessing the **manufacturing maturity** of a technology or product and plans for its future maturation
  - Understanding the level of manufacturing risk in trying to produce a weapon system or transition the technology into a weapon system application
- Designed to complement TRLs
- Designed to help set the agenda for manufacturing risk mitigation
- Usage
  - Army, for Future Combat Systems development efforts
  - Missile Defense Agency using EMRLs on all development programs
  - Several defense primes using on weapon system programs
  - **Mandated by AFRL on all hardware CAT I ATDs**



# MRL Relationships



## *Relationship to System Acquisition Milestones*



## *Relationship to Technology Readiness Levels*



# MRL Evaluation Criteria (Threads)



- Technology and Industrial Base
- Design
- Materials
- Cost and Funding
- Process Capability and Control
- Quality Management
- Manufacturing Personnel
- Facilities
- Manufacturing Management



# MRL Evaluation Criteria (Threads)



S&T Phase		6.2 / 6.3	6.3 / 6.4	6.3 / 6.4 / 7.8	6.4 / 6.8 / 7.8	7.8
Acq Phase		Pre CR		TD		SDD
Thread	Sub-Thread	MRL 3	MRL 4	MRL 5	MRL 6	MRL 7
Technology & Industrial Base	Technology Maturity	TRL 3	Should be assessed at TRL 4.	Should be assessed at TRL 5.	Should be assessed at TRL 6.	Should be assessed at TRL 7
	Technology Transition to Production	Potential manufacturing sources identified for technology needs. (Commercial/Government, Domestic/Foreign)	Industrial Base capabilities and gaps/risks identified for key technologies, components, and/or key processes.	Industrial Base assessed to identify potential manufacturing sources.	Industrial Capability Assessment (ICA) for MS B has been completed. Industrial capability in place to support mfg of development articles. Plans to minimize sole/foreign sources complete. Need for sole/foreign sources justified. Potential alternative sources identified.	Industrial capability to support production has been analyzed. Sole/foreign sources stability is assessed/monitored. Developing potential alternate sources as necessary.
	Manufacturing Technology Development	Initial demonstration of Mfg Science	Mfg Science & Advanced Mfg Technology requirements identified	Required manufacturing technology development efforts initiated.	Manufacturing technology efforts continuing. Required manufacturing technology development solutions demonstrated in a production relevant environment.	Manufacturing technology efforts continuing. Required manufacturing technology development solutions demonstrated in a production representative environment.
Design	Producibility Program	Evaluate relevant materials/processes for manufacturability & producibility	Producibility & Manufacturability assessment of design concepts completed. Results guide selection of design concepts and key components/technologies for Technology Development Strategy. Manufacturing Processes assessed for capability to test and verify in production, and influence on O&S.	Producibility & Manufacturability assessments of key technologies and components initiated. Systems Engineering Plan (SEP) requires validation of design choices against manufacturing process and industrial base capability constraints.	Producibility assessments of key technologies/components and producibility trade studies (performance vs. producibility) completed. Results used to shape System Development Strategy and plans for SDD or technology insertion programs phase.	Detailed producibility trade studies using knowledge of key design characteristics and related manufacturing process capability completed. Producibility enhancement efforts (e.g. DFMA) initiated.
	Design Maturity	Evaluate product lifecycle requirements and product performance requirements.	Systems Engineering Plans and the Test and Evaluation Strategy recognize the need for the establishment/validation of manufacturing capability and management of manufacturing risk for the product lifecycle. Initial Key Performance Parameters (KPPs) identified.	Identification of enabling/critical technologies and components is complete and includes the product lifecycle. Evaluation of design Key Characteristics (KC) initiated.	Basic system design requirements defined. All enabling/critical technologies/components have been tested and validated. Product data required for prototype manufacturing released. A preliminary performance as well as focused logistics specification is in place. Key Characteristics and tolerances have been established.	Product requirements and features are well enough defined to support detailed systems design. All product data essential for manufacturing of component design demonstration released. Potential KC risk issues have been identified and mitigation plan is in place. Design change traffic may be significant.



# Air Force MRL Implementation Approach



In partnership with Joint Defense Manufacturing Technology Panel (JDMTP)

- **Conduct pilot MRAs on various programs**
  - Advanced Technology Demonstration programs
  - Weapon system acquisition programs
  - Demonstrate benefits of using MRLs
- **Conduct training for key program personnel**
  - What are MRLs, how to conduct an MRA
    - Air Force ManTech personnel
    - Category I ATD IPTs and ACAT pilot program personnel
  - Utilize various training materials that can be tailored
  - Transition to DAU once MRLs are in policy
- **Put MRLs into policy documents**
  - AFRL, AFMC, AF, DoD



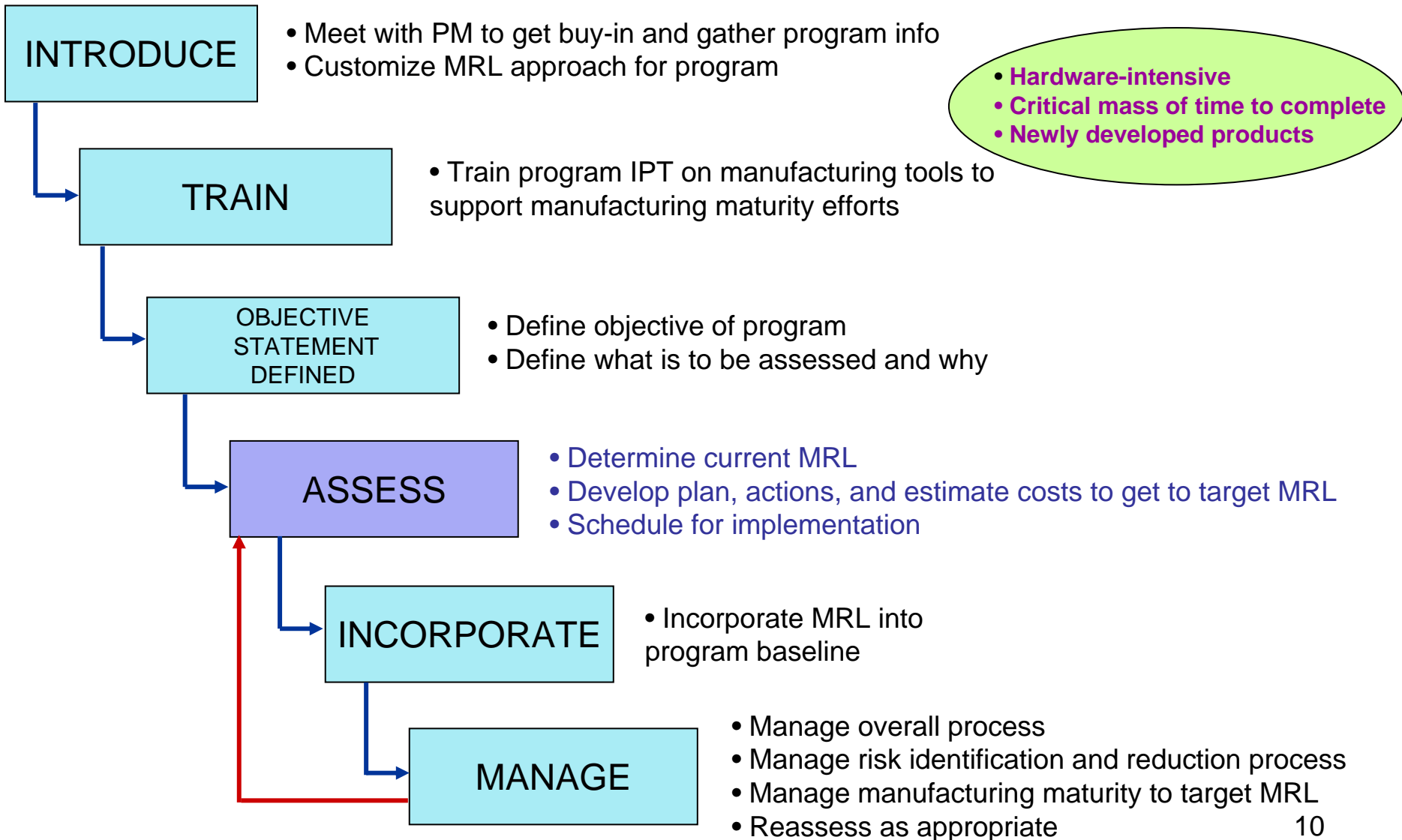
# MRL Incorporation into AFRL ATDs



- AFRL/RXM conducted ATD pilot assessments on five ATDs, Nov 04 – May 05
  - Identified gaps in manufacturing maturity that would delay technology transition upon ATD graduation
    - Highlighted what was required to turn technologies into products
  - Tasked by AFRL/CA to implement MRLs into all “hardware” intensive ATDs
    - Developed three year plan to reach steady state
    - Developed basic MRL implementation process
    - Developed training for ATD IPTs and ManTech personnel
- Identified core ManTech funding for MRAs and selected follow-on MRL maturation
- Now taking on all CAT I “hardware” intensive ATDs



# Manufacturing Readiness Level Implementation Approach (ATDs)





# MRA Deliverables



- Identification of **current MRL**
- Identification of key factors where manufacturing readiness falls short of **target MRL**
  - Define driving issues
  - Define high risk areas
- Identify programs and plans to reach target MRL
  - **Generate the manufacturing maturation plan (MMP)**
- Assess type and significance of risk to cost, schedule and/or performance





# Emerging MRA Successes

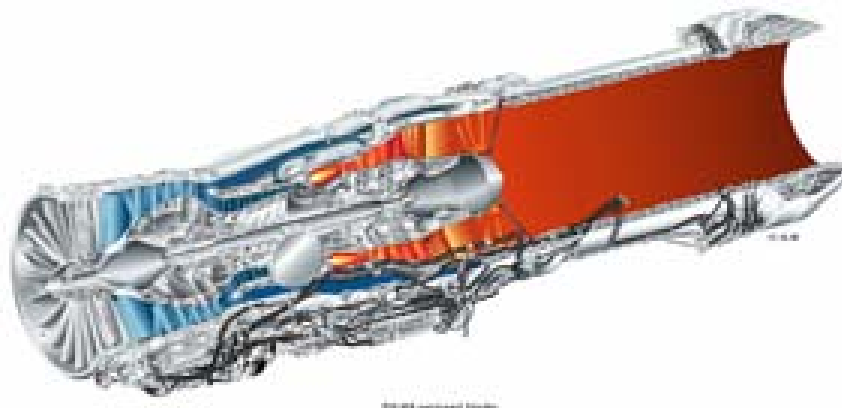


## High Durability Hot Exhaust Structures

- Provided identification of high risk processes and single point failures driving scale-up from MRL 3
- Maturation plan provides awareness of issues relating to move to new production facility
- Follow-on MRA at new facility will help ensure transition success

## F135

- Enabling opportunity to accelerate transition for F135 thrust improvement by ~4 years
- Advanced feature high cost driver: must overcome producibility issues
- Developed plan to mature from MRL 3 to 5 leveraging commercial and military IR&D, F135 program, and ManTech funding





# Emerging MRA Success



## Sensor Hardening for Tactical Systems (Two contractors)

- Identified common manufacturing readiness driver among both contractors -- Optical Power Limiter (OPL) -- MRL 3
- Drilling down into OPL supplier processes to identify root issues -- OPL also likely driver on Sensor Hardening for UAS ATD
- MRA enabling identification of common manufacturing issues and ManTech investment opportunity



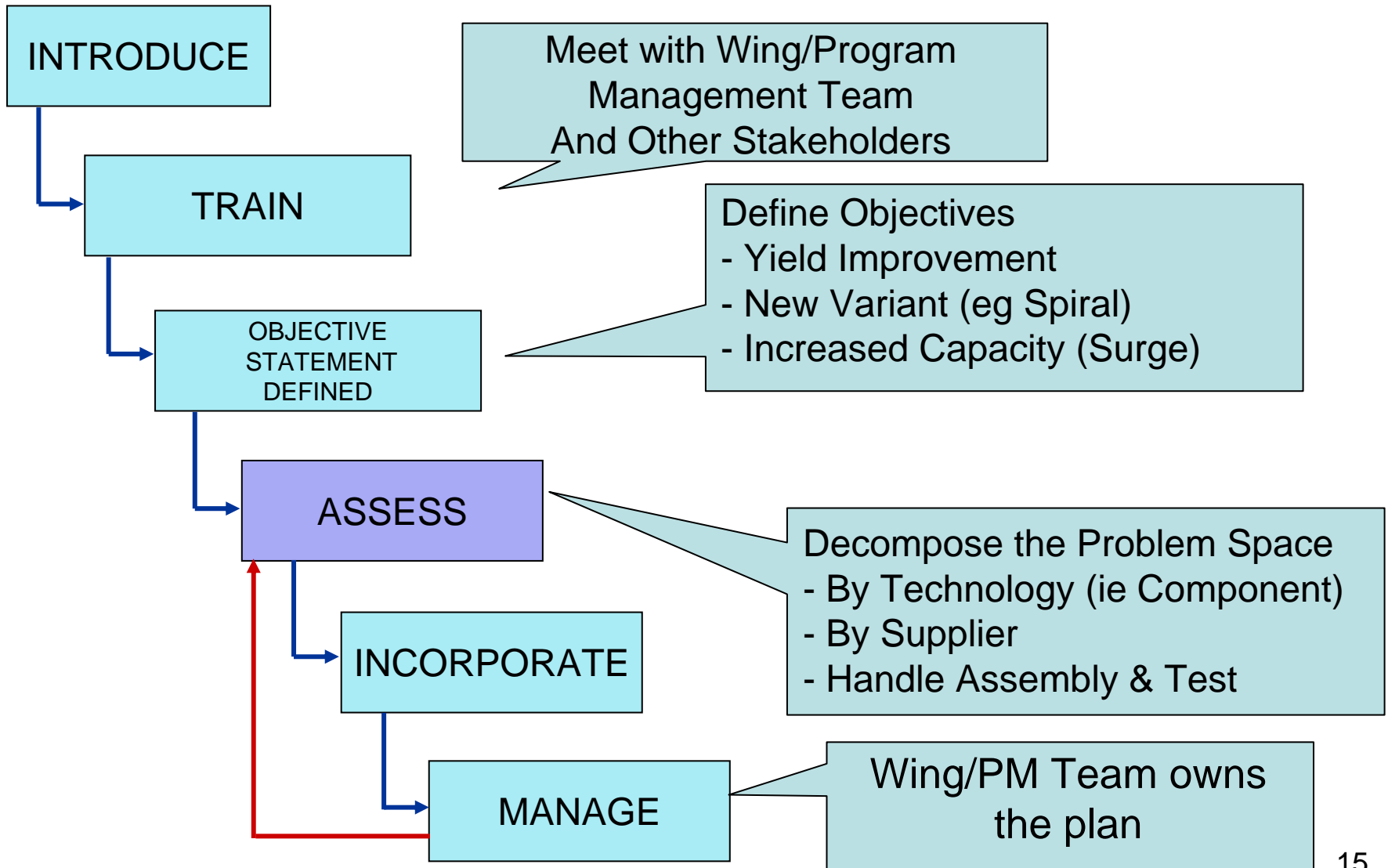
# ACAT MRA Pilot



- **Translate the successful MRL ATD process to acquisition programs**
- **Common themes**
  - Utilize approximately the same process
  - Utilize current MRL definitions to assess against
  - 3-5 people per MRA
- **What is different**
  - **ATDs focus on MRL 3 – MRL 6**
    - Assess manufacturing maturity with a goal of transition/implementation
  - **ACATs focus on MRL 4 – MRL 9**
    - Schedule, cost, manning considerations
    - Milestone decisions
    - Production planning process
    - Will require a more rigorous approach
- **Develop and document a structured ACAT assessment approach**
  - **MRA Deskbook**
    - First draft completed Mar 07 based on ATD and limited ACAT experience
    - Drafted with SAF/AQRE, MRL Working Group, and ASC/EN
  - **Test drive on acquisition programs**
    - Update based on lessons learned

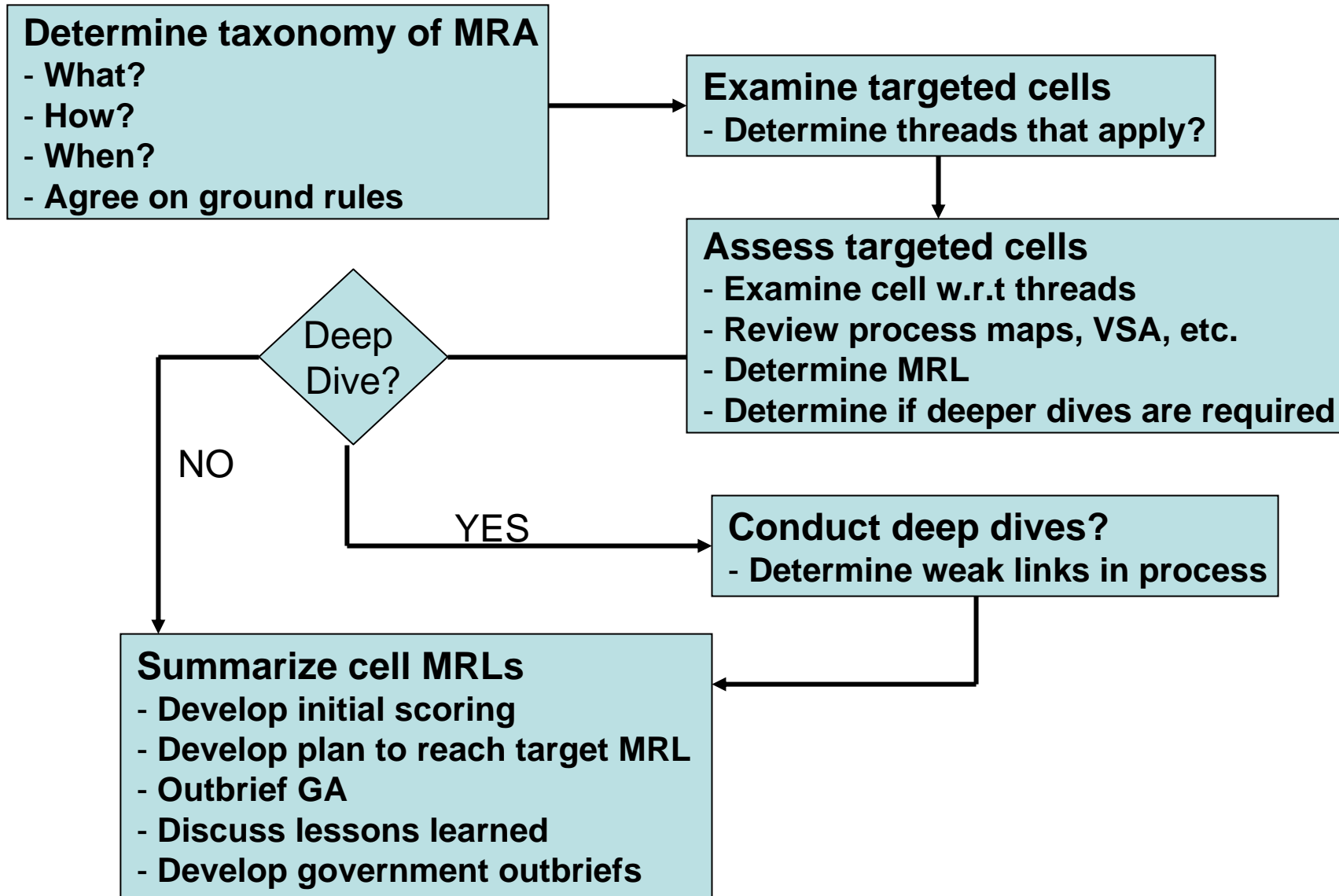


# Manufacturing Readiness Implementation Approach (ACATs)





# ACAT MRA Process





# AMRAAM



- What: Performed a system-level MRA on the AMRAAM C-7 variant
  - Looked at all test and assembly steps, including FACO
  - Fourteen key suppliers; over thirty-five technology areas examined
- Impact: Based on independent assessment, AMRAAM Group received go-ahead to proceed to next production lot for C-7 variant; reduced testing cycle time in particular cell by 90%





# Some MRA Thoughts



- MRLs are not a report card
  - ***MRL 7 might not be good***
  - ***MRL 3 might not be bad***
- MRLs are a tool to manage and mitigate manufacturing risk
  - ***A common language used to assess manufacturing maturity***
  - ***Provide insight not oversight***



# Some MRA Lessons Learned



- Process is more effective if company is actively engaged in the assessment
- System integration and test operations are often ripe for maturation efforts
- Resources required to conduct an MRA will vary significantly
  - Not all programs are equal
- Subject matter expertise is needed to “do it right”
- Templates and guidelines developed
  - Not a one size fits all solution
  - Engineering skills/judgment still need to be used
  - Avoid a checklist mentality





# Future Steady State



- Programs utilizing MRLs
  - Funding MRL maturation
  - Understanding of manufacturing concepts
- Use of MRLs in policy
  - Program offices staffed/trained
  - Manufacturing a key component for milestone reviews
- Training
  - DAU acts as the primary DoD training agent
  - AFIT supports detailed manufacturing training



# Additional Information



- MRL definitions can be found at DAU web site:
  - <https://acc.dau.mil/CommunityBrowser.aspx?id=18231>
    - Look for MR definitions
    - Look for MR matrix (threads)
    - Look for MRL tutorial
    - Look for MRA Deskbook
- Google – manufacturing readiness assessments



# In Closing



- Using a three-pronged approach to implementation
  - Piloting and incorporating into various programs
  - Training
  - Policy insertion
- Overall implementation is progressing
  - Air Force
  - DoD
- We are still learning and applying lessons learned

***Air Force is Leading DoD-wide Implementation***

# ***Headquarters U.S. Air Force***

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*Integrity - Service - Excellence*

## **Rapid Prototyping: Leapfrogging into Military Utility**



**Mr. Randy Walden**

**Air Force Rapid Capabilities Office  
(SAF/RCO)**

**9<sup>th</sup> Annual NDIA Science & Engineering  
Technology Conference**

**16 April 2008**



# Rapid Prototyping Needed

Force Protection  
(e.g., IEDs)



Homeland Defense  
concerns



Faster evolution of  
traditional threats



- **Asymmetric threat has a very short timeline for change**
  - **COTS timeline available to threats**
  - **WWW used by threat**
- **DoD Acquisition has relatively long timeline**
  - **Limited access to COTS**
  - **Budget process is multi-year**
- **Complex systems stress definition of requirements/architecture**
  - **Requirement trade-offs delay system**
  - **Only as fast as slowest element**



# SAF/RCO Rapid Prototyping

---

## *Objectives*

- Rapidly develop new capabilities to counter the increasing pace of threat evolution
  - Improve acquisition process; facilitate faster transition of S&T to warfighter
  - Realistic definition of requirements & architectures for complex problems; prototype to innovate
- 

## *Enablers*

- Mindset: acceptance of 80% solution
- Team: leadership support, warfighter involvement, “A-team” executing
- Investments for the future: open architectures, etc.
- Experience: practice to improve



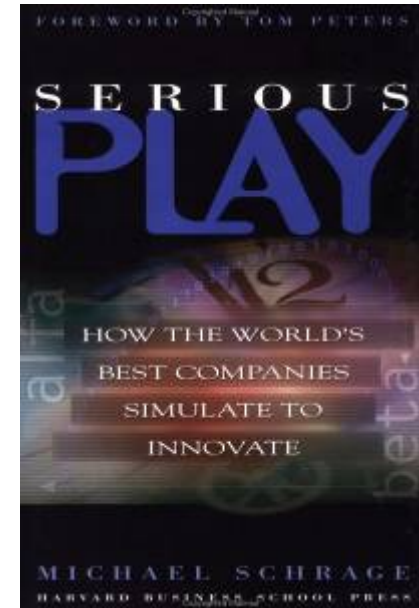
# “Rapid Prototyping” in Commercial Industry



*A tool for rapid design & manufacturing ...*



*A way to rapidly get products to market ...*



*A way to innovate ...*

**Not a new idea; approaches well established in commercial industry**



- Motivation / Objectives
- ➔ ■ Air Force Rapid Capabilities Office
- Rapid Prototyping
  - Rapid capability development examples
  - Enablers to rapid development
  - Prototyping to innovate
- Summary





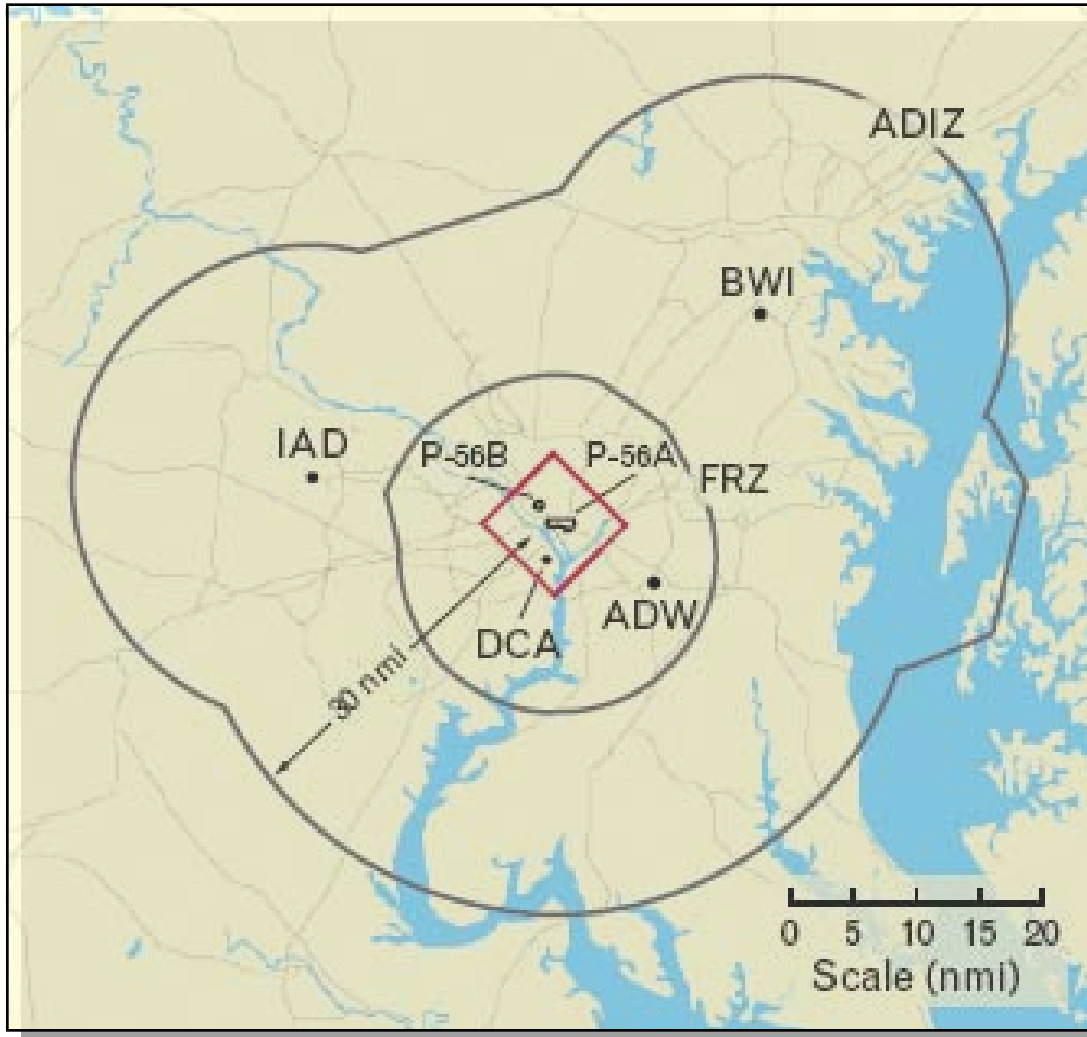
# Air Force Rapid Capabilities Office

---

- **Established April 2003**
- **Mission: Expedite development and fielding of select DoD systems**
  - **Leveraging defense wide technology development efforts and existing operational capabilities**
- **Reports directly to Board of Directors**
  - **SecAF, CSAF, SAF/AQ, and USD(AT&L) chairs**
  - **Responds to Combat Air Force (CAF) and Combatant Command (COCOM) requirements**
- **Rapid Prototyping Example: National Capital Region (NCR) IADS**
  - **Enhanced Regional Situational Awareness (ERSA)**
  - **Norwegian Advanced SAM System (NASAMS)**



# National Capital Region Airspace



**ADIZ – Air Defense Identification Zone**

**FRZ – Flight-Restricted Zone**

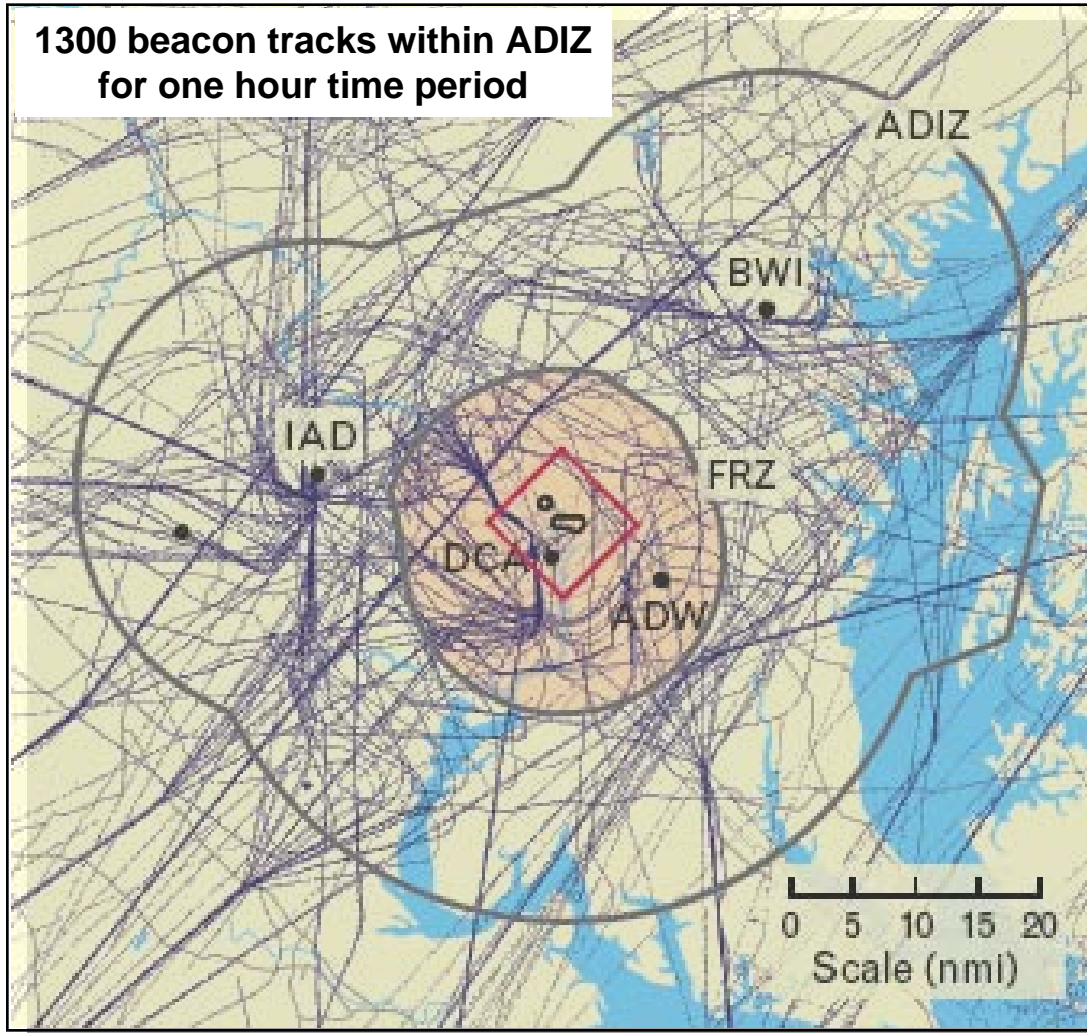
**IAD – Dulles International Airport**

**DCA – Reagan National Airport**

**ADW – Andrews Air Force Base**



# National Capital Region Airspace



**ADIZ – Air Defense Identification Zone**

**FRZ – Flight-Restricted Zone**

**IAD – Dulles International Airport**

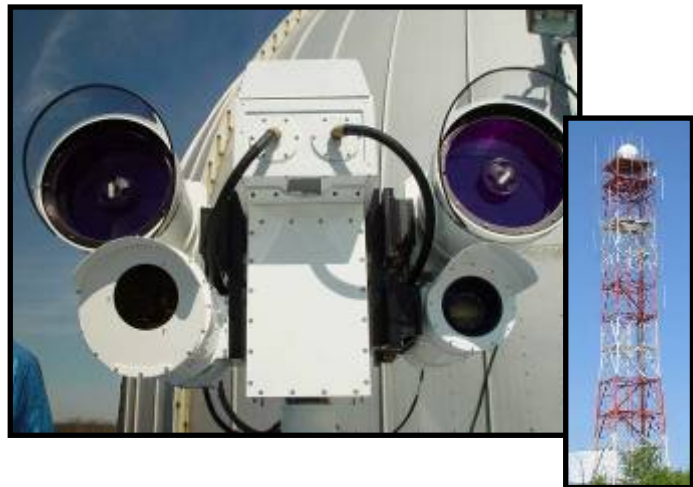
**DCA – Reagan National Airport**

**ADW – Andrews Air Force Base**



# RCO Rapid Developments

## Enhanced Regional Situational Awareness (ERSA)



- Integrated air defense system for National Capital Region (NCR) in 2 years
- Operational for Jan 2005 Presidential Inauguration
- Developed and Fielded
  - Tower Mounted Radars
  - Aircraft ID
  - Visual Warning

## Norwegian Advanced Surface to Air Missile System (NASAMS)



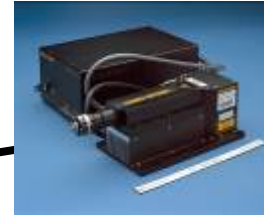
- Developed & integrated system into NCR IADS
- 9 months from Chairman JCS tasking to IOC



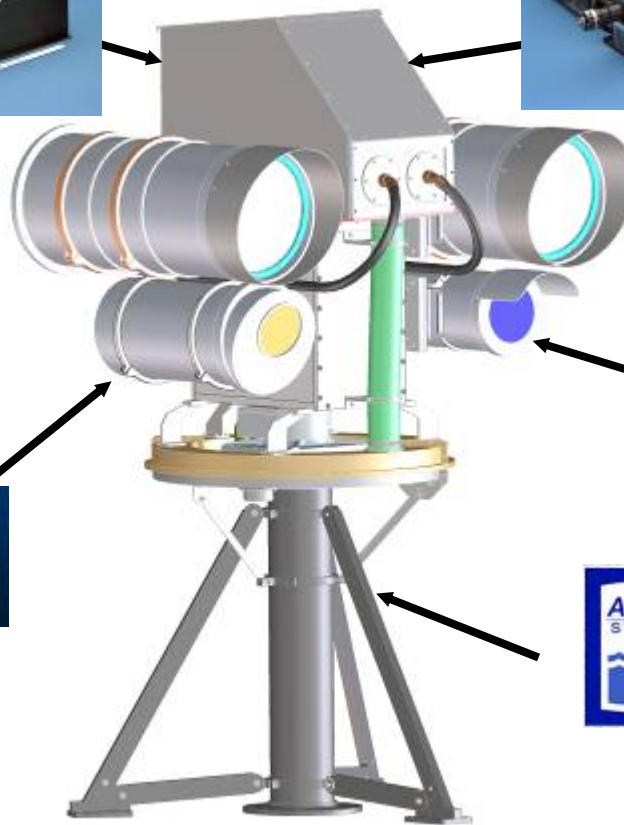
# Rapid Prototyping Visual Warning System (VWS)



Red Light



Green Light



Visible Camera



Infrared Camera



Pedestal

Visual Warning System developed by rapidly integrating COTS to create a new capability



# Visual Warning System (VWS)

- Provide visual warning to errant pilots entering NCR airspace
- Eye safe system at aperture and beyond
- Precision pointing at single aircraft
- Special Flight Advisory has been published on meaning of lights
- Operational on 21 May 2005



- Warning Sequence with translucent covers on



- Nighttime aircraft view from 3 nm, 28 Jan 05





# NORAD uses the Visible Warning System

## U. S. Capitol, 12 March 2008

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### AIR SAFETY

## Small Plane Enters Restricted Space

2nd Incident in a Week Prompts Calls to Refine Evacuation Process at Capitol

By [Mary Beth Sheridan](#)

Washington Post Staff Writer

Thursday, March 13, 2008; Page B06

A small plane penetrated restricted air space and flew within six miles of the U.S. Capitol yesterday before being intercepted without incident, officials said.

When air-traffic controllers couldn't reach the pilot by radio, military personnel on the ground aimed red and green warning lights at the cockpit, said Maj. Brian Martin, a spokesman for the [North American Aerospace Defense Command](#), or NORAD. That prompted the pilot to veer west, Martin said.

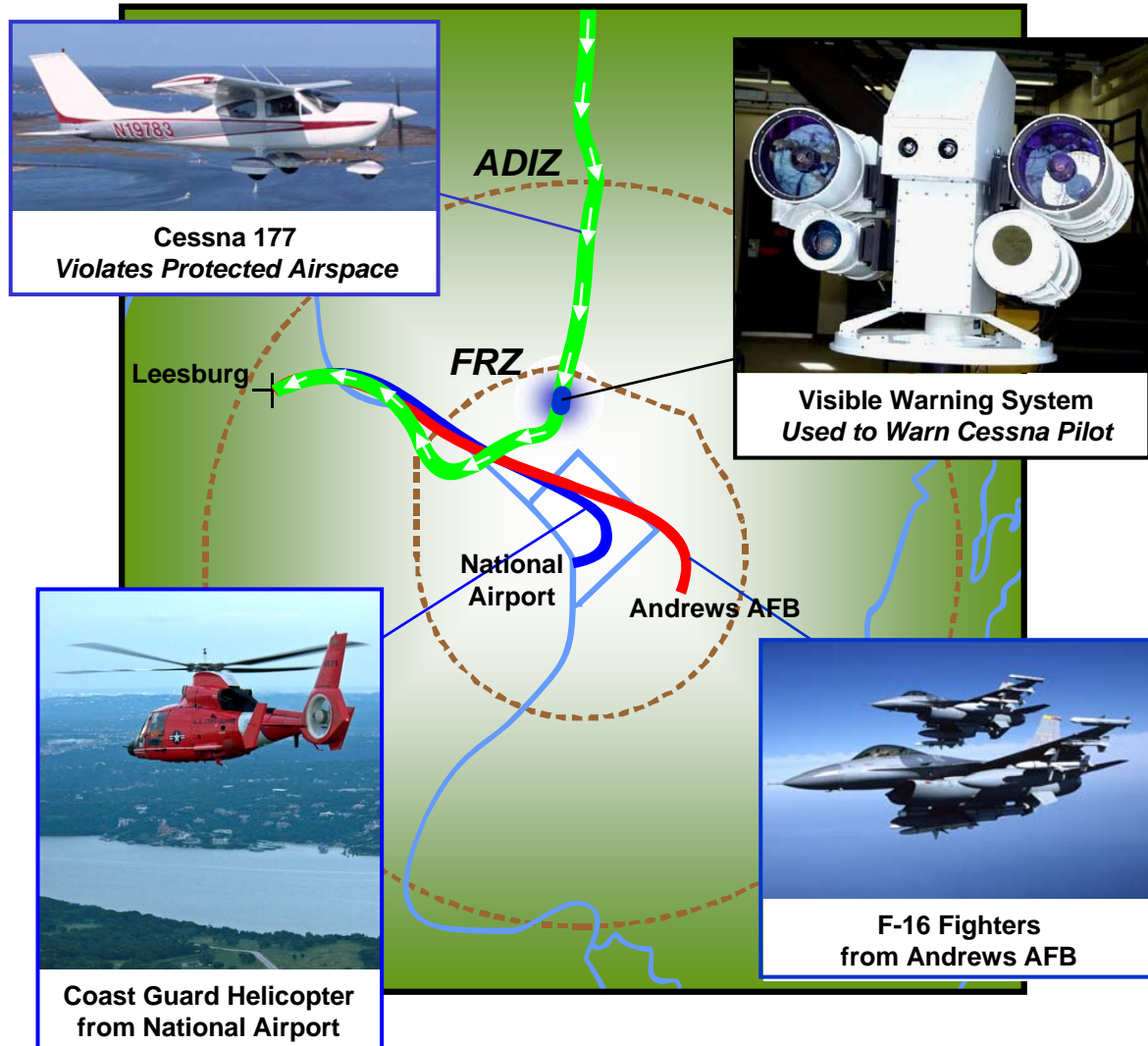
Two F-16 jets from [Andrews Air Force Base](#) and a [Coast Guard](#) helicopter escorted the plane to [Leesburg](#) airport, where the pilot was questioned by the [Secret Service](#) and the FAA, officials said. He was not considered a threat, they said.

***A NORAD spokesman  
cites the use of the  
Visible Warning System***



# 12 March 2008 Events

- A Cessna 177 crosses the Air Defense Identification Zone (ADIZ) in violation of airspace rules
- NORAD warns pilot using the Visible Warning System
- The Cessna is escorted to Leesburg Airport by F-16 interceptors



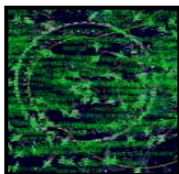




# NASAMS Integration Timeline



Chairman JCS Direction ▲



AT&L funding ▲

Fire Control Cue Developed ▲

Integration with fire control unit ▲



Fire Distribution Center

Live Fire Tests ▲ ▲

NORAD Validation and Acceptance Testing ▲ ▲

NASAMS IOC in NRC ▲



**NASAMS developed, deployed and operational in nine months**



## *Key Attributes for Rapid Fielding*

---

- **Clear Charter with Clear Priorities**
  - **Schedule was #1; field ERSA by inauguration day 2005 (18 months)**
  
- **Senior DoD, Joint Staff, US Air Force, & US Army leadership buy-in**
  - **Short chain of command facilitated quick decisions**
  
- **Small, Focused, Empowered Team; 5 – Program Office, 7 Contractor, plus key external POC's**
  - **Experienced, solution oriented, A-team type personnel**
  - **QRC focus – Long hours, 6 & 7 days/week were routine**
  
- **Recognition of Need for After-Fielding Clean Up**
  - **Formalized needed leases and MOAs/MOUs**
  - **Minor safety adds to installed equipment**
  - **Long-term transition planning**

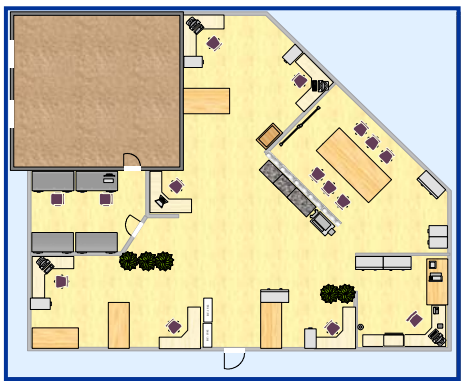


- **Motivation / Objectives**
- **Air Force Rapid Capabilities Office**
- **Rapid Prototyping**
  - **Rapid capability development examples**
  - ➔ ■ **Enablers to rapid development**
  - **Prototyping to innovate**
- **Summary**



# Enablers to Rapid Development

Facilities



Hardware / Software Enablers

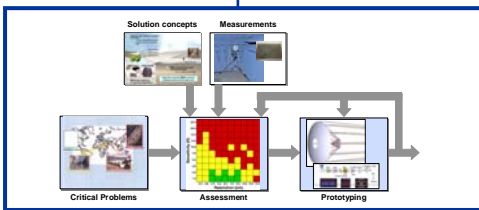


Rapid Innovation Cell

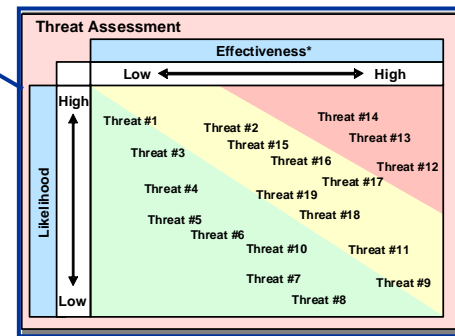
User Connection



Blue Team Process



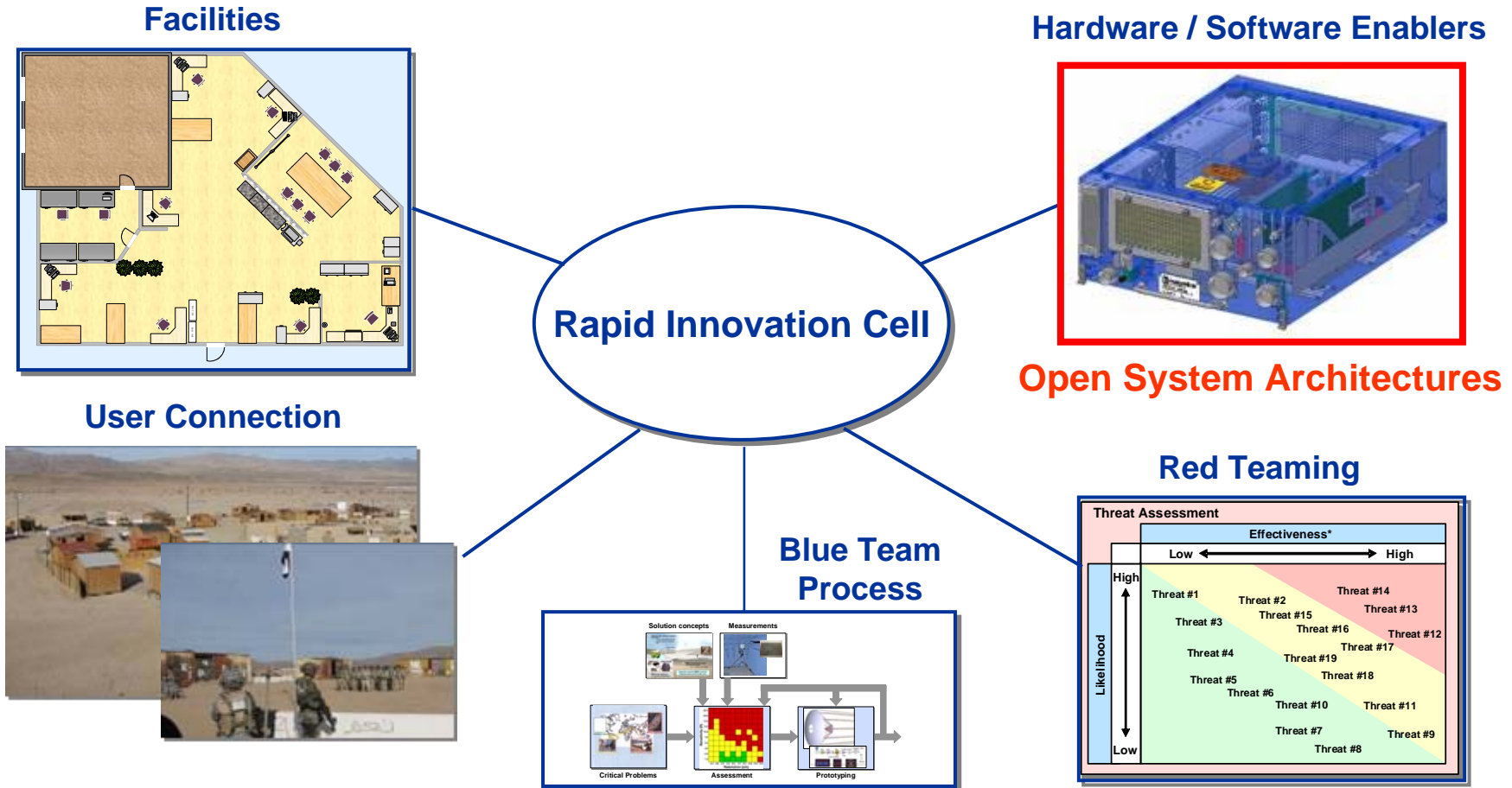
Red Teaming



- Series of elements key to enabling rapid innovation, demonstration, prototyping, and fielding of critical military capabilities



# Enablers to Rapid Development



• Series of elements key to enabling rapid innovation, demonstration, prototyping, and fielding of critical military capabilities



# Open System Architecture

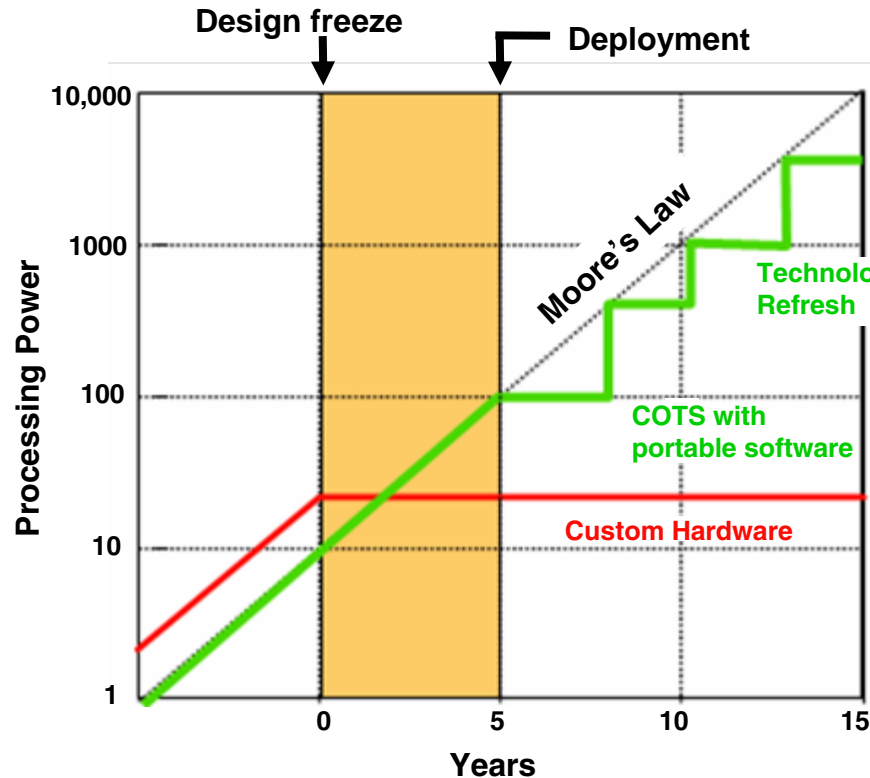
## *Advantages*

---

- ***Commonality allows lower cost ...***
  - Plug and play pieces reusable from system to system
- ***Innovation enabler ...***
  - Allows entrance of “smaller” players, often with innovative ideas
- ***Rapid development & rapid upgrades ...***
  - Open design allows replacement of individual components
  - Allows isolation of components that evolve technically at differing rates (e.g., rapid Moore’s Law advance in computing)
  - Upgrades vs. replace; more responsive to agile threats



# Open Systems Support “Leverage Adapt” Strategy



## “Leverage & adapt”

- Good for rapidly changing technology
- Good for rapidly changing requirements
- Built-in refresh and improvements
- More difficult to manage

## “Freeze & build”

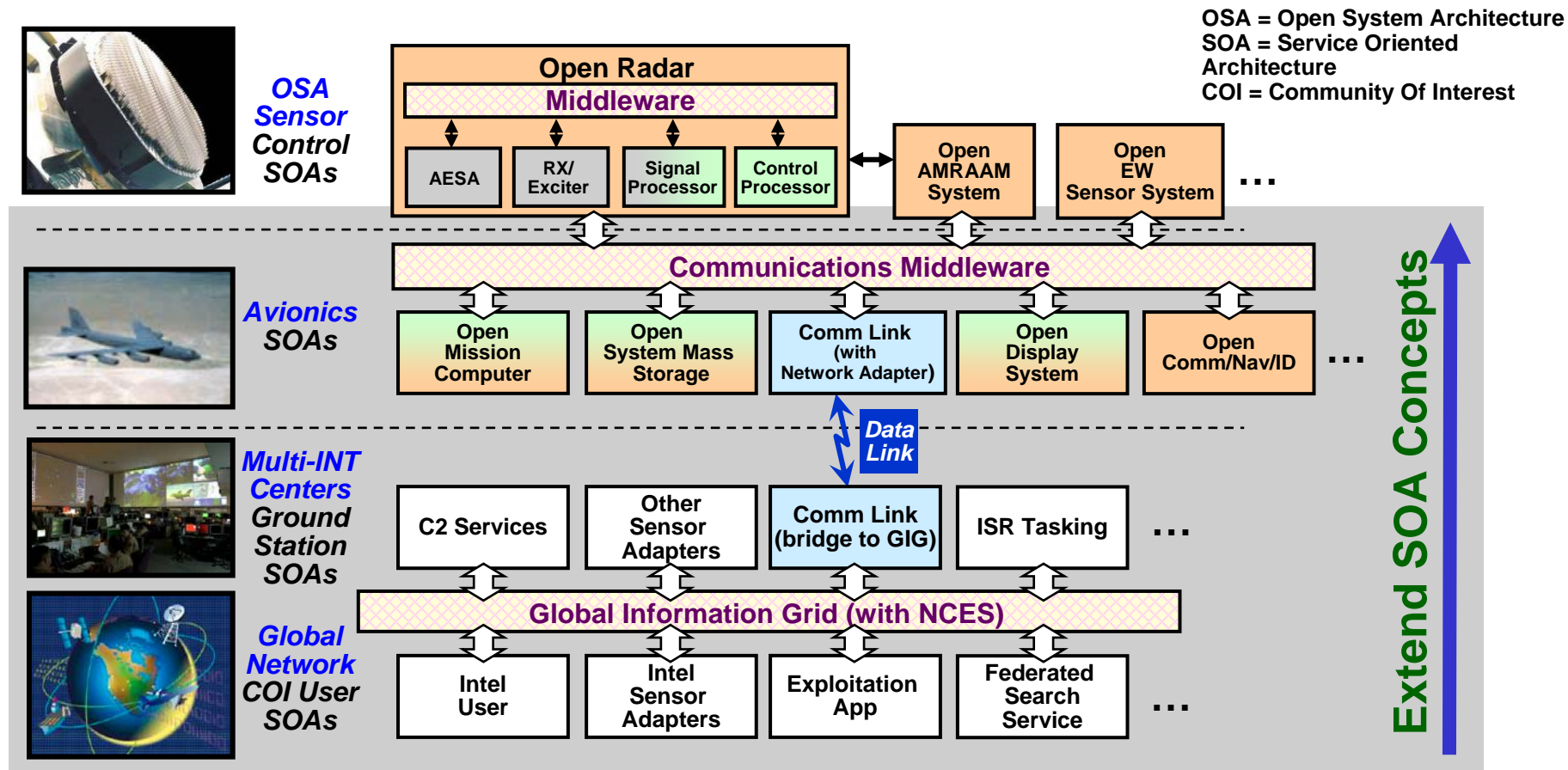
- Freezes technology and builds to fixed design
- Acceptable for slow moving technologies
- Requires stable requirements throughout lifecycle
- Easier to manage with current acquisition strategy

- Open Systems supports “leverage and adapt” strategy; allows DoD to leverage commercial industry’s investment
- Continuous upgrade/refresh possible to meet evolving threats and obsolescence





# Layered Open System Architecture Approach



- Change with technology and readily add new capabilities





- **Motivation / Objectives**
- **Air Force Rapid Capabilities Office**
- **Rapid Prototyping**
  - **Rapid capability development examples**
  - **Enablers to rapid development**
  - ➔ ■ **Prototyping to innovate**
- **Summary**



# Prototyping Facilitates Innovation



**“It is far easier for [users] to articulate what they want by playing with prototypes than by enumerating requirements.”<sup>†</sup>**



<sup>†</sup> Schrage, Michael, *Serious Play: How the World's Best Companies Simulate to Innovate*, Harvard Business School Press, December 1999.

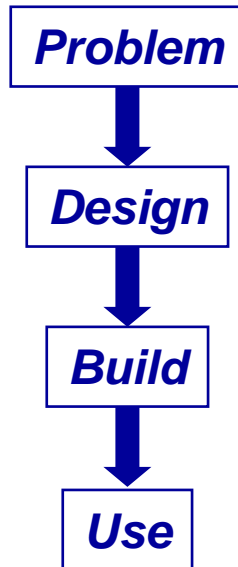
- Key additional use of rapid prototyping is for innovation; “simulate to innovate” concept



# Development Approaches

## Linear / “Waterfall” Approach

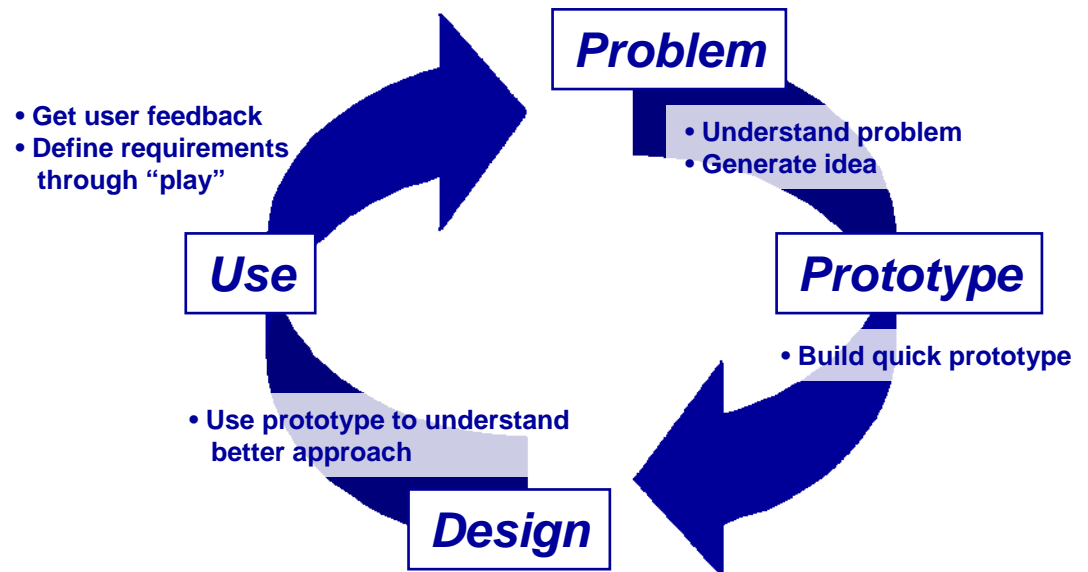
### *Fixed Design*



- Assumes “design” can be accomplished a priori
- No developer / user co-design

## Rapid Prototype Approach

### *Inherent Feedback*



- Build prototypes to explore “design” approach
- Iterate based on user feedback; design influenced by user response



# Prototype to Innovate

## *National Capital Region IADS*



- **Integrated Air Defense for protection of the National Capital Region**

## *Touch Table*



- **Vehicle for novel data extraction / representation and action**

## *X-37B Orbital Test Vehicle*



- **Unmanned reusable vehicle test platform for new space technologies**



# Summary

---

- **Rapid prototyping permits timely, cost effective military capability development**
  - **Strongly motivated by increasing pace of threat cycle**
  
- **Air Force Rapid Capabilities Office (SAF/RCO) established to expedite development of selected DoD systems**
  - **Number of successful projects (e.g., ERSA, NASAMS)**
  
- **Success of rapid developments dependent on variety of factors**
  - **80% solution mindset, strong team, enabling investments (e.g., Open system architectures)**
  
- **Additional rapid prototyping role in innovating new military capabilities**
  - **Rapid prototyping cycle allows refinement of solution**



# Challenge to S&T Community

---

- Traditional “S&T Gap” still exists; greater warfighter interchange needed
- Apply rapid prototyping approach earlier in S&T development

*Early insertion of new technologies*  
*Faster innovation*  
*Discovery of new / advanced capabilities*

Mr. Randy Walden / (703)696-2407 / safcroworkflow@pentagon.af.mil



9th Annual Science & Engineering Technology Conference /  
DoD Tech Exposition

# Boeing's Approach to Innovation & Technology Integration

**Dr. David Whelan**

Vice President & Deputy GM, Advanced Systems  
& Chief Scientist, Integrated Defense Systems  
The Boeing Company

April 16, 2008



# The Boeing Company Today

Boeing Technology

Integrated Defense Systems

## Boeing Commercial Airplanes



## Integrated Defense Systems





# Customers Demanding Connected, Integrated and Intelligent System of Systems

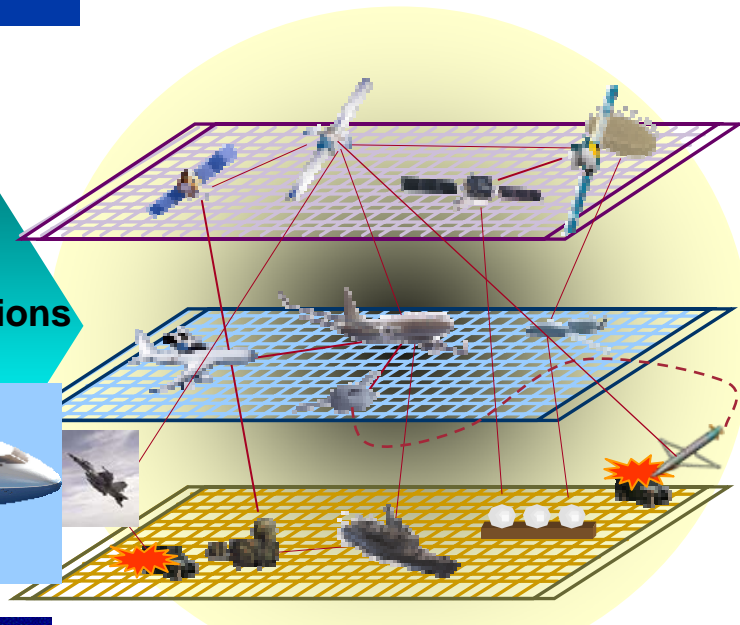
Boeing Technology

Integrated Defense Systems

**Today**

**Transformation Programs**

**Tomorrow**



**Ad hoc network of highly adaptable systems**

***Boeing is balancing a customer pull for integrated systems with technology push for "Innovation"***

# Innovation Strategy

Boeing Technology

Integrated Defense Systems

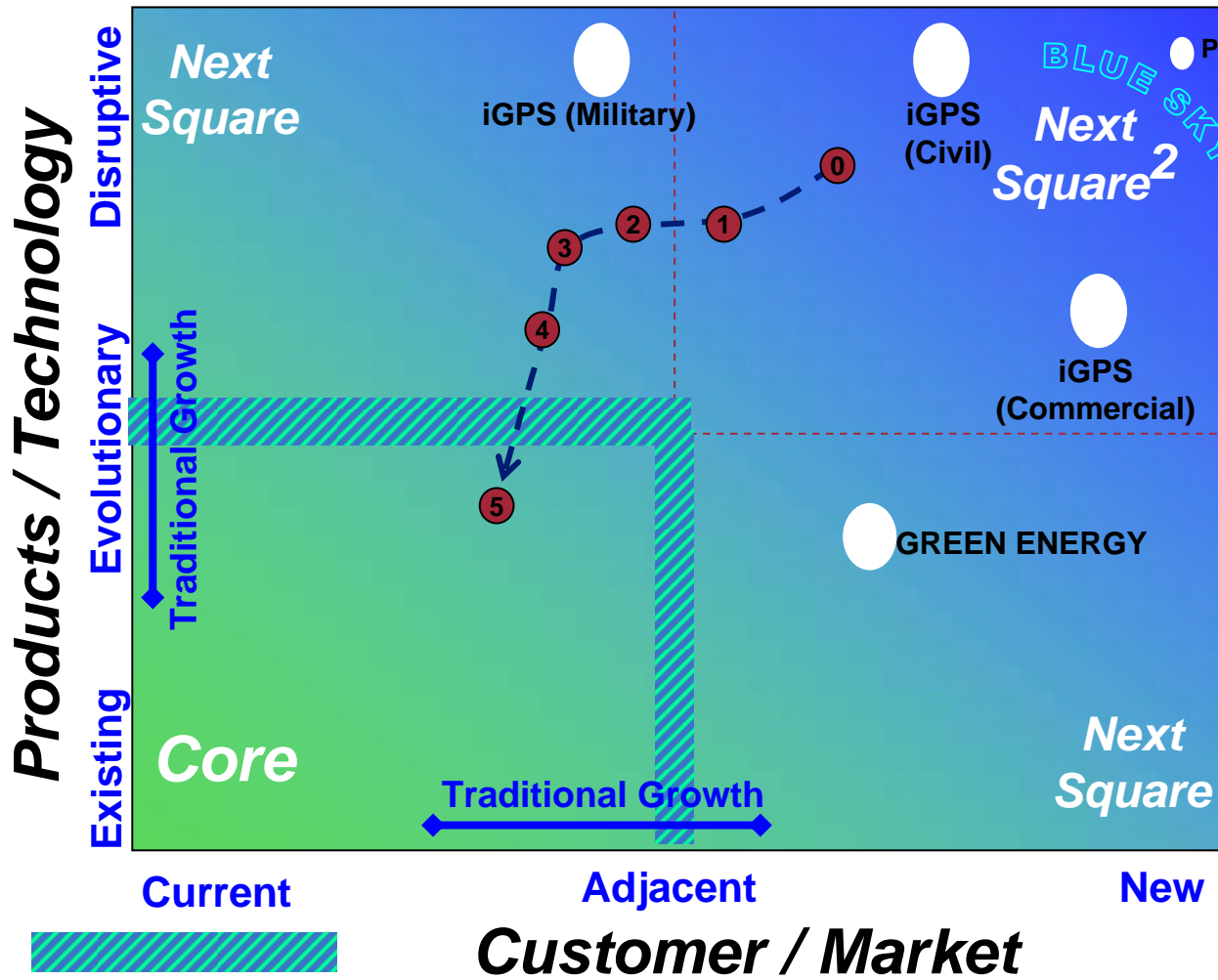
- **Leverage Boeing technology to find & develop growth platforms:**
  - Markets & businesses that meet Boeing criteria
- **Create competitive advantage in new markets and businesses**
  - Leverage Boeing's differentiated assets
  - Focus on Breakthrough Technology
  - Create new verticals via development/acquire
- **Leverage outside R&D resources (DARPA, military labs, universities,...)**
- **Efficient Stage/Gate Innovation Process**
  - Migrating growth opportunities to comfort zone



# Strategy for Technology Integration – Spiral to Core

Boeing Technology

Integrated Defense Systems



*The Key was to move FCS toward the core by:*

✓ **Partnering**

- ① **Experimentation & Customer Feedback**
- ② **Teamed with SAIC**
  - Army Land Combat domain knowledge
- ③ **Army LSI for FCS**
  - UDLP & GD added

✓ **Spiral Development**

- ④ **Phased Technology Increments**

✓ **Spiral Out**

- ⑤ **To Current Force**

Transitions - Spiral to Core

# Technology Integration Driven by Customer Requirements (Pull) and Innovation (Push)

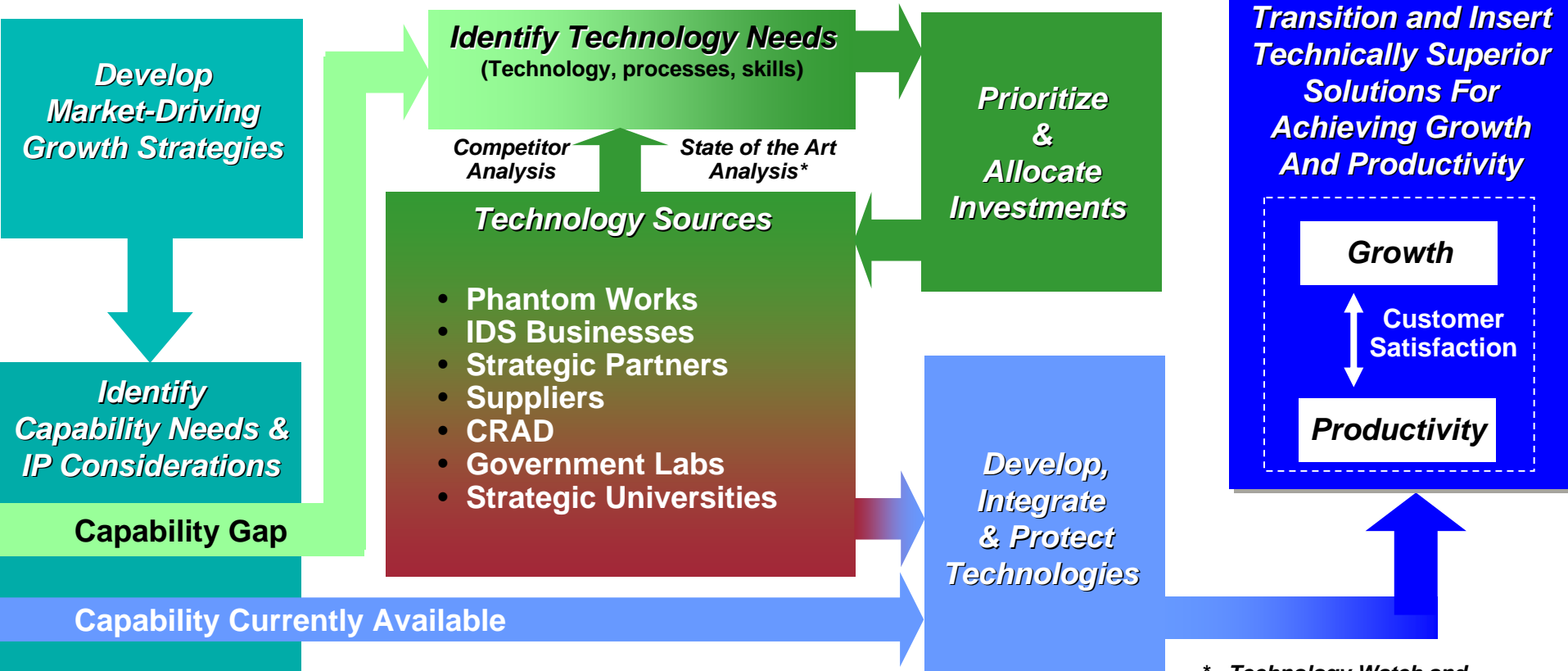
Boeing Technology

Integrated Defense Systems

**Understand Customers Most Important & Deficient Capability Needs**



Spin-off to Adjacent Markets (Next Square<sup>2</sup>)



\* - Technology Watch and Disruptive Technologies - STFs

# 21<sup>st</sup> Century Defense Technology Vectors

Boeing Technology

Integrated Defense Systems

## Key Vectors

### Boeing Perspective

## Imperatives

<u>Key Vectors</u>	<u>Products</u>	<u>Development</u>	<u>Research / Ideas</u>	<u>Imperatives</u>
<u>Precision Sensing, Navigation &amp; Timing</u>	ICBM-IMU <u>JDAM</u>	GPS-IIF <u>SDB</u>  <u>GMD</u>	GPS-III  <u>iGPS (Comm &amp; Nav)</u>	<u>10 x improvement, Integrate Comms &amp; Navigation</u>
<u>Integrated C4ISR</u>		<u>FCS SOSCOE</u>  P-8A	EP-X  <u>TSAT</u>  Foliage Penetration	<u>No Stovepipes between ISR Systems Ad-Hoc Task/Exploit</u>
<u>Info Assurance</u>	EA-18G  Railhead	<u>JTRS</u>  <u>Secure Network Server (SNS)</u>	High Integrity Knowledge Mgmt	<u>High Integrity Networks &amp; Computer Systems</u>
<u>Nano-electronics &amp; Nano Technology</u>	<u>ASIC Processors</u>	G-bytes/sec Analog-Digital  Mission Specific Processors	RF & Digital Systems on Chip  Carbon-X	<u>Intelligence at the edge, 20 yrs till Silicon = Human</u>
<u>Laser &amp; Photonics</u>		<u>ABL</u>	<u>Laser Comms</u>  ATL Solid State HE Lasers	<u>Communicate, Tag and Engage at the Speed of Light</u>
<u>Unmanned Systems &amp; Robotics</u>	<u>ScanEagle</u>	A-160  FCS Robotics	<u>Orbital Express</u>  Variably Manned Systems	<u>High Integrity Zero "Pilot" Operations</u>
<u>Energy &amp; Environment</u>	<u>Space Solar Cells</u>	Terrestrial Solar Cells	Bio-Fuels BWB H <sup>2</sup> Powered UAVs	<u>High Efficiency, Zero Emissions, Alternate Energy</u>

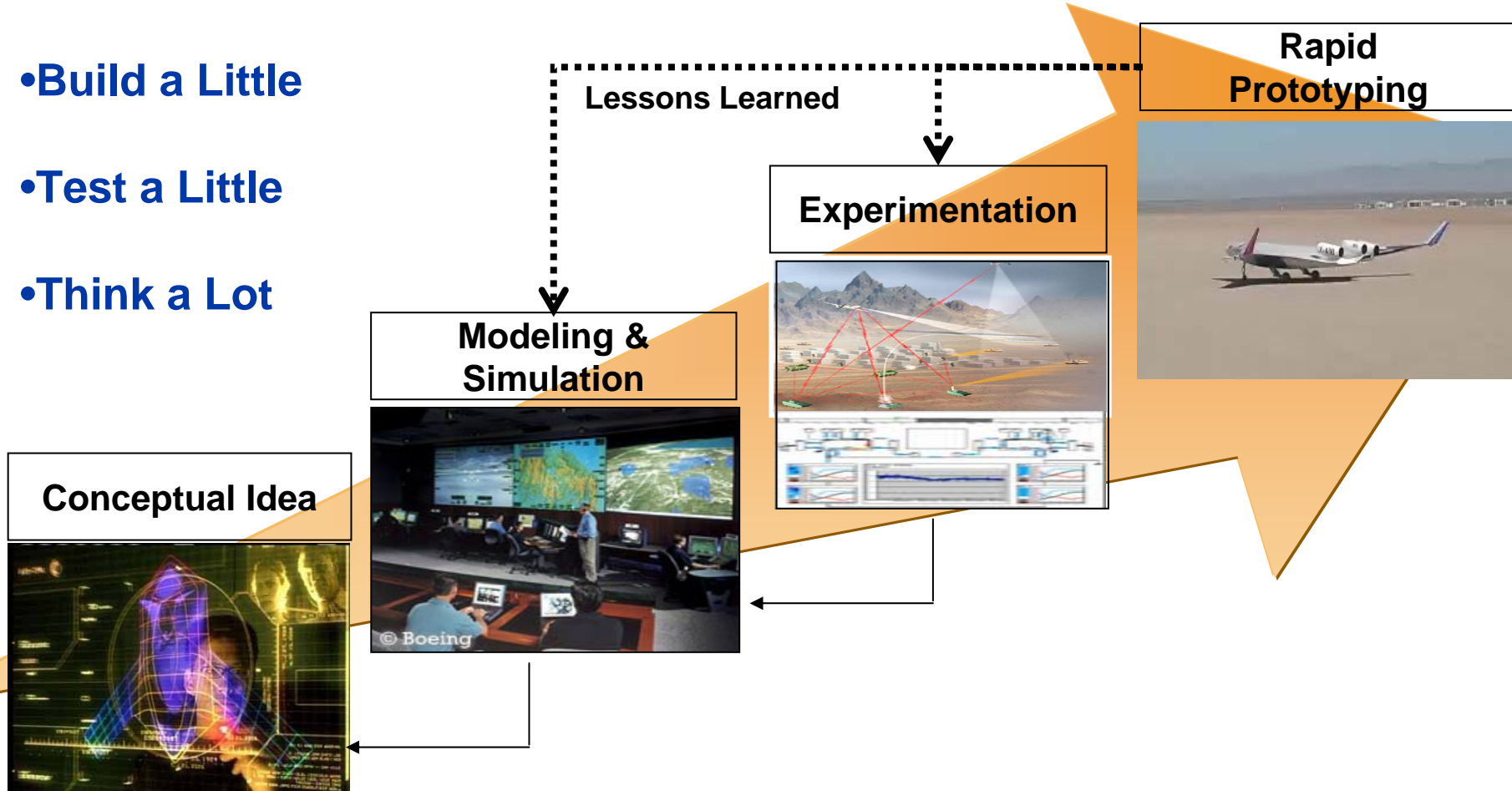


# Successful Technology Integration Requires M&S, Experimentation, and Rapid Prototyping

Boeing Technology

Integrated Defense Systems

- Build a Little
- Test a Little
- Think a Lot

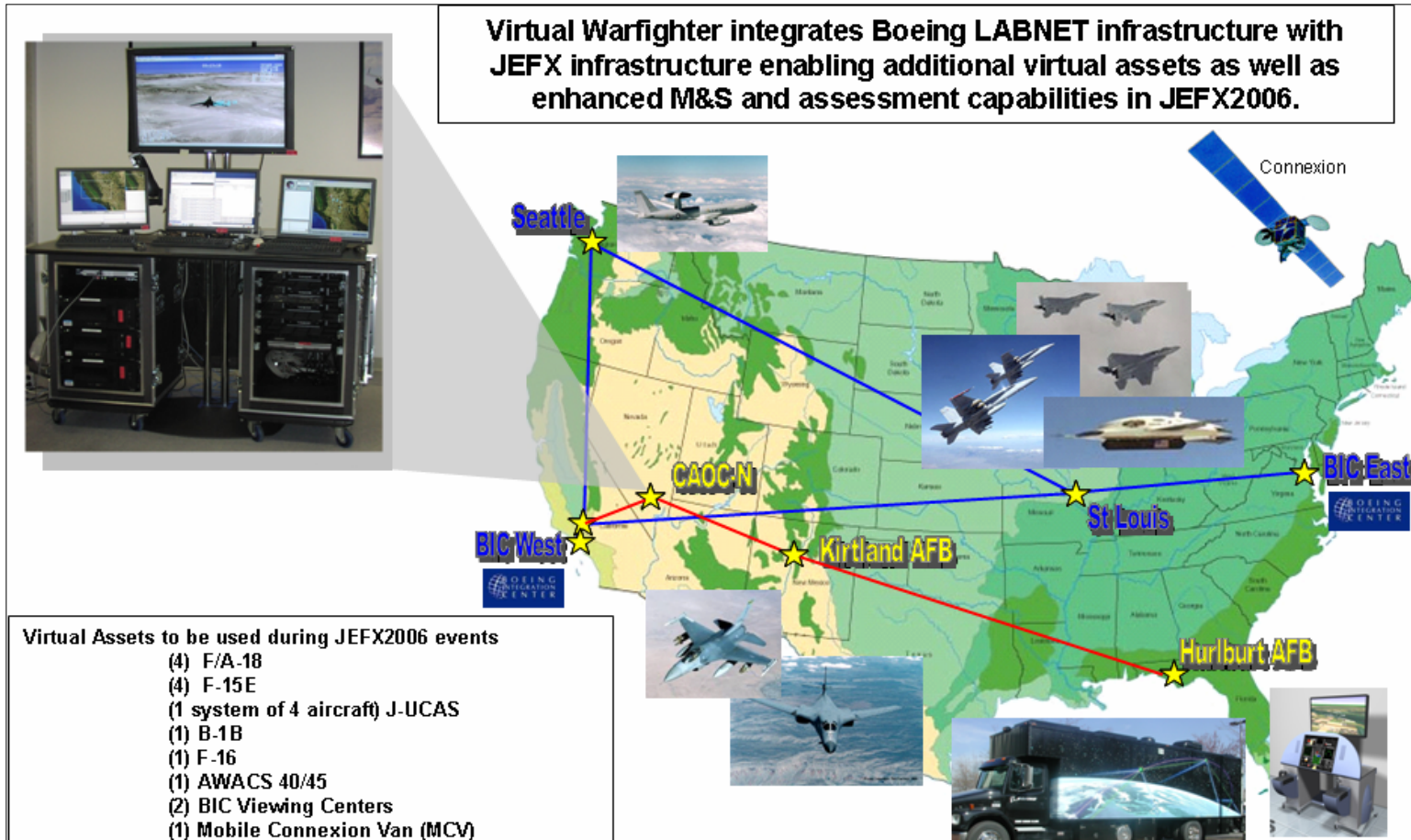


**Key Components for Successful Technology Integration**

# Modeling & Simulation Environment

Boeing Technology

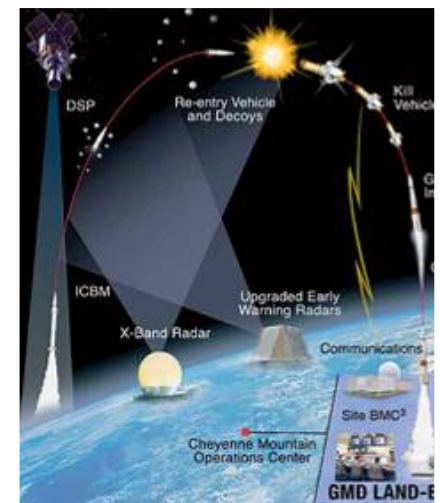
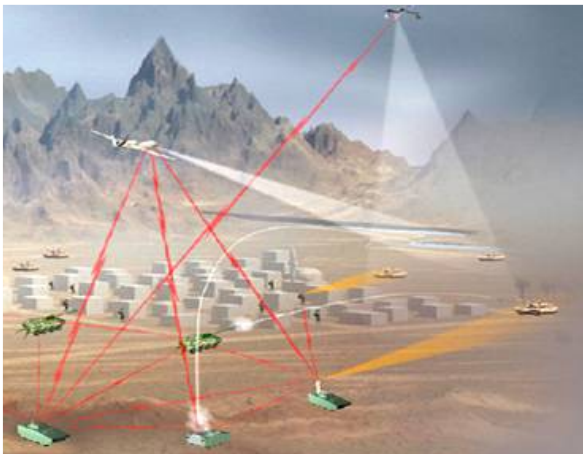
Integrated Defense Systems



**Live-Virtual-Constructive enables Pilots to fly real hardware in live events without live fly costs**

# Technology Evaluation through Experimentation

- **Experimentation, using M&S, enables exploring the impact of new technology at every level of insertion...before building or buying**
  - For example, improved sensor and data link capability in A&M aircraft supporting BP counter drug operations (existing military or entirely new)
  - Or new counter cruise missile radar/sensor capabilities
  - Or better forest firefighting equipment
  - Or new WMD detection capabilities
  - Or direct hospital to first responder medical support technologies
  - Or ...





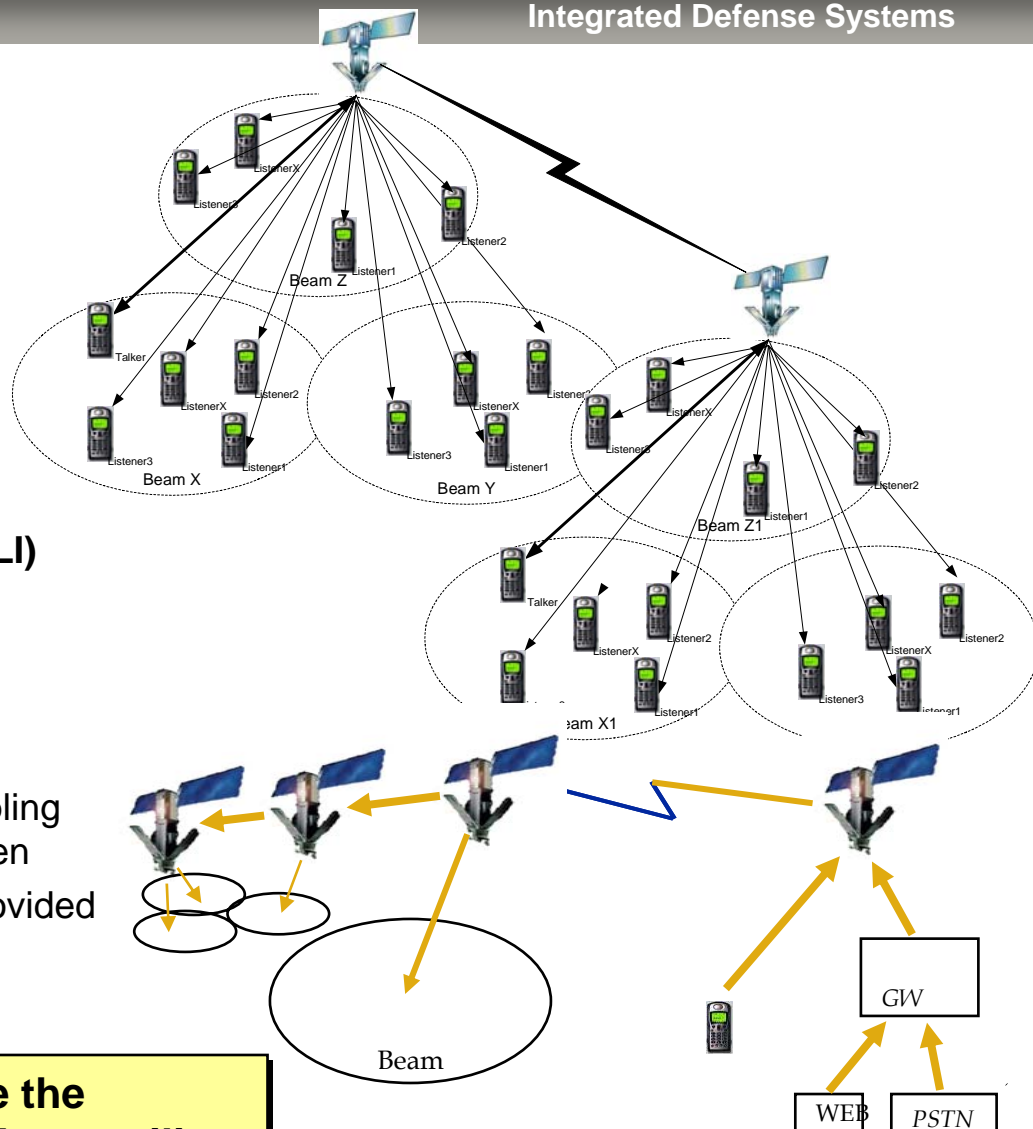
# Boeing's & Iridium's "Group Call" On-Orbit Upgrade

Boeing Technology

Integrated Defense Systems

**Enables Iridium Cellular system to function a "UHF Satcom Radio"**

- **Service(s)**
  - Support DOD customers
    - Encrypted service, does not require call intercept
  - Three types of Services
    - Push to talk (PTT)
    - Broadcast
    - Position Location Information (PLI)
  - GC shall not impact the call performance of non-GC users
- **Security**
  - All group calls shall be encrypted
  - System shall have the capability of disabling specific users if equipment is lost or stolen
  - Encryption key management shall be provided
  - All group members shall have the latest encryption update prior to joining a GC



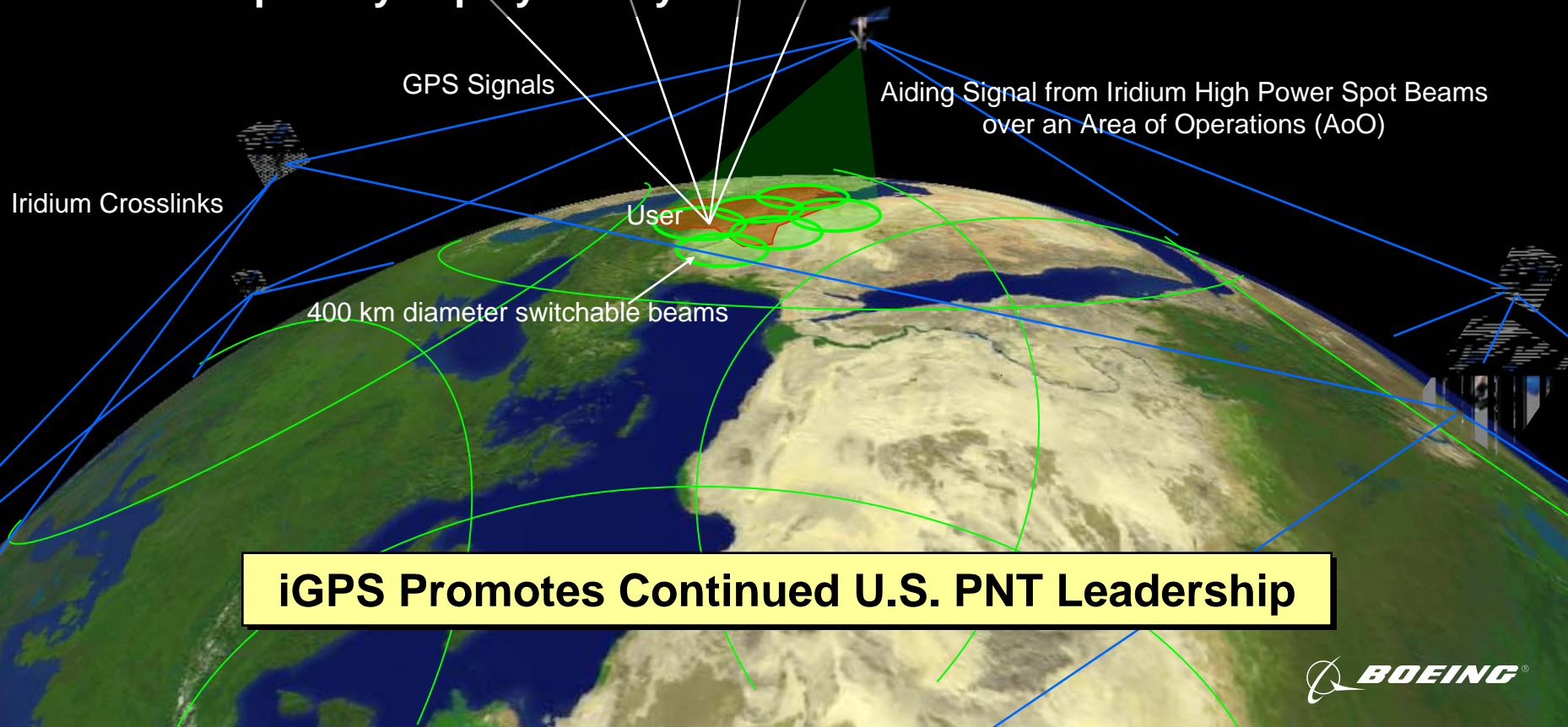
**Boeing has already been able to upgrade the constellation to offer new services with Army utility**

# High Integrity GPS (iGPS Enhancement via Iridium)



Enabled by Horizontal (ground) Integration of Iridium Nav-Com System & GPS

- Disruptive innovation opportunity to address unmet needs
  - Antijam, Accuracy, Integrity, Availability
- Creates a more Robust PNT Constellation
- Integrates GPS's Psuedorange multilateration with Transit's FDOA
- Initial capability deployable by 2010



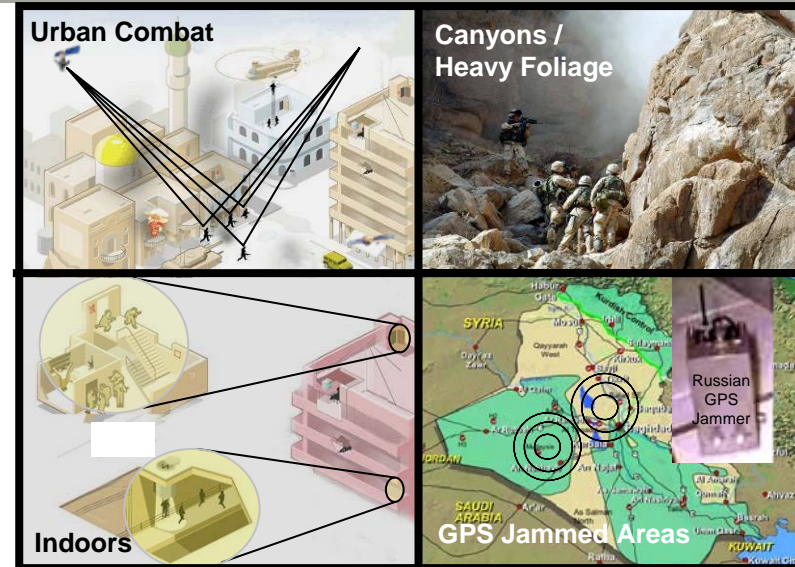
**iGPS Promotes Continued U.S. PNT Leadership**

# Application: Early SOF iGPS Capability to SOCOM

Boeing Technology

Integrated Defense Systems

**US Opportunity:**  
**Decisive Navigation Superiority**  
**that is Secure and Dependable**



- More Robust GPS
  - Accuracy, integrity, and availability
- Keep GPS During Electronic Countermeasures
  - iGPS AJ Prevents ECCM from interfering with DAGR
- Improve GPS Availability in Restrictive Environments
  - Forests, Mountainous, Urban
  - iGPS Redundant Dynamic Ranging Counteracts Sky Blockage in spite of High Mask Angles
- Support Global JBFSA
  - iGPS offers 2-way satellite data link and JBFSA GUI embedded in DAGR
  - Network of DAGRs can triangulate enemy jammer locations
- Rapid (<2 min) Time to First Fix under Severe Jamming (>70 dB J/S)
  - Improves battery life for extended missions

# A160 Background

- **Autonomous Vertical-UAS utilizing Optimum Speed Rotor technology coupled with other design features to achieve long endurance and long range with significant payload capability**
- **Wide mission range**
  - C4ISR
  - Organic armed ISR
  - Utility missions
- **DARPA-Army program, began in 1998 – presently in Phase I (started Aug 2003)**



# Technical Approach

- **Advanced Rotor**
  - **Optimum (Variable) Speed Rotor (OSR), 50-100% RPM**
  - **Low Disk Loading**
  - **High Lift/Drag Blade Airfoils**
  - **Hinge-less Rigid In-Plane Rotor for Precision Control**
- **Fuselage**
  - **Aerodynamically clean retractable main gear**
- **Autonomous Vehicle Flight Control**
  - **Flight Waypoint Control**
  - **Auto take-off and land**
- **Structure**
  - **Lightweight high stiffness blades**
  - **Lightweight fuselage**
- **High Fuel Fraction**



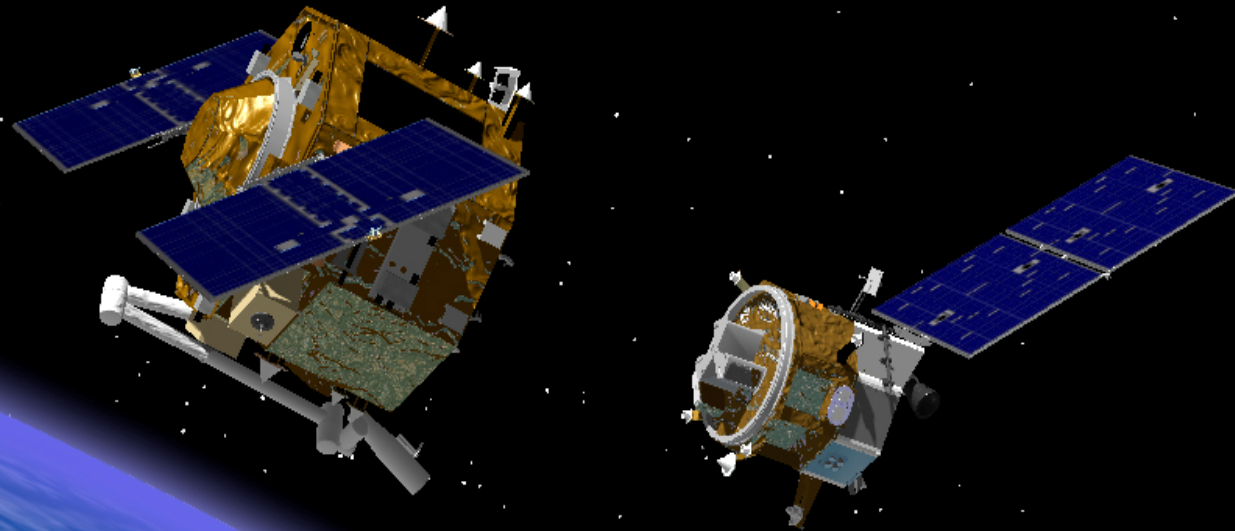


# A160 Phase I Performance Goals

- **20 hrs (sea level) endurance with 300 lb payload**
- **HOGGE of 15,000 ft altitude; flight at 30,000 ft altitude**
- **>2,200 nm range**
- **Airspeed to 140 knots**
- **Re-supply delivery of 1000 lb payload to a radius of 500 km**
- **System reliability to enable 1,000 flight hours between air vehicle losses**



# DARPA & Boeing's Orbital Express: *On-orbit servicing enhances space missions*



**Autonomous Rendezvous & Soft Docking allows:**

- **Inspect & service satellites / spacecraft**
- **Deliver commodity consumables / cargo**
- **Assemble large space structures**



# Future Systems Enabled by Orbital Express

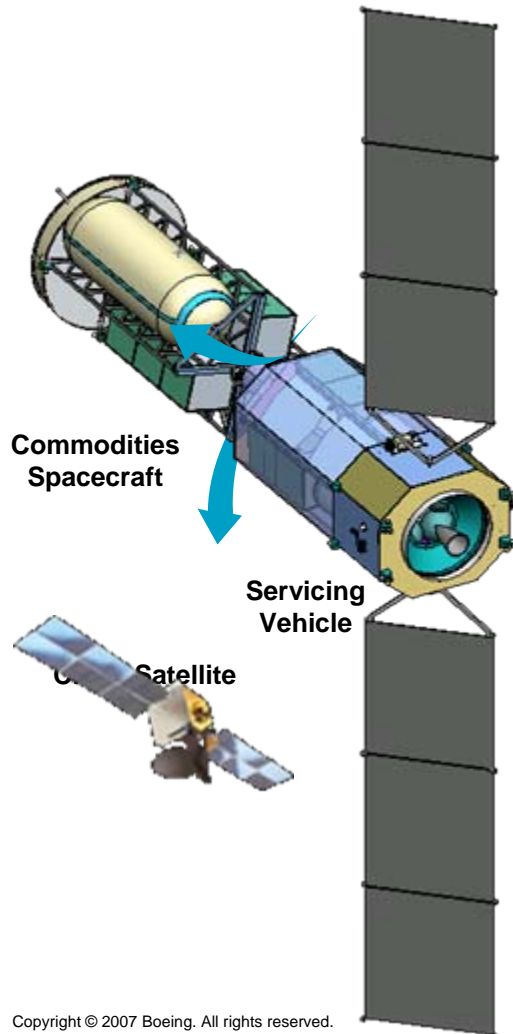
Boeing Technology

Integrated Defense Systems

**Demonstrated key technologies to build a future operational system.**

**The concept of operations provides:**

- A servicing vehicle to rendezvous with client vehicle.
- Required services.
- Rendezvous with a commodities depot to replenish supplies before servicing the next client vehicle.



## Capabilities enabled by servicing include:

- Refueling
- Avoidance
- Maneuverability
- De orbit
- Resolution
- Repositioning
- Time over target
- Contingency refueling
- Repeated access
- Early operational capability
- Increased life
- Coverage patterns
- Randomization
- Reduce launch mass
- Replace or upgrade component
- P3I – new technology infusion
- Contingency replacement or repair
- On-orbit assembly, test, and checkout
- Large space optics
- NASA exploration concepts
- Asset Inspection

# Blended Wing Body



Boeing Technology | Phantom Works

Blended Wing Body – Multi-Role Platform

*X-48B Being Installed in NASA 30x60 Tunnel*

## Two vehicles built at Cranfield Aerospace

- Dynamic 8.5% scale – 20.4-foot wing span
- Remotely piloted, dynamically scaled
- NASA/AFRL contributions include testing in 30x60 wind tunnel and at Dryden

# • BWB Low Speed Vehicle (X-48B)

## Investigate

- Stall characteristics & departure boundaries
- Asymmetric thrust controllability
- Control surface hinge moments
- Dynamic ground effects



## Vehicle Characteristics

- Max Equiv Airspeed: 118 kts
- Max Altitude: 10,000 ft MSL
- Vertical Load Factor Limits: +4.5 to -3.0 g's
- Flight Duration: 30 to 50 min
- Emergency Recovery System (Drogue, Parachute, and Air Bags)

# X-48B As Initial Flight Mechanics Risk Reduction



Boeing Technology | Phantom Works

Blended Wing Body – Multi-Role Platform

- First flight July 20, 2007; 11 flights completed
- Addressing risk reduction
  - Low speed flight environment
  - Flight mechanics (flight control laws, stability and control characteristics)
  - Secondary Power (control surface / actuator power)





# Summary: Transitioning Technology



Boeing Technology | Phantom Works

Blended Wing Body – Multi-Role Platform

- Fulfilling Customer Needs via Technology Innovation
- Balance of Technology Push and Systems Pull
- M&S, Experimentation and Demonstrations Critical









**FUTURE COMBAT SYSTEMS**



*One Team-The Army/Defense/Industry*

**"The Future is Here Now"**

# **Inserting Technology Incrementally: Introducing FCS Technology into the Current Force**

## **NDIA Conference**

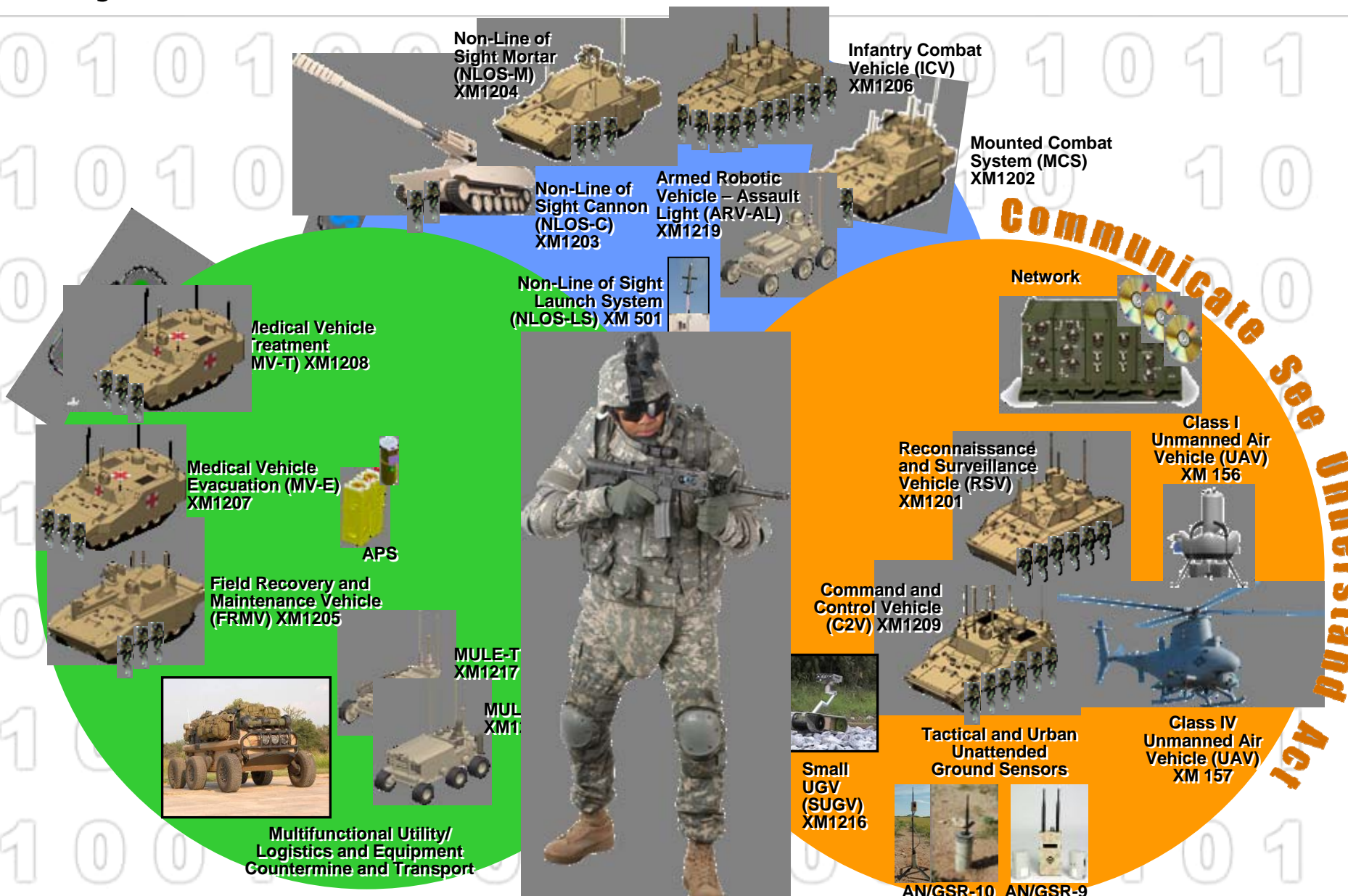
**Dan Zanini**

**LSI Deputy Program Manager, Future Combat Systems  
Senior Vice President, SAIC**

**17 April 2008**



# Connect – Detect – Protect – Project...FCS



Non-Line of Sight Mortar (NLOS-M) XM1204

Infantry Combat Vehicle (ICV) XM1206

Mounted Combat System (MCS) XM1202

Non-Line of Sight Cannon (NLOS-C) XM1203

Armed Robotic Vehicle – Assault Light (ARV-AL) XM1219

Non-Line of Sight Launch System (NLOS-LS) XM 501

Medical Vehicle Treatment (MV-T) XM1208

Medical Vehicle Evacuation (MV-E) XM1207

APS

Field Recovery and Maintenance Vehicle (FRMV) XM1205

MULE-T XM1217

MUL XM1

Multifunctional Utility/Logistics and Equipment Countermine and Transport

Network

Reconnaissance and Surveillance Vehicle (RSV) XM1201

Class I Unmanned Air Vehicle (UAV) XM 156

Command and Control Vehicle (C2V) XM1209

Tactical and Urban Unattended Ground Sensors

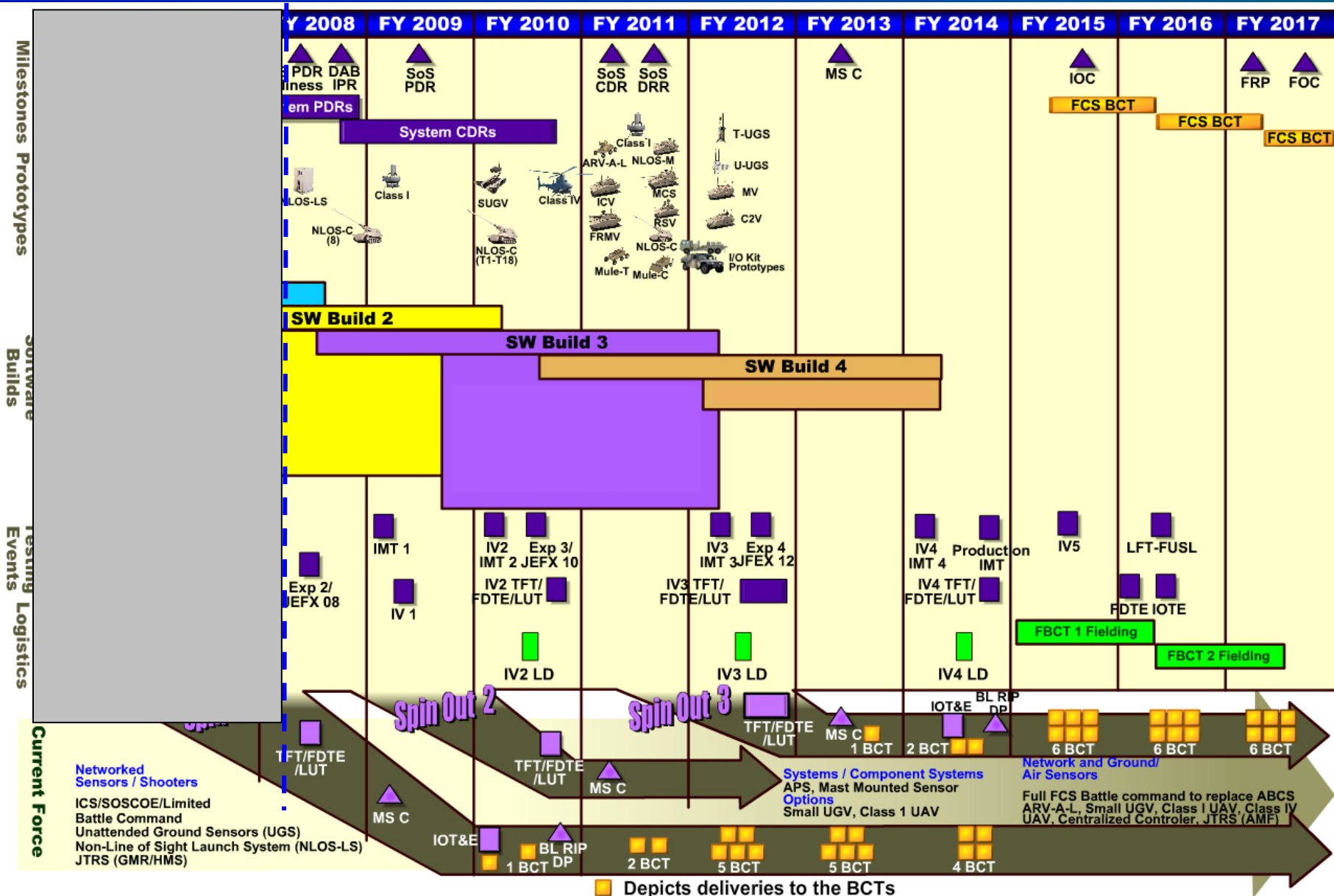
Class IV Unmanned Air Vehicle (UAV) XM 157

Small UGV (SUGV) XM1216

AN/GSR-10 AN/GSR-9

Communicate See Understand Act

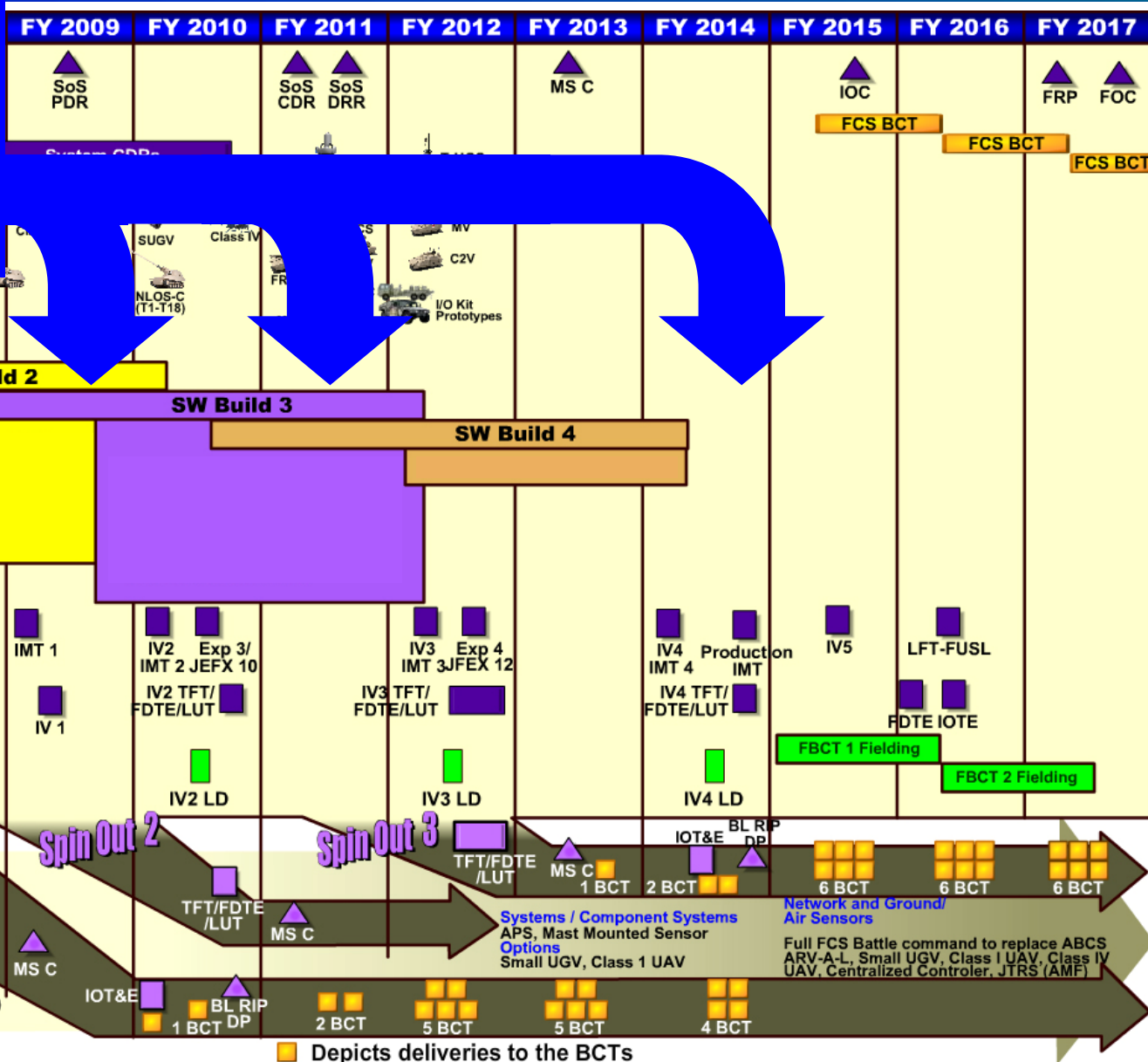
# FCS (BCT) System-of-Systems Schedule



# Potential for Inserting Technology/Capabilities

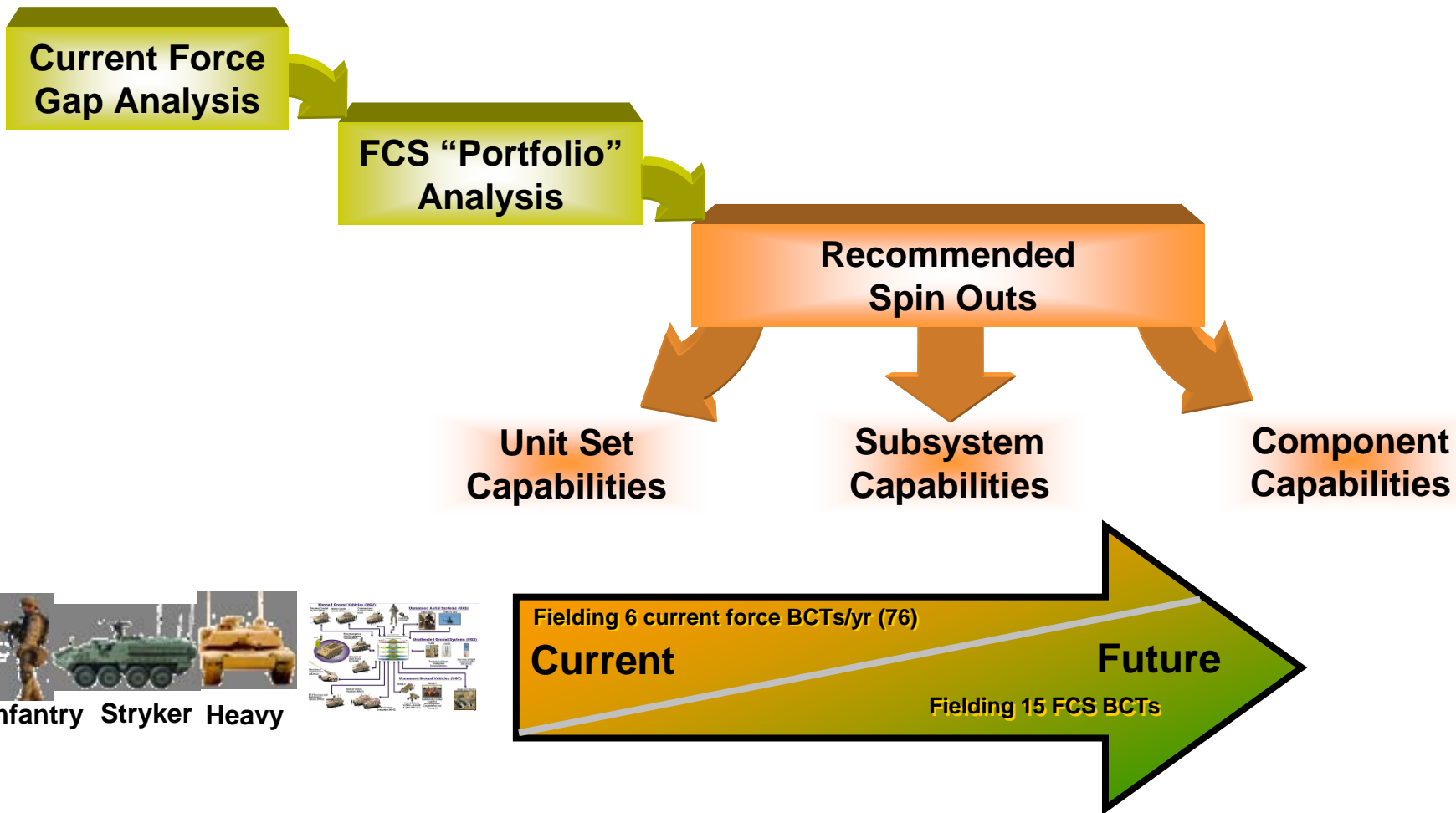
## Tech Development & Growth Strategy

- Gap Analysis
- Tech Forecast/Roadmaps
- Tech Maturation/Analyses
- Design Integration & Test



Depicts deliveries to the BCTs

# FCS Technology to the Force





# B-Kit Spin Out 1 Status

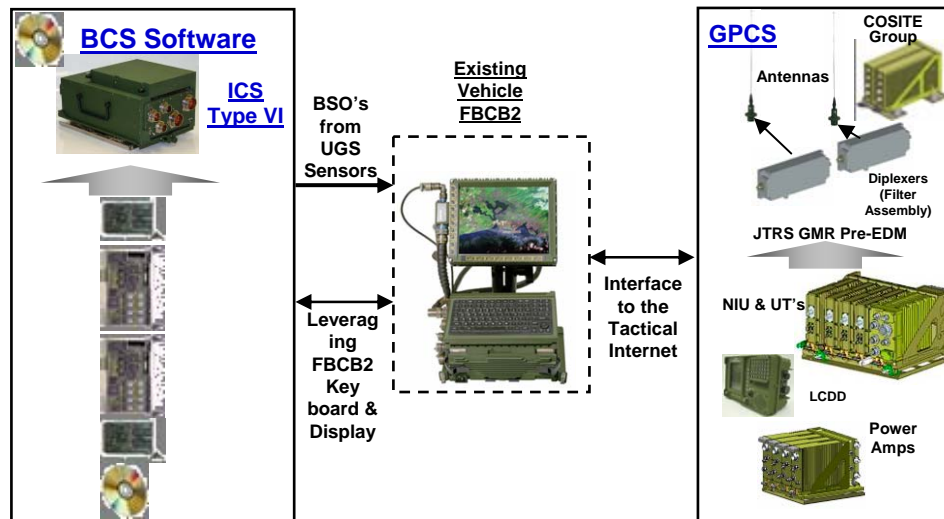


## KEY ACCOMPLISHMENTS:

- ✓ Abrams, Bradley and HMMWV NET
- ✓ SO1 B-Kit FQT SW to Current Force Vehicles
- ✓ B-Kitted HMMWV, Abrams and Bradley delivered for test

## FY08-09:

- AETF Evaluation Events
  - PTRR: 2Q FY08
  - TFT Dry Runs Start: 2Q FY08
  - TFT: 2Q FY08
  - FDT&E: 3Q FY08
  - LUT: 3Q/4Q FY08
- Abrams and Bradley Final Safety Release: 2Q FY08
- Complete Abrams and Bradley IQT at APG: 3Q FY08
- SO 1 Milestone C: 2Q FY09



# UGS Spin Out 1 Status

## U-UGS

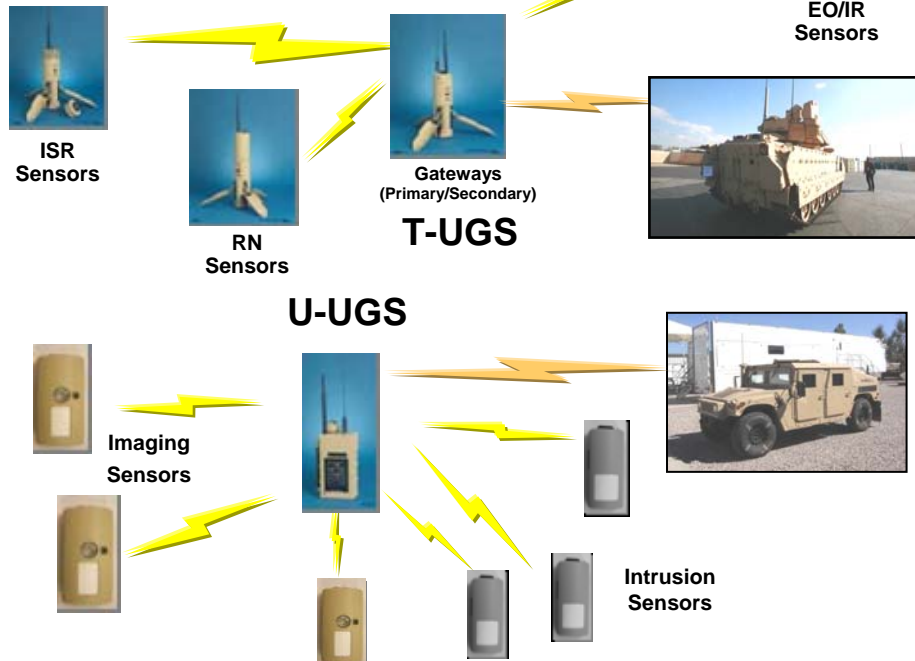


### KEY ACCOMPLISHMENTS:

- ✓ UGS NET
- ✓ T/U UGS prototypes delivered for test

### FY08-09:

- AETF Evaluation Events
  - PTRR: 2Q FY08
  - IQT: 2Q FY08
  - TFT Dry Runs Start: 2Q FY08
  - TFT: 2Q FY08
  - FDT&E: 3Q FY08
  - LUT: 3Q/4Q FY08
- SO 1 Milestone C: 2Q FY09



## T-UGS





# Non Line of Sight Launch System (NLOS-LS) Spin Out 1 Status

## KEY ACCOMPLISHMENTS:

- ✓ Current Forces Integration
- ✓ (AFATDS (FA Control Cell), FOS, CFFT)
- ✓ Container Launch Units (CLUs) Delivery
- ✓ Five prototype CLUs delivered
  - One additional CLU in Feb
- ✓ Conducted NLOS-LS NET
- ✓ Conducted NLOS-LS LOG Dem

## FY08-09:

- **NLOS-LS Flight Testing**
  - CFT-12: 2Q FY08
  - CTV-2: 2Q FY08
  - CFT-13: 3Q FY08
  - NLOS-LS GTV 1-9: 4Q FY08 - 1Q FY09
- **AETF Evaluation Events**
  - TFT: 2Q FY08
  - FDT&E: 3Q FY08
  - LUT: 4Q FY08
- **Award of Long Lead Items Contract: 2Q FY08**
- **SO 1 Milestone C: 2Q FY09**
- **NLOS-LS Flight LUT: 2Q FY09**
- **Production Decision/LRIP I Award: 3Q FY09**





# Class I Unmanned Aerial Vehicle (UAV) Block 0 Acceleration



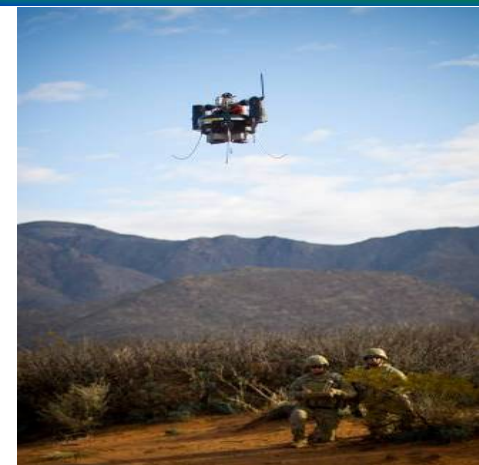
## Key Accomplishments

- ✓ AETF NET
- ✓ Acceleration Reviews
- ✓ MAV Deployed with EOD and other units



## FY08-09:

- Continue in theater assessment: pres-FY09
- C4 Network Integration: 1Q-3Q FY08
- E3 and Environmental Safety Tests: 3Q FY08
- Blk 0 Delta NET: 3Q-4Q FY08
- Proceed decision: 4Q FY08



# Small Unmanned Ground Vehicle (SUGV) Block 1 Acceleration



## Key Accomplishments:

- ✓ Mobility testing
- ✓ Drop test
- ✓ EMI testing
- ✓ Water resistance
- ✓ Safety release
- ✓ AETF NET Soldiers Trained
- ✓ 3 Prototypes delivered

## FY08-09:

- NET: 2Q FY08
- User events/test: 3Q/4Q FY08
- C4 Network Integration: 2Q/3Q FY08
- Deliver 22 units to the AETF (3Q FY08) for experimentation testing scheduled for the Summer of 2008.
- Proceed Decision: 4Q FY08





# NLOS-Cannon Status



Firing Platform 2006-2008



Prototype 1 - Integration



## KEY ACCOMPLISHMENTS:

- ✓ July 07 Completed Stability Testing
- ✓ Nov 07 Completed ROF/ACCS/DI Testing
- ✓ Dec 07 Fired Excalibur Mass Simulators w/Tactical Bases
- ✓ >1500 Rounds Fired on the Firing Platform as of 18 Feb 08

## FY08-10:

- Safety Release - Maintenance & Re-Arm: 3Q FY08
- NLOS-C P1 Roll Out at Army Ball: 3Q FY08
- NLOS-C Congressional MS C: 1Q FY09
- Soldiers Driving/Firing NLOS-C at YPG: 2Q FY09
- NLOS-C Fielded to AETF: 4Q FY09



Prototype 3 - Integration



Prototype 4 - Ready for Integration

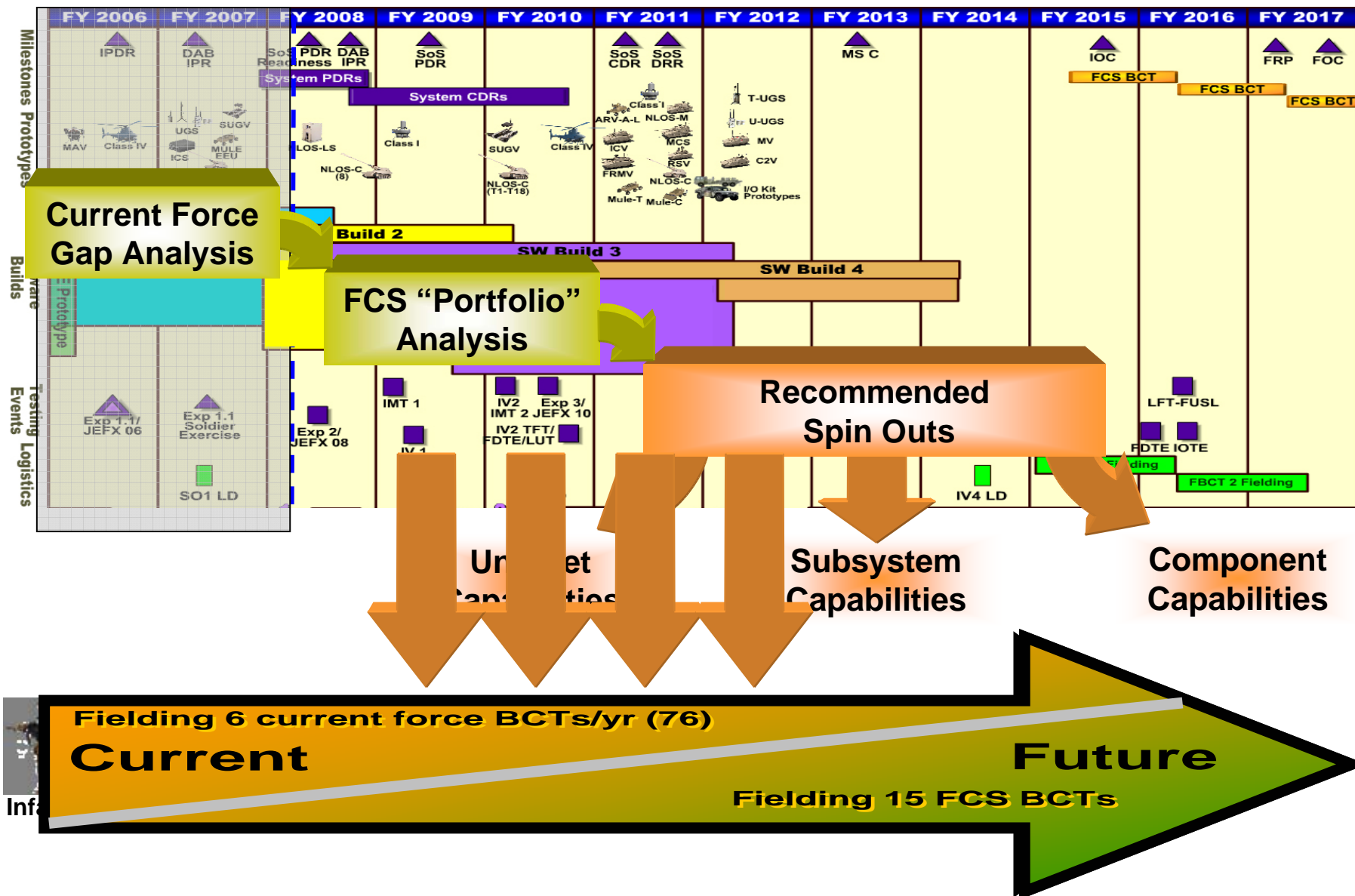


Prototype 5 - Suspension Machining



Prototype 6 - Hull Welding

# FCS Technology to the Force



# FCS – Reducing the “Log FOOTPRINT”

## FCS Increment 1 Threshold Design (2012-2014)

### Current Force Maintenance



58 Abrams



109 Bradley



27 Hercules



78 = Field Level



19 = Sustainment

### FCS Maintenance



60 MCS



102 ICV



10 FRMV



10 = Field Level



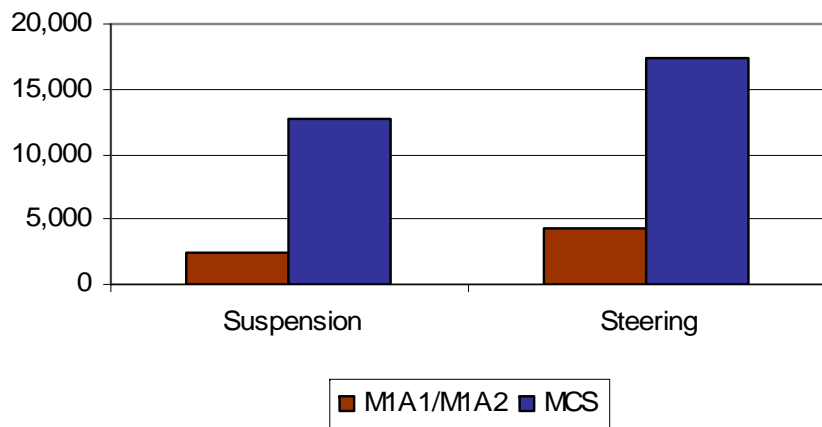
<11 = Sustainment

**Fewer soldiers required for logistics**

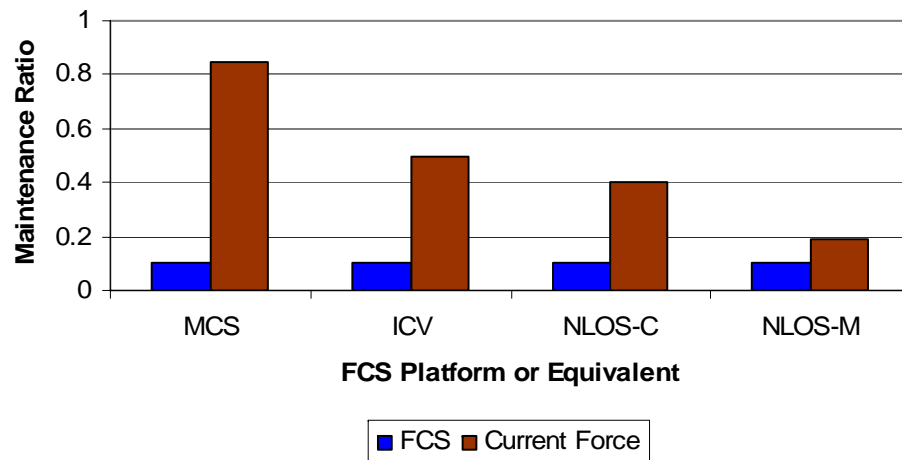
# FCS MGV Reliability Design Improvement Over Current Force Platforms



**Mean Times Between System Abort (MTBSA) in Hours**  
(More is Better)



**Maintenance Ratio (MR)**  
(Less is Better)



**Commonality maintains high, consistent component reliability across FCS platforms**

- MTBSA Source: RAM-T Cases, Sept 04
- MR Source: Affordability and Strategic Integration IPT
- All costs based on LSI estimates, not the Army Cost Position.



FUTURE COMBAT SYSTEMS



*One Team-The Army/Defense/Industry*

# The Future is Now



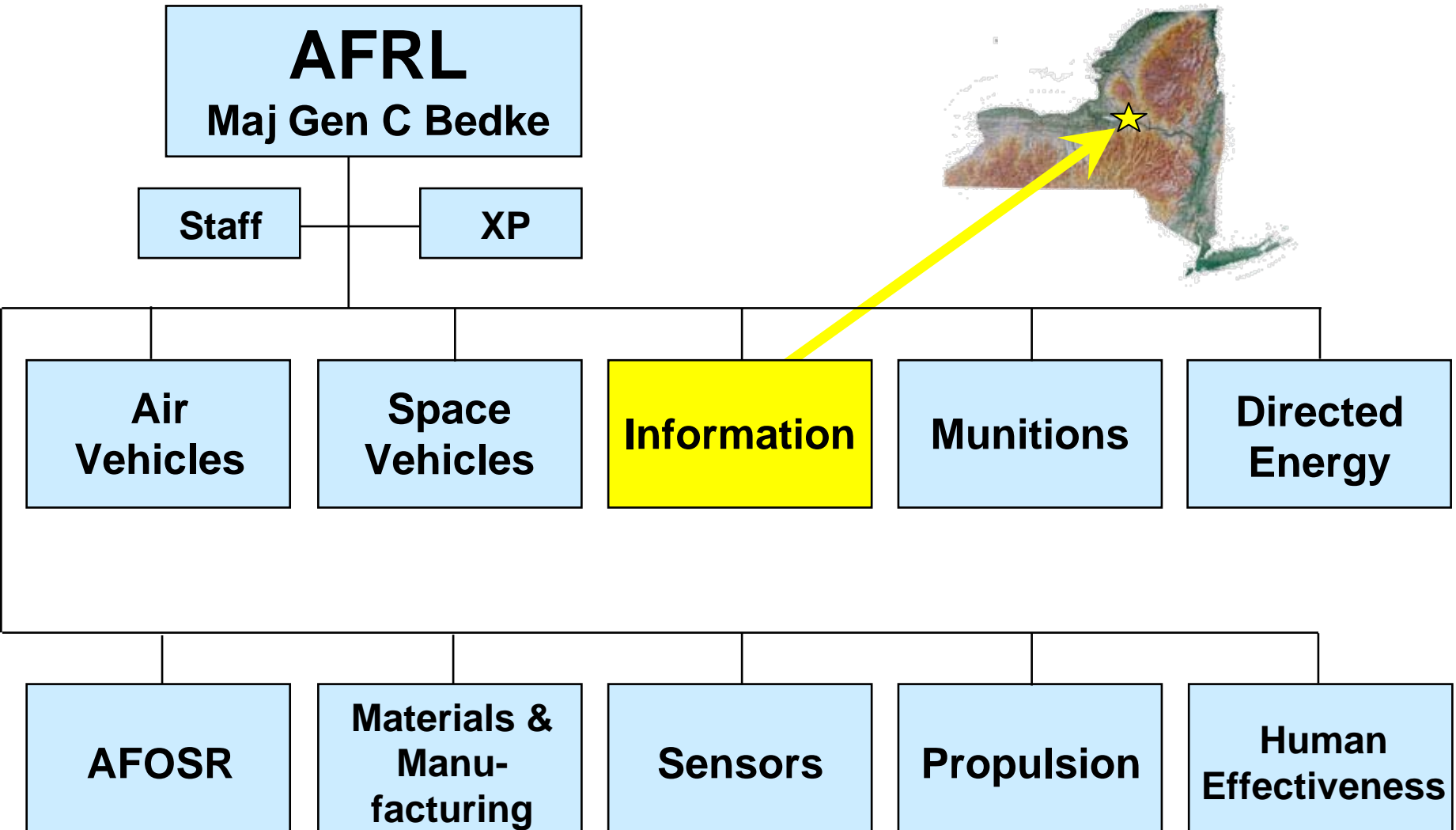
# Cyberspace: New Frontiers in Technology Insertion



**Dr. John S. Bay, ST**  
**Chief Scientist,**  
**Air Force Research Laboratory,**  
**Information Directorate**



# AFRL Structure





**Information Exploitation**

**Information Fusion & Understanding**

**Information Management**

**Advanced Computing Architectures**

***Cyber Operations***

**Connectivity**

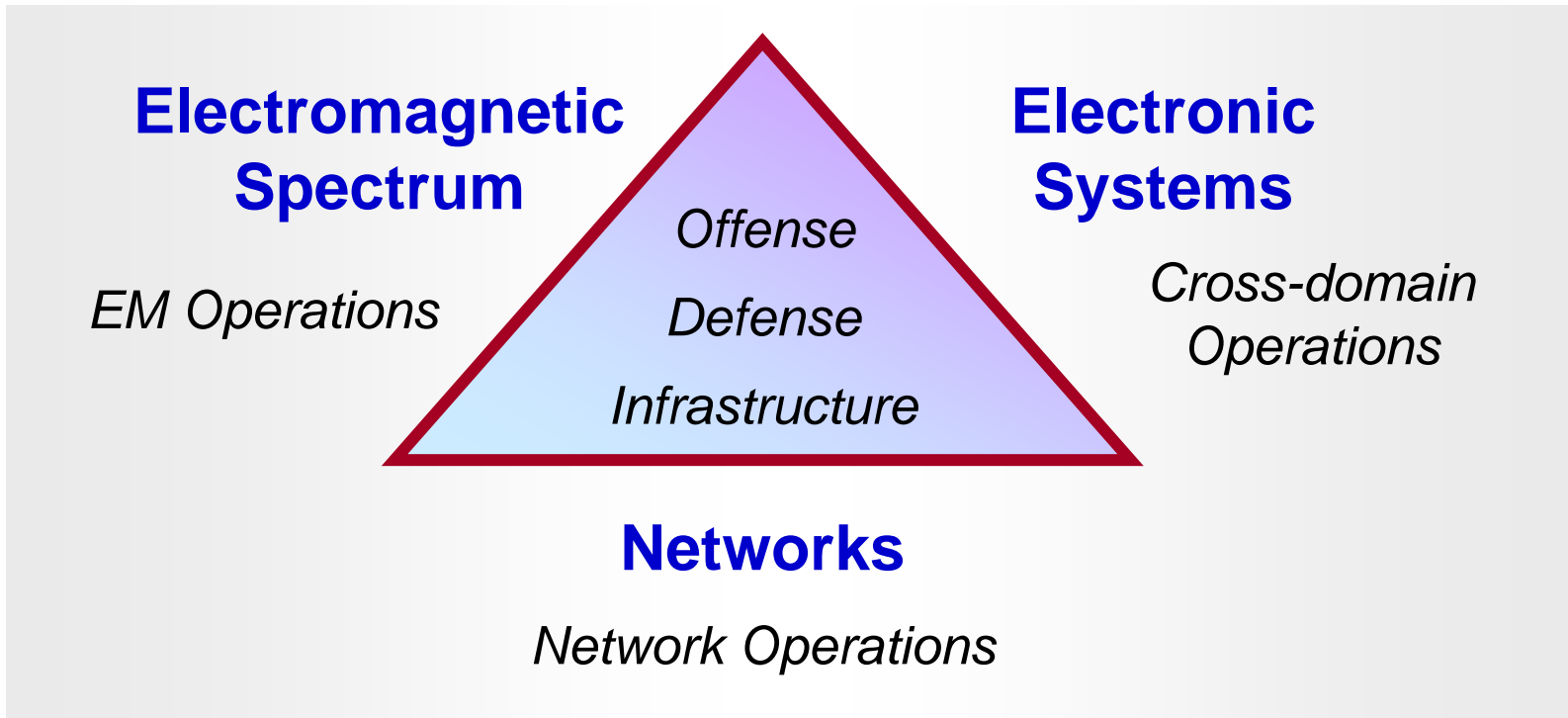
**Command & Control**



# CyberSpace Operations



**DoD Definition: Cyberspace is a domain characterized by the use of electronics and the electromagnetic spectrum to store, modify, and exchange data via networked systems and associated infrastructures**



Lt Gen Bob Elder



# Some Important Characteristics of Cyber Operations



- Low cost of entry
  - The enemy can be a disgruntled individual with a cheap computer
- Not characterized by physical or geographic boundaries
  - The enemy can be anywhere and everywhere, outside *and inside*
- R&D and Operations are done in highly classified environment
  - Makes information sharing difficult
- Often relies on exploits that are easily discovered and repaired
  - Sometimes, we only get “one shot”
  - Offense and defense are tightly coupled
  - Technology turnover/refresh



# Characteristics of AFCYBER that Catch Our Attention



- Effects, C2, and assessment are to be implemented as integrated capabilities
  - Integrated with other kinetic and non-kinetic capabilities
- The 8<sup>th</sup> AF capabilities will be organized around an AOC
  - Implies known structure, CONOPs, and doctrine, *but only for air and space domains*
- The executing authority is the COMAFFOR/JFACC
  - Implies known resources, training, responsibilities, *but only for air and space domains*

*The parity of Cyber with Air and Space domains suggests parallel concepts in C2, battle management, and intelligence technologies*





# Cyber Operations Technology Thrusts



1. Access	
2. Stealth & Persistence	<b>CYBER</b>
3. Cyber Intelligence	<b>OFFENSE</b>
4. Effects (D5) <i>Deny, Disrupt, Degrade, Deceive &amp; Destroy</i>	
5. Avoid	
6. Defeat	<b>CYBER</b>
7. Survive	<b>DEFENSE</b>
8. Recover	
9. Situational Awareness	<b>CYBER</b>
10. Education	<b>SUPPORT</b>



# Warfighting Concepts with a Cyber Twist



- ATR
  - What is a “target” in cyberspace?
  - How do we recognize it when we see it?
- ISR
  - What sensors can we deploy, and how are these assets shared?
- EBO/EBA
  - In cyberspace, the observability of effects is tenuous
  - Second-order effects and cause/effect relationships even more so
- BDA
  - Cyber effects propagate in hard-to-detect ways; including in peoples’ behaviors. What is total effect? Can we determine in real-time?
- AOR
  - Can cyberspace be sensibly decomposed into manageable combatant commands?
- SA and PBA
  - “Situation” is an abstract concept in cyberspace.
  - Visualizations and dynamics (motion, patterns) are ill-defined
- C2 tools
  - Can kinetic and cyber tools be controlled with a single toolset?
  - Can kinetic and cyber tools be integrated/synchronized in a single operation?



# AFCYBER Key Areas



- **FY 07**
  - Cyber ORM
  - Software Assurance
  - Critical Infrastructure Identification
  - Offensive Cyber Program Research
- **FY08**
  - Mission Assurance
  - Security Enhancements (Full CAC compliance)
  - Expanded data encryption (at rest and in transit)
  - Sensitive data offline storage
  - Globally Linked AOCs
  - Offensive Cyber Program Development (Integrated with Air and Space C2)
  - DIB IA
- **FY09**
  - Expeditionary Networks
  - Counter IO: Data protection
  - IP camouflage
  - Active Defense
  - Critical Infrastructure Protect
  - Boundary monitoring
  - Cyber Control
- **FY10**
  - Network Survivability
  - Cyber Attack
  - Cyber Interdiction
  - Sensor Disruption
  - C2 Disruption
  - Cyber enabled weapons degradation
  - Electronic Sys Attack (w/ DE)



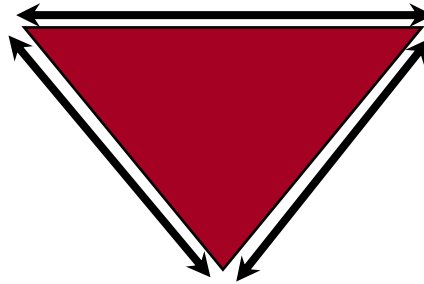
# “Traditional” AFRL Transition



- 6.1 → 6.2 → 6.3, Critical Experiments and Advanced Technology Demonstrations
- Advanced Technology Council

## Lab (☆☆)

- Identify ATD Candidates
- Budget for Technology Programs
- Develop Transitionable Technologies



## User (☆☆☆☆)

- Define Requirements
- Budget Transition Funds

## Center (☆☆☆☆)

- Interpret Requirements
- Build Transition Program
- Integrate Into Systems



# POM-Oriented Transition



## ***ATD Categories***

- Category 1: MAJCOM or Agency supports and has programmed required funding for transition **within the FYDP**
- Category 2A: MAJCOM or Agency supports and is committed to identify transition funding **in the next Program Objective Memorandum (POM) cycle** or Amended POM
- Category 2B: MAJCOM or Agency supports but is not currently able to program for transition funding



# Traditional Acquisition



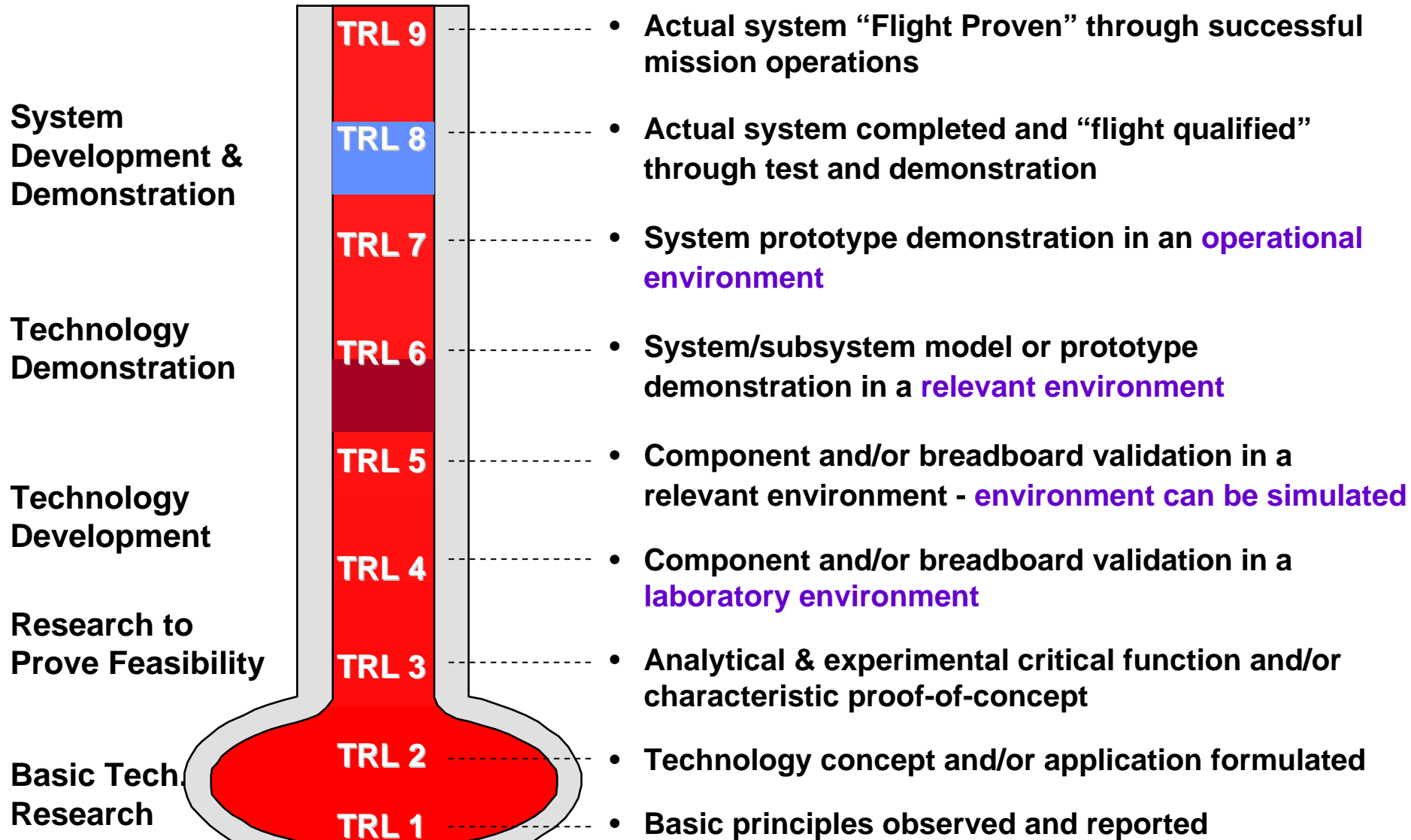
**Traditional acquisition practices support the development, deployment, and sustainment of long term, highly capable systems**

- Focus on minimum risk**
- Stable requirements (or a known roadmap)**
- Dedicated development and test cycles**
- Refined over years based on large body of experience**
- 10 year cycle typical for development to transition & Integration**





# Technology Readiness Levels

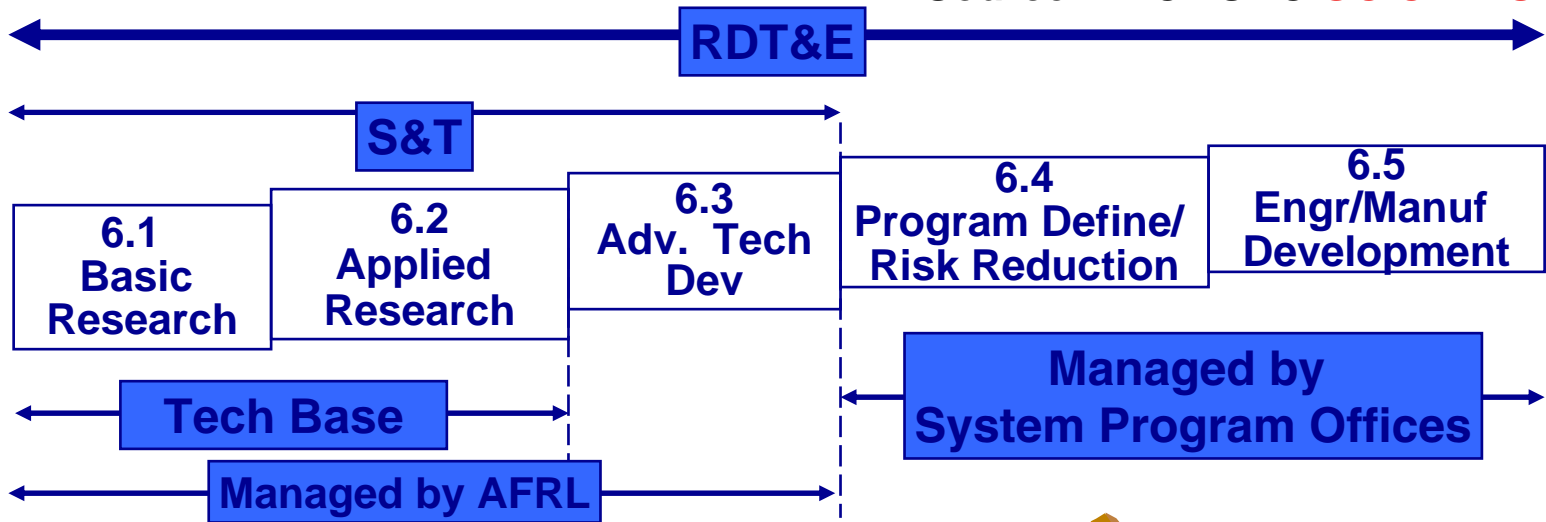




# The Current Landscape

## Bridging The Technology Transition Gap

Source: AFC2ISRC GCIC AFISR ATC



## Applied Technology Council

### Means for Tech Transition

- Advanced Technology Demo (ATD)
- Advanced Concept Tech Demo (ACTD)
- Technology Planning IPT
- Technical Events (JEFX, CWID etc.)
- SPD Initiative
- Industry Initiative
- Senior Leader Initiative

Tech Transition "Seam"

### Emphasis is Necessary on Technology Transition

- Sustained Senior Leader Emphasis
- Continuous Communication
- Integrated Process
- Budget For Production Incorporation



# The S&T Transition Struggle

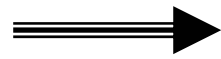


## Technology Standards

## Acquisition Standards

New Ideas

Tech. Push →



Tactical

- Meets User Need
  - Specific Capability
- GOTS/COTS Avail.
- TRL Level Validated
- Production Capable
- Allows COTS Prod. Integration

Strategic

- Meets Planners Projections
  - General Technology
  - Future Capability
- General Applicability
  - Enhances Performance
  - Foundation (i.e. Open Syst.)
  - Lead Industry
- Expandability – **General**
- Flexibility – **General**

Transition Gap



Req Pull

Current Needs





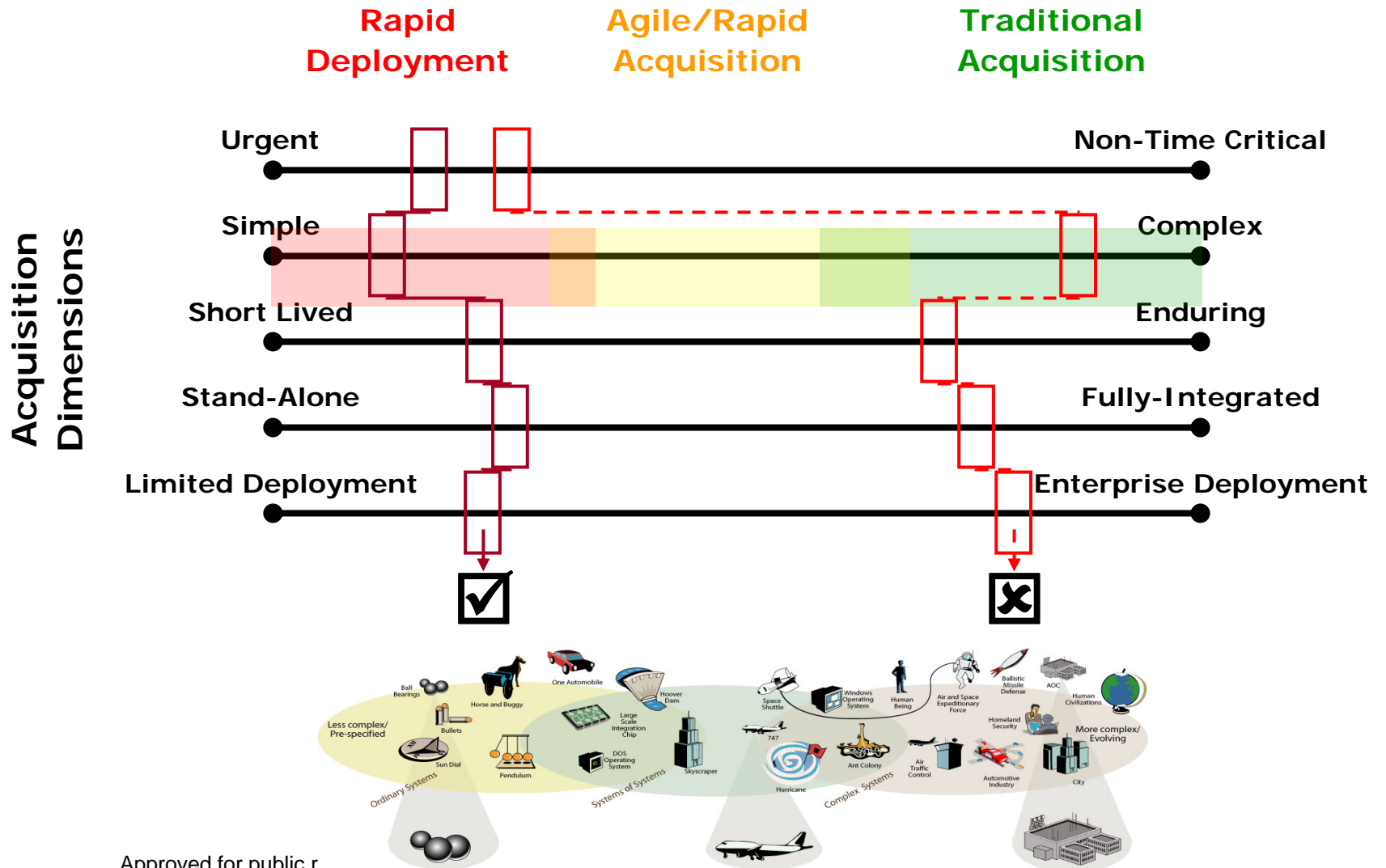
# CYBER Transition Requires new Acquisition Processes



- **Cyber Acquisitions may require:**
  - Very rapid, urgent fielding needs (days to weeks)
  - Agile development and fielding (months)
  - Traditional development, fielding, and sustainment (months to years) with regular capability “releases” or spirals
- **Application to very short cycle times requires alternative approaches**
  - Decreased research & development time
  - Limited test and verification
  - “Short tail” logistics
- **Strategies to continually innovate and assess**
  - threats and emerging technology,
  - Rapid prototyping
  - Supporting AFCYBER stated capability needs
  - Develop key partnerships
- **Migration of some development and assessment efforts to “pre-need” phase**
  - Emerging threat R&D strategy to complement reactive acquisition strategy

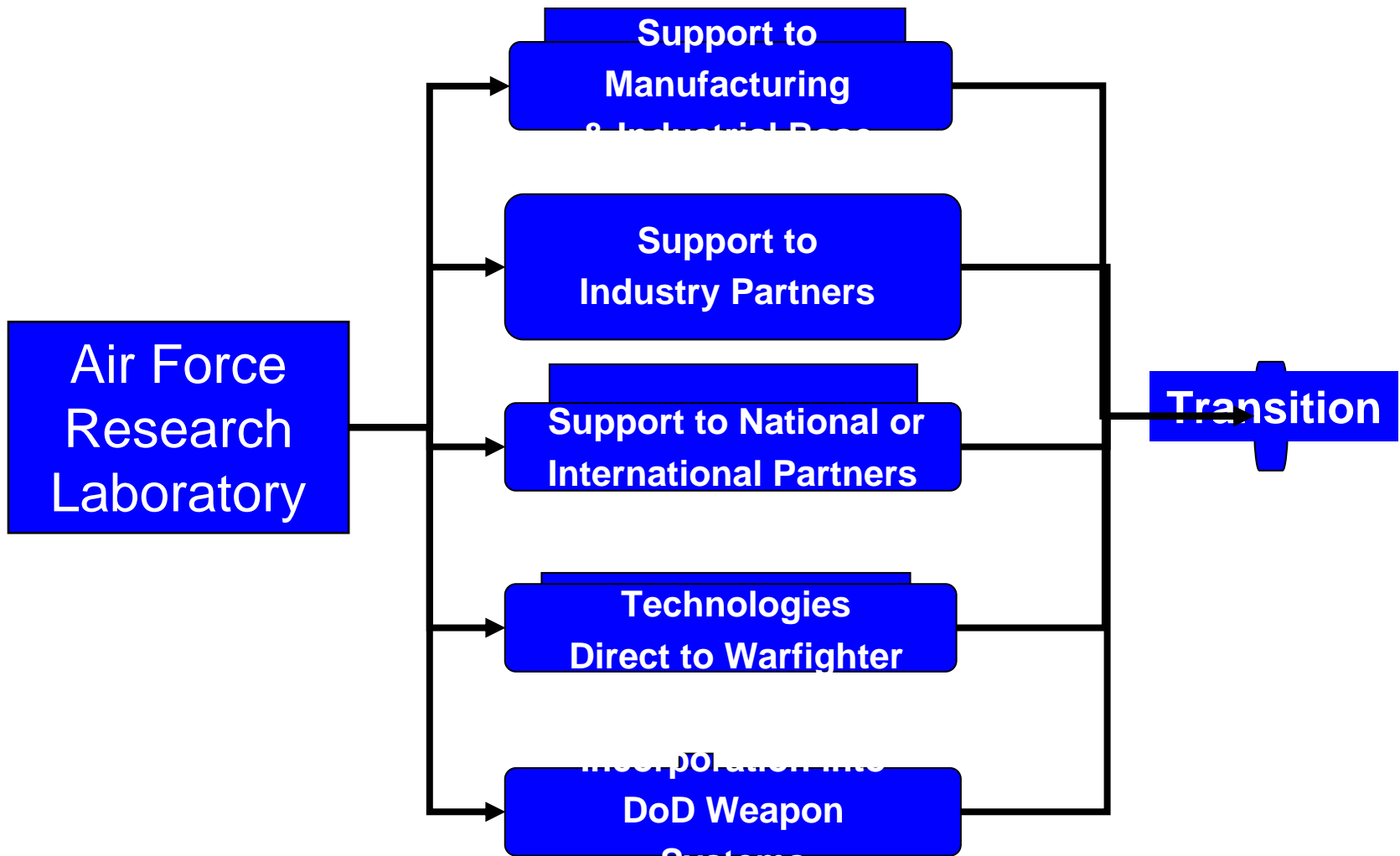


# Full Spectrum Acquisition





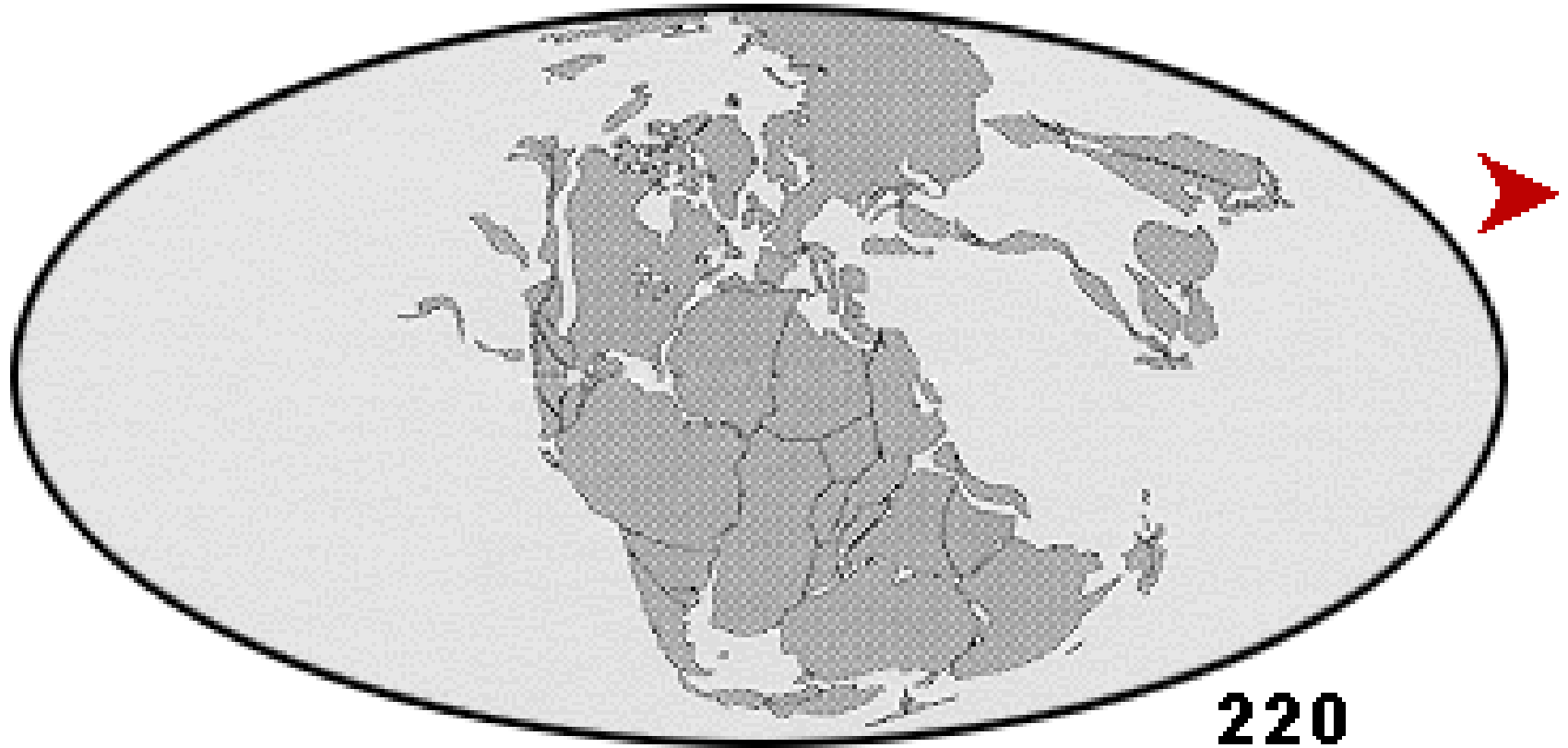
# Alternative Transition Paths







# Conclusions: The Changing Battlefield of CyberSpace



**220**

*“Transition to WHAT?”*



# Summary



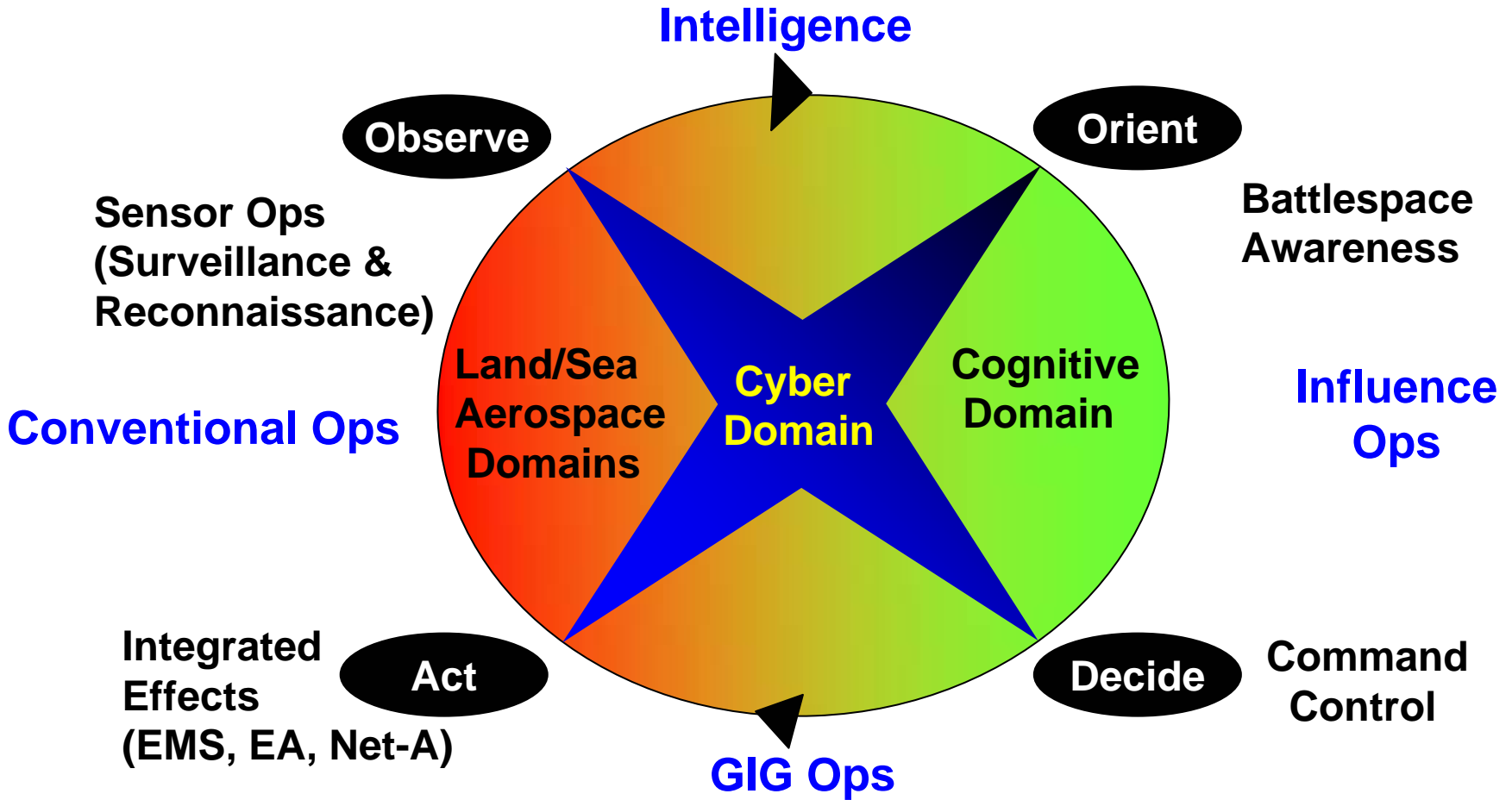
- **Rapid research & development strategies**
- **Constant reassessment of changing landscape resulting in short duration R&D efforts and rapid technology transition**
- **New acquisition strategies required**
- **New relationship between research and acquisition**
- **Innovative challenges/opportunities for community to develop a responsive cyber research and development strategy to work with a full spectrum acquisition capability**
- **AFRL/RI to lead R&D for the cyber big “A” team**



# Questions?



# The Battle in Cyberspace



**Offense, Defense, Infrastructure Elements**

Lt Gen Bob Elder



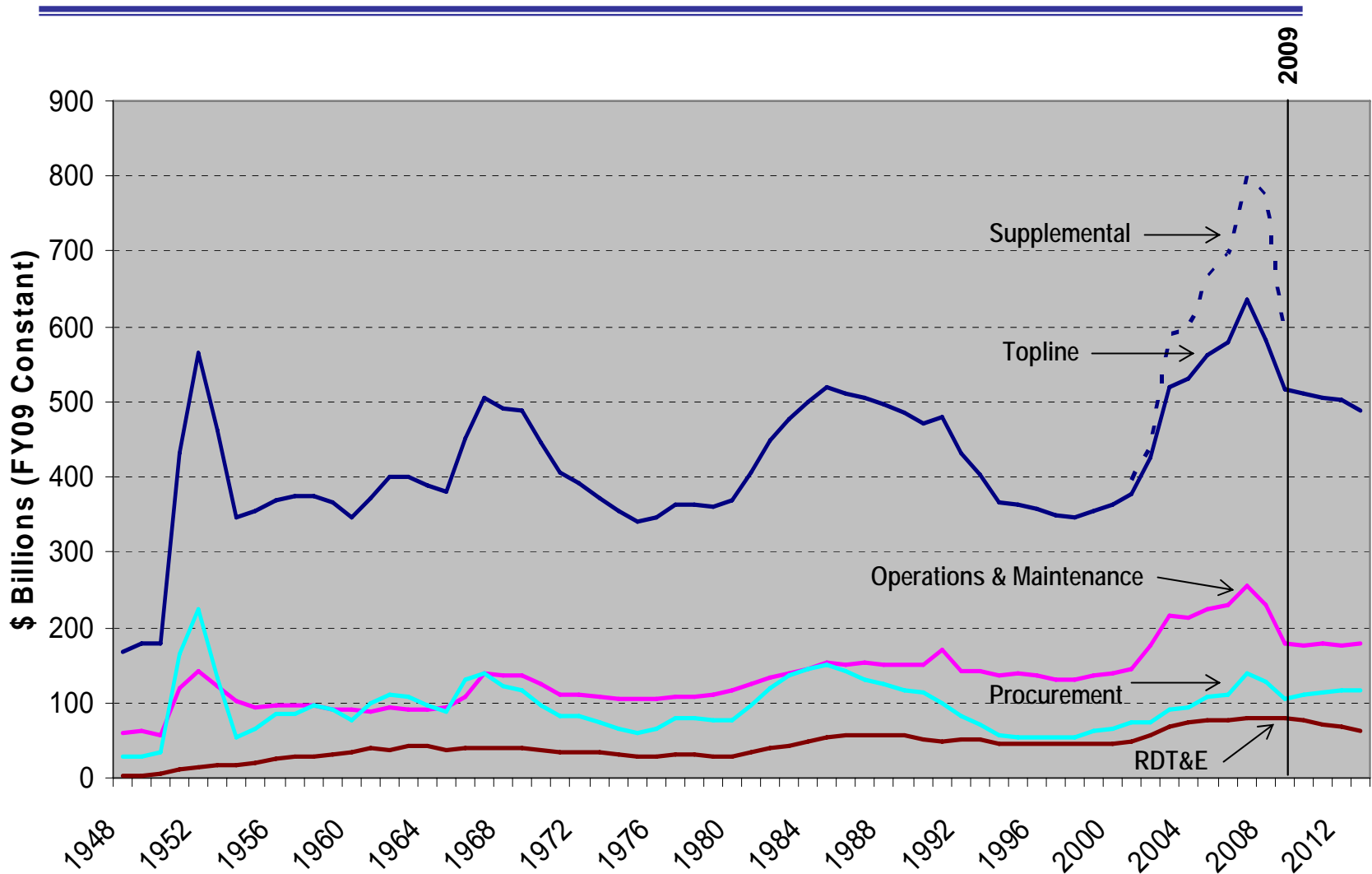
# **NDIA Science and Engineering Technology Conference/ DoD Technology Exposition**

**April 17, 2008**

**Gary Powell  
OUSD(AT&L)  
[gary.powell@osd.mil](mailto:gary.powell@osd.mil)**

# Defense Budget Trends

(DoD Budget Authority)



Source: USD (Comptroller) National Defense Budget Estimates for the FY 2009 Budget (Green Book)



March 2008

**DEFENSE  
ACQUISITIONS****Assessments of  
Selected Weapon  
Programs**

GAO-08-467SP

“...total costs for the fiscal year 2007 portfolio of major defense acquisition programs increased 26 percent from first estimates ...development costs ... increased by 40 percent ... In most cases, programs also failed to deliver capabilities when promised - often forcing warfighters to spend additional funds on maintaining legacy systems...Of the 72 weapon programs we assessed this year, **no program had proceeded through system development meeting the best practices standards for mature technologies, stable design, and mature production processes** – all prerequisites for achieving planned costs, schedule, and performance outcomes.”



# ***Why Should DoD Invest in Basic Research?***

A Presentation for

The 9th Annual NDIA Science &  
Engineering Technology Conference/DoD  
Tech Exposition

***Dr. William S. Rees, Jr.***  
***Deputy Under Secretary of Defense***  
***(Laboratories and Basic Sciences)***  
***Office of the Director***  
***Defense Research and Engineering,***  
***April 15-17, 2008***



## Context

- The growth rate of the world population is declining
- 90% of population growth is in developing and poorer countries
- 40% of the world's population – 2.5 billion people – live on less than \$2 per day
- Proportion of working age adults (15-59) is expected to decrease in every area except Africa
- 880 million people were illiterate, 250 million children worked and 110 million school age children did not attend school, as of 2000

Source: "Joint Operating Environment" United States Joint Forces Command, December 2007,



## Context

- By 2030, China is expected to have 348 million people over 60, nearly as many as the entire projected population of the US
- 13% of the global population lived in cities in 1900. Today the global proportion of the urban population is 49%. 60% of the globe's population - 4.9 billion people - will live in urban areas by 2030
- Massive urbanization – 17 of 22 “mega cities” will be in the developing world by 2015.



## Context

- Since the 1970's, weather/climate-related losses have increased about 10% per year and accounted for 88% of all property losses covered by insurers from 1980 to 2005
- India and China will develop “first world” energy appetites
- Many oil exporting countries may use production for their own economies

Source: “Joint Operating Environment” United States Joint Forces Command, December 2007



## Context

- Current major supplies of petrochemical products will not keep pace with projected demand
- Only 12 years from now, machine intelligence could equal or surpass that of humans – eventually, it will become impossible to differentiate between man and machine
- Weapons of mass effect will shrink and proliferate: nuclear, bio, directed energy, nanotechnology, and CYBER

Source: "Joint Operating Environment" United States Joint Forces Command, December 2007



## Context

- Science, technology, and engineering are available globally
- US scientific leadership is at risk
- Multi-disciplinary technologies will have revolutionary impact - 70 % of world R&D is conducted outside the US
- China is now the third largest investor in R&D (adjusted for purchasing power), behind only the US and Japan

Source: "Joint Operating Environment" United States Joint Forces Command, December 2007





## Context

- The United States is today a net importer of high technology products (+\$54B in 1990 to -\$50B in 2001)

Source: "Joint Operating Environment" United States Joint Forces Command, December 2007

# OUTLINE



- DoD Basic Research
- DoD STEM Education
- Prize Competition



## Leaders support Basic Research

- President Bush :

***“...double federal support for critical basic research in the physical sciences...”***

- The Secretary of Defense supports Basic Research

***“... greater emphasis on basic research, which in recent years has not kept pace with other parts of the budget.”***



## Basic Research

- Basic research is systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts *without specific applications towards processes or products in mind.*

*It is farsighted high payoff research that provides the basis for technological progress.*



## Why Does DoD fund Basic Research?

- DoD is perpetually, permanently in the capability business
- By funding basic research, DoD is able to maintain its technological edge
- Technology is the key to military superiority
- Basic research is the foundation of technological innovation
- Identifying and developing new technologies is essential for DoD's mission
- The DoD's investment in basic research is a critical component of its long-term strategy
- Scientific and technological progress is essential for the DoD's ability to meet future challenges
- Technologies move rapidly across borders
- If technology exists, it will be used, first in weapons

***We cannot know when a discovery will become a capability but we know with absolute certainty that without discovery, our capabilities remain static.***



## Why Does DoD fund Basic Research?

- Generates discoveries, new knowledge, and improved understanding
- Achieves technological superiority
- Prevents technological surprise
- Educates scientists and engineers in physical science disciplines
- Ensures that scientific expertise and engineering rigor supports DoD technical decisions
- Sustains the human talent and research infrastructure

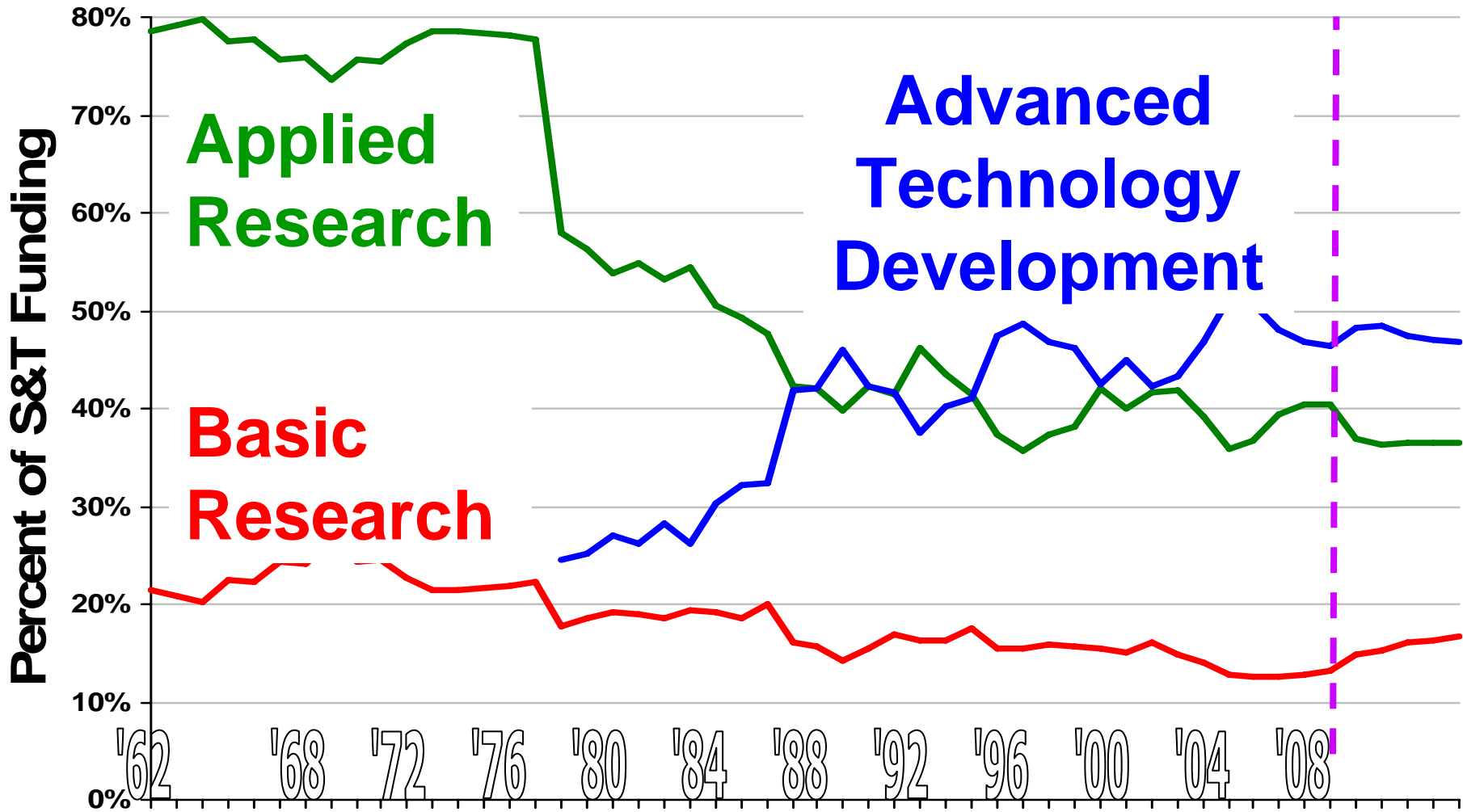


**Don't expect  
Basic Research  
to solve all problems**





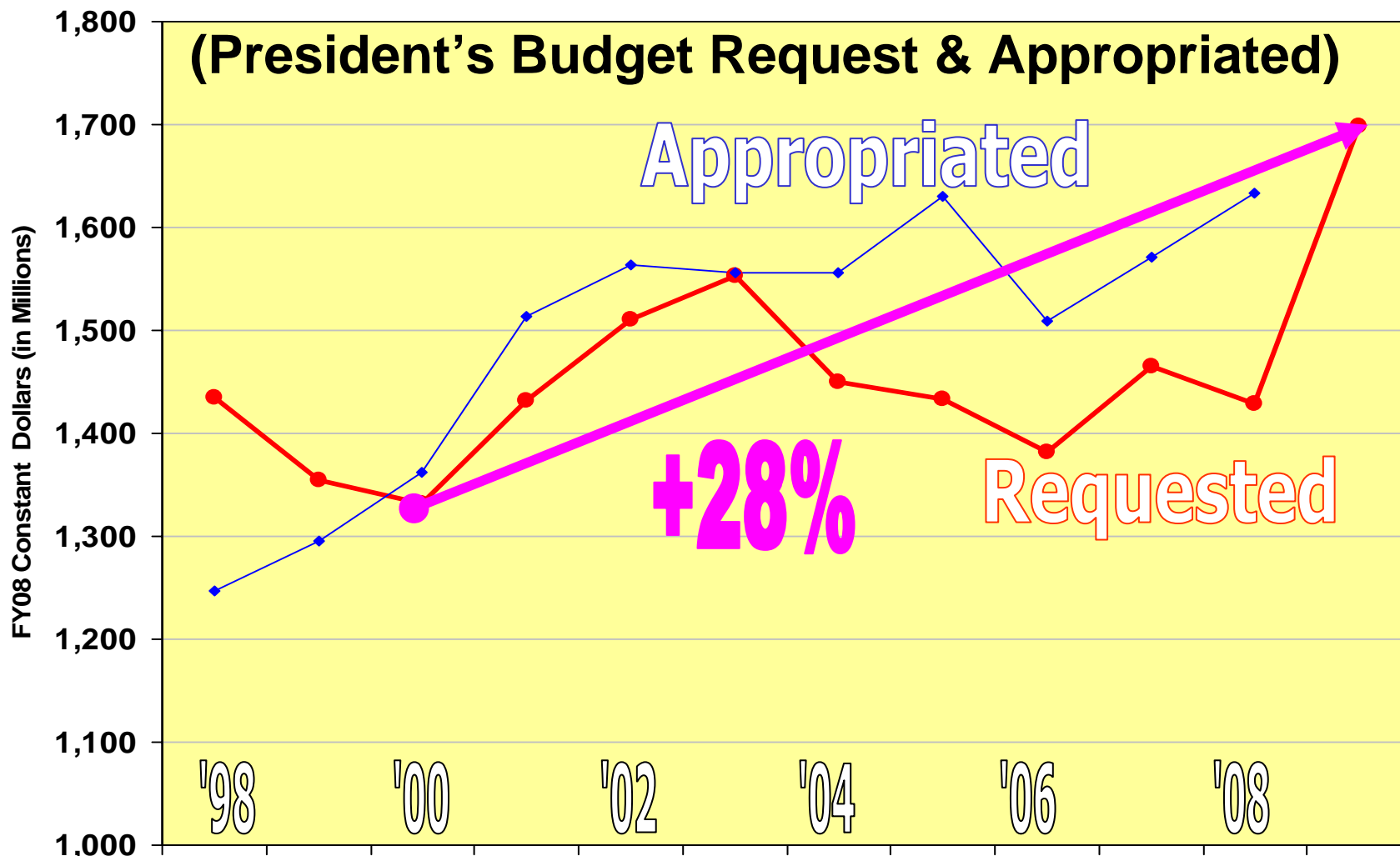
# DoD S&T Requests



**Note:** Advanced Technology Development funding began in FY78



# DoD Basic Research Funding FY1998-2009



+28%

Requested

Appropriated

(President's Budget Request & Appropriated)

FY08 Constant Dollars (in Millions)

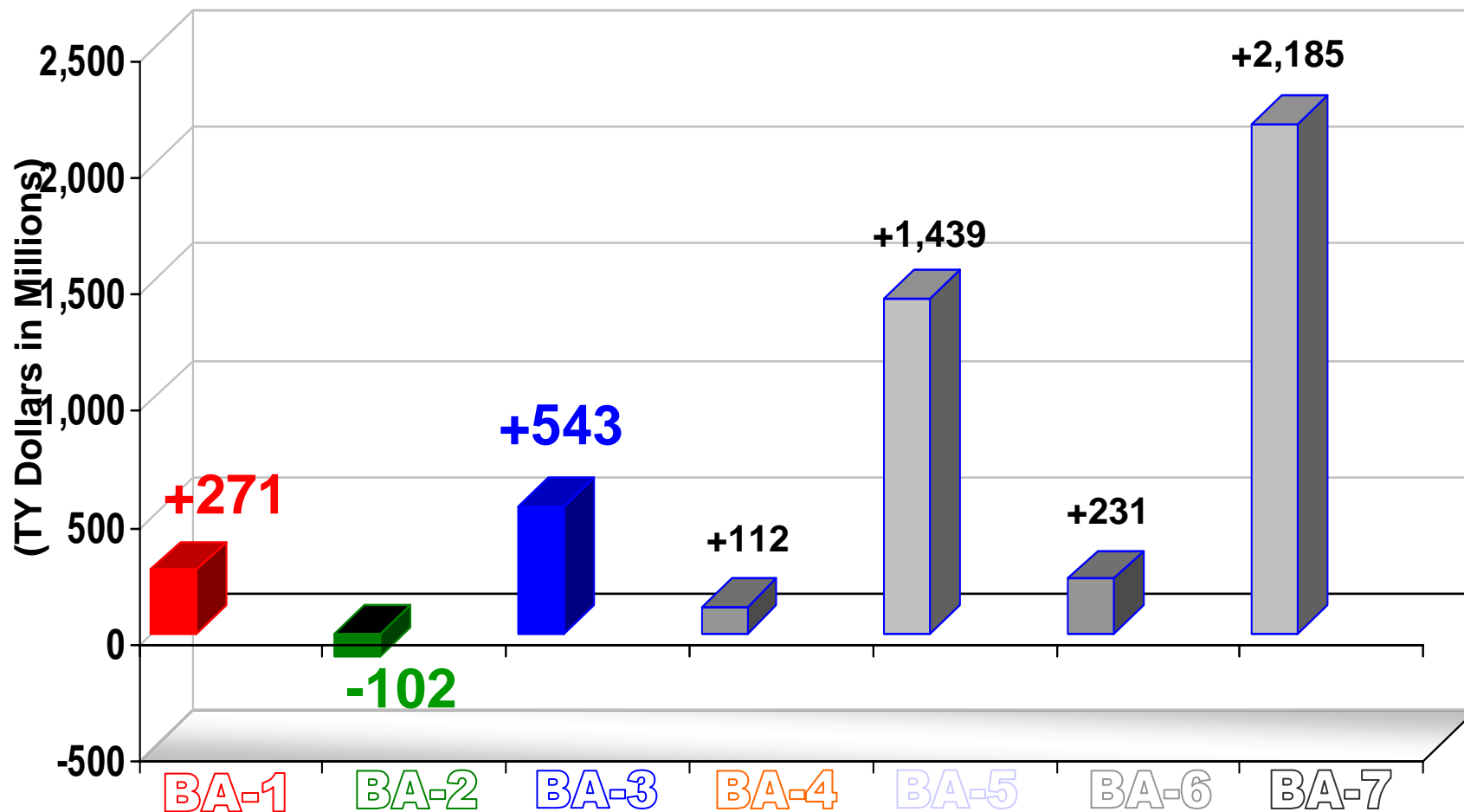
'98 '00 '02 '04 '06 '08

Source: DOD, DDR&E



# RDT&E Budget Request Growth

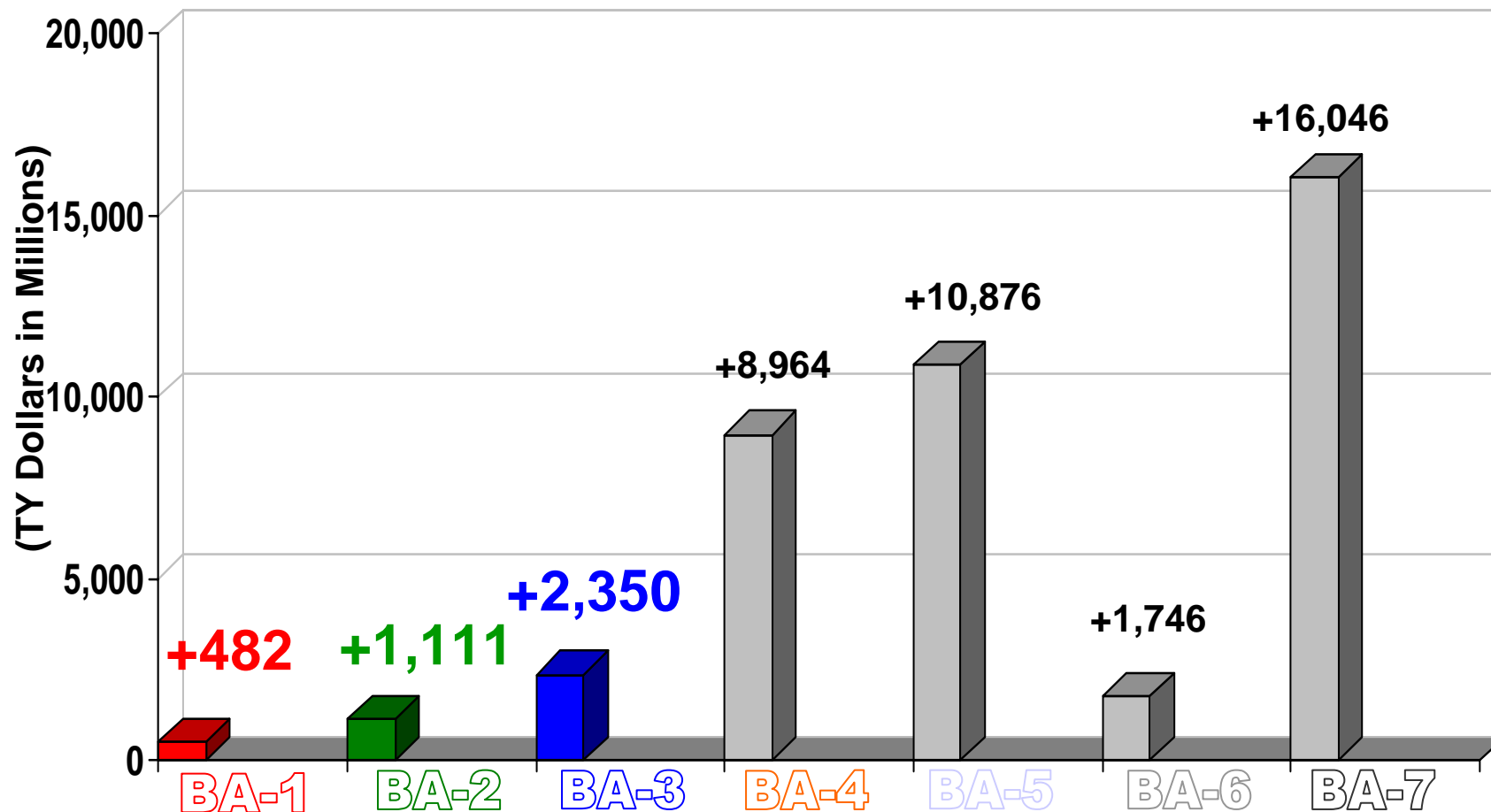
*FY09 Compared to FY08*





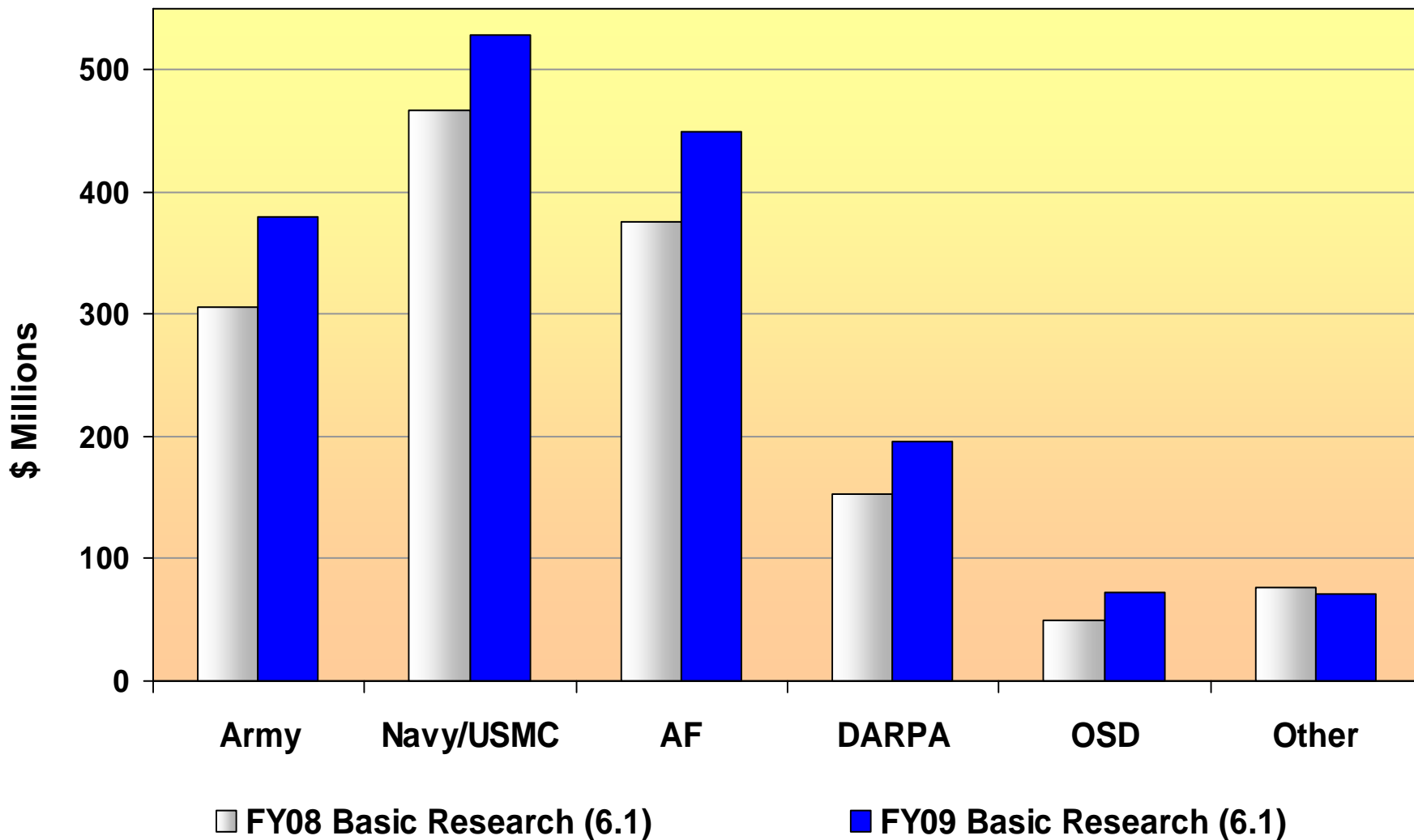
# RDT&E Budget Request Growth

*FY09 Compared to FY01*





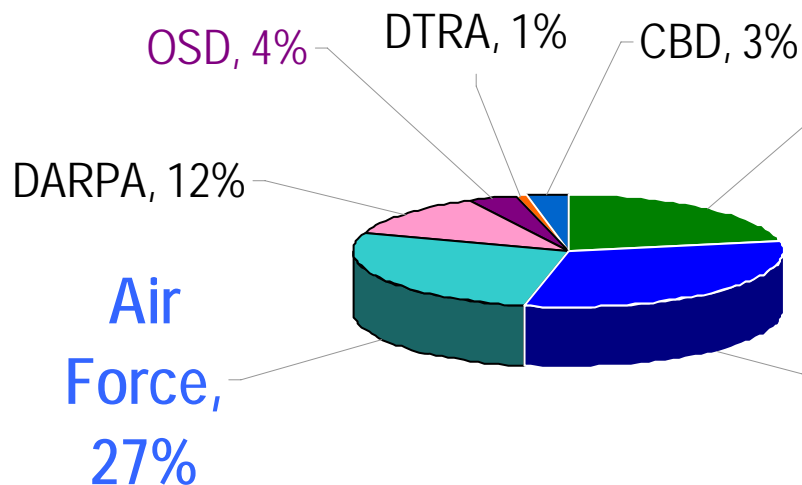
# FY08 & 09 DoD 6.1 Budget Request



Source: DOD, DDR&E



# Sources & Destinations of Defense Basic Research Funding



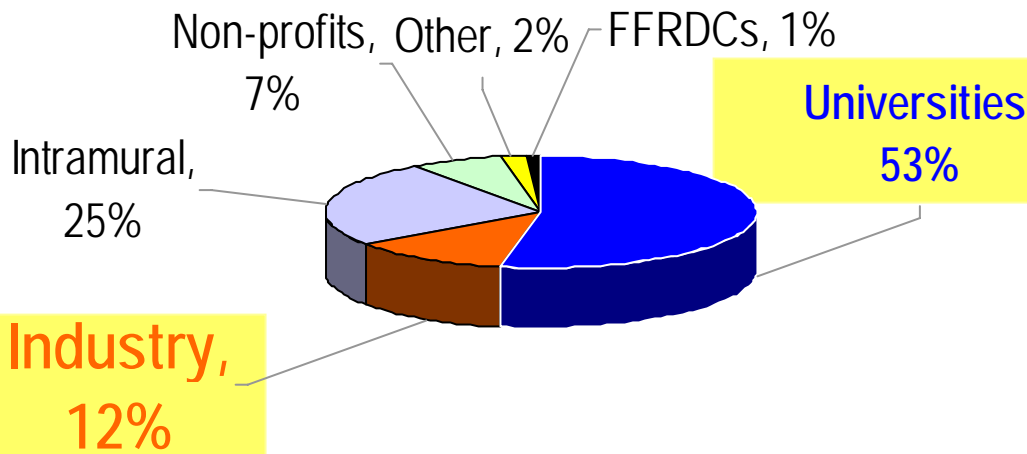
**← Source 80% of Defense Basic Research is Investments by Military Departments**

Army, 22%

Navy, 31%

## Destination →

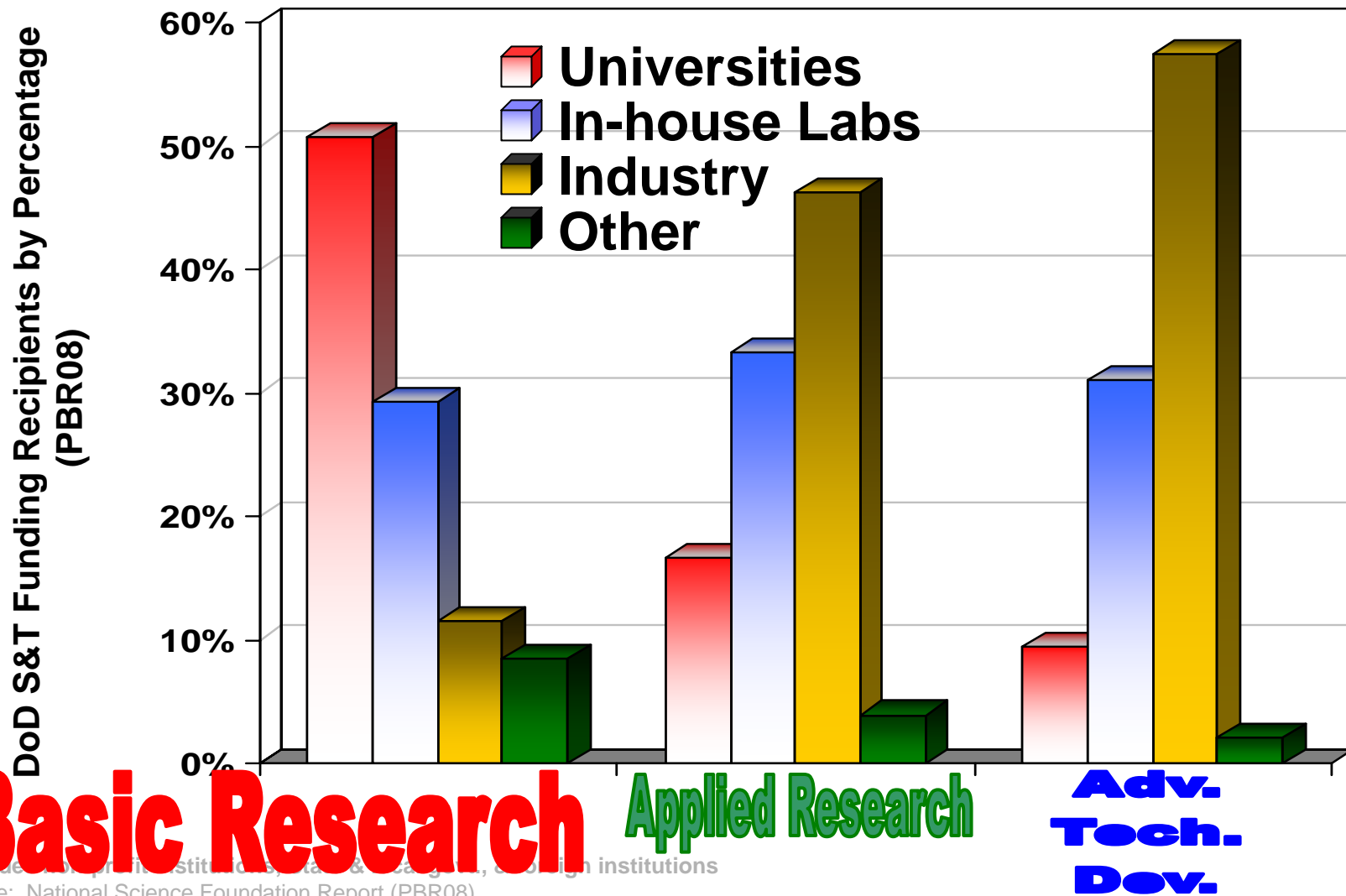
**Performers of Defense Basic Research - 65% to Universities & Industry**



Sources: FY09 President's Budget & DoD component inputs to NSF Federal Funds for R&D survey (FY08 - latest available)



# Recipients of DoD S&T Funds



**Basic Research**

**Applied Research**

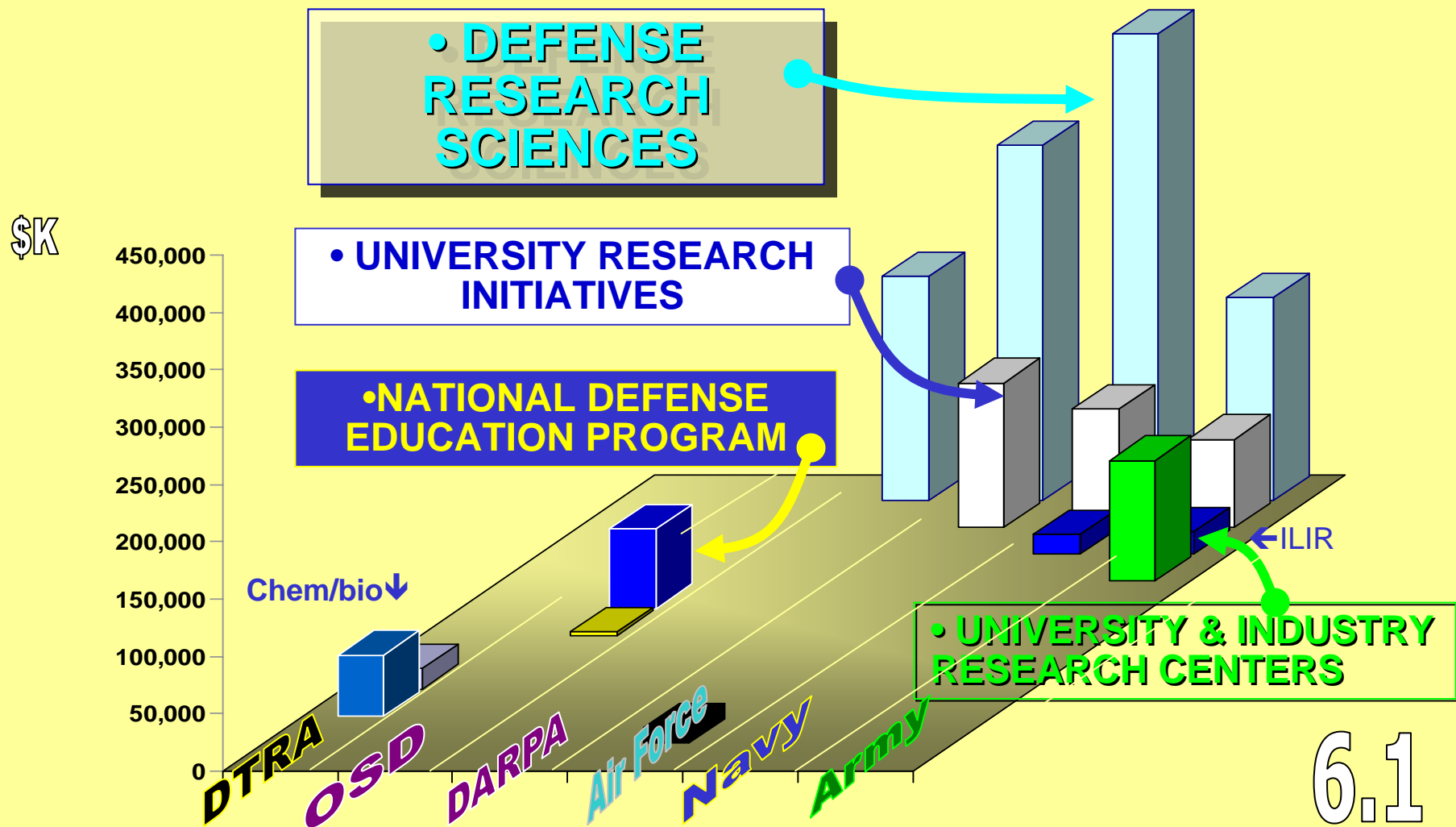
**Adv. Tech. Dev.**

\*Includes non-profit institutions, state & local government, and foreign institutions  
Source: National Science Foundation Report (PBR08)





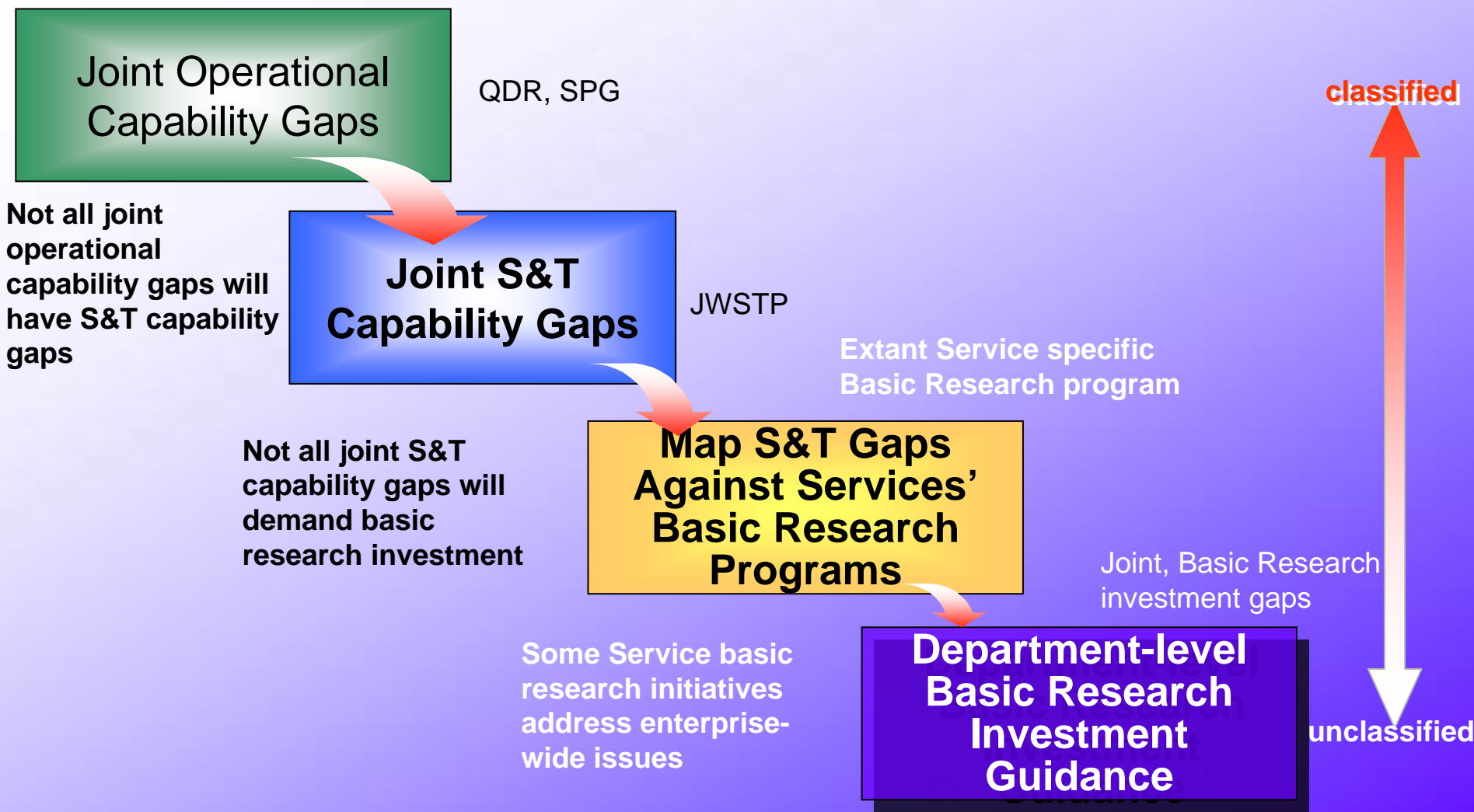
# FY09 President's Budget Request for DoD Basic Research



6.1

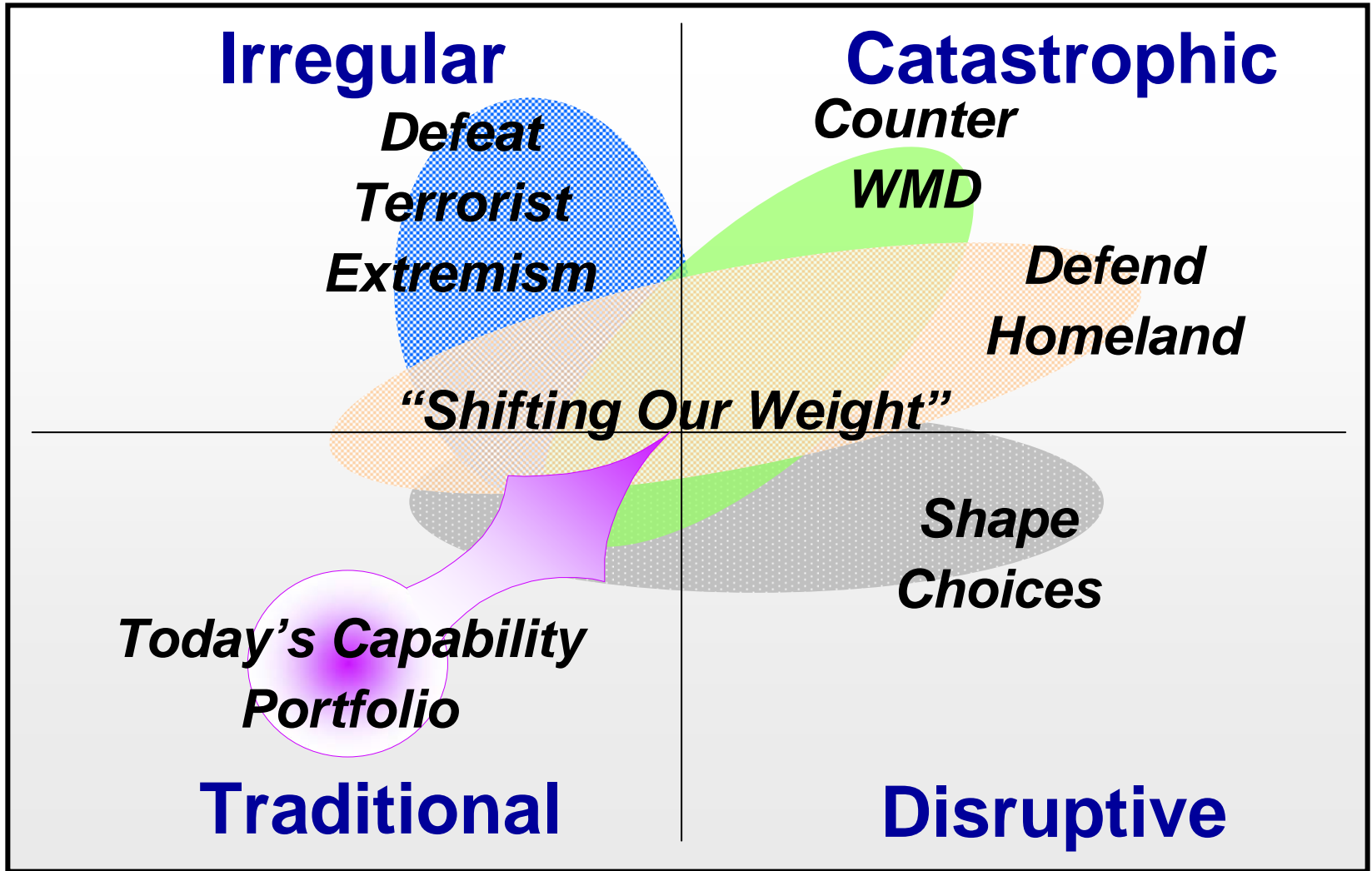


# Conceptual Strategic Planning Process



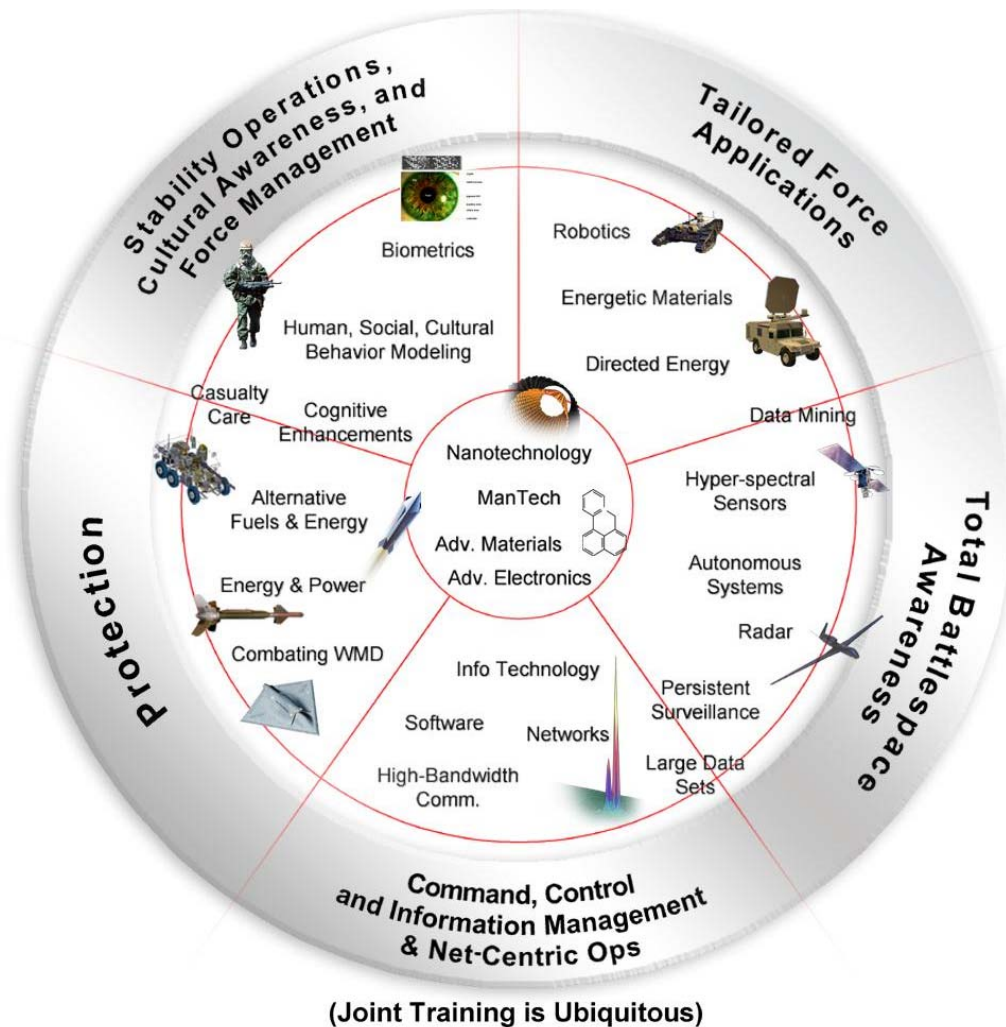


# Quadrennial Defense Review





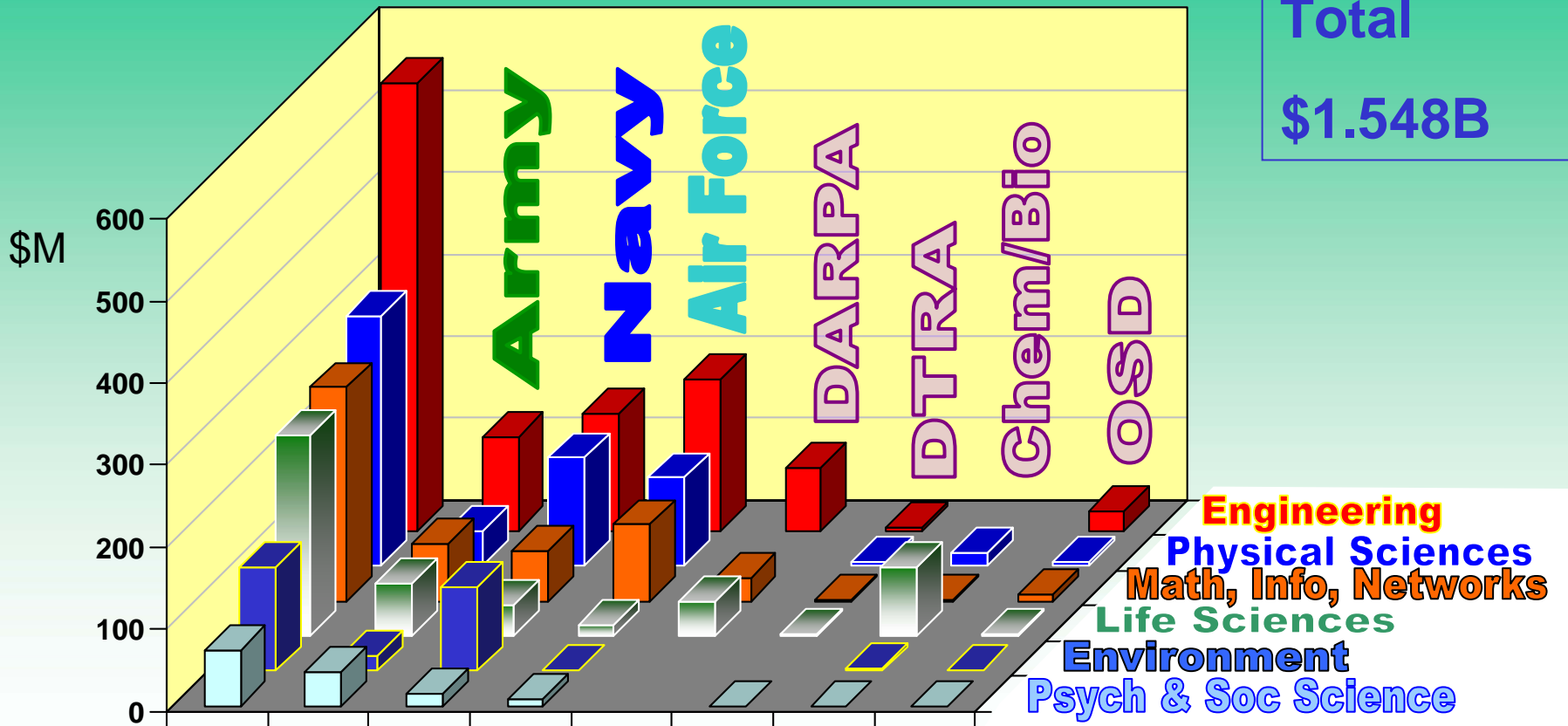
# Desired S&T Investment Areas



(Joint Training is Ubiquitous)



# FY07 DoD Basic Research (by Taxonomy Category)





# Addition to DoD Basic Research

\$M	FY08 PBR	FY08 Appropriation	FY09 PBR	Change from PBR 08	Real Change from PBR 08
<b>Army</b>	305.8	381.5	379.4	24.06%	21.36%
<b>Navy</b>	467.2	506.1	528.3	13.06%	10.61%
<b>Air Force</b>	375.2	407.7	452.3	20.55%	17.93%
<b>Defense-Wide</b>	279.9	338.3	338.7	21.00%	18.37%
<b>Total Basic Research</b>	1,428.1	1,633.7	1,698.6	18.94%	16.36%



# OUTLINE

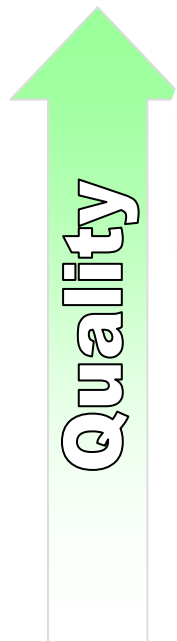
- DoD Basic Research
- DoD STEM Education
- Prize Competition





# A Unique National Security Problem

**HIGH**



Job Applicants



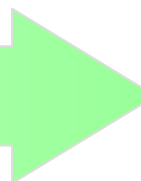
**Desired  
Employees**

Job Applicants

**LOW**

Not  
Clearable

Clearability



**Clearable  
at highest  
level**



## Opportunities

- “The development of a strategic S&T scouting effort linked to the US university and private

***“When I compare our high schools to what I see when traveling abroad, I am terrified for our workforce of tomorrow.”***

***- Bill Gates***

technology, and engineering education in the United States.”



## Millennials are tomorrow's workforce

- They watch wars and revolutions live on TV and the Internet
- Elvis died 20 years before they were born
- Satellite radio has been around since they were 5 years old
- They have only known two presidents
- WWI started nearly a century before they were born
- They have never seen a film camera
- There have always been hybrid cars

Source: "Millennial: About them" Navy Recruiting Command briefing, 7 Feb 2008



## Millennials are tomorrow's workforce

- They have always been online
- They have never known a world without digital phones or DVDs
- Soviet Union fell 7 years before they were born
- When Sputnik was launched, their parents were in kindergarten
- Their buddy lists span the globe.
- There has always been one Germany
- One electronic device does it all: TV, Internet, Phone, Music, Data, Computing

Source: "Millennial: About them" Navy Recruiting Command briefing, 7 Feb 2008



# Millennials are tomorrow's workforce

## Globalism

- Millennials grew up seeing everything in the world as:
  - Global
  - Connected
  - Open for business 24/7

Source: "Millennial: About them" Navy Recruiting Command briefing, 7 Feb 2008



# Millennials are tomorrow's workforce

- They are taking longer to graduate from college
- Only 37% of first-time freshmen at four-year schools earned their bachelor's degrees in four years
- Another 6% took up to six years

Source: "Millennial: About them" Navy Recruiting Command briefing, 7 Feb 2008



## Millennials are tomorrow's workforce

- They are technology sophisticates
- Through media multitasking kids are spending 6.5 hours a day with media, but are packing more than 8.5 hours worth of exposure into that time

Younger kids have more and more media devices; of those 8-14 years old -

- 39% have cell phones
- 24% have a hand-held Internet device or PDA
- 12% have a laptop computer

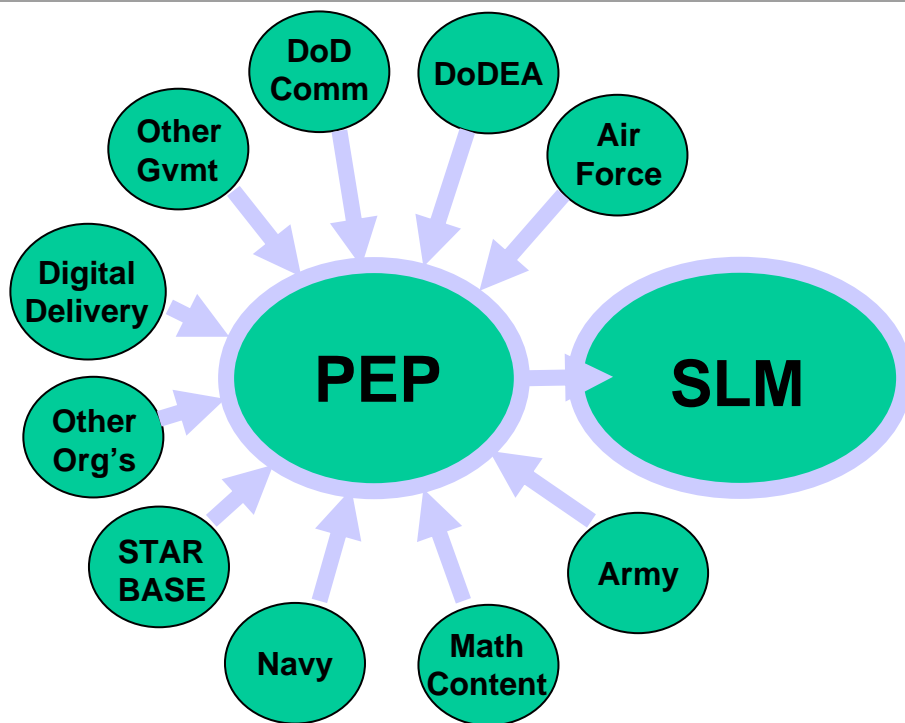
Source: "Millennial: About them" Navy Recruiting Command briefing, 7 Feb 2008





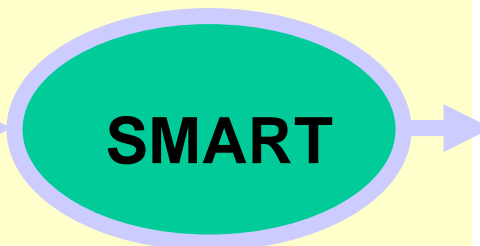
# NDEP Portfolio Components

## Pre-College (K-12)



***STEM Interest...  
Potential DoD Employees***

## Undergraduate Graduate



***DoD  
Employees***

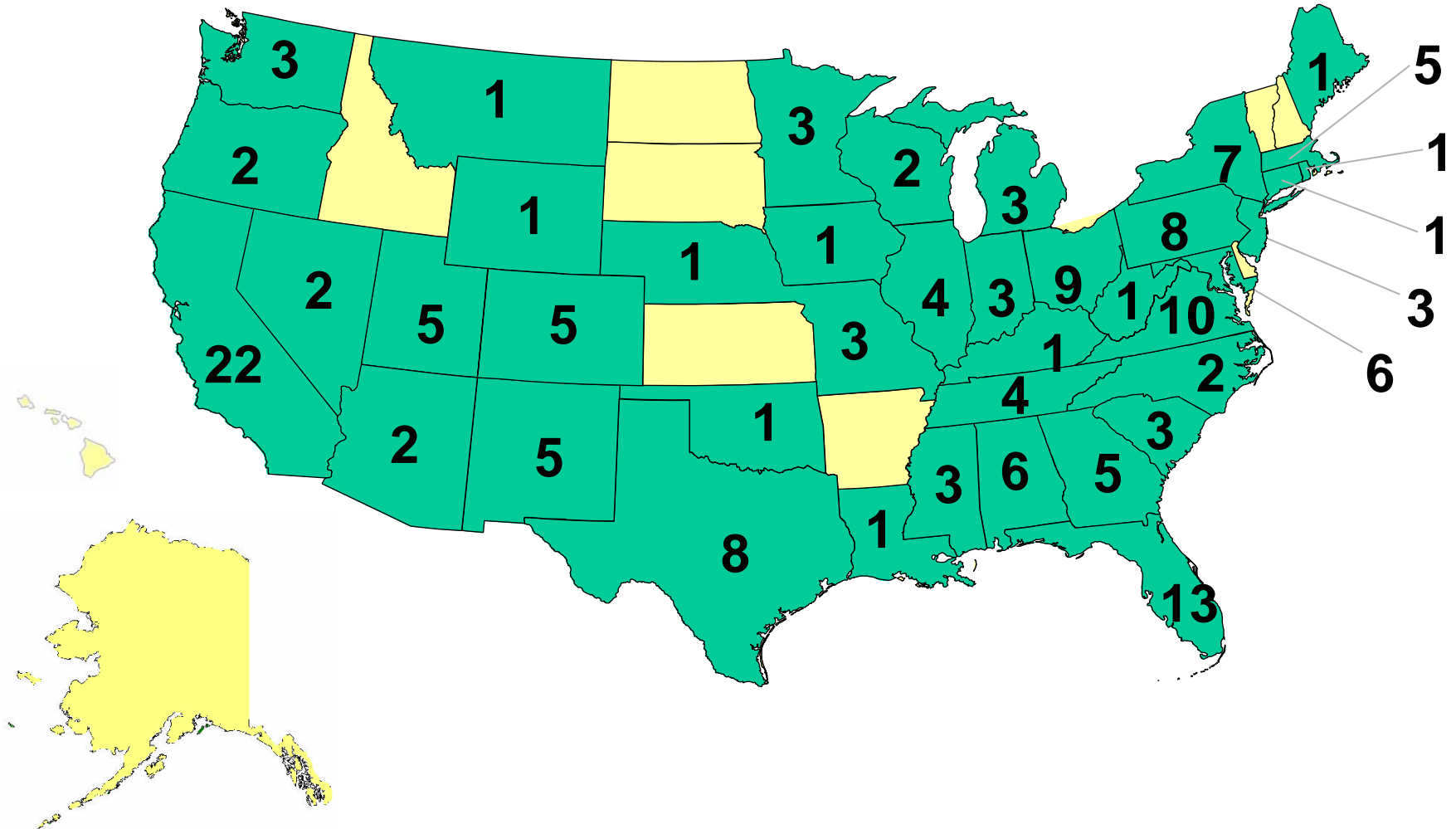
## Post-Graduate



***DoD  
Affiliated  
Faculty***



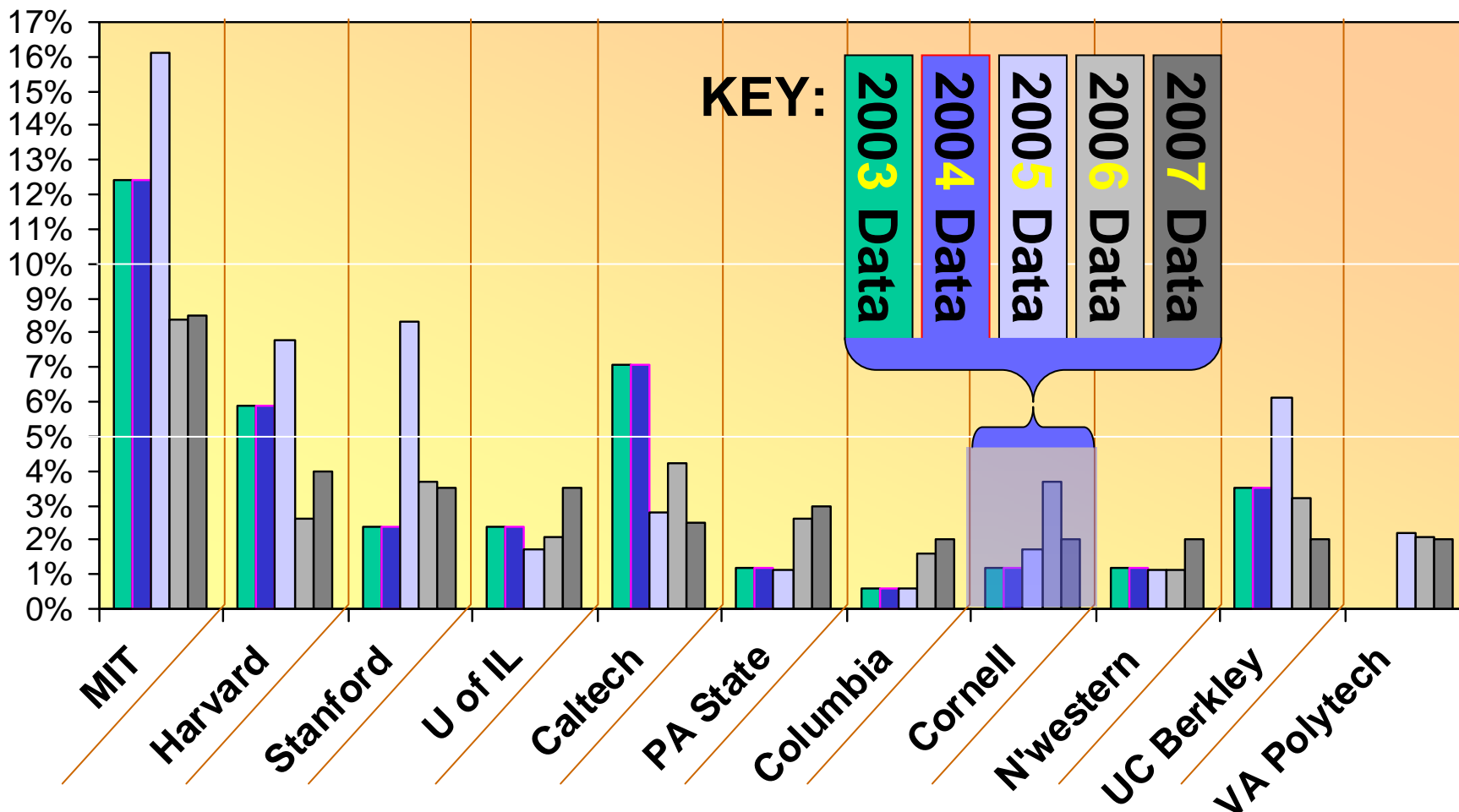
# SMART's National Impact



Note: Student awards (by state of residence)



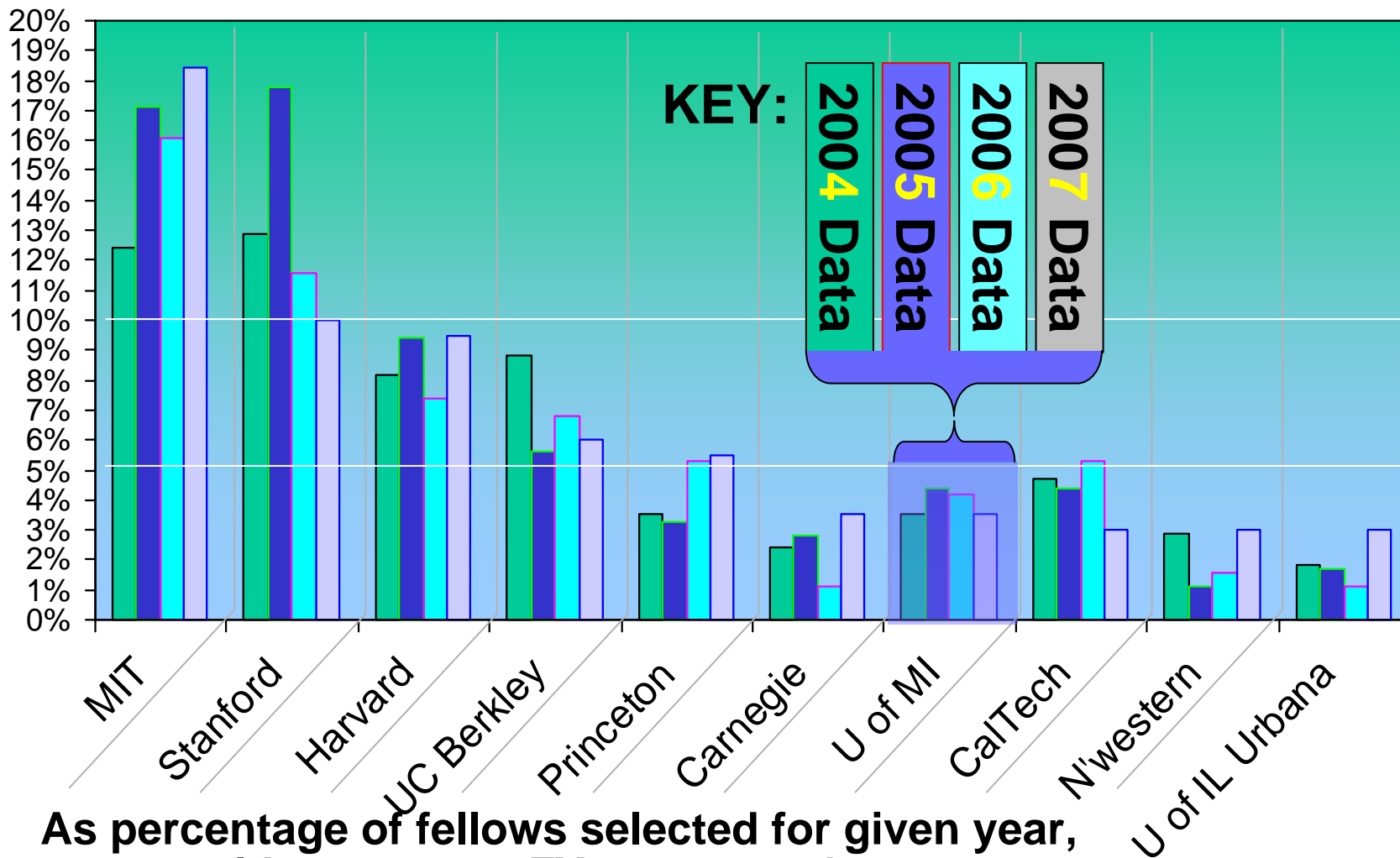
# NDSEG –Fellows’ Undergraduate Schools



As percentage of fellows selected for given year, with respect to FY07 top numbers



# NDSEG –Fellows’ Graduate Schools





# OUTLINE

- DoD Basic Research
- DoD STEM Education
- Prize Competition



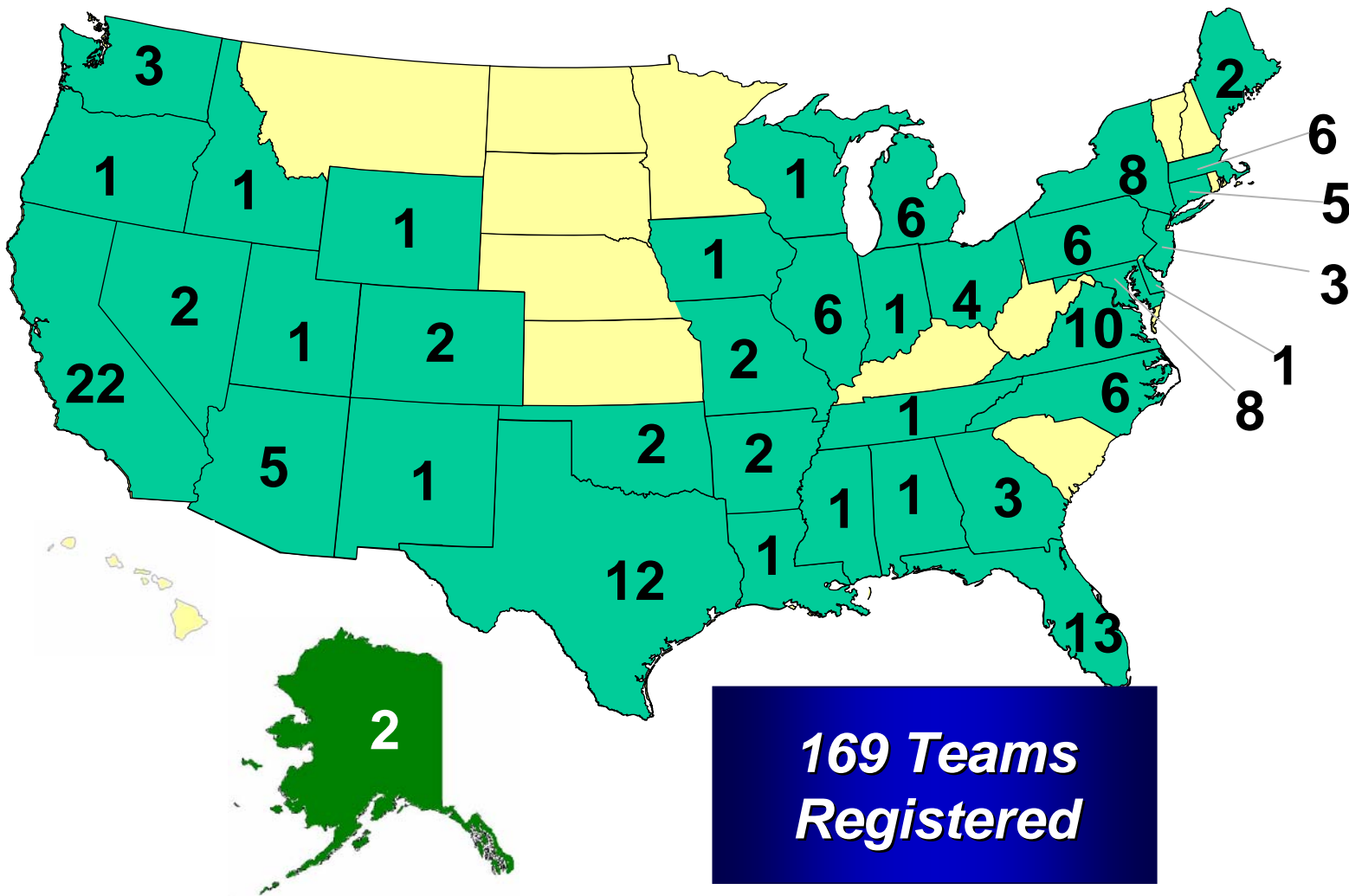
# Wearable Power Prize



- 1<sup>st</sup> Prize \$1M, 2<sup>nd</sup> prize 500K, 3<sup>rd</sup> prize: \$250K
- Goal: Reduce weight of Warfighters' power systems
- Competitors will produce prototypes that provide 20W average electric power continuously for 4 days, attach to a vest, and weigh 4 kg or less
- Capstone event will be held on October 4<sup>th</sup>, 2008, at the Marine Corps Air-Ground Combat Center, Twentynine Palms, California. See: <http://www.dod.mil/ddre/prize>



# Wearable Power Prize Team Registrations



**169 Teams Registered**





***Dr. William S. Rees, Jr.  
Deputy Under Secretary of Defense  
(Laboratories and Basic Sciences)***

***Office of the Director  
Defense Research and Engineering***

***(703)-692-4592***

***william.rees@osd.mil***





# DOD Technology Innovation & Transition



Science and Engineering  
Technology Conference  
15 April 2008



Strategic Initiative for  
Innovation and  
Technology Transition



## Culture Change

Kathleen L. Harger  
Assistant Deputy Under Secretary of Defense  
Innovation and Technology Transition





# The Landscape Has Changed

## Drivers Behind the Change

- Technology access now on a global scale
- Proliferation of potentially disruptive technologies
- Greater uncertainty of security challenges
- Fewer resources
- DoD no longer at forefront of most technology research
- Warfighting-relevant technologies have short refresh cycle
  - “Time-to-market” is the imperative

## But...

- Linear acquisition process
- “Inward-looking” culture
- Barriers to entry for non-traditional businesses



# The Call to Change



## Congress

- Public Law 107-314, Dec 2, 2002 Technology Transition Initiative
- Section 255 of the FY06 Defense Authorization Act Requesting DOD Report on Technology Transition Barriers and Challenges
- Public Law 109-163, Jan 6, 2006 Technology Transition
- GAO Report, “Best Practices: Stronger Practices Needed to Improve DoD Technology Transition Processes” (2006)

## Advisory Committees

- Defense Science Board Task Force, “Technology Capabilities of non-DoD Providers” (2000)
- National Research Council of the National Academies, “Committee on Accelerating Technology Transition” (2004)
- Defense Science Board Summer Study, “21<sup>st</sup> Century Strategic Technology Vectors” (2006)
- Defense Science Board Task Force, “Defense Industrial Structure for Transformation” (2007)



# The Call to Change

## Office of the Secretary of Defense

- Defense Acquisition Performance Assessment, Jan 2006
- Advocate for Innovation & Technology Transition created in Mar 2007
- DoD Report to Congress on Technology Transition, Sep 2007
- Strategic Initiative on Innovation and Technology Transition, Dec 2007

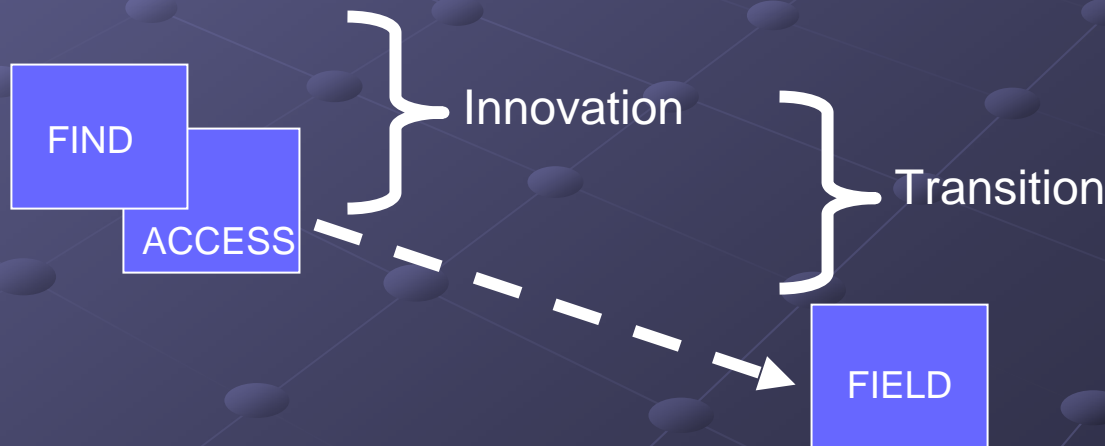
DepSecDef: “Breakdown the walls...that inhibit the efficient transfer of commercial technology into Warfighter hands”

USD (AT&L): “Drive the capability to defeat any adversary on any battlefield”



# Strategic Initiative on Innovation & Technology Transition

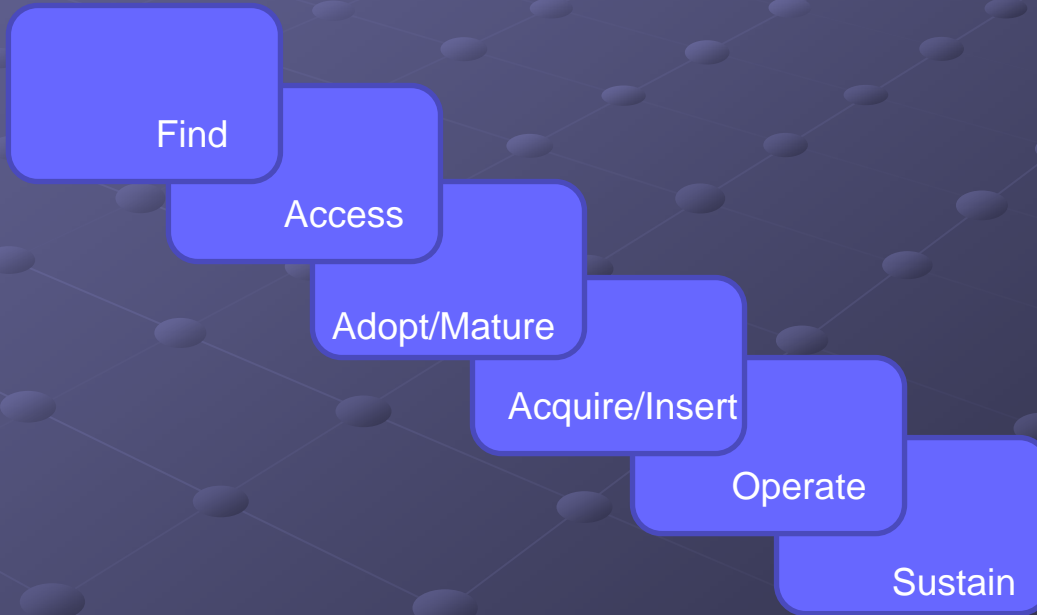
Create an Enterprise-wide strategy for accelerating the movement of technology from any source to our warfighters





# Technology Life Cycle

Innovation and transition must be inextricably linked in the Technology Life Cycle to address both urgent wartime needs and long-term military requirements





# Solution Focal Points



6.1

6.2

6.3

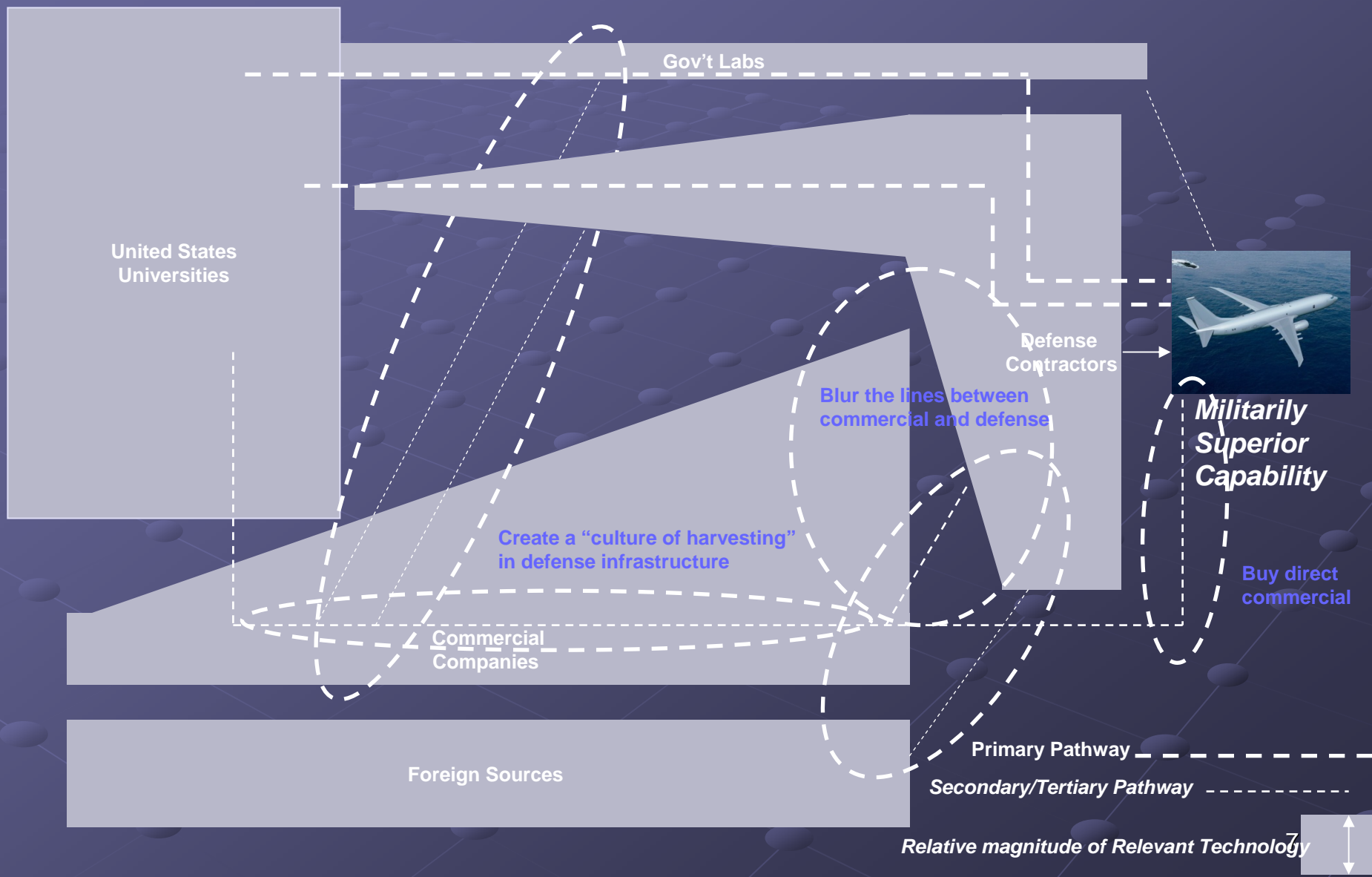
6.4

6.5

6.6

Proc

O&M





# Near Term

# Mid Term

# Far Term

FY 08 09 10 11 12 13 14 15 16 17 18

## Front End

*Aggressive Communications And Business Practices To Attract Non-Traditionals (Selected Technologies)*



*Broaden Technology Range, Proliferated Best Practices*



*Expand Overseas Access, Few "Non-Traditionals"*



## Back End

*Leverage Selected Pathways To Move Solutions Through the System*



*Execute Big-A Reform, Defense Industry Incentivized to Harvest, ITAR Overhaul Industries*



*Blending of Defense and Commercial*



## Cross-Cutting

*Maximize Use of Existing Tools, Increase Rotations, Strengthen CTO*



*Proliferate Training Across DoD, Execute Human Resources Reform*



*Continue Training, Institutionalize Rotation Across Defense and Commercial*



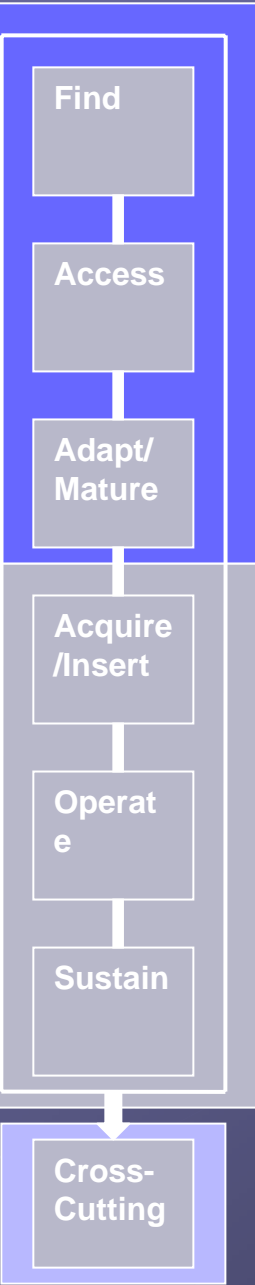
Beginning of turning outward, End-to-end existence proof, Seeds of acquisition reform And 21<sup>st</sup> century leadership



Expansion of outward focus, Leverage defense base for harvesting, remove global barriers



Routine outreach, defense industry walls porous with routine commercial access, globally-savvy, entrepreneurial leadership





# Near-Term Initiatives

- **Global Outreach:** Harvest technology and innovation in the private/global marketplace through collaborative venues whereby non-traditional sources can access information concerning DoD needs, opportunities for interactions, and streamlined approaches to doing business with DoD.

- **Barriers to Entry for Non-Traditional Suppliers:** Promote flexible contracting instruments through creation of a “non-traditional business cell” pilot program.

- **Strategic Linking of Agile Acquisition Programs:** Create enterprise-level strategy for deliberate and aggressive use of authorities and investment opportunities associated with agile acquisition.

- **Culture of Harvesting:** Create environment that rewards global outreach and attracts the best and brightest to collaborate with/work in our S&T and acquisition communities.



## How Will We Know We've Succeeded?

- When we have an 'outward' looking culture in which we seek and access innovation from any source
- When it becomes standard practice to collaborate inside and outside the Department
- When we embrace the use of flexible contracting as a way of doing business
- When the linking of our agile acquisition authorities and investments, driven by a corporate strategy, results in more affordable and effective capabilities
- When our Warfighters can defeat any adversary on any battlefield

# Contact Information

Ms. Kathleen L. Harger  
Assistant Deputy Under Secretary of Defense  
(Innovation & Technology Transition)

Office: 703.607.5311

Email: [Kathleen.Harger@osd.mil](mailto:Kathleen.Harger@osd.mil)



# *Innovation at a Large Scale*

***Ed Morris***

***Director, Hardware and Manufacturing***

***Lockheed Martin  
Corporate Engineering and Technology***

***April 17, 2008***

# The Men and Women of Lockheed Martin



- **140,000 Employees**
- **70,000 Scientists and Engineers**
  - **25,000 IT Professionals**
- **Operations in 1,000 Facilities, 500 Cities, 50 States and 75 Countries**

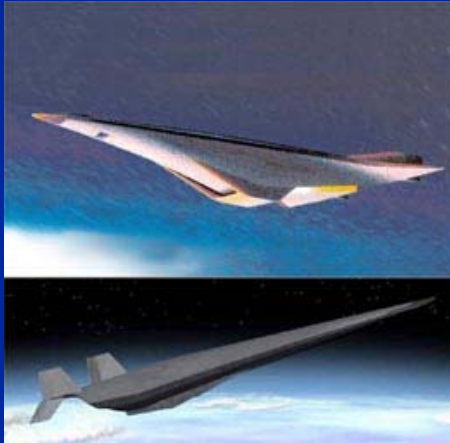
**Partners to Help Customers Meet Their Defining Moments**



# Redefining What Is Possible



**Hypersonics**



**Biometrics**



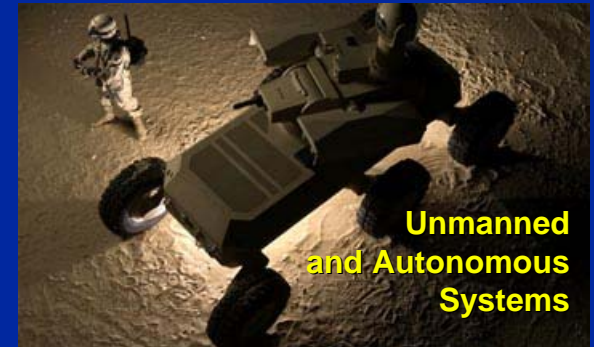
**Return of Crew Space Exploration**



**Persistent Surveillance**



**Information Fusion**



**Unmanned  
and Autonomous  
Systems**

**A Passion for Invention**

# Lockheed Martin Business Areas



LOCKHEED MARTIN



## Aeronautics



## Electronic Systems



## Space Systems



## Information Systems & Global Services



# Large Scale Friction Stir Welding (FSW) for Performance & Cost



## LO2 Barrel Welds (OB)

4 each 8 -feet long  
Tapered Thickness

## LH2 Barrel 1 (Longeron Welds)

4 each 15-feet long  
Tapered Thickness

**Barrel Welds**  
8000 inches  
out of  
36,000 total inches



Space Shuttle External Tank FSW  
Longitudinal Barrel Welds

## LH2 Barrels 2, 3 and 4 Welds

24 each 20-feet long

## LH2 Barrel 1 Welds (HB1)

6 each 15-feet long

# FSW – An Amazing Innovation!



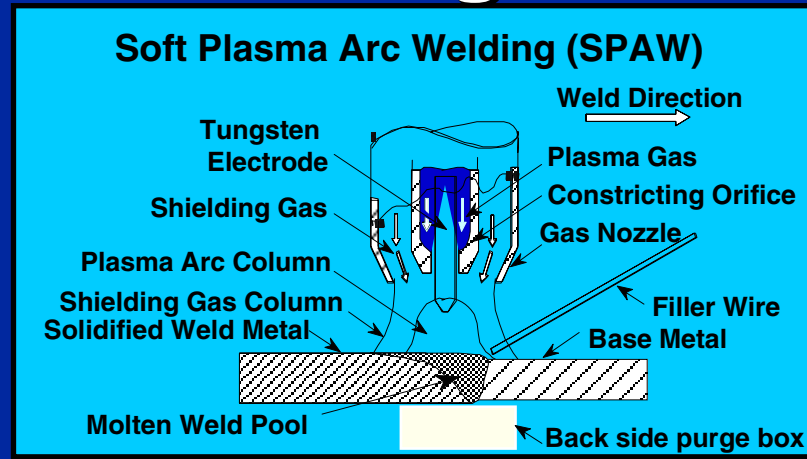
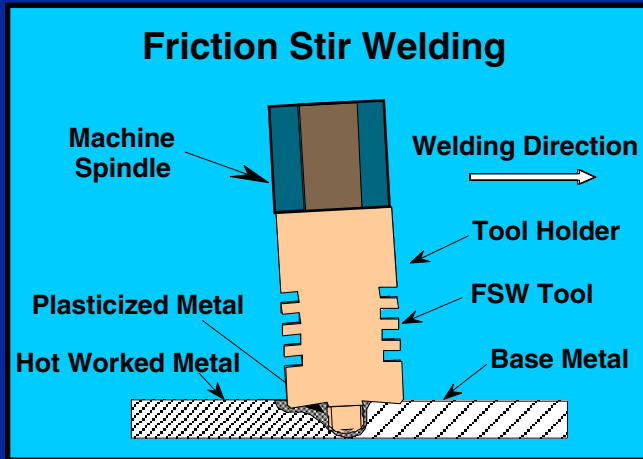
## Friction Stir Welding *The Concept*

Produced by Graphic Services  
Lockheed Martin Space Systems Company  
Michoud Operations

LOCKHEED MARTIN



# FSW Versus Fusion Welding

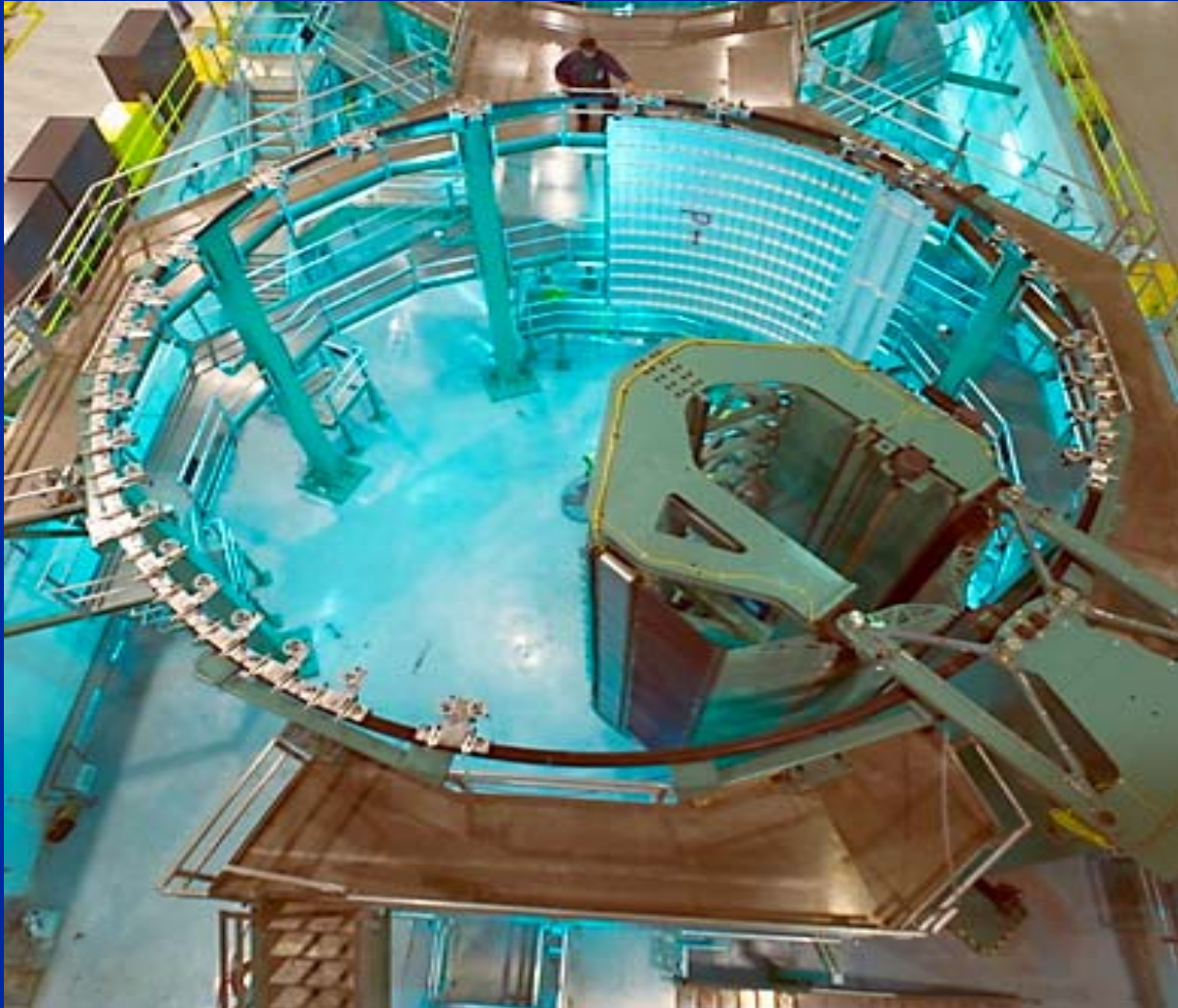


	FSW	Fusion
Weld Set Up	Schedule Selection Pin Tool Selection	Schedule Selection Shield Cup Design Orifice size Tungsten position Tungsten size/type Wire alloy and diameter
During Welding	Plunge depth/load Rotation speed Weld speed Centerline position Pin length (tapers)	Current Voltage Travel speed Wire feed rate APC/AVC Additional Reverse Current Plasma gas and flow Shield gas and flow Back side Purge gas and flow Pulse Frequency/Duty Cycle Arc gap Oscillator width (Cover pass only) Oscillator dwell (Cover pass only) Oscillator speed (Cover pass only)

***Friction Stir Welding vastly reduces and simplifies the process variables***



# FSW Barrel Weld Tool



***Manufacturing Process Simplicity on a Large Scale***

# Shop Floor Innovation: Flexible, Reconfigurable Factories



- **Modular workstations with quick-connect utilities wired underneath the floor**
- **The workstations are daisy chained together forming work cells**
- **The stations are mobile, can be customized, and can be set to a variety of heights and configured with numerous shelving options**
- **They can be converted to class 10K flow booths to meet production needs**
- **The workstations and cells are so flexible that entire cells can be reconfigured in two hours**





# Fire Control Factory Engineered Workstations



**Engineered Workstation**

- **Standardized approach and design engineered for flexibility and functionality**
- **Integrated casters and utility chase allow workstations to be disconnected, relocated and reconnected in a matter of minutes**
- **Utility chase for power, air, phone and LAN**
- **Need a class 10K flow booth? Simply wheel the portable flow booth to the workstation**

***Lean + Agility = Affordability***



**10K Flow Booth Option**



**Relocate, Connect and Go**

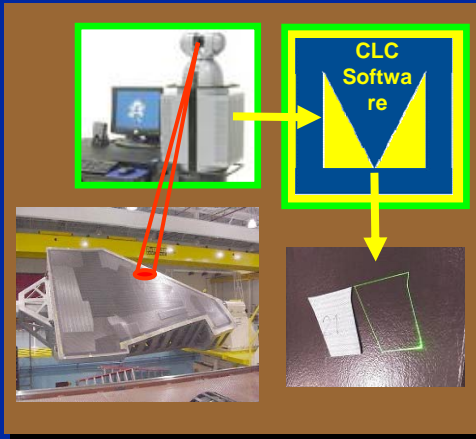
# Fire Control Factory Engineered Equipment



*Self-contained Oven and Mix Booth*

- **Factory equipment designed to support rapid rearrangement & flexibility**
- **Custom designed oven set-up and mix station incorporate filtration system eliminating need to vent to the outside environment**
- **Casters and standard 110v power operation further simplifies rearrangement**

# Integrated Composite Technology for Large Aircraft Structures



## *Optimize Cured Laminate Compensation (CLC) Process*

- *Highly Accurate Thickness Control*
- *Integral to Cure Process*
- *No Machining Required*
- *Supports LO*



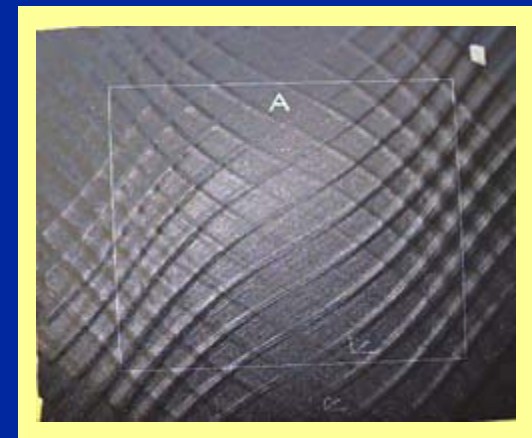
*Future Mobility Platforms*

*Future High Altitude UAV*



## *Vacuum Assisted Resin Transfer Molding*

- *Integrated caps*
- *Sandwich stiffened*
- *Elimination of fasteners*



## *Variable Stiffness Tailored Laminates*

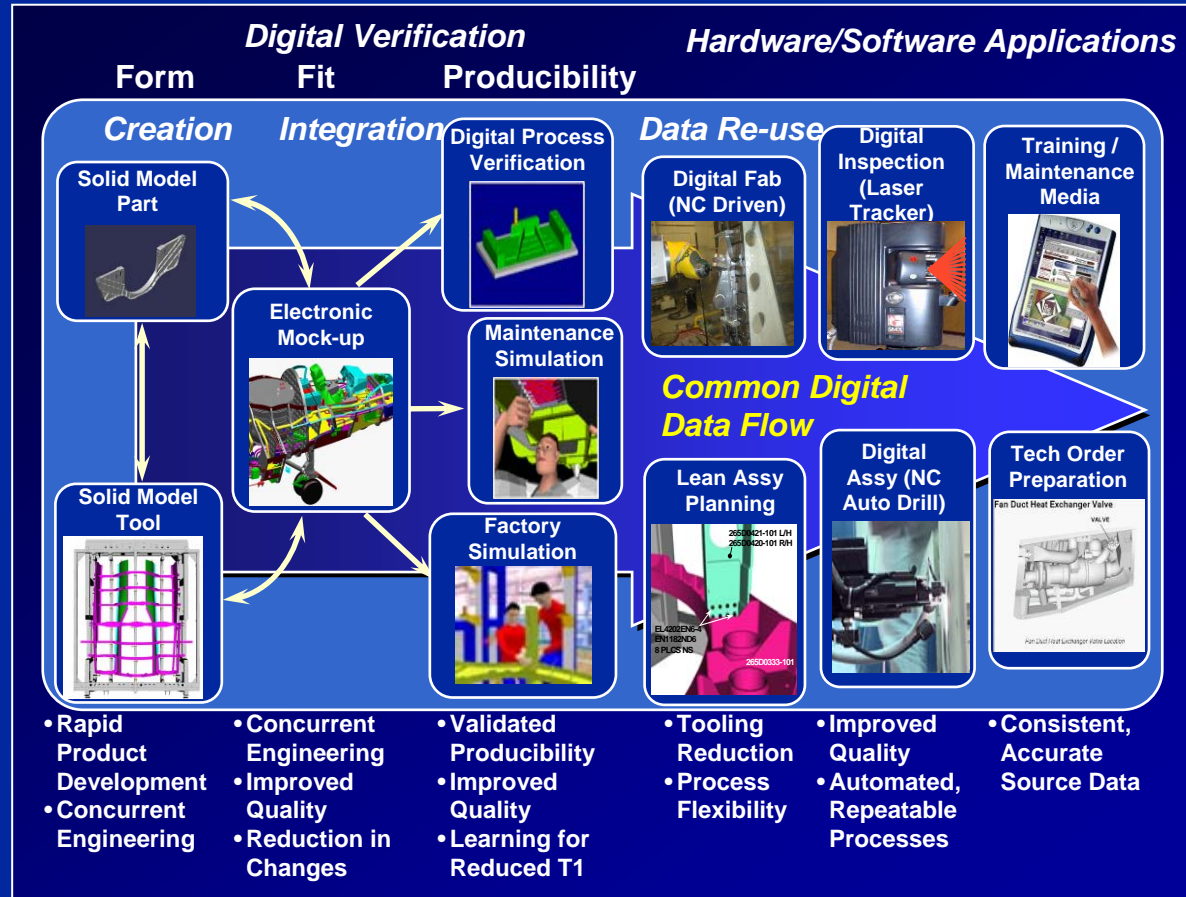
- *Increased design freedom*
- *Load path optimization*



# Common “Digital Thread” Is Key to Reduced Cost, Schedule and Risk

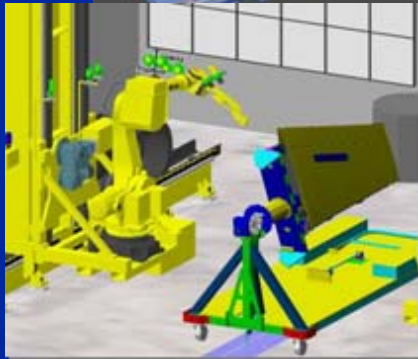
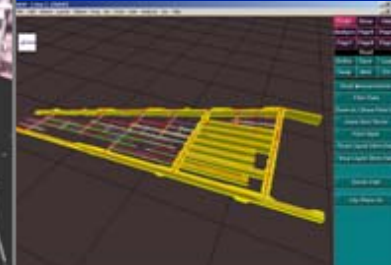


- **Solid Model Data Source**
  - *Single Exact Definition*
  - *Reduces Span Time for Creation*
- **Data Re-Use**
  - *Eliminates Interpretation Error*
  - *Reduces Task Span Times*
- **Digital Product / Process Verification**
  - *Form, Fit, & Producibility Verified Prior to Build*
  - *Improves Quality*
  - *Reduces Cost and Risk*
- **Concurrent Development Process**
  - *Reduces Program Span Time*

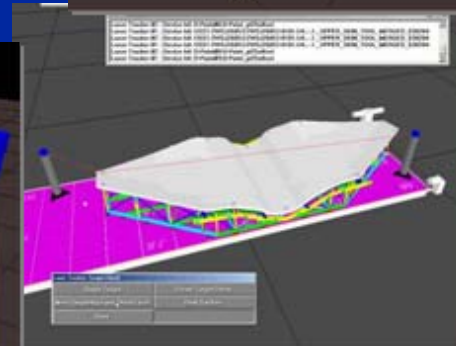
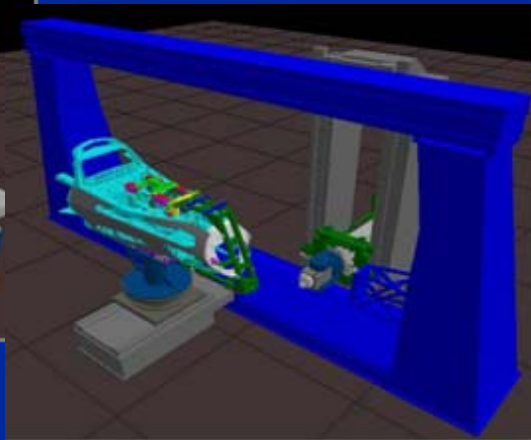
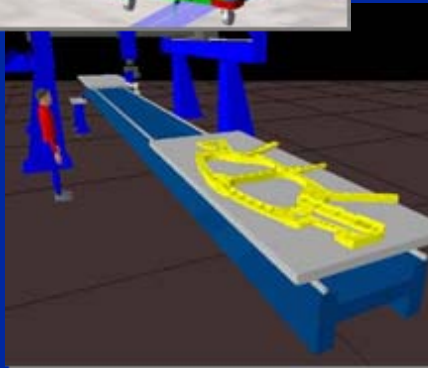
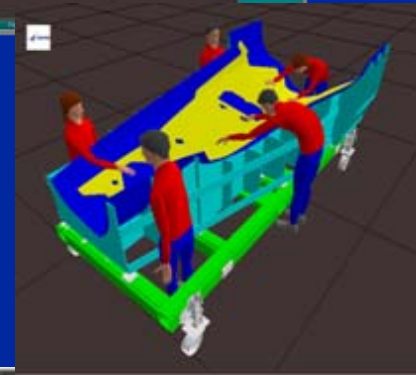


**Form, Fit and Producibility of Parts and Tools To Be Verified in the Digital Mock-up Prior to BTP Release**

# Exploiting the “Digital Thread” Begins with Modeling & Simulation



**Advanced  
Modeling &  
Simulation**



# Large Scale Assembly Innovations Using Common Digital Thread



## Automated Drilling Systems

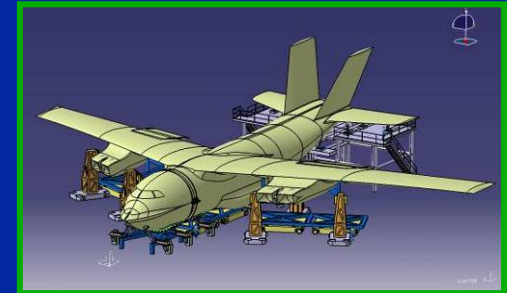


## Digital/Optical Wire Harness Assy.



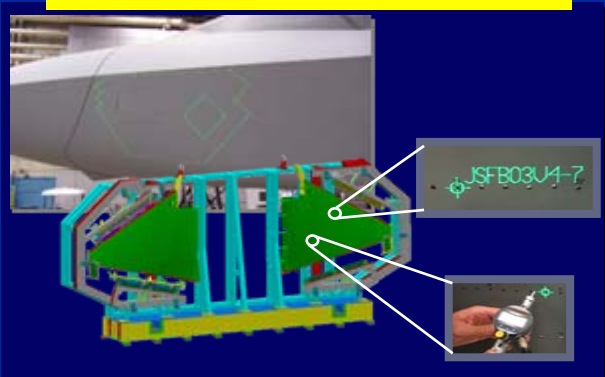
- Optically Identifies Connector Locations for discrete Wire locations
- Reduces Assembly Span Time by 50%
- Reduces Error in FACT Test Errors by over 100%.

## Electronic Mate / Assy.



- Laser Tracking / Real Time Location
- High Tolerance Servo-Driven Jacks
- Eliminates Massive / Inflexible Tools

## Laser Projection Systems



- Real Time Updates to Associated Data
- Projected at the Point-of-use
- Eliminates Need for Discreet Work Instructions/Drawing Access

## Automated Robotic Paint/Coating Systems



- Accurate / Repeatable Application
- Digitally Driven from Engineering Data

***Carbon Nanotubes  
at Work!***



***Ed Morris***  
***Director, Hardware and Manufacturing***  
***Lockheed Martin Corporate Engineering and Technology***  
***973-603-9710***  
***ed.morris@lmco.com***



Industry Perspective:

The Challenge of  
Transitioning  
Innovative Technology

NDIA-Charleston  
15 Apr 08

Mal O'Neill, PhD, NAE  
LTG USA/CTO LMC (ret)

# Agenda:

- Situation
- People
- Difficulties
- Successes
- Actions

# What's happening to our products?

- Complexity is following Moore's law
- Transformational system requirements are daunting
- Customers' expectations increasing and expanding

# Innovative Modernization is 4-D

- New customer
- New developer
- New process
- New product

# Innovative Technology:

- **Promises major long term improvements in performance, cost, quality, and/or totally new capabilities**
  - Largely unproven
  - Faces competition/adversaries
  - Lacks advocates, especially with customer
  - Forces change
  - Adds risk for industry, developer and user

# People Create Innovation

- Aging workforce – experience lost
- HS Math/Science scores poor
- Engineering enrollments down
- System Engineering only On-job
- Growing Demand for Engineers

***Where are tomorrow's innovators?***



# Why is Transitioning So Difficult?

- Uneducated decisionmakers
- New customers
- Acceptable legacy systems
- Monies needed
- Unknown unknowns
- Doctrine/Force Structure threatened
- Community of Practice damaged

# Warfighter is Critical

- Operational Insights
- Value/impact of potential capability
- When/how much new capability is needed
- But he ---
  - Doesn't understand the technology/potential
  - Might be wrong customer
  - Can't articulate key knowledge to developer

“If I'd asked my customers what they wanted – they would have asked for a faster horse” Henry Ford

# Industry Reluctant To Lead Transition

- **Prefers incremental modernization**
- **Hesitates to provide leadership and resources**
- **Doubts credibility of innovators**

# Success – Nano Testimony

- **Don't say “innovative” – avoid frontal assault**
- **Engage suppliers in modernization strategy**
- **Worst vice is overselling!!! Credibility is Key!!**

**Interview, Dr. Tom Cellucci,  
Pres/COO, Zyvex Corp.**

# Nanomaterials Hit the Field

**Easton**  
**The Ballpark**

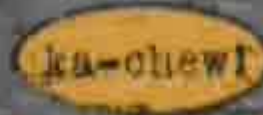
**"Range-Baseball :25/:05"**

**EAST 0502**

**TRT: 30 Seconds**

**04-27-05**

**Edited Master**

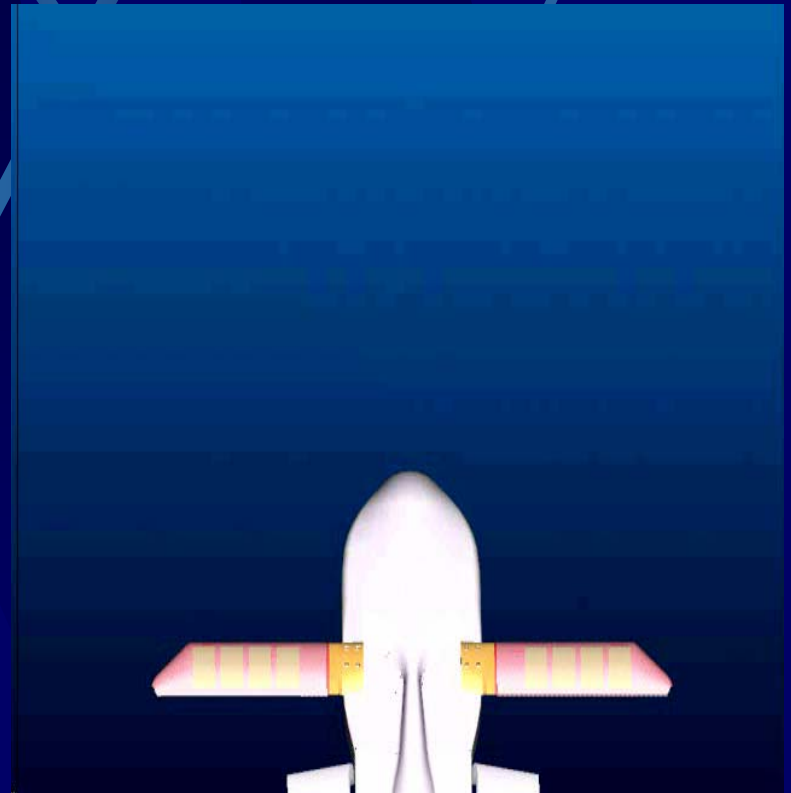


LIVE ACTION | GRAPHIC | ANIMATION

# Success: DOD Nanomaterial

- **Multifunctional Nano-Structures**

- **Ultra Light Weight**
- **Strength, rigidity**
- **Producibility**
- **Mission Adaptability**



**Extended Wing LOCAAS**

**Courtesy of Dr. Les Kramer, LMMFC**



# Success – JSF Lift Fan

- Lean team '87: USMC, DARPA and Lockheed
- USMC stayed in-charge
- DARPA support before IRAD \$
- PM designed/advocated “lift fan”
- Competitor influenced final “lift fan” decision
- AF code convinced engine teams
- AF added strong staff/tech support

**Interview, Dr.P. Bevilaqua, NAE  
Skunk-PM, Invented Lift Fan**

# FIRST: STO-SSDash-VL



**Courtesy of LMAero**

# Action: Materiel Developer

- Engage the internal R&D community
- Strengthen focus on new ideas
- Refresh labs/RDECs to ensure in-house capabilities in SE and across new domains

**Reference: Mike Marshall, “From Science to Seapower”**

# Action: DOD AT&L

- Fund designated innovative technologies
- Add strong system engineering discipline
- Hire/support new S&Es
- Engage Industry/DOE/DHS/NSF

# Action: Warfighter

- Include industry in Combat Developments
- Train cadre to examine capability options
- Use concept of “pilot” operations in field to evaluate new hardware
- Be willing to revise Doctrine, TOEs, TTPs

# Action: Industry (1)

- Develop accountability
- Allocate resources
- Shield innovative technologies
- Develop credibility with customer
- Convince BOD/shareholders



# Action: Industry (2)

- Establish Skunkworks
- Develop Mod-Sim-Test
- Tie above to Warfighter/Developer
- Explore the potential of new tech
- Educate system engineers, et al
- Allow failure

# Summary/Conclusion

**Transition is hard but essential for DOD success**

**Technical and engineering skills are vital**

**A team is required –**

**Industry/Warfighter/Developer**

“I must work longer and harder each day to weave a world in which I can live.”

Callahan, *Adrift – 76 Days Lost at Sea*

ANY QUESTIONS ?

BACKUP

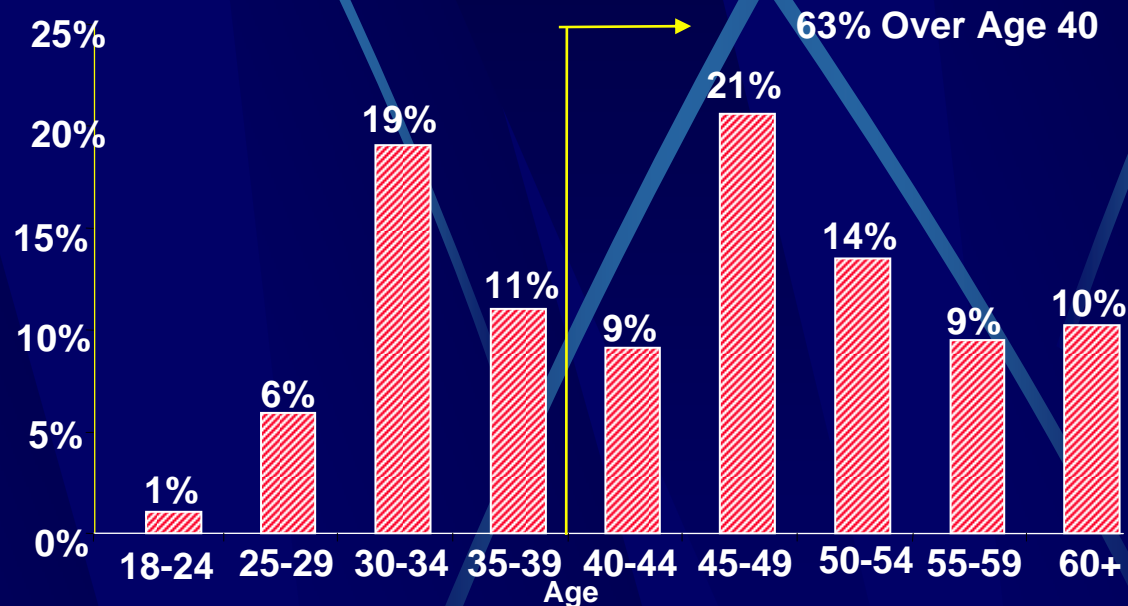
# People Make Products Work

- John Roebling designed the Brooklyn Bridge, alone
- Frank Crowe drove the construction of Hoover Dam alone
- Ed Heinemann knew the Grumman A-4 better than anyone else
- Kelly Johnson knew every Lockheed airplane better than anyone else

***Where are system engineers today?***

# Aerospace Workforce Aging

## Industry Age Distribution



Source: BAH Study

**Industry losing many experienced SE's annually**



# Engineering Enrollment Down ...

## Full-Time Engineering Enrollments



Source: National Science Foundation –  
Science and Engineering Indicators 2000

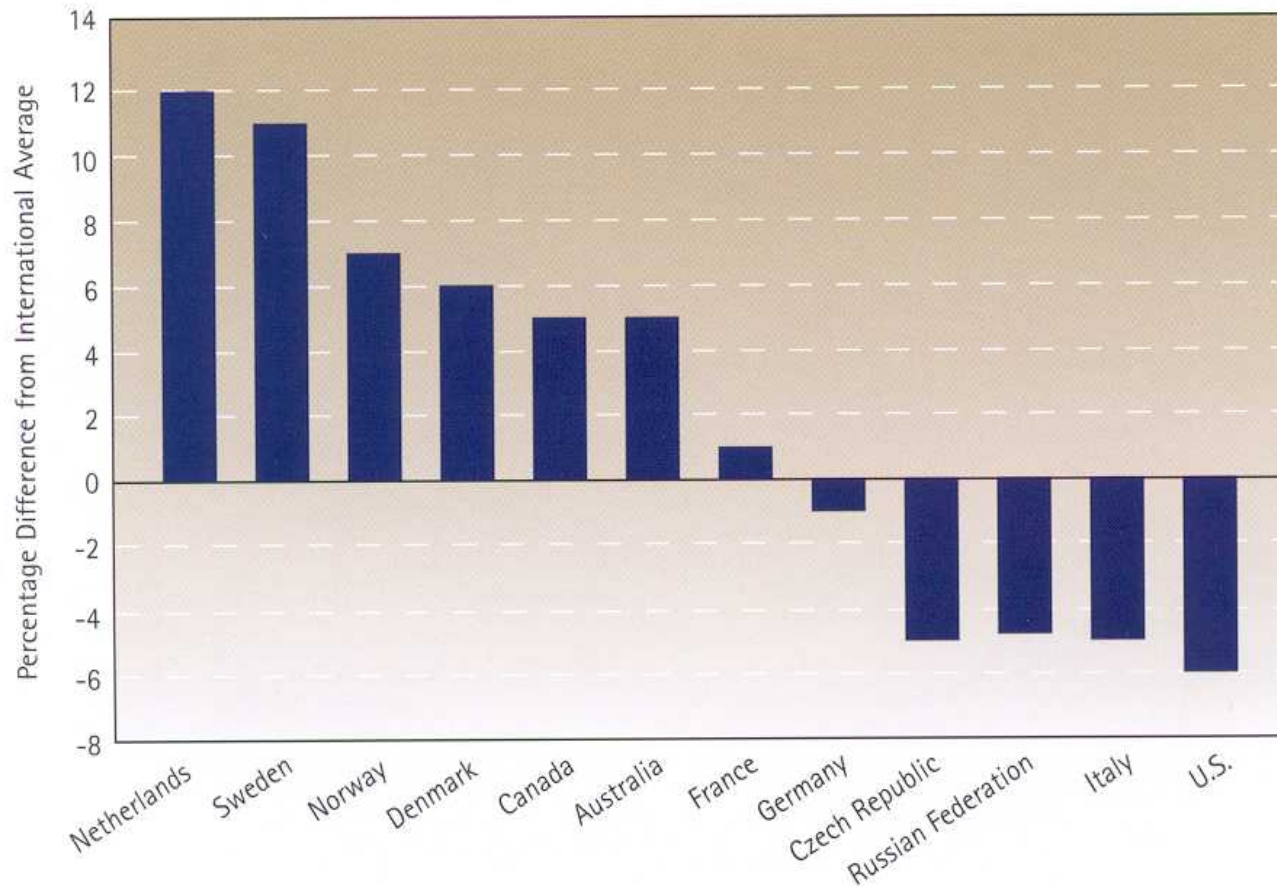
## Engineering Graduates Selected Disciplines

Discipline*	1991	2000
Aerospace	4,072	2,175
Electrical	29,024	21,424
Mechanical	19,443	17,241
Computer	8,259	15,351
Total	60,798	53,189

Source: Engineering Workforce Commission

\*System Engineering Discipline not available in most universities

# U.S. 12<sup>th</sup> Graders Underperform in Math and Science



IEA Third International  
Mathematics and Science  
Study (TIMSS) 1994-95, 1999

# ... While Demand Growing

## U. S. Engineering Job Growth- Selected Disciplines 1998-2008

Discipline*	1998	2008	% Change
Aerospace	53,000	58,000	9.4
Electrical	357,000	450,000	26.0
Mechanical	220,000	256,000	16.4
Computer	5,626,000	11,144,000	98.0
Total	6,056,000	11,908,000	96.6

*Source: U. S Bureau of Labor Statistics*

**\*System Engineers needed for most DOD applications**

# Comparison Between Commercial and Defense Manufacturing Maturity

**Bob Schafrik**  
**GE Aviation**  
**17 April 2008**



# Overview

- GE Aviation
- Commercial engine environment
- Military engine environment
- Materials technology examples
- Takeaways

# GE Aviation Product catalog ...

## world's largest fleet

### **Commercial Power**

<b>CT7</b>	<b>CF34</b>
<b>CF34</b>	<b>CFM56</b>
<b>CF6</b>	<b>GE9x</b>
<b>GP7000</b>	<b>GE90</b>



### **Military Power**

<b>T58/64</b>	<b>T700</b>
<b>J79/85</b>	<b>TF34</b>
<b>F103</b>	<b>F108</b>
<b>F404/14</b>	<b>F101/18</b>
<b>F110</b>	<b>F136</b>



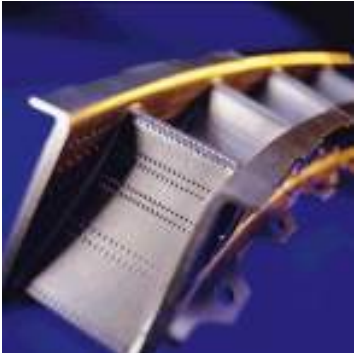
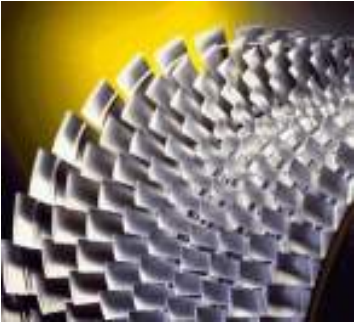
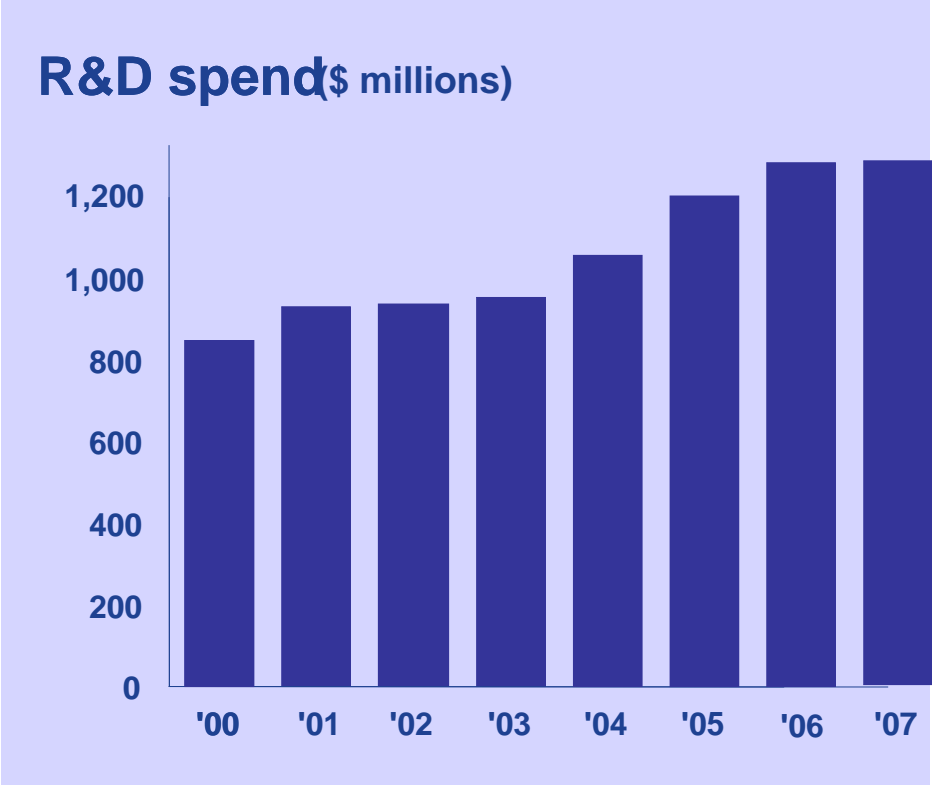
### **Marine & Industrial Power**

<b>LM500</b>	<b>LM1600</b>
<b>LM2500</b>	<b>LM5000</b>
<b>LM6000</b>	<b>LMS100</b>





# Today ... highest R&D commitment in history ... \$8.3B since '00

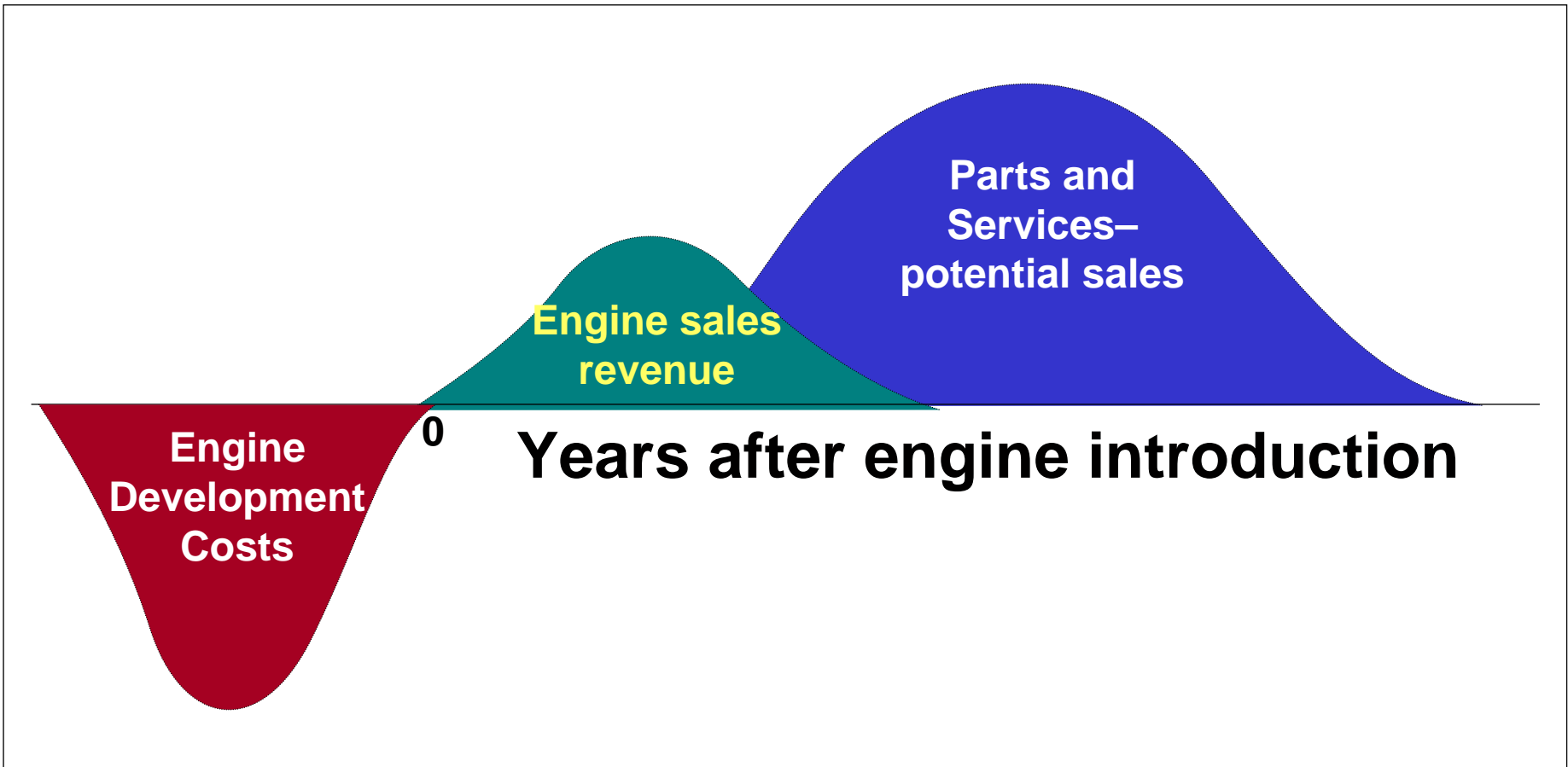


# Comparison of Environments

	<b>Commercial</b>	<b>Defense</b>
<b>Development Time</b>	<b>short</b>	<b>long</b>
<b>Cost Risk</b>	<b>OEM</b>	<b>DoD/Services</b>
<b>Schedule Risk</b>	<b>OEM</b>	<b>DoD/Services</b>
<b>*Build Rate</b>	<b>high</b>	<b>rarely high</b>
<b>No of Customers</b>	<b>large</b>	<b>limited</b>
<b>Product Improvements</b>	<b>Frequent</b>	<b>limited</b>

**Both environments are highly competitive**

# Commercial Engine Business Model



# Commercial Business Case Perspective

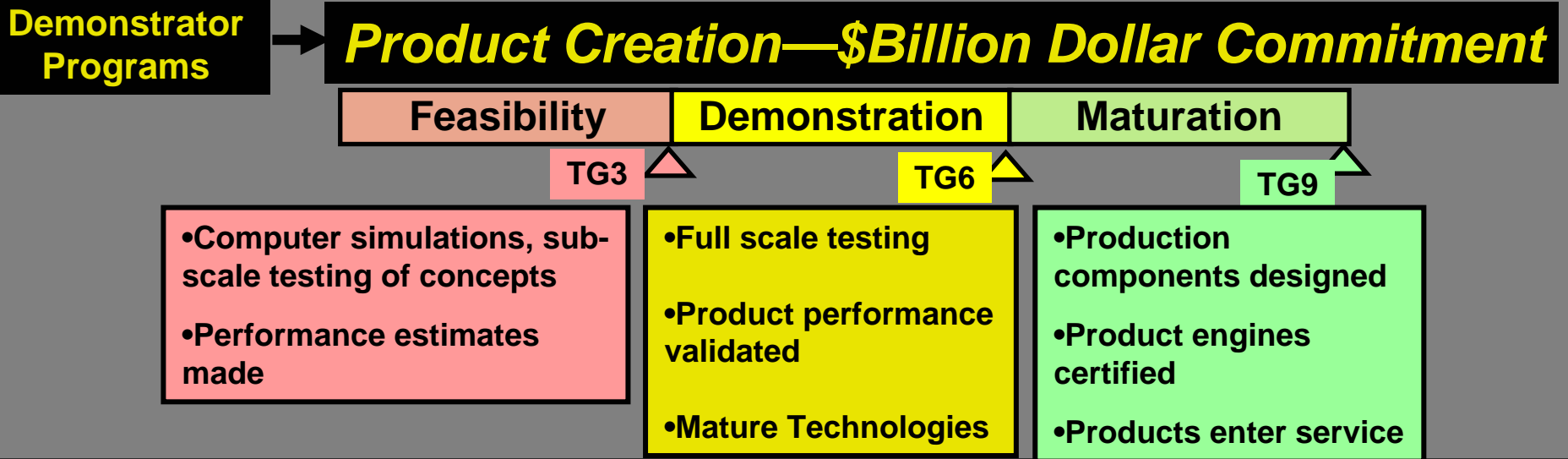
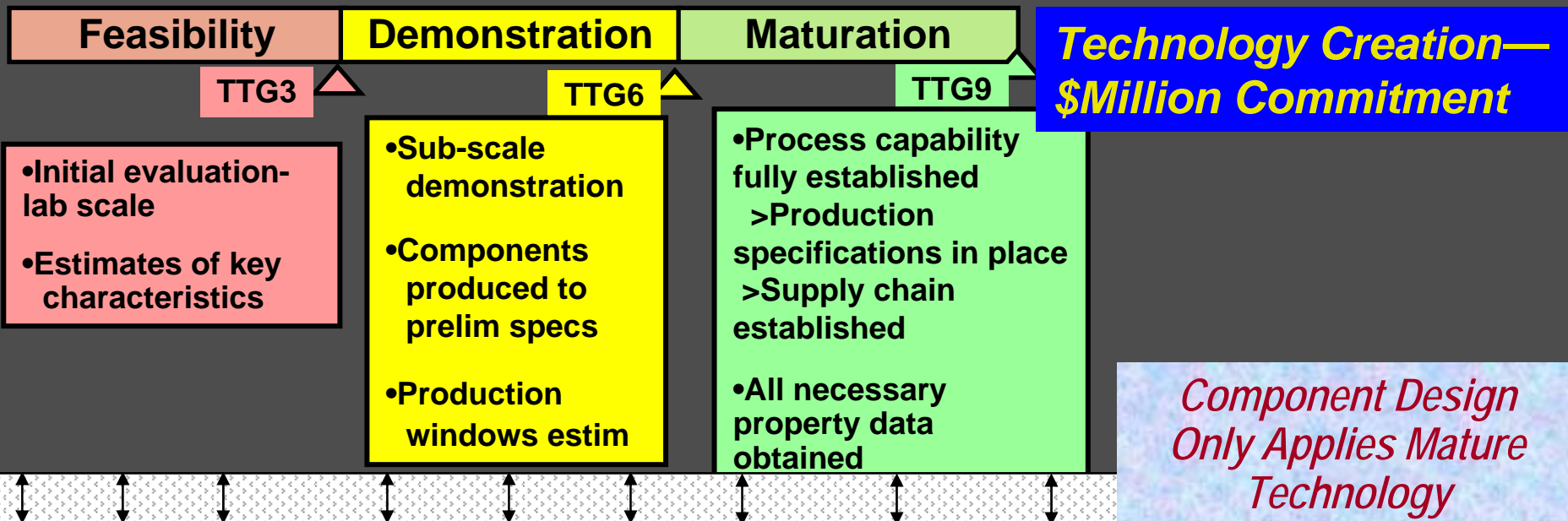
- What does the Technology add to Customer Value
  - Benefits
- Will the Technology deliver the Benefits
  - How well do we understand the risks
  - What are mitigation plans
- What will the Technology Cost
  - Learning Curve
- Is the Business Plan prudent

Manufacturing Maturity Underpins the  
Answers to These Questions

# Commercial Programs Integrate TRL & MRL

- Producibility evaluated early in technology development cycle
  - Will not proceed without a clear path
  - Program gets added plus if MRL is high
    - Development uses production process
- Determine if Supply Base can meet production rate and cost goals
  - Single source vs. Dual source
- May need to develop new supply chain
  - Estimate Business Case for Suppliers

# Commercial Development Stages



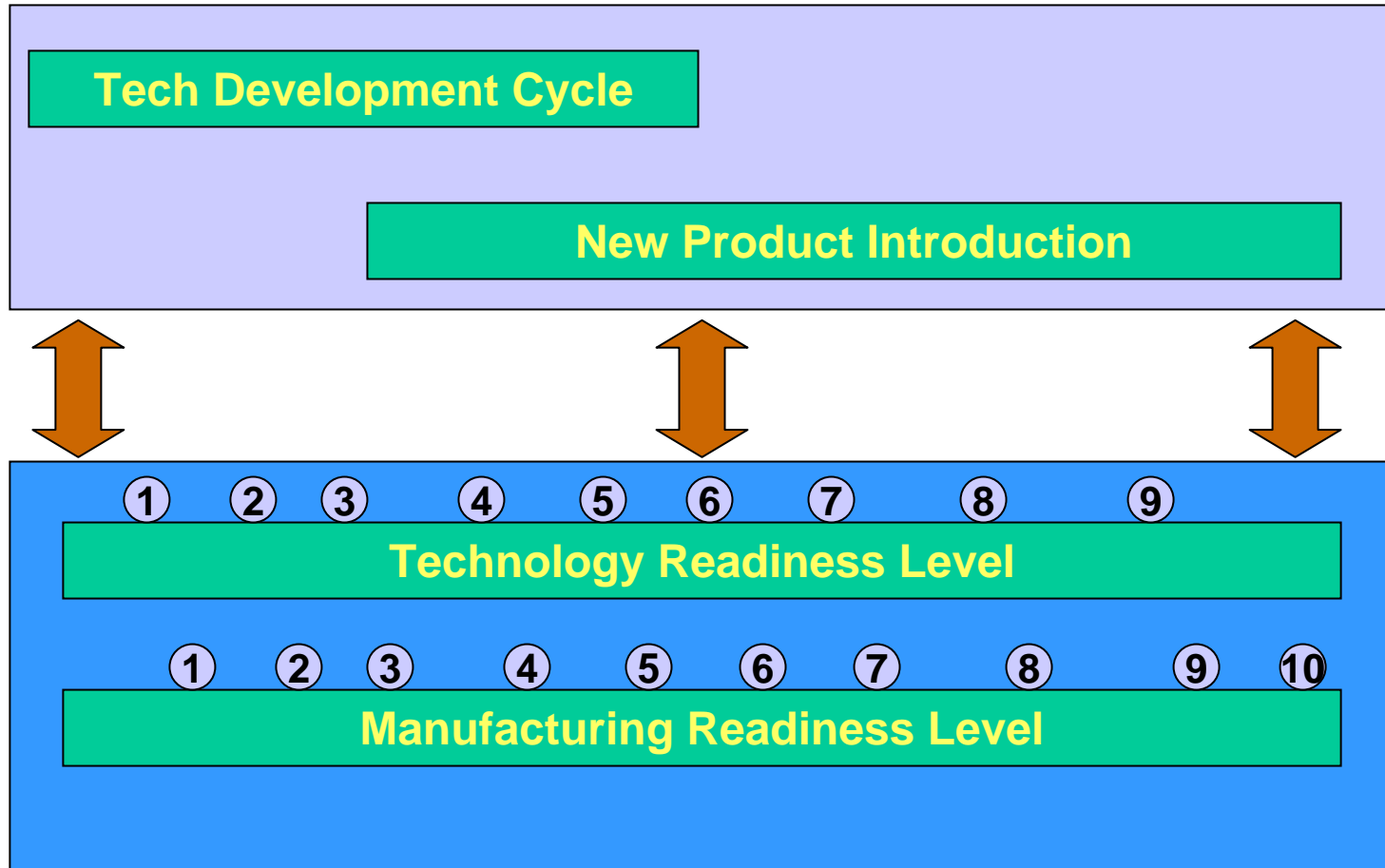


# Producibility Challenges for Military Programs

- Mixed message to Supply Base
  - Early focus on OEM design & tech demos
  - Competition strongly encouraged
  - Social policy, political forces
- Long, drawn-out development timeline distorts investment decisions
  - Difficult to discern the “real” program
  - Limited trade-off of Performance vs. Producibility
    - Maintain budget profile by reducing production quantities

# GE Aviation Support For MRL – TRL

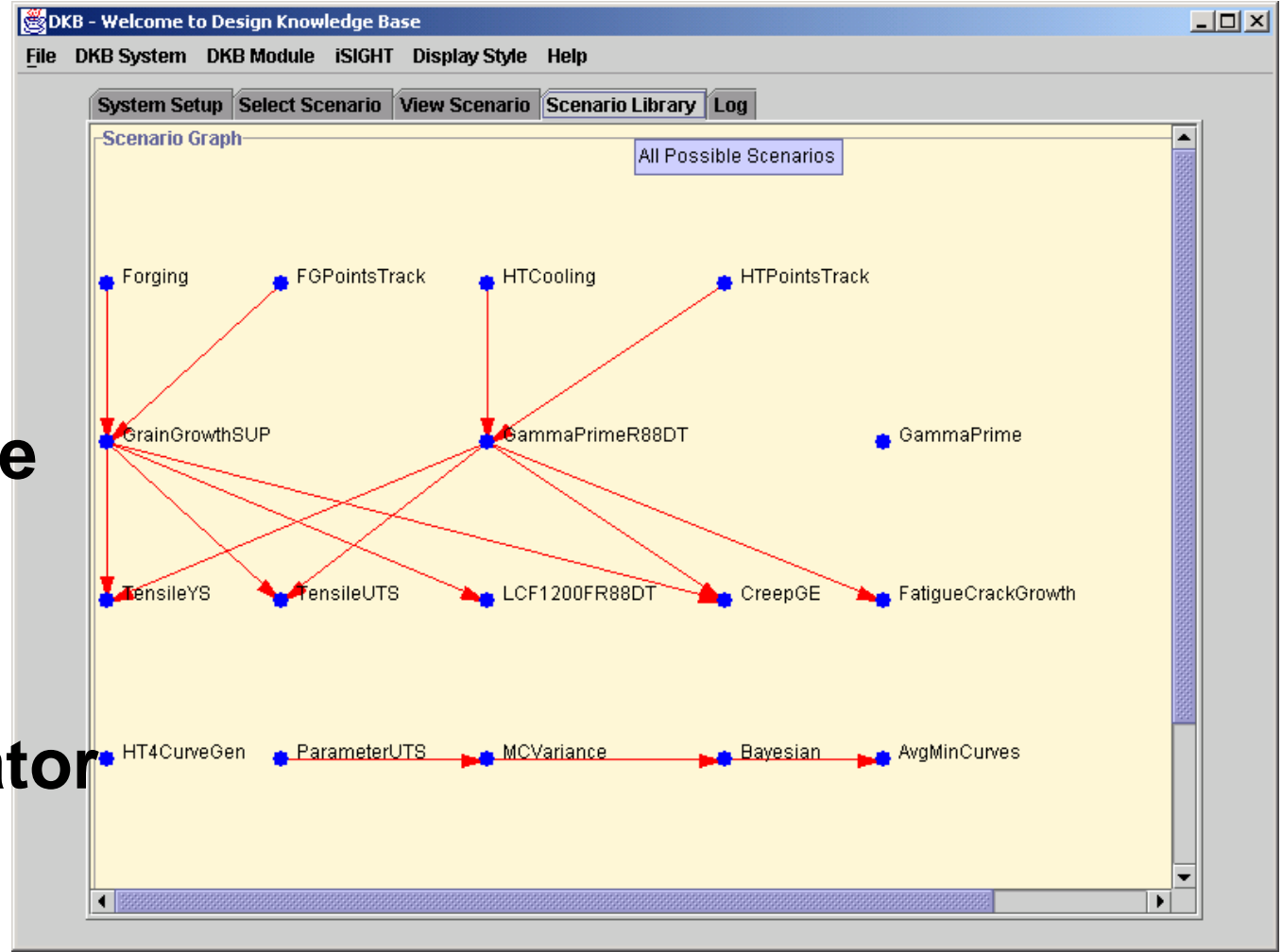
## Compatible With Commercial Development Cycle



# Materials Examples

- Powder Metal Turbine Disks
- Composite Technology
- Titanium Aluminides

# Go-Forward: Integrated Materials & Process Models



Processing

Microstructure

Properties

Curve Generator

# Takeaways

- Commercial program perspective
  - Develop a producible competitive system
    - Success depends on ability to perform
    - Manufacturing Readiness essential
- Military program perspective
  - Develop highly capable affordable system
    - Want leading edge technology NOW
    - Assume that market forces for supply chain
- OEMs are key to developing, focusing supply chain

# Contact Information

Robert Schafrik

(513) 243-0167

[robert.schafrik@ge.com](mailto:robert.schafrik@ge.com)





**Department of Defense  
Science and Technology Program  
*-- A Time of Continued Change --***

***Mr. Al Shaffer  
Principal Deputy  
Defense Research and Engineering  
15 April 2008***

**VISION: To develop technology to defeat any adversary on any battlefield**

***Any Battlefield includes physical, cyber, space, undersea, etc***



# The Evolution to New Ideas



**The DoD, Like the World, is moving from Physics Based to Multidisciplinary and Non-Kinetic Science**

*“Any sufficiently advanced technology is indistinguishable from magic.”*  
~Arthur C. Clarke

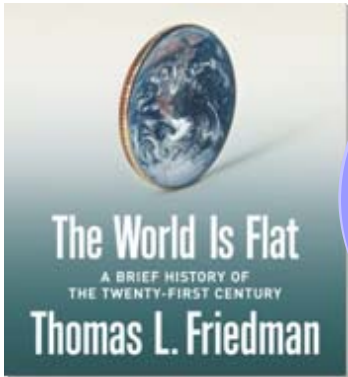
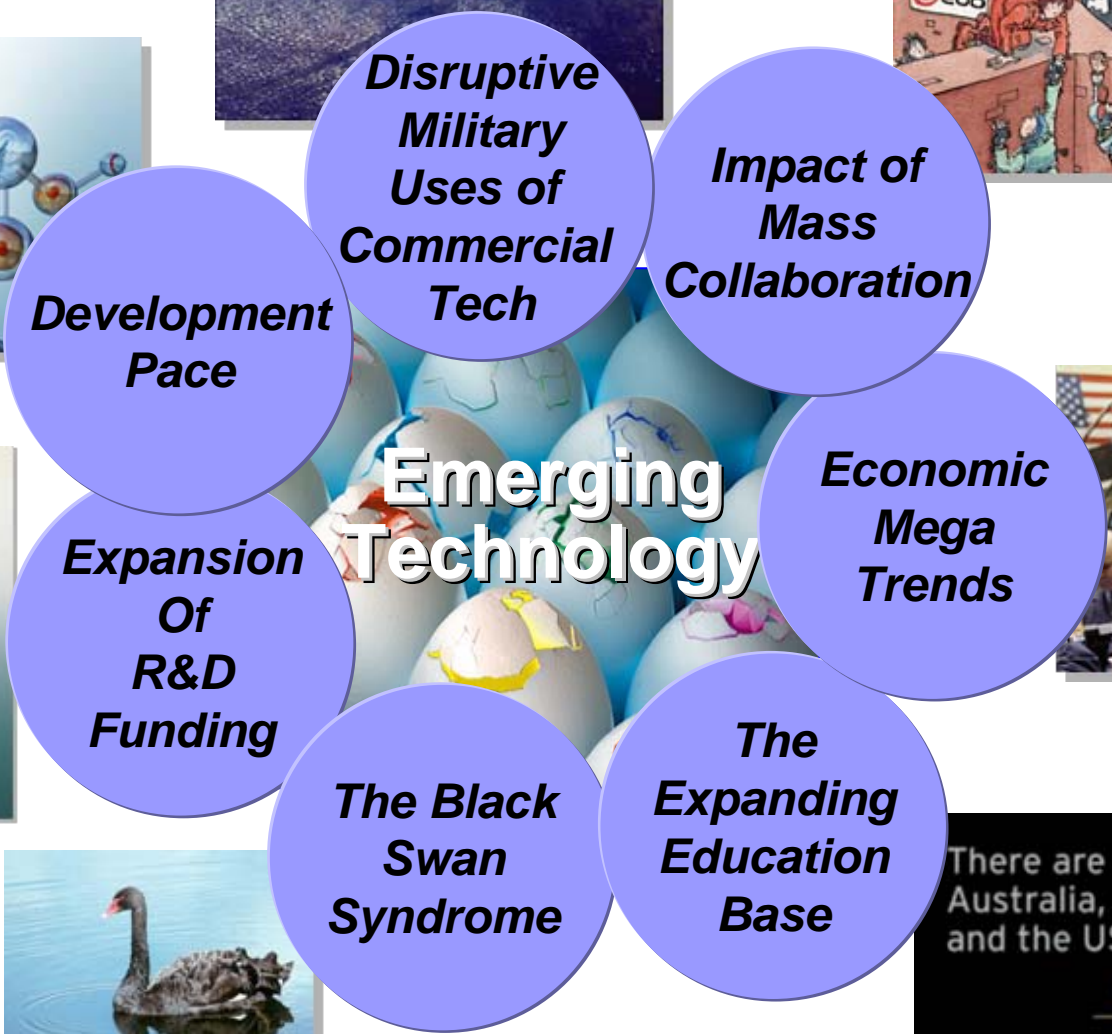
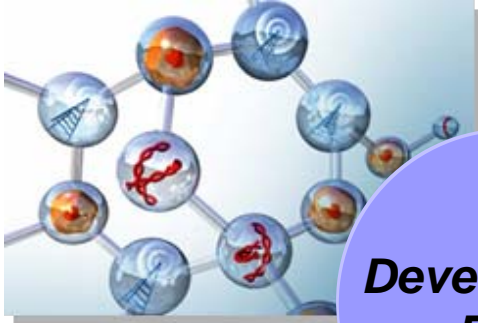
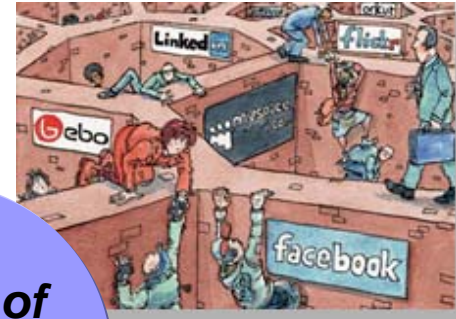
*“In times of change, learners inherit the Earth, while the learned find themselves beautifully equipped to deal with a world that no longer exists”*

Eric Hoffer





# A Changing World . . .

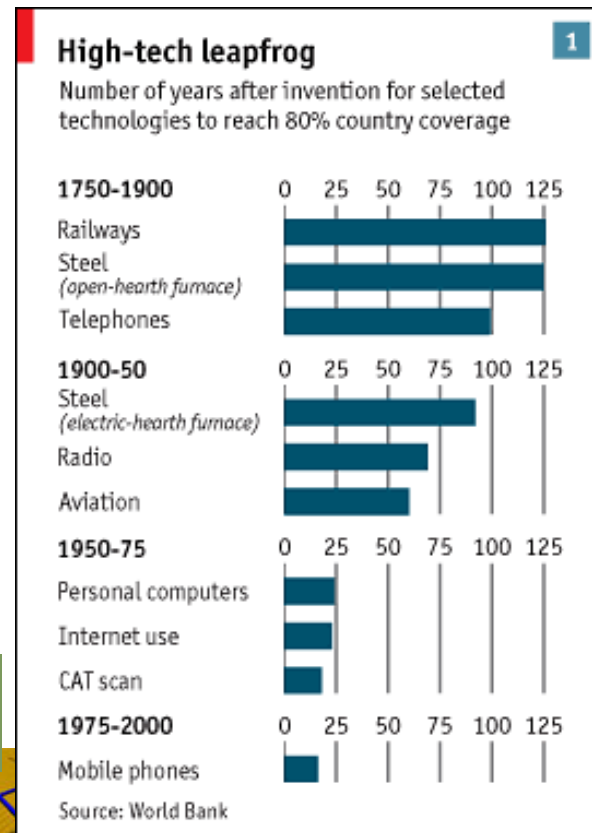


There are students in China, Australia, Austria, Bangladesh, and the USA who collaborate on projects everyday

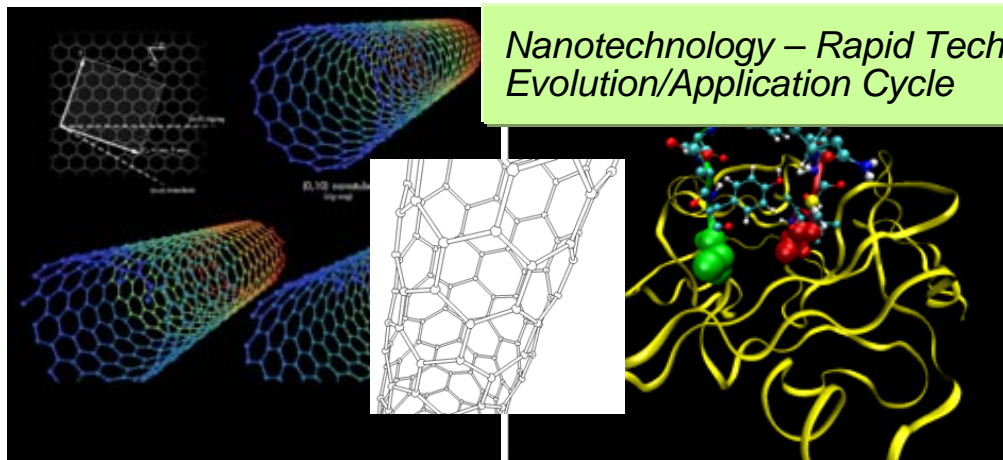
# Pace of Technology Continues to Increase



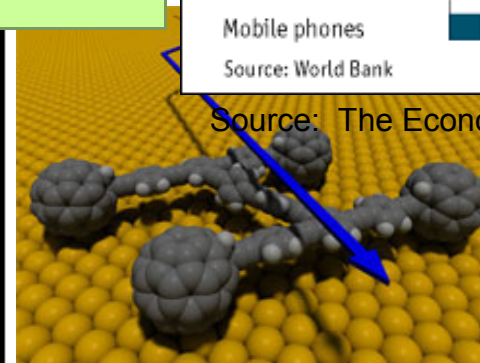
- Time between modeling of semiconducting properties of germanium in 1931 and first commercial product (*transistor radio*) was 23 years
- Carbon nanotube
  - Discovered by Japan (1991)
  - Researchers recognized carbon nanotubes were excellent sources of field-emitted electrons (1995)
  - “Jumbotron lamp” - nanotube-based light source available as commercial product (2000)



Source: The Economist, Feb. 9, 2008



Nanotechnology – Rapid Technology Evolution/Application Cycle

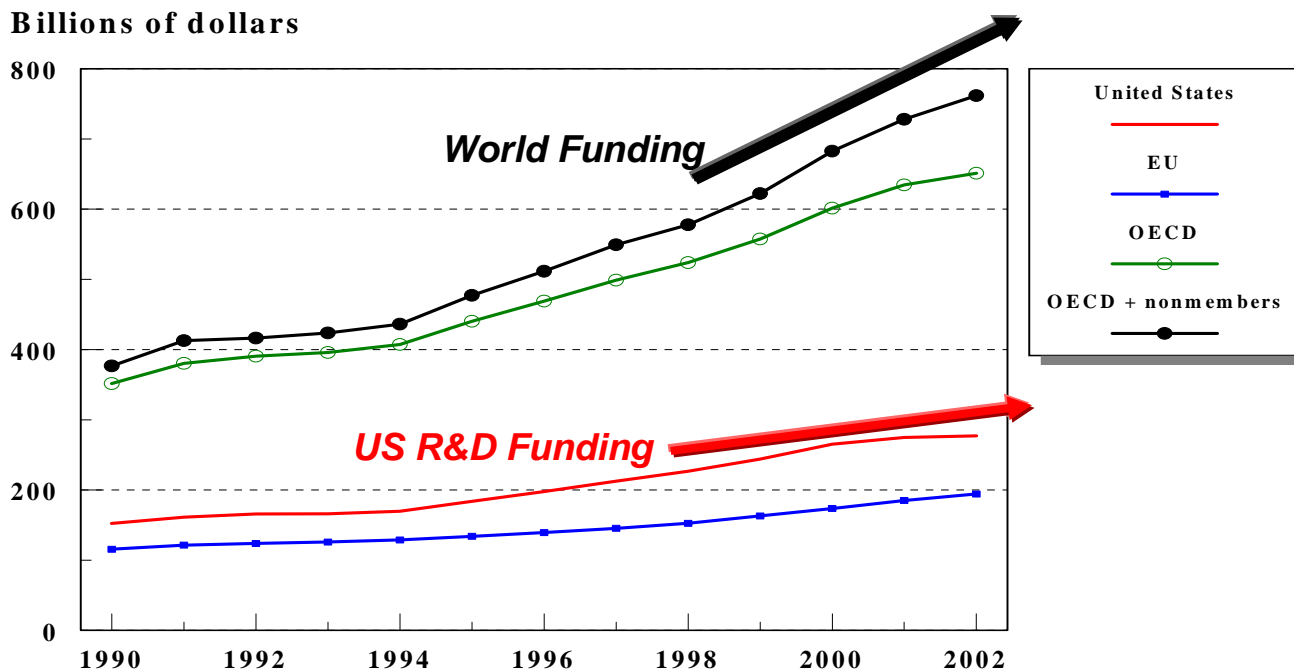




# International R&D trends

- R&D expenditures are increasing robustly around the world, driven by both governments and industry.

Figure 1. Estimated worldwide R&D expenditures: 1990-2002



NOTE: Billions of current dollars converted with purchasing power parities.

EU data since 1998 include 10 new member countries.

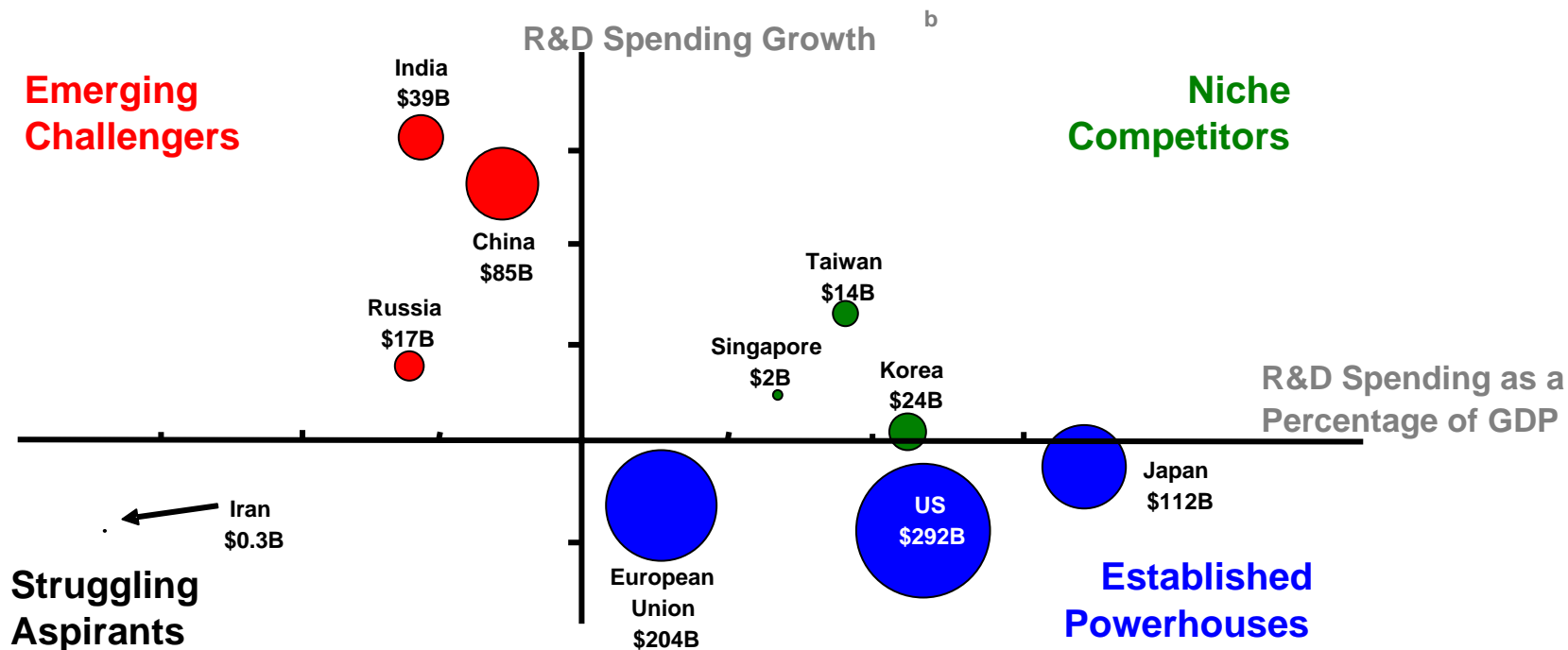
SOURCE: OECD, Main Science and Technology Indicators database, November 2004



# Global Technology (R&D) Spending and Growth

## The R&D Spending Landscape - Selected Entities <sup>a</sup>

(Circle size reflects R&D spending levels.)



<sup>a</sup>R&D spending as a percentage of GDP and spending growth are defined in Figures 1 through 3. R&D spending levels are in current billions of PPP dollars.

<sup>b</sup>Growth rates are calculated since 2000, except for Russia, which was calculated since 1992 due to high uncertainty in the regression since 2000.

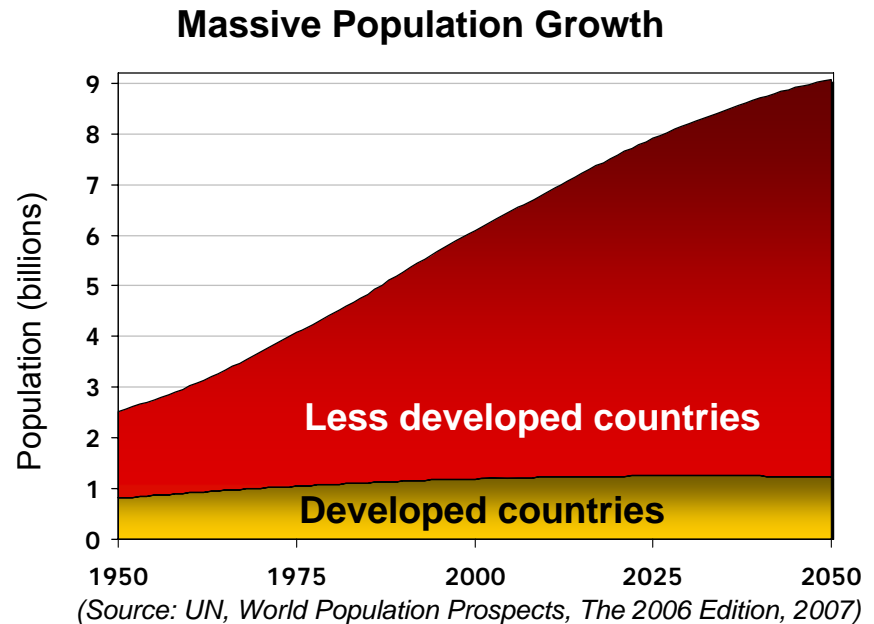
Sources: OECD, Main Science and Technology Indicators Volume 2005; UNESCO, Science Report 2005; Indian Ministry of Science and Technology, S&T Annual Report 2004-2005; H. Arfaei, "Status of Scientific Research -- Iran 2005", April 2005; CIA World Fact Books, 1981-1990, 1997-2004; and World Bank, Development Indicators database, 1981-1990, 1997-2004.



# Demographic Trends



- Demographic trends are the most predictable of the trend sets
- The major trends with significant defense implications:
  - North-South divide in age structure
    - Demographic “bonus” India, Latin America
    - Youth bulges in fragile states and migrant populations
    - Aging and low birth rates in key allies & China
  - International and internal migration
    - Push away from trouble
    - Pull to economic opportunity
    - Migrating political interests
  - Youth, conflict, and ideology
  - Urbanization

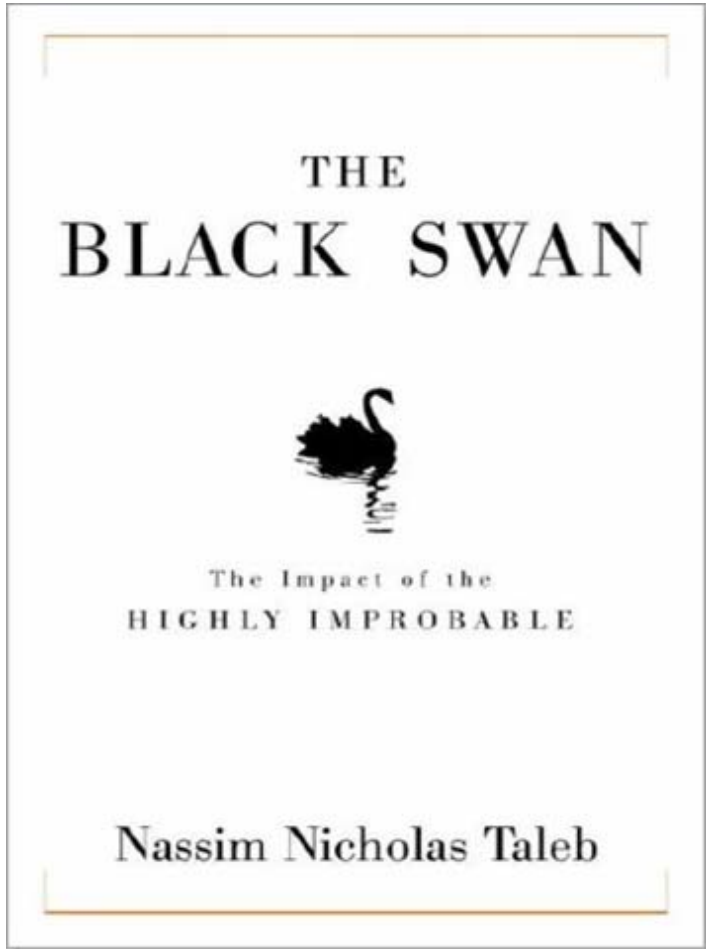


**Demographic change will increase stress on fragile states, create risks around access to resources, and generate a range of governance, societal, cultural, & health issues as states adjust to population transformations within and between states**

# The “Black Swan” Syndrome



***Cognitive biases create false expectations of predictability.  
Acknowledging uncertainty may allow us to adapt better to unforeseen events.***

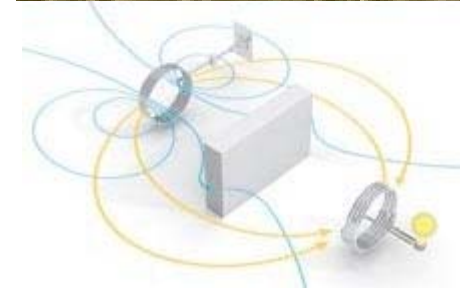
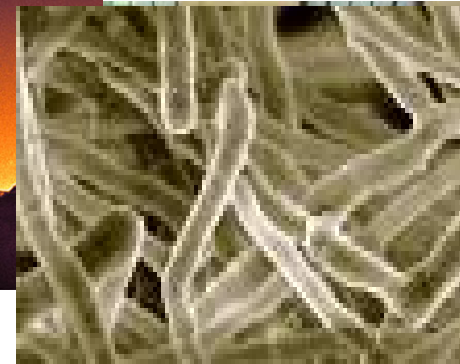
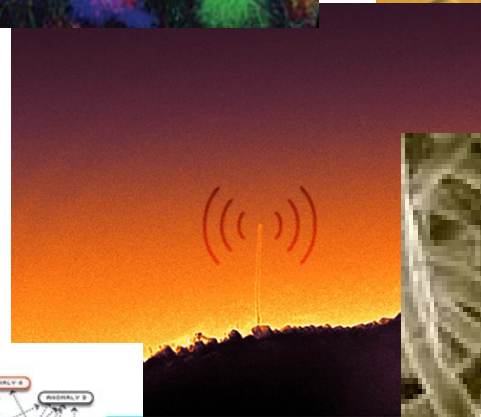
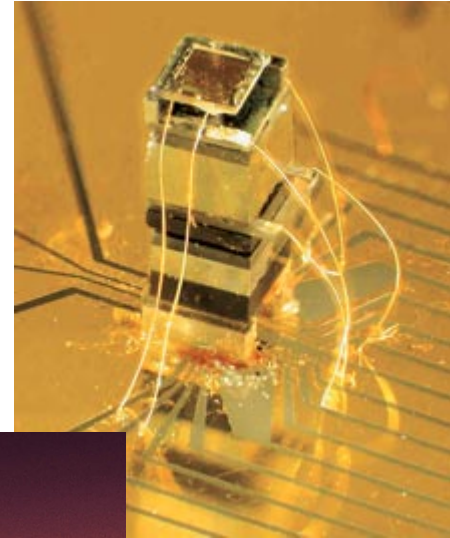
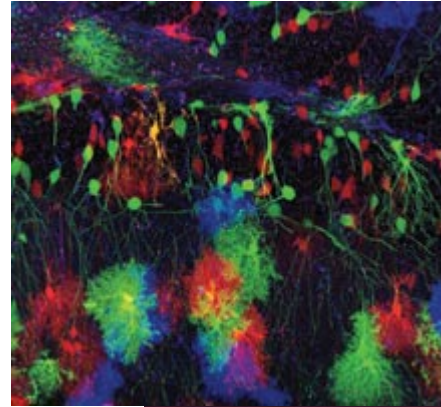


- “Black Swans”: ***large-impact, impossible to predict, and rare event beyond the realm of normal expectations***
  - 9/11, Google, internet bubble
- “Outside context problem”: ***Problem outside a given groups experience, with an immediate, ubiquitous and lasting impact upon it***
  - Perry’s Black Ships arriving in Japan
- “Accelerating change”: ***increase in rate of technological/ cultural/social progress in history (contrast to linear view)***
  - Accumulation of knowledge, access to knowledge and lowering of transactional barriers to knowledge

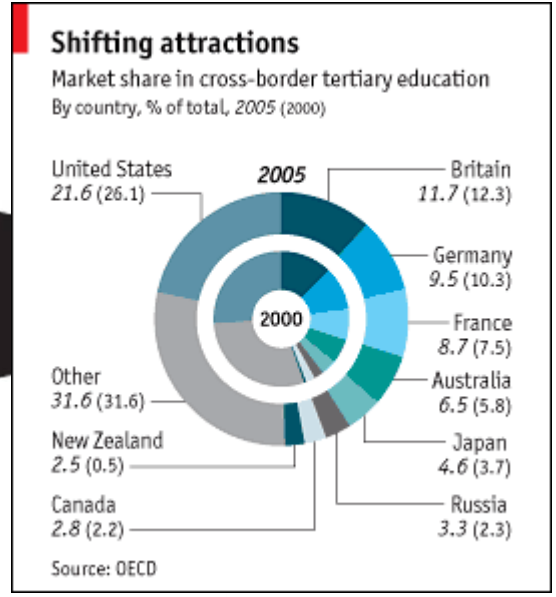
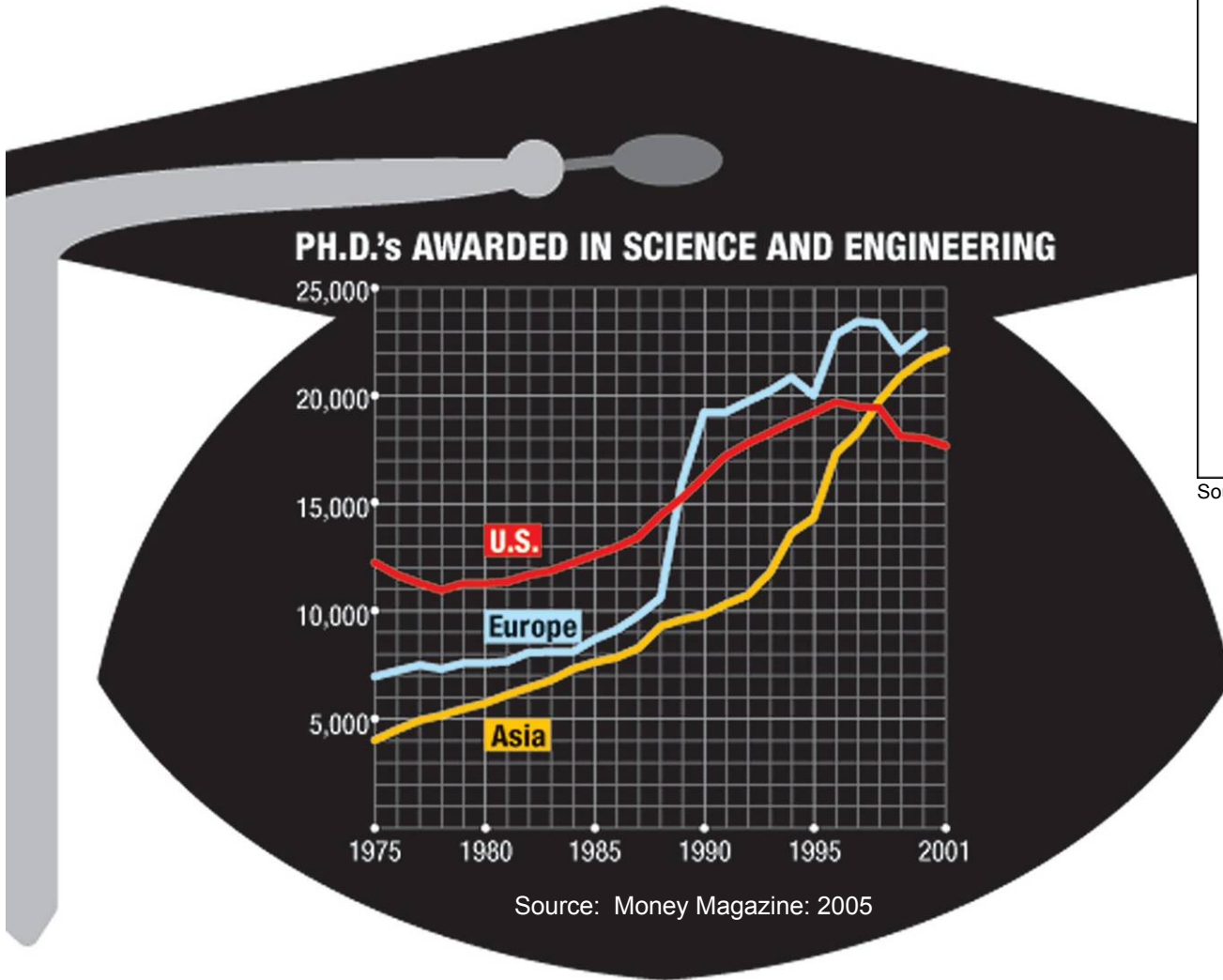
# March/April 2008 MIT Innovations List of 10 Emerging Technologies



- *Cellulolytic Enzymes*
- *Atomic Magnetometers*
- *Surprise Modeling*
- *Connectomics*
- *Probabilistic CMOS*
- *Reality Mining*
- *Offline Web Applications*
- *Graphene Transistors*
- *Nanoradio*
- *Wireless Power*



# Comparison of Scientists & Engineers (S&Es)



Source: The Economist, Nov. 15, 2007

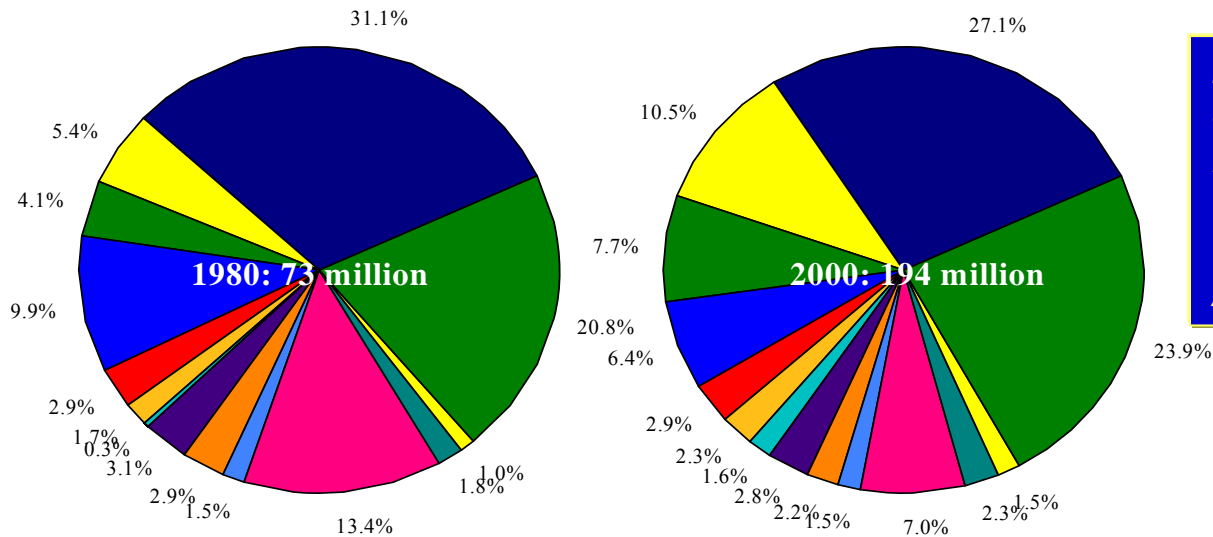
# Growth of Educated Asian Population



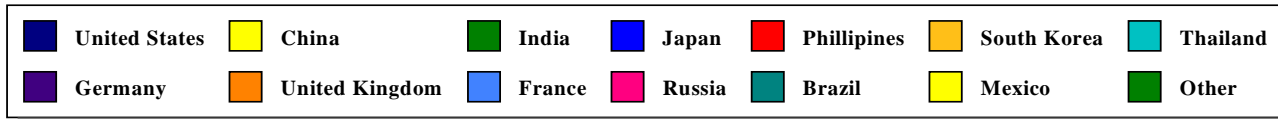
- International S&E labor force data can only be approximated.

Figure 20. Population 15 years and older with tertiary education, by country/region: 1980, 2000

**Number in S&E Labor Force, 1980:**  
**US 22.8M**  
**Asia: 17.7M**



**Number in S&E Labor Force, 2000:**  
**US 52.6M**  
**Asia: 60.9M**



SOURCE: Adapted from R.J. Barrow and J. Lee, Center for International Development: International Data on Educational Attainment, 2000



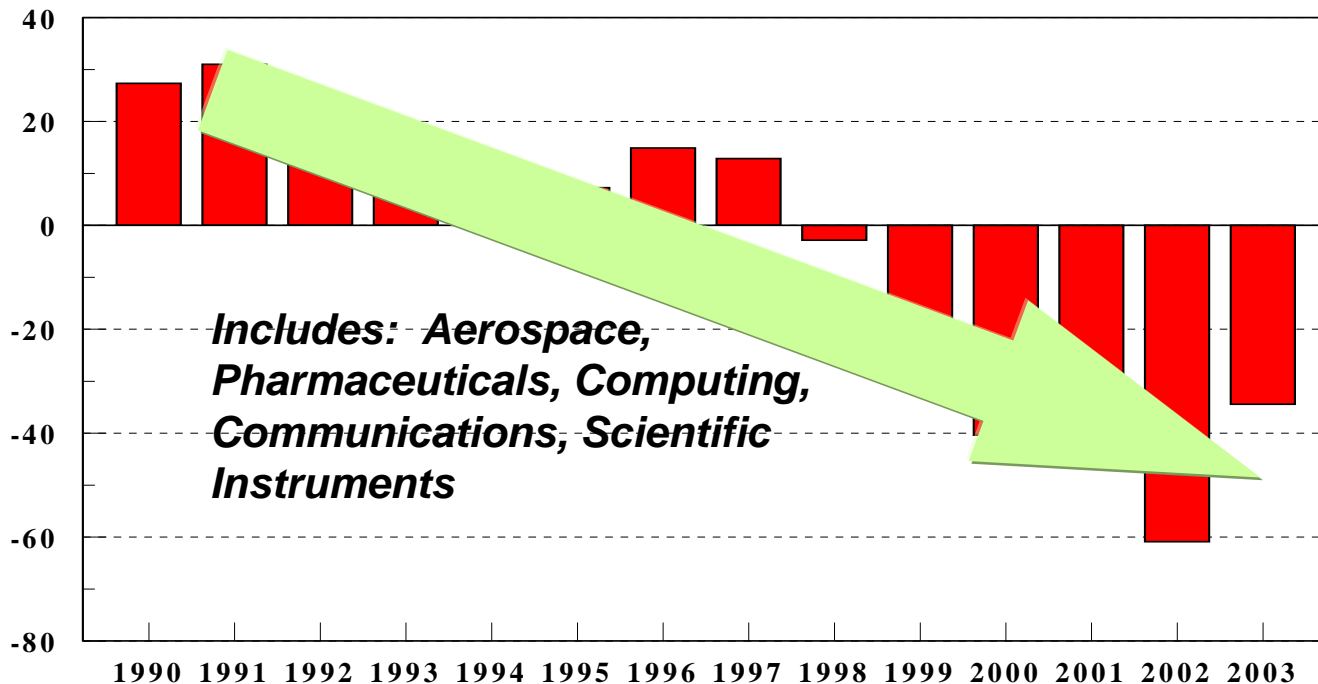
# U.S. trade balance – high tech industries

- The trade balance of U.S. high technology industries has turned negative

Figure 12. U.S. trade balance for five high technology industries:

1990-2003

Billions of dollars



NOTE: Includes aerospace; pharmaceuticals; office and computing equipment; communication equipment; and scientific instruments.

SOURCE: Global Insight and S&E Indicators 2006



# Forecasting Future Disruptive Technology—Mass Collaboration



- DoD & National Academies
- Teaming to produce a recurring technology forecast that is a:
  - Multidimensional Description of the technology
    - Estimation/description of impact
    - Temporal profile of development
  - Based on a wide group of experts
    - Develop a New web collaboration environment
    - Industry, academia, venture capitalists, government experts, etc.
    - Use collaboration environment to access a global community
  - Examines both traditional and non-traditional technology trends

Looking more than 15 years ahead . . .



Using mass collaboration as the tool for “*Effective Forecasting*”

# Disruptive Technology

## *The Non-Textbook Definition*



- **Rapid evolution from old, stable technology to new, dominating technology**
- **A technology surprise that gives a competitor an advantage**
  - Business - Technology that overturns market
  - Military - Technology that causes a fundamental change in force structure, basing, and capability balance
- **Disruptive Technologies can be intended or unintended - but both represent change**
- **Disruptive Technologies may arise from systems or enabling technology**



# Desert Storm

- The advent of information-based warfare feeding the emergence of irregular warfare
- US dominance over Soviet-era systems “shocked” potential adversaries and combined to give US conventional superiority
  - Precision Weapons
  - Night Vision
  - Low Observability
  - Networked Systems

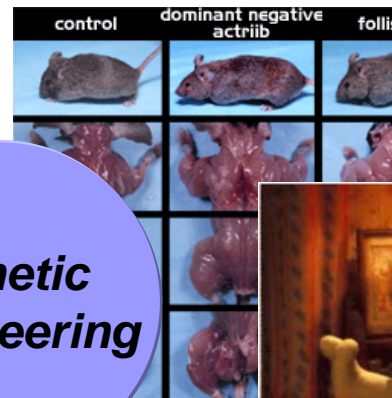






# R&D Expansion & “Disruption” --Applications of Commercial Technologies--

- Fundamentally can have global impact & change the balance and approach to force expression
- Drives and fuels the need for & new innovative concepts
- Includes how new capabilities are built on emerging technology
- Appearing increasingly from the global commercial marketplace



**Genetic Engineering**



**Future Processors**



**Proliferant Lasers**



**Unmanned Vehicles**



**Wireless Devices**



# An information age Pearl Harbor?



NO....but this guy is far cry from Imperial Japan



George Hotz, 17, of Glen Rock, New Jersey holding the iPhone® that he separated from the AT&T network and used on the T-Mobile Network. **Career goal: hack the human brain**

- ❑ Apple and AT&T released the iPhone on 29 June
- ❑ An exclusive agreement guaranteed the iPhone could only be used on AT&T's mobile network
- ❑ Hotz spent approximately 500 hours working on his “summer project”
- ❑ The hack was announced on 24 August.
  - ❑ AT&T - market cap: \$245B
    - annual revenue: \$90B
  - ❑ Apple - market cap: \$117B
    - annual revenue: \$23B
  - ❑ Hotz - PRICELESS

**This is the new asymmetry—victory goes to the agile and innovative**



# Trends

- **Increasing**
  - International Science and Technology Relative to the US
  - Industrial Globalization of R&D
  - Pace of Technology Development
  - US Trade Balance in High-Tech Goods
  - Potential for “*Hybrid*” Disruption
  - Mass Collaboration “*Flattening*” the world
- **Decreasing**
  - US Production of Global Scientists and Engineers relative to World

**US High Technology Advantage not Assured**

**Competition Increasing**

**Therefore, Have to Work on “High Payoff” Areas**

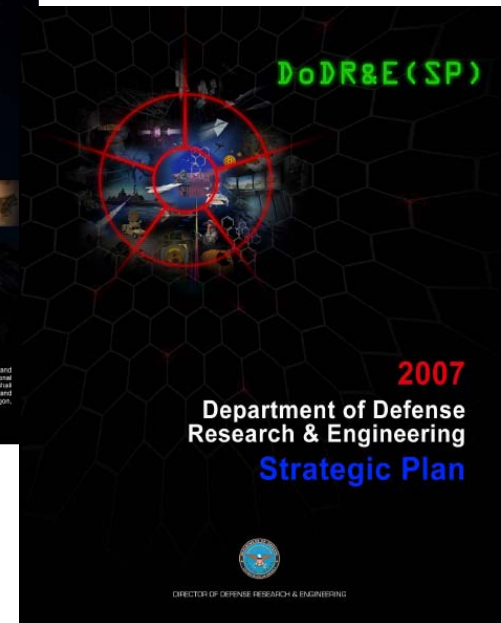
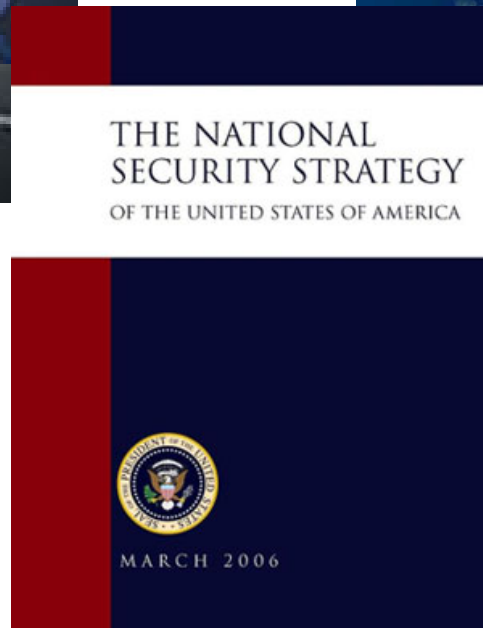
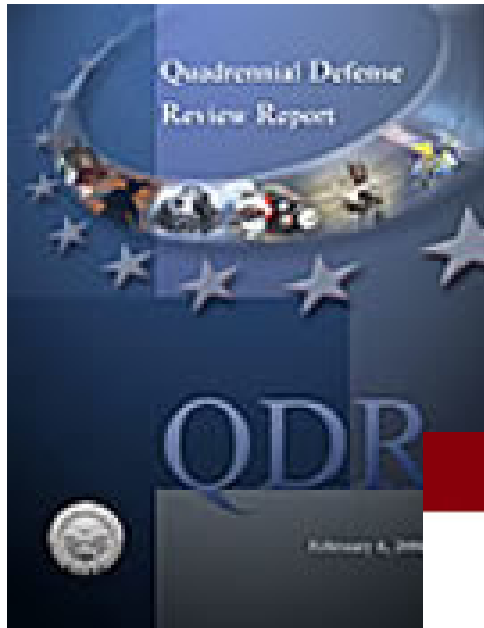


# Where are we going?

## S&T Strategy and Plans



## Defense Science and Technology Strategy and Planning

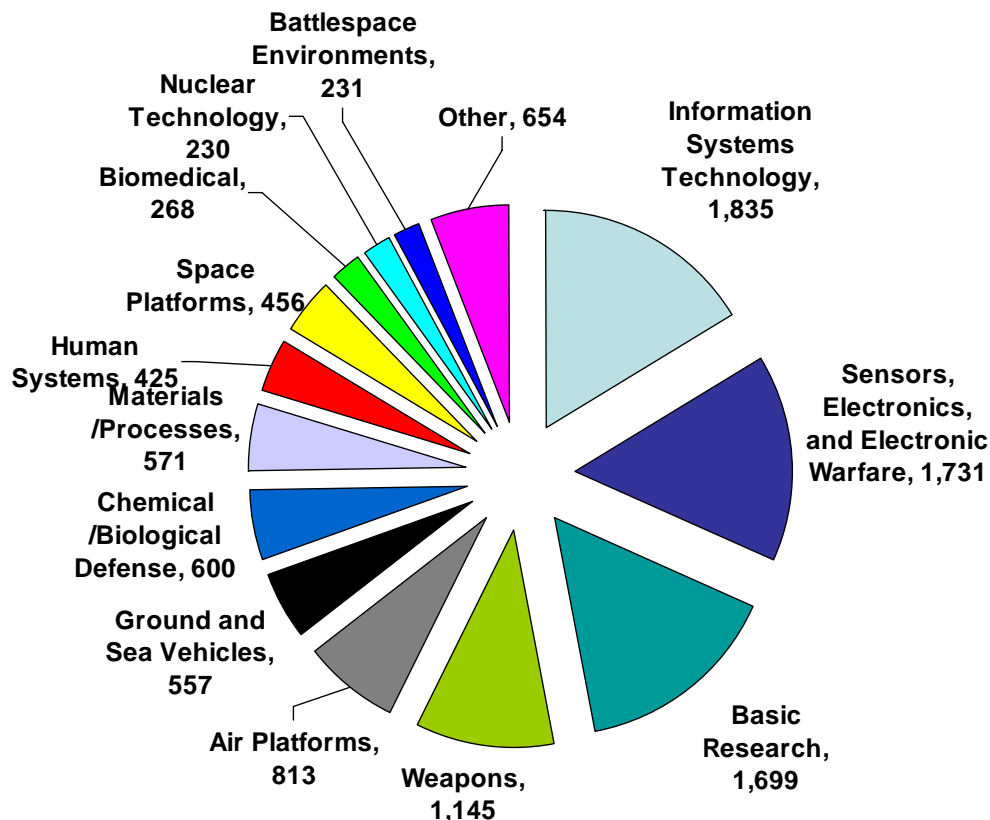




# Where is the DoD S&T money going?

## Funding

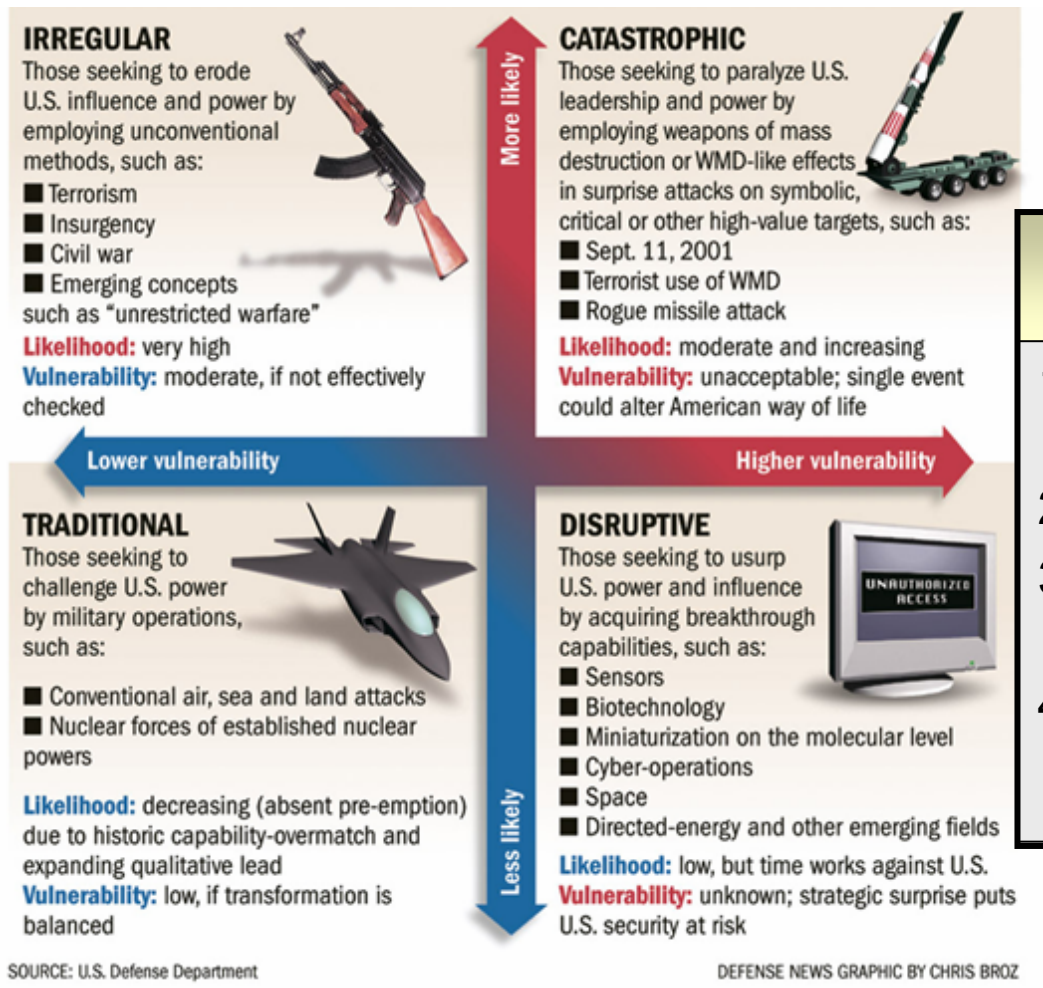
- Current year S&T dollars: \$10.77B FY08 to \$11.48B FY09
- Percent of DoD funding: 2.24% FY08 to 2.22% FY09
- Over 50% of total investment in 4 functional areas:
  - Information Systems (1.8B)
  - Sensors, Electronics / EW (1.7B)
  - Basic Research (1.7B)
  - Weapons (1.1B)



***DoD S&T program is focused on “sensing and shooting”  
But is changing.....***



# 2006 QDR Challenge Construct



SOURCE: U.S. Defense Department

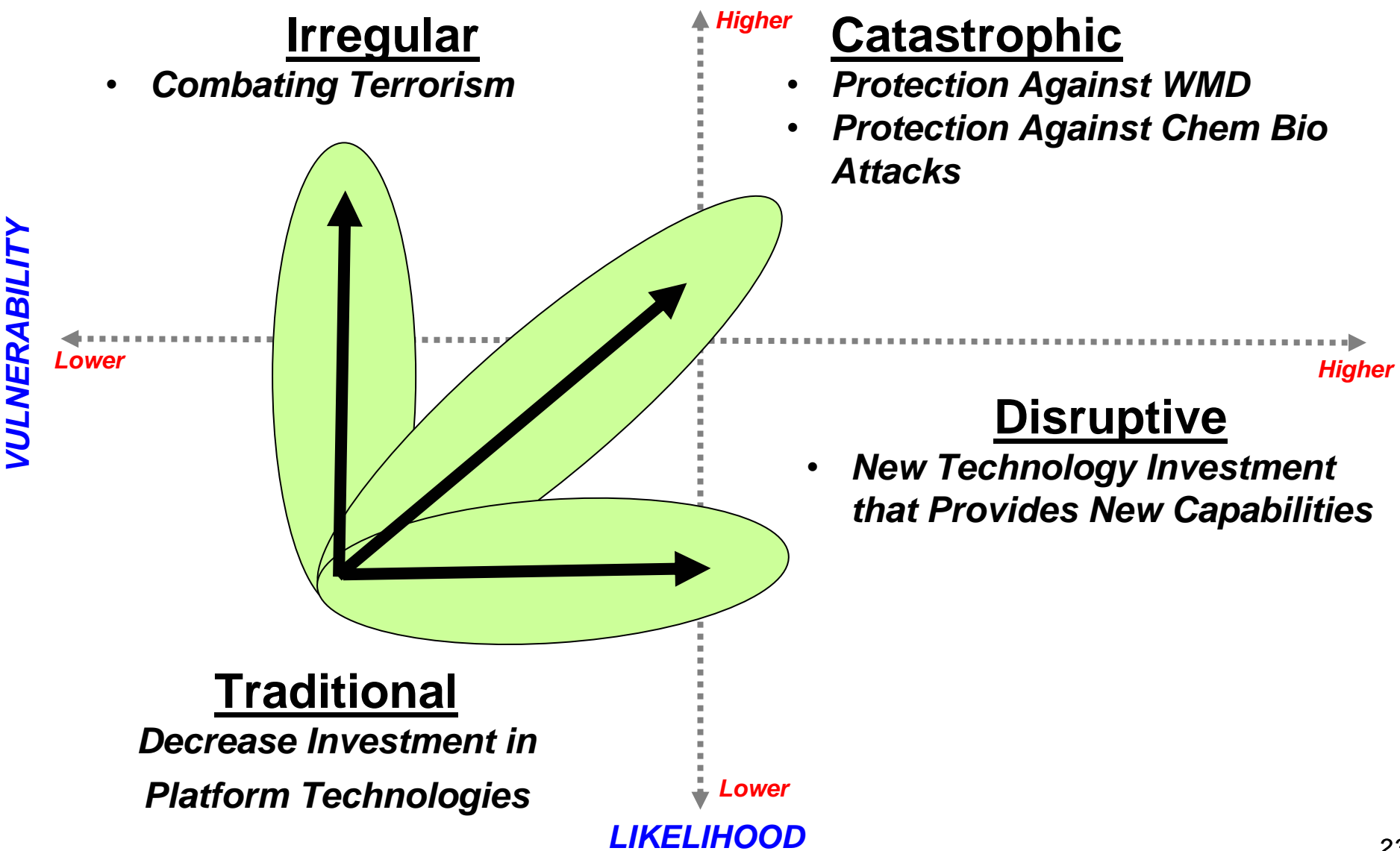
DEFENSE NEWS GRAPHIC BY CHRIS BROZ

## Four Hard Problems

1. Build partnerships to defeat terrorist extremism
2. Defend the homeland in-depth
3. Prevent acquisition or use of WMD by hostile actors.
4. Shape choices of countries at strategic crossroads



# National Defense Strategy Drives Investment Strategy



# Science and Technology Enabling Technology Priorities



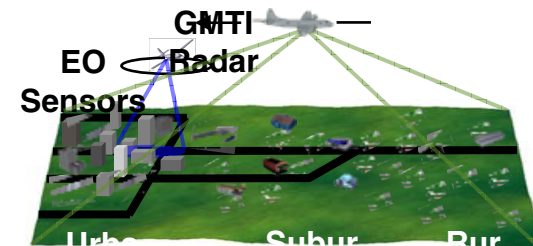
- **Technology focus areas:**
  - **Biometrics and Biological exploitation**
  - **Information technology and applications**
  - **Persistent Surveillance Technology**
  - **Networks and Communication**
  - **Human, Social, Cultural, and Behavioral Modeling**
  - **Language**
  - **Cognitive Enhancement**
  - **Directed Energy**
  - **Autonomous systems**
  - **Hyperspectral sensors**
  - **Nanotechnology**
  - **Advanced Materials**
  - **Energy and Power**
  - **Affordability**
  - **Combating Weapons of Mass Destruction Technologies**
  - **Energetic Materials**

*In Blue—Areas with Substantial Increases in FY08/09 President's Budget Request*

# Increased S&T Requests Addresses Capability Gaps



- Special (“non-kinetic”/enabling) technologies:
  - Clandestine Tagging, Tracking and Locating
  - Biometrics
  - Human, Cultural, Social Behavior Modeling
  - Networks
  - Persistent Surveillance
- Technologies to decrease energy consumption/increase alternatives
- Combat and tactical armor for protection against a range of threats
- Accelerating transition to fielded systems



***Investment shifted away from platform-specific technologies***



# Increased S&T Requests Addresses Capability Gaps



- New technology/emphasis areas
  - \$270M increase to Basic Research
    - SecDef initiative to increase peer-reviewed basic research
      - To develop innovative solutions
      - Enhance the science and engineering personnel base
    - Increase will support targeted focus areas for
      - Early to mid-career scientists and engineers with a team of students and post docs
      - Single Investigator awards with larger grants
    - Emphasis will be on emerging technology areas, e.g.,
      - Cyber protection and information assurance
      - Biosensors and biometrics
      - Human sciences (cultural, cognitive, behavioral, neural)
      - Software sciences and materials
      - Immersive sciences for training and mission rehearsal
      - Power and energy management
    - Anticipate about 500 focused research efforts

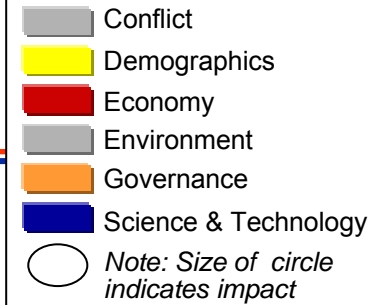
# Increased S&T Requests Addresses Capability Gaps



- New technology/emphasis areas (*Cont'd*)
  - Increased protection for dismounted troops and ground forces
  - Research in plasma and meta-materials to address emerging threats
  - Cyber protection
  - Hypersonics/Prompt Global Strike (Blackswift) – New technology prototype \*\*

# Shocks from the Past Century

## Categories of trends



□ Strategic shocks can change how we think about security and the role of the military, e.g.:

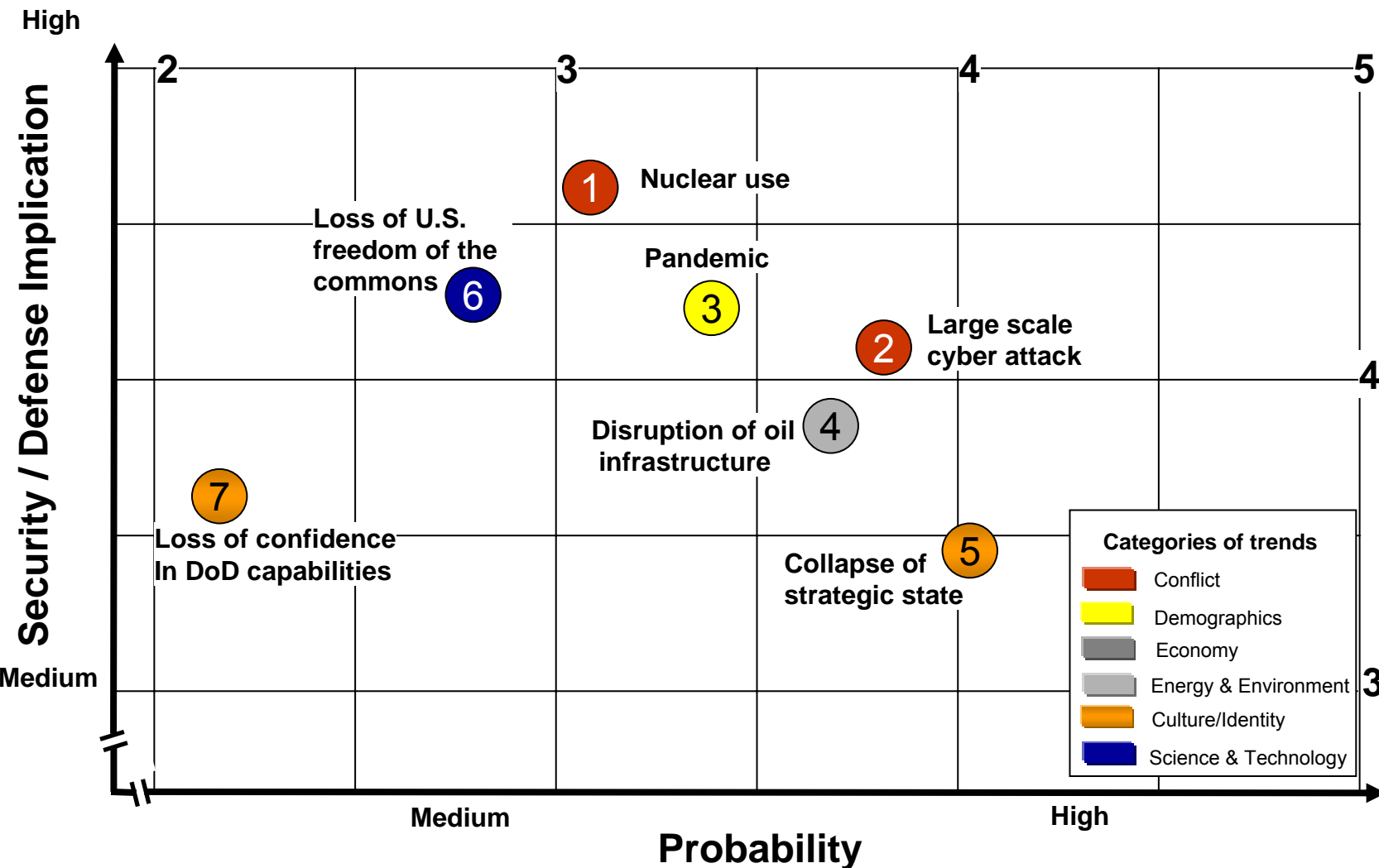
Implications for:	1929	1941	1945-1955	1957	1989-1991	2001	2005
<b>Military</b>	<ul style="list-style-type: none"> <li>Reduced role of military in society</li> </ul>	<ul style="list-style-type: none"> <li>Led to two-front war; Made intelligence a core element of operations</li> </ul>	<ul style="list-style-type: none"> <li>Nuclear warfare and capability become primary military mission</li> </ul>	<ul style="list-style-type: none"> <li>Space as a military domain</li> </ul>	<ul style="list-style-type: none"> <li>Led to the drawdown of the U.S. military – shifted focus to peace-keeping missions</li> </ul>	<ul style="list-style-type: none"> <li>Made homeland defense and irregular warfare central military missions</li> </ul>	<ul style="list-style-type: none"> <li>Increased military role in managing domestic catastrophes</li> </ul>
<b>Security</b>	<ul style="list-style-type: none"> <li>Reinforced isolationist tendencies in the U.S.</li> </ul>	<ul style="list-style-type: none"> <li>Recognition of vulnerability – led to international engagement and industrialization for war on home front</li> </ul>	<ul style="list-style-type: none"> <li>Emergence of MAD and escalation management</li> </ul>	<ul style="list-style-type: none"> <li>Space leveraged for national power and prestige</li> </ul>	<ul style="list-style-type: none"> <li>End of bipolar world</li> </ul>	<ul style="list-style-type: none"> <li>Redefined security for the American public – CT emerges as USG focus</li> </ul>	<ul style="list-style-type: none"> <li>American public looks to the federal, rather than local, government for disaster relief</li> </ul>
<b>Shocks</b>	<p>Great Depression</p>	<p>Pearl Harbor</p>	<p>Atomic Revolution</p>	<p>Sputnik</p>	<p>Fall of the Soviet Union</p>	<p>9/11 Attacks</p>	<p>Katrina</p>
			<i>Cold War</i>				

***In retrospect, these shocks were the product of long-term trends***



# Analysis of Potential Shocks (2 of 2)

- Relative impact and likelihood out to 15 years

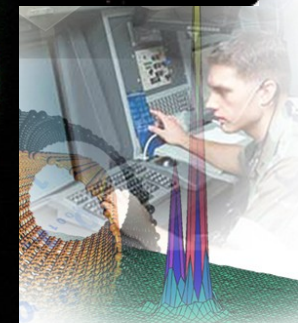


**VISION: To develop technology to defeat any adversary on any battlefield**

***Any Battlefield includes physical, cyber, space, undersea, etc***



**QUESTIONS?**



0.0.0.0

# Young Memo



- **Technology focus areas:**
  - **Active and Conventional Armor Technology**
  - **Defeat Speed of Light Systems**
  - **Immersive Training**
  - **Cyber Protection**
  - **Handling Large Data Sets**
  - **Human, Social, Cultural, and Behavioral Modeling**
  - **Cognitive Enhancement**
  - **Autonomous systems**
  - **Hyperspectral sensors**
  - **Nanotechnology**
  - **Advanced Materials**
  - **Energy and Power**
  - **Biometrics**
  - **Network Technology**
  - **Combating Weapons of Mass Destruction Technologies**

*In Blue—Areas with Substantial Increases in FY08/09 President's Budget Request*





# 2006 RAND Study\*: Top 16 Technology Applications

***Need to understand the second-order effects of emergent technologies on the DoD***

- ⇒ Cheap solar energy
- ⇒ Rural wireless communications
- ✓ Communication devices for ubiquitous information access anywhere, anytime
- Genetically modified (GM) crops
- ⇒ Rapid bioassays
- ⇒ Filters and catalysts for water purification and decontamination
- ⇒ Targeted drug delivery
- Green manufacturing
- ✓ Ubiquitous RFID tagging of commercial products and individuals
- ⇒ Hybrid vehicles
- ✓ Pervasive sensors
- ⇒ Tissue engineering
- ⇒ Improved diagnostic and surgical methods
- ⇒ Wearable computers
- ✓ Quantum cryptography
- Cheap autonomous housing

✓ *Direct Military Application*

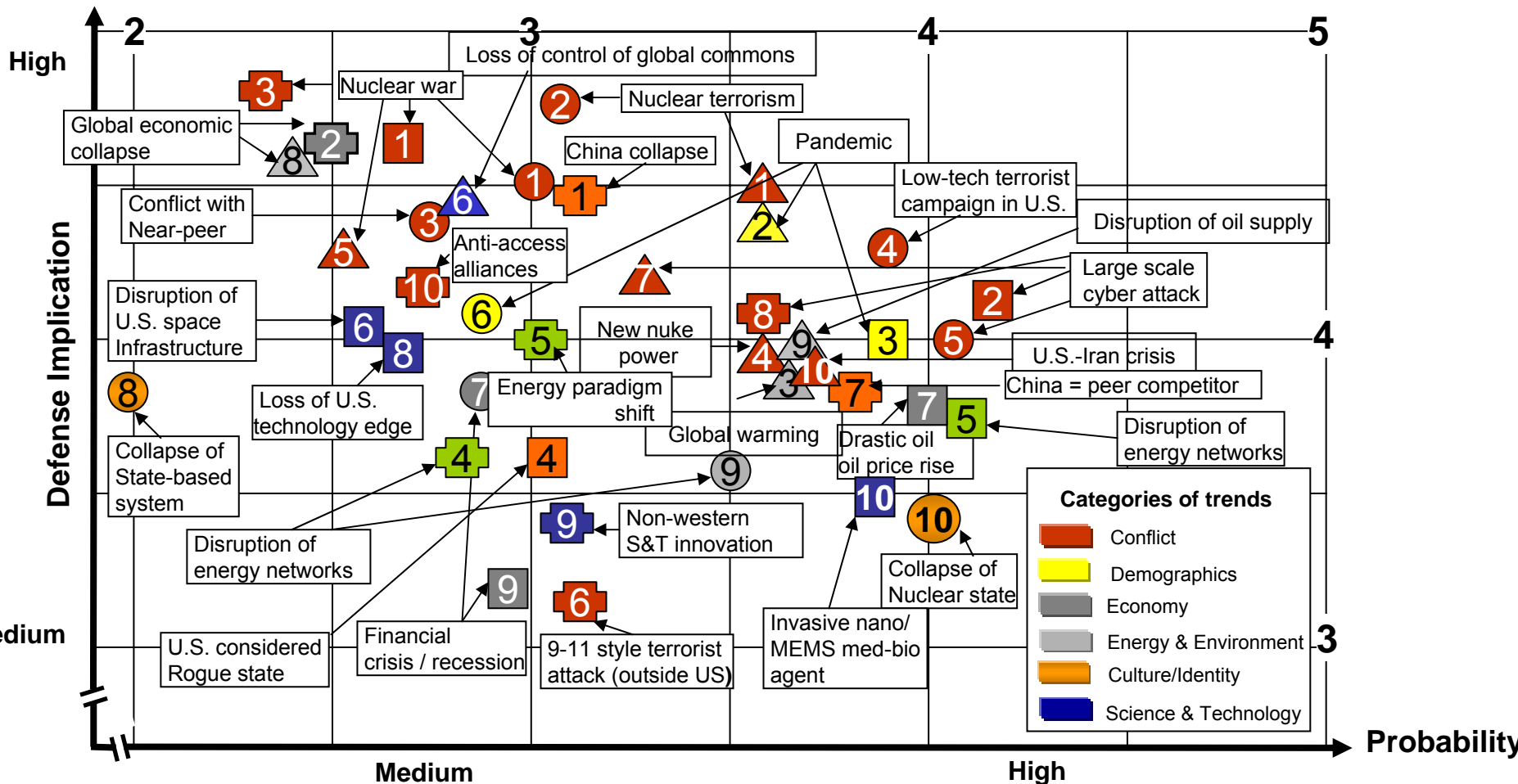
⇒ *Indirect Military Application*

• *No Military Application*



# Analysis of Potential Shocks (1 of 2)

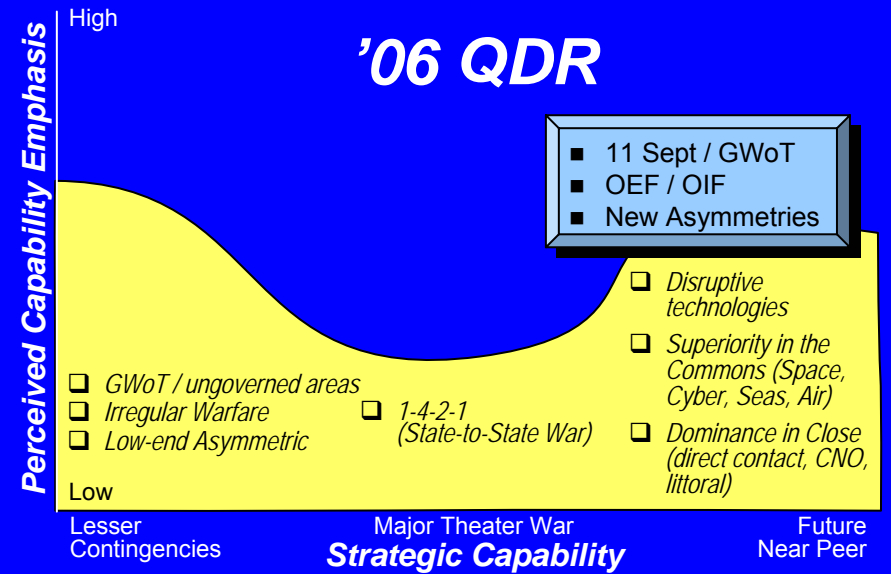
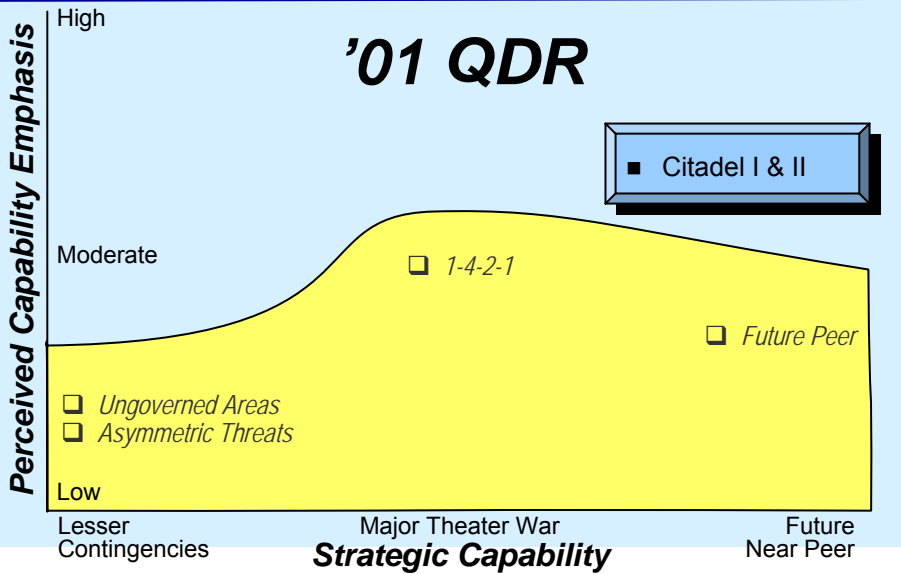
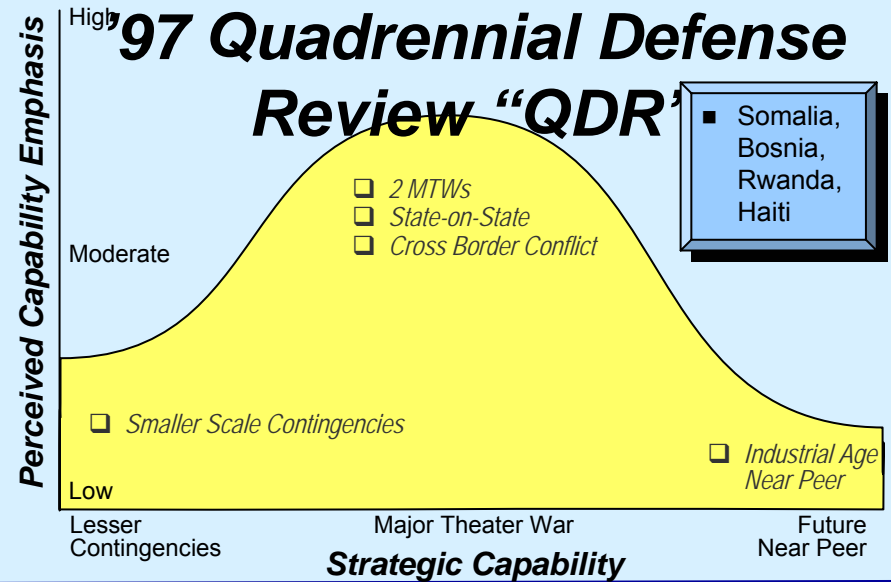
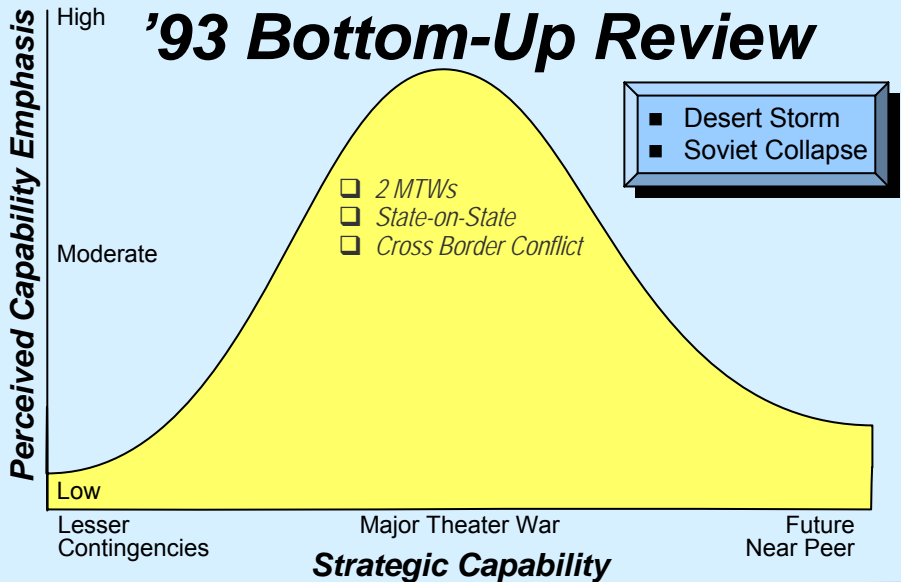
• Relative impact and likelihood out to 15 years



Source: Compare and contrast three symposiums: 08 June, 27 August, 25-26 September 2007 and 18-19 December 2007  
 Johns-Hopkins University APL Warfare Analysis Laboratory, Laurel MD and Booz Allen Hamilton Inc, Herndon VA



# Decade of Strategic Evolution



# Building the Science and Engineering Base



- We need to continually develop, mature and field technology to stay ahead of our adversaries
- President Bush acknowledged the importance of science and engineering development in his January 2008 State of the Union address

*“To keep America competitive into the future, we must trust in the skill of our scientists and engineers and empower them to pursue the breakthroughs of tomorrow... I ask Congress to double federal support for critical basic research in the physical sciences and ensure America remains the most dynamic nation on Earth..”*

*President George W. Bush, State of the Union address, January 28, 2008*

*“As changes in this century’s threat environment create strategic challenges – irregular warfare, weapons of mass destruction, disruptive technologies – this request places greater emphasis on basic research, which in recent years has not kept pace with other parts of the budget.”*

*Secretary of Defense Posture Statement on the FY09 Budget, February 2008*

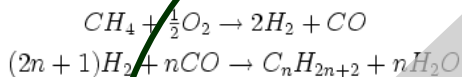




# Energy Security Challenge

## Supply

- Conventional fossil fuels
- Synthetic fossil fuels (e.g. coal, shale oil and tar sands derived fuels)
- Alternative fuels (e.g. biodiesel, alcohols, hydrogen, etc.)
- Renewables (e.g. solar, geothermal, wind)
- Novel supply (e.g. fuel cells)
- Exotics (e.g. isomers)



## Demand

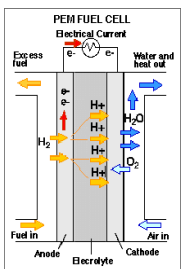
- Conservation Initiatives
- Fixed base
- Tactical base
- Platforms
- Efficiency
- Life-Cycle Cost



- Direct oil / fossil fuel costs
- Policy, processes and risk assessment
- Refining Capacity
- Doctrine

## Assured Distribution

## Convergence for Energy Security







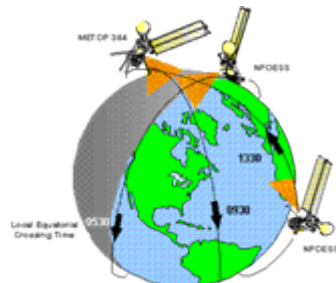
# DoD S&T is a Partnership

Link to the Warfighter



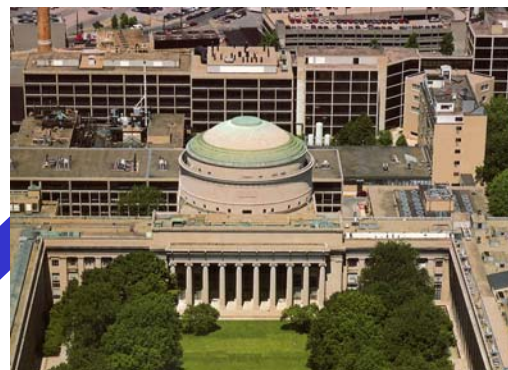
Service Labs

Expanded Resource Base



Interagency

New Ideas, Knowledge

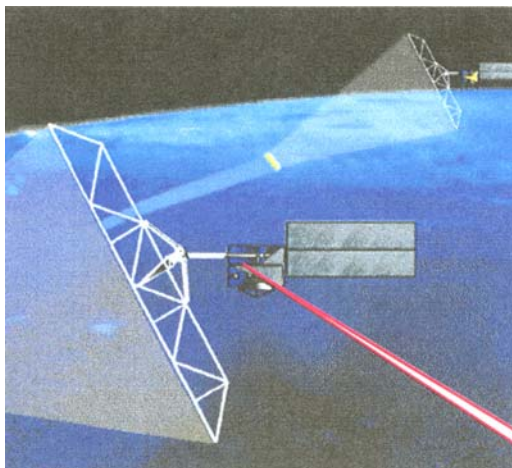


Universities

Industries

Maximum National Security Payoff

DARPA



High Risk, High Payoff

International



Coalition Capability



Innovation, Transition





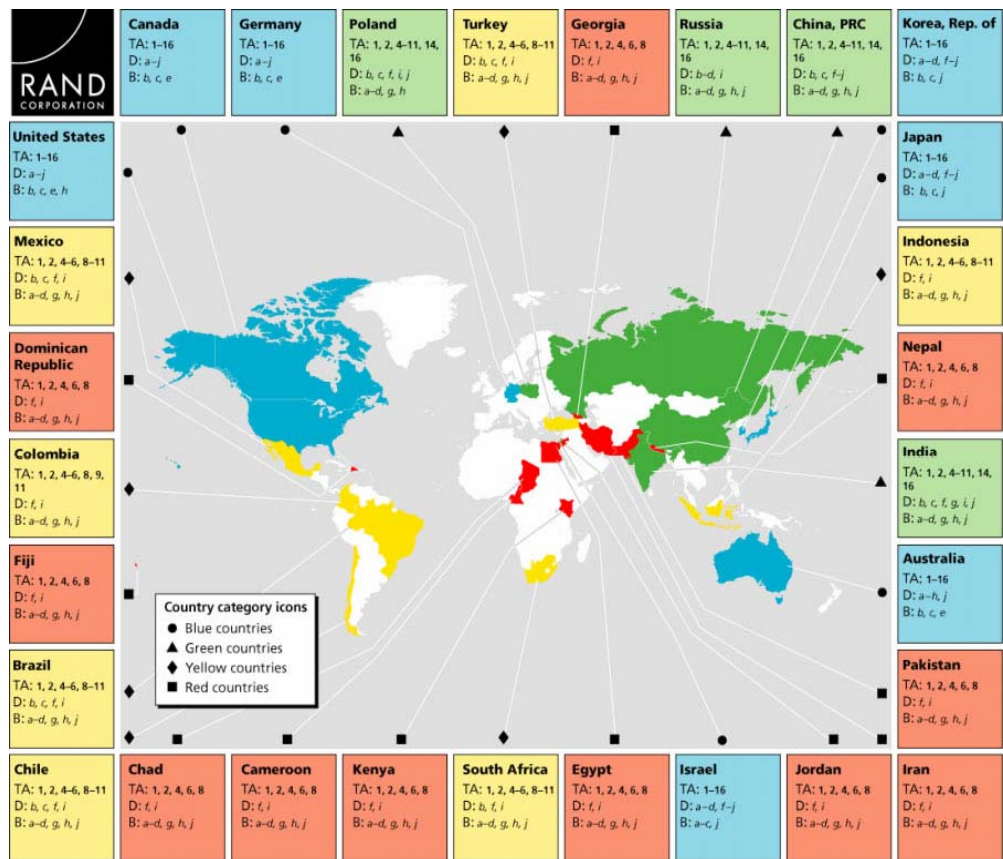
# Selected Countries Capacity to Acquire the Top 16 Technology Applications\*

Scientifically advanced

Scientifically proficient

Scientifically developing

Scientifically lagging



\* The Global Technology Revolution 2020, In-Depth Analyses



- ***Held at Irvine Ca, Nov 2006***
- ***The Most Probable Future Technology Shocks areas are:***

**Biotechnology**

**Nanotechnology**

**Information  
Technology**

**Potential Military Applications:**

- High Energy Fuels
- Bio-based Computers

- Advanced Materials
- Energy Storage / Distribution

- Assisted Decision Making
- Aided Target Recognition



# Science and Technology and the Joint Warfighter

MG William J. Troy

Vice Director  
Force Structure, Resources, and Assessment  
Joint Staff, J8



# Joint Staff Roles in S&T

- The “Voice of the Warfighter”
  - Consolidate needs of the COCOMs (via Integrated Priority Lists – IPLs) into JROC validated Capability Gaps
  - JUONs
  - JCTD validation

## ***BOTTOM LINE:***

***Ensure the Joint Warfighter has the required capabilities to execute the assigned mission in a resource constrained environment...***



# JCIDS Update

- Senior Warfighters' Forums (SWarFs)
- Focus on Cross-cutting Issues
- JCA Rebaseline
  - Nine Tier 1 JCAs
    - Approved by DAWG to Tier 3
  - Two new FCBs:
    - Building Partnerships
    - Corporate Management
- Gap Prioritization
  - New Integrated Priority Lists (IPLs) from COCOMs recently submitted, gap analysis/formulation/ prioritization in progress
- FY08 NDAA Provisions

# Warfighter-Influenced Direction for DoD S&T...



- What has 5 years of war told us to help shape the direction of DoD S&T?
  - ISR
    - Readily available and tailorable coverage
  - Robotics
    - Same/improved capabilities, keeping Soldiers and Marines out of harm's way
  - Force Protection
    - Armor Protection vs. Armor Defeat – where does it end?
  - Managing violence in a dense battlespace
    - Interoperability, C2, Precision Fire



# Interoperability and Interdependence on Demand in a Fluid Situation



- Ground Forces
  - Army Tanks and Infantry
  - Marine LAV and AAV
- Rotary Wing Forces
  - Army and Marine Helicopters
- Fixed Wing Forces
  - Navy and Air Force Fighters
- Special Operation Forces
- Coalition Forces
- Fully integrated and task organized



**Joint and Coalition combined forces, executing together with Unity of Effort and Unity of Command in a space no larger than Pentagon South Parking**



# Success ...

- Solutions to warfighter needs with an S&T solution

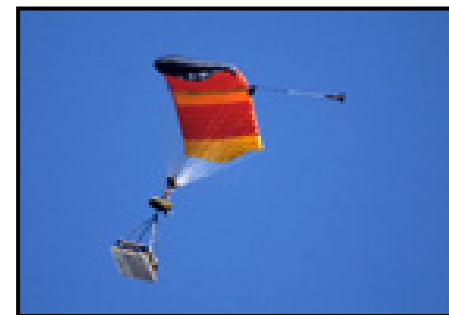
- Predator (ACTD)



- Counter Radio controlled improvised explosive device Electronic Warfare (CREW) IED Electronic Jamming (JUONS)



- Joint Precision AirDrop System (JPADS) (ACTD)





# ...and the Future

- Currently SEVEN “Technologically Challenged” JUONS - the “hottest” issues from the warfighter on the front lines
  - Six are related to counter IED
  - One is related to renewable energy
- Currently handled by the JRAC through JIEDDO, appropriate FCB, OSD (AS&C), DSTAG currently not involved
- For discussion: Should the DSTAG become involved with these?
  - Meets monthly - can react quickly
  - Represents DoD-wide S&T agencies, providing increased visibility
  - May be able to provide solutions for these JUONS, stand up Ad-Hoc Technology Focus Team, leverage other R&D/R&E projects, etc.

# QUESTIONS/COMMENTS



# Defense Policy Implications of Global Technology Trends



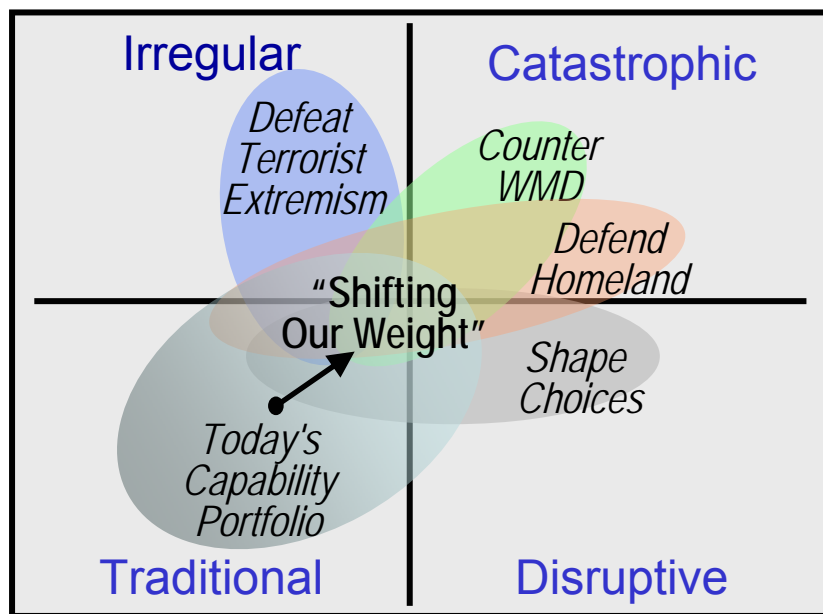
28 December 2007

Col W. Eric Herr  
ODASD Policy Planning



# The 2006 QDR Construct

- The 2006 QDR used the “Quad Chart” to analyze the changing nature of warfare



- ### Four Hard Problems
- 1. Build partnerships to defeat terrorist extremism**
  - 2. Defend the homeland in-depth**
  - 3. Prevent acquisition or use of WMD by hostile actors.**
  - 4. Shape choices of countries at strategic crossroads**

***This construct is the basis for our current defense strategy***



# *Understanding the 21<sup>st</sup> Century*

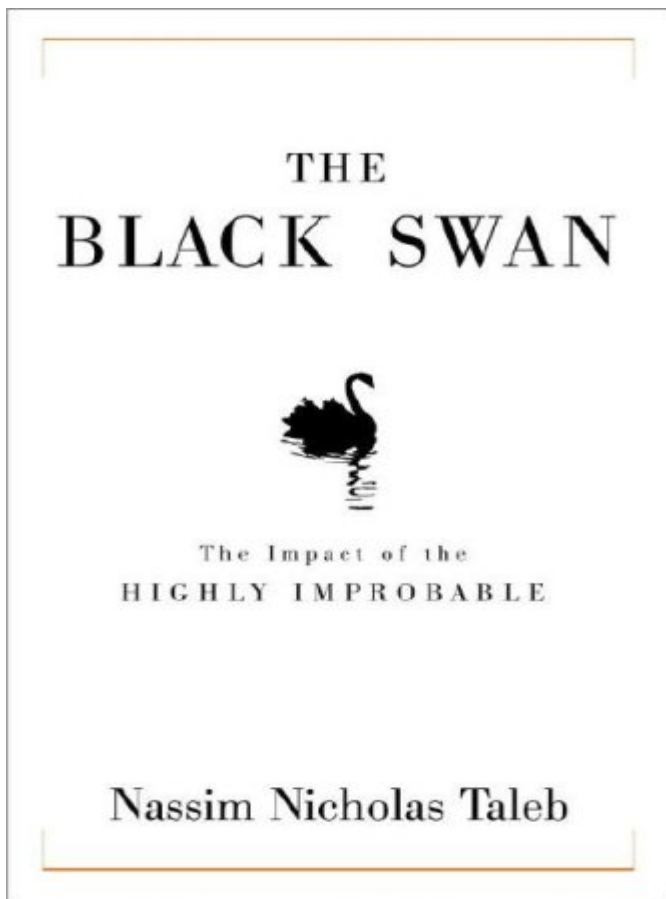


- The “Quad Chart” was the strategic construct for the 2005 National Defense Strategy and 2006 Quadrennial Defense Review
- A new strategic construct might be more appropriate in preparation for the next set of strategic documents
- This model should account for the increasing complexity of the global environment
  - Many non-military factors disrupt international security – we need to better anticipate and respond to these disruptive events



# “Black Swan Theory”

***Cognitive biases create false expectations of predictability.  
Acknowledging uncertainty may allow us to adapt better to unforeseen events.***



- “Black Swans”: ***large-impact, impossible to predict, and rare event beyond the realm of normal expectations***
  - 9/11, Google, internet bubble
- “Outside context problem”: ***Problem outside a given groups experience, with an immediate, ubiquitous and lasting impact upon it***
  - Perry’s Black Ships arriving in Japan
- “Accelerating change”: ***increase in rate of technological/ cultural/social progress in history (contrast to linear view)***
  - Accumulation of knowledge, access to knowledge and lowering of transactional barriers to knowledge

“But there are also **“unknown unknowns”** — the ones we don't know we don't know.” *Former Secretary of Defense Donald Rumsfeld, Feb 12, 2002.*



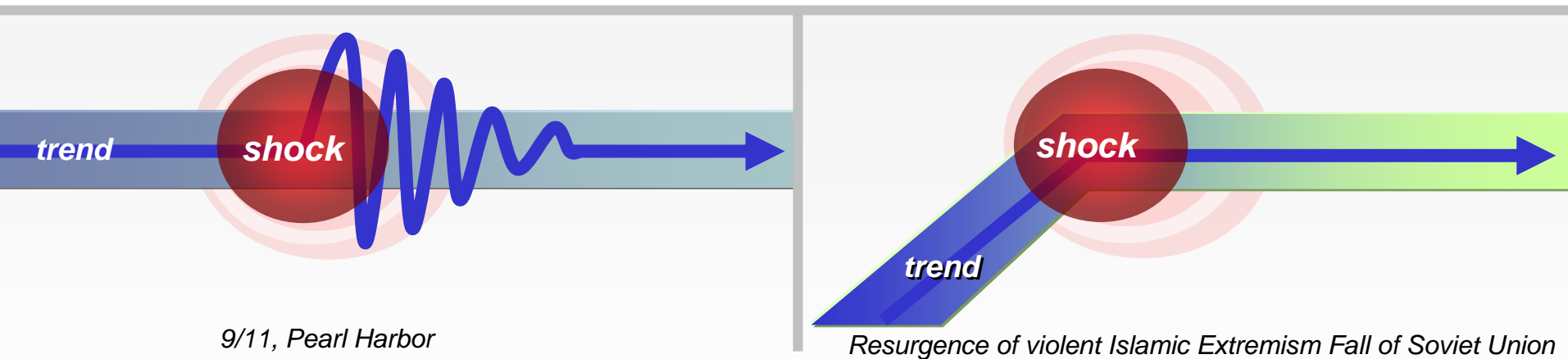
# Purpose and Outline

- Purpose
  - Examine U.S. defense and security implications of future technology trends and potential shocks
- Outline
  - Summarize five technology areas by outlining:
    - Current assessment
    - Future trends
    - Defense implications
    - Potential shocks
  - Technology Meta-Trends
  - Way Ahead



# Understanding Strategic Shocks

- What is a “strategic shock”?
  - An event that punctuates the evolution of a trend (a discontinuity that either rapidly accelerates its pace or significantly changes its trajectory) and, in so doing, undermines the assumptions on which our current assumptions are based.



- Some “strategic shocks” may not surprise us we actively plan for them, both to reduce the risk of their occurrence and to be positioned to act
- Other “strategic shocks” may catch us unaware and unprepared

# *The Genesis of Trends and Shocks*



- With hindsight, it is clear that most shocks are the product of long-term trends
- Furthermore, shocks are less disruptive when we have anticipated and responded to the underlying trends
- The challenge is identifying key trends and pre-adaptation for strategic shocks before they occur
  - Reviewing how effective the United States was in foreseeing major trends in the previous century illustrates this effect



# Reviewing Major Trends

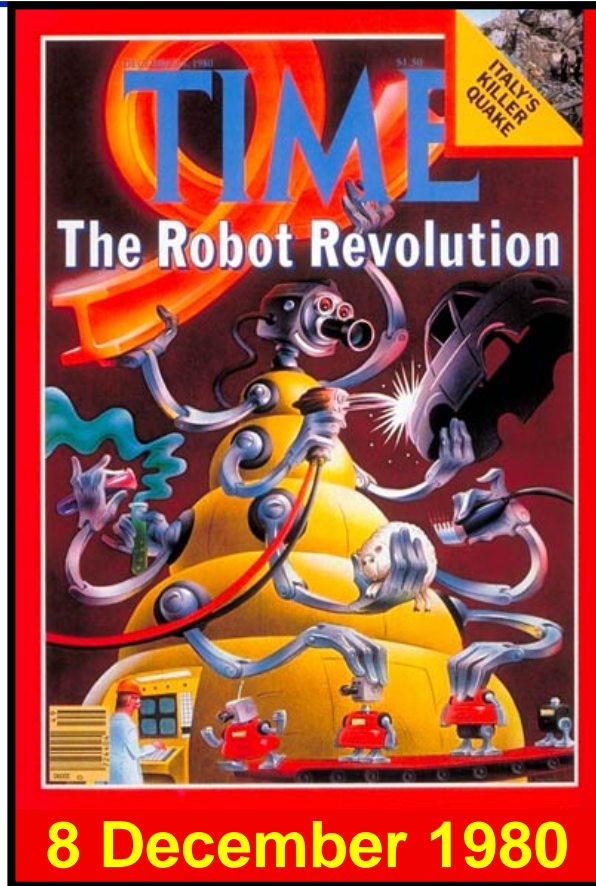
Categories	Trend Examples
Conflict	<ul style="list-style-type: none"> <li>Increasing lethality and scope of irregular challenges</li> <li>Military operations in new domains</li> <li><i>Rise of China</i> <span style="float: right;"><b>Rise of a Near-Peer Competitor</b></span></li> <li><i>Cyber war</i> <span style="float: right;"><b>Cyber Warfare</b></span></li> <li><i>Increasing nuclear proliferation</i> <span style="float: right;"><b>Highly Proliferated World</b></span></li> </ul>
Demographics	<ul style="list-style-type: none"> <li><i>Youth bulge—87% of 10-19 year-olds live in dev. states</i> <span style="float: right;"><b>Geopolitical Demographics</b></span></li> <li><i>Global aging: The ranks of those over age 60 are growing about 2% each year – 60% faster than the overall population. Primarily affects: Europe, Japan</i></li> <li>Urbanization — by 2025, nearly 60% of global population will live in cities</li> </ul>
Economy	<ul style="list-style-type: none"> <li>Growing gap between rich and poor countries</li> <li>Increasing regional and global integration of economies</li> <li>Increasing Asian influence in international markets</li> </ul>
Environment	<ul style="list-style-type: none"> <li><i>Disruptions to resource distribution (e.g., water, energy)</i> <span style="float: right;"><b>Winners and Losers</b></span></li> <li><i>Climate change leading to rise in sea level, changing climatic zones, weather patterns</i></li> </ul>
Governance	<ul style="list-style-type: none"> <li>State remains dominant unit in international system</li> <li>Strong, but challenged, US leadership in international arenas (e.g., global commons)</li> <li>Increasing influence of the individual, private sector, NGOs on international system</li> <li><i>Increasing salience of trans/sub-national identities</i> <span style="float: right;"><b>Anthropological Lens on Conflict</b></span></li> <li><i>Strong national and sub-national bonds sustained and reinforced through web and remittances</i></li> <li><i>Increasing tension between the “individuals rights” versus “groups rights”</i></li> </ul>
Science & Technology	<ul style="list-style-type: none"> <li><i>Technology: Information, Nanotechnology, Bio, Energy, Robotics</i> <span style="float: right;"><b>Five Revolutions</b></span></li> <li>Increased proliferation of technologies and knowledge</li> </ul>



# Technology surprise?



# Promises raise expectations – delivery tends to lag



- Late delivery desensitizes decision makers to need for change
- True bolts from the blue are possible, but unlikely
- Intersecting revolutions hypothesis



# Purpose and Outline

- Purpose

- Examine U.S. defense and security technology trends and potential

- Outline

- Five technology areas:

- Current assessment
- Future trends
- Defense implications
- Potential shocks

- Technology Meta-Trends

- Way Ahead

**Information Technology (IT)**  
 Description: Computers, communication, sensors, electronic control

**Biotechnology / Genetics**  
 Description: Medical technology, pharmacology, molecular biology,

**Robotics / Man-machine Interface**  
 Description: Programmed, remote, and direct human control of machines, human-machine intelligence, and hybrid

**Material and Production Science**  
 Description: Advanced materials, nanotechnology, micro (and nano)

**Energy Technology**  
 Description: Alternative sources, portable power systems, energy efficient designs

<p><b>Current Assessment</b></p> <ul style="list-style-type: none"> <li>• Developed world vulnerable to energy disruptions</li> <li>• Major oil companies reluctant to invest heavily in alternatives</li> <li>• Global climate concerns driving search for hydrocarbon alternatives (low CO<sub>2</sub> options)</li> </ul>	<p><b>Future Trends (next 15 yrs)</b></p> <ul style="list-style-type: none"> <li>• Investment will continue on multiple fronts (hedging and competing constituencies)</li> <li>• Scale of demand and infrastructure will limit pace of change</li> <li>• Private sector will drive battery / portable power technology</li> </ul>
<p><b>Defense Implications</b></p> <ul style="list-style-type: none"> <li>• DoD will continue to have a large energy footprint</li> <li>• Expanded use of small / remote systems will require more portable power with higher energy density</li> <li>• DoD will be tasked to set examples in efficiency and innovation</li> </ul>	<p><b>Potential Shocks (next 15 yrs)</b></p> <ul style="list-style-type: none"> <li>• Dramatic increase (or decrease) in oil production (or consumption)</li> <li>• Radiological attack on petroleum mega-node</li> <li>• New dominant energy source (energy density better than oil)</li> </ul>

Deliberative document; for discussion purposes only. Not subject to FOIA release.



# Information Technology (IT)



**Description:** Computers, comm, sensors, **networks**, electronic control systems, information storage, manipulation, and display

## Current Assessment

- DoD leads in Military C4ISR
- U.S. private sector leads global IT markets (rising competitors)
- DoD is a market follower in enterprise systems
- High investment (and cost) area

## Future Trends (next 15 yrs)

- Moore's law continues / Bandwidth increases (fiber and wireless)
- IT will accelerate change other areas (Bio/Materials)
- Decreasing quality / disposability (in hardware and software)

## DoD Implications

- Continued increasing influence in all mission areas
- Free movement of knowledge (blue and red)
- Increasing exploitation potential (red and blue)

## Potential Shocks (next 15 yrs)

- Large-scale SCADA (system control & data acquisition) attack
- Accessible quantum encryption
- Quantum computing becomes widely available

# Biotechnology / Genetics



**Description:** Medical technology, pharmacology, molecular biology, biochemistry, bioinformatics, and genetic engineering

## Current Assessment

- U.S. private sectors leads in (most areas)
- Free cross-border collaboration and movement of knowledge
- High dual-use potential, light footprint, difficult to assess intent

## Future Trends (next 15 yrs)

- Dramatic cost reductions in gene sequencing equipment
- Expanding / accessible databases
- Social and cultural norms will limit some advances (in U.S.)
- Increasing demands from aging (and wealthy) populations

## DoD Implications

- DoD has traditionally focused technology on machines (not men)
- Human performance has a dramatic effect on all operations
- Greatest asymmetric danger
- Ambiguous U.S.G. authorities

## Potential Shocks (next 15 yrs)

- Development of performance degradation technology
- Attack with engineered pathogens
- 2-10X Human Performance Enhancement: sleep, endurance, strength, cognitive ability
- Massive failure in food supply

# Robotics / Man-machine Interface



**Description:** Programmed, remote, and direct human control of machines, human-machine intelligence and hybrid systems

## Current Assessment

- Man (or man-machine) interface often limits system performance
- U.S. leads the world in unmanned defense systems
- Growing investment (cost) area
- Rising powers will apply low cost, dual-use technology

## Future Trends (next 15 yrs)

- Increased focus on neural function, perception, and cognition
- Expansion of autonomous systems and virtual presence
- Rapidly emerging threats
- New vulnerability sets (links, data, control)

## DoD Implications

- Unmanned systems have proven (and increasing) value
- Remotely-manned and hybrid systems can be used in increasingly complex missions
- Amputation / neurological casualties from IEDs

## Potential Shocks (next 15 yrs)

- Fused human-machine intelligence
- Low cost, swarming systems or autonomous precision attack systems



# Material and Production Science



**Description:** Advanced materials, nanotechnology, micro (and nano) electromechanical devices, prototyping, production

## Current Assessment

- Area of U.S. competitive advantage
- DoD is the global leader in existing mission areas (air-sea-land-space)
- DoD will follow in expanding commercial markets
- High dual-use potential

## Future Trends (next 15 yrs)

- Rapidly expanding nano and MEMS (commoditization)
- Increasing focus on MEMS/NEMS
- Continued convergence of IT, robotics, and bio technology
- Increased emphasis on reducing development to market timelines

## DoD Implications

- Dual-use makes this technology difficult to control
- Proliferation will reduce DoD's technical edge and expand asymmetric attack options
- Increased reliability / reduced cost (must pair with agile acquisition)

## Potential Shocks (next 15 yrs)

- Proliferation of highly energetic materials
- Invasive nano particles/NEMS used as medical or biological agents; delousing
- Sensor dust, ubiquitous sensing
- Broad-band metamaterials



# Energy Technology

**Description:** Alternative sources, portable power systems, energy efficient designs

## Current Assessment

- Developed world vulnerable to energy disruptions
- Major oil companies reluctant to invest heavily in alternatives
- Global climate concerns driving search for hydrocarbon alternatives (low CO<sub>2</sub> options)

## Future Trends (next 15 yrs)

- Investment will continue on multiple fronts (hedging and competing constituencies)
- Scale of demand and infrastructure will limit pace of change
- DoD must will drive battery / portable power technology

## DoD Implications

- DoD will continue to have a large energy footprint
- Expanded use of small / remote systems will require more portable power with higher energy density
- DoD will be tasked to set examples in efficiency and innovation

## Potential Shocks (next 15 yrs)

- Dramatic increase (or decrease) in oil production (or consumption)
- Radiological attack on petroleum mega-node
- New dominant energy source (energy density better than oil)



# An information age Pearl Harbor?

NO....but this guy is far cry from Imperial Japan



George Hotz, 17, of Glen Rock, New Jersey holding the iPhone® that he separated from the AT&T network and used on the T-Mobile Network. **Career goal: hack the human brain**

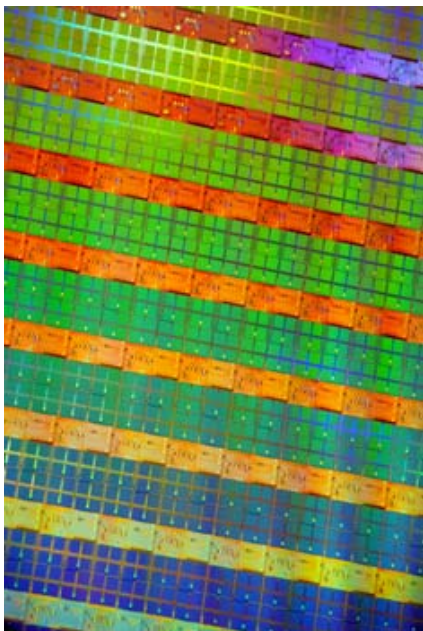
- ❑ Apple and AT&T released the iPhone on 29 June
- ❑ An exclusive agreement guaranteed the iPhone could only be used on AT&T's mobile network
- ❑ Hotz spent approximately 500 hours working on his “summer project”
- ❑ The hack was announced on 24 August.
  - ❑ AT&T - market cap: \$245B  
- annual revenue: \$90B
  - ❑ Apple - market cap: \$117B  
- annual revenue: \$23B
  - ❑ Hotz - PRICELESS

**This is the new asymmetry—victory goes to the agile and innovative**



# Recent Developments

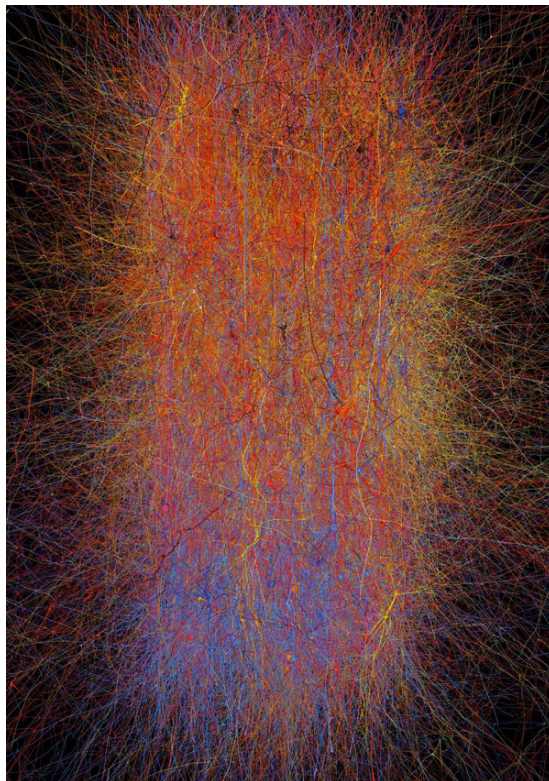
## Hafnium oxide: 45nm transistors



A beam of light travels less than a tenth of an inch during the time it takes a 45nm transistor to switch on and off.

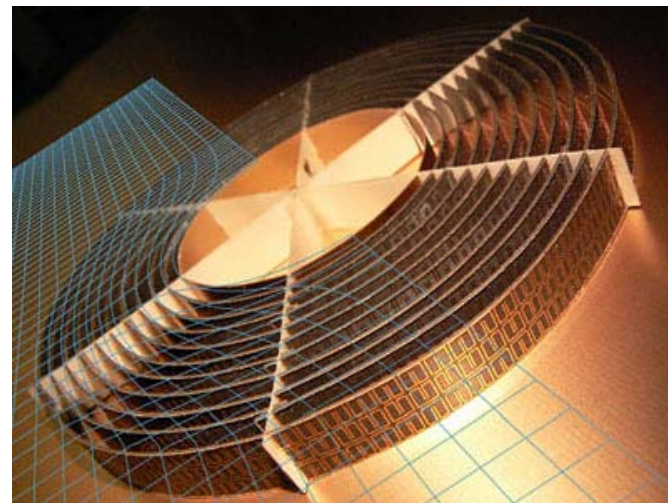
Surprise revival of Moore's law just before anticipated end of silicon chip progress

## Supercomputer neuro-map: 10,000 neurons and 30 million connections

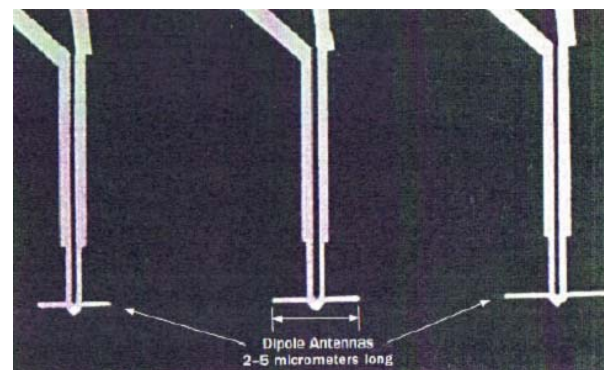


Scientists are now planning to model the entire human brain within just 10 years - "fantastic acceleration in brain research"

## Metamaterials: 2D microwave "invisibility cloak"



From theory to tech demonstration in 5 months



## Nano Antennas: receiving infrared RF signals

Could lead to sensors a million times more sensitive than current technology. First predicted in 1960s





# Age of Scientific Innovation

- Paradigm-shifting scientific discoveries have historically occurred at a young age
  - Newton – 24; Darwin – 22; Einstein - 26
- Mid-career scientists are now considered to be most productive--if measured by lists of publications
  - May be due to longer training phases, accumulative advantage, focus on acceptance vs. discovery
- Scientific and technological discovery and innovation are not limited to academic publications and PhD's.
  - Some of the most successful innovators of recent decades have been college drop-outs
    - Bill Gates, Steve Wozniak, Michael Dell
  - Some of the most threatening innovators have been under the age of twenty-five
    - Global Bot “Mastermind” – 18 year old alleged by FBI to lead effort of infecting and controlling over a million computers world-wide
    - Godfather of Cyber Terrorism – recently arrested 22 year old Al Qaeda internet operative
    - World’s Most Famous Hacker – Kevin Mitnick, who broke into DEC computers to steal their operating system development software at 16



# Technology Meta-Trends (1)

## ❑ Technological change is accelerating

- Accelerating application of knowledge and technology
  - Past – Change limited by state-based science, technology, capital
  - Future – Change limited by interest, policy, and law
- Increasing rate of “paradigm shifts”
- Invention/innovation speeds up invention/innovation (feedback loop)

## ❑ U.S.’s technological advantage eroding

- Free-flowing factors of production: S&T, labor, capital
- Nation state risk aversion: bureaucratic, conservative governance
- U.S. economy may fall to world’s 3<sup>rd</sup> largest in latter half of century
- Increasing number of 6- $\Sigma$  individuals migrating into productive sector in China/India

## ❑ Discovery may rely more on global collaboration than years of graduate study

- Innovation as a “young man’s game” (Planck) vs. the realm of experienced, qualified experts





# Technology Meta-Trends (2)

- “Silicon” computing power on path to exceed “carbon” computing power
  - Implications of machines surpassing computing power of human brain
- Super-empowerment and new global actors
  - Technology investment geared to empower the individual - personal transportation, communications, finance, entertainment, health care
  - Proliferation of “new” technologies in the hands of agile adversaries
    - Nation-state’s destructive power available to single decision-makers
    - Growing access to converging technologies (speed, cost, scope)
- Unforeseeable technology innovation – the third step
  - How will technology used in ways we cannot predict?
  - How will technology change the way we think and organize?
- Perception U.S. less open to foreign students and scholars
  - Enrollment declined in 2003-07 for first time since 1971; however, 2006-07 school year saw increase
  - Post-9/11 restrictions make European institutions seem more attractive



# Recommendations – People

- Make government lab resources more widely available to University researchers and develop programs to continue those relationships
  - Expand Summer Faculty Research Program and Sabbatical Leave Program (ASEE); Post-doctoral fellowship (ASEE); Defense Science and Engineering Graduate Fellowships
- Develop and expand existing innovative hiring, employment, and contracting authorities
  - Intergovernmental Personnel Act, Highly Qualified Experts, industry fellowships, SMART program, NSEP
  - Develop attractive rotational career paths and collaborative opportunities
- Partner with research and development competitions
  - Odyssey of the Mind, Exploravision, Science Olympiad, FIRST, Idea to Project

# Recommendations – Horizon Scanning



- Enhance organizations with staff and methodology to alert senior leaders to disruptive trends, shocks, and potential mitigation
  - Build technology intelligence program that includes technology scanning and collaboration with partners, private sector – X2 as a model
  - Link tech intelligence to technology red teaming and blue teaming process (DDR&E)
    - Technology war-gaming / Identify indicators and red lines
  - Integrate operational perspectives by recruiting and strategically placing/detailing “technology scouts”
    - Services and Defense Agencies
    - Intern, externs, fellows, and gray beards
  - Develop protocols to raise major issues to senior leadership
  - Share information and increase visibility across government

# Recommendations – Leveraged Innovation



- Sponsor technology research and “challenges” that focus on interdisciplinary research and applications
- Examples: DARPA challenges, MURIs, tech venture funds that
  - Open doors for groups pursuing innovative research that would not/could not pursue access to DoD market
  - Award winners, dramatic innovators – continue relationship high potential teams
  - Provide seed money to promising teams (tech CERP) for ideas
- Example focus areas:
  - Energy: portable power; domestically sources compatible with legacy equipment and infrastructure; carbon neutral / carbon sequestration
  - TTL: “Naked man” problem; tag at a distance; stand-off detection of fissile material



*Questions?*



# BACKUPS

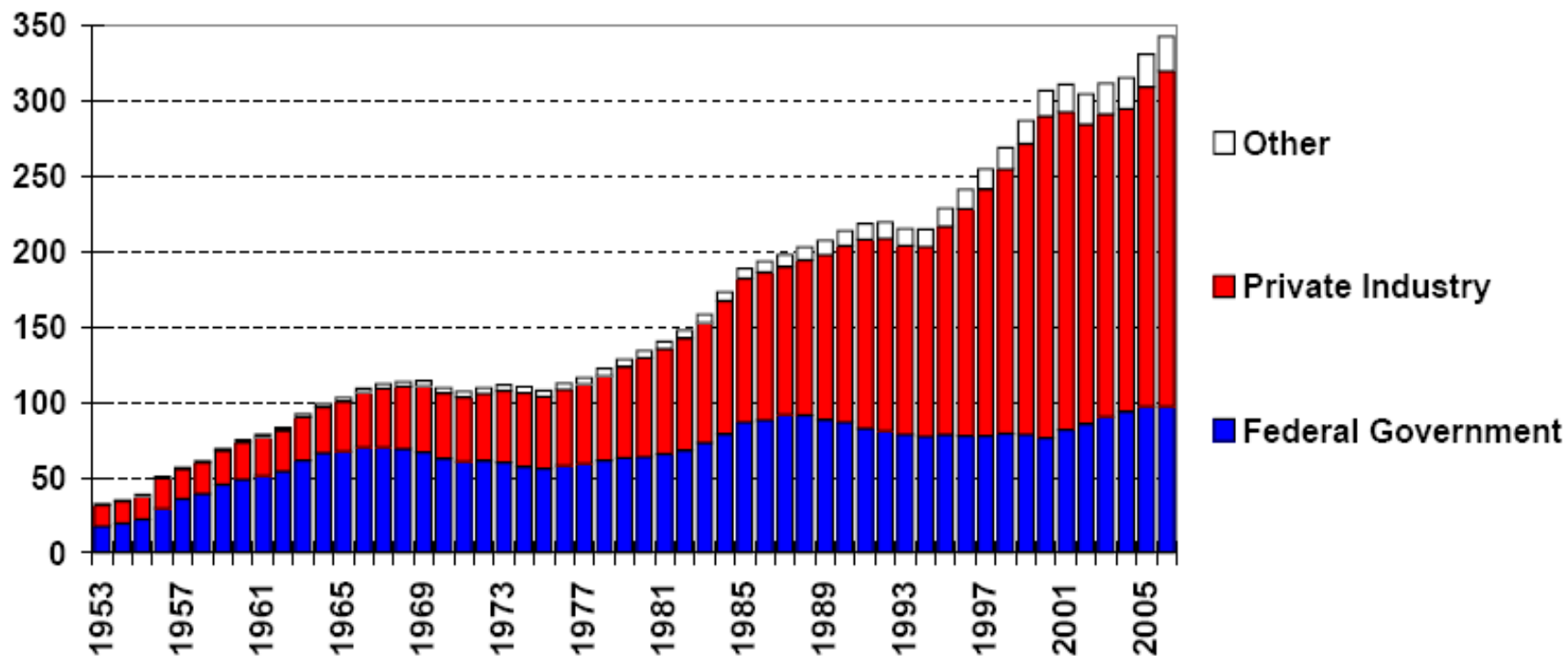


# Decreasing Weight of USG Investment



## U.S. R&D Funding by Source, 1953-2006

expenditures in billions of constant 2006 dollars



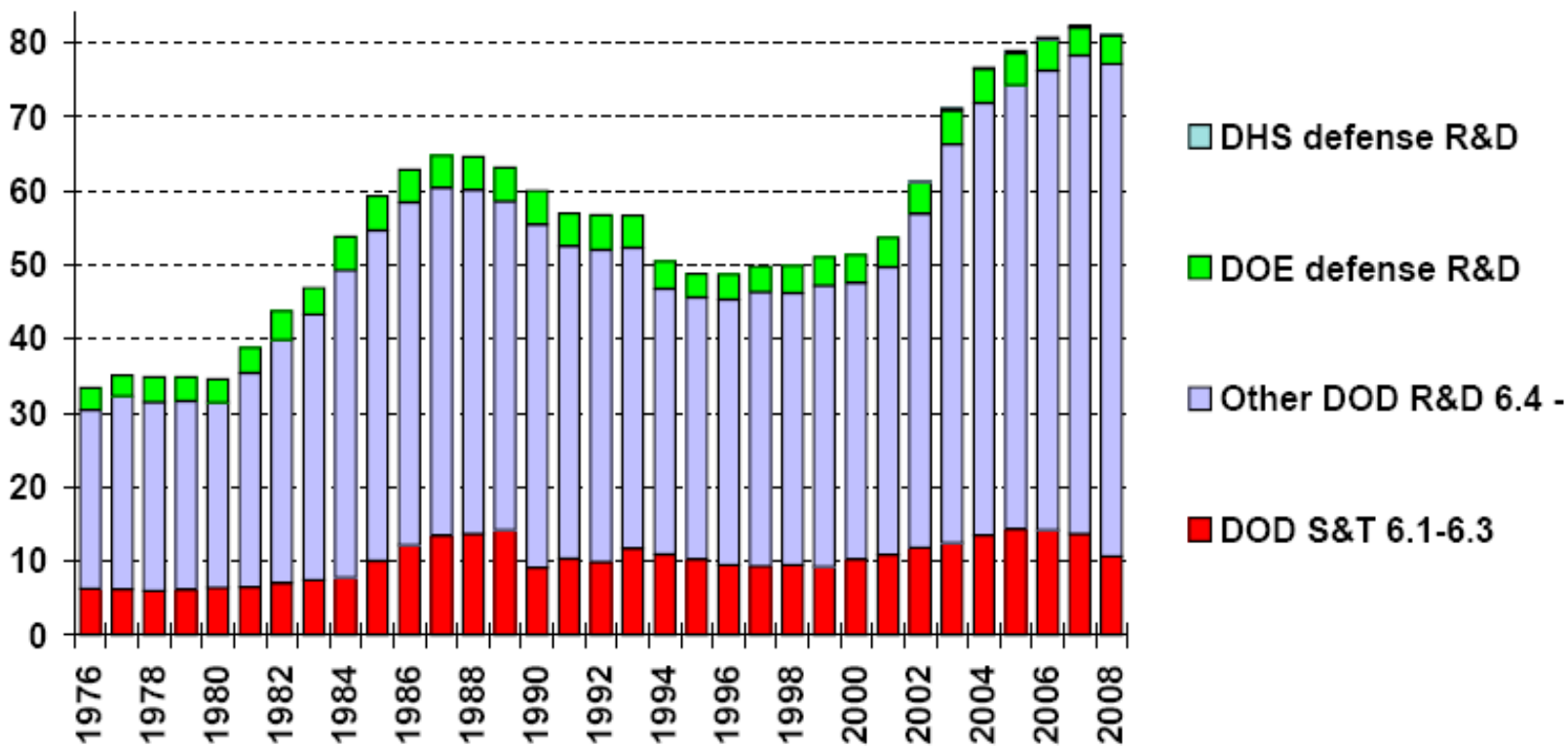
Source: NSF, Division of Science Resources Statistics. (Data for 2005 and 2006 are preliminary.)

APRIL '07 © 2007 AAAS

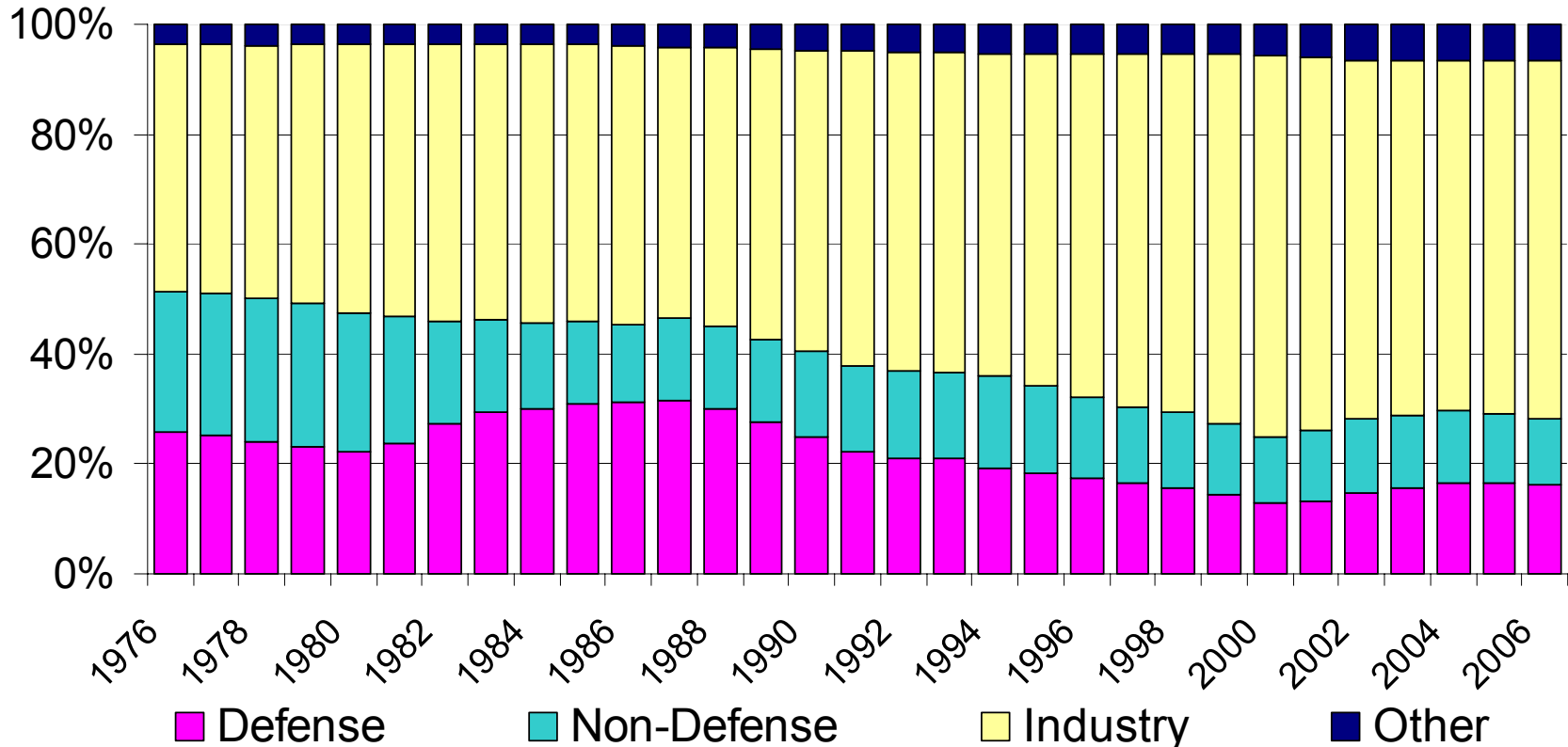


# Defense R&D

Trends in Defense R&D, FY 1976-2008 \*  
in billions of constant FY 2007 dollars



# 30 Year Trend in U.S. R&D Investments

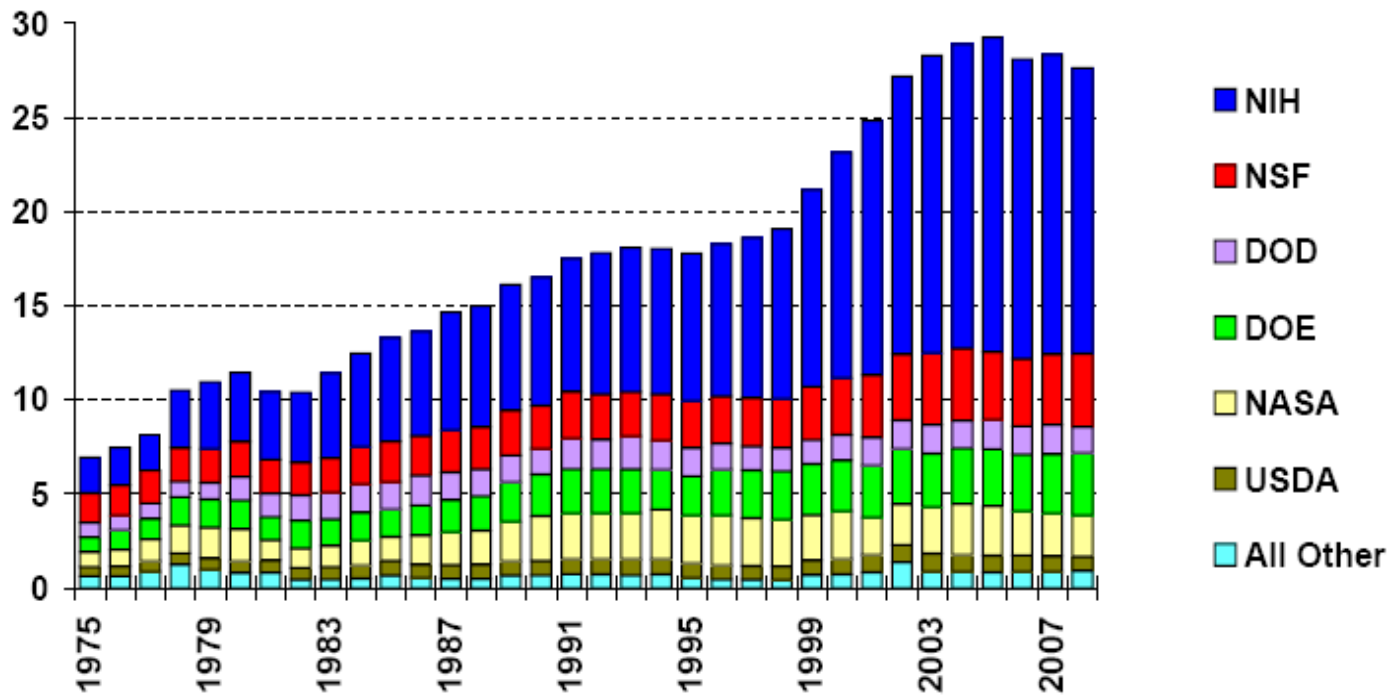


- DoD R&D effort down from 26% to 16% of U. S. total
- Total Federal effort down from 51% to 28%
- Industry R&D effort up from 45% to 65%
- Non-profits, educational institutions, state, and local up from 4% to 7%

# Basic Research (BA 1)



Trends in Basic Research by Agency, FY 1975-2008 \*  
in billions of constant FY 2007 dollars

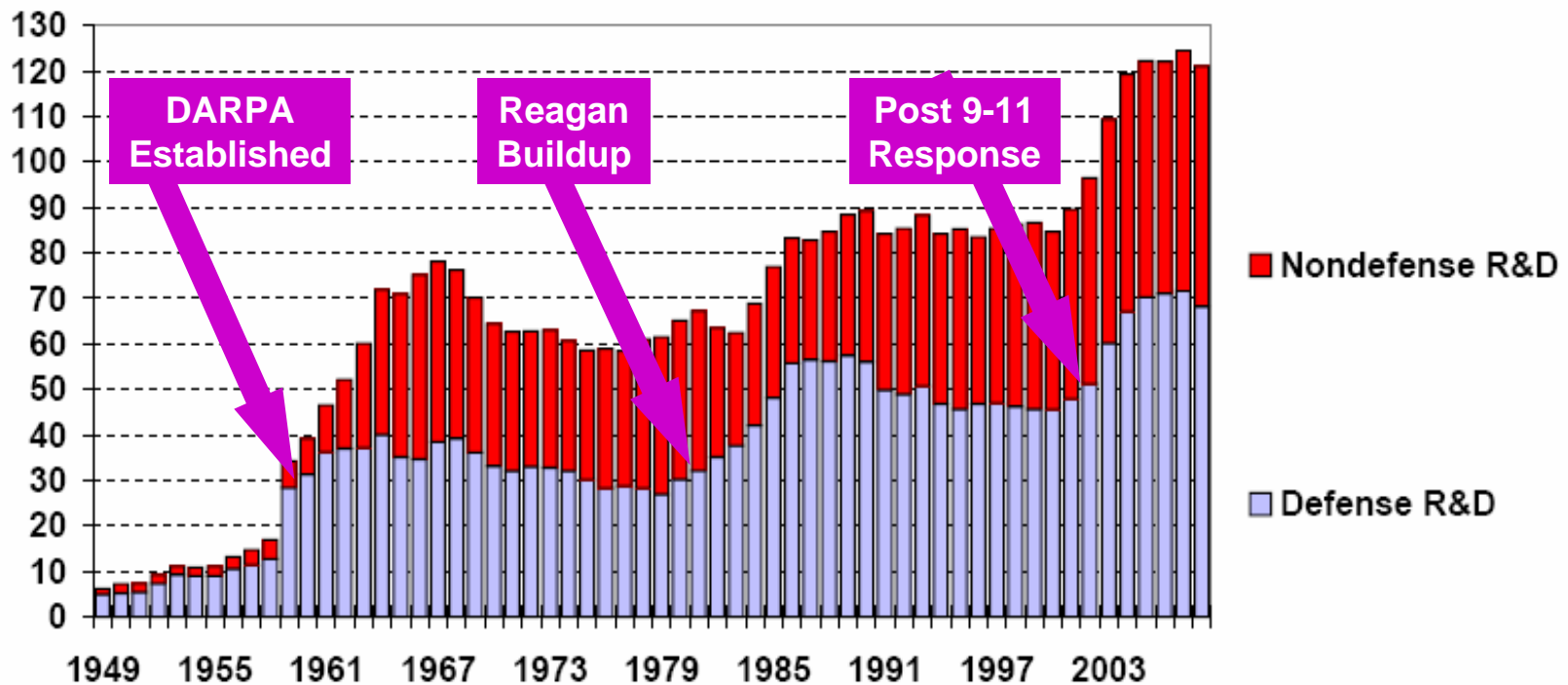


# DoD R&D is about half of U.S.G. total



## Federal Spending on Defense and Nondefense R&D

Outlays for the conduct of R&D, FY 1949-2008, billions of constant FY 2007 dollars



# The Importance of Horizon Scanning



- Inductive logic – necessary and overwhelmingly attractive
  - *The sun will rise tomorrow...*
  - *78 percent of Americans support...*
  - *The top mutual performing fund for the last ten years...*
- The law of large numbers
  - Regression analysis, curve fitting, and forecasting
  - Sufficient and random sampling of independent variables
- The farmer and the chicken
  - When do we have enough information?
  - Should we constantly challenge our current ideas and theories?
  - Should we take every day one day at a time?



# One Effect of Quantum Computing: Ability to Break RSA Public Key Encryption



The RSA algorithm was invented in 1977; it is a **computationally secure** based on four parameters:  $P$ ,  $Q$ ,  $E$ , and  $D$

- $P$  and  $Q$ , two large prime numbers
- $E$  such that  $E$  is greater than 1,  $E$  is less than  $PQ$ , and  $E$  and  $(P-1)(Q-1)$  have no prime factors in common
- $D$  such that  $(DE - 1)$  is evenly divisible by  $(P-1)(Q-1)$

The encryption function is  $C = (T^E) \bmod PQ$  ( $C$  is the ciphertext)

- The **public key** is the pair  $(PQ, E)$

The decryption function is  $T = (C^D) \bmod PQ$  ( $T$  is the plaintext)

- The **private key** is the number  $D$

**One can publish the public key freely**

- There are no practical methods of calculating  $D$ ,  $P$ , or  $Q$  given only  $(PQ, E)$
- If  $P$  and  $Q$  are each 1024 bits long, **the sun will burn out before the most powerful classical computers can factor  $PQ$  into  $P$  and  $Q$  (quantum computer could do it in minutes)**

**Quantum computers undo the computational security of public key encryption**

# Research & Development Budget Categories



**Budget Activity 1: Basic Research**

**Budget Activity 2: Applied Research**

(S&T)

**Budget Activity 3: Advanced Technology Development (ATD)**

**Budget Activity 4: Advanced Component Development and Prototypes (ACD&P)**

**Budget Activity 5: System Development and Demonstration (SDD)**

**Budget Activity 6: RDT&E Management Support**

RDT&E

**Budget Activity 7: Operational System Development**

Budget Activities 1 through 3 are often collectively referred to as **Science and Technology (S&T)**

Budget Activities 4,5 and 7 are normally associated with acquisition programs

Budget Activity 6 funds RDT&E infrastructure

# Research & Development Budget Categories



Budget Activity 1: **Basic Research**, the systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind (formerly known as 6.1)

Budget Activity 2: **Applied Research**, the systematic study to understand the means to meet a recognized and specific need (formerly known as 6.2)

Budget Activity 3: **Advanced Technology Development (ATD)** includes development of subsystems and components and efforts to integrate subsystems and components into system prototypes for field experiments and/or tests in a simulated environment (formerly known as 6.3)

# We Don't Know What We Don't Know



**“By 2020, organic electronics should provide for increased brightness of widespread lighting systems and displays.”**

*RAND, The Global Technology Revolution 2020  
(Released in 2006)*



**Super-vivid, super-efficient displays  
New OLED displays for mobile gadgets are poised for debut in U.S. and European markets**

*Technology Review  
November 06, 2006*

**Sony: 1,000,000:1 OLED TV on sale in 2007**

*Engadget  
Posted 12 April 2007*

# Performance Remediation



## World First Power Ankle

- **Developed at biomechatronics group at the MIT Media Lab**
- **Small battery-powered motor mimics the energy-storage capacity of the human ankle**
- **Power-assisted spring propel the foot forward as it pushes off the ground**
- **about 20 percent more efficient than past devices**
- **Tested in partnership with Military Amputee Research Program**



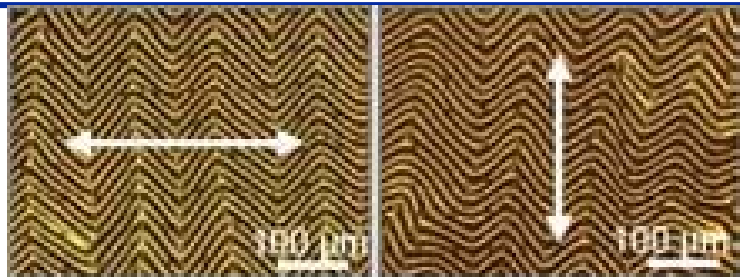
# Brain-Machine Interface



- **Emotiv Systems electro-encephalograph (EEG) cap**
- **On sale to software developer's**
- **Used to build games that use the electrical signals from a player's brain to control the on-screen action**
- **Could be useful in virtual-world games, such as Second Life**
- **Commercial successful remains uncertain**

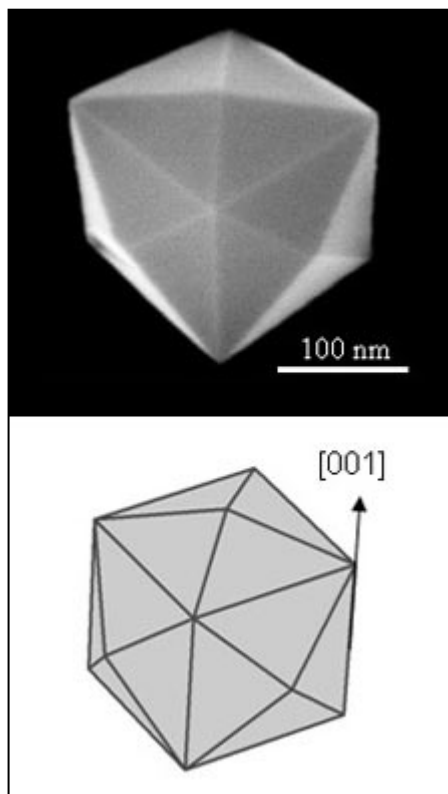


# Current Materials Research



**Sheets of Stretchable Silicon**  
**Researchers have shown that ultrathin sheets of silicon can stretch in two dimensions-- opening up the possibility of electronic eyeballs and smart surgical gloves.**

Technology Review  
May 15, 2007



**Better Catalysts for Fuel Cells**  
**Nanoparticles with a completely new shape may lead to cheaper catalysts that could make many experimental-energy technologies more practical.**

Technology Review  
May 15, 2007

# Public Companies with \$150B\* in Revenue (why oil matters so much)



\$366.24B	Exxon Mobil Corporation engages in the exploration, production, transportation, and sale of crude oil and natural gas.	Irving, TX
\$355.38B	Wal-Mart Stores, Inc. operates retail stores in various formats worldwide.	Bentonville
\$318.13B	Royal Dutch Shell plc, through its subsidiaries, engages in the exploration, production, and trading of various energy resources worldwide.	The Hague
\$263.89B	BP p.l.c. provides fuel for transportation, energy for heat and light, retail services, and petrochemicals products.	London
\$209.84B	Toyota Motor Corporation operates in the automotive industry worldwide.	Toyota City
\$204.78B	DaimlerChrysler AG engages in the development, manufacture, distribution, and sale of automotive products, including passenger cars, trucks, vans, and buses worldwide.	Stuttgart
\$191.74B	General Motors Corporation and its subsidiaries engage in the development, production, and marketing of cars, trucks, and parts worldwide.	Detroit
\$189.82B	Chevron Corporation operates as an integrated energy company worldwide.	San Ramon
\$176.14B	TOTAL S.A., together with its subsidiaries, operates as an integrated oil and gas company worldwide.	Paris
\$167.21B	General Electric Company (GE) is a diversified industrial corporation.	Fairfield , CT
\$164.72B	Ford Motor Company and its subsidiaries design, develop, manufacture, and service cars, trucks, and parts worldwide.	Dearborn, MI
\$162.22B	ConocoPhillips operates as an integrated energy company worldwide.	Houston, TX
\$152.55B	AXA, through its subsidiaries, provides global financial protection and asset management services.	Paris
\$141.44B	China Petroleum & Chemical Corporation, through its subsidiaries, operates as an integrated oil and gas, and chemical company in the People's Republic of China and Hong Kong.	Beijing

# U.S. Science and Math Literacy



Average science score of eighth grade students, by country: 2003

Country	Score
International average	473
Singapore	578
Chinese Taipei	571
South Korea	558
Hong Kong, China	556
Estonia	552
Japan	552
Hungary	543
Netherlands	536
<b>United States</b>	<b>527</b>
Australia	527
Sweden	524
Slovenia	520
New Zealand	520
Lithuania	519
Slovak Republic	517
Belgium	516
Russian Federation	514
Latvia	512
Scotland	512
Malaysia	510
Norway	494
Italy	491
Israel	488
Bulgaria	479
Jordan	475
Moldova	472
Romania	470
Serbia	468
Armenia	461
Iran	453
Macedonia	449
Cyprus	441
Bahrain	438
Palestinian National Authority	435
Egypt	421
Indonesia	420
Chile	413
Tunisia	404
Saudi Arabia	398
Morocco	396
Lebanon	393
Philippines	377
Botswana	365
Ghana	255
South Africa	244

Average higher than U.S. average

Average not measurably different from U.S. average

Average lower than U.S. average

SOURCES: P. Gonzales, J.C. Guzman, L. Parelow, E. Pahlke, L. Jocelyn, D. Kastberg, and T. Williams, *Highlights From the Trends in International Mathematics and Science Study (TIMSS) 2003*, U.S. Department of Education, National Center for Education Statistics, NCES 2005-005, table 9 (2004); and data from International Association for the Evaluation of Educational Achievement, *Trends in International Mathematics and Science Study (TIMSS)* (2003).

Science and Engineering Indicators 2006

Average mathematics literacy score of 15-year-old students, by country: 2003

Country	Score
OECD countries	500
Finland	544
South Korea	542
Netherlands	538
Japan	534
Canada	532
Belgium	529
Switzerland	527
New Zealand	523
Australia	524
Czech Republic	516
Iceland	515
Denmark	514
France	511
Sweden	509
Austria	506
Germany	503
Ireland	503
Slovak Republic	498
Norway	495
Luxembourg	493
Poland	490
Hungary	490
Spain	485
<b>United States</b>	<b>483</b>
Portugal	466
Italy	466
Greece	445
Turkey	423
Mexico	385
Non-OECD countries	
Hong Kong, China	550
Liechtenstein	536
Macao-China	527
Latvia	483
Russian Federation	468
Serbia and Montenegro	437
Uruguay	422
Thailand	417
Indonesia	360
Tunisia	359

Average higher than U.S. average

Average not measurably different from U.S. average

Average lower than U.S. average

OECD = Organisation for Economic Co-operation and Development

SOURCES: M. Lamka, A. Sen, E. Pahlke, L. Parelow, D. Miller, T. Williams, D. Kastberg, and L. Jocelyn, *International Outcomes of Learning in Mathematics Literacy and Problem Solving: PISA 2003 Results From the U.S. Perspective: Highlights*, U.S. Department of Education, National Center for Education Statistics, NCES 2005-003, table 2 (2004); and data from OECD, Programme for International Student Assessment (PISA) (2003).

Science and Engineering Indicators 2006

# Rise of China's R&D Efforts



- U.S. Leads World in R&D Spending, China Moves to 3rd Place

The United States continues to lead the world in R&D with 34 percent of world R&D spending in 2005, according to data from the OECD. U.S. industry, government and other sectors spend more on R&D than the entire EU combined. The U.S. share has declined from 40 percent during most of the 1990s. China has increased its R&D performance dramatically in recent years and is just narrowly the 3rd largest performer of R&D (adjusted for purchasing power), and will overtake 2nd place Japan in 2006.

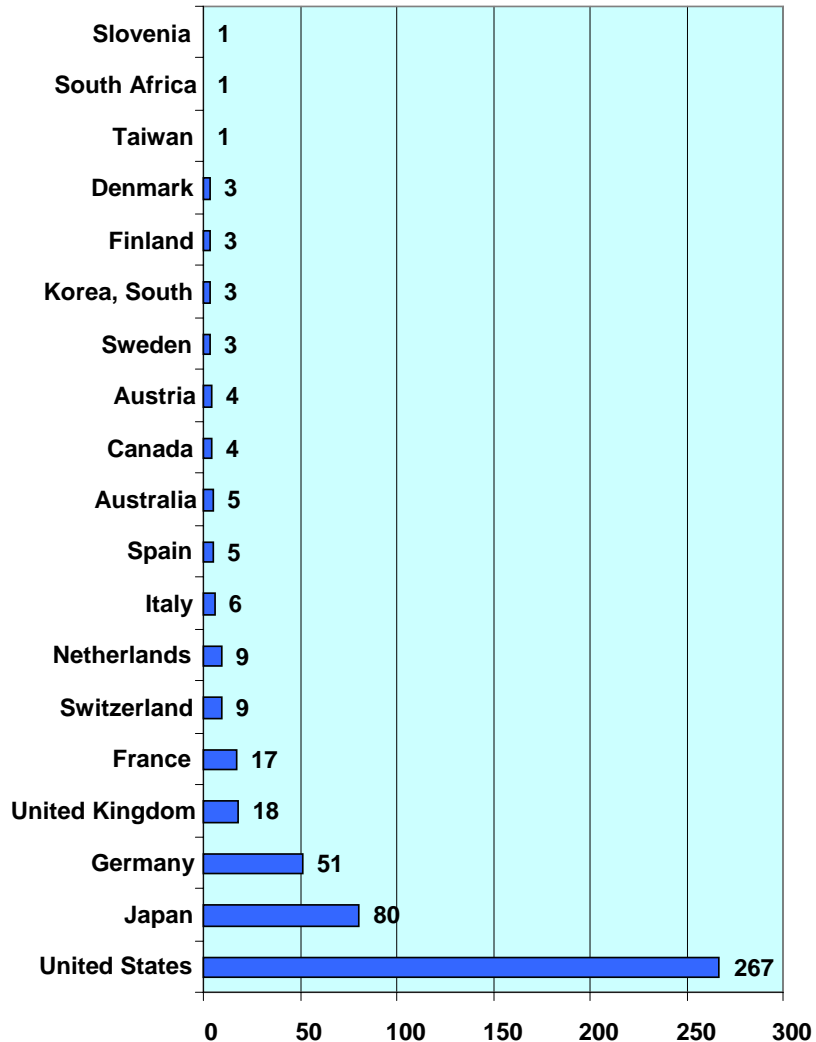
- In scientists and engineers employed in R&D activities, China is already 2nd in the world behind only the United States.

May 15, 2007  
American Association  
for the Advancement of Science

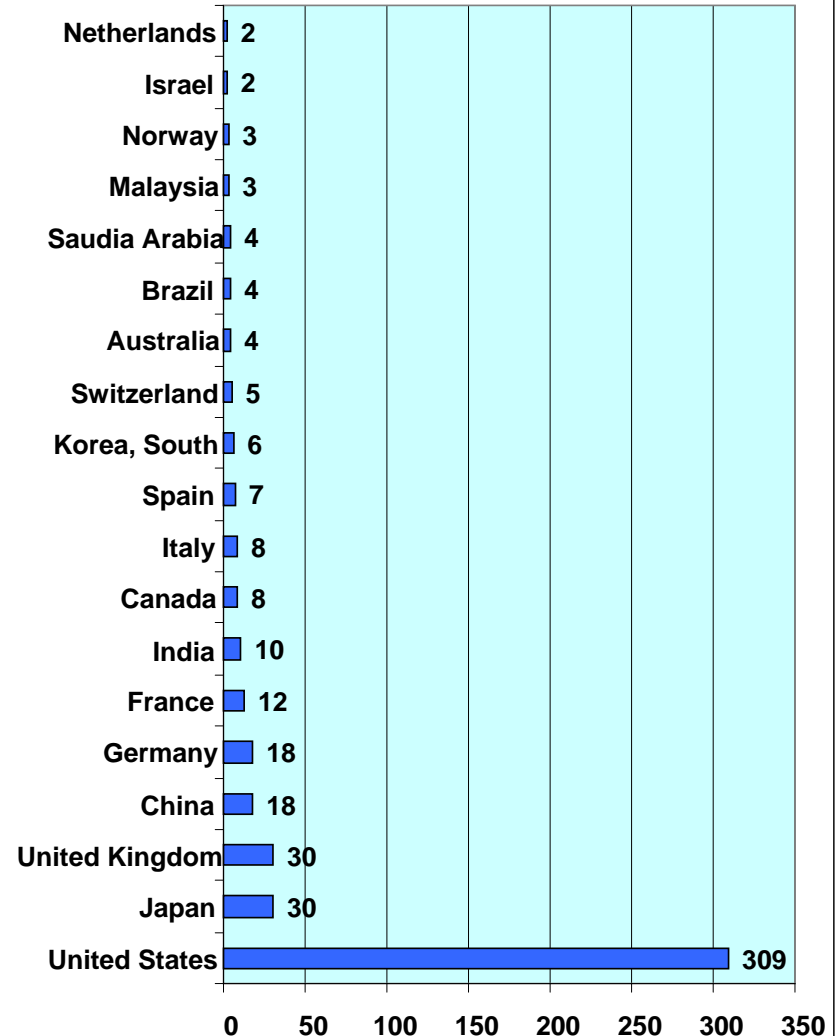
# Super Computers: Number of Top 500



November 1996



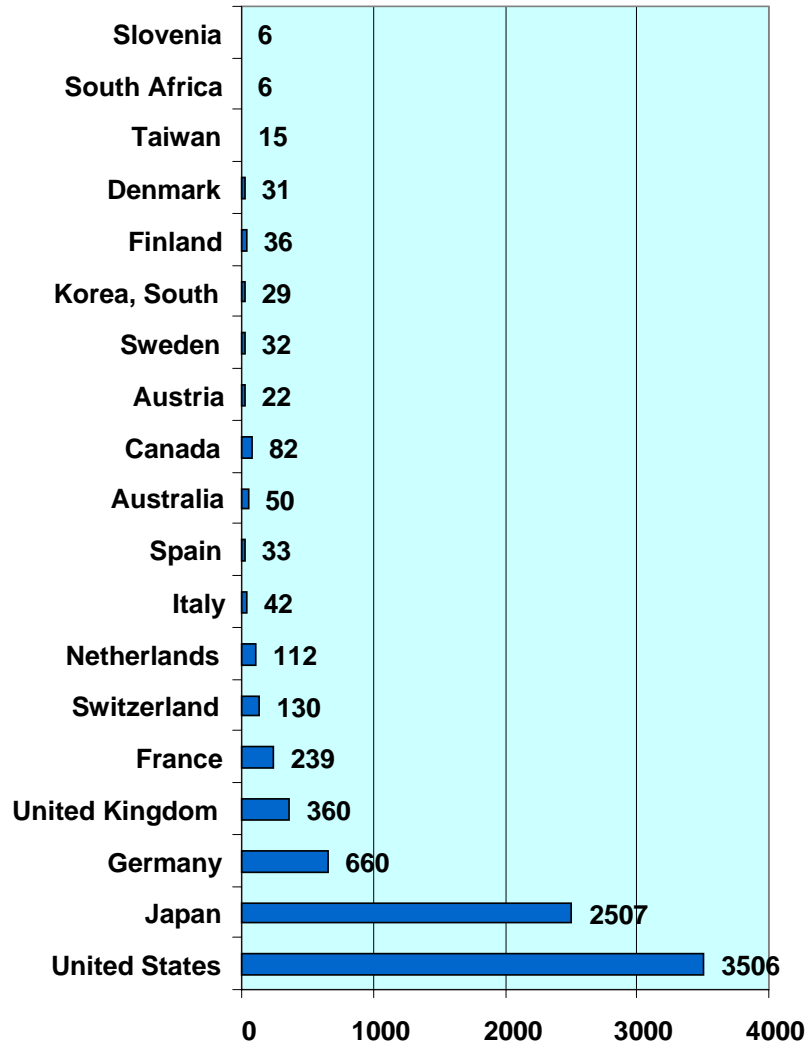
November 2006



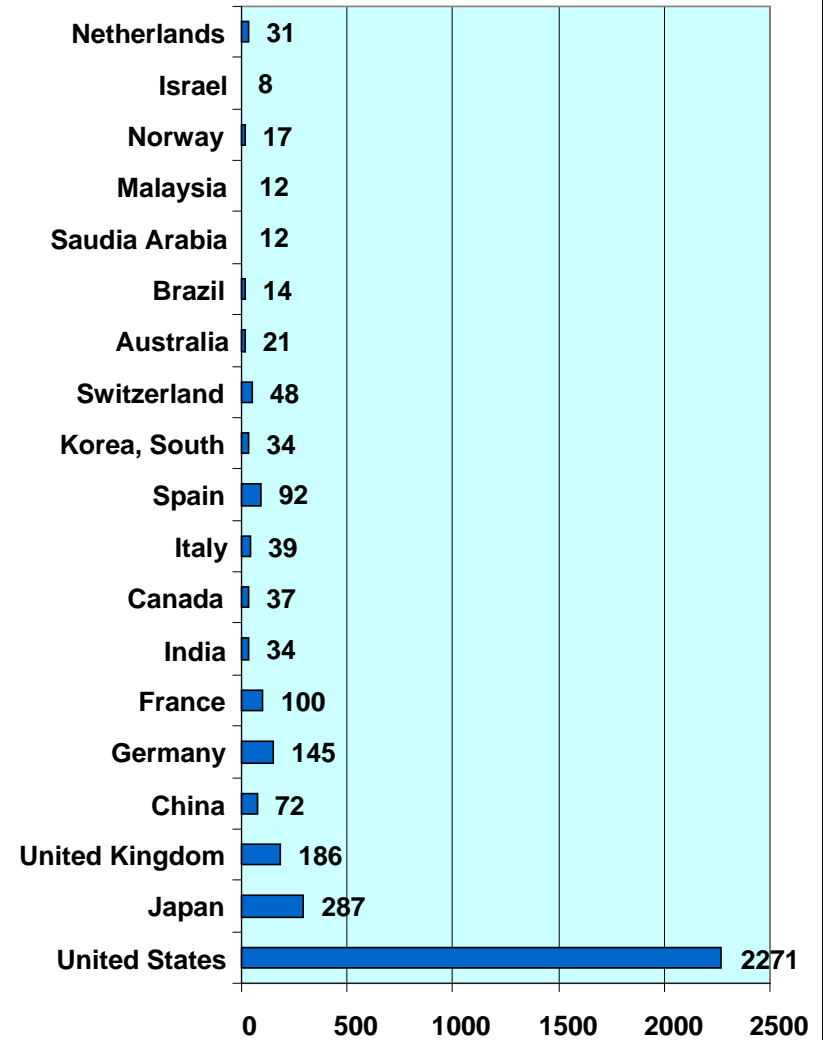
# Super Computers: Processing



November 1996 (GigaFlops)



November 2006 (TeraFlops)





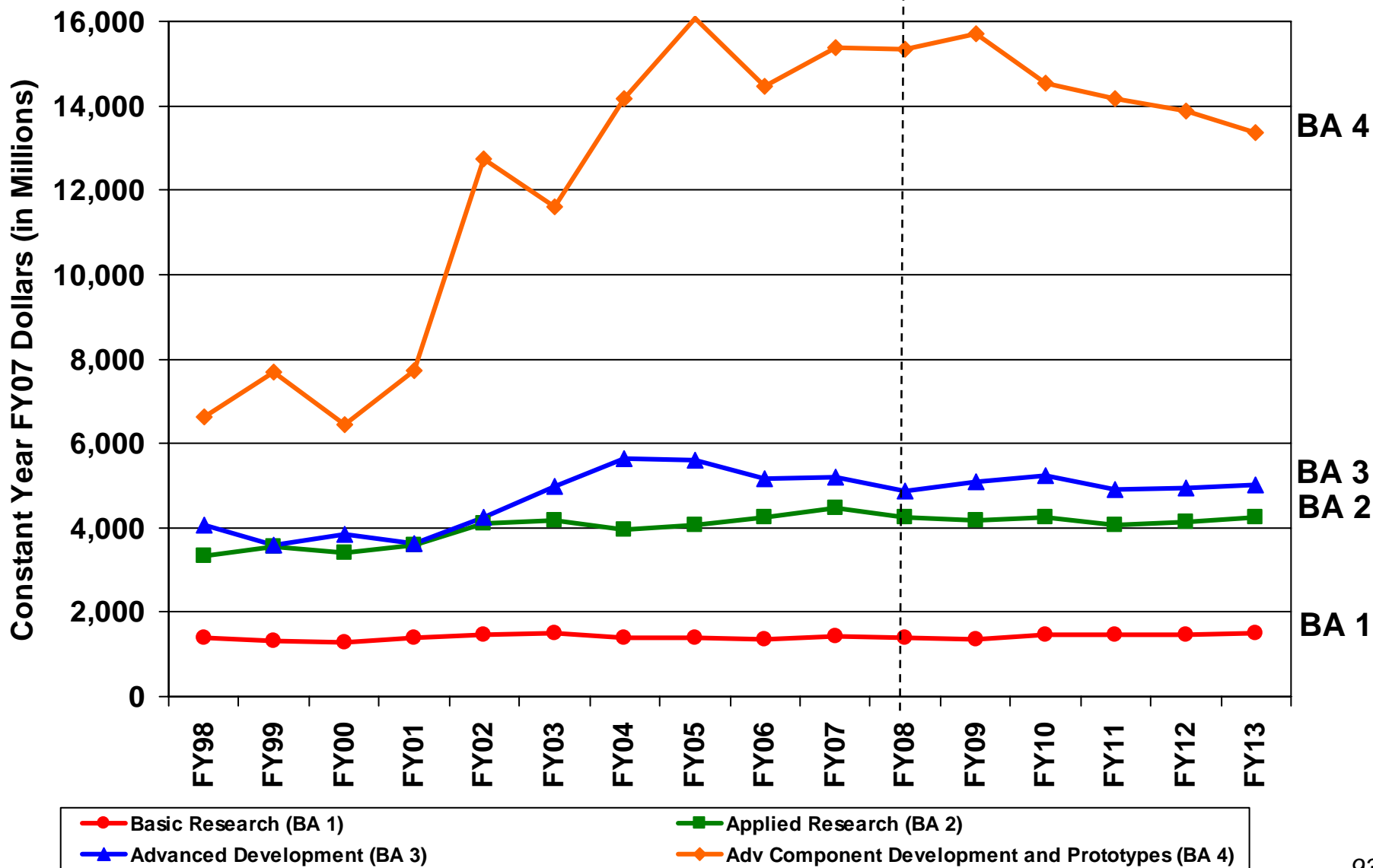
# Selected Sources



- *Science and Engineering Indicators 2006. Two Volumes*  
National Science Board  
National Science Foundation, 2006
- *21th Century Strategic Technology Vectors*  
Defense Science Board, 2006
- *Proceedings, Australia-U.S. Bilateral Emerging Technology Conference*  
May, 2007
- *Converging, Combining, Emerging*  
Dr. George Poste, Presentation,  
Highland Forum XXXII
- *Steering Group Report: Brain Science as a Mutual Opportunity for the Physical and Mathematical Sciences, Computer Science, and Engineering*  
National Science Foundation  
August 2006
- *Globalization, Biosecurity, And The Future of The Life Sciences*  
**Institute of Medicine and National Research  
Council of the National Academies, 2006**
- *Human Performance Modification Collaboration Workshop Report*  
Dr. Adam Russell and Ms. Bartlett Bulkley  
Scitor Corporation, 2006
- *The Global Technology Revolution 2020, In-Depth Analyses Bio/Nano/Materials/Information Trends, Drivers, Barriers, and Social Implications*  
Richard Silbergliitt, Philip S. Antón, David R. Howell, Anny Wong  
RAND, 2006

# DoD R&E Funding By Budget Activity

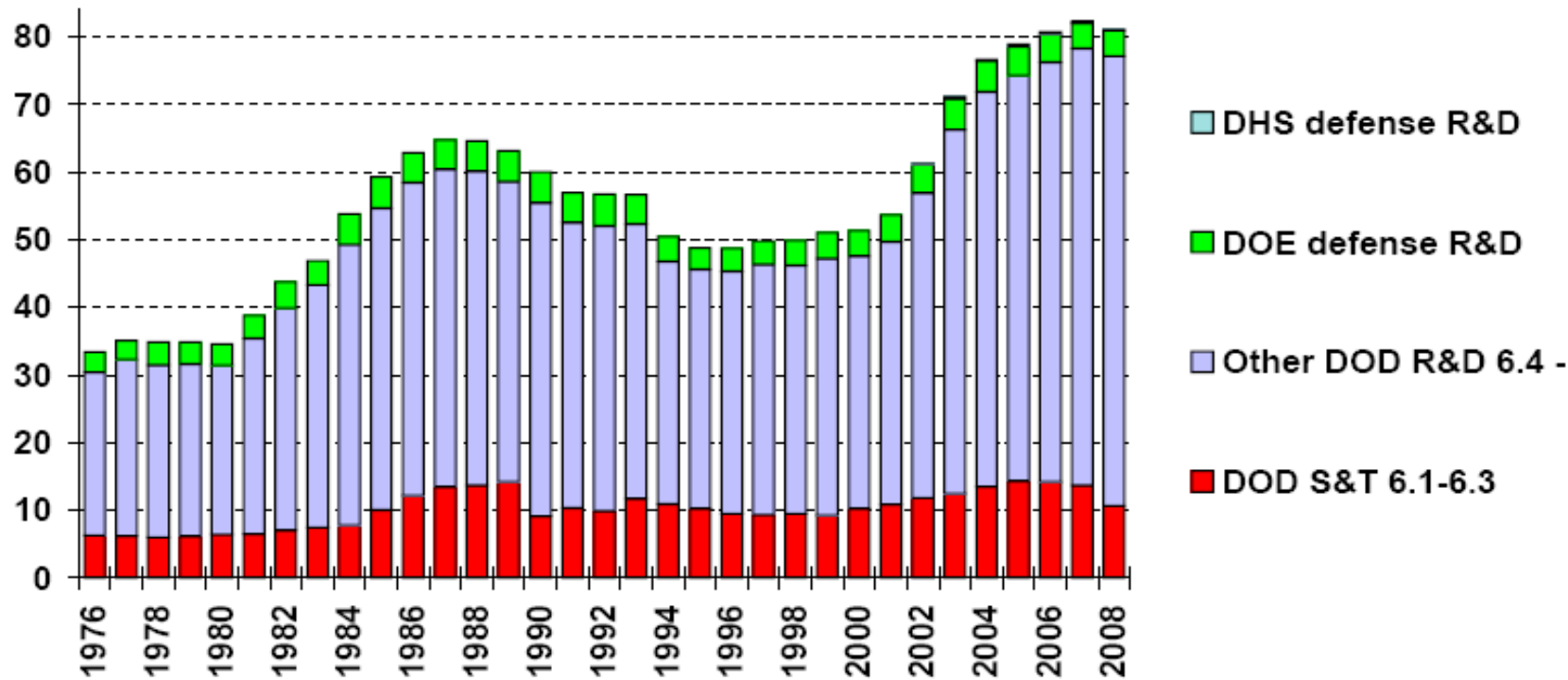
## President's Budget Requests - in FY07 Constant Dollars





# Defense R&D Spending

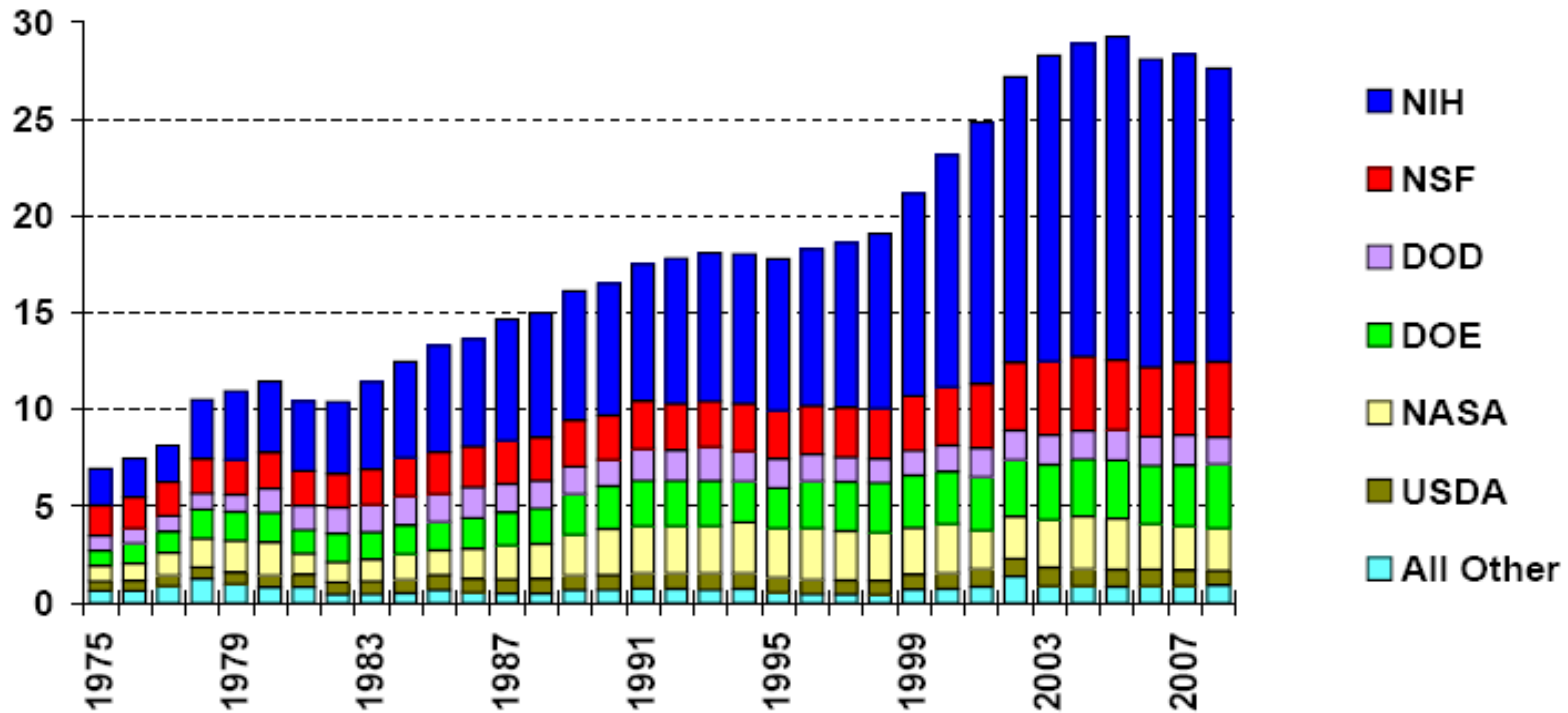
**Trends in Defense R&D, FY 1976-2008 \***  
in billions of constant FY 2007 dollars



# Federal Basic Research Spending



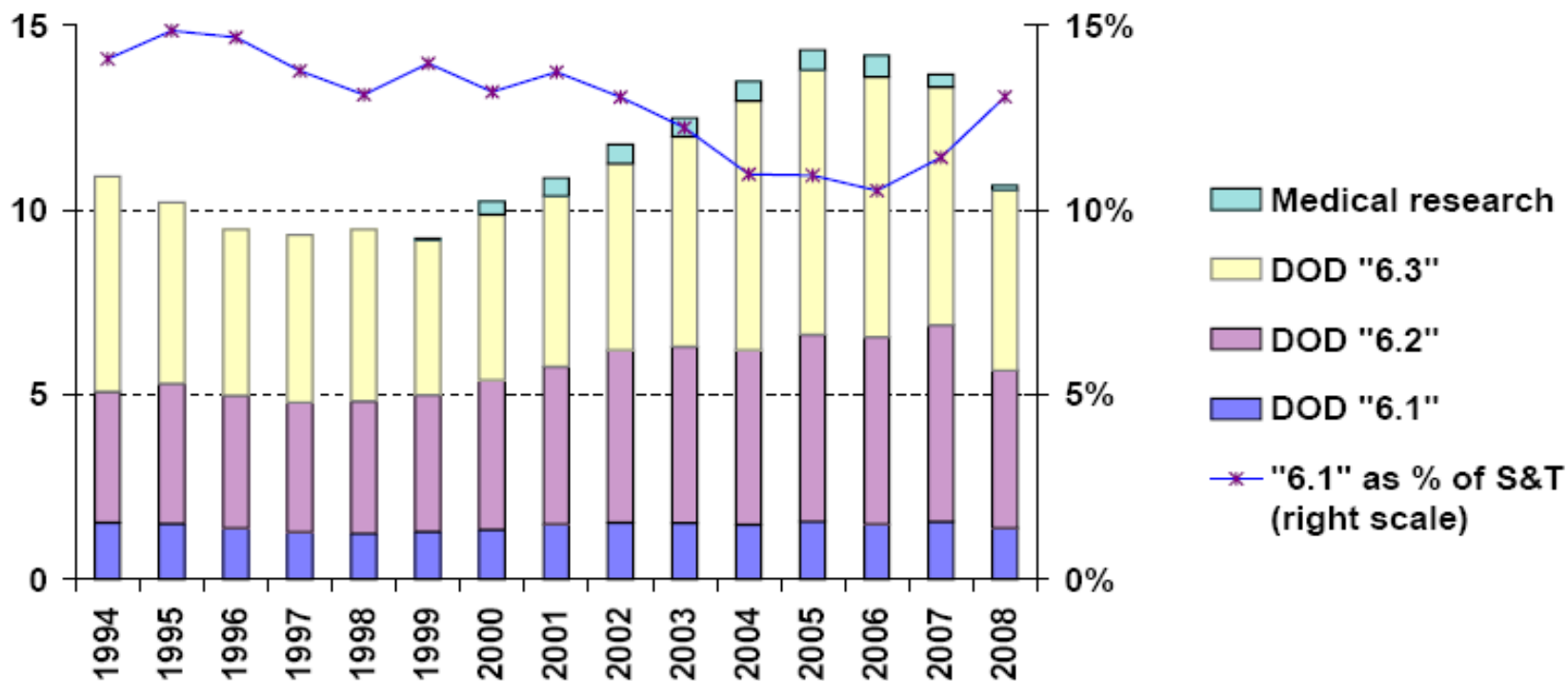
Trends in Basic Research by Agency, FY 1975-2008 \*  
in billions of constant FY 2007 dollars





# DOD S&T Spending

**Trends in DOD "S&T", FY 1994-2008 \***  
in billions of constant FY 2007 dollars





# Moore's Law Continues

## FUTURE TECH

### 5-TERABYTE HARD DRIVES

AROUND THE year 2013, the gigabyte will become passé, thanks to a team of researchers at Toshiba and Tohoku University. By then, their recently developed hard-drive technology should lead to 5TB desktop drives and 1TB 2.5-inch notebook drives. Called Nanocontact Magnetic Resistance (NC-MR), the technology greatly boosts a drive head's ability to detect tiny changes in magnetic fields. Down the road, NC-MR should let manufacturers increase storage density from the current 178.8 gigabits per square inch all the way up to 1 terabit per square inch. Heat-Assisted Magnetic Recording (HAMR), being developed by Seagate and others, should eventually push storage density even higher—perhaps to 50 terabits per square inch by 2019.

### 45nm Size Comparison

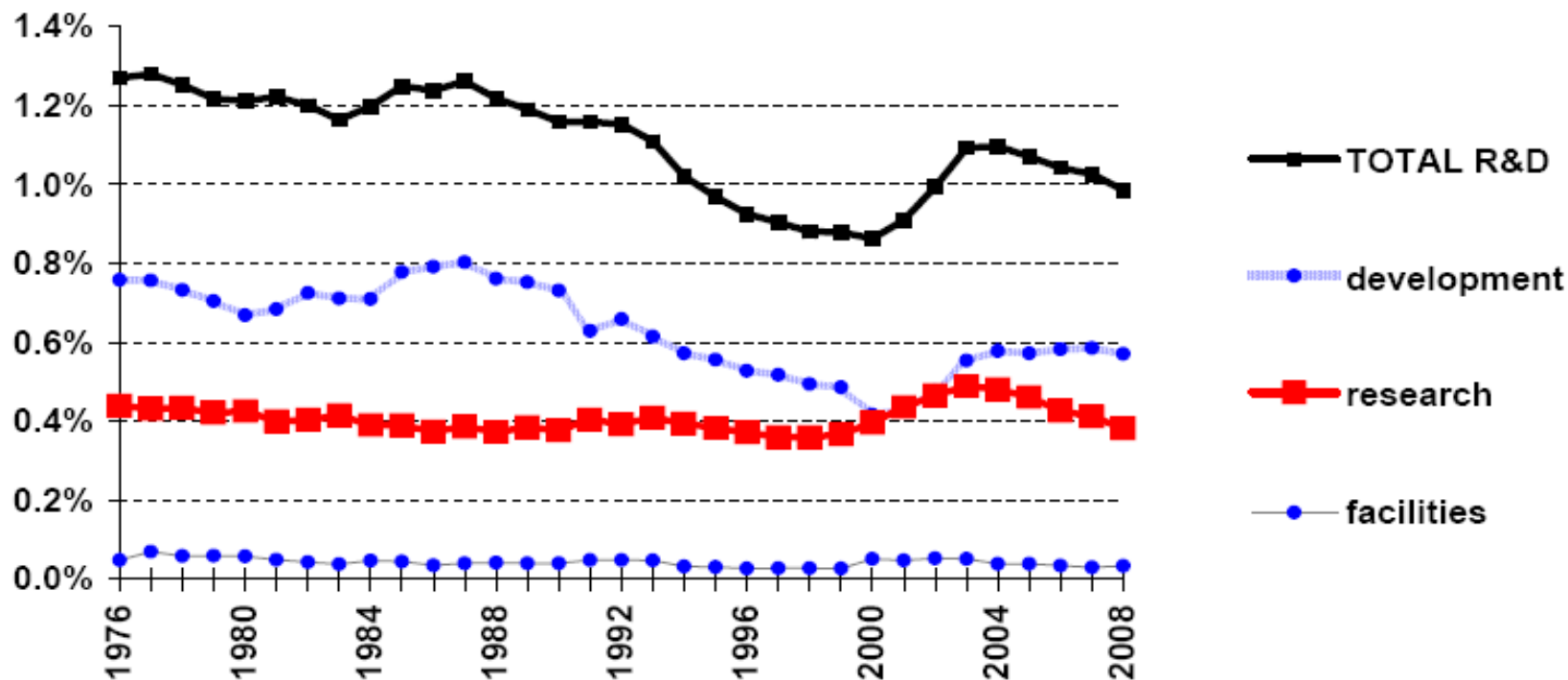
- A nail = 20 million nm
- A human hair = 90,000nm
- Ragweed pollen = 20,000nm
- Bacteria = 2,000nm
- Intel 45nm transistor = 45nm
- Rhinovirus = 20nm
- Silicon atom = 0.24nm





# Federal R&D Spending

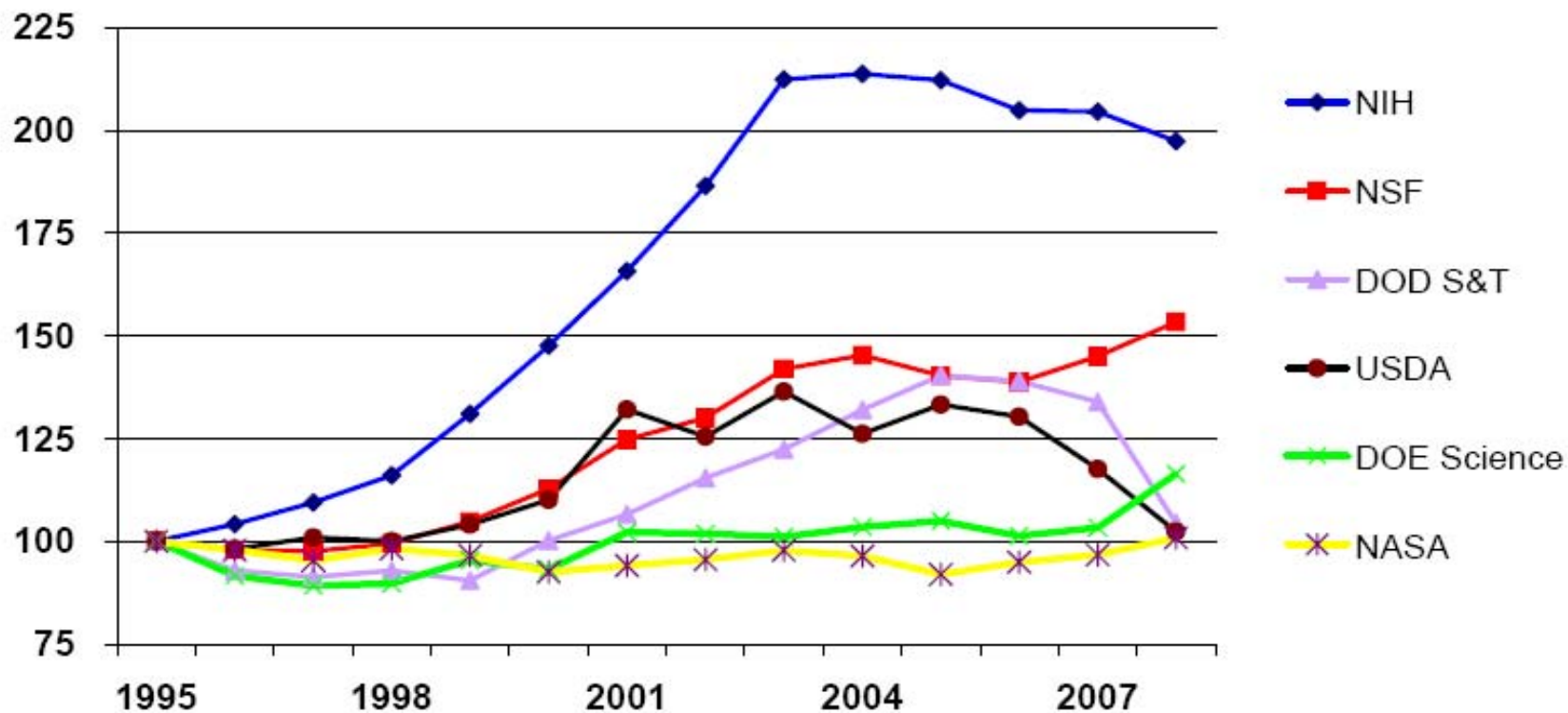
## Trends in Federal R&D as % of GDP, FY 1976-2008





## Trends in Federal R&D, FY 1995-2008\*

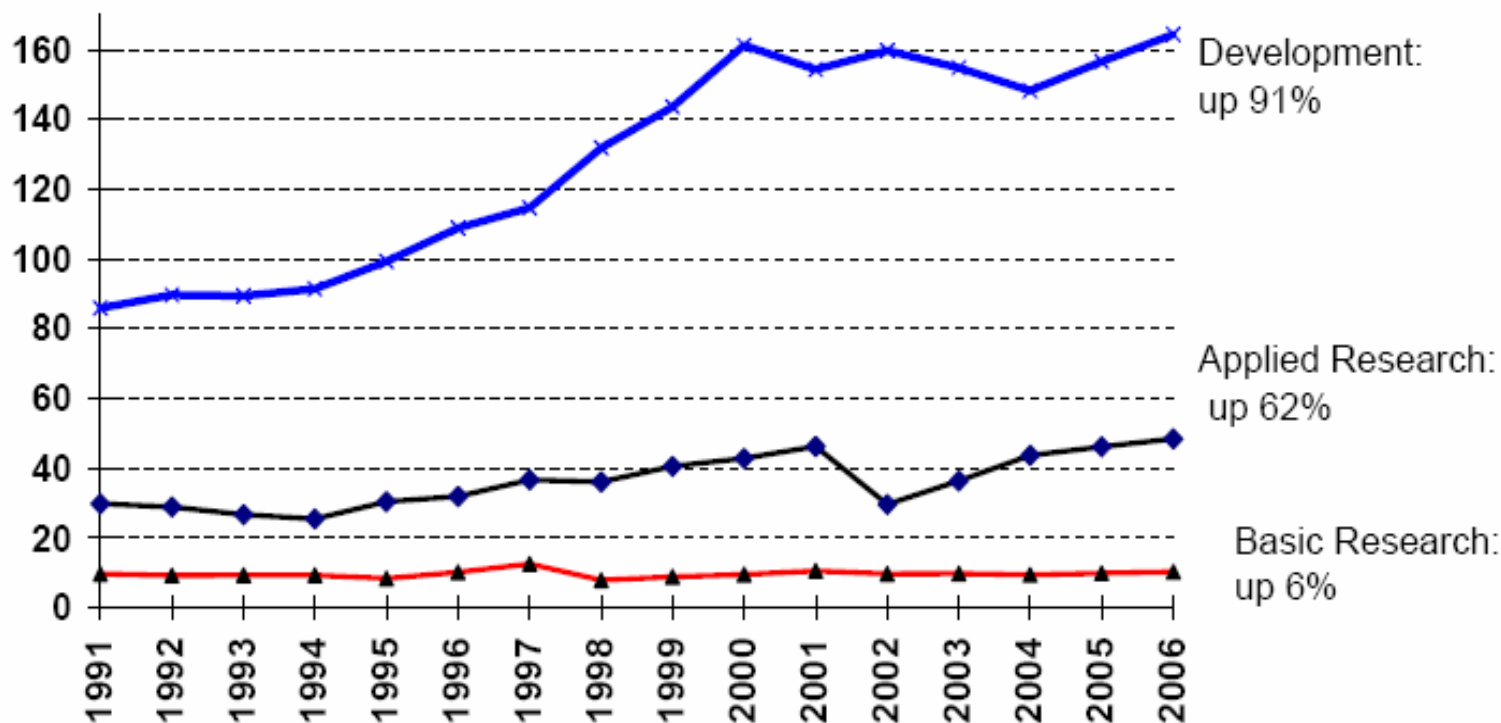
selected agencies in constant dollars, FY 1995=100





# Industry R&D Trends

**Trends in U.S. Industry R&D, 1991-2006**  
Expenditures in billions of constant 2006 dollars



# Strategic Missile R&D Thrusts



- Science & Technology (BA 6.1-6.3)
- **Radiation Hardened Electronics**
- Technology for Sustainment of Strategic Systems
- Position, Navigation & Timing
  
- Thermal Protection Systems Materials & Structures
- Strategic Applications Programs (BA4 Air Force & Navy)
- Guidance
- Re-entry Vehicles
- **Propulsion**
- Command & Control

# The need for technical intelligence . . .



FIGURE 1  
Percentage  
22  
20  
18  
16  
14

Policy Department  
Economic and Scientific Policy

## TECHNOLOGY ASSESSMENT ON CONVERGING TECHNOLOGIES

(IP/A/STOA/SC/2005-183)

06-6

PE 375.882

manyworlds®

### Converging Technologies for Improving Human Performance

Neurotechnology, Biotechnology,  
Information Technology and Cognitive Science  
Applications to Human Performance



Terry C. Pierce

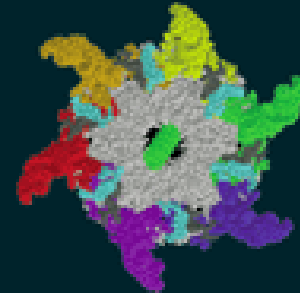
WARFIGHTING  
AND DISRUPTIVE  
TECHNOLOGIES  
Disrupting Innovation

### RISING ABOVE THE GATHERING

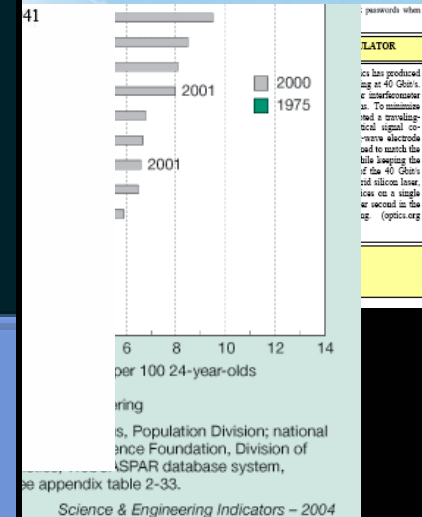
#### MANAGING NANO-BIO-INFO-COGNO INNOVATIONS

#### CONVERGING TECHNOLOGIES IN SOCIETY

WILLIAM SAUNDERS, BARBARA BRIDGE AND MARGARET C. FOX (Eds.)



Springer



CLAYTON  
National Best

# THE INNOVATION DILEMMA

The Revolutionary Book that Will  
Change the Way You Do Business

# The Direction of Technical Intelligence



- **Other than WMD and terrorism, we see little strategic threat to US from today's forces, but:**
  - Are we effectively projecting future foreign technology, capabilities, threats & emerging applications
- **Possible threats to continued US military advantage are largely technology based, and rate of change of technology is increasing**
- **US maintains capability advantage unless:**
  - New technology from adversary (e.g. stealth, PGM, NVDs)
  - Disruptive Technologies (radar, satellites, anti-satellite technologies)
- **Therefore, must enhance technology intelligence to minimize surprise from**
  - New technology from adversary
  - Technology/tactics that can mitigate our capability advantage

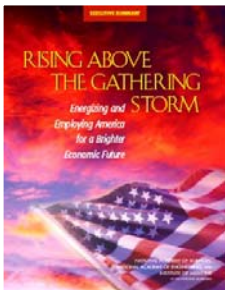


# Future Tech-Intel Motivation

“Move away from Lists of Lists”



- We need to understand global technology developments, evaluating their potential impact on national security
- Global development is so prolific that is difficult to keep up, much less address impact
- Limited funding, limited analysts, limited time prevent us from looking at everything
- Multiple analyses and lists of emerging tech exist, but most do not address impact to DoD or national security; those that do are typically generated by very small group with focused agendas
- Our concern remains “are we missing something” and “how do we better identify & track trends” because . . .



***To avoid technology surprise we are moving to plan for an uncertain future, recognizing the global collaborative landscape by forecast future emerging technology & disruptive applications***



# Radiation Hardening Applications Program (RHAP)



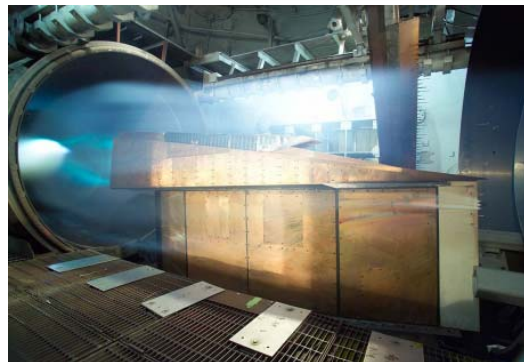
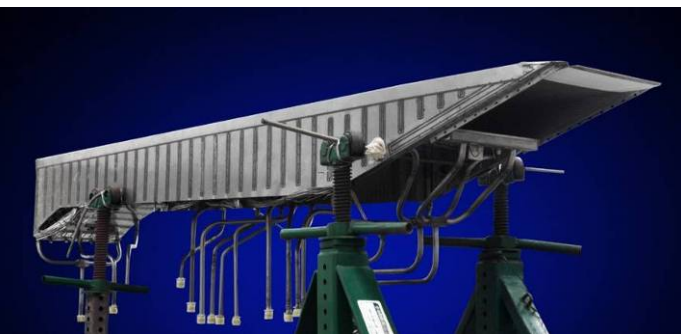
## Objectives

- Develop a tool to model strategic system radiation effects
  - EMP missile plume coupling
  - Electrical parasitics noise coupling
  - Multi-wire cable SGEMP
- Develop a hardened boundary scan technology for mixed-signal integrated circuit application to improve testability

## Payoffs

- Improve the understanding of system survivability
- Improve the quality of radiation testing
- Cost savings to the program by reducing time in isolating failures
- Reduce assembly reworks by detecting / isolating analog faults
- Capture unique skills in RAD Hard system design

# Air Force Hypersonic X-51 Scramjet Engine Demo (SED)



## Description

## Benefits to the War Fighter

- Flight Demo HyTech HC Scramjet Engine
- Fixed geometry scramjet, 12 min durability
- Waverider airframe w/ ATACMS booster
- Proves scramjet performance in flight

- Near Term: Affordable Fast Reaction Standoff Weapon
- Time sensitive targets: rapid response, long range standoff (600 NM in 10 min)
- Deeply buried targets: terminal velocity 1K-4K fps
- 250-500 lb modular payload (penetrator, explosive, or submunition)
- Reduced vulnerability to enemy air defenses
- Far Term: Affordable On-demand Access to Space with Aircraft-like Operations

## Technologies

- Scramjet operating from Mach 4.5 to 7+
- Affordable, high lift-to-drag airframe
- Storable endothermic hydrocarbon JP fuel

# Bottom Line: Warfighter Confidence



*Right Materiel, Right Place,  
Right Time, at the Right Cost -  
All The Time*

# Planned Tasks Beginning in FY08



- **Enhanced Ballistic Reentry Vehicle**
  - Future systems may require current ballistic RVs to fly at extended ranges
  - Identify current RV “weak links” for extended range ballistic flight
  - Design improvements for identified “weak links”
  - Current funding does not support flight testing
- **Advanced Fuze Alternatives**
  - Fielded fuzes utilize 1970’s and 80’s technology
  - Evaluate technologies for future fuze concepts
  - Reduce costs and increase maintainability while maintaining current capability and nuclear hardness



# Shift Happens . . .



We are currently preparing students for jobs and technologies that don't yet exist...in order to solve problems we don't even know are problems yet.

More than 70% of U.S. 4-year-olds have used a computer



There are students in China, Australia, Austria, Bangladesh, and the USA who

collaborate

on projects everyday



# An Uncertain, Changed World



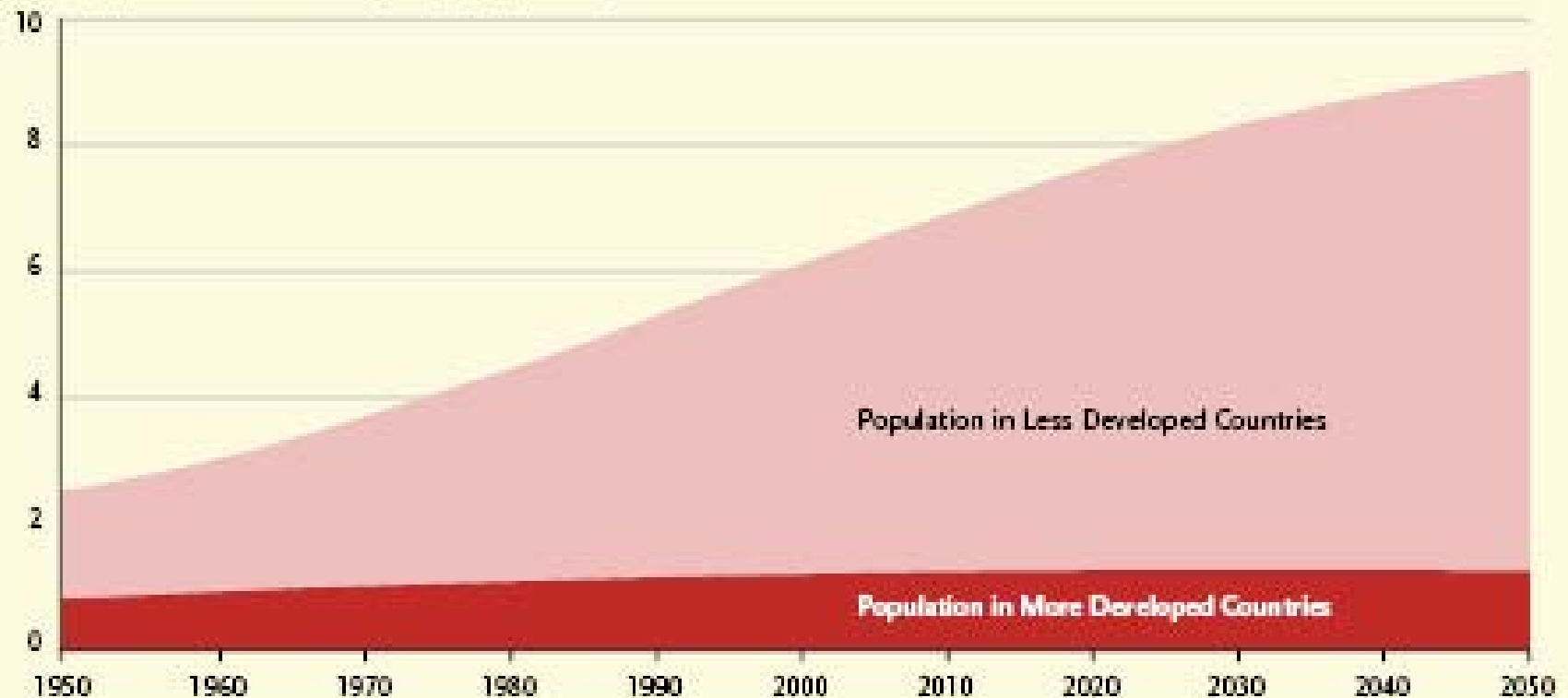
- **Technology Maturation Cycle**
- **Intellectual Capital Center Shifts**
- **Economic Factors Affecting R&D**

# Population Trends



## Global Population Growth Is Driven By Developing Countries.

World population in billions, 1950-2050 (projected)



SOURCE: United Nations, *World Population Prospects: The 2006 Revision* (2007).

# Changing Security Environment

## Four Challenges



### Irregular

- ❑ Unconventional methods adopted by non-state and state actors to counter stronger state opponents
- ❑ (e.g., terrorism, insurgency, civil war, and emerging concepts)

### Catastrophic

- ❑ Acquisition, possession, and use of WMD or methods producing WMD-like effects against vulnerable, high-profile targets by terrorists and rogue states.
- ❑ (e.g., homeland missile attack, proliferation from a state to a non-state actor, devastating WMD attack on ally)

### Traditional

- ❑ Military capabilities and military forces in long-established, well-known forms of military competition and conflict.
- ❑ (e.g., conventional air, sea, land forces, and nuclear forces of established nuclear powers)

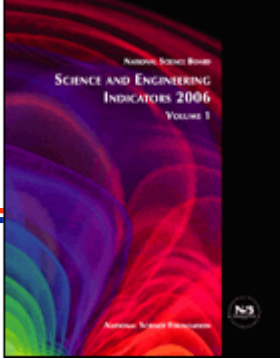
### Disruptive

- ❑ International competitors developing and possessing breakthrough technological capabilities intended to supplant U.S. advantages in particular operational domains.
- ❑ (e.g., sensors, information, bio or cyber war, ultra miniaturization, space, directed-energy, etc)

Higher  
Lower  
LIKELIHOOD

Lower  
Higher  
VULNERABILITY

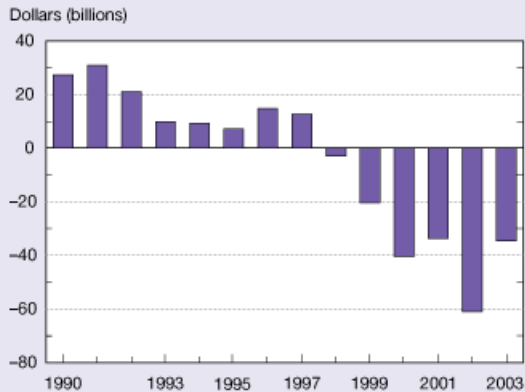
**Uncertainty is the defining characteristic of today's strategic environment**



# More on the Trade Gap



Figure O-12  
U.S. trade balance for five high-technology industries: 1990-2003

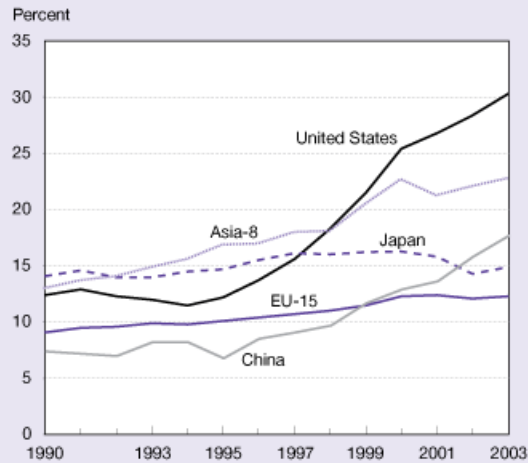


NOTE: Includes aerospace, pharmaceuticals, office and computing equipment, communications equipment, and scientific instruments.

SOURCES: Global Insight, Inc., World Industry Service database (2005). Historical data from United Nations Industrial Development Organization, United Nations System of National Accounts, Organisation for Economic Co-operation and Development; and country sources. See appendix table 6-4.

Science and Engineering Indicators 2006

Figure O-10  
High-technology share of total manufacturing, by country/region: 1990-2003



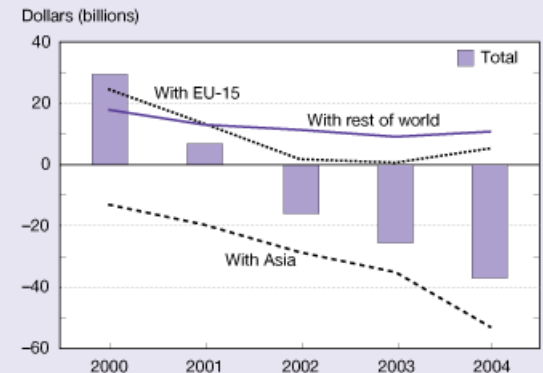
EU = European Union

NOTE: Asia-8 includes South Korea, India, Indonesia, Malaysia, Philippines, Singapore, Taiwan, and Thailand.

SOURCES: Global Insight, Inc., World Industry Service database (2005). Historical data from United Nations Industrial Development Organization, United Nations System of National Accounts, Organisation for Economic Co-operation and Development, and country sources. See appendix table 6-2.

Science and Engineering Indicators 2006

Figure O-13  
U.S. trade balance in high-technology goods: 2000-04

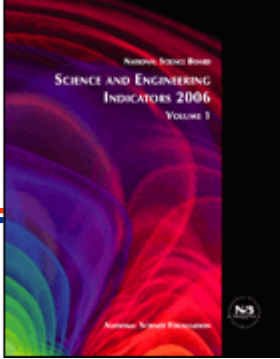


EU = European Union

SOURCE: U.S. Census Bureau, Foreign Trade Division, special tabulations (March 2005). See appendix table 6-6.

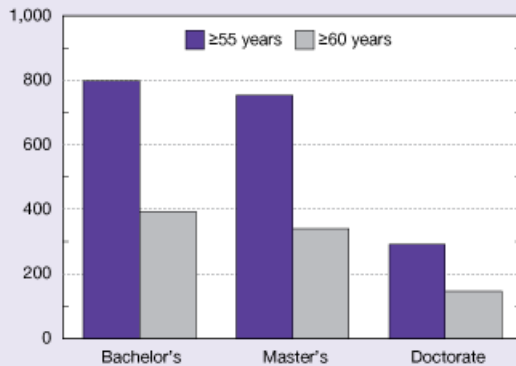
Science and Engineering Indicators 2006

# More on Education



**Figure O-35**  
**Individuals in U.S. S&E labor force nearing retirement age, by degree level: 2003**

Individuals (thousands)



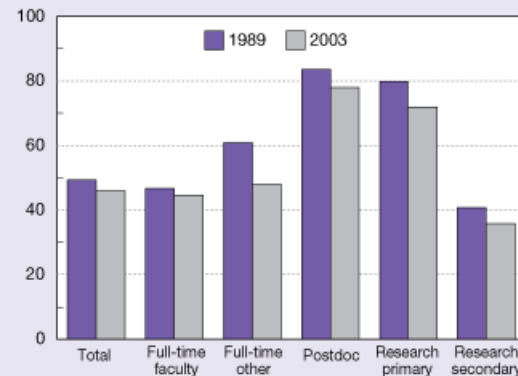
NOTE: Preliminary estimates made in 2005 based on 2003 data

SOURCE: National Science Foundation, Division of Science Resources Statistics, National Survey of College Graduates, preliminary estimates (2005).

*Science and Engineering Indicators 2006*

**Figure O-43**  
**Academic S&E doctorate holders receiving federal support for research: 1989 and 2003**

Percent

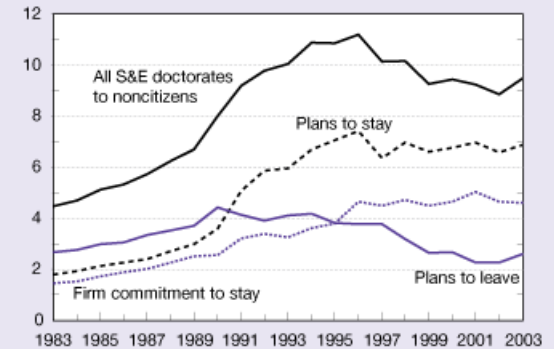


SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients, special tabulations. See appendix table 5-37.

*Science and Engineering Indicators 2006*

**Figure O-31**  
**Foreign student plans to stay in United States after receipt of U.S. S&E doctorate: 1983-2003**

Students (thousands)



SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Earned Doctorates, special tabulations (2005). See appendix table 2-33.

*Science and Engineering Indicators 2006*



# Capabilities to Defeat Terrorist Networks

- Persistent surveillance
- Locate, tag, and track terrorists in denied areas
- Capabilities to fuse intelligence
- Language and cultural awareness
- Non-lethal capabilities
- Joint coordination, processes and systems

*Non-kinetic  
capabilities*

- Urban warfare capabilities
- Prompt global strike
- Riverine warfare capabilities

*Kinetic  
Capabilities*

***All These Capabilities are Joint, Coalition Centric***



# Capabilities to Defend the Homeland In Depth



- Interoperable, joint command and control
- Enhanced air and maritime awareness
- Consequence management
- Broad spectrum medical countermeasures

*Non-kinetic capabilities*

***All These Capabilities are Joint, Coalition Centric***

# Capabilities to Prevent the use of Weapons of Mass Destruction



- Locate, tag, track, and characterize
- Stand off fissile material detection
- Wide area persistent surveillance
- Capabilities to “render safe” WMD
- Non-lethal weapons



*Non-kinetic capabilities*

***All These Capabilities are Joint, Coalition Centric***

# Capabilities to Shape the Choices of Countries at Strategic Crossroads



- Improved language and cultural awareness
- Persistent surveillance (penetrate and loiter)
- Cyberspace shaping / defense
- Secure broadband communications
- Integrated defense against all missiles

*Non-kinetic capabilities*

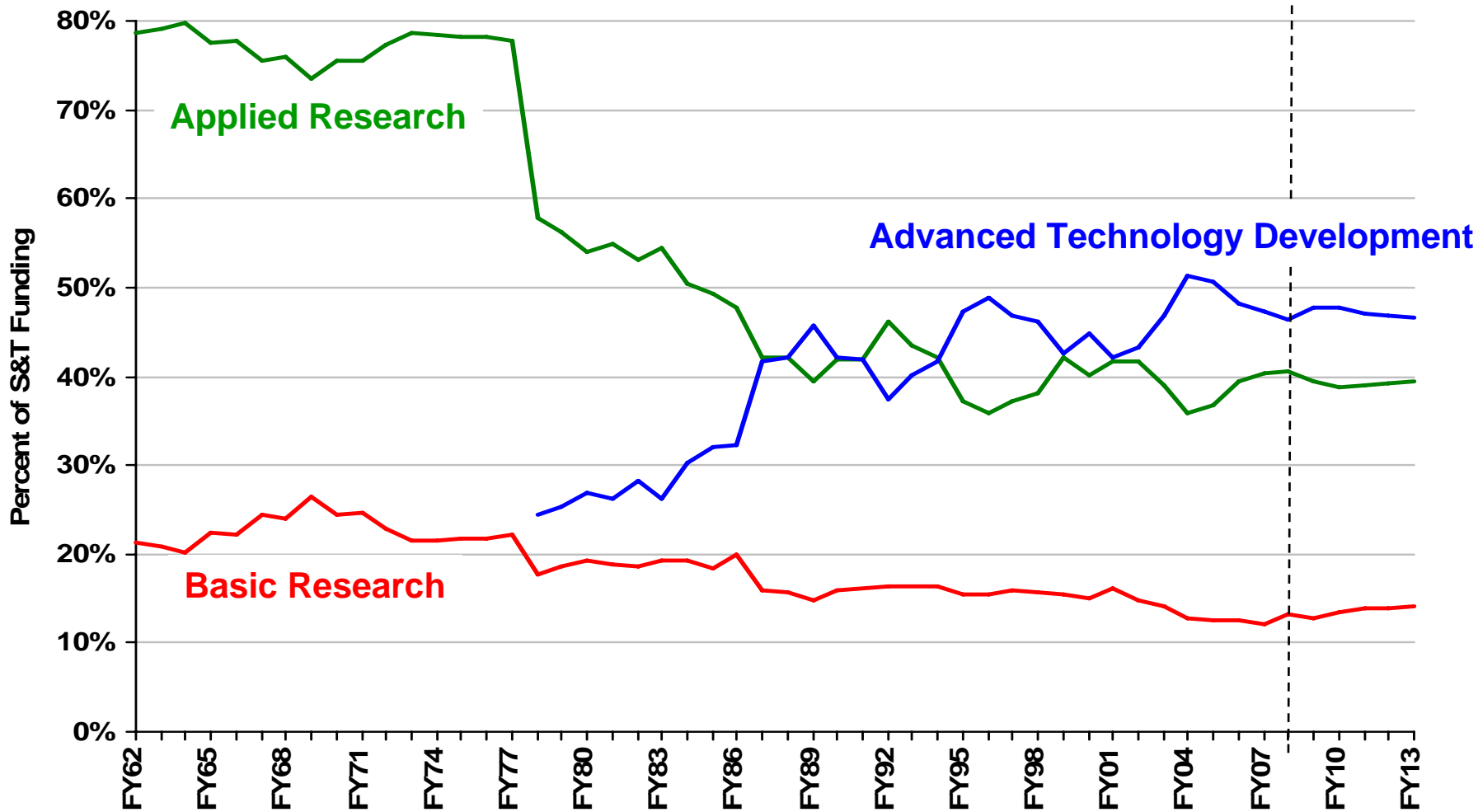
- Prompt, high-value global strike
- Air dominance
- Undersea stealth

*Kinetic*

***Most of These Capabilities are Joint, Coalition Centric***

# DoD S&T Requests

## - by Percent Budget Activity -



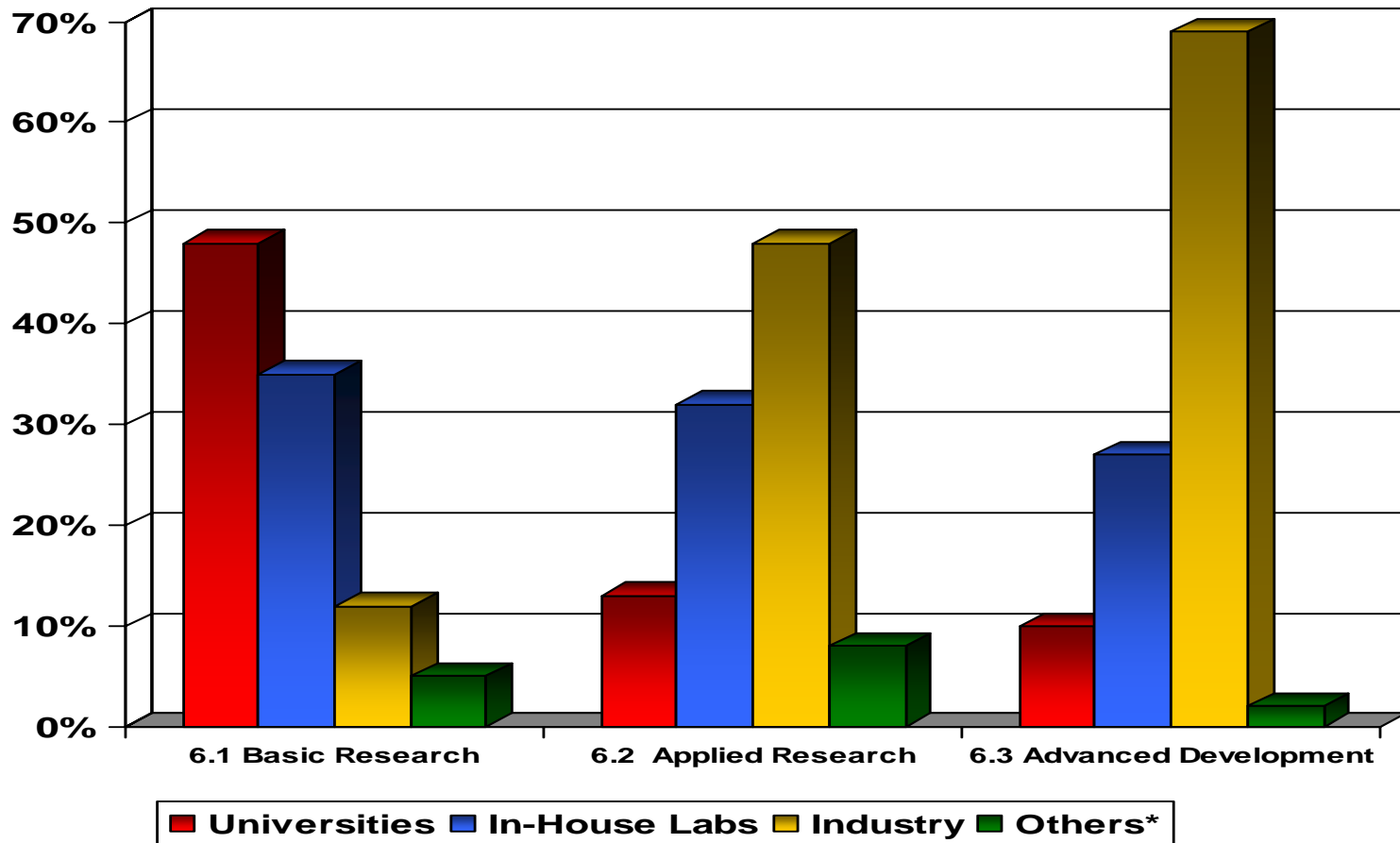
***DoD is increasing emphasis on nearer-term projects***

\*\* Note: Advanced Technology Development funding began in FY78

# Recipients of DoD S&T Funds



DoD S&T Funding Recipients by Percentage  
(FY2006)



\*Includes non-profit institutions, State & local govt., & foreign institutions  
Source: National Science Foundation Report (FY 2006)

# Technology for Sustainment of Strategic Systems (TSSS)



**DoD Science and Technology Program Initiated by USD(AT&L)  
in response to the highest priority needs identified by USSTRATCOM**

**Missile Propulsion**

**Post-Boost Control System Propulsion, Valve Technology & Materials**

**Ageing and Surveillance**

**Missile Flight Sciences**

**Missile Electronics**

**Underwater Launch**

**Guidance Navigation and Control for Strategic and Precision Strike**

**Ordnance Initiation Technology for Strategic Missile Systems**

**Submarine Navigation**

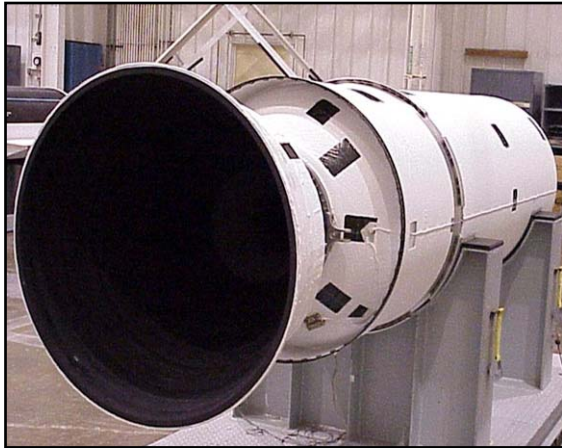
TSSS supports the capability to sustain and upgrade existing Inter-Continental Ballistic Missiles (ICBM) and Fleet Ballistic Missiles (FBM) systems and to engineer, design, and develop new ballistic missile systems. Contributing factors include maintaining system safety, reducing operations and maintenance (O&M) costs, increasing service life of existing systems, and reducing reliance on physical testing of existing strategic systems.



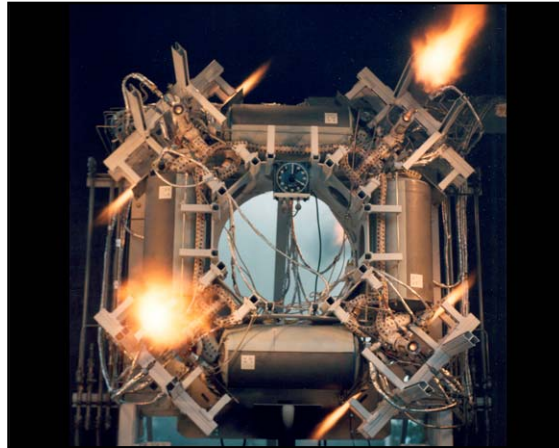
# TSSS Technology Objectives



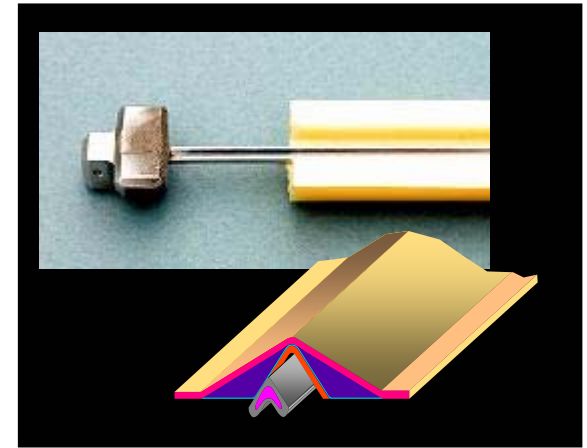
## Missile Propulsion



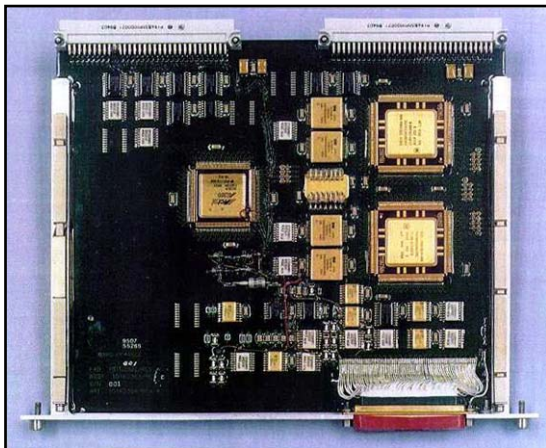
## Post Boost Control



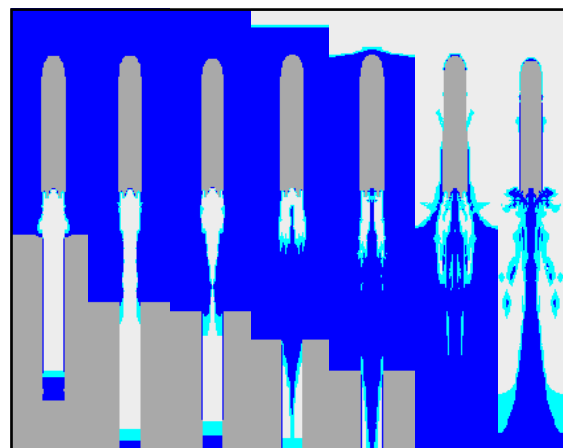
## Ordnance



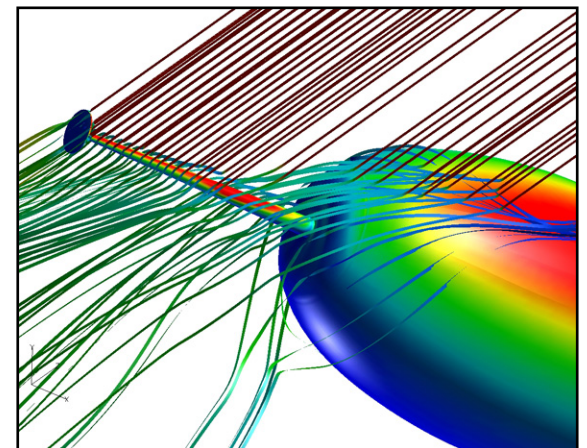
## Missile Electronics



## Underwater Launch



## Flight Sciences & Analysis





# TSSS - Aging and Surveillance

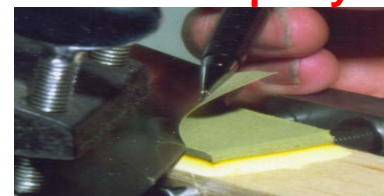
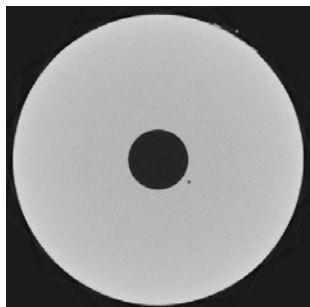
**NDE Data Processing Program**

**Service Life Prediction Technology Program**

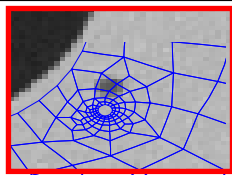
**Chemical/Mechanical Property Assessment**

**Critical Defect Assessment Program**

**CT Flaw Detection**



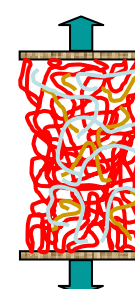
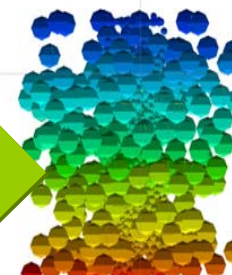
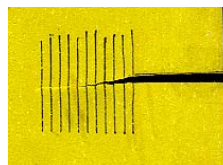
**Polymer Mechanics**



**Automated Flaw Meshing**

**Particle Packing**

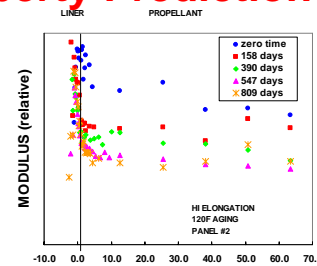
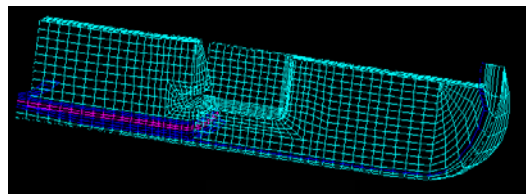
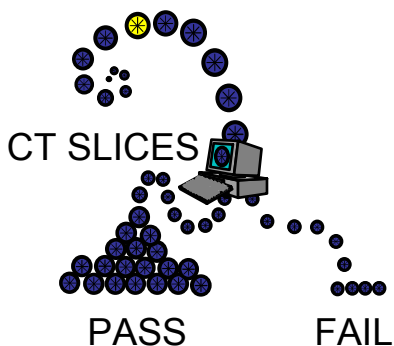
**Automated Fracture Propagation**



**Automated Flaw Evaluation**

**3D Structural/Ballistic Modeling**

**Chemical/Mechanical Property Prediction**



**Service Life Prediction**

# Strategic Propulsion Applications Program (SPAP)



## Objectives

- Demonstrate/validate emerging technologies suitable for ICBM/SLBM
- Maintain critical skills and tools
- Improve predictive aging models/techniques
- Demonstrate Systems Engineering Skills for systems and subsystems integration
- Reduce development/qualification time required to initiate production of alternative components

## Payoffs

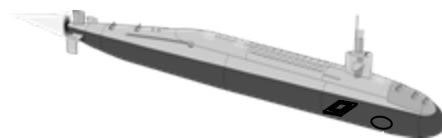
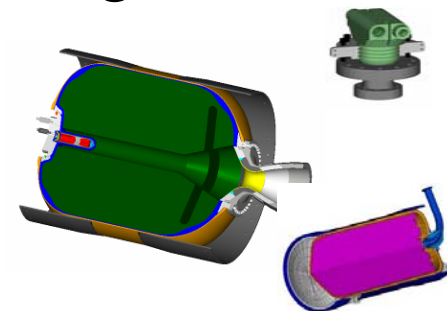
- Viable alternative technologies in support of D5 Life Extension
- Demonstrations of affordable and high performance technologies for boost motor, PBCS and ordnance
- Maintenance of SLBM-unique development and sustainment skills related to high-energy, high-elongation Class 1.1 Propellant
- Elimination of hazardous materials in Ordnance





# Strategic Missile System Technology Efforts (ICBM and SLBM)

- Technology for the Sustainment of Strategic Systems (TSSS)
  - Propulsion (IHDRPT)
    - Missile Boost Propulsion
    - Post Boost Control System Propulsion
    - Aging and Surveillance – Life Prediction, NDE
  - Guidance Navigation and Control
  - Navigation Sonar
  - Ordnance
  - Electronics
  - Systems Engineering Tools



**Emphasizes Technology Sustainment  
(Reduced Cost of Ownership, Increased Performance)**

# Guidance Applications Program (GAP)



## Objectives

- Provide a minimum strategic guidance technology design and development capability
- Transition to a long-term readiness status to support deployed systems
- Focus on modern replacement alternatives to antiquated or obsolete technologies which provide radiation hardened velocity, attitude (gyro) and stellar sensing capabilities with strategic performance

## Payoffs

- Preserves critical design and core development capability
- Allows for orderly replacement of unsupportable technologies
- Applications to alternate missions
- Lower life cycle costs

# QDR Priority Formulation



- **Balanced what the US wants to protect against (Strategic Challenges) and outcomes the US wishes to accomplish (Strategic Outcomes)**
  - **Strategic Challenges**
    - Traditional
    - Irregular Warfare
    - Combating WMD
    - Disruptive
  - **Strategic Outcomes**
    - Defeat Terrorist Networks
    - Defend the Homeland in-Depth
    - Shape Choices of Countries at Strategic Crossroads
    - Prevent the Use of WMD

**QDR In A Banner – A Shift in Emphasis from “Kinetic” to “Non-Kinetic” Systems**

# Technology and the Modern World



*“ We can’t solve problems by using the same kind of thinking we used when we created them”*

*Albert Einstein*

*There is no reason anyone would want a computer in their home*  
*Ken Olson, President, DEC, 1977*

*Everything that can be invented has been invented*  
*Charles Duell, Commissioner US Patent Office, 1899*

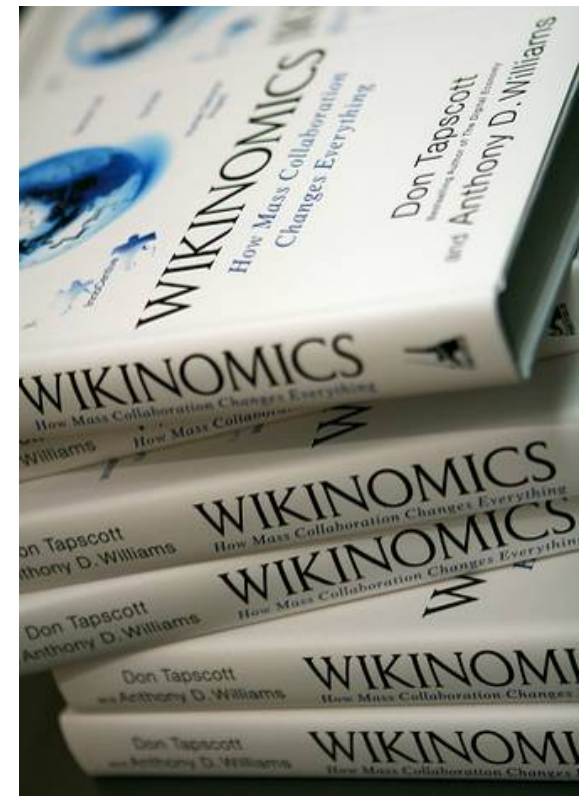
*“I think there is a world market for maybe five computers.”*  
*Thomas Watson, IBM Chairman, 1943*

*“640K ought to be enough for anybody.”*  
*Bill Gates, CEO of Microsoft, 1981*

*If you don’t know where you are going, you might end up someplace else*  
*Yogi Berra*

*These changes, among others, are ushering us toward a world where knowledge, power and productive capability will be more dispersed than at any time in our history – a world where value creation will be fast, fluid, and persistently disruptive.*

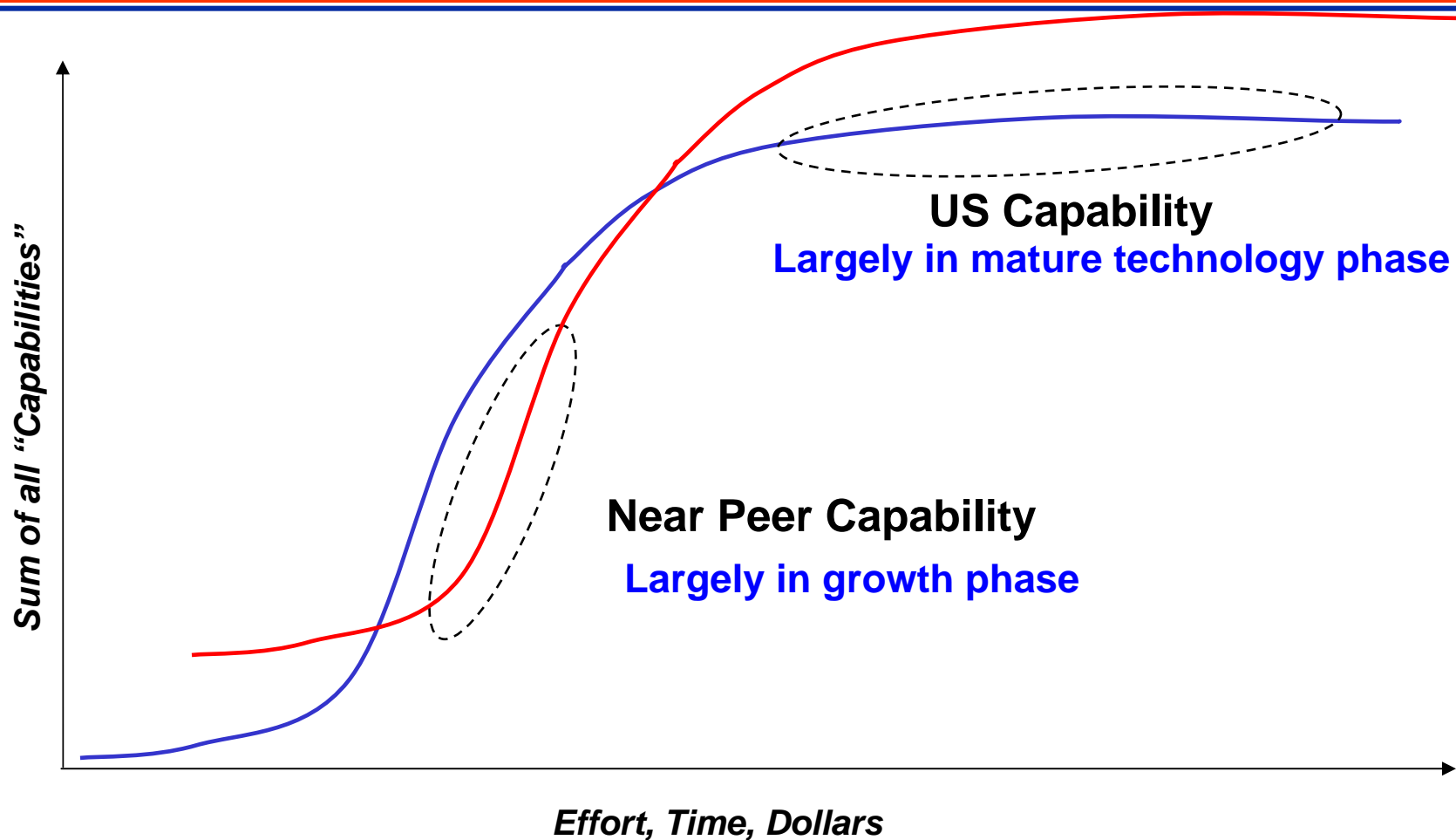
*Don Tapscott and Anthony Williams, Wikinomics*



***“The conjunction of 21st century internet speed and 12th century fanaticism has turned our world into a tinderbox” -- Tina Brown ,Washington Post, 19 May 2005***



# What Can Happen if We Hold onto Mature Technology Too Long

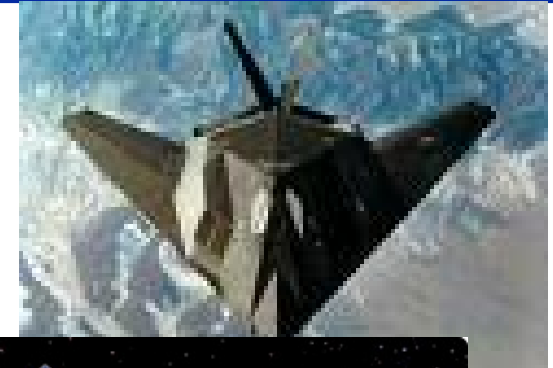


**ASSERTION: Without changing the US investment profile, US could spend more yet have capability gap close**

# Technological “Shock” of Desert Storm



- Based on dominant US capabilities “in the commons”
  - Low observability
  - Space-based capabilities
    - Comms
    - GPS
  - Night Vision
  - Info Ops
  - Missile Defense

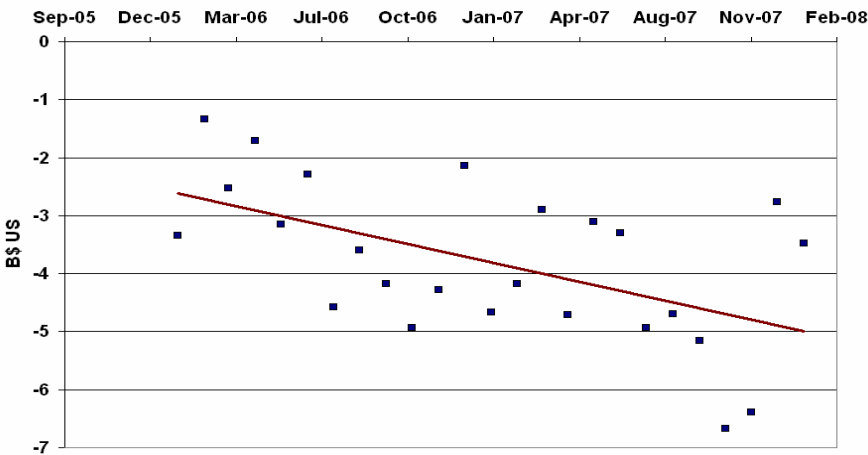


# Mega-Trends Economy



## The US Trade Balance

### US Advanced Technology Products Trade Balance



Source: The Economist, Jan 24, 2008

- US Merchandise Trade Balance for 12 Months ending December 2007: 815.6B\$
- Largest Advancing Technology deficits in these areas (2007YTD)
  - Information technology -7.9B
  - Life Sciences -1.7B
  - Opto-electronics -1.5B
  - Advanced Materials -0.8B
- Losses Outpaced gains in:
  - Aerospace +4.0B
  - Electronics +1.9B
  - Biotechnology +0.3B

Source: The Economist, March. 8, 2008

Source (FT900: U.S. International Trade in Goods and Services, Released January 2008, US Census Bureau), Data not Seasonally Adjusted  
[http://www.census.gov/foreign-trade/Press-Release/current\\_press\\_release/press.html](http://www.census.gov/foreign-trade/Press-Release/current_press_release/press.html)

# Disruptive Technologies

*Frequently Take a Forcing Function*



Technology	Approximate Date Of First Lab Demo		Approximate Date of First Military Apps	Technology
Radio	1901	<b><i>World War I</i></b>	1914	Electronics
Airplane	1903		1916	Internal Comb
Vacuum Tube	1906		1915	Electronics
Mechanized Tank	1916		1916	Engine/Metals
Liquid-Fueled Rockets	1922	<b><i>World War II</i></b>	1944	Chem/Metals
Radar	1925		1939	Electronics
Gas Turbine	1935		1944	Metals
Digital Computer	1943		1945	Electronics
Ballistic Missile	1944		1945	Chem/Guide
Nuclear Weapons	1945		1945	Physics
Transistor	1948	<b><i>Cold War</i></b>	1957	Electronics
Inertial Navigation	1950		1955	Electronics
Nuclear Propulsion	1950		1954	Physics
Artificial Earth Satellites	1957		1960	Computers
Integrated Circuit	1960		1970	Electronics
Laser	1961		1967	Photonics
Precision Weapons	1965		1967	Electronics

***One function of S&T – Keep the pantry stocked***

# Disruptive Technology

## A Case Study



- **Digital Equipment Corporation:**
  - 1957 -- Founded
  - 1960 -- Programmable Data Processor 1 (PDP-1) Introduced
    - World's First Minicomputer
    - 10% cost of Mainframe Computers
  - 1965 -- PDP-8 Rolled-out; World's #1 Selling Computer
  - 1970's – 1990—DEC #2 International Computer Sales
  - 1990 -- 120,000 Employees; Revenues \$14B
  - 1998 – Company Bought by Compaq—and Dead



**“It was the sudden demise of DEC that first drew my attention. How could a company, once described by Business Week as a freight train that obliterates all competitors, fall so precipitously?” Interview with Clayton Christensen, Harvard Business School on Line, April 1999**



(UNCLASSIFIED)

# Central Technical Support Facility (CTSF)

U.S. Army Materiel Command



**Terry Edwards**  
**Chief Information Officer (CIO)**  
**Chief Technology Officer (CTO)**  
**HQ Army Materiel Command, CIO-G6**  
**Ft. Belvoir, VA, 22060**

**April 15, 2008**



"Need to be faster, more agile,  
less bureaucratic - Need to  
fight this every day"

(UNCLASSIFIED)





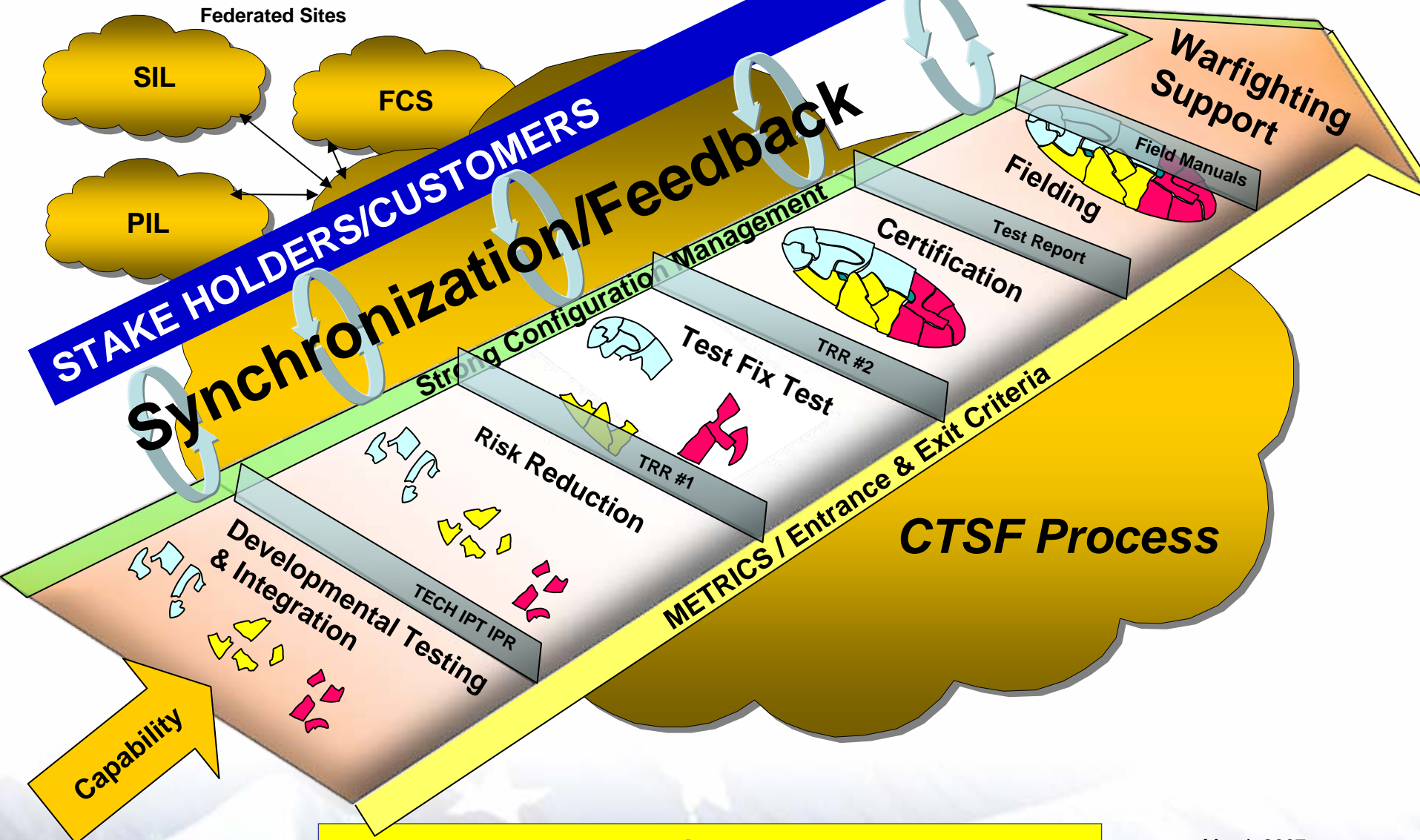
# ***CTSF Mission***

**The CTSF provides a unique, innovative, and scalable environment, with skilled and dedicated personnel, using qualified synergistic processes in order to support the DoD's net enabled strategic vision by executing configuration management, systems engineering support, and interoperability certification testing for Army and Joint C4I providers.**

***Promote a Lean Culture in All We Do.***



# SOS Focused CTSF Process



**Promote a Lean Culture in All We Do.**

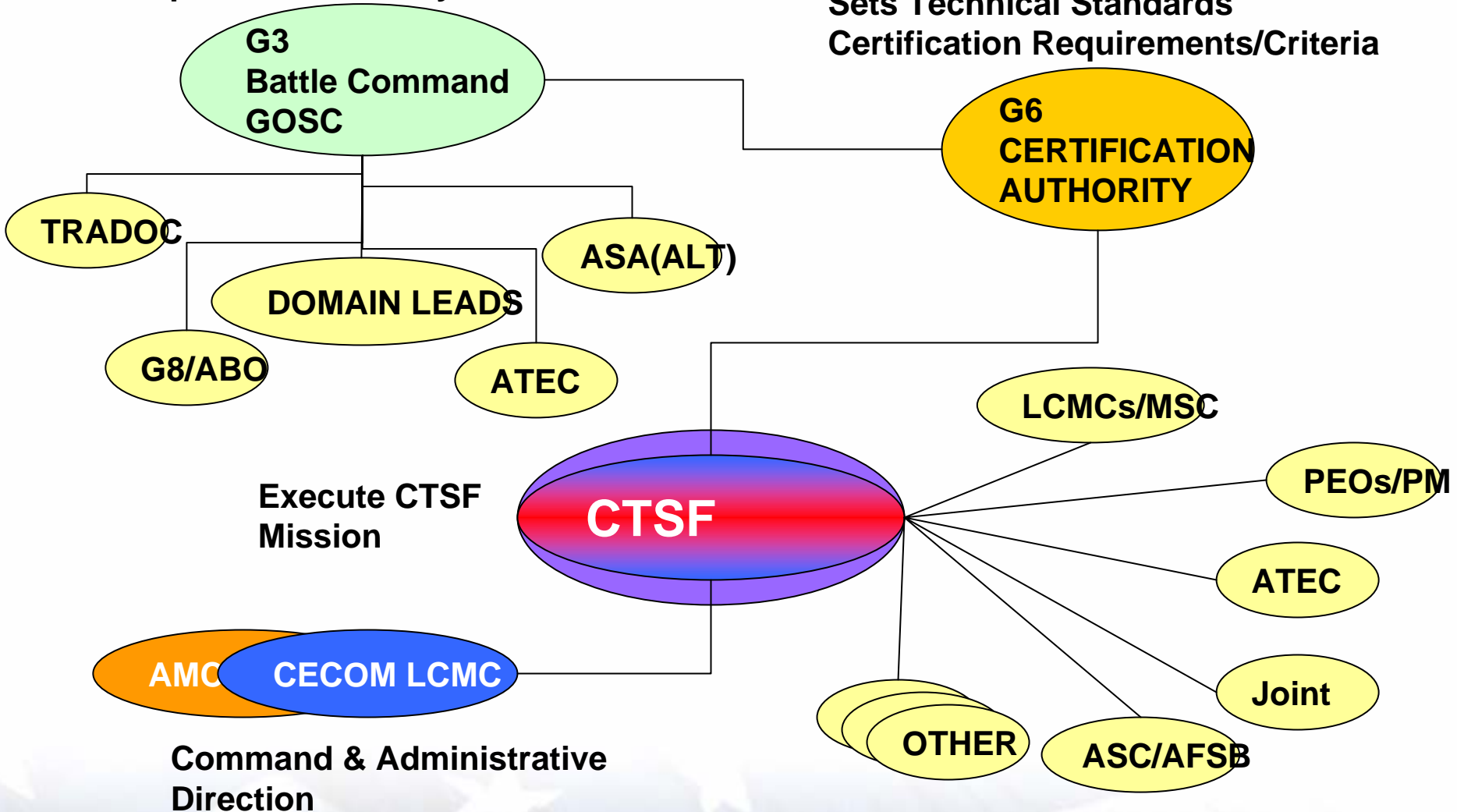


# Governance Structure



Sets Operational Priority & Direction

Sets Technical Standards  
Certification Requirements/Criteria



Execute CTSF Mission  
Command & Administrative Direction

**Promote a Lean Culture in All We Do.**



# CTSF The Stats...

- **250,000 sq ft Facility:** 41,305 square feet dedicated to integration, testing and certification
- **Fully Wired Infrastructure:** with tactically representative routers, switches, hubs, fiber, 10Base2, 10BaseT and video to provide flexibility for test and exercise reconfiguration.
- **Instrumented Facility** for data collection and reduction equipment to support a vehicle platform to Corps level architecture, fully instrumented with SIM/STIM and data collection/reduction capability.
- **Configuration Control Capability** to support integration and fielding of Software
- **High Speed Communication Links** to facilities at Ft. Hood and externally to sister service sites, battle labs and contractor facilities; DREN access.
- **Established Processes** to support integration, testing, configuration management and training “Go to War” software.

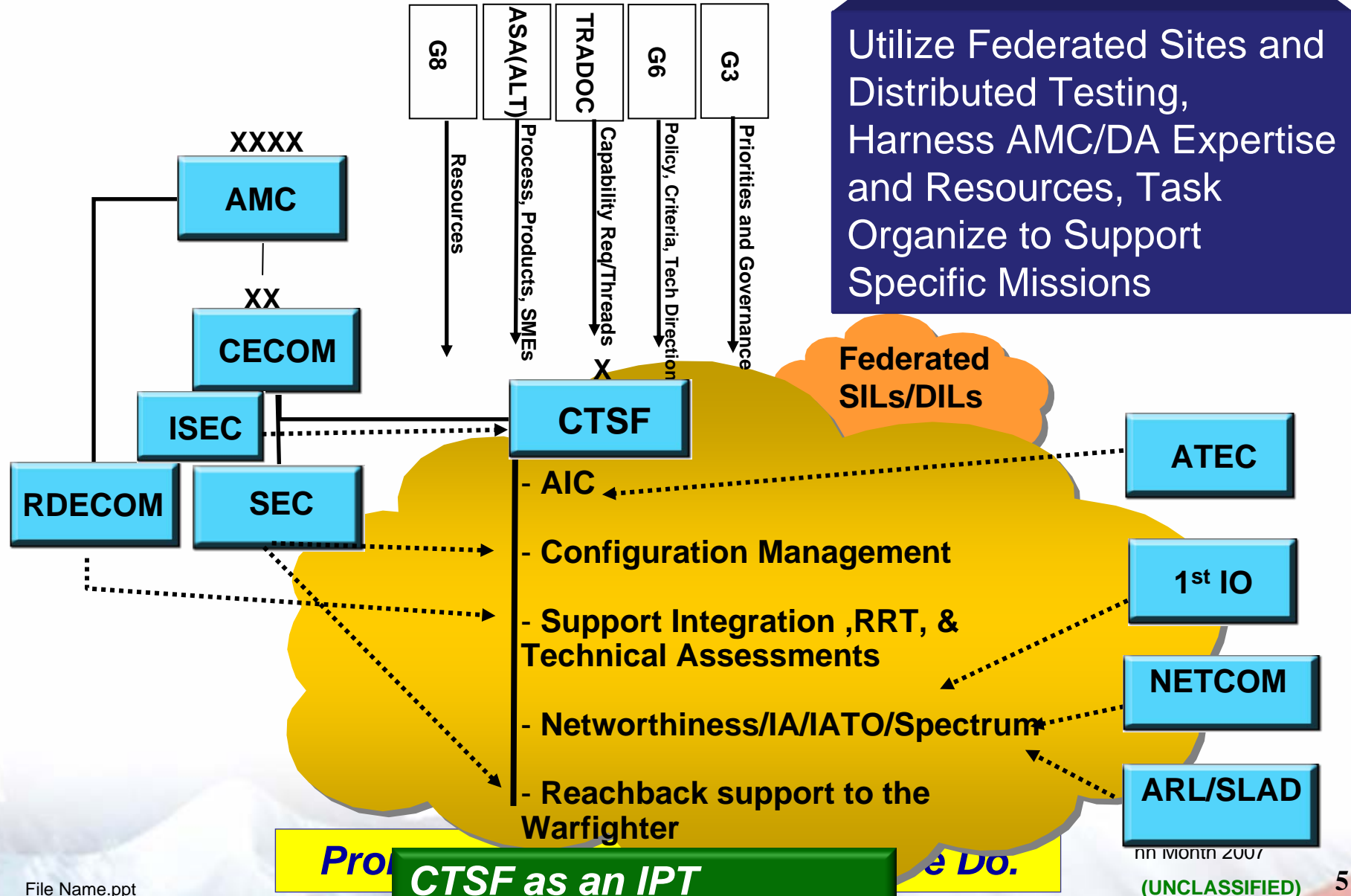


**Over 900 government civilians, and contractors form the Team of the CTSF to support, maintain & sustain the Army’s digital systems deployed world- wide.**

***Promote a Lean Culture in All We Do.***



# Leveraging The Army "Task Organize for Success"



Utilize Federated Sites and Distributed Testing, Harness AMC/DA Expertise and Resources, Task Organize to Support Specific Missions



# Partnering is Key



Promote a Lean Culture in All we Do.





# Key to CTSF Success

- **Unity of Command - no barriers, organizations coming together to get the job done on behalf of the Warfighter, synchronization of efforts**
- **CTSF missions serve many customers (i.e. G3, G6, ASA(ALT), G8, ATEC, Joint and Coalition Warfighters)**
- **Synergy → Focused on Warfighter Needs**
- **In depth technical understanding of systems**
- **Knowledge of warfighter needs and constraints**
- **A set of disciplined processes for Testing, CM, and System Engineering**
- **Formal/Informal Partnerships (PMs, Warfighter, Test Community, Joint Community, PdM Netops)**
- **Adaptable and Responsive**
- **Honest Broker**
- **Well known across Army → DoD**

***Promote a Lean Culture in All We Do.***



SERVING OUR ARMY AT WAR

# *Questions?*

*CTSF*

RELEVANT AND RESPONSIVE

***Promote a Lean Culture in All We Do.***



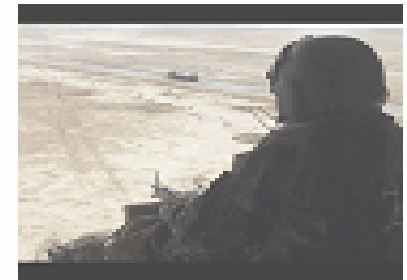
# *Back-Up*

***Promote a Lean Culture in All We Do.***



# CTSF Vision

To become a customer valued organization ensuring the best net-centric C4I capabilities are available to US Army, Joint and Coalition Warfighters.



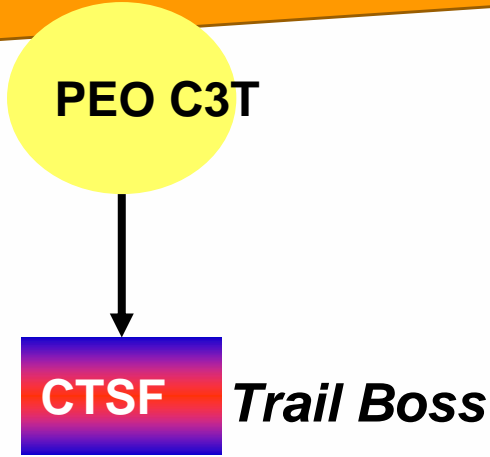
**Bottom Line: CTSF is the Interoperability “Check Ride” for Current & Future Army Programs**

*Promote a Lean Culture in All We Do.*



# CTSF Organizational Evolution

## Integration

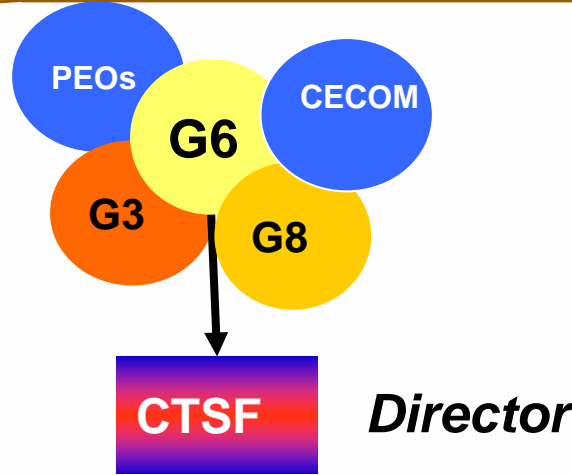


1 Digital Div  
 Proof of Principal  
 SW Functionality

11 Systems

ABCS Integration

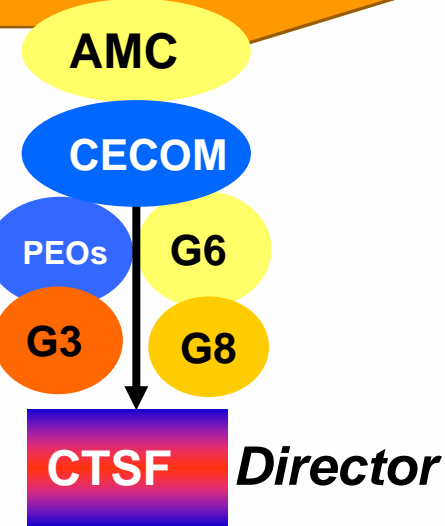
## Integration and Certification



10 Digital Divs  
 40+ BCTs  
 C2 Interoperability

SWB 1 - 75+ Systems

SoS Interoperability



Future Digital Force  
 Net Centric  
 Interoperability

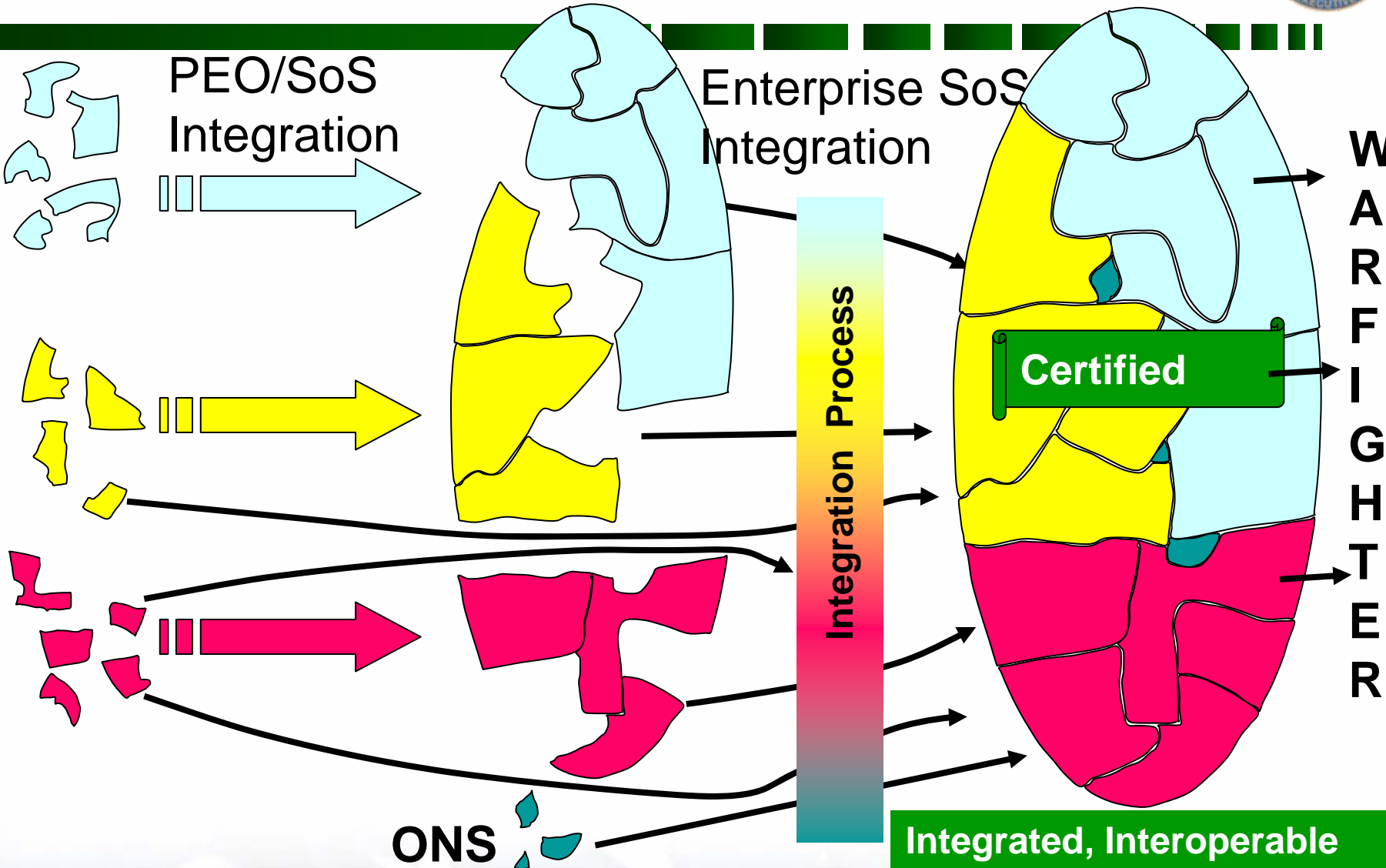
Systems... AIC  
 T...  
**JOINT**  
 Army  
 Interoperability

**Promote a Lean Culture in All We Do.**



# CTSF SOS Focus

Programs of Record (PORs)

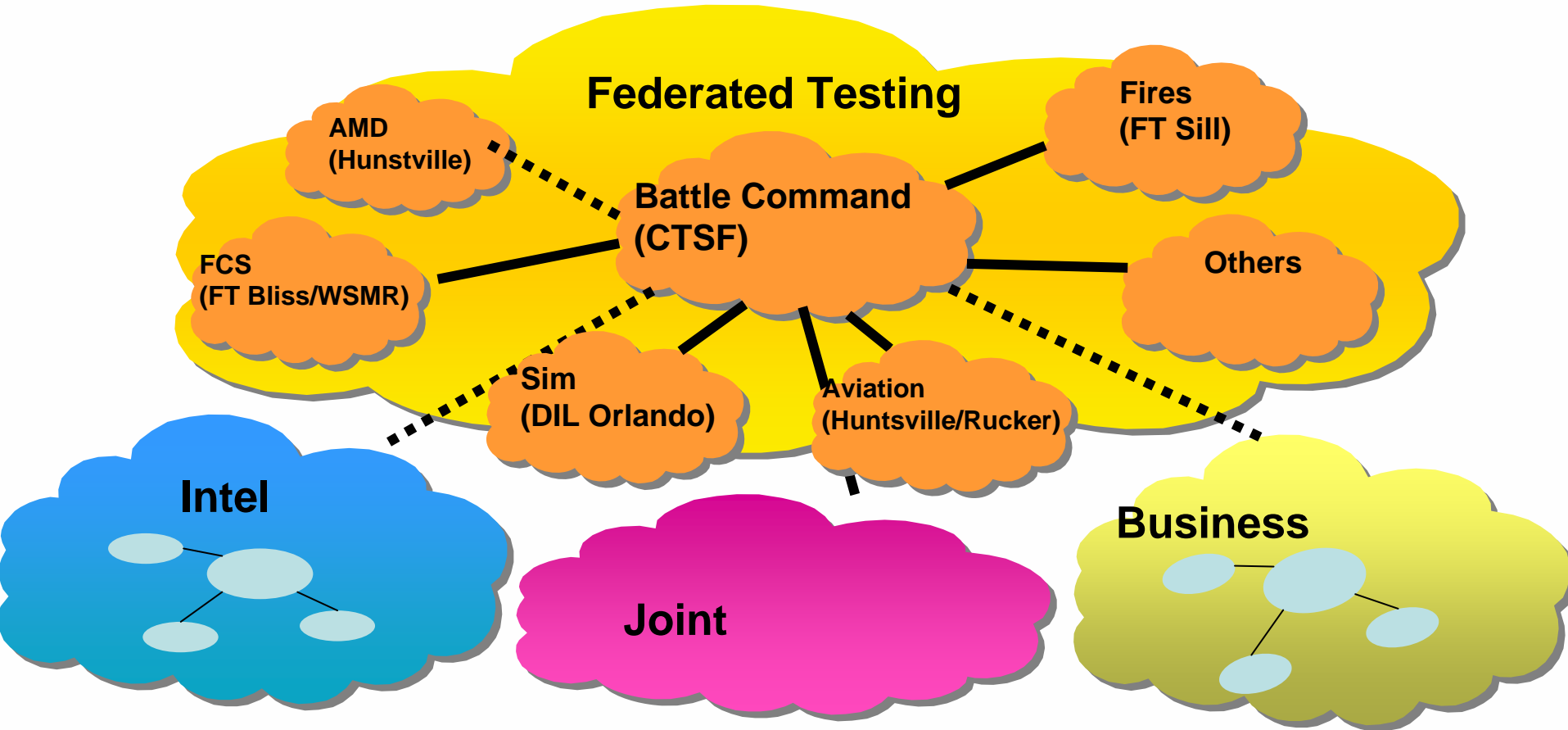


**Promote a Lean Culture in All**





# FANS Concept of Execution

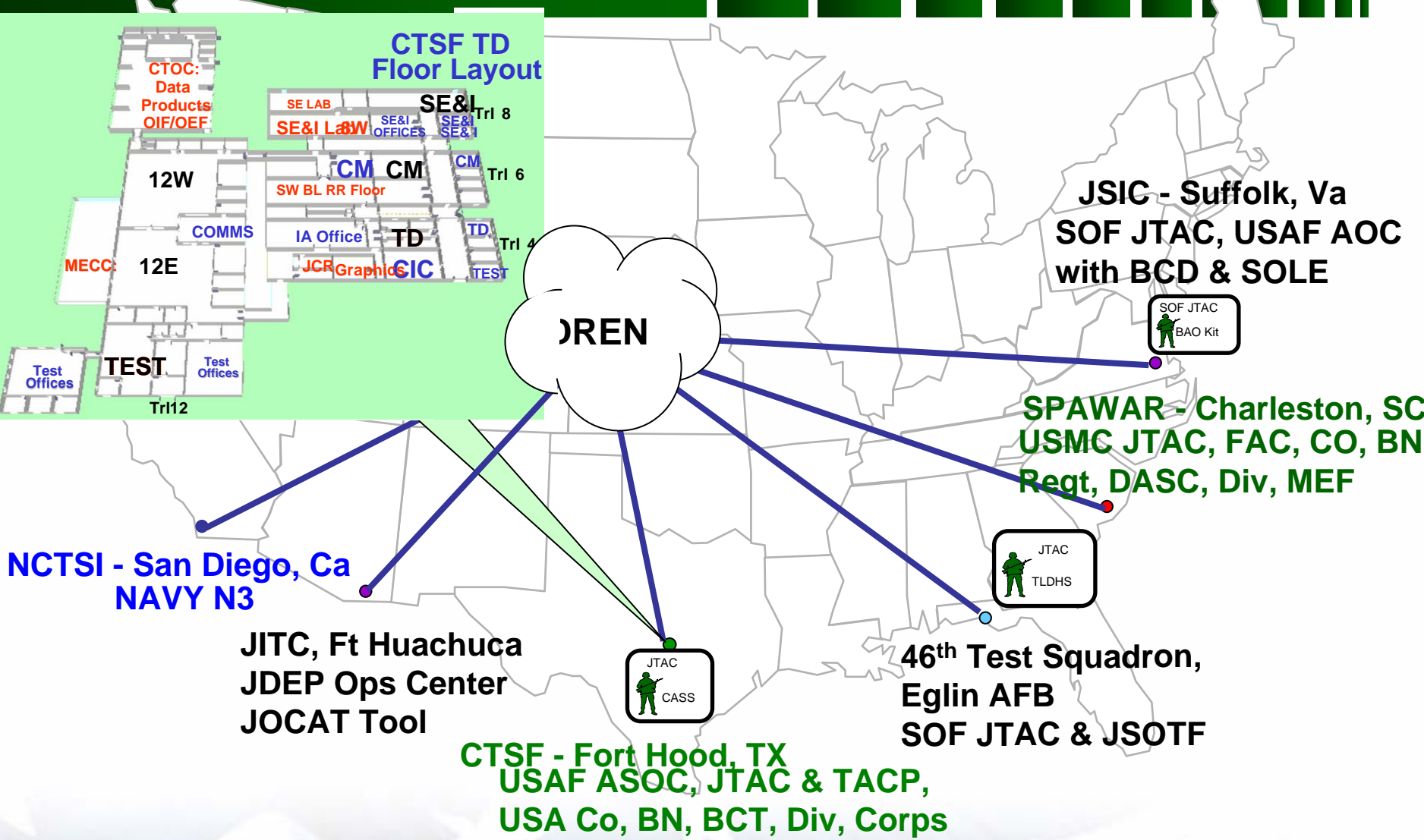


## Federated Army Net-Centric Sites

*Promote a Lean Culture in All We Do.*



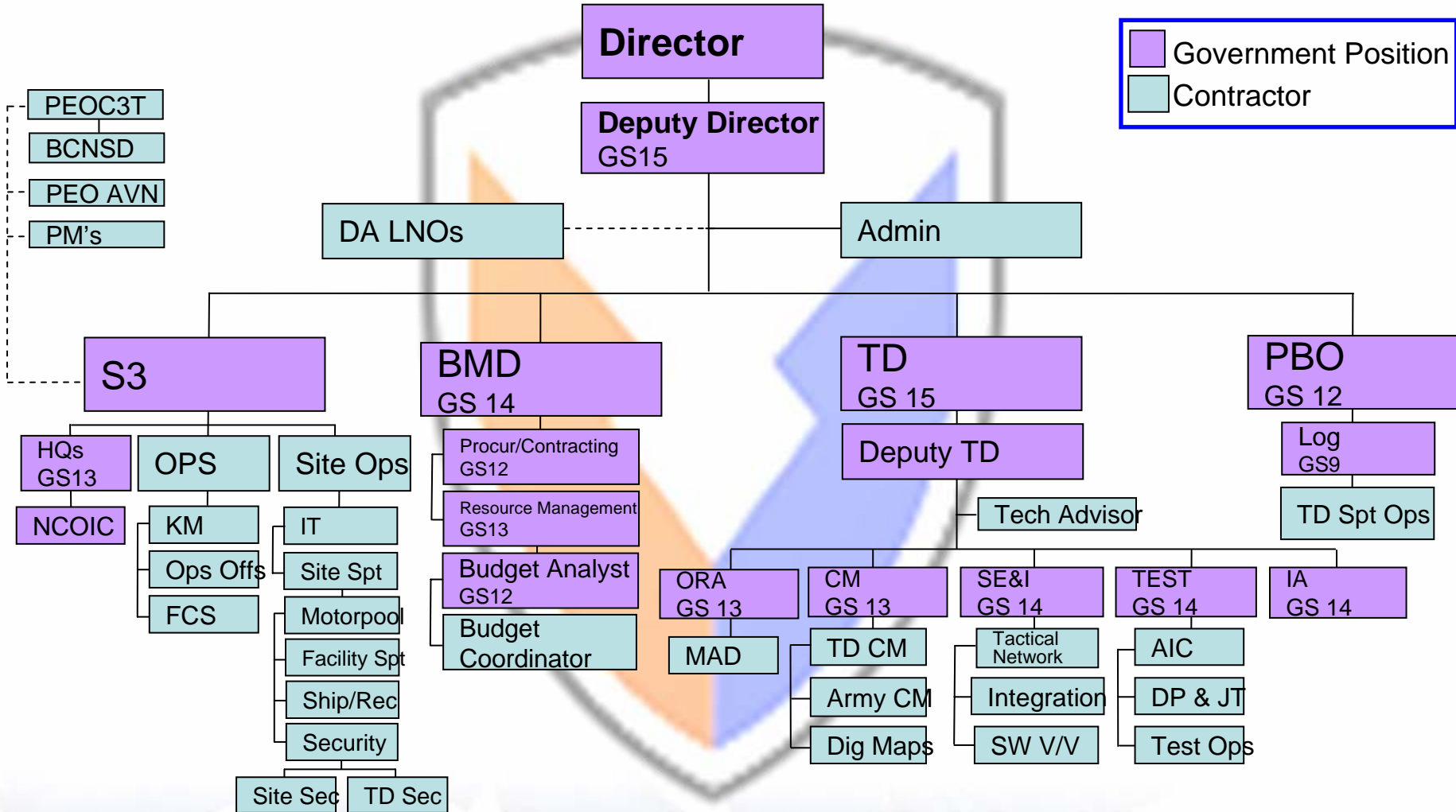
# CTSF Distributed Testing Capability



**Promote a Lean Culture in All We Do.**



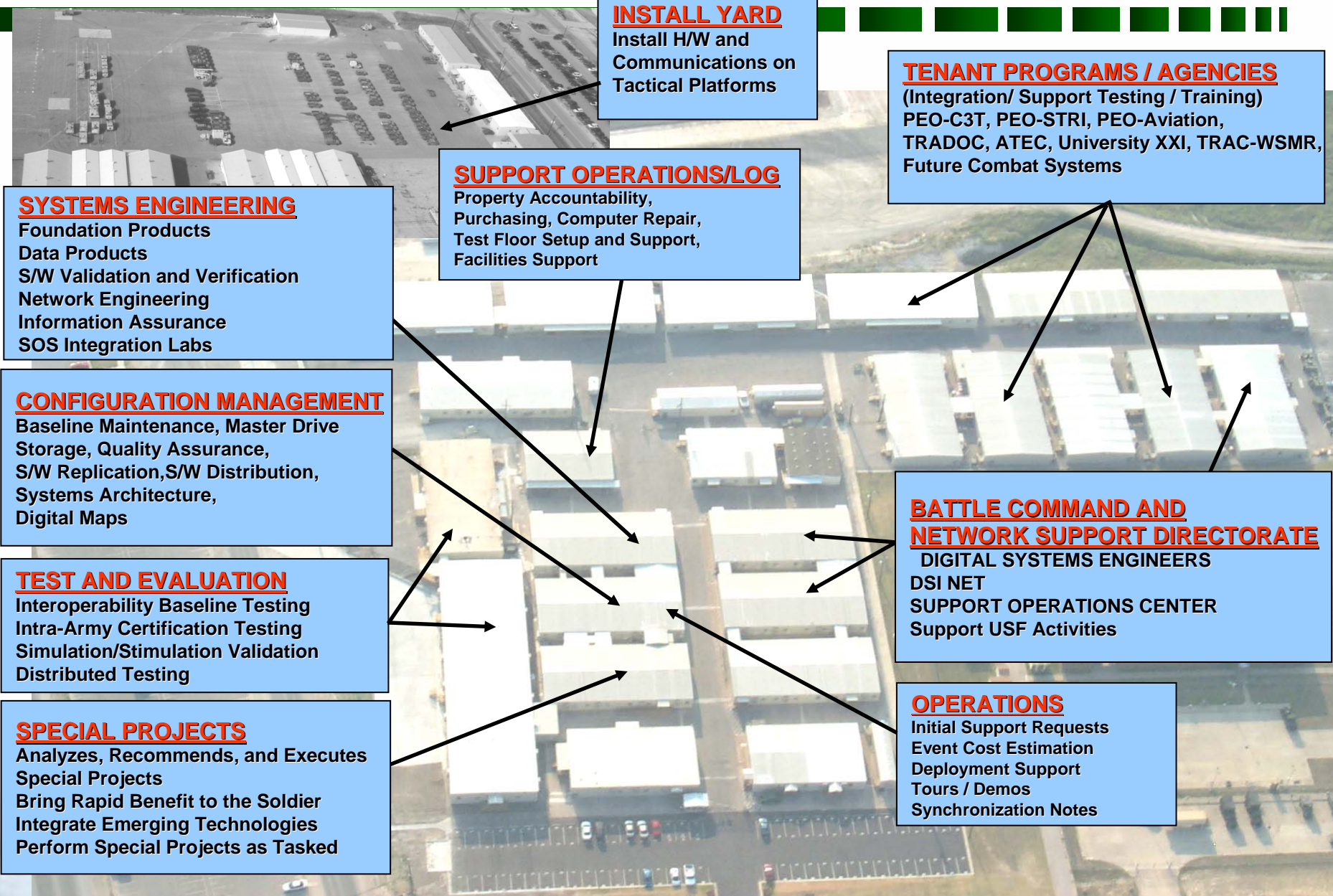
# CTSF Organization



**Promote a Lean Culture in All We Do.**



# CTSF Campus



## INSTALL YARD

Install H/W and Communications on Tactical Platforms

## TENANT PROGRAMS / AGENCIES

(Integration/ Support Testing / Training)  
PEO-C3T, PEO-STRI, PEO-Aviation,  
TRADOC, ATEC, University XXI, TRAC-WSMR,  
Future Combat Systems

## SUPPORT OPERATIONS/LOG

Property Accountability,  
Purchasing, Computer Repair,  
Test Floor Setup and Support,  
Facilities Support

## SYSTEMS ENGINEERING

Foundation Products  
Data Products  
S/W Validation and Verification  
Network Engineering  
Information Assurance  
SOS Integration Labs

## CONFIGURATION MANAGEMENT

Baseline Maintenance, Master Drive  
Storage, Quality Assurance,  
S/W Replication, S/W Distribution,  
Systems Architecture,  
Digital Maps

## TEST AND EVALUATION

Interoperability Baseline Testing  
Intra-Army Certification Testing  
Simulation/Stimulation Validation  
Distributed Testing

## SPECIAL PROJECTS

Analyzes, Recommends, and Executes  
Special Projects  
Bring Rapid Benefit to the Soldier  
Integrate Emerging Technologies  
Perform Special Projects as Tasked

## BATTLE COMMAND AND NETWORK SUPPORT DIRECTORATE

DIGITAL SYSTEMS ENGINEERS  
DSI NET  
SUPPORT OPERATIONS CENTER  
Support USF Activities

## OPERATIONS

Initial Support Requests  
Event Cost Estimation  
Deployment Support  
Tours / Demos  
Synchronization Notes



# FY07 Accomplishments

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP		
Testing	SW													
	1200 IA Scans		415 SW Products V&V		6,600 Hard Drives Imaged				130 Test RPTs					
	117 DP Products Processed													
	59 Unit Data PKGs Tested													
System Eng	Systems Integration Support													
	Over 2300 SW Updates													
	Distinct Baselines													
Unit SPT	22 BCT Rotations													
	144 DSE Tool Kits													
	2 Div + 1 Corps MRXs + 2 Division Prep													
	22 CTC Spt													
	1 Corp + 1 Corp Prep													
148K CD Images			13K DVD Images			225 Cable Shop WO			1821 Cables Produced			335 Units' Digital Map Requests		

**Promote a Lean Culture in All We Do.**

nn Month 2007





UNCLASSIFIED

# Technology Insertion: Fleet/Operating Forces

9<sup>th</sup> Annual Science and Engineering Technology Conference  
Charleston, SC  
17 April 2008



Ms Char Rusnak  
ONR Science Advisor to  
US Fleet Forces Command

**Distribution Statement A**  
Approved for public release.  
Distribution is unlimited

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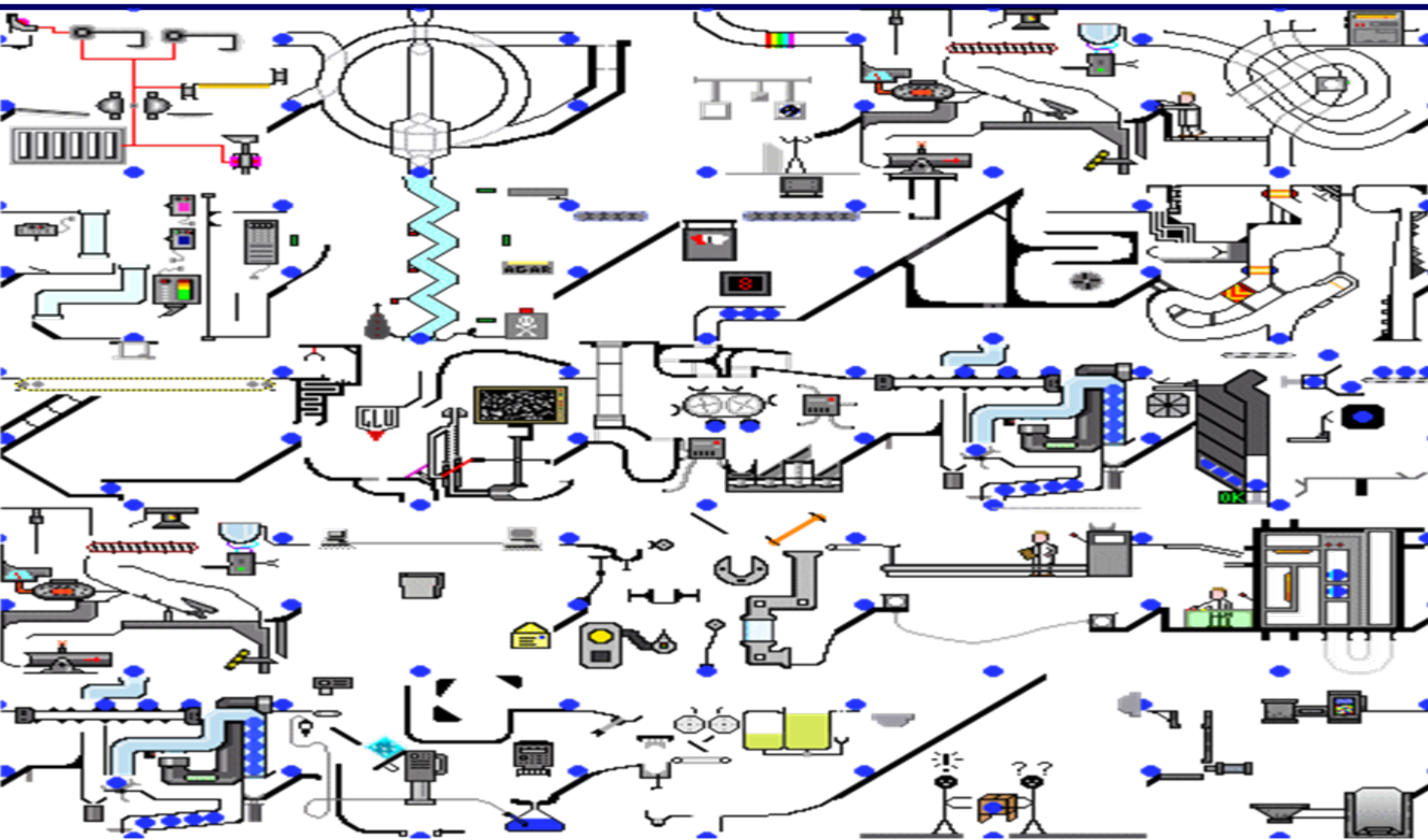
# Overview

- **War Fighter Requirements Articulation**
- **War Fighter – S&T Community Interaction**
- **Technology Insertion Programs**





# Simplified S&T Process





# Navy Senior Leader S&T Oversight

## Technology Oversight Group – Navy Representatives

- **Principal Deputy Assistant Secretary of the Navy, Research Development and Acquisition**
  - Acquisition/Transition
- **Chief of Naval Research**
  - Technology Development
- **Deputy Chief of Naval Operations, Integration of Capabilities and Resources (CNO N8)**
  - Resources and Requirements
- **Deputy Commander US Fleet Forces Command**
  - Fleet War Fighting Requirements



# US Fleet Forces Command Missions Functions and Tasks

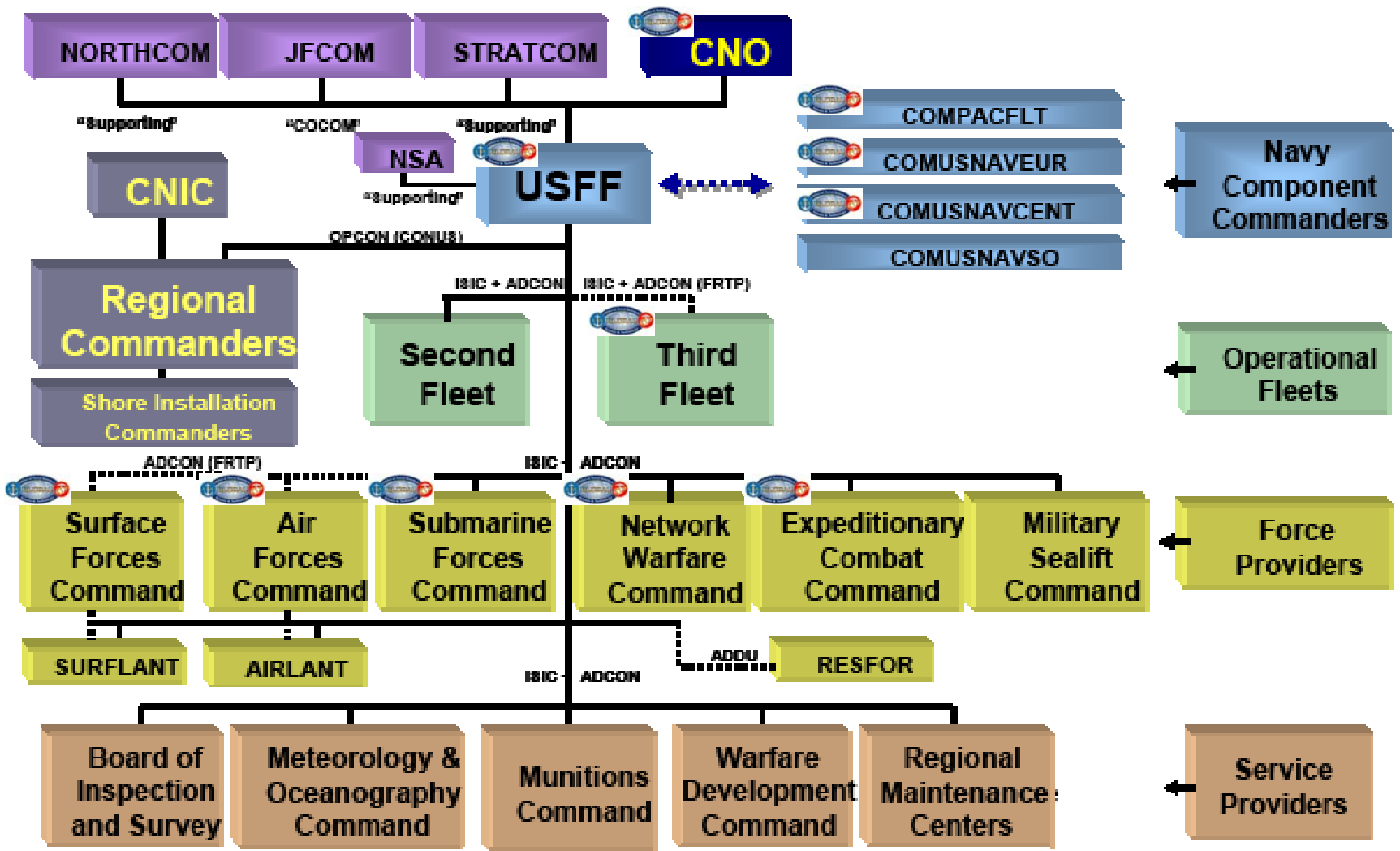
- **OPNAV INSTRUCTION 5440.77**
  - **Section 2c: USFLTFORCOM will integrate and articulate authoritative fleet war fighting, readiness, and personnel capability requirements to the Chief of Naval Operations (CNO)**
  - **Section 5d1: (USFLTFORCOM will) Coordinate integration of US Pacific Fleet (PACFLT), US Naval Forces European Command (NAVEUR), US Naval Forces Central Command (NAVCENT), and US Naval Forces Southern Command (NAVSO) war fighting, readiness, personnel and capability requirements to the CNO**





# USFF Command Relationships

## USFF Annual Plan 208





# Sea Power 21

Force Protection  
 Surface Warfare  
 Undersea Warfare  
 Theater Air & Missile Defense



Strike  
 Naval Fire Support  
 Strategic Deterrence  
 Ship to Objective Maneuver



- Sea Trial
- Sea Warrior
- Sea Enterprise

ISR  
 Common C3F/Sea  
 Operational  
 Tactical Picture  
 Communications  
 & Data Networks



Deploy & Employ  
 Integrated Joint Logistics  
 Pre-position Joint Assets Afloat



**SURFACE  
 WARFARE**



**NAVAL  
 AVIATION**



**UNDERSEA**



**NAVAL  
 NETWORK  
 FORCENET**



**NAVAL  
 EXPEDITIONARY**

Capability  
 Providers

Resource  
 Sponsors

Capability  
 Providers

Resource  
 Sponsors

Capability  
 Providers

Resource  
 Sponsors

Capability  
 Providers

Resource  
 Sponsors

Capability  
 Providers

Resource  
 Sponsors

**WARFARE ENTERPRISES**





# S&T Program Selection

## Top Down, Requirements Driven

- **Overarching National, Joint and Navy Strategies**
  - **War Fighting Requirement Analysis**
  - **Analysis of Existing Capabilities**
  - **Gap Identification**
    - **Near Term (Fleet Focus)**
    - **Far Term**
    - **S&T Project Development to Address War Fighting Gaps**
    - **Fleet Input to Prioritize Execution of S & T projects**
  - **War Fighter and S&T Community Work Together to Develop Capabilities to Fill Gaps**
- 
- A large military helicopter, possibly a Sikorsky HO4S, is on the deck of an aircraft carrier. The helicopter is painted in a camouflage pattern and has 'NAVY' and '155' visible on its side. A person is standing on the deck near the helicopter, and another person is walking in the foreground. The background shows the blue ocean and a clear sky.



# Technology Insertion Programs

- **Future Naval Capabilities (FNC)**
  - Provides capabilities to close war fighting gaps
  - Up to 5 years
  - Potential for Joint Capability Technology Demonstration (JCTD) program
    - Build upon FNC adding Joint/Coalition/Agency capability
- **Rapid Technology Transition**
  - Increases rate that new, innovative, and potentially disruptive technologies are inserted into acquisition programs
  - Technology Readiness Level 6 or higher, 2 yr, \$2M program



# Technology Insertion Programs (cont.)

- **Rapid Development and Deployment Program**
  - Rapid development and fielding of prototype solutions to meet urgent needs in the Global War on Terrorism
  - Validated Naval urgent need that requires rapid (270 days) development of material solutions not readily available off-the shelf
    - Naval Innovation Laboratory
- **Sea Trial**
  - Speed development of new concepts and technologies to the war fighter
    - Wargaming, experimentation, and exercises
  - Candidates with the greatest potential to provide dramatic increases in war fighting capability



# Summary

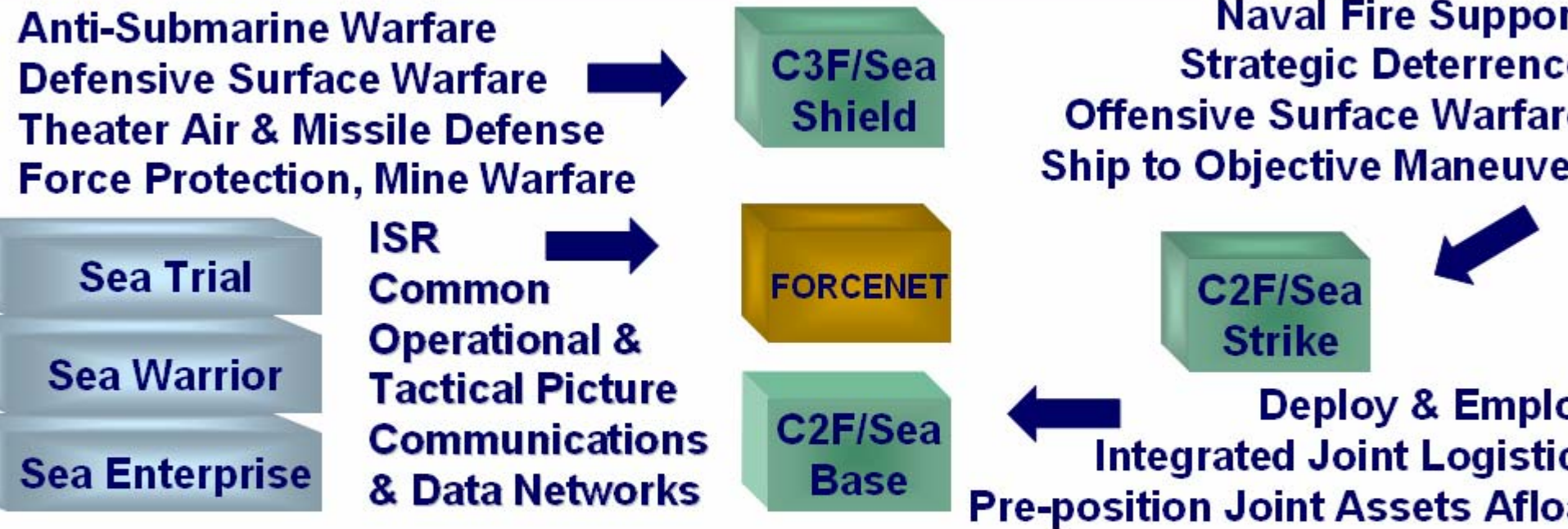
- **USFF is responsible for integrating and articulating authoritative fleet war fighting requirements to the CNO**
- **Navy S&T requirements are a part of the overall Navy requirements generation process**
  - **Senior leadership oversight**
- **Representatives from requirements, resources, development and acquisition work together from the beginning to support technology transfer in the Navy**
- **Multiple venues are available for technology transfer**







# Sea Power 21



WARFARE ENTERPRISES



# **Honeywell Aerospace MRA's for Systems & Product Families**

**NDIA Science, Engineering, & Technology Conference  
Manufacturing Technology Industry Panel**

**Dr. Al Sanders**

**Advanced Manufacturing Engineering**

**Honeywell Aerospace**

**April 17, 2008**

**Honeywell**

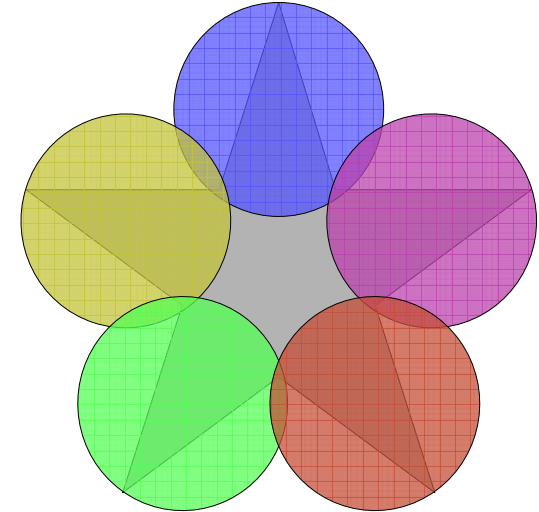
- **MRL used on key NPD programs since fall 2005**
  - Criteria based on May 2005 DoD TRA Deskbook definitions
  - Maturity model developed to baseline key NPD programs
  - Assessments driven by newly formed AME organization
  - Over 300 assessments (including updates) conducted to date
- **Enabling DFM analysis tools developed to assist evaluations**
  - Quantitative first order analyses to identify design shortfalls
  - Enable “what if” analyses to quantify impact of design changes
  - Score card metrics developed to report and track improvements
- **Recent MRL applications on key programs and pursuits**
  - DARPA Micro Air Vehicle (MAV) lab to production transition
  - Army HTS900 Milestone C review leading to an LRIP decision
  - Airbus A350 XWB Avionics and Mechanical Systems pursuits

***MRL Assessments Integral to AME Operating System***

# Honeywell MRL Maturity Assessment

- **Manufacturing Readiness Levels**
  - Based on DoD Definitions & Exit Criteria
  - Scoring criteria include product focus
  - Allow product or technology baselines
- **Honeywell MRL maturity assessment**
  - Five rating categories (threads)
  - Standardized exit criteria for each level
  - Maps to TRL & IPDS Process

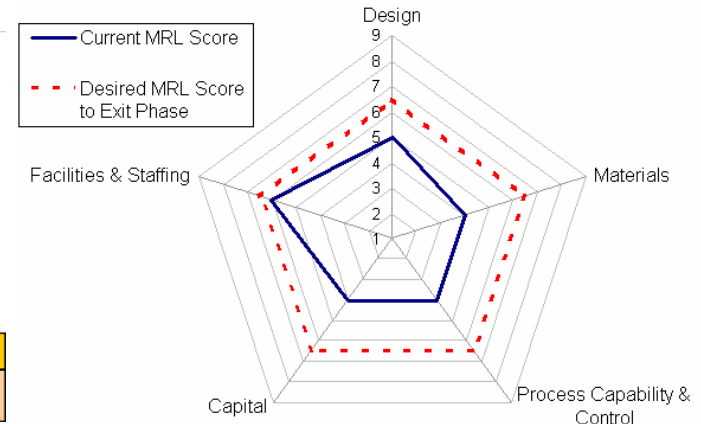
Manufacturing Readiness Elements



Paper Studies    Technology Development    Technology Insertion

Technology Readiness Level (TRL)										
TRL 1	TRL 2	TRL 3	TRL 4	TRL 5	TRL 6	TRL 7	TRL 8	TRL 9		
Basic principles observed and reported	Technology concept and/or application formulated	Analytical and experimental critical function and/or characteristic proof of concept	Component and/or breadboard validation in laboratory environment	Component and/or breadboard validation in relevant environment	System/subsystem model or prototype demonstration in a relevant environment	System prototype demonstration in the actual relevant environment or application	Actual system completed and "flight qualified" through test and demonstration	Actual system "flight proven" through successful mission operations		
Manufacturing Readiness Level (MRL)										
MRL 1	MRL 2	MRL 3	MRL 4	MRL 5	MRL 6	MRL 6.5	MRL 7	MRL 8	MRL 9	MRL 10
Manufacturing gap assessment	Manufacturing concept formulation	Manufacturing concept development	Laboratory manufacturing processes identified	Manufacturing process development	Critical manufacturing process development	Prototype manufacturing system	Prototype manufacturing demonstration	Manufacturing process maturity demonstration	Manufacturing processes proven	Sustain and continuous improvement
Pre-IPDS			IPDS 1	IPDS 2	IPDS 3	IPDS 4	IPDS 5	IPDS 6		IPDS 7
Novel Concepts and Emerging Technologies			Pre-Concept	Concept	Product Definition	Detailed Design	Product Validation	Delivery, Support, & Improvement		Sunset

MRL Maturity Rating

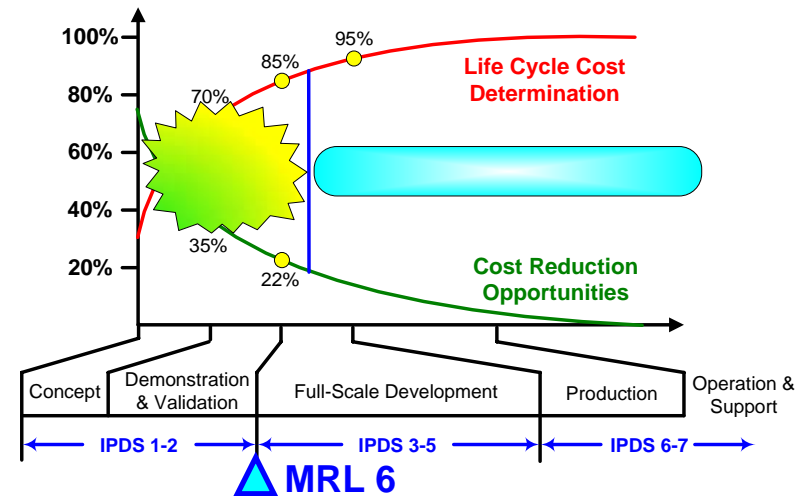


Linkage to DoD Milestones    ▲ A    ▲ B    ▲ C

**Original DoD Criteria used as Basis for Internal MRL Model**

# Early MRL Motivation at Honeywell

- Early decisions responsible for many production ramp issues
  - Actual costs exceed estimates
  - Quality levels below expectations
  - Low yield and delivery problems
  - Service related reliability issues
  - Supply chain inefficiencies



Source: DARPA Rapid Design Exploration & Optimization Project

- MRL's drive proactive planning
  - Sets agenda for risk mitigation
  - Mfg requirements defined early
  - Optimal supply chain strategies
  - Synchronizes SBU/ISC/E&T
  - Applies to both technology AND system development programs

## What does MRL 6 Mean?

### Manufacturing Risks Identified & Planned For

- Design Cost & Producibility Drivers
- Potential Availability & Yield Issues
- Baseline Architecture DFM Shortfalls
- Industrial Base Capability Gaps
- Capital Investment Needs & Rationale
- Alignment of Supply Chain Strategies

**Critical to Identify and Plan for Shortfalls in Early Phases**

# MRL Applications within Honeywell

- **Technology Development (Low TRL, Low MRL)**
  - Many technology demonstrators push manufacturing limits
  - MRL maturation being driven lock-step with TRL maturation
- **New Product Development (High TRL, Low MRL)**
  - Mature “similar to” baselines often have producibility issues
  - Key is pinpointing shortfalls early during concept definition
- **Supplier Transition/Reposition Risk Mitigation**
  - Global supply base continues to be an ever changing entity
  - Knowing gaps early accelerates supplier development
- **“Red” Program Deep Dives and Recovery Plans**
  - Pinpoints root cause of problem areas needing attention
  - Focuses program recovery on next steps to address gaps

***MRL has Applications throughout Product Life Cycle***

# MRL and Enabling AME Tool Linkage

## *Assessments for sub-systems (e.g. avionics box)*

- Assessment triggers to identify high risk sub-systems & components

- Manufacturing Readiness Level (MRL) maturity model
  - Macro view of systemic supply chain top level risk areas
  - Enables proactive risk identification and mitigation plans

## *Assessments for components (e.g. circuit card assembly)*

- Complexity analyses to quantify manufacturing difficulty
  - Captures first order design attributes driving complexity
  - Enables “what if” design simplification trade studies
- Yield analyses for up-front prediction of quality targets
  - Correlates defect opportunities with process capability
  - Establishes “upper bound” on anticipated first pass yield
- DFM score card analyses to quantify impact of DFM violations
  - Quantifies impact of first order DFM drivers on producibility
  - Enables designs to be “graded” based on ease of producibility

***AME Enabling Tools Developed to Assist Assessments***



# Platform/System MRL Scorecard

Sub-Systems	AME Prod Line Mgr	Priority	IPDS Phase	SLI	Risk Assess: WBS Complete					Comments	
					MRL	Tool data	GS	Overall MRL Assessment	Probability Metric		Complexity Assessment
<b>Integrated Avionics Unit</b>					6						
Chassis Cabinet	J. Smith	High	6	Y	TBD	TBD	TBD	TBD	Y	Sheet metal cabinet with low yield (86%) and card insertion issues	
Power Supply CCA	J. Smith	High	6	Y	TBD	TBD	TBD	TBD	TBD	(To be scheduled)	
Processor CCA	J. Smith	High	5	Y	G	G	G	G	Y	Custom Manufacturing and test issues for final release to production line	
Control I/O CCA	J. Smith	High	6	Y	Y	G	Y	Y	Y	Redesign required to address 486 processor obsolescence issue, functional test unit needs troubleshooting	
Generic I/O CCA	J. Smith	High	6	Y	TBD	TBD	TBD	TBD	TBD	(To be scheduled)	
Control Module	J. Smith	High	5	Y	G	G	G	G	G	Ongoing manufacturing and test issues for final release to production line	
<b>Crew Interface Display Unit</b>					7						
Flat Panel Display	B. Johnson	High	6	Y	Y	Y	Y	Y	Y	Moderately complex design, significant manufacturing assembly, moderate DFM violations noted	
Graphics Processor CCA	B. Johnson	High	5	Y	G	G	G	G	Y	Just completing IPDS Phase 5 with TSO submitted	
Tray	B. Johnson	Low	6	N/A	N/A	N/A	N/A	N/A	N/A	COTS purchased part	
Backshell I/O Connector	B. Johnson	Low	6	N/A	N/A	N/A	N/A	N/A	N/A	COTS purchased part	
Backshell Power Connector	B. Johnson	Low	6	N/A	N/A	N/A	N/A	N/A	N/A	COTS purchased part	
Cursor Control Device	B. Johnson	Low	6	N/A	N/A	N/A	N/A	N/A	N/A	COTS purchased part	
Multifunction Keyboard	B. Johnson	Low	6	N/A	N/A	N/A	N/A	N/A	N/A	COTS purchased part	
Reversion / Dimming Panel	B. Johnson	Low	6	N/A	N/A	N/A	N/A	N/A	N/A	COTS purchased part	
Electronic Standby Indicator	B. Johnson	Low	6	N/A	N/A	N/A	N/A	N/A	N/A	COTS purchased part	
<b>Inertial Reference System</b>					6						
Processor CCA	H. Simpson	M	4	Y	R	G	G	R	G	DFM violations, DFM scorecard =60%	
Power Supply CCA	H. Simpson	M	4	Y	G	G	G	G	G	Manufacturing issues	
MEMS Gyro CCA	H. Simpson	M	6	Y	R	Y	R	Y	G	Moderately complex board (5.3), significant yield issues (80%), DFM scorecard=87%, yield improvement re-spin not included in green sheet	
Accelerometer CCA	H. Simpson	M	3	Y	Y	G	Y	Y	G	Low complexity board (2.7), projected first pass assembly yield of 80%	
Connector CCA	H. Simpson	M	4	Y	G	G	G	G	G	Manufacturing issues	

**Green – No Concern**

**Yellow – Minor Concern**

**Red – Major Concern**

**Sub-System BOM Breakdowns**

**MRL & DFM Assessment Results**

**Green Sheet Assumption Impact**

**Assessment Details and Next Steps**

**Scorecard “Bundles” Component Level Assessments**

# Summary and Conclusions

- **Streamlined product MRL assessment developed for internal use**
  - Leverages industry standard criteria in a repackaged format
  - MRL assessments called out as part of internal IPDS process
  - Proprietary enabling DFM tools developed to assist with ratings
  - Over 300 assessments (including updates) conducted to date
  - Process used during key pursuits to understand risks/opportunities
- **Investigation of MRL for “aircraft system” concept evaluations**
  - DoD criteria applicable to component technology development
  - Honeywell version adapted criteria to reflect a sub-system focus
  - System level application requires “system engineering” philosophy
  - Tier 1 MRL (new) would focus on overall supply chain architecture
  - Tier 2 MRL (current) would focus on component level manufacturing

***Early Industrial Base Design around Product is Key***

# Questions?

## Contact Information

**Dr. Al Sanders**

**602-231-1886**

**Al.Sanders@Honeywell.com**

**Honeywell**



# Technology & Manufacturing Readiness Assessments @ RMS

Dale Iverson  
April 17, 2008

# Contents

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- History of Technology & Manufacturing Readiness Assessment (T&MRA) Activities at RMS
- T&MRA Project
- Lessons Learned

# History of T&MRA Activities at Raytheon Missile Systems (RMS) – 2005 & 2006

## ■ 2005

- RMS leader attended Defense Acquisition University course...first delivery of Manufacturing Readiness Level (MRL) materials
- ManTech white papers, quad charts & proposals require MRLs & notional MRL Maturity Plans (MMP)

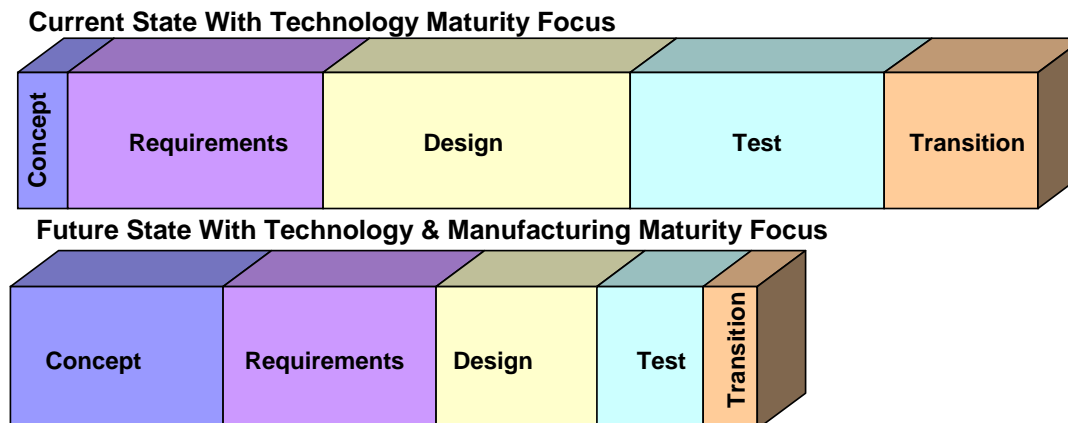
## ■ 2006

- RMS employees attended MRA training course established by Air Force Research Lab (AFRL)
- 2-Part Pilot MRAs conducted by AFRL on AMRAAM Program
- RMS Kicked-off T&MRA Project with Raytheon Six Sigma Team
- Full Time MRA Manager assigned to Air-to-Air Product Line
- Joint Service ManTech Program Awarded, required MMP
- Conducted first independent T&MRA on Radome portfolio
- T&MRA @ RMS website goes live



# It Simply Makes Good Business Sense!

- Establishing TRLs, MRLs and maturity plans in accordance with the DoD's TRA & MRA requirements is not only necessary to support customer led assessments, but also:
  - T&MRA processes can **change the culture** by driving a collaborative partnership between programs, design and manufacturing engineering earlier in the product development life cycle where maturity efforts can have greatest impact on **improving program affordability and predictability**
  - Lower risk designs lead to shorter development cycles with fewer design re-starts, more accurate delivery dates, and lower overall development costs
    - Can mitigate 20% post CDR cost growth trend noted in GAO reports
    - Cost reductions of 30% or more can be achieved

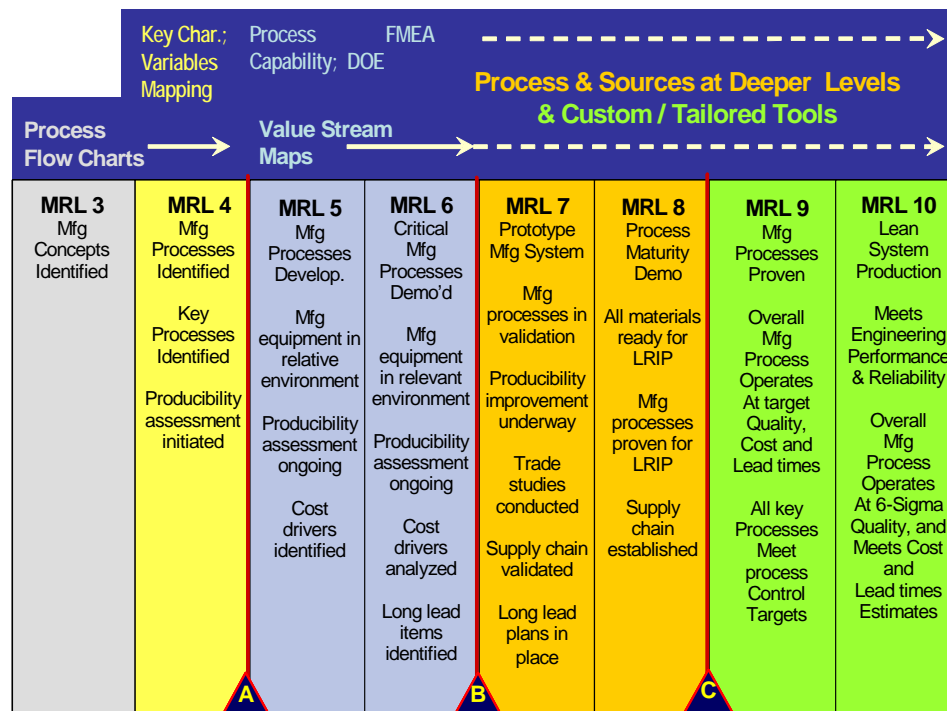
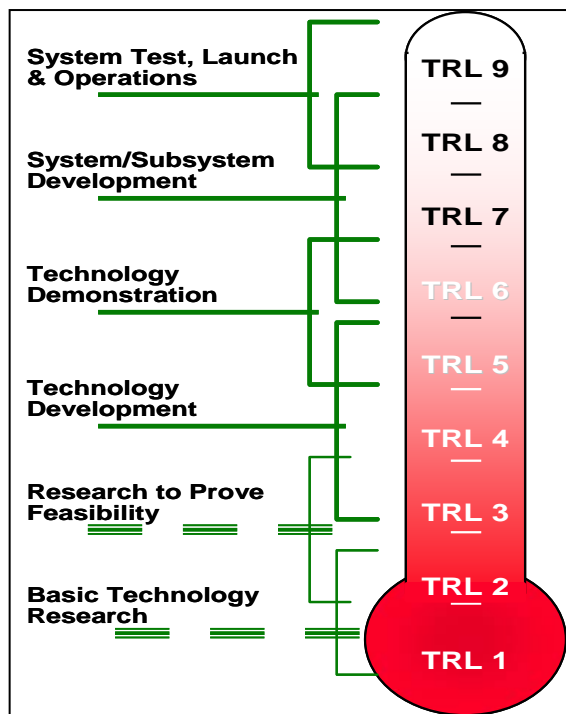


# T&MRA @ RMS Project Vision

Technology & Manufacturing Readiness is integrated and measured in RMS business practices and culture.

Established TRA Process:  
Technology Readiness Assessment

New MRA Process:  
Manufacturing Readiness Assessment



# T&MRA @ RMS Project Focus Areas

## ■ Awareness & Training

- T&MRA socialization across RMS & Raytheon
- T&MRA preparation and facilitation training

## ■ T&MRA Knowledge Management

- Environmental scanning, knowledge capture, information warehousing & easy access (e.g. website, docushare and eRooms)
- Capture lessons learned from internal & external cycles of learning
- Assist DoD in the shaping MRA regulations, policies, and processes


## ■ Standardization of T&MRA @ RMS Processes

- 10-Step process created (includes capture of lessons learned)
- Aligned with DoD MRA process, combined with DoD's TRA

## ■ Directive System Support

- Modify Directives, Proposals, Contracting, Practices, Instructions, etc. to support consistent and compulsory deployments

# T&MRA Website for Knowledge Capture & Reuse



Technology & Manufacturing Readiness @ RMS

## Links

- Defense Acquisition University
- Defense Acquisition Guidebook
- Acquisition Community Connection
- DAU - Manufacturing Readiness Assessments
- DoD ManTech
- MRL Assist

## T&MRA Tool Box

- MRL Matrix & Definitions+
- T&MRA Baseline & Planning Workbook
- TRL HW & SW Definitions (DAG October 2004)
- T&MRA Summary Report Template

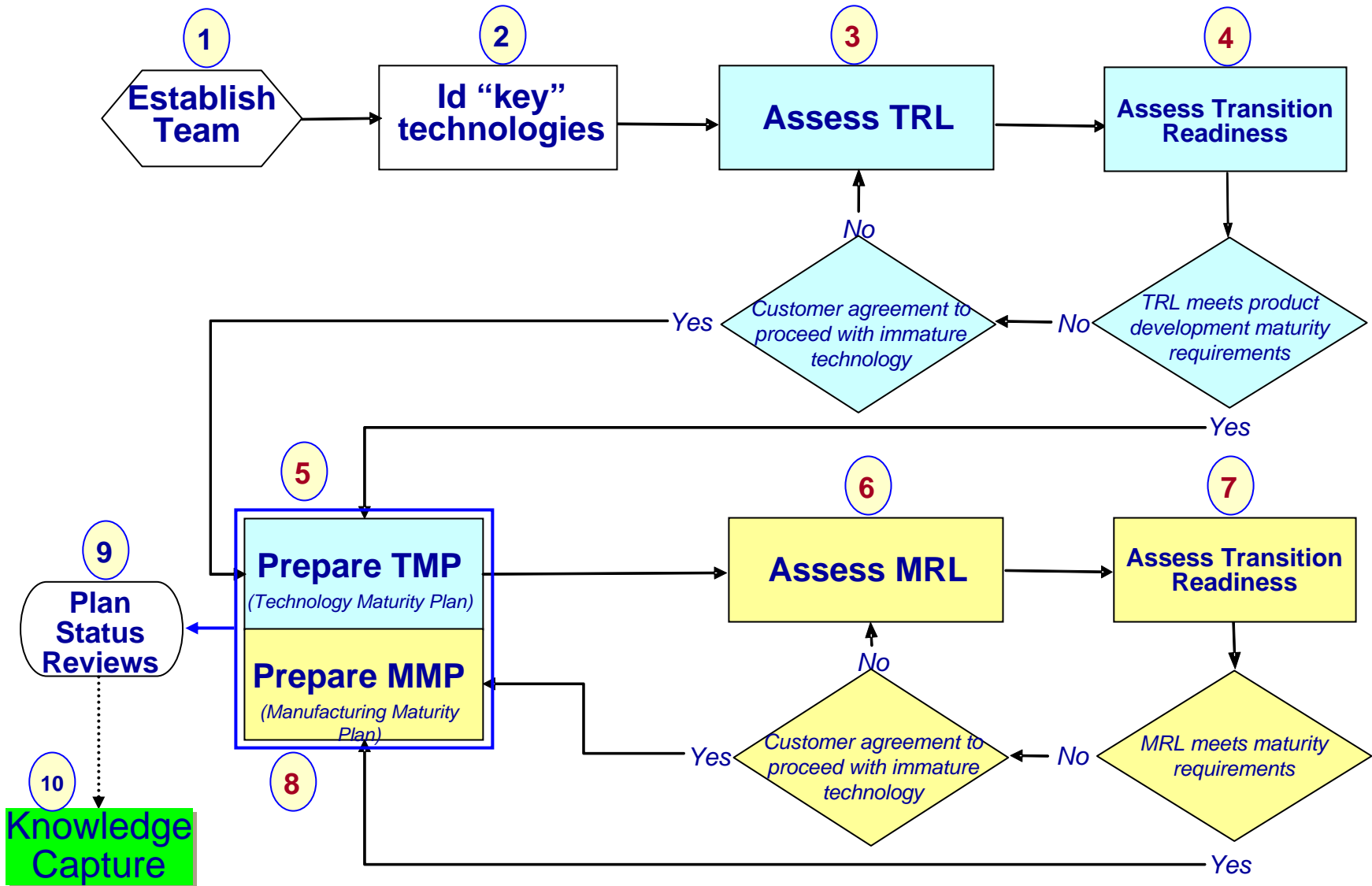
## Reference Materials

- 2007 Defense Manufacturing Conference
- 2007 Technology Maturity Conference
- AFRL MRA Workshop - 2006 DMC
- DoD Integrated Management Framework - Back
- DoD Integrated Management Framework - Front
- GAO-07-706SP Assessments of Selected Weapon Programs, March 2007
- Manager's Guide to Technology Transition in an Evolutionary Acquisition Environment, Version 2.0, June 2005
- Misc. T&MR Presentations
- Senate Report 109-254, National Defense Authorization Act for Fiscal Year 2007, May 9, 2006
- T&MRA Process Training
- T&MRA Overview
- Technology Readiness Assessment (TRA) Deskbook, May 2005

# History of T&MRA Activities at RMS - 2007

- T&MRA 10-Step Process developed – aligned with MRA
- T&MRA awareness seminars conducted across RMS
- Project Lead attended 2-week DAU course with DoD PMs; teams conducted notional MRAs from GAO facts & data
- MRAs considered good Management practice - not plus-ups
- T&MRL baselines in 3 major proposals (lessons learned)
- T&MRA added to RMS Manufacturing Excellence Model
- Early T&MRL requirements for Architectural Review Boards
- Participated in JDMTP's MRA Working Group with Industry
- "T&MRA @ RMS" presented at Raytheon Symposiums and Defense Manufacturing Conference
- MRL maturity included in Operations Strategy and Reviews

# Combined “Technology & Manufacturing Readiness Assessment” Model





# History and Plans for T&MRA Activities at RMS - 2008

- T&MRA detailed 10-step process training developed
- T&MRA tools refined and added – to assess current state, develop maturity plans, report progress and document T&MRA
- Corporate IPDS Change Review Board scheduled to review T&MRA for potential incorporation into IPDS to ensure consistent and compulsory deployment in 2008
- T&MRA project lead scheduled to present “T&MRA @ RMS” at this year’s:
  - National Defense Industry Association (NDIA) Science & Engineering Technology Conference in April
  - Enterprise Process Group Workshop in July

# Tool to Capture, Plan and Status T&MRLs and Maturity Plans

- Tool created to demo important T&MRA planning & reporting characteristics
  - Facilitates and documents the Baseline & Current State T&MRLs by MRL Matrix Thread
  - Potential to roll-up 10 separate technology assessments to an assembly level TRL & MRL
  - Transition Risk Color Coding based on DoD Best Practices for each phase of PDLC

**Program:** example: HyperSonic Missile Program  
**Product Description:** example: Guidance & Navigation Unit (GNU)  
**Product Development Phase:** Technology Development  
**Transition Readiness Goals:** 6  
**T&MRL Valuation Method:** **Lowest T&MRL Values**  
**Most Recent Assessment Date:** None

Roll-Up T&MRLs							
All Baseline Values				All Current Values			
Low TRL	4.0	Low MRL	3.0	Low TRL	6.0	Low MRL	3.0
High	8.0	High	5.0	High	6.0	High	3.0
Avg	5.8	Avg	4.0	Avg	6.0	Avg	3.0

# MRL Matrix Evaluation Threads		# MRL Matrix Sub-Thread		T&MRL Assessments (Max. 10 Technologies per Roll-Up)							
				Acronym 1		Acronym 2		Acronym 3		Acronym 4	
				Baseline	Current	Baseline	Current	Baseline	Current	Baseline	Current
1	Technology & Industrial Base	1	Technology Readiness Level (TRL)	5	6	4		6		8	
		2	Technology Transition to Production	4	5	4		6		7	
		3	Manufacturing Technology Development	4	5	4		6		7	
2	Design	4	Producibility Program	5	6	4		6		7	
		5	Design Maturity	5	5	3		6		5	
3	Materials	6	Maturity	3	5	3		6		5	
		7	Availability	5	5	4		6		6	
		8	Supply Chain Management	5	5	5		6		6	
		9	Special Handling	7	7	7		5		6	
4	Cost & Funding	10	Production Cost Knowledge (Cost Modeling)	4	5	4		5		6	
		11	Unit Production Costs	4	4	4		6		6	
		12	Manufacturing Investment Budget	3	4	3		6		7	
5	Process Capability & Control	13	Modeling & Simulation (Product & Process)	3	3	3		6		7	
		14	Manufacturing Process Maturity	5	5	4		6		7	
		15	Manufacturing Technology Initiatives					8		7	
		16	Process Yields & Rates	5	5	4		5		5	
6	Quality Management	17	Quality Management Including Supplier Quality	5	6	4		6		6	
7	Manufacturing Personnel	18	Manufacturing Personnel	6	6	5		6		6	
8	Facilities	19	Facilities	7	7	6		8		7	
9	Manufacturing Management	20	Manufacturing Planning & Scheduling	5	5	4		7		7	
		21	Materials Planning	6	6	6		7		7	
		22	Tooling & Special Test Equipment	5	6	5		6		7	
Baseline MRL (excludes TRL):				3.0		3.0		5.0		5.0	
Current MRL (excludes TRL):					3.0		-		-		-
High MRL (excludes TRL):				7.0	7.0	7.0	0.0	8.0	0.0	7.0	0.0
Low MRL (excludes TRL):				3.0	3.0	3.0	0.0	5.0	0.0	5.0	0.0
Average MRL (excludes TRL):				4.8	5.3	4.3	#DIV/0!	6.1	#DIV/0!	6.4	#DIV/0!

Transition Readiness Risk Guide by PLC Phase			
CR	TD	SDD	LRIP
4	6	8	9
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10

# T&MRL Maturity Planning for Each Technology Assessed

- Plan vs Actual TRL and MRL with transition readiness risk color codes
- Detailed tasks, POC, rationale, dates, funding, and sources of funding
- “What-if?” analysis capability

**Program:** Hypersonic Missile Program  
**Product Description:** Guidance & Navigation Unit  
**Product Development Phase:** Technology Development  
**Transition Readiness Goals:** 6  
**T&MRL Valuation Method:** **Lowest T&MRL Values**

Key Technology Assessed:

Acronym:

Manufacturing Readiness Level - MRL											
Item #	Task Description	Rationale/Evidence/Risks to Completion	Responsible POC	Plan Due Date	Complete Date	MRL Increase	Funding Req'mts	Funding Type	Funded (Y/N)	MRL Base Plan	MRL Act'l
1.00	Baseline MRL	Rationale/Evidence/Risks to Completion	Name		10/07					3	3
1.01	Maturity Advancement Action 1	Rationale/Evidence/Risks to Completion	Name	12/07	11/07		\$100 K	IRAD	Y	3	3
1.02	Maturity Advancement Action 2	Rationale/Evidence/Risks to Completion	Name	01/08	12/08		\$20 K	IRAD	Y	4	3
1.03	Maturity Advancement Action 3	Rationale/Evidence/Risks to Completion	Name	01/08	01/08		\$45 K	Contract	Y	4	3
1.04	Maturity Advancement Action 4	Rationale/Evidence/Risks to Completion	Name	02/08	01/08	1	\$30 K	Contract	Y	5	4
1.05	Maturity Advancement Action 5	Rationale/Evidence/Risks to Completion	Name	02/08	02/08	1	\$10 K	Contract	Y	5	5
1.06	Maturity Advancement Action 6	Rationale/Evidence/Risks to Completion	Name	03/08	02/08		\$25 K	Contract	Y	6	5
1.07	Maturity Advancement Action 7	Rationale/Evidence/Risks to Completion	Name	03/08			\$25 K	Contract	Y	6	0
1.08	Maturity Advancement Action 8	Rationale/Evidence/Risks to Completion	Name	05/08			\$1,200 K	Capital	N	7	0
1.09	Maturity Advancement Action 9	Rationale/Evidence/Risks to Completion	Name	07/08			\$260 K	Contract	Y	7	0
1.10	Maturity Advancement Action 10	Rationale/Evidence/Risks to Completion	Name	08/08			\$50 K	Contract	N	8	0
1.11											0
1.12											0
1.13											0
1.14											0
1.15											0
1.16											0
1.17											0
1.18											0
1.19											0
1.20											0

MRL funding plan: \$1,765 K      Current MRL: 5  
 Funded: \$515 K      MRL Plan Complete? **N**  
 Unfunded: (\$1,250 K)      In Risk Register? **Y**

# Key Lessons Learned

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- Cultural change...T&MRA is a means to facilitate earlier collaborations between design engineering, manufacturing and supply chain during any phase of PDLC
- Leadership & Assessment Team alignment required before T&MRA deployments
- TRLs & MRLs should be established at the critical technology levels (best practice)
- Wherever possible, the T&MRA should be completed prior to developing a proposal to ensure technology, design & manufacturability risks are accounted for:
  - Assess program feasibility and technology transition readiness (risks)
  - Program cost and schedules should include maturity plans and goals
  - Identify key manufacturing processes that need to be matured for program success

# Key Lessons Learned

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- Command media revisions required for consistent & compulsory use
- Tailoring of assessment based on fidelity level desired
- MRA and Production Readiness are not the same
- Systems Engineering organization to own the T&MRA process
- Need further development and integration of tools and management systems to capture, plan and report T&MRL progress
- MRL Matrix can be enhanced further to focus on Manufacturing Process Maturity
- **Low MRLs are not necessarily an issue...not having a maturity plan is!**

# In Summary...

- TRLs are part of our culture at Raytheon...more discipline required
- MRLs are relatively new...Industry is still in early stages of adoption
  - Sense of urgency within the DoD – TRA & MRA processes are being taught to and deployed by our customers...and for very compelling reasons
  - Acquisition Policy, Guidance and Legislation associated with TRA & MRA are in place and/or currently under revision & development for 2008 release
- The use of T&MRA processes will not guarantee program success
- T&MRA processes and tools will:
  - Change culture - bridge the divide between engineering & manufacturing
  - Provide insight into current state technology & manufacturing maturity and capability
  - Identify contributing factors & issues driving the “Gaps” in T&MRL maturity
  - Identify the type and significance of risks to program cost, schedule and performance
  - Lead to more accurate, time phased, and priced maturity plans
  - **Improve program affordability and predictability**



# T&MRA @ RMS

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If you have any questions, feel free to contact me at:

## **Dale Iverson**

Raytheon Missile Systems

520-241-9275 (cell)

520-794-2947 (office)

[ddiverson@raytheon.com](mailto:ddiverson@raytheon.com)



# Army Science and Technology



**NDIA**  
**9th Annual Science & Engineering  
Technology Conference**



*15 Apr 2008*

*Dr. Thomas H. Killion  
Deputy Assistant Secretary  
for Research and Technology/  
Chief Scientist*



# Outline

---

- ***Army Science and Technology (S&T) Strategy and Funding***
- ***Future Force Technologies***
- ***Future Combat Systems***
  - ***Spinouts to the Current Force***
- ***S&T Insertions to Current Operations***
- ***Basic Research Thrusts***



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S. Adams



# Science & Technology for a Campaign Quality Army with Joint & Expeditionary Capabilities

## Current Force



~100 lb. load



Limited network



> 70 tons



< 10 mph

## Enabling the Future Force

Science and Technology—  
develop and mature  
technology to enable  
transformational capabilities  
for the Future Force  
while seeking opportunities  
to accelerate technology  
directly into the  
Current Force

## Enhancing the Current Force

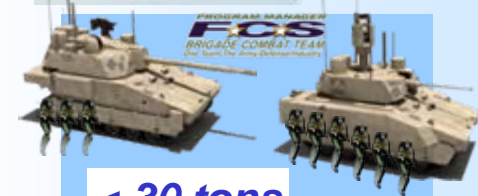
## Future Force



< 40 lb. load



Fully networked



< 30 tons

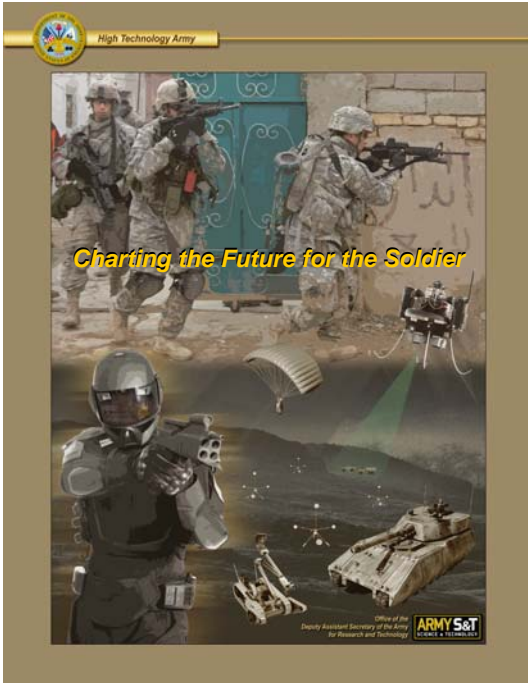


> 40 mph





# Elements of Army S&T Strategy



- **Ensure investments are aligned with Army missions and capability needs**
- **Maintain balanced & responsive portfolio across**
  - **Elements of investment (6.1/6.2/6.3)**
  - **Disciplines and technology areas**
  - **Performers (intramural/extramural)**
  - **Capability pull and technology push**
- **Sustain critical infrastructure—people and physical—responsive to Army needs**
- **Communicate S&T vision and approach to senior decision makers, key stakeholders, partners and customers**
- **Establish and refine processes and metrics to promote innovation, efficiency & effectiveness, and facilitate transition**





# FY09 Funding—Research to Systems

## 3 Different Types of S&T Investments

**S&T**

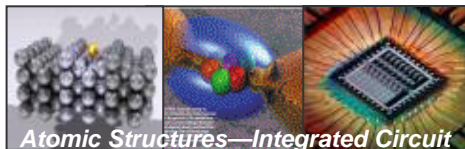
**Development (RDT&E)**  
\$8.7B

**Acquisition (Procurement)**  
\$24.6B

**\$1.8B**

**6.1: Basic Research**  
\$379M (21% of S&T)

### Nanoscience



- Understanding to solve Army-unique problems
- Knowledge for an uncertain future

67% Universities/Industry

Far Term

**6.2: Applied Research**  
\$724M (39% of S&T)

### Integrated Textile Conductors

Embedded Input Device



Power Transmitting Textiles



Embedded Circuits

- Applications research for specific military problems
- Components, subsystems, models, new concepts

35% Industry

Mid Term

**6.3: Advanced Technology Development**  
\$739M (40% of S&T)

Precision Air Drop—  
50 meters



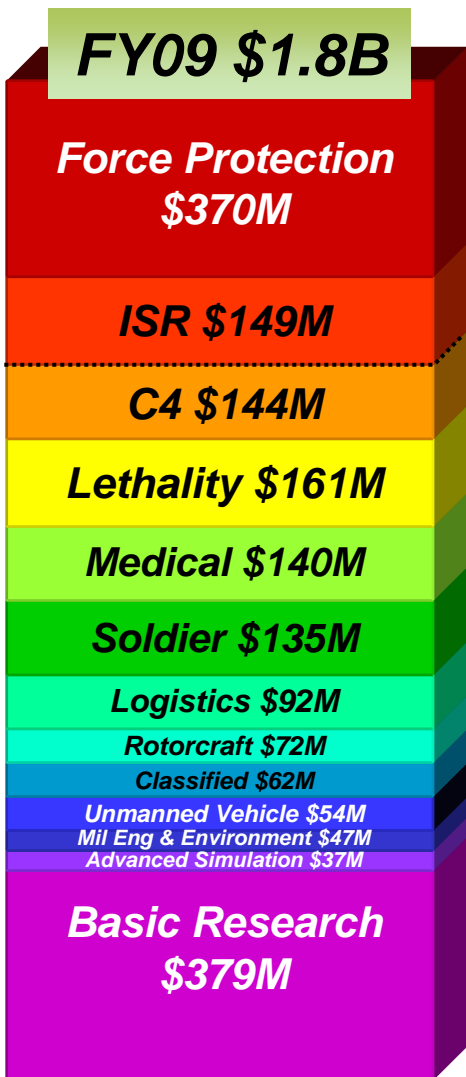
- Demonstrate technical feasibility at system and subsystem level
- Assess military utility
- Path for technology spirals to acquisition—rapid insertion of new technology

60% Industry

Near Term



# Technology Area Investments to Satisfy Gaps—New Capabilities



## Current Force Capability Gaps Areas



6<sup>th</sup> Gap Analysis

1. Protect Force in Counterinsurgency Operations
2. Networked Enabled Battle Command
3. Logistics and Medical in Counterinsurgency Operations (COIN) and non-contiguous battlespace
4. Soldier Protection in Counterinsurgency Environment
5. Tactical Communications
6. Joint Interoperability, Coalition, and Interagency Operations
7. Train the Force How and As it Fights
8. Timeliness of Analysis and Information Dissemination
9. Ability to Conduct Joint Urban Operations
10. Information Operations



## Future Force Capability Gap Areas



CNA FY 10-15

1. Modular, Scalable and Tailorable Battle Command and Control
2. Strategic Force Projection / Intra-theater Operational Maneuver and Sustainment
3. Dynamic, Uninterrupted Communications Network
4. Capability for Lethal / Non-Lethal Overmatch
5. Modular, Tailorable Forces
6. Enhanced Collection, Exploitation and Dissemination
7. Enhanced Soldier Protection
8. Sustainment of Modular Forces
9. Enhanced Platform / Group Protection
10. Ability to Train the Force How and As it Fights

*Enabling the Future Force*

*Enhancing the Current Force*



# Future Force Technologies

## Force Protection

Army component—Joint High Power Solid State Laser Program



Structural Armor



High Energy Laser

KE Active Protection System



Integrated Rotorcraft Protection

## C4/ISR



Knowledge Fusion

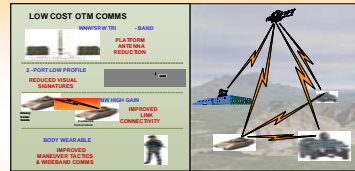


Sense Thru Wall



Flexible Displays

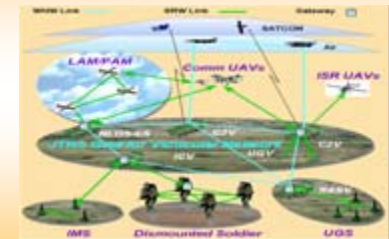
## Advanced Antennas



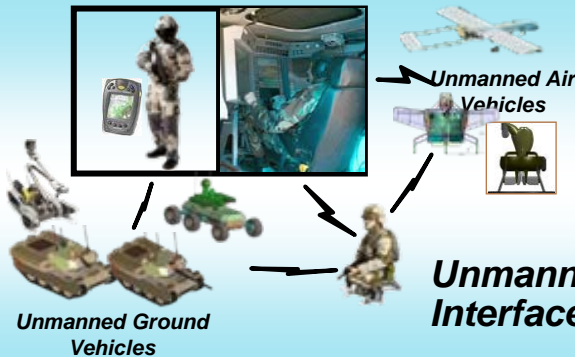
Tactical Network & Communications Antennas

Directional Antennas

## Tactical Mobile Networks



## Unmanned Systems



Unmanned Ground Vehicles

Unmanned System/Human Interface Technology

## Unmanned Ground Vehicle Technologies

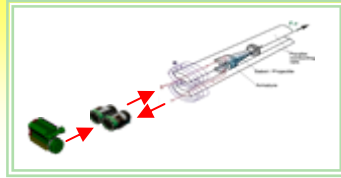






# Future Force Technologies

## Lethality



EM Gun



Warhead Small Arms Technology

Non Line of Sight - Launch System (NLOS-LS)



Scalable Effects

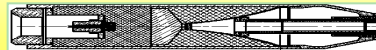


Inert Frags



Reactive Frags

Urban Assault Munitions



<p>Seeker Miniaturization &amp; Cost Reduction</p>	<p>Multi-Purpose Warheads to Defeat Armor, Fortifications &amp; Personnel</p>	<p>Electronics Miniaturization &amp; Cost Reduction</p>	<p>Novel Maneuver Techniques</p>
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Smaller, Lighter, Cheaper Munitions

## Soldier Systems

Combat Rations



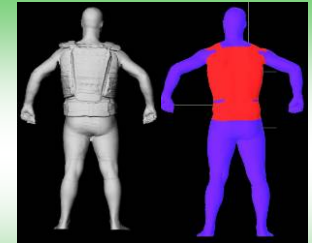
Soldier Mobility and Advanced Load Carriage



System Flame Test



Current New  
LiCFx Half-Size  
BA-5590  
Battery



Armor Coverage

## Logistics

Power & Energy



Hybrid Electric Drive

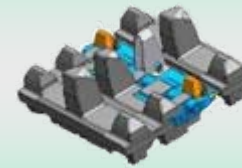
Sustainment

Fuel Cell Development



Advanced Hybrid Engines

Segmented Band track



Deployability



Precision Air Drop 30k lbs



# Future Combat Systems— Spinouts to the Current Force

PROGRAM MANAGER  
**FCS**  
BRIGADE COMBAT TEAM  
One Team-The Army/Defense/Industry

## Manned Ground Vehicles (MGV)

Infantry Carrier Vehicle (ICV)

Command and Control Vehicle (C2V)

Mounted Combat System (MCS)



## Unmanned Aerial Systems (UAS)

Class I UAV

Class IV UAV



FCS 1.1

Reconnaissance And Surveillance Vehicle (RSV)



## Unattended Ground Systems (UGS)

T-UGS

U-UGS



Tactical and Urban Unattended Ground Sensors



Non-Line of Sight Launch System (NLOS-LS)

Common Chassis

Advanced Lightweight Armor

Engine



Non-Line of Sight Cannon (NLOS-C)

Non-Line of Sight Mortar (NLOS-M)



Medical Vehicle Treatment (MV-T)

Medical Vehicle Evacuation (MV-E)

FCS Recovery and Maintenance Vehicle (FRMV)



## Unmanned Ground Vehicles (UGV)

MULE-C

Multifunction Utility/ Logistics and Equipment Countermine and Transport

MULE-T



Armed Robotic Vehicle – Assault (Light) (ARV-A-L)



Small UGV (SUGV)



19 Jan 07

High Technology Army





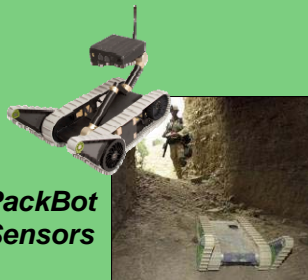
# Technology Insertions for Current Operations

## Benefiting from Past Investments

Interceptor Body Armor



PackBot Sensors



Blue Force Tracking



Guided MLRS



## Adapting/ Accelerating On-going S&T Programs



Mobile Remote Access & Information Diagnostics

Every Soldier A Sensor Simulation



USMC Dragon Fire II with Lightweight Counter Mortar Radar (LCMR)

Mine Detecting Ground Penetration Radar (GPR)

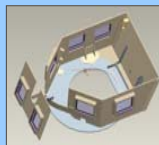


## Leveraging Scientist & Engineer Expertise



Enhanced Rocket, Mortar & Sniper Detection

RG-31 Engineer Vehicle Add-on Armor Kit



Hellfire Launch On Predator

HMMWV Expedient Armor







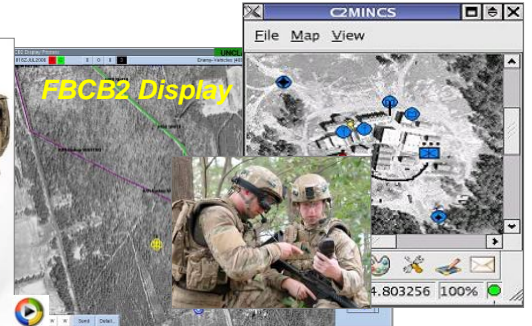
# Accomplishments—2007



MCS



**Future Force Warrior (FFW)**



Mid-Range Munition



Line-of-Sight Multi-Purpose



Low Cost Accuracy Improvement for LOS Munitions

**Mounted Combat Systems & Abrams Ammunition System Technologies**

**C4ISR—On The Move Experiment**



Buffalo



MRAP



HMMWV

**Add On Armor & EW Subsystems**



**Battlemind Training**



# Basic Research Thrusts

*Revolutionize military training and mission rehearsal through the development of technology and art for simulation experiences and the development of virtual human technology*

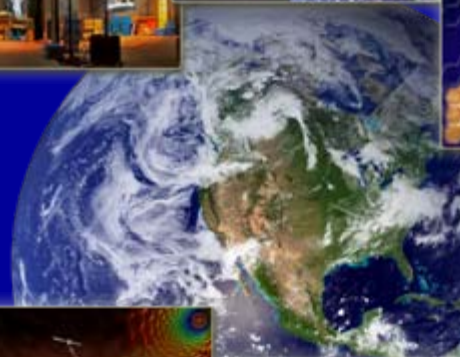


*Research in human-engineered and biologically-evolved networks to improve performance, increase reliability and enhance network-centric mission effectiveness*



*Research to understand biological construction of novel materials, structures and processes to develop biologically-derived materials, sensing systems, information processing and power and energy*

*Discover, develop and exploit robotic devices and systems with highly sophisticated sense, response and processing systems approaching that of biological systems to dramatically enhance Soldier survivability*



*Research in understanding the functional brain to improve training techniques, human-machine interface design, the nature of traumatic brain injuries, and to more fully understand the decision-making process*

*Discover and create new materials with properties that will revolutionize military technology and make Soldiers less vulnerable to the enemy and environmental threats*



*Generate advances in quantum sciences that will enable revolutionary approaches to information processing, cryptography, information assurance, and communication*



# Predicting the Future

---

***It's tough to make predictions, especially about the future. Some famous technology predictions include:***

- ***“Heavier-than-air flying machines are impossible.”***
  - *Lord Kelvin, 1895*
- ***“Airplanes are ...of no military value.”***
  - *Marshal Ferdinand Foch, 1911*
- ***"Who ... wants to hear actors talk ?"***
  - *H. M. Warner, 1927*
- ***"... (T)here is world market for maybe five computers."***
  - *T. Watson, IBM Chairman, 1943*
- ***"640k (RAM) ought to be enough for anybody."***
  - *Bill Gates, 1981*





# Army S&T... Engine of Transformation





**RDECOM**

CERDEC Contributions  
to Army Battle  
Command Networking  
Efforts



***TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.***

**Mr. David Jimenez**

**Director, Space & Terrestrial Communications Directorate**



## Civil War



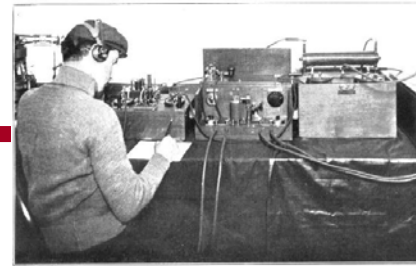
U.S. Army Signal Corps (1860)



Telegraph



WWI Pigeon, Mocker



Clark Portable Army Radio Set (1906)

## World War I

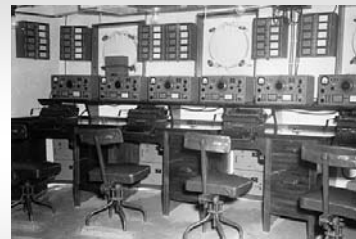
## Vietnam



PRC-77



PRT-4 & PRR-9



WWII Radios



United States Army Pigeon Service

## World War II

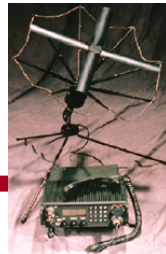


PRC-6

## 1980s-2006+



MSE



Manpack UHF SATCOM



SINGARS

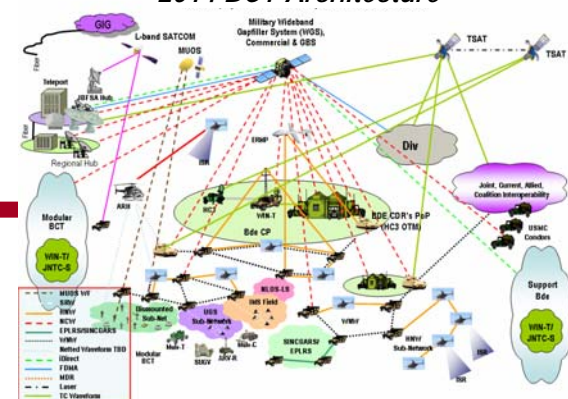


EPLRS

## Tactical Internet



## 2014 BCT Architecture





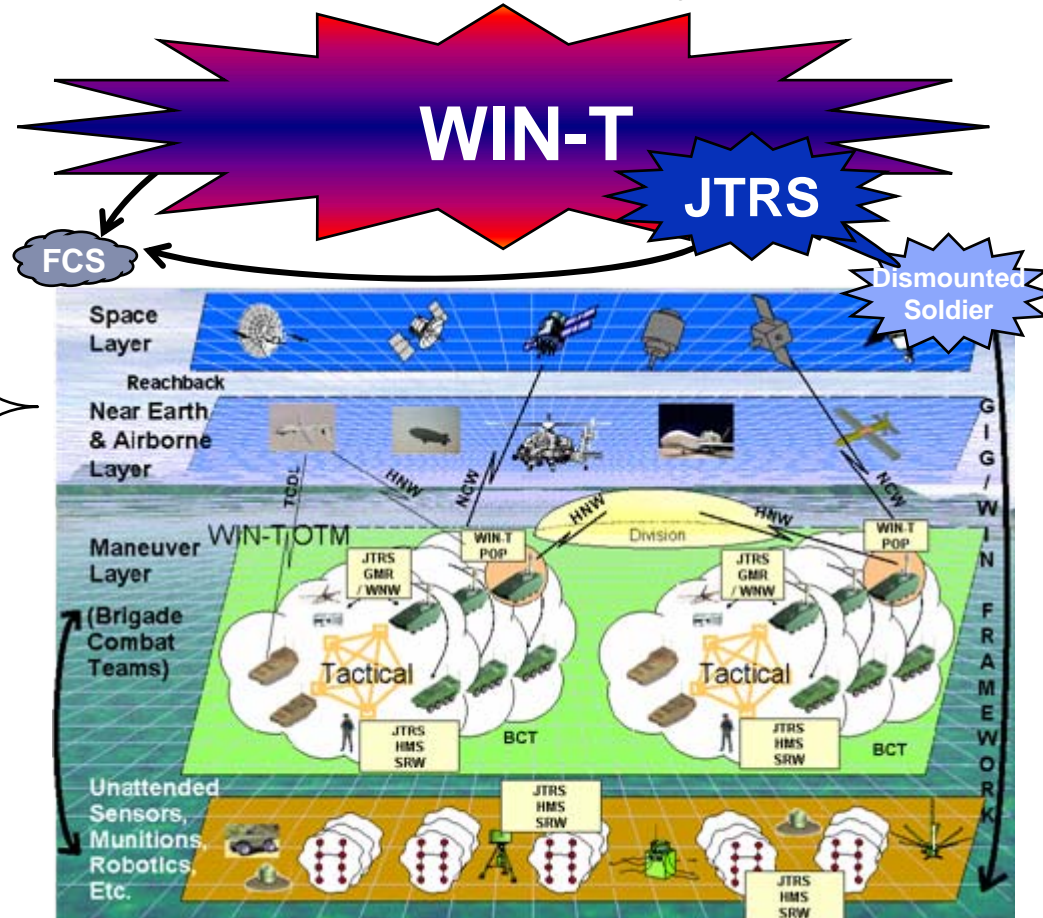
**Connectivity**

**Capacity**

**Security**

## Future Force Comms Systems

- Mobile Networking
- Antennas
- Information Assurance



**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

## Commercial

- Mobile Subscriber, Fixed Infrastructure
- Pre-configured Networks
- Tall, Fixed Antenna Towers
- Fiberoptic Internodal Connections
- Spectrum Availability
- Fixed Frequency Assignments
- Protection: None ⇌ Privacy (single level)
- Interference Rejection is Somewhat Important
- Low probability of Detection (LPD) is not an issue

### COMMERCIAL



High Bandwidth

### TACTICAL



Small Bandwidth



Primarily Robust Static Infrastructure



Radio-Based Highly Mobile Comms



Highly Skilled Large Teams



MOS w/Multi-duties

## Military

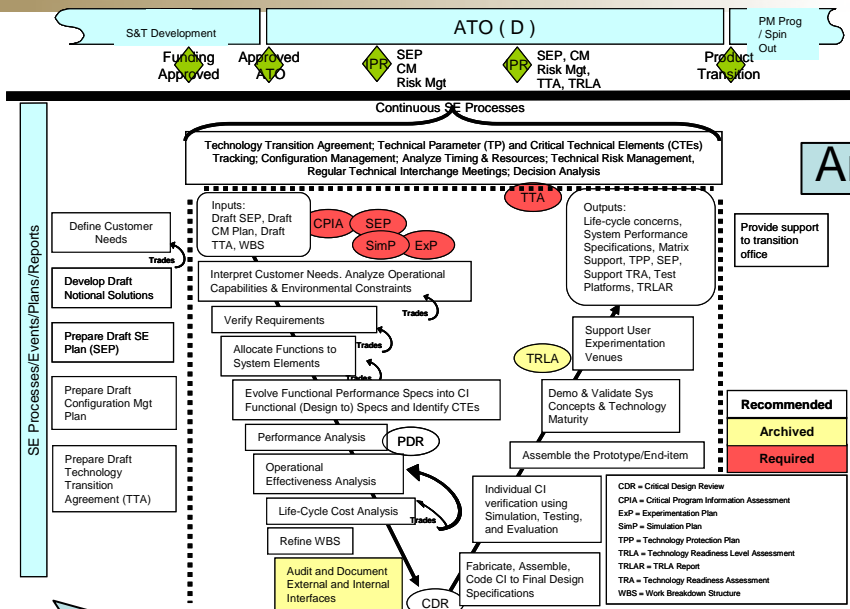
- Mobile Subscriber - Mobile Infrastructure
- Ad Hoc, Self Organizing Networks
- Small, Easily Erectable Masts; Low Profile OTM Antennas
- Mobile, Wireless, Internodal Connections
- Restricted Frequency Assignments; Geographically Impacted
- Protection: None ⇌ Top Secret/ SI (Multiple, Simultaneous Levels)
- Interference Rejection and Antijam are Critical
- Low Probability of Detection (LPD) is Critical

**Strategy =**

*Adopt*

*Adapt  
Modify*

*Develop and/  
or Influence*



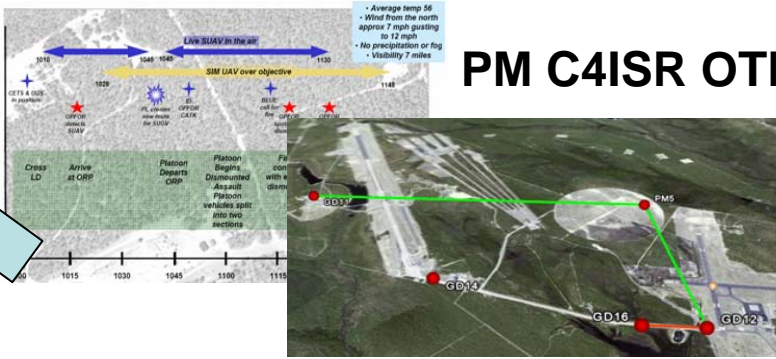
Analysis

Applied to Customers Requirements:  
 FCS BW for BC  
 FCS Voice Architecture Study  
 FCS Network Assumptions Whitepaper  
 Tactical Network Ground Forces Study  
 Etc....

Test & Validation

Lessons Learned

## SE Process



- Architecture**
- Operational Views
  - System Views
  - Technical Views
  - Network Model Development



- Network M&S**
- OPNET
  - CES/QUALNET
  - NETWARS

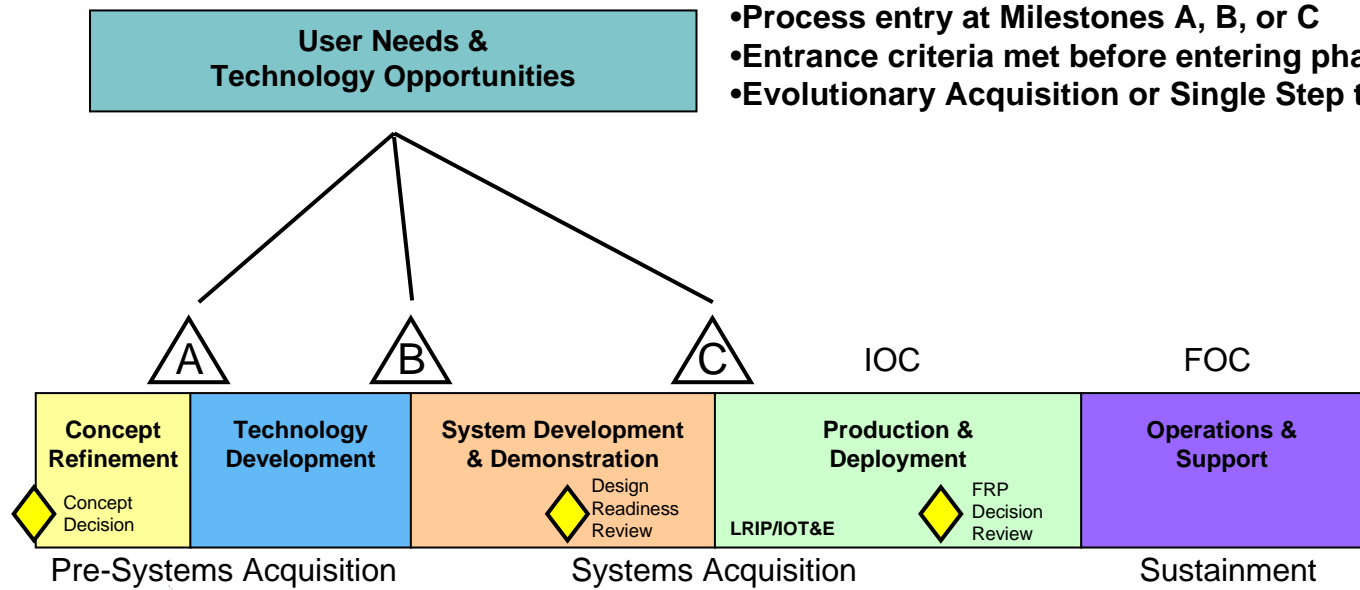


- Field & Experimental Testing/Evaluation**
- PM C4ISR OTM
  - Data Collection



**Emulation**

**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**



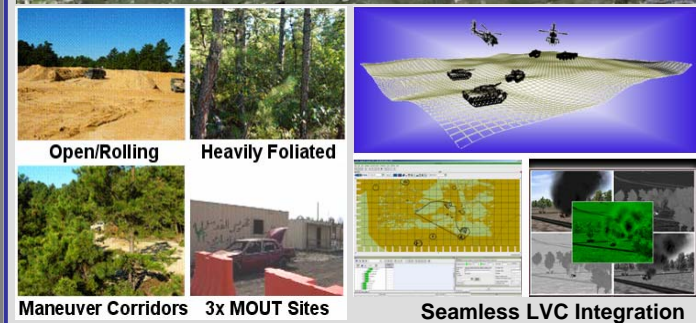
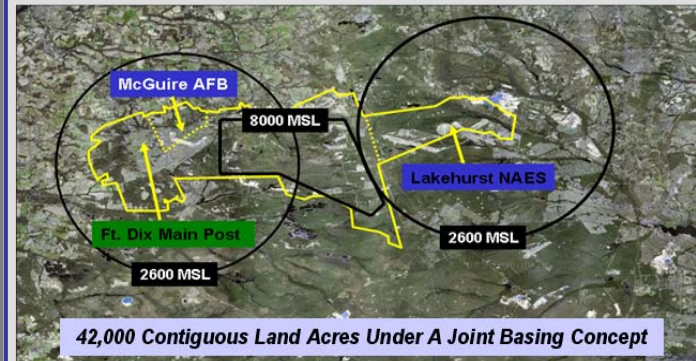
*Validating TRL's & Supporting POR's  
Milestone Decisions*





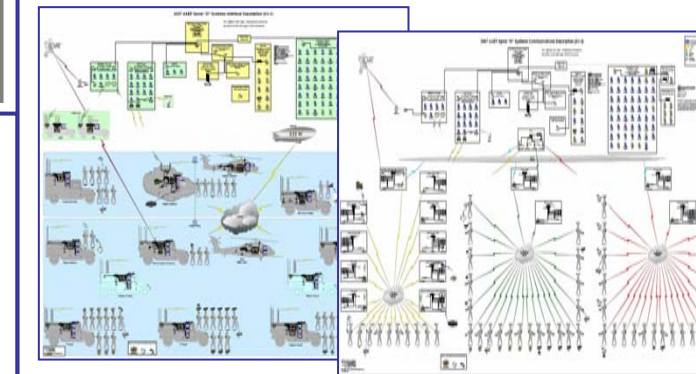
- R&D **venue** offering the **Tech Base** and **Programs of Record** a **continuous** and enduring **evaluation** capability for Network Centric Warfare (NCW) concepts
- Conducts Live, Virtual, and Constructive **technology demonstrations** currently supporting scales on the order of **100 live and 3,000 virtual/constructive** entities
- Provides a **relevant environment** to assess emerging technologies in a C4ISR **System-of-Systems (SoS)**
- **Mitigate risk** for FCS Concepts, Future Force technologies
- Opportunities for **acceleration of technology insertion** into the Current Force
- Venue for **validation of Technology/Software/ Integration Readiness Levels**
- Includes a **state-of-the-art instrumentation, data collection & reduction (IDC&R)** tool suite that supports the quantification of NCW activities
- Employs system of systems engineering methods that promote **rapid SoS reconfiguration** and enable repeatable assessments
- Has a diverse set of experience over the past seven years in working with dozens of government and industry partners to **integrate and execute large-scale, distributed Live/Virtual/Constructive events**

Fort Dix – McGuire AFB – Lakehurst NAES Joint Megabase

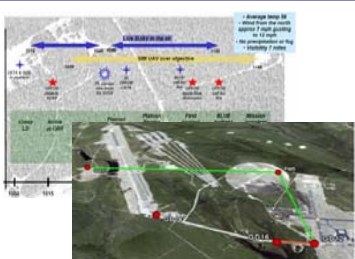


42,000 Contiguous Land Acres Under A Joint Basing Concept

Open/Rolling Heavily Foliated Maneuver Corridors 3x MOUT Sites Seamless LVC Integration



SoS engineering processes & procedures – rapid prototyping frameworks



Seasoned team of subject matter experts & analysts



Warfighters and scientists working side by side



Seven years of field experimentation experience

## Technical Metrics

### C4ISR System Performance

- Network Connectivity
- Message Completion Rate
- Probability of Detection
- Probability of Identification
- Detection Accuracy
- Power Usage
- Visualization Resolution

## System Knowledge

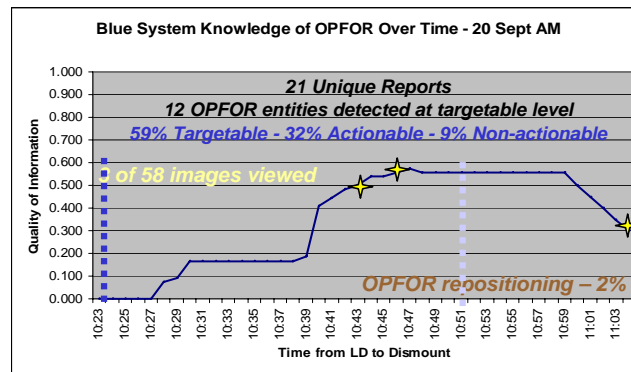
### Quality of Information

- Accuracy, Completeness & Timeliness of Information about Threat
- Level of Situational Awareness Achieved
- Number and Types of Decisions Made

## Operational Metrics

### Soldier Unit Performance

- Time to Execute Mission
- Blue Losses
- Red Losses
- Degree of Surprise
- Ability to Maneuver Undetected
- Number of PIR Satisfied



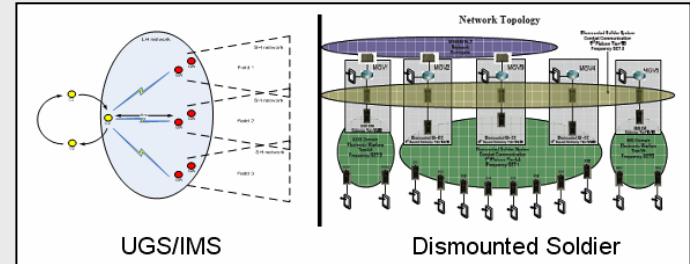
**Quantifying How Technical Performance Impacts Operational Effectiveness**





## PM WIN-T 2007 Increment 2 Engineering Field Test

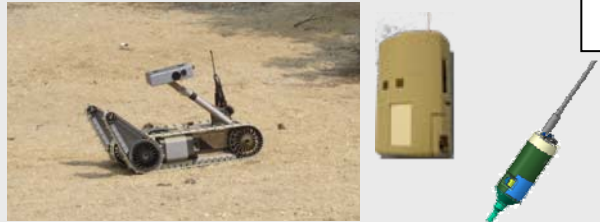
- Critical Technology Elements
- Network Scalability



## JTRS SLICE SRW 2006/7 Technical Field Tests

- Waveform maturation

**PM C4ISR OTM**  
 SEE FIRST  
 UNDERSTAND FIRST  
 AGT FIRST  
 FINISH DECISIVELY.  
**ENABLING THE FUTURE FORCE**



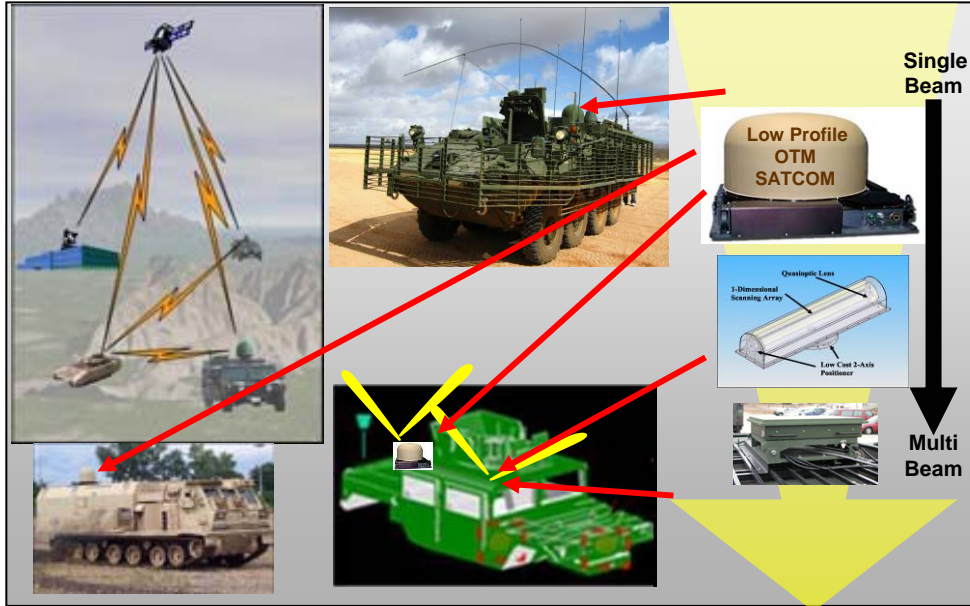
## PM FCS 2007 Technical Field Tests

- SUGV Teleoperation
- T-UGS / U-UGS
- NEBC Technology Transition



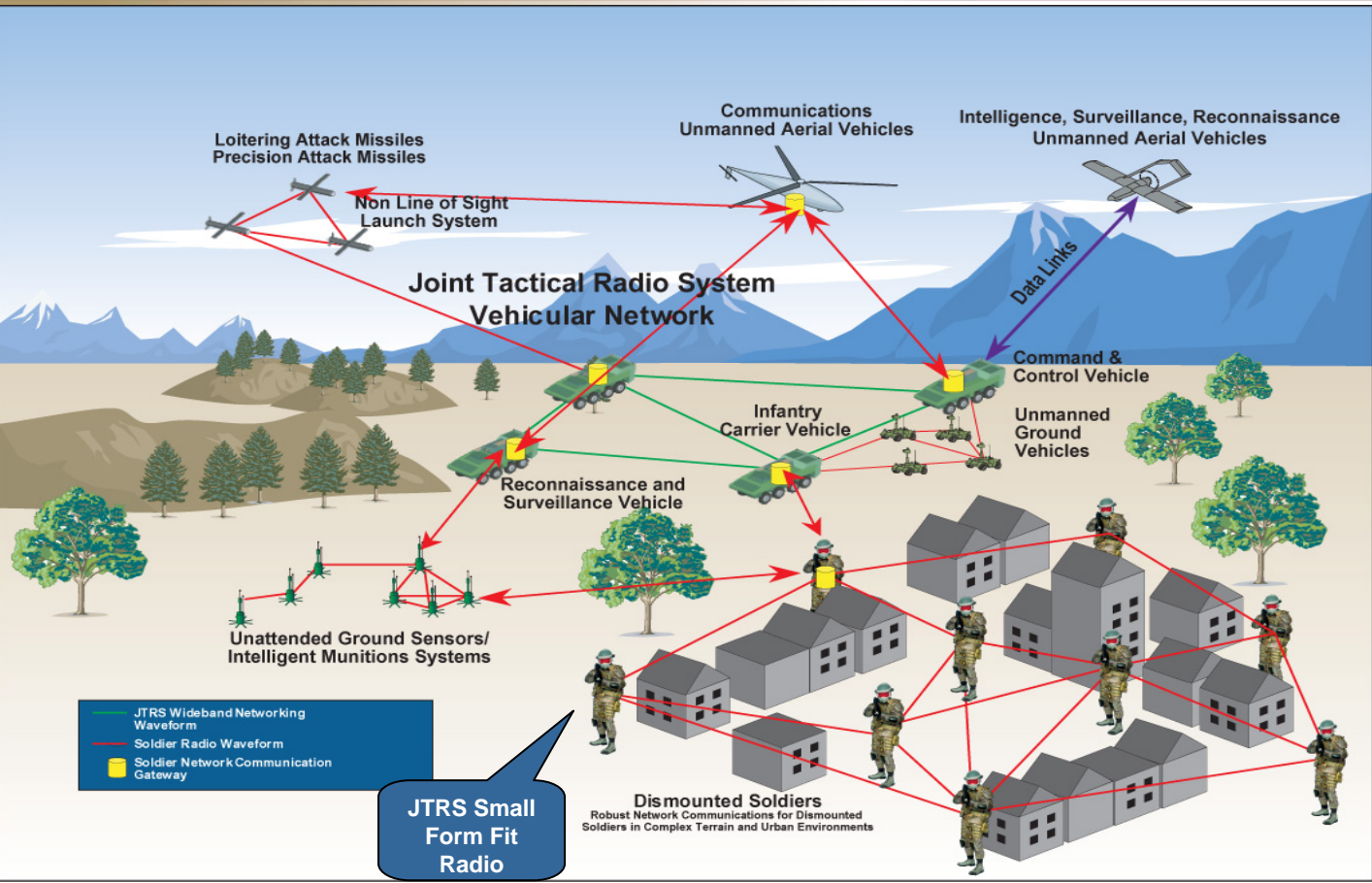
## Natick Soldier Center 2006/7 Future Force Warrior







- Exit Criteria Testing
- Transition to PEO Soldier



- **Body Wearable Antenna Technologies for SRW**
- **2 Port Low Profile Antenna for Wideband Networking Waveform (WNW)/ Soldier Radio Waveform (SRW) bands**
- **Antenna optimization Modeling and Simulation for Command & Control Vehicle (C2V) and Reconnaissance & Survivability Vehicle (R&SV)**

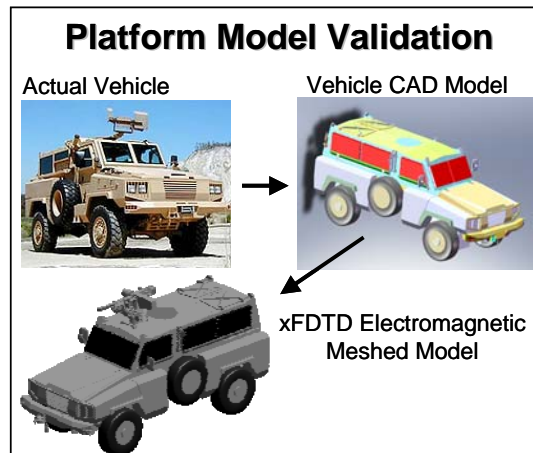
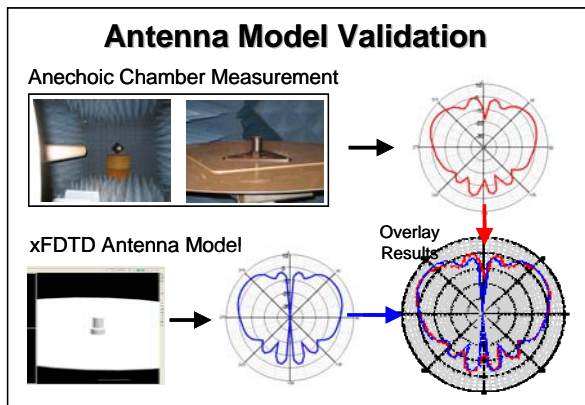
- **Tactical Wireless Network Assurance**
  - **Black Side Intrusion Detection system**
- **Soldier Radio Waveform**
  - **Mobile AdHoc networking for Soldiers, sensors, munitions**
- **Command and Control of Robotic Entities (C2ORE)**
  - **UAV mission planning and execution software autonomously controls multiple UAVs**
  - **Enhances planning and management of unmanned sensor assets (UGS, UAV, UGV, etc)**



-  Ground Soldier System
-  Unmanned Ground Vehicles
-  Unmanned Aerial Vehicles
-  Intelligent Munitions Systems
-  Unattended Ground Sensors
-  Non-Line of Sight-Launch Systems

**The Soldier Radio Waveform is a mobile, ad-hoc, networking waveform developed and transitioned to provide improved voice and data communications, for platforms with Size, Weight, and Power constraints. Hosted on Joint Tactical Radio Systems (JTRS) Handheld Manpack Small Form Factor (HMS) and Ground Mobile Radio (GMR)**





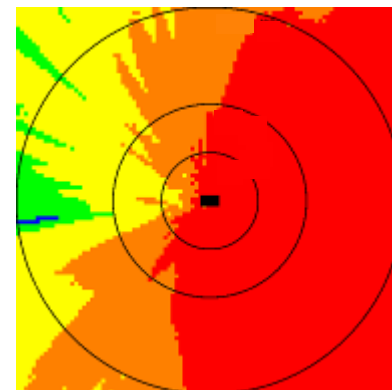
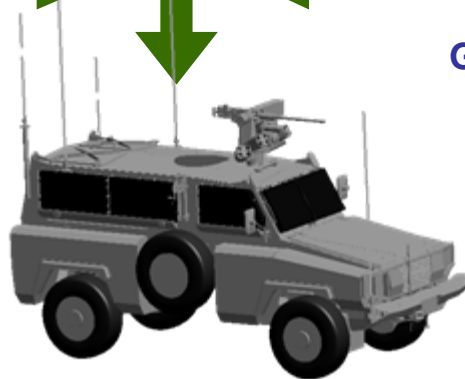
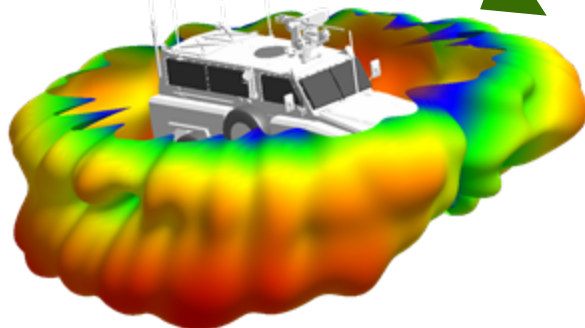
Vehicle Model with Validated Antennas

Finite Difference Time Domain (FDTD) Simulation

Geometrical Theory of Diffraction (GTD) Simulation

360° Far-Field Antenna Gain Pattern

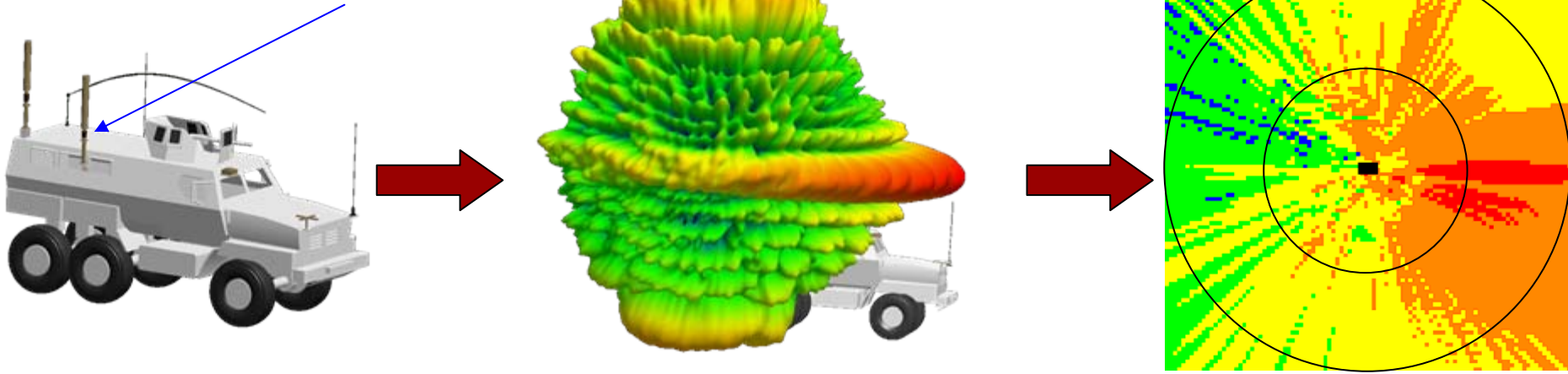
Power Contour Plots



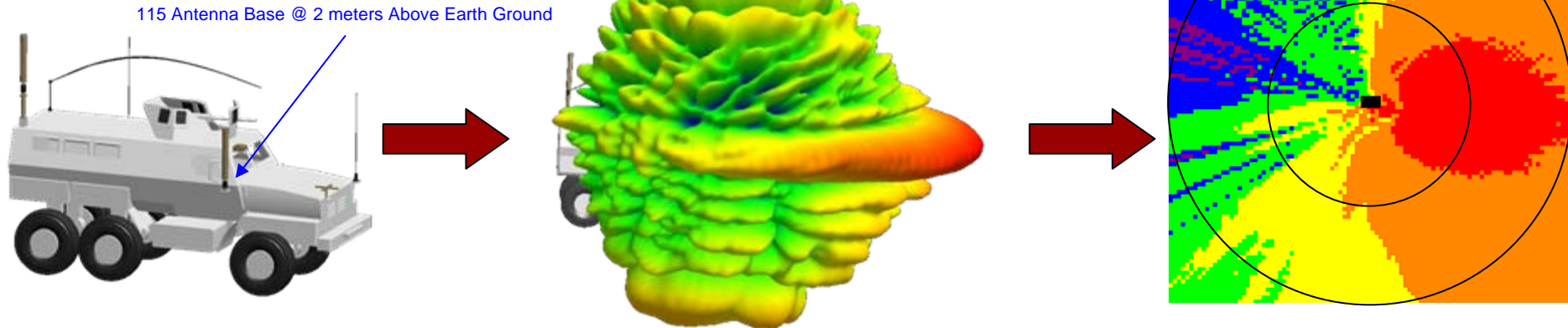
Hybrid M&S Results

# Example: MRAP Antenna Placement Optimization

SPAWAR Recommended Location **Poor Pattern**



CERDEC M&S Placement with **Optimized Pattern**





## Purpose:

- **Develop Affordable, Low Profile Solutions For OTM SATCOM**
- **Develop Affordable Directional Antennas for Terrestrial Directional Networking**
- **Develop Omni-directional Antennas With Higher Gains, Lower Profiles with Ballistic Radomes, and Multiple Ports to Reduce the Number of Platform Antennas**
- **Develop Integrated Antennas for Dismounted Soldier**
- **Develop Distributed Antennas to Improve Omnidirectional Antenna Performance and Reduce Cosite Interference**

## Products:

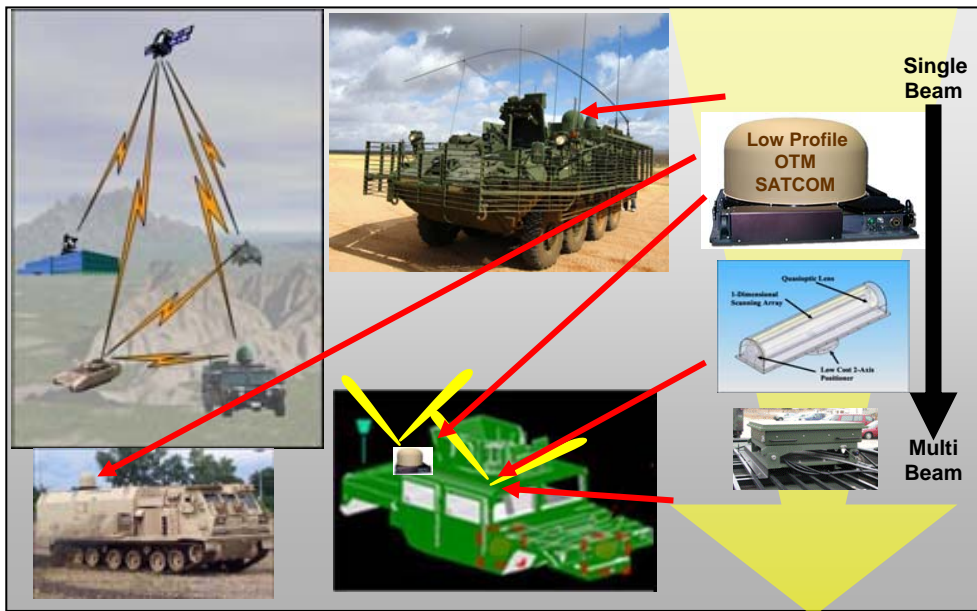
- **Low Cost Ku/Ka Band OTM SATCOM Antenna Systems**
- **Low Cost X-band Point Of Presence**
- **Efficient Ku and Ka Band Power Amplifiers**
- **Low Profile Single Beam Ku/Ka SATCOM Ant System**
- **Low Profile Multibeam Ku/Ka/Q SATCOM Ant Analysis**
- **Affordable Terrestrial Directional Antennas**
- **WNW High Gain Omni Antennas**
- **2-Port Low Profile Omni Antennas with Ballistic Radome supporting multiple waveforms (Ground/RW)**
- **3-Port Tri-band Omni Antennas**
- **Integrated Body Wearable Antennas**
- **Distributed Antenna Array**

## Payoffs:

- **Affordable OTM SATCOM and Terrestrial Directional Ants.**
- **Reduced Visual Signatures & Antenna Counts**
- **Improved Link Connectivity and Ballistic Protection**
- **Reduced Platform Power Consumption**

**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**





### Purpose:

- **Develop, mature, and demonstrate low profile antennas for directional and satellite communications (SATCOM) on-the-move (OTM)**

### Products:

- **Low-profile, single-beam (Ku/Ka) antenna**
- **Low-profile, multi-beam (Ka/Q) antenna**
- **Single-beam high capacity communications capability (HC3) (Ka/Q) antenna**
- **Small aperture blue force tracking (BFT) antenna**
- **C/Ku Affordable Directional Antenna**
- **Integrated Ka/Q-band Power Amplifier**

### Payoff:

- **Increased Communications Capabilities at all echelons through greater use of SATCOM OTM**
- **Reduced platform burden through reductions in antenna size, weight, and power(SWaP)**
- **Increased survivability through reduced visual signature**
- **Affordable SATCOM OTM for the warfighter through antenna cost reductions**



## **Purpose:**

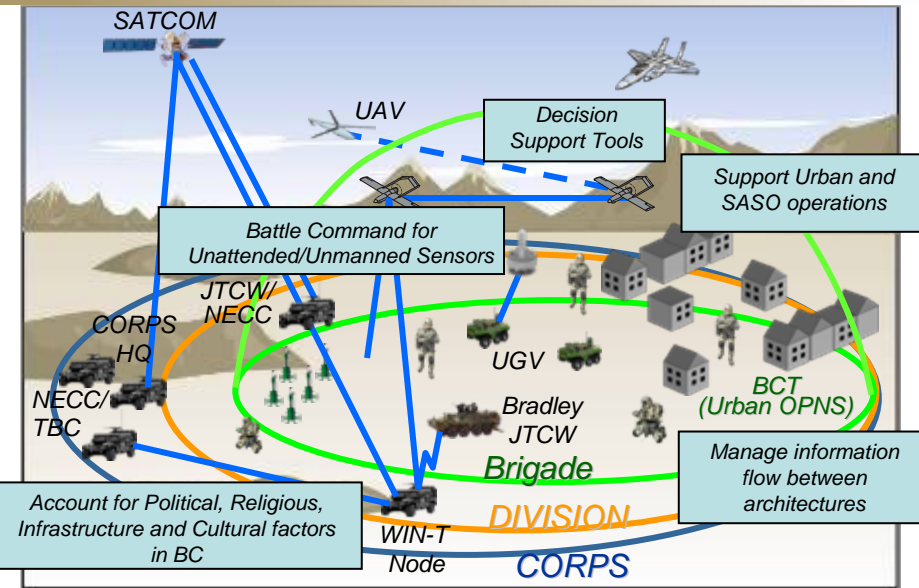
To develop and transition wireless network protection solutions for a tactical Mobile Ad-hoc Networking (MANET) environment that is typical of WIN-T and the Future Force.

## **Product:**

- Tactical security administration tool for mobile wireless environment.
- Intrusion Detection Algorithms for MANET routing protocols
- Tactical Public Key Infrastructure (TPKI)
  - Architecture
  - Certificate Issuance
  - Field Replacements
  - Revocation

## **Payoff:**

- Prevent threat Information Warfare attacks from damaging mobile networks.
- Maintain Warfighter trust/confidence in battlefield information.
- Reduce system and network vulnerabilities.



## Purpose:

**Develop and transition software and algorithms that tailor and manage the flow of Battle Command (BC) information and C2 services between current and future systems throughout all phases of operations and environments**

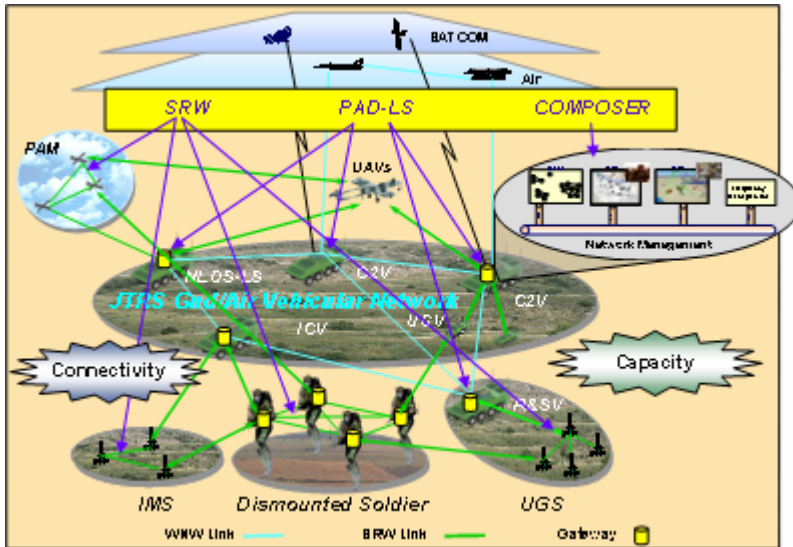
## Products:

- **Battle Command Planning/execution/re-planning products for:**
  - **Dismounted applications in Complex and Urban Terrain**
  - **Current Force Tactical C2 Systems**
  - **Unmanned systems and sensors**
  - **Decision support tools that account for political, religious, cultural and other factors**
- **Managed Connectors that govern the flow of information between disparate architectures while globally managing resources**

## Payoff:

- **Increased speed/quality of BC planning and execution adjustments**
- **Improved commanders' understanding of Battlespace and related factors**
- **Faster decision-making**

**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**



## Purpose:

- Develop Soldier Radio Waveform (SRW) for Dismounted Soldier and manned & unmanned systems.
- Develop communications and networking technologies that address Future Force constraints for bandwidth and connectivity while on the move.

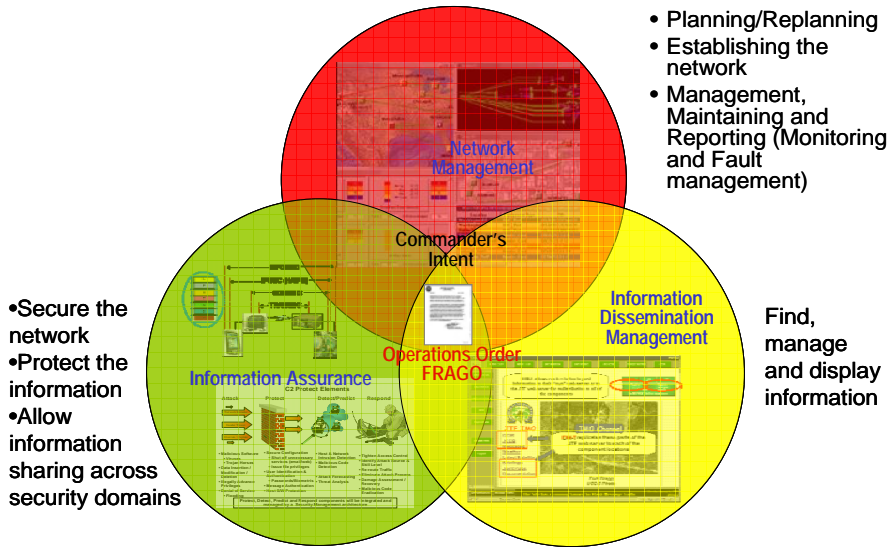
## Product:

- JTRS Software Communications Architecture (SCA) v2.2 compliant, energy-efficient Soldier Radio Waveform (SRW)
- PILSNER Proactive Diverse Link Selection (PAD-LS) algorithms to enhance OTM connectivity and capacity
- Faster than real time dynamic link estimation for connectivity and capacity for Network Management and man in the loop experimentation

## Payoff:

- Energy efficient voice & data tactical communications for Ground Soldier Systems/Future Force Warrior and sensor-to-shooter linkages
- Increased OTM connectivity and usable bandwidth
- Enable commanders to plan communication coverage for OTM Coarse Of Action (COA)
- Addresses PM FCS (BCT) Critical Technology #7B (SRW), Risk #93 mitigation (SRW Availability) to support "Network Ready"





## Purpose:

- Develop, mature, and demonstrate modular tools and technologies that significantly improve the network planning and management of the tactical network
- Develop, mature, and demonstrate security tools to protect mobile networks from attacks and allow information to be shared across security domains
- Develop, mature, and demonstrate agent enhanced Battle Command (BC) tools to enable real time situational awareness and relevant strategic and tactical battlefield information sharing

## Products:

- Automated Network Management (NM) Tools
- Information Assurance (IA) Tools
- Space/Strategic and Tactical Information Dissemination and Management (ID&M) Applications and COA development

## Payoff:

- Reduce manpower and network management configuration time
- Share information across security domains while ensuring trust/confidence in information being sent to the Warfighter
- Improve information sharing by providing relevant information from strategic to a tactical operational unit

**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

- **Affordable Satellite Antennas for Transformation Comm Systems**

- On The Move Multi band, single/multi beam
- Affordable phased array antennas

- **Advanced Wireless Security Services**

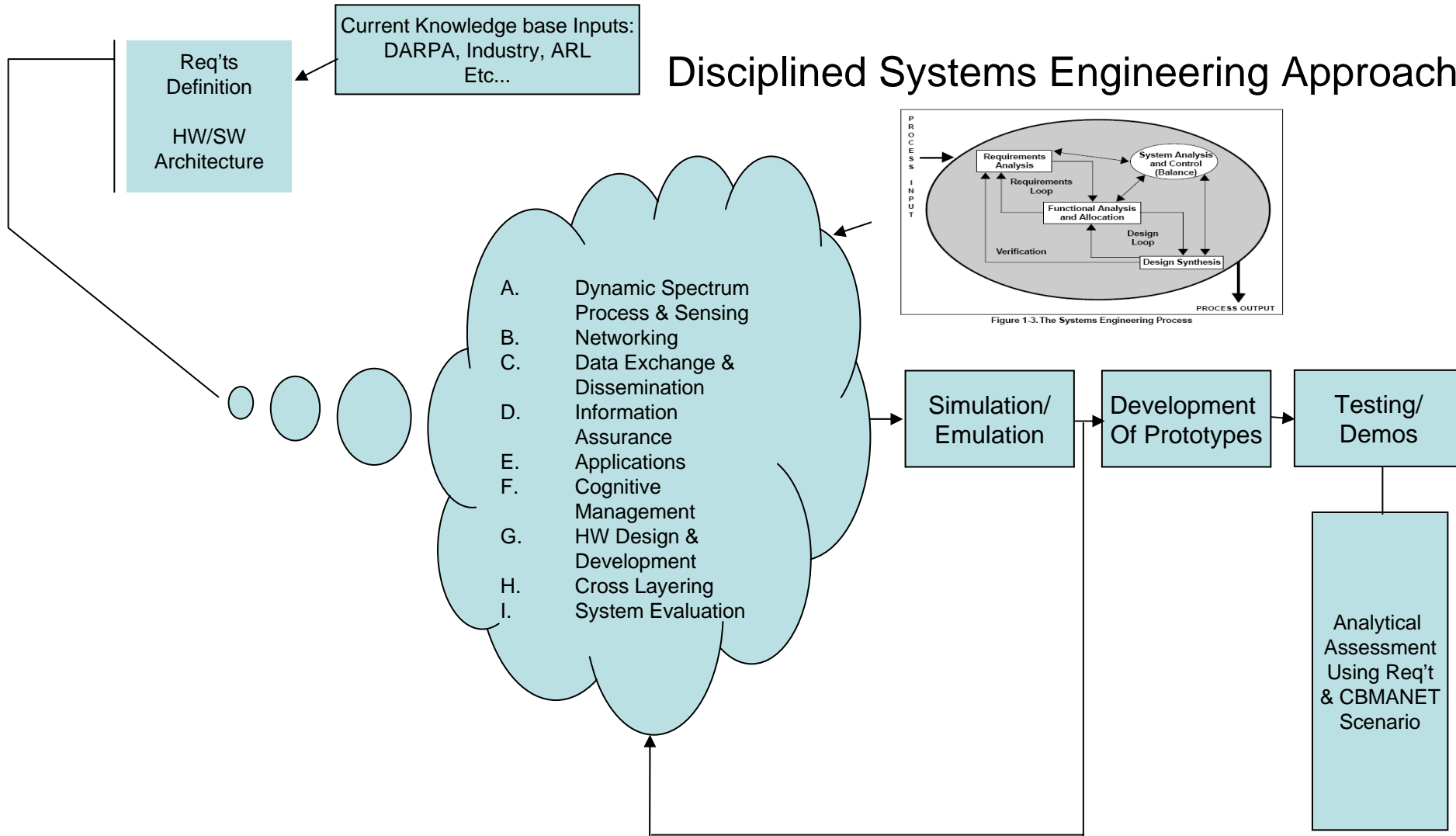
- Integrated Information Assurance (IA) Correlation and Response
- Software Cross Domain Security Services

- **Cognitive Networking**

- Multi-Function RF systems (Radio / EW)
- Dynamic Spectrum Access Capabilities
- Adaptive middleware for applications to adjust to network conditions.



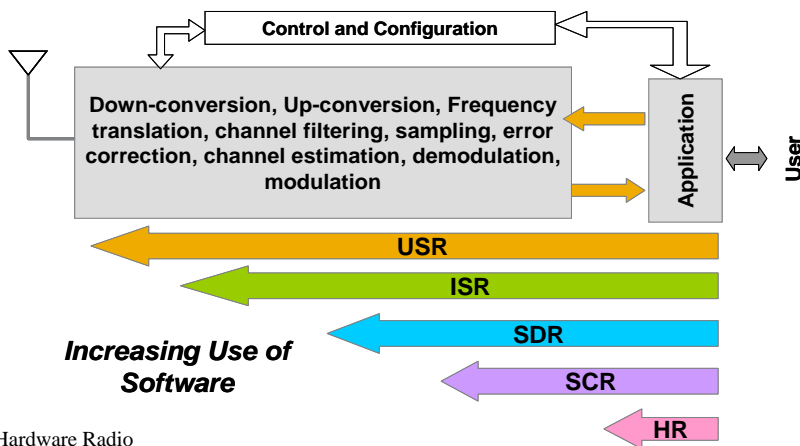
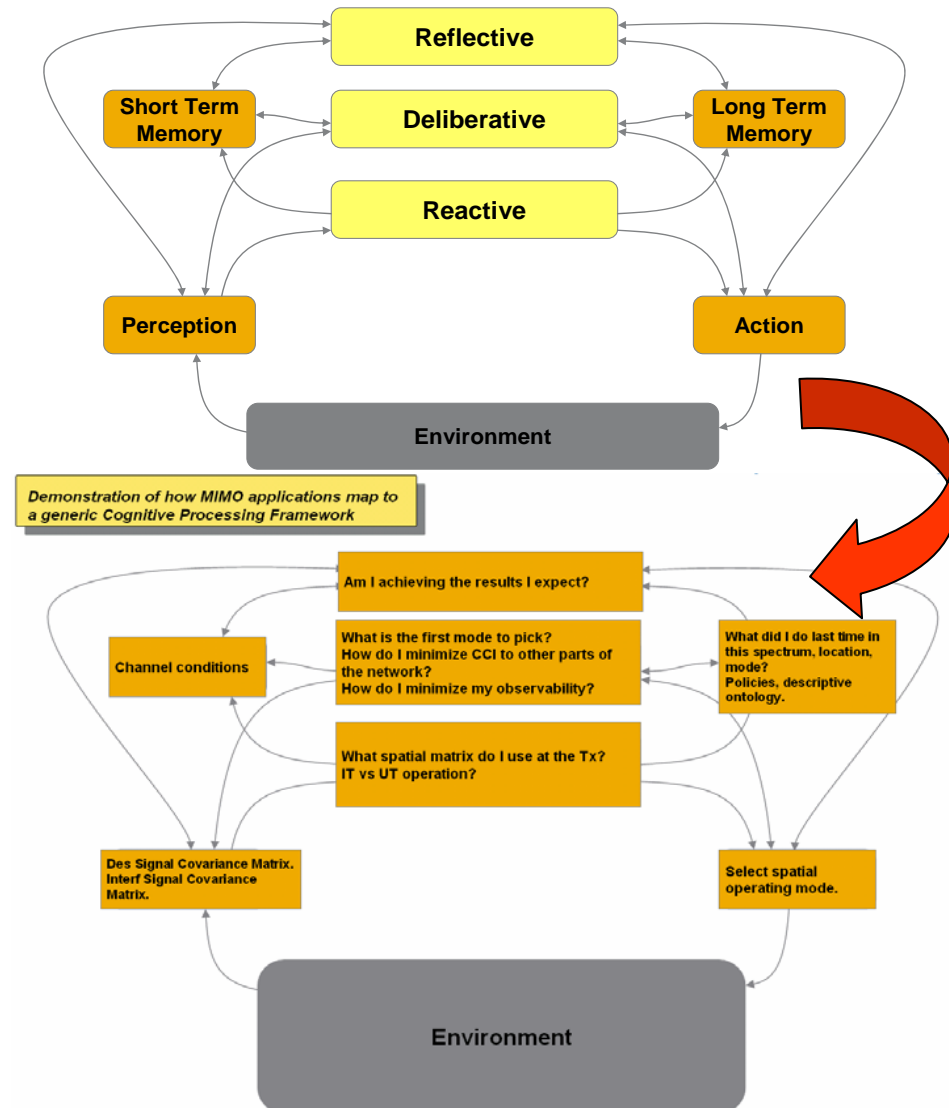
## Disciplined Systems Engineering Approach



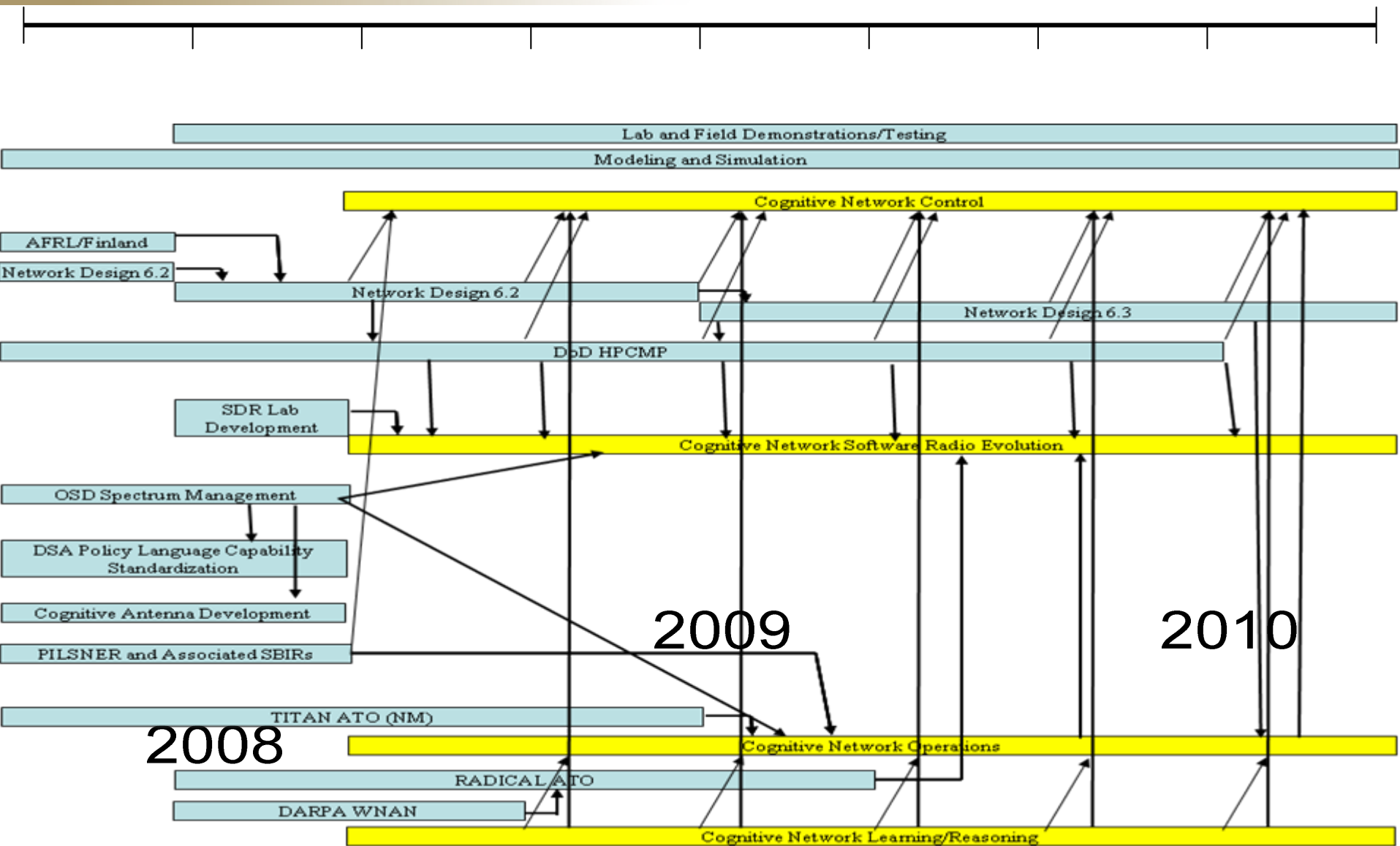
**Description:** A cognitive network consists of technologies that can perceive current network conditions, and then sense, plan, decide and act on those conditions. The network can learn from these adaptations and use them to make future decisions, all while taking into account end-to-end performance goals and user needs

**Benefits:** A cognitive radio has awareness of changes in its environment and adapts its operating characteristics to improve its performance or to minimize a loss in performance

## Generic Cognitive Processing Framework – An Example



- HR – Hardware Radio
- SCR – Software Controlled Radio
- SDR – Software Defined Radio
- ISR – Ideal Software Radio
- USR – Ultimate Software Radio



**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

## Current Radio Architectures

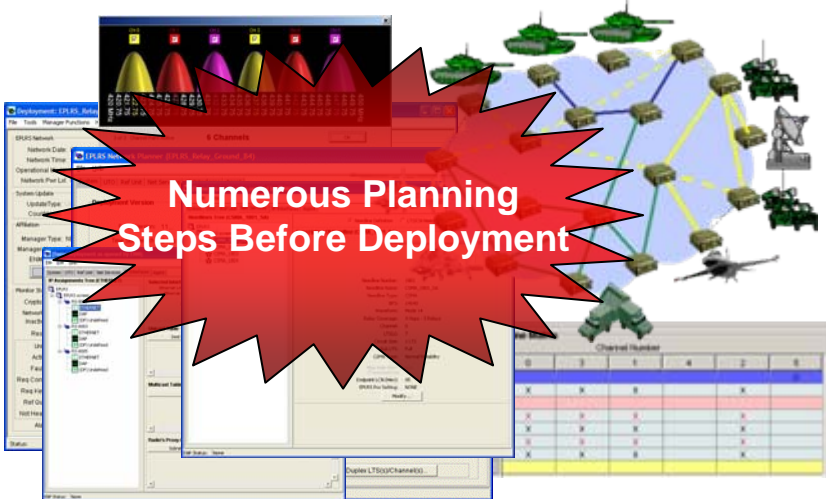
- Extensive planning before deployment
- Detailed organization structure required accounting for every radio
- Detailed definition of Comm. Circuits and static routing procedures
- Intensive training for network development
- Static Network Configuration
- Limited network adjustment
- Individual nodes unaware of conditions experienced by other nodes
- Unaware of context of operation

**Cognitive Radio R&D**

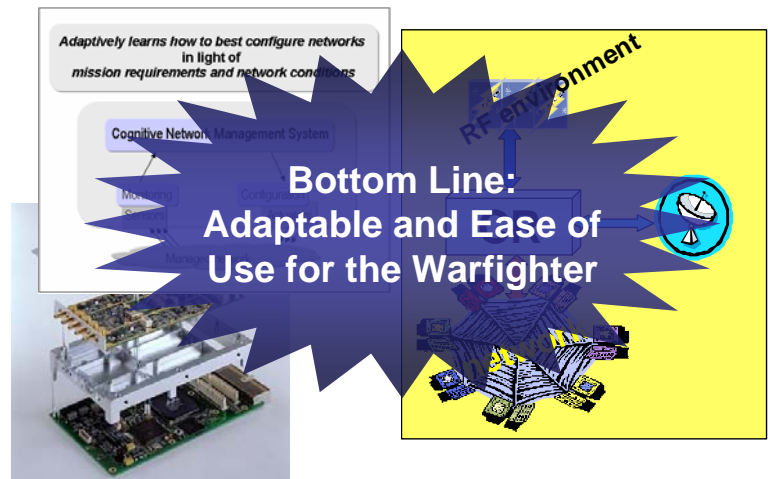
## Future Cognitive Radio Architectures

- Automated Policy Planning
- Policy Adjustment Based on Needs
- Less “Knobs” for the Warfighter
- Lessens training required for operators
- Decisions made to meet requirements of user with minimal interaction
- Variable network configurations in real-time
- Automated response fostering optimum network performance
- Learning from user experiences in entire network to adjust goals
- Automatic adaptation based on changing context

## Legacy Example: EPLRS



**Numerous Planning Steps Before Deployment**



**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

# Questions?



# Model Based Manufacturing – Predicting Future Performance

Jim Lorenz

Manager, Advanced Industrial Engineering

April 17, 2008

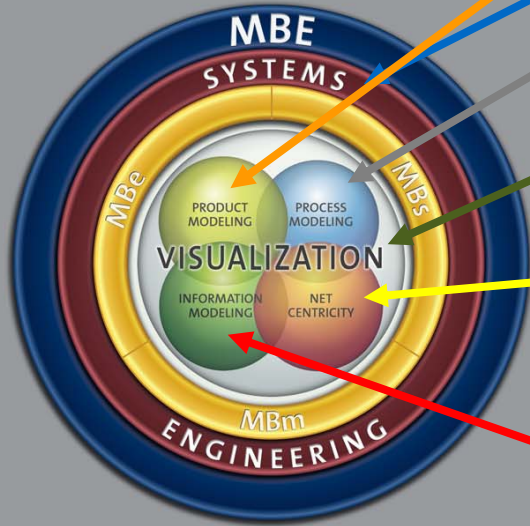
***Rockwell  
Collins***



# Agenda

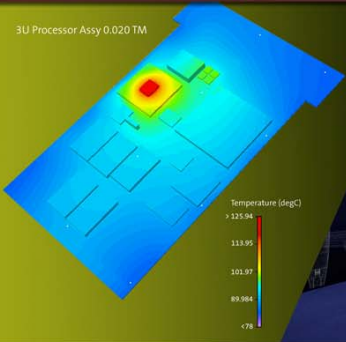
- MBE Overview
- MBm Projects
- MBm/MRL Relationship
- Summary

Model Based Enterprise (MBE).



Product modeling  
 Systems Engineering  
 Model Based Enterprise: An integrated environment that manages and addresses performance and lifecycle requirements, which allows prediction of future performance of a product throughout the life cycle, facilitates efficient use of tools and processes and enables multi-disciplinary decision making throughout the entire life cycle. Information modeling and time supporting multi functional decision making and execution across the extended enterprise making tools and processes

SYSTEMS ENGINEERING



Model Based Engineering (MBe)

Model Based Manufacturing (MBm)

Model Based Sustainment (MBS)

MODEL BASED MANUFACTURING

Enhances performance through integrated simulation and visualization environments.



Process  
Modeling:  
Improve  
process  
efficiency

Product Modeling

- > Optimize design implementation
- > Reduce prototype investment
- > Improve manufacturing yield

Information Modeling

- > Interoperability of like domain tools
- > Interoperability of cross domain tools
- > Reduce life cycle costs

Process Modeling

- > Improve process efficiency
- > Reduce manufacturing variation
- > Enhance inventory management

Net Centric Manufacturing

- > Improve supply chain management
- > Increase effectiveness of manufacturing execution within the enterprise
- > Enhance customer communication



**PDES,  
Inc.**

MBe – Model Based Engineering  
 MBm – Model Based Manufacturing  
 MBs – Model Based Sustainment



Systems Engineering  
 (AP233)

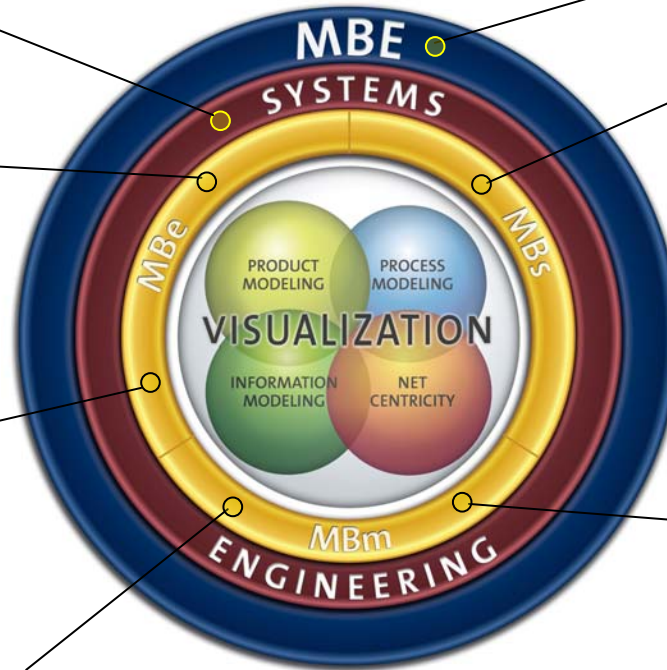
MBE-IF Testing

Engineering Analysis -  
 STEP Composites and  
 CAE Visualization in  
 Adobe Acrobat

System Life  
 Cycle Support

EM Pilot – Warpage  
 Simulation

**Potential MBs Project:  
 Long Term Data Retention**



**Potential MBe Project:  
 ECAD/MCAD Integration**

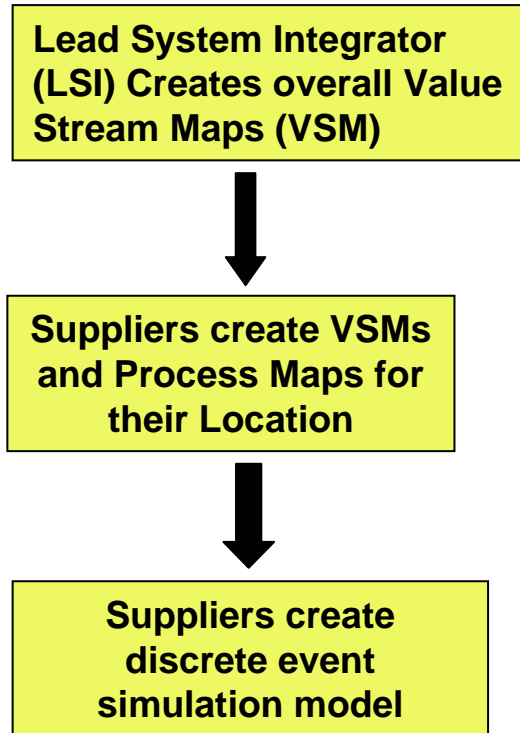
**Value Stream  
 Mapping**

**Flow  
 Equivalent  
 Servers**

**Potential MBm Projects:  
 Next Generation Supply Chain Modeling  
 Integrated Flow Modeling and Physical Layout  
 Design For Ergonomics  
 Cognitive Virtual Environment**



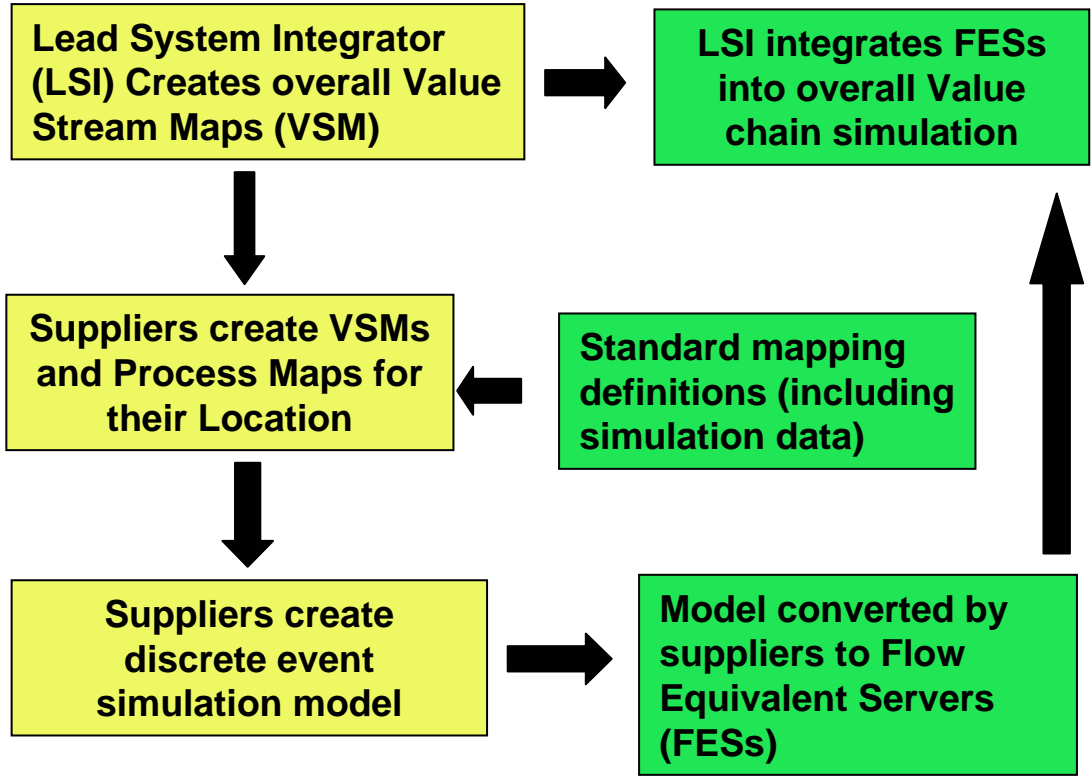
# Process Modeling: VSM to Simulation (Current State)



## Issues with Current State:

- Discrete event simulations are time consuming to create and duplicate much of the effort to generate the VSM
- Suppliers are hesitant to share simulation data because it can include intellectual property
- Inconsistencies in how simulations are done make it difficult to gather information from a large supply chain

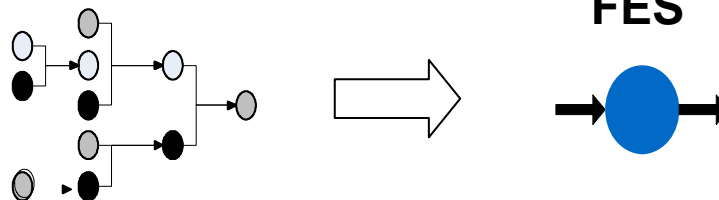
# Process Modeling: VSM to Simulation (Future State)



## Benefits of Future State:

- DESs are easier to generate and more standard
- Enhanced communication between customer and LSI
- Predictive supply chain modeling
- Reduced intellectual property concerns

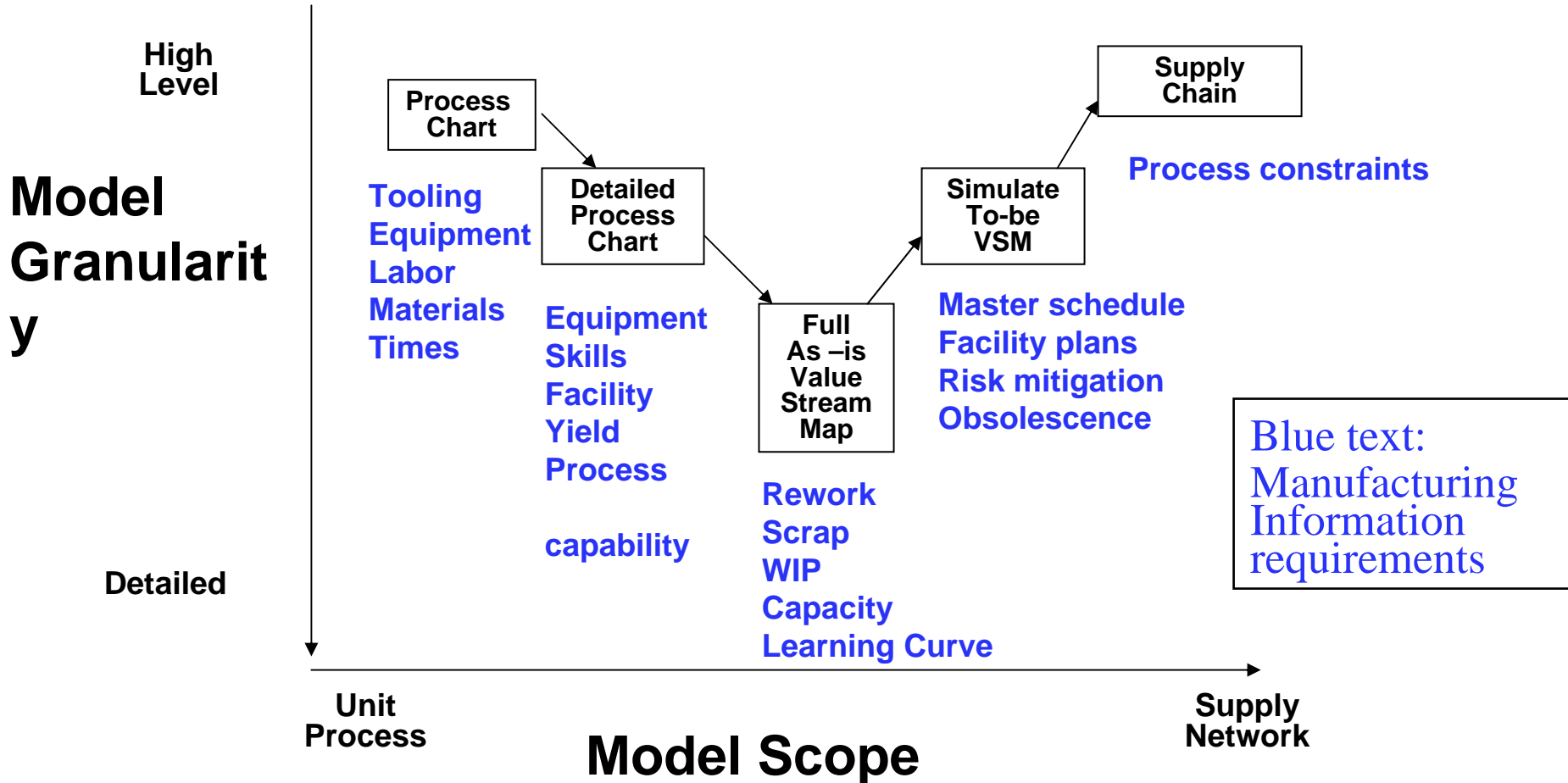
## Complex Network





# Process Modeling within the MRL Structure

MRL 3 4 5 6 7



# Summary

- Manufacturing Readiness Levels assesses whether or not a design will be successful in production
- Model Based Manufacturing provides the ability to predict the performance of products and processes
- Information flow across boundaries requires standard data definition

# Contact Information

Jim Lorenz

Manager, Advanced Industrial Engineering

Rockwell Collins

319-295-8536

[jllorenz@rockwellcollins.com](mailto:jllorenz@rockwellcollins.com)



# Science & Technology Program

## 16 April 2008

**Dr. James Sheehy**  
**Chief Scientist / Technology Officer**  
**Human Systems, AIR-4.6T)**

E-mail: [james.sheehy@navy.mil](mailto:james.sheehy@navy.mil)

Phone: (301) 342-8480

# NAVAIR Sites



## TRAINING SYSTEMS DIVISION, ORLANDO, FL

Center for research, development, test and evaluation, acquisition and product support of training systems for the world.



## AIRCRAFT DIVISION, LAKEHURST, NJ

Provides aircraft launch and recovery expertise to the fleet.



## AIRCRAFT DIVISION, PATUXENT RIVER, MD

Provides acquisition management, research and development capabilities, air and ground test and evaluation, aircraft logistics and maintenance management for Naval aviation.



## WEAPONS DIVISION, CHINA LAKE & PT MUGU, CA

Provides our forces with effective and affordable integrated warfare systems and life cycle support to ensure battlespace dominance.



## NAVAIR DEPOT, NORTH ISLAND, CA

Provides comprehensive quality aviation support to the nation's warfighters.

Aircraft: F/A-18 Hornet; E-2C Hawkeye; C-2 Greyhound; S-3 Viking; H-60 Seahawk



## NAVAIR DEPOT, CHERRY POINT, NC

Delivers on time quality products and services for Naval aviation as service to the fleet.

Aircraft: AV-8B, Harrier; H-53, Sea Stallion; C-130, Hercules; H-46, Sea Knight; V-22, Osprey; VH-3, Presidential Helicopter



## NAVAIR DEPOT, JACKSONVILLE, FL

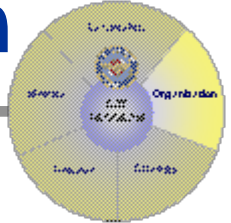
Delivers high quality maintenance, engineering, logistics and support services to the fleet.

Aircraft: P-3 Orion; EA-6B Prowler, F-14 Tomcat, F/A-18 Hornet; S-3 Viking; SH-60 Seahawk

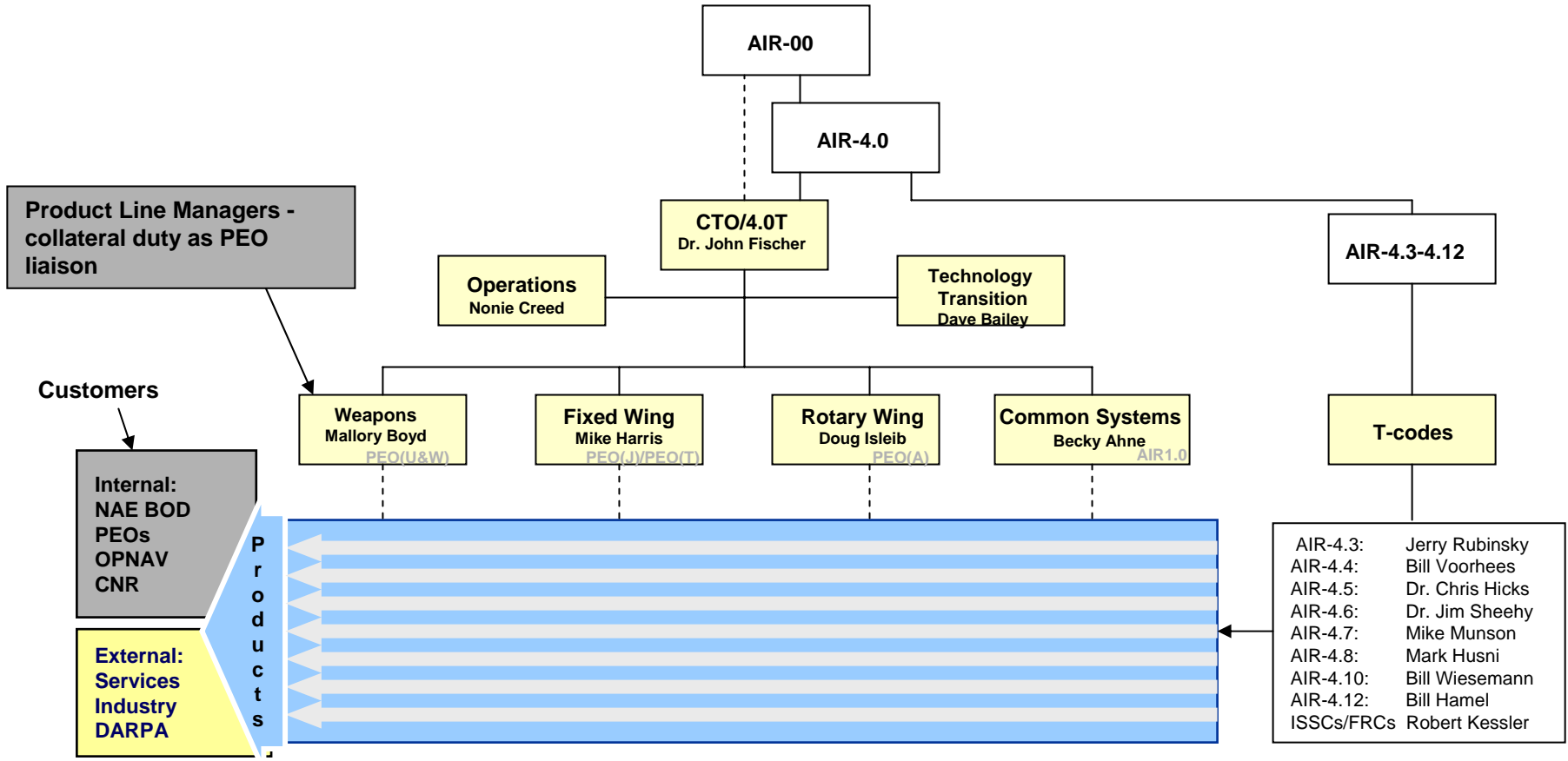




# Science & Technology Organization



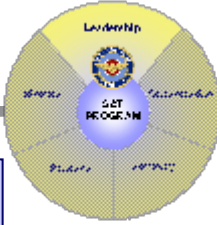
*The S&T Program is managed by an Integrated Program Team of Product Line Managers and NAVAIR Technologists (T-codes)*







# Chief Technology Officer (CTO)



*CTO engages internally and externally to develop an S&T Program that responds to capability needs with innovative technology solutions*

## **External Focus**

- Maintain knowledge of Naval Aviation needs through strong ties to the warfighting community
- Continually seek innovative solutions for warfighter needs. Champion for innovative ideas that do not address a specific need
- Foster relationships with potential technology providers (DoD, Industry, Academia, etc.)
- Support ASN(RDA), Chief of Naval Research and other Enterprise CTOs in planning and executing an effective Navy S&T Program

## **Internal Focus**

- Primary advisor to AIR-00, Naval Aviation Enterprise (NAE) Board of Directors and Program Executive Officers for technology issues & investments
- Advisor to AIR-00 & AIR-4.0 for issues related to S&T workforce & infrastructure, including workforce revitalization efforts
- Monitors health of S&T portfolio and progress toward delivery of capability through the use of approved metrics & processes



# NAE S&T Objectives

- ◆ 32 NAE S&T Objectives
  - Represents the *goals* of the NAE S&T program. Used as the baseline for identifying, prioritizing, aligning, and synchronizing S&T efforts throughout the enterprise.
  - Derived from 340+ capability needs provided by warfighters
  - Developed by a Working Group comprised of warfighters
  - Coordinated throughout the enterprise
  - Aligned with ONR Focus Areas, Joint Capability Areas, and Sea Power 21 Pillars
  - Support scenarios contained in Naval Aviation Capability Needs 2030-2050
- ◆ **NAE STOs will be presented at 18 April NAE BOD meeting for approval/signature**
  - NAVAIR and CNAF already briefed, ready to approve STO Document



## Naval Aviation Enterprise Science and Technology Objectives

Commander Naval Air Forces

Commander Naval Air Systems Command

Director, Air Warfare Division

30 April 2008

\_\_\_\_\_  
VADM Thomas J. Killeline, Jr.  
Commander, Naval Air Forces

\_\_\_\_\_  
VADM David J. Venlet  
Commander, Naval Air Systems Command

\_\_\_\_\_  
RADM Allen G. Myers  
Director, Air Warfare Division



# STO Distribution (by Capability Gap Area)

32 Total STOs

- Force Protection (FP) **(3)**
- Surface Warfare (SUW) **(1)**
- Under Sea Warfare (USW) **(3)**
- Theater Air and Missile Defense (TAMD) **(2)**
- Strike Operations (STK) **(7)**
- Deploy and Employ Forces (DEF) **(3)**
- Integrated Logistics Support (ILS) **(1)**
- Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) **(6)**
- Enterprise and Platform Enablers (EPE) **(1)**
- System Safety, Availability and Affordability (SSAA) **(2)**
- Naval Warrior Performance (NWP) **(3)**

*# of STOs*



# Summary

---

- ◆ NAE is improving the way it plans and manages the S&T program
  - CTO organization
  - Processes
  - Metrics
- ◆ Developed 32 S&T Objectives (STOs)
  - Developed by warfighters, technologists and intelligence community
- ◆ Work closely with ONR to ensure that NAE objectives are communicated and advocated
- ◆ CTO office supports OPNAV efforts in science and technology
  - Identifying capability needs
  - Identifying appropriate funding venue
  - Update on programs/projects



---

**Dr. John Fischer**  
**Director, Systems Engineering (AIR-4.1)**  
**Chief Technology Officer (AIR-4.0T)**

E-mail: [john.fischer@navy.mil](mailto:john.fischer@navy.mil)

Phone: (301) 757-2328



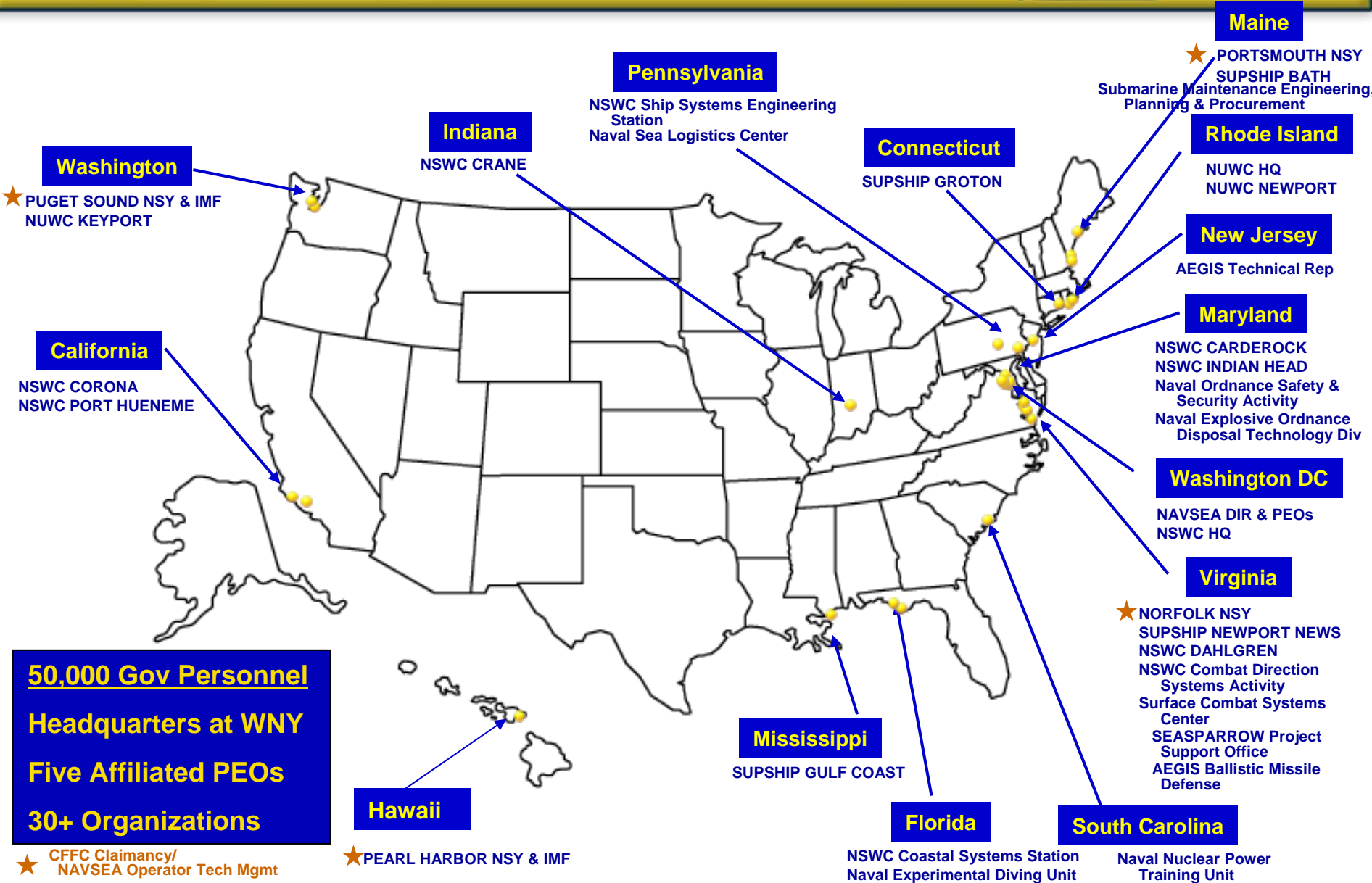
## **INNOVATIVE TECHNOLOGY INSERTION – NAVSEA’S PERSPECTIVE**

### **9<sup>th</sup> ANNUAL NDIA SCIENCE & ENGINEERING TECHNOLOGY CONFERENCE**

**Brian J. Persons**  
**Executive Director**  
**Naval Systems Engineering Directorate (SEA 05)**  
**& Corporate Chief Technology Officer**  
**16 April 2008**



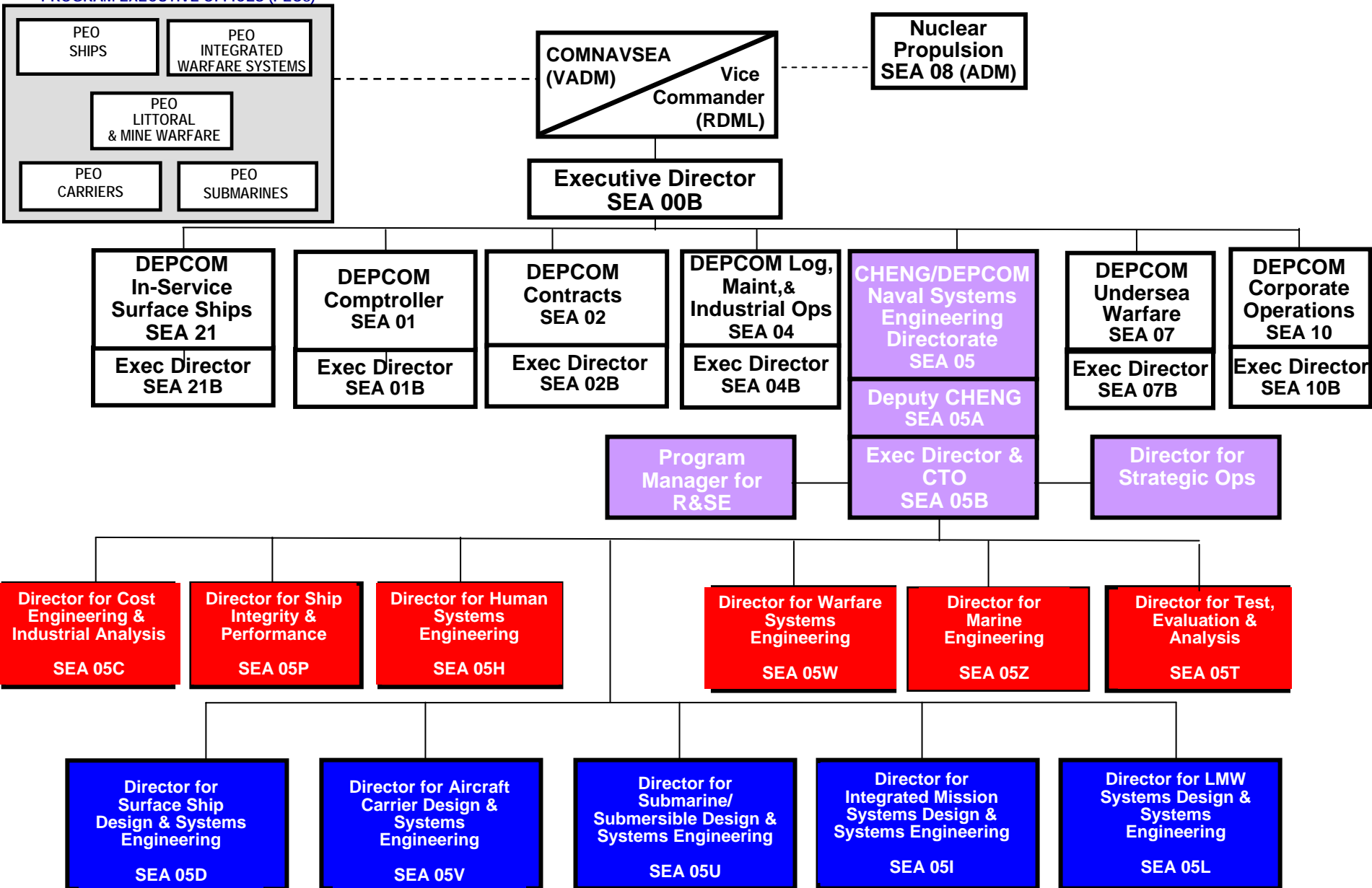




★ CFFC Claimancy/  
NAVSEA Operator Tech Mgmt

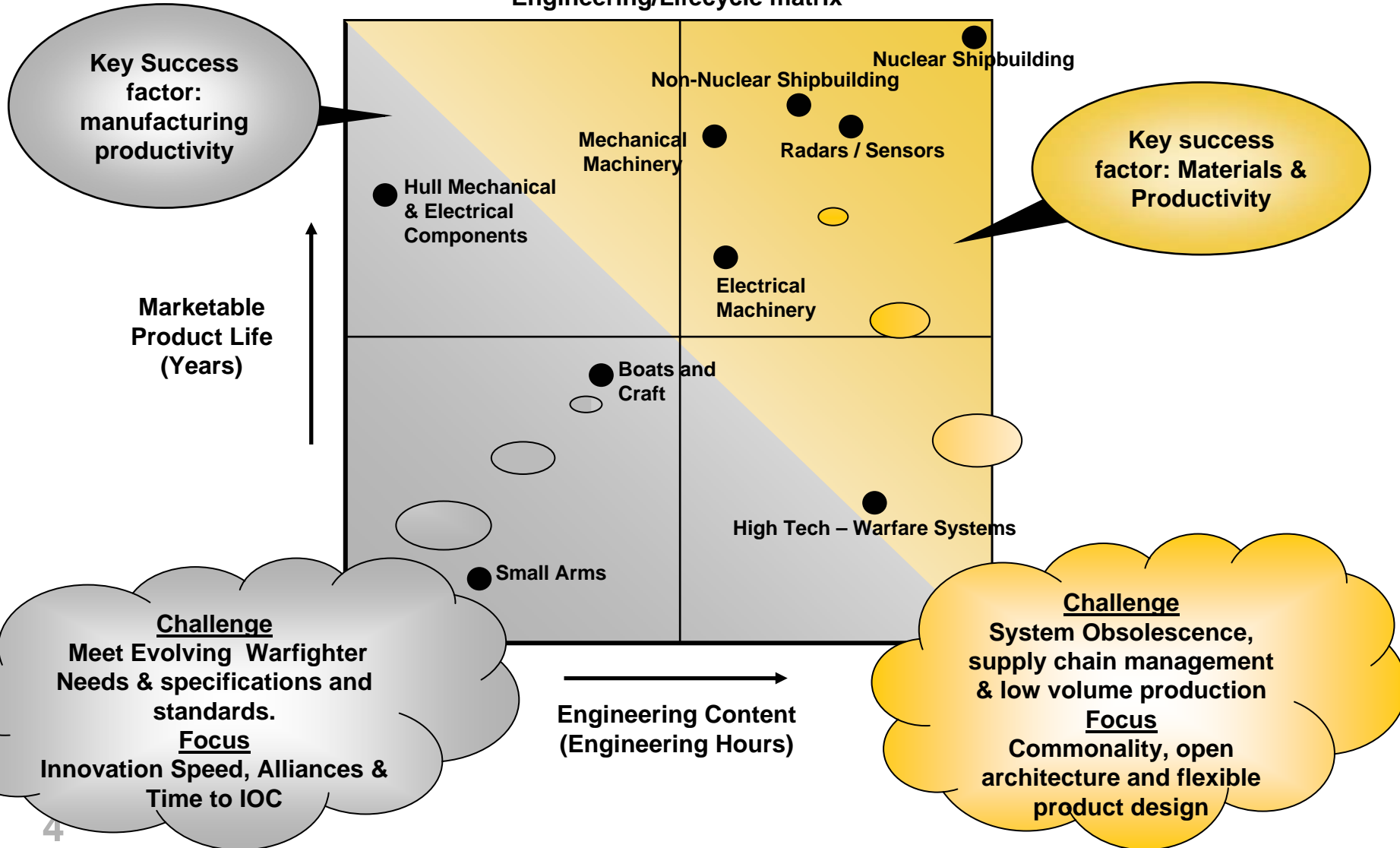
★ PEARL HARBOR NSY & IMF

PROGRAM EXECUTIVE OFFICES (PEOs)



## Delivering A Diverse Portfolio of Products to War Fighter That Meet All of Their Expectations!

Engineering/Lifecycle matrix



- Mr. Michael Bosworth  
Deputy Chief Technology Officer  
(202) 781-3072  
[Michael.Bosworth@navy.mil](mailto:Michael.Bosworth@navy.mil)
- Ms. Lisa King  
NAVSEA CTO Office  
(202) 781-1582  
[Lisa.M.King.Ctr@navy.mil](mailto:Lisa.M.King.Ctr@navy.mil)
- Mr. Dean Putnam  
NAVSEA SBIR Program Manager  
(202) 781-3261  
[Dean.R.Putnam@navy.mil](mailto:Dean.R.Putnam@navy.mil)
- Dr. Delbert (Ace) I  
NAVSEA Warfare Center Science & Technology Executive  
(850) 234-4202  
[Delbert.Summey@navy.mil](mailto:Delbert.Summey@navy.mil)



# Integrating Innovative Battle Command Capabilities

15 April 2008

BG Nick Justice  
Program Executive Officer,  
PEO Command, Control, Communications Tactical

# Agenda

- Understanding the Battle Command (BC) SoS Environment
- Translating S&T Understanding into BC SoS Solutions
- Integrating and Validating New BC Capabilities
- Emerging Innovative Battle Command Technology Examples



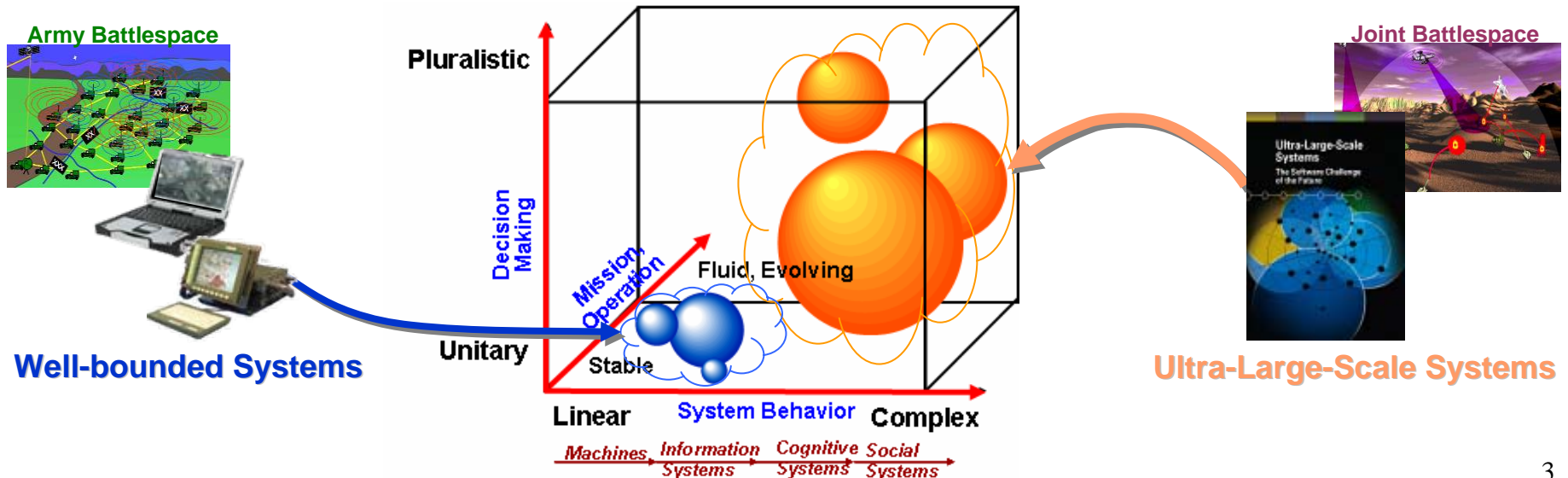
# Understanding the Battle Command SoS Environment

## Driving Factors

- Uncertain strategic environment demands *agile/adaptive responses*
- *Information as* competitive source of *power*
- Demand for enterprise and extended *enterprise-wide solutions*

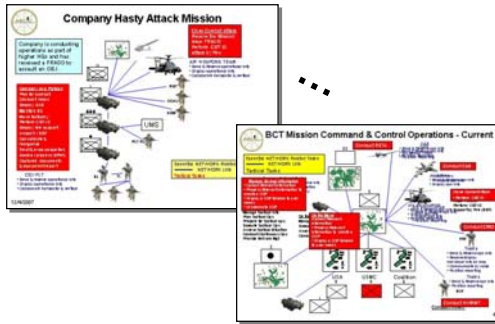
## Solution Characteristics

- Richly *interconnected*; increasingly *interdependent*
- *Cross traditional boundaries...* functional, organizational, programmatic
- *Increasing scale/scope*
- *Increasing complexity*



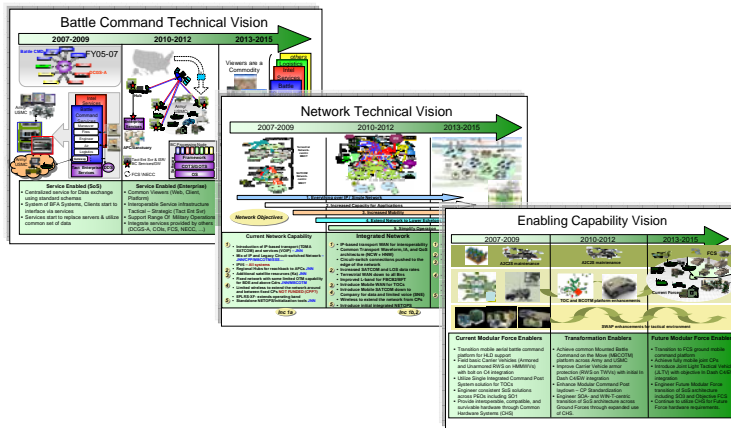
# Army Service-Based Approach for Tactical BC Capabilities

Operational Capabilities



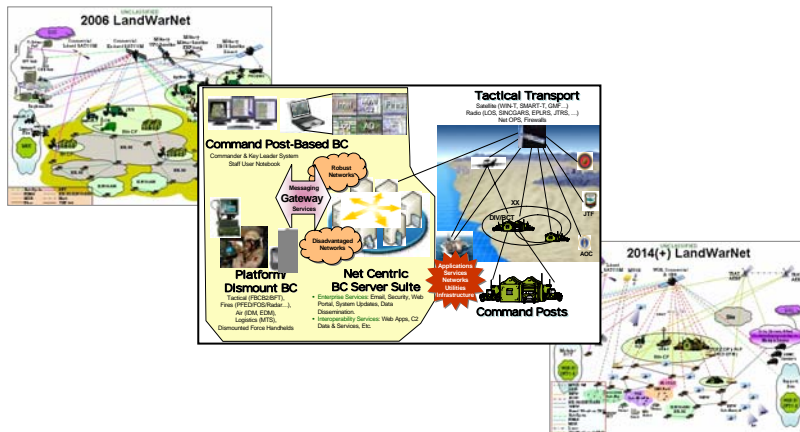
- Establish warfighter operational needs
  - Currently reworking with “Good Enough Take 2”

Services



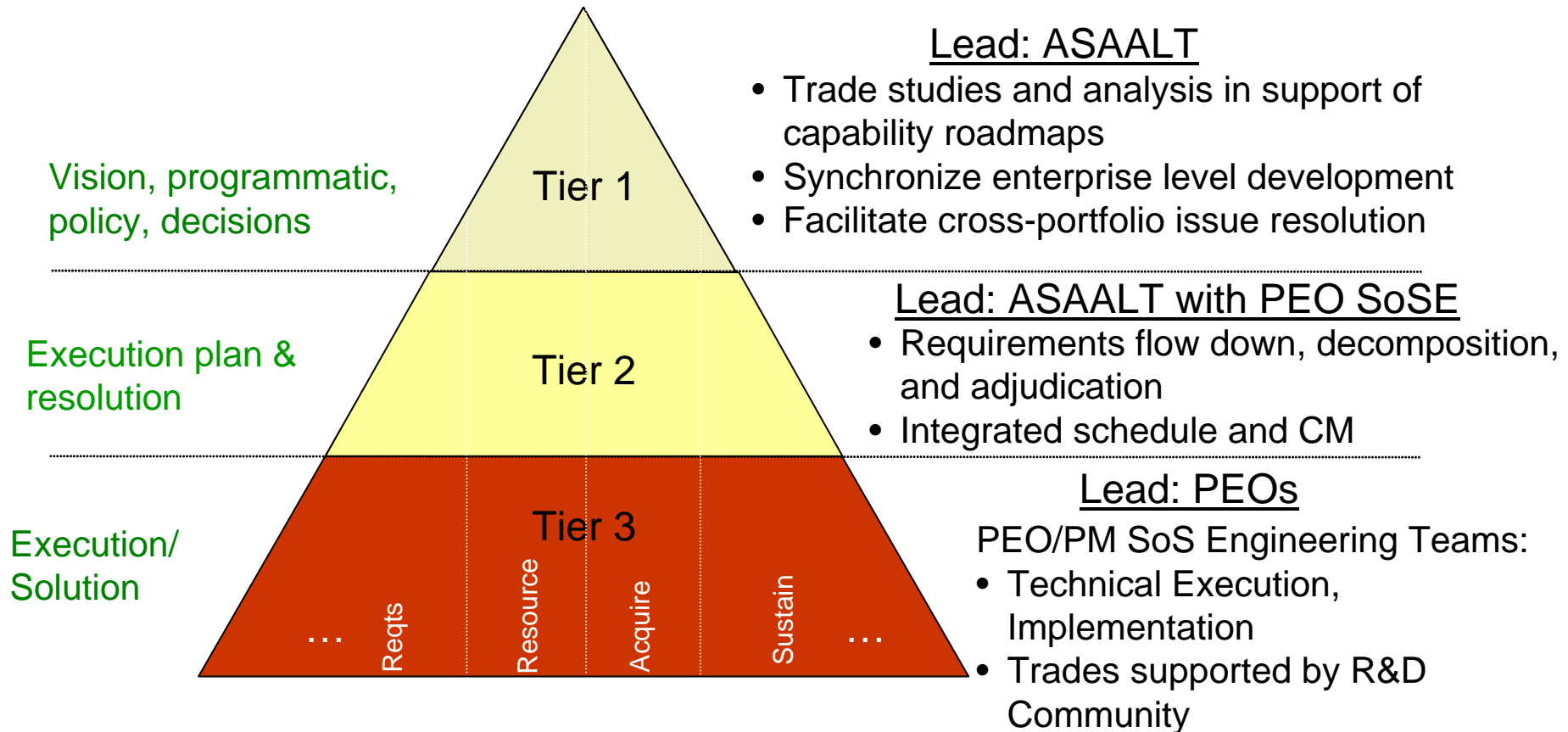
- Translate a BC technical vision for Service implementation to operational capabilities
  - Converging current and future force service strategies

System of Systems



- Execute technical vision through a System of Systems engineering and integration approach
  - Extending to an ASAALT-led cross Army approach

# Instituting Cross-Army SoS Engineering

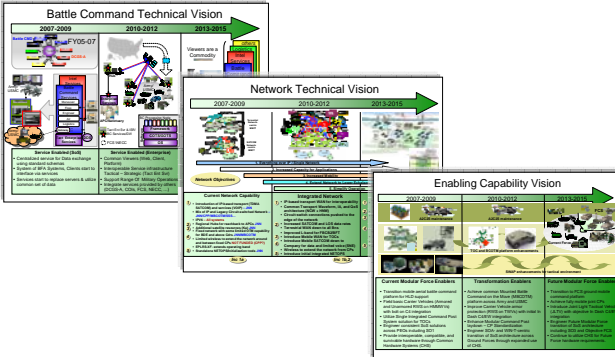


**Managing depth and breadth of SoS Engineering issues vertically (within) and horizontally (between) C4ISR capability portfolios**

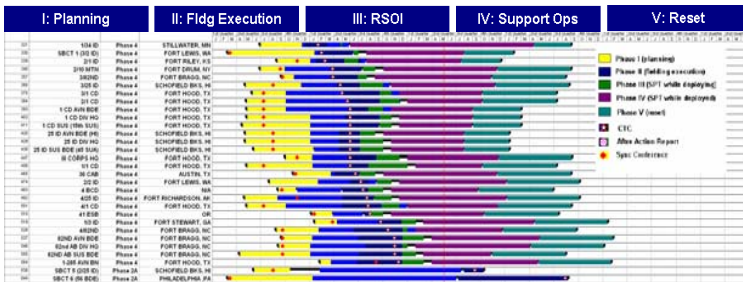
# An S&T Innovator's Response

## Adapting to the BC SoS Challenge

### S&T Transition Challenge

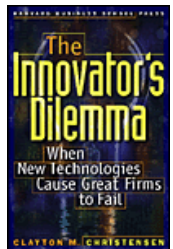


- **Establish a Shared Vision**
  - Demonstrate operational understanding of the Warfighting domain
- **Create Product Partnerships**
  - Partner with high impact programs to fill critical technical/operational gaps



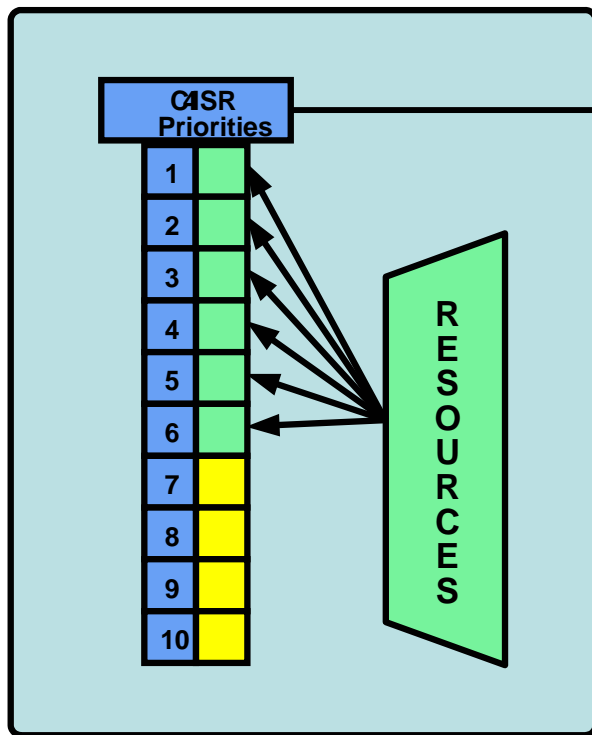
- **Align Execution Processes**
  - Link S&T solution rollout with aggressive Modular Force capability block development and fielding

Evolution v. Revolution in fiscally constrained environment



# Prioritizing Tactical C3 S&T Execution

## PEO C3T Top 20 S&T Priorities



Technology Transition Matrix (T2Matrix)

Technical Gaps - View All

T2Matrix  
Technology Transition Matrix  
GOTS, Developed by PEO C3T

View by S&T Projects | ADD A GAP | REPORTS | Show Gaps Using Preferences | CONTROL PANEL

PEO	PEO Priority	PM	PM Priority	\$	Gap Title	Program Type	S&T Projects	Transition Stage	Date
C3T	1	SE&I	1		Enhancing C2 in a Counter Radio Control (RC) IED Environment	DARPA (Ph III)	next Generation Communications (XG)	Proposed	27FEB2007
						DARPA (Ph IV)	Chip Scale Atomic Clock (CSAC)	MOA (Draft)	02NOV2007
						JCTD	Coalition Joint Spectrum Management Planning Tool (CJSMPT) JCTD	TTA (Approved)	21MAY2007
C3T	2	SE&I	3		Application Controlled Quality of Service (QoS)	ATO-D	Tactical Information Technologies for Assured Network Operations (TITAN)	TTA (Draft)	23JUL2007
						SBIR Phase I	Commercial Wireless DoS Mitigation Techniques	Agreement	27JUL2007
						SBIR Phase II	Adaptive Bandwidth Service (ABS)	PEO Endorsed	30MAR2007
C3T	3	SE&I	2		Tactical Cross Domain Solutions (TCDS)	ATO-D	Tactical Information Technologies for Assured Network Operations (TITAN)	TTA (Draft)	23JUL2007
C3T	4	WIN-I	1		Affordable OTM Antenna Technologies	ATO-D	Affordable Directional Antenna Program Technologies (ADAPT, TNCA ATO[D])	TTA (Approved)	13JUN2006
						ATO-D	Affordable Low Profile SATCOM OTM (ALPS)	Proposed	17OCT2007
						ATO-D	Antenna Technologies (AT, TNCA ATO [D])	PEO Endorsed	08AUG2005
						ATO-R	Breakthrough Antenna Technology (BAT)	Proposed	17OCT2007
						SBIR Phase I	High Efficiency, Low Power, Low Noise Amplifiers for SATCOM	Agreement	27JUL2007
						SBIR Phase II	Ballistic Radomes for SATCOM Antennas	Agreement	01MAY2006
						SBIR Phase II	Distributed & Flex Based Spatially Combined mHEMT PA for SATCOM	Agreement	04MAY2007
						SBIR Phase II	Dual Band X/Ka OTM Antenna System	Agreement	04MAY2007

Jump to Page: | Page Size: 15 | Jump to Gap #:

**Top 4 PEO C3T Technology Gaps**

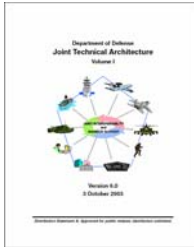
<https://t2matrix.kc.us.army.mil>

Institute an open process to align limited S&T resources with prioritized operational needs and increase transition successes



# Transitioning S&T Solutions to PORs

## Challenges



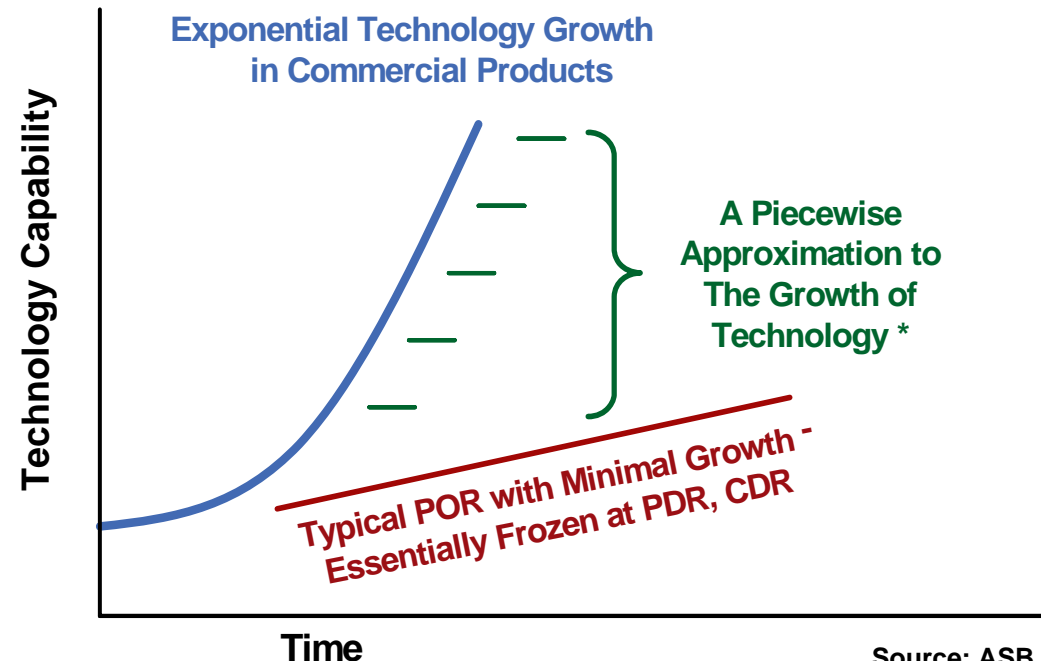
### –“Operationalizing”

- Delivering Warfighter-Focused v. Technology Policy-Driven Solutions



### –Execution Ownership

- Strategizing with PMs early (and often) on S&T transition

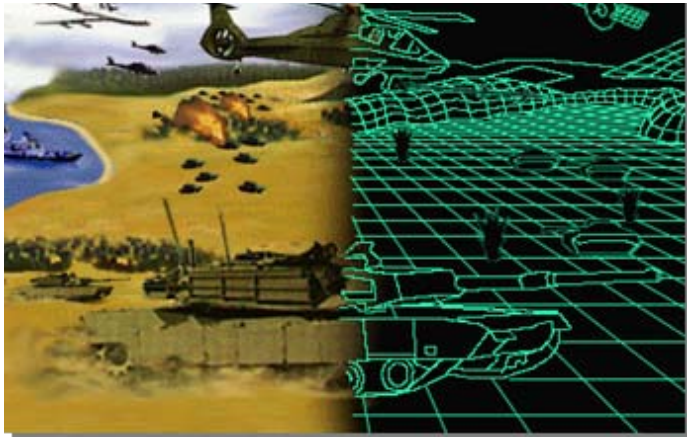




# Advancing C4ISR SoS M&S Capabilities

- Integrated C4ISR Live/Virtual/Constructive Demonstrations and Analyses
  - Enables C4ISR System of Systems Engineering analyses of greater scale and accuracy
  - Relevant across the spectrum of program life cycle
  - More quickly, more efficiently, resulting in significant cost savings/avoidance

*Analysis of operational data collected in-theater and used in M&S enabled bandwidth assessments*



*Insertion of realistic C4ISR effects into live experimentation environments*



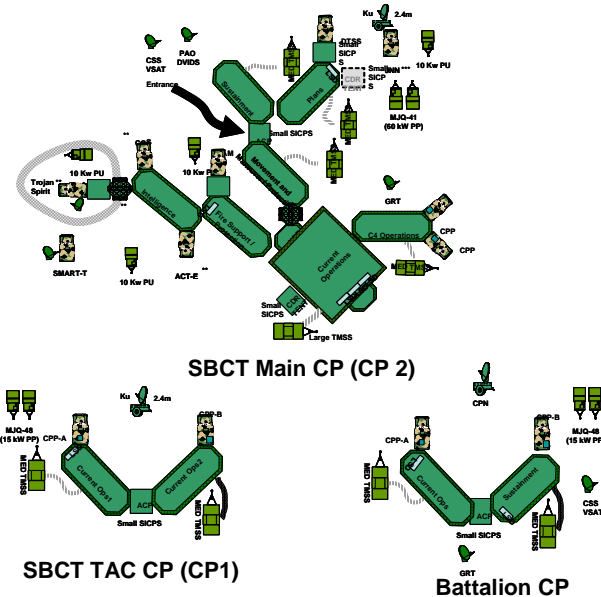
High-Performance-Computing  
Army Laboratory for  
Live/Virtual/Constructive  
Experimentation (H.A.L.L.E.)

# Instituting Operational Design Reviews



- TOCFEST

- Team C4ISR engineering field study to validate the current Command Post SoS from 11 Mar to 13 Apr 2008 at Fort Indiantown Gap, PA (FTIG)

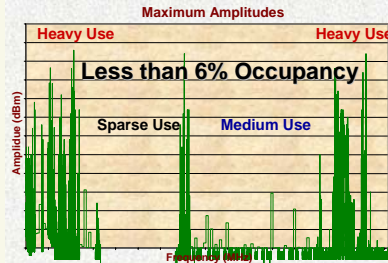


Standardizing **Command Post** baseline architecture – *physical and logical*  
Evaluating **technical and operational** effects of configuration changes  
Setting conditions for **ongoing C4ISR SoS** operational design reviews

# Selected BC Enabling Technologies

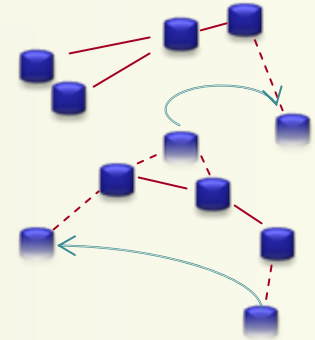
- **neXt Generation Communications (XG) Dynamic Spectrum Access Technology**

- *Maximize access to and use of required tactical spectrum*



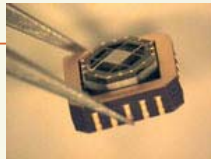
- **Disruption Tolerant Networking (DTN)**

- *Assure tactical C2 info delivery when no network path exists*



- **Chip Scale Atomic Clock**

- *Deliver precise timing and positioning for the “last tactical mile”*



- **Serious Gaming**

- *Enhance C4ISR training environments, linking Command Post capability usage with realistic tactical scenarios*



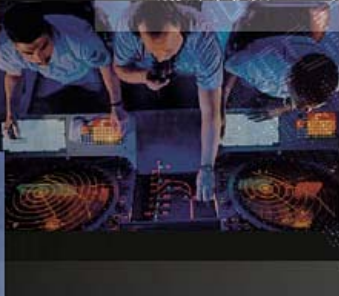


Questions?

CONNECT  
FUTURE  
NOW

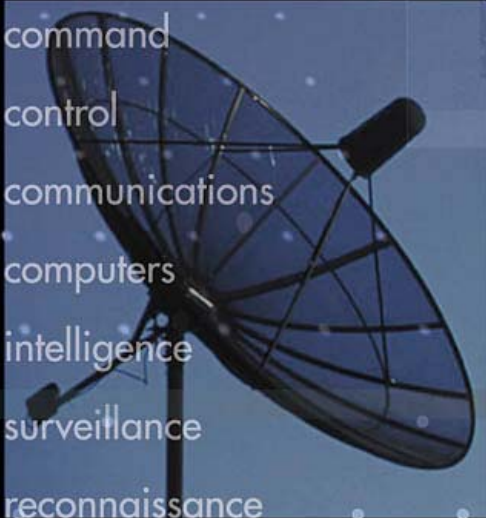


# COMMAND OVERVIEW



## C4ISR

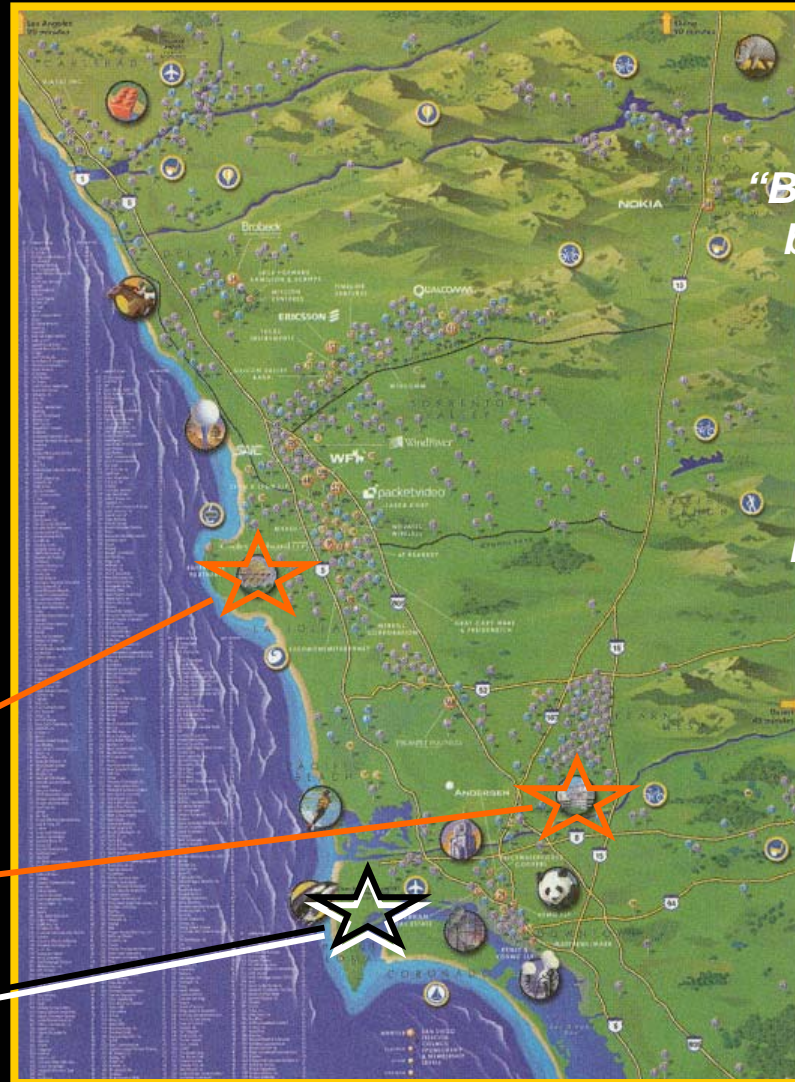
- command
- control
- communications
- computers
- intelligence
- surveillance
- reconnaissance



SPAWAR  
Systems Center  
San Diego

# San Diego/ IT Research Hub

- Qualcomm, Inc
- SAIC
- Nokia Mobile Phones
- ViaSat
- Leap Wireless
- Kyocera America
- Titan Wireless
- Applied Micro Circuits Corp.
- Wireless Facilities
- Siemens...



*“Best place in country for business and careers”*  
- Forbes magazine

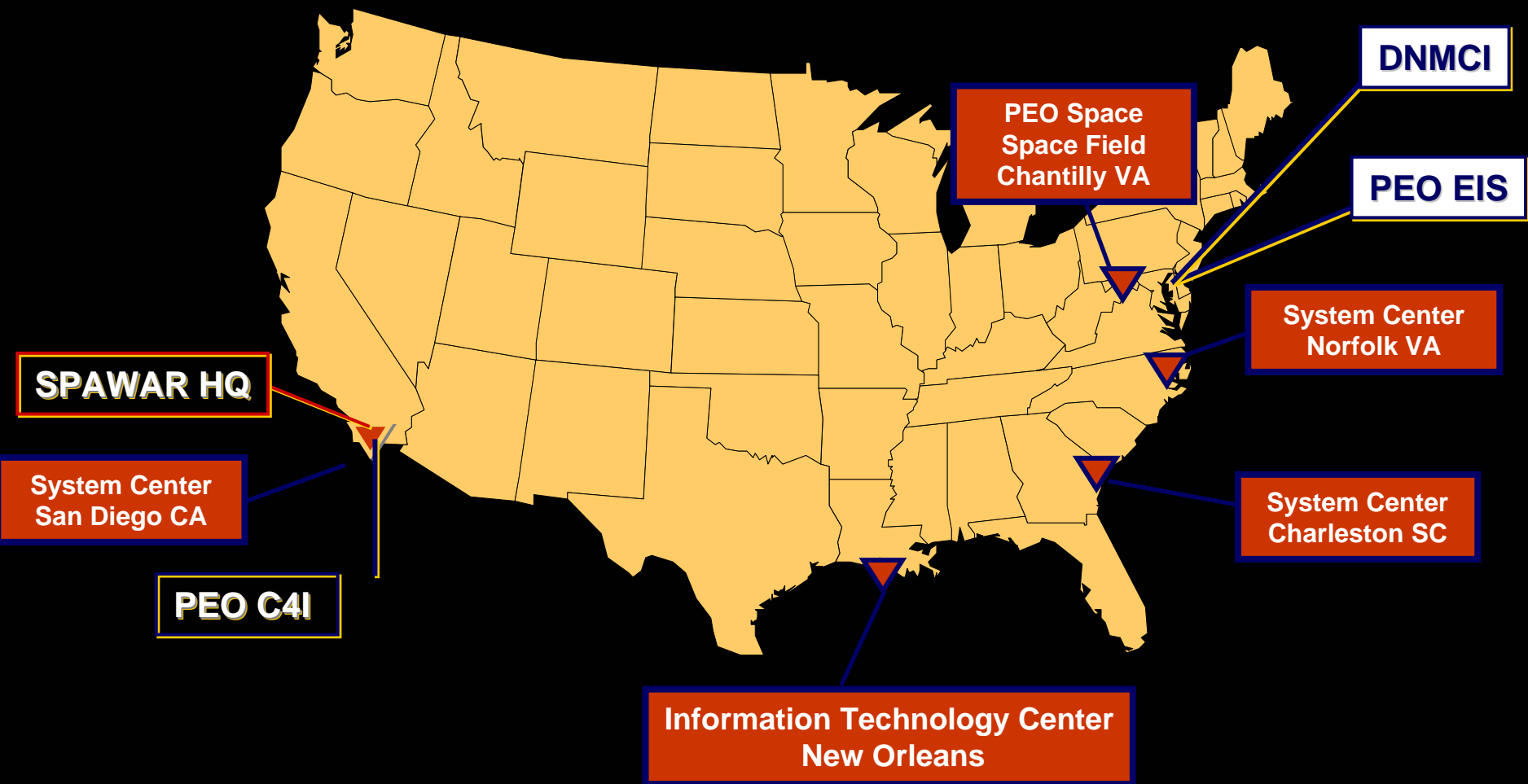
*San Diego is the hot spot for careers in information technology”*  
-Kaplan Newsweek Careers

UCSD

SDSU



# TEAM SPAWAR



# Co-Located with the Fleet, Industry and Academia



**SPAWAR HQ/PEO  
Old Town Campus**

**Naval Special Warfare Command  
Naval Region, Southwest  
Naval Station, San Diego  
Naval Amphibious Base  
Naval Air Station  
Naval Sub Base  
3<sup>rd</sup> Fleet**

**SPAWAR Systems Center  
San Diego**

**Camp Pendleton  
MC Air Station Miramar**

# Team SPAWAR

## COMMANDER

RADM Michael Bachmann, USN  
SPAWAR 00

Headquarters  
Support Staff

Washington  
Operations Office  
Mr. Bill Flynn

Vice Commander  
RDML Grunt Smith, USN  
SPAWAR 09

Deputy Commander  
Mr. Rod Smith  
SPAWAR 00A

CIO  
Ms. Sarah Lamade  
SPAWAR 00CIO

Comptroller  
Mr. Steve Dunn  
SPAWAR 01

Contracts  
Mr. Tim Dowd  
SPAWAR 02

Readiness &  
Logistics Support  
Mr. Jeff Klein  
SPAWAR 04

Chief Engineer  
RDML Will  
Rodriguez, USN  
SPAWAR 05

Command  
Information Office  
Ms. Sarah Lamade  
SPAWAR 08

## Echelon III Activities

SPAWAR Space Field  
Activity, Chantilly VA  
RDML Vic See, USN

SPAWAR Systems  
Center New Orleans  
CAPT Mark Krause, USNR

SPAWAR Systems  
Center Charleston  
(Working Capital Fund)  
CAPT Urbon, USN

SPAWAR Systems  
Center Norfolk  
CAPT Jim Reed, USN

SPAWAR Systems  
Center San Diego  
(Working Capital Fund)  
CAPT Mark Kohlheim, USN

## Commands Supported

PEO C4I & Space

PEO EIS

PEO Space Systems

JPEO JTRS

Mission Funded

Mission

Program  
Funded

**SPAWAR Systems Center San Diego**  
**TEAM SPAWAR Chief Technology Officer**  
*“Leadership and Innovation”*



***SPAWAR S&T OPPORTUNITIES***

17 Apr 2008  
Mr. Gary Wang  
Code 73  
(619) 553-2010  
gary.wang@navy.mil

# *S & T OPPORTUNITIES*



- **Industry and Government Teaming**

- **CCAT (Center for Commercialization of Advanced Technologies)**  
Commercialization of emerging technologies (private and government) /  
Stephen Lieberman, stephen.lieberman (553-2778);  
<http://www.ccatsandiego.org/>
- **CRADAS (Cooperative Research & Development Agreement)**  
Means to perform research with industry Stephen Lieberman,  
stephen.lieberman (553-2778); Roger Boss, roger.boss (553-1606)
- **Commercial Sales Agreement (U.S. Code 2539B) and Work for Private Parties (U.S. Code 2563)**  
Laws & policies to increase private sector access to defense-unique capabilities Raj Samuel, raj.samuel (767-4156)
- **SBIR (Small Business Innovation Research)** Contracts awarded to small businesses for innovative research through congressionally mandated federal program. Steve Stewart, steve.stewart (553-2546)
- **MP (Mentor Protégé)** Small business partnering with large companies in developing innovative technologies Cliff Hudson, cliff.hudson (553-7442)

# *S & T OPPORTUNITIES (cont)*



- **CTO Services for Transition, Technology Strategies, and Forecasting**
  - **ILIR (In-House Laboratory Independent Research)** Internal discretionary 6.1 funds from ONR emphasizing basic research / Roger Boss, roger.boss (x31606) <https://donst.nrl.navy.mil/cgi-bin/login-form.cgi>
  - **IAR (Independent Applied Research)** Internal discretionary 6.2 funds from ONR emphasizing revitalization and transition / Roger Boss, (x31606) <https://donst.nrl.navy.mil/cgi-bin/login-form.cgi>
  - **S&T Capabilities Initiative** Internal G&A funding emphasizing 6.2-6.3 transitions / Roger Boss, roger.boss (x31606)
  - **S&T Challenges** Internal funding used to support for about 5 yrs a team of researchers building a 6.1-6.3 S&T capability vital to the Center's mission / Eric Hendricks, eric.hendricks (x31624) / Roger Boss, roger.boss (x31606)

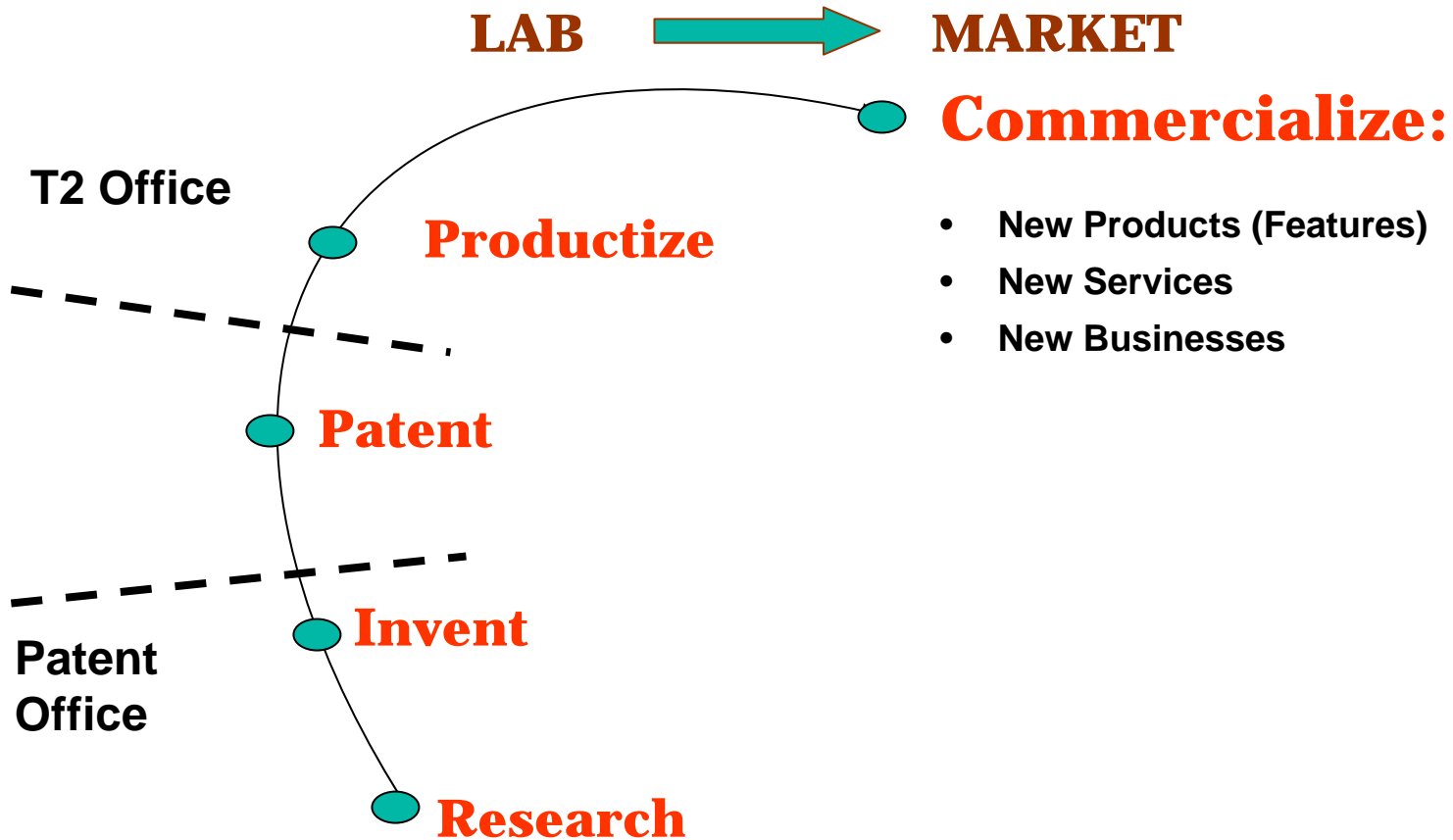


# Outline



- What is T2
- Why do we do T2
- How do we do T2
- What's in it for you? for the Navy?

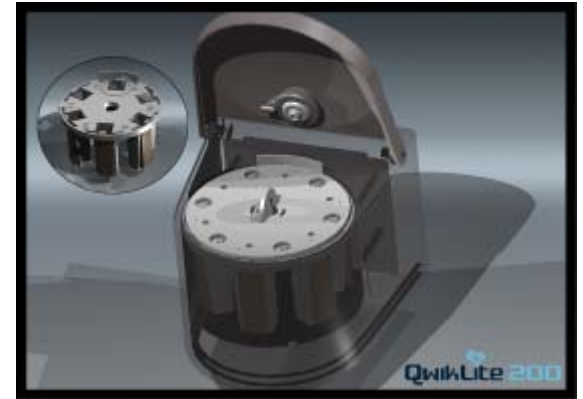
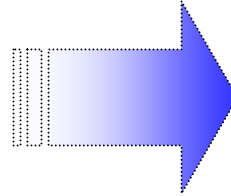
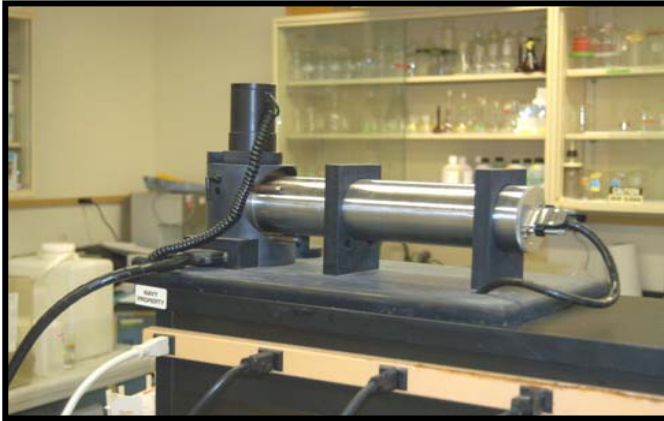
# What is T2



*Adapted from Ricardo dos Santos, Sr. Director of New Business Development, Qualcomm, Inc.*

# Lab to Market

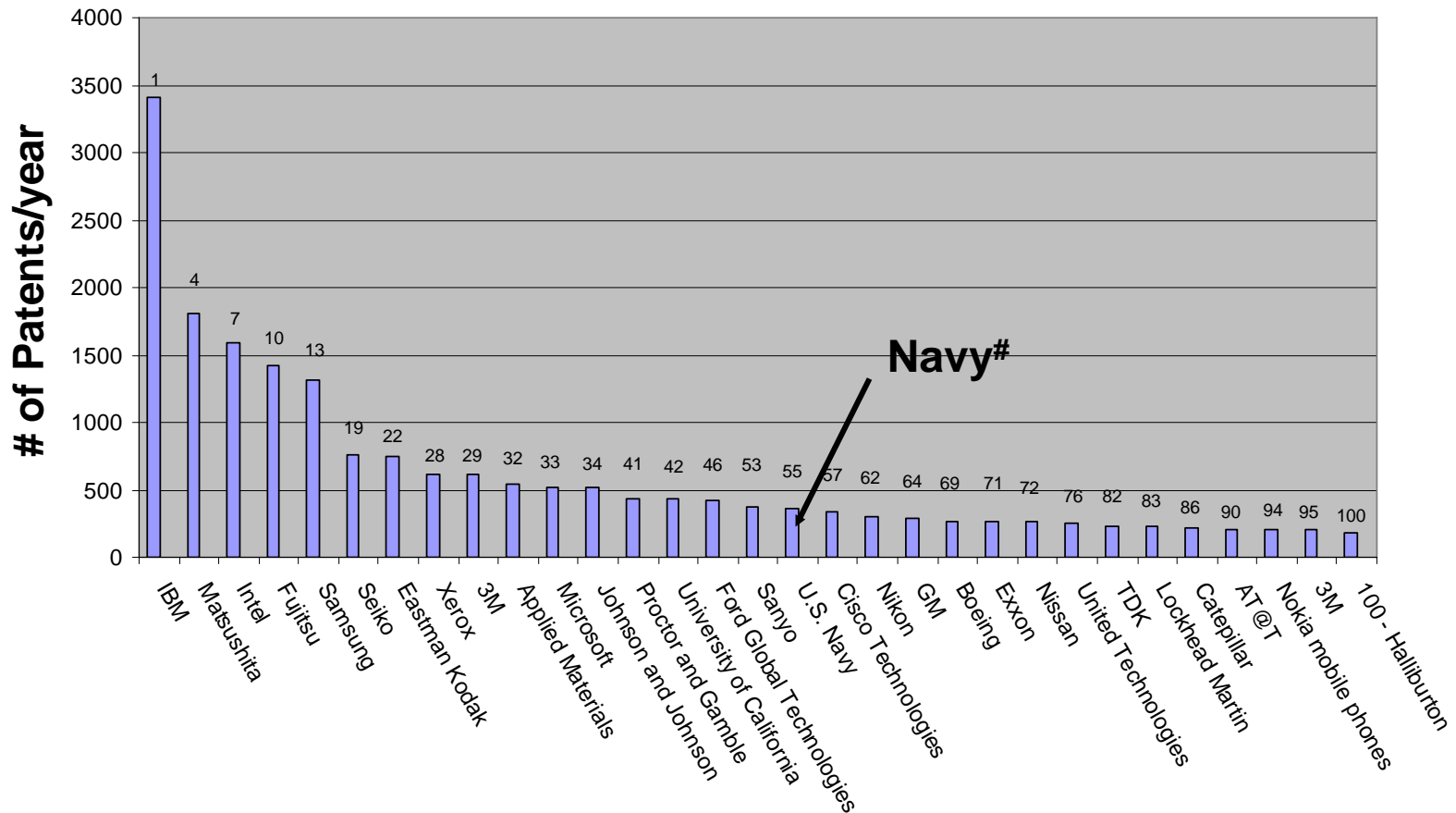
## Example: QwikLite Technology



# Background

## *Top 100 USPTO Patent Recipients*

**Navy averaged 59th out of top 100 Patent Recipients for years 2001-2006**



**Company**

**#Chart shows data for 2003**



# Background

## SSC San Diego vs. San Diego Based Companies

SSC San Diego ranked 5th compared to San Diego based corporate patent recipients in 2006

Rank/Company	Number of Patents
1. Qualcomm	200
2. Kyocera Wireless	32
3. Applied Micro Circuits Corp.	30
4. Science Applications Int.	24
5. SSC San Diego	21
6. Agouron Pharmaceuticals	19
7. Cymer	18
8. Genral Atomics	14
9. Gen-Probe	14
10. Diversa	11
11. Amylin Pharmaceuticals	9

*Data from San Diego Union, 25 Jan 2006 -- SSC SD data added. (Does not include data from local Universities)*

## *Why do T2*

- Facilitate the transfer of SSC San Diego innovations for the benefit of public and warfighter
- Enhance the research experience of SSC San Diego scientists and engineers through technology transfer
- Promote economic development by leveraging SSC San Diego innovations
- Provide financial incentives to SSC San Diego scientists and engineers to stimulate technological innovations



## *How: T2 Vehicles*

- Patent License Agreements (PLAs)
- Cooperative Research and Development Agreements (CRADAs)

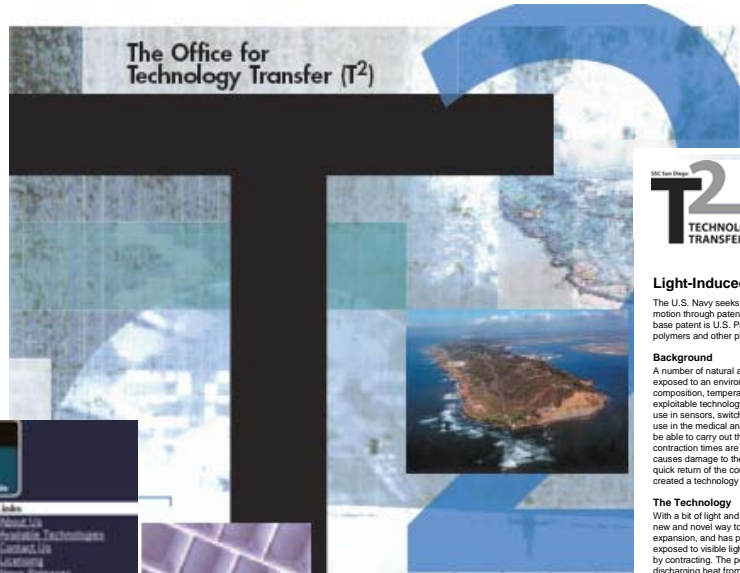
# Licensing

## *Guiding Principles*

- **Benefit the public and the warfighter.**
- **Licensee should be capable of bringing the invention to the marketplace.**
- **Timely development, marketing, and deployment of the invention.**
- **Fair consideration in exchange for the grant of commercial licensing rights.**

# Technology Transfer: How

T2 Brochures



The Office for  
Technology Transfer (T<sup>2</sup>)

T2 TIP Sheets



T2 Web Site




## T2 MISSION

The Office for Technology Transfer (T<sup>2</sup>) is easy for commercial businesses or start-up companies to access and implement technologies. Our mission is to facilitate the transfer of intellectual property resources and information between the Navy and the business community in an effort to enhance the commercial value of inventions at work. In addition, there are other benefits as:

- Stimulating our economy with manufacturing and high-technology jobs
- Increasing competitiveness within the sector
- Gaining visibility within the technical community
- Promoting innovation and creativity with SSC San Diego resources

## Light-Induced Mechanical Motion

The U.S. Navy seeks to commercialize a technology for light-induced mechanical motion through patent licensing and collaborative commercial partnerships. The base patent is U.S. Patent 6,143,138: Visible light pH change for activating polymers and other pH dependent reactants.

### Background

A number of natural and synthetic fibers and gels expand and contract when exposed to an environmental change, such as exposure to a change in solvent composition, temperature, pH, electric field or photo irradiation. As a commercially exploitable technology, the fibers and gels have applications in many fields, such as use in sensors, switches, motors, pumps, and non-metallic operations; as well as use in the medical and robotic fields where it is envisioned that these materials will be able to carry out the function of human muscle tissue. With current technology, contraction times are extremely short (10 nanoseconds), the light used is UV and causes damage to the solution, and heat buildup is discharged too slowly for a quick return of the compound to its natural resting state. SSC San Diego has created a technology that overcomes these deficiencies.

### The Technology

With a bit of light and a simple solution of polymers, SSC San Diego has created a new and novel way to induce mechanical motion in the form of contraction and expansion, and has patents on both the method and apparatus for doing so. When exposed to visible light, the solution's pH balance changes and the polymer reacts by contracting. The polymer can maintain the contraction indefinitely, all the while discharging heat from the light so that once the light is removed, the solution can return to its original state in milliseconds. Thus an expandable and contractible polymer solution can be made to respond rapidly to a change in pH while the heat-release mechanism of the invention allows the polymer to return to its initial configuration in milliseconds.

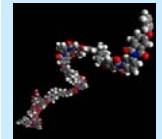
### Key Benefits

- Indefinite contraction times
- No need for UV light; needs only non-damaging visible light
- Continuous heat discharge allows the solution to return to its original state in milliseconds

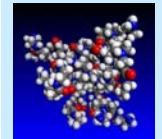
### Development Status

- DDD 5200 Series Technical Readiness Level 6: Tested in Relevant Environment
- Three patents issued:
  1. 17 Aug 2004: U.S. Patent 6,776,971
  2. 27 July 2004: U.S. Patent 6,699,442
  3. 07 Nov 2000: U.S. Patent 6,143,138

For more information regarding technology transfer, please contact us at (619) 553-2778 or email [T2@spawar.navy.mil](mailto:T2@spawar.navy.mil)  
©2004, April 2007: SSC San Diego, San Diego, CA 92152-5001  
 Approved for public release; distribution is unlimited.



A polymer strand in relaxed state: no visible light



When exposed to visible light, the polymer strand contracts



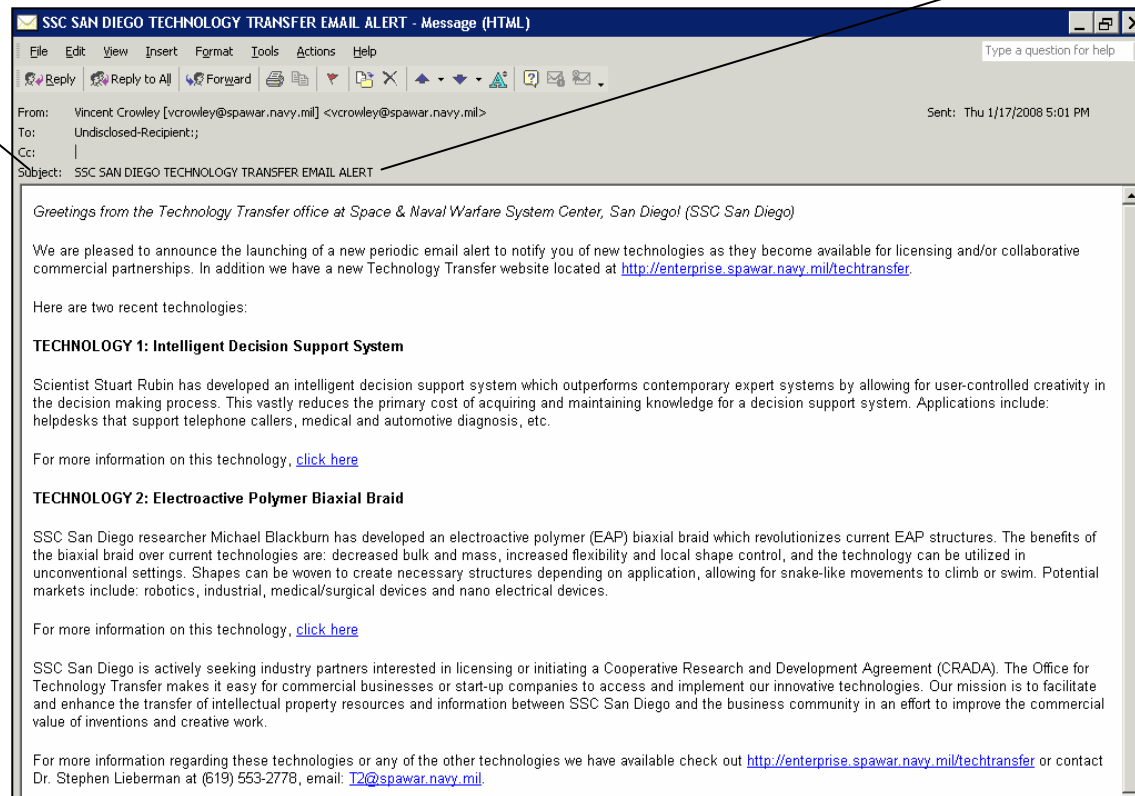
Example: Artificial muscle application of polymer solution

Space and Naval Warfare Systems Center San Diego (SSC San Diego) is the U.S. Navy's research, development, test and evaluation, engineering and field support center for command, control and communication systems and ocean surveillance.  
<http://www.spawar.navy.mil/sandiego>

<http://enterprise.spawar.navy.mil/body.cfm?type=c&category=29&subcat=211>

# Technology Transfer: How Marketing Cont.

**Subject: SSC San Diego Technology Transfer Email Alerts**



SSC SAN DIEGO TECHNOLOGY TRANSFER EMAIL ALERT - Message (HTML)

File Edit View Insert Format Tools Actions Help

Reply Reply to All Forward

From: Vincent Crowley [vcrowley@spawar.navy.mil] <vcrowley@spawar.navy.mil> Sent: Thu 1/17/2008 5:01 PM  
To: Undisclosed-Recipient;;  
Cc:  
Subject: SSC SAN DIEGO TECHNOLOGY TRANSFER EMAIL ALERT

Greetings from the Technology Transfer office at Space & Naval Warfare System Center, San Diego! (SSC San Diego)

We are pleased to announce the launching of a new periodic email alert to notify you of new technologies as they become available for licensing and/or collaborative commercial partnerships. In addition we have a new Technology Transfer website located at <http://enterprise.spawar.navy.mil/techtransfer>.

Here are two recent technologies:

**TECHNOLOGY 1: Intelligent Decision Support System**

Scientist Stuart Rubin has developed an intelligent decision support system which outperforms contemporary expert systems by allowing for user-controlled creativity in the decision making process. This vastly reduces the primary cost of acquiring and maintaining knowledge for a decision support system. Applications include: helpdesks that support telephone callers, medical and automotive diagnosis, etc.

For more information on this technology, [click here](#)

**TECHNOLOGY 2: Electroactive Polymer Biaxial Braid**

SSC San Diego researcher Michael Blackburn has developed an electroactive polymer (EAP) biaxial braid which revolutionizes current EAP structures. The benefits of the biaxial braid over current technologies are: decreased bulk and mass, increased flexibility and local shape control, and the technology can be utilized in unconventional settings. Shapes can be woven to create necessary structures depending on application, allowing for snake-like movements to climb or swim. Potential markets include: robotics, industrial, medical/surgical devices and nano electrical devices.

For more information on this technology, [click here](#)

SSC San Diego is actively seeking industry partners interested in licensing or initiating a Cooperative Research and Development Agreement (CRADA). The Office for Technology Transfer makes it easy for commercial businesses or start-up companies to access and implement our innovative technologies. Our mission is to facilitate and enhance the transfer of intellectual property resources and information between SSC San Diego and the business community in an effort to improve the commercial value of inventions and creative work.

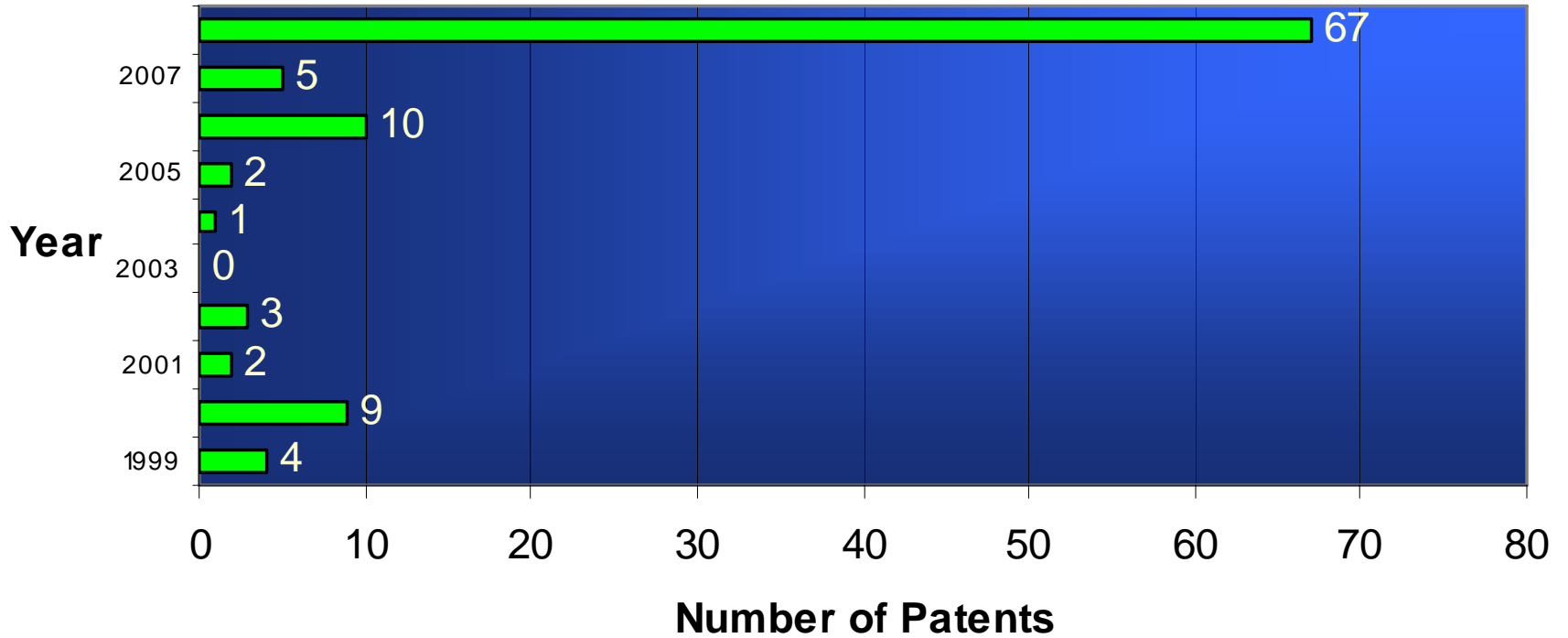
For more information regarding these technologies or any of the other technologies we have available check out <http://enterprise.spawar.navy.mil/techtransfer> or contact Dr. Stephen Lieberman at (619) 553-2778, email: [T2@spawar.navy.mil](mailto:T2@spawar.navy.mil).

# Technology Transfer: How Marketing Cont.

- Partner with Navy, DoD, Federal T2 organizations, Entrepreneurial groups, industry trade organizations, State, Local Economic Development Groups

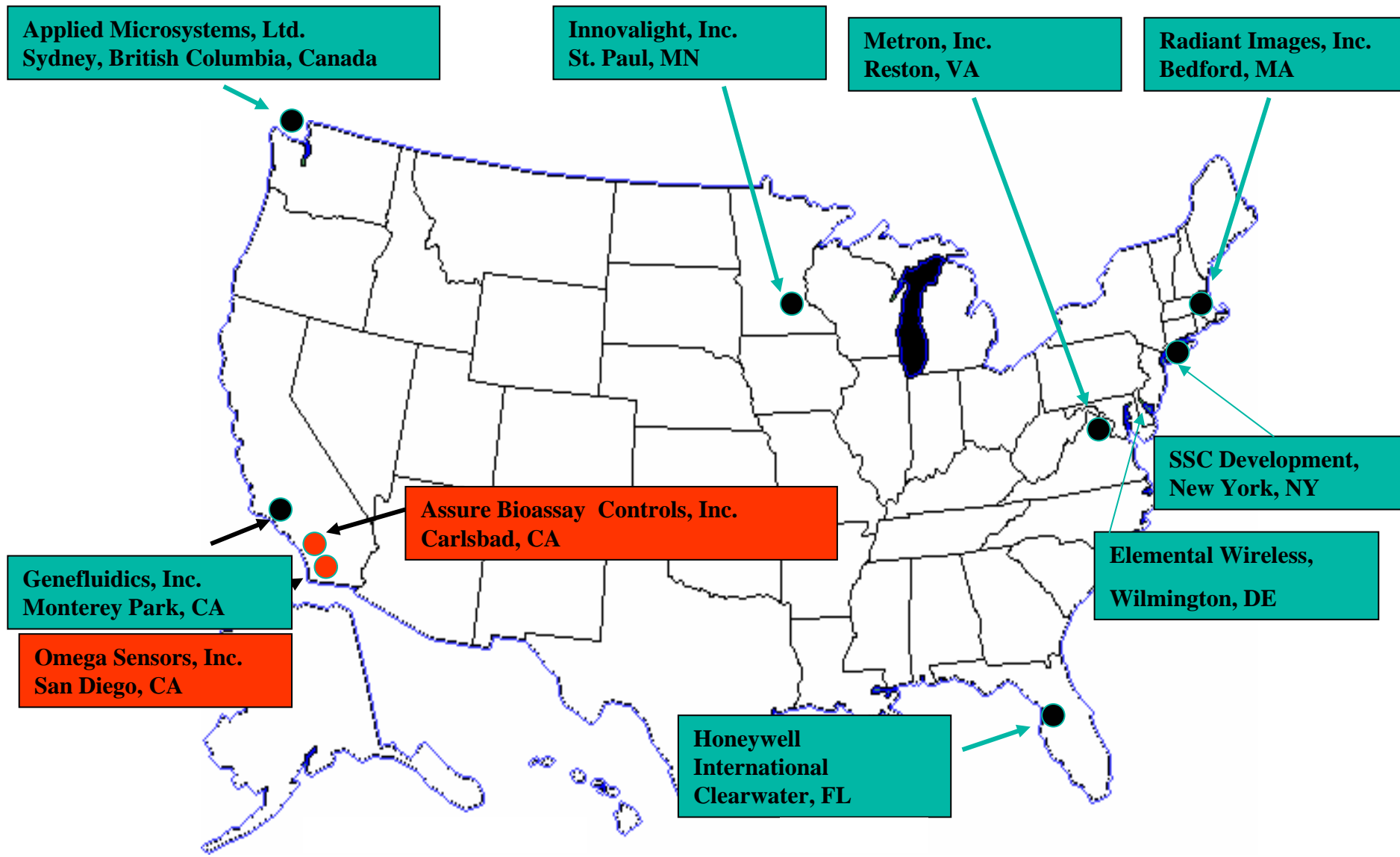


# *Number of Patents Licensed/Year*





# SSC San Diego Licensee Distribution



# *Benefit to Small Business*

- Gov't. developed technologies can:
  - Provide technology for new start-up companies
  - Provide enhancement to existing product lines
- Industry can partner with the govt. to gain access to facilities, equipment, and personnel in specific technical areas consistent with laboratory mission

## *Benefit to the Navy*

- Provides ROI to Navy's for investment in patent process
- Important path to move Navy innovations from lab to product
- Promotes economic development
  - » **Make US more competitive in global marketplace**

# *Cooperative Research and Development Agreements (CRADA)*

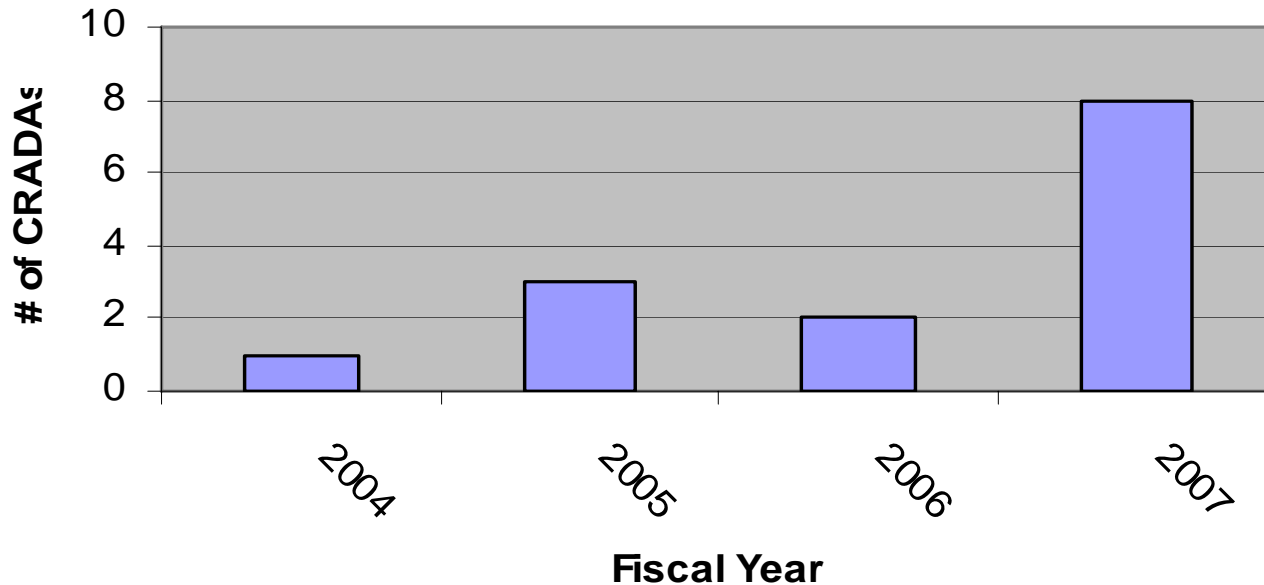
- What is a CRADA
  - **Legal agreement between a government R&D laboratory and interested partners**
  - **Allows partners to collaborate in mutually beneficial R&D in specific technical areas consistent with laboratory mission**
  - **Pre-determines all intellectual property rights**

## *CRADA cont.*

- Ground Rules
  - Partners can provide facilities, equipment, and personnel in support of CRADA
  - Government labs can enter into CRADAs with private sector, universities, and state and local governments
  - The non-government partner can provide funds to the government laboratory to perform tasks under the CRADA
  - The Government laboratory **CANNOT** provide funds to their partners

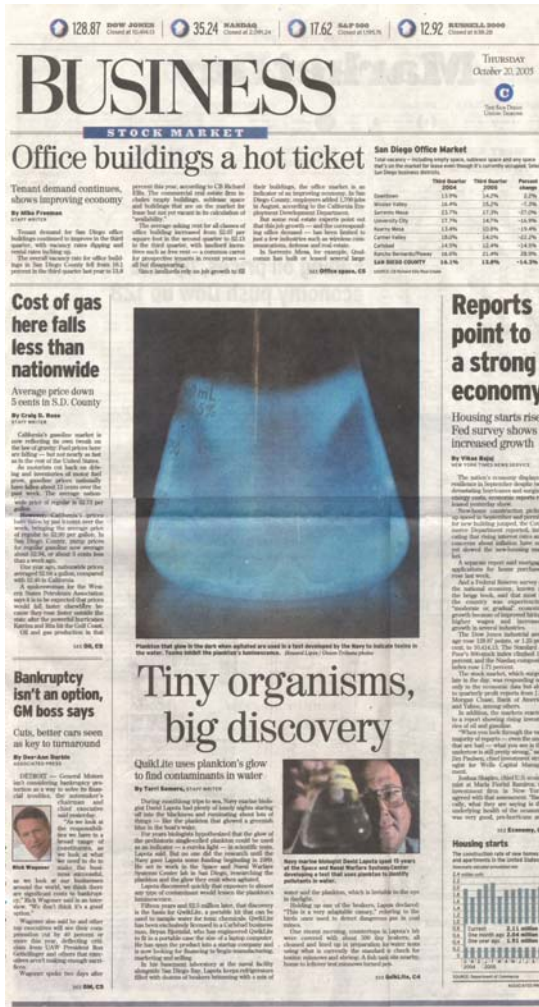
# Recent CRADA Activity

## Number of CRADAs per Fiscal Year





# SSC San Diego Technologies in the News



**Brad Chisum, CEO Lumedyne technologies (formerly Omega Sensors Inc.) rings the opening bell on NASDAQ, August 2007**

**San Diego Union-Tribune  
Page 1: Business Section**

## *Contact Info*

Stephen H. Lieberman, Ph.D.

619-553-2778

Email: [T2@spawar.navy.mil](mailto:T2@spawar.navy.mil)

# *SSC San Diego - Teaming with Industry*

**Raj Samuel**

**Science & Technology**

**[raj.samuel@navy.mil](mailto:raj.samuel@navy.mil)**



**SECOND PRIORITY : Add value to SSC San Diego.**

# Teaming with Industry



- **Objective**
  - Efficient transition of the DoD technologies to the warfighter
- **Supported by**
  - Congress, the Secretary of Defense, and the Secretary of the Navy
- **Vehicles**
  - Laws & policies to increase private sector access to defense-unique capabilities
  - 10 U.S.C. §2539B ... Sale of testing services outside the DoD
  - 10 U.S.C. §2563 ... Sale of Articles & services outside the DoD

# *Advantages to the Industry Partner*

THE UNIVERSITY of TENNESSEE   
Center for Executive Education

## Best Practices of Public Private Partnering

---

*Developing a win-win strategy for working with depots*

A White Paper Authored By:  
Kate Vitasek, Jerry Cothran, Steve Ruter

*Spring 2007*

- **Leverage Center's capabilities**
- **Access to knowledgeable workforce**
- **Use of existing facilities & equipment**
- **Minimize process flows**
- **Avoid investment in duplicate capabilities**
- **Compliance with Government regulations**
- **Increase profits**
- **Reputation associated with partnerships**

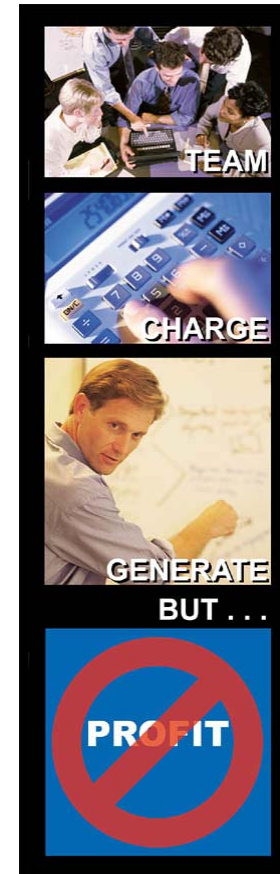


# *Working Capital Fund*

## Works like private industry

- We team to do the work
- We charge our salaries & expenses to the project
- We generate overhead to pay operating expenses

**But we cannot make a profit**



# ***10 U.S.C. §2539B***

**Authorizes the Secretary of Defense to allow the military departments to**

**(1) sell, rent, lend, or give samples, drawings, and manufacturing or other information to any person or entity;**

**(2) sell, rent, or lend government equipment or materials to any person or entity**

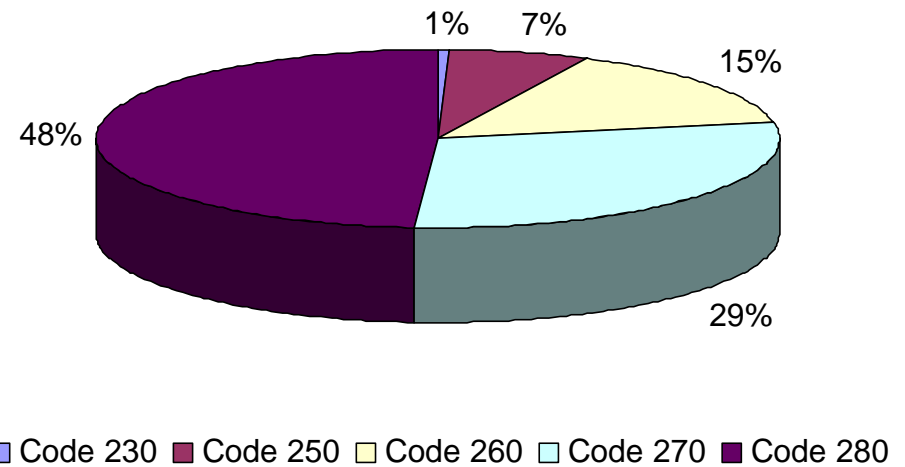
**(3) make available to any person or entity, at an appropriate fee, the services of any government laboratory, center, range, or other testing facility for the testing of materials, equipment, models, computer software, and other items.**



# 10 U.S.C. 2539B

74 executed FY03 thru FY07

Total value \$4.1M





# *10 U.S.C. 2539B*

Deep Silence Engineering Lab & Test Facilities
Medium Weight Shock Test (MWST)
Acoustic Testing and Evaluation
Acoustic Evaluation of Hydrophones
TRANSDEC - Acoustic Evaluation of Hydrophones
Antenna and Radome Testing
Acoustic Evaluation of Hydrophones
TRANSDEC - Acoustic Evaluation of Hydrophones
Joint Tactical Radio System Test & Evaluation Lab
High Assurance Internet Protocol Encryptor (HAIPE)
HAIPE - Falcon III Manpack Radio (RF-300M-MP)
Deepwater National Security Cutter Antenna Test

# 10 U.S.C. §2563



Authorizes the Secretary of Defense to sell *articles and services* that are manufactured or performed by any DoD working capital funded facility of the armed forces (e.g. *SSC San Diego*) to parties outside of the DOD (*Industry*).

# 10 U.S.C. §2563 Statute Criteria

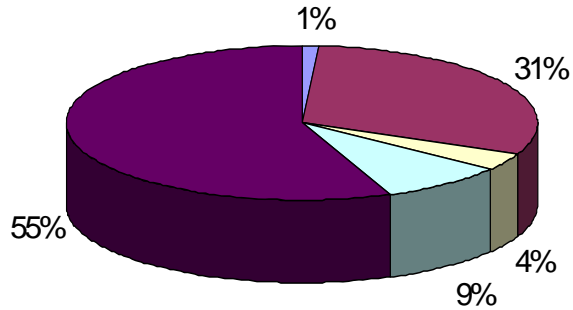




# *10 U.S.C. §2563 Elements*

- **Non Availability Letter**
  - Indicating that required articles or services are unavailable from a U.S. commercial source
- **Sale of Articles or Services Agreement**
- **Statement of Work**
  - Defining tasking, costs, period of performance, deliverables & reporting requirements

# 10 U.S.C. § 2563



■ Code 211 ■ Code 230 ■ Code 240 ■ Code 270 ■ Code 280

24 executed FY03 through FY07

Total \$25.5M

# *10 U.S.C. § 2563*

AS-4614 / URD Antennas

CLS for Minuteman Program

Data Link Gateway System

VLF / LF High Voltage Testing

AS-4614 & AS-4623 Antennas

# Sample of Partners

Agreements have involved both major corporations as well as small businesses.



# Conclusion



**2539B and 2563 are excellent vehicles for Industry to acquire DoD technology / assets for transition**

**The agreements are easily adaptable**

**SSC San Diego**

- **is the pre-eminent provider of C4ISR solutions**
- **has a successful track record with 2539B and 2563 agreements**
- **is actively engaged in Best In Class processes & Continuous Improvement**

# *SSC San Diego - Teaming with Academia*

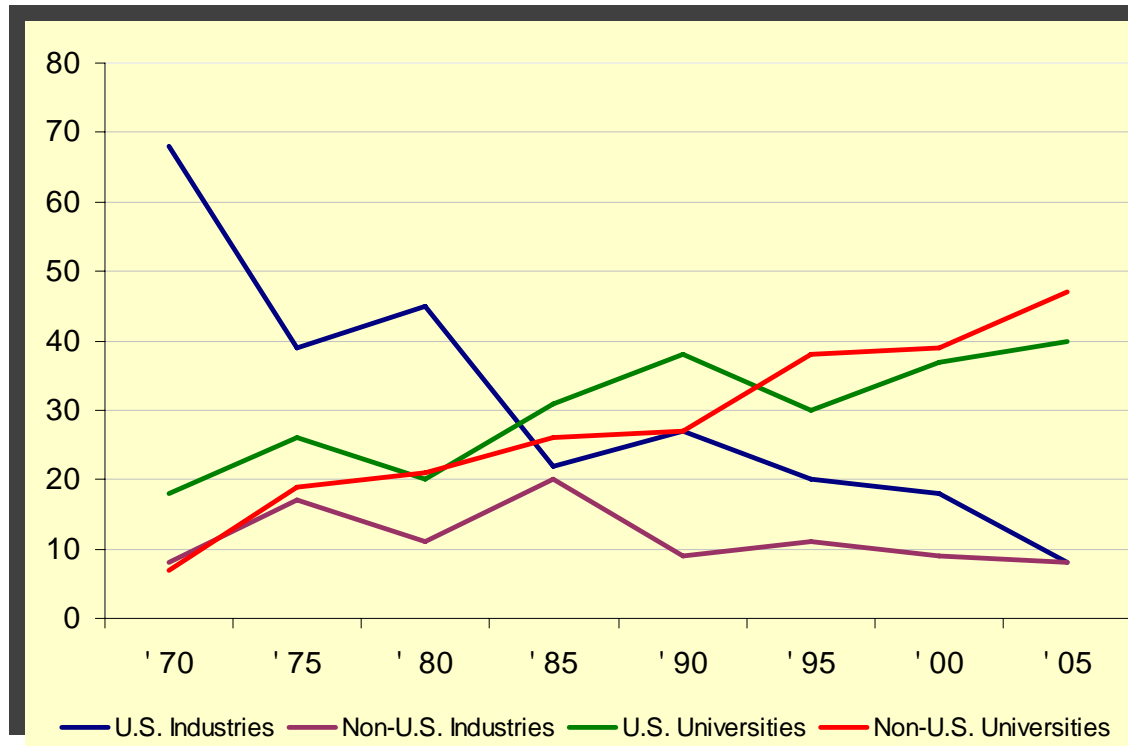
**Raj Samuel**

**Science & Technology**

**[raj.samuel@navy.mil](mailto:raj.samuel@navy.mil)**



# Shift in Comms Research..... % of IEEE papers published



Source: Bob Lucky, Telcordia / SAIC

# Cal ISI ..

## California Institutes for Science & Innovation



- **Launched in 2000 to support multi disciplinary research in biomedicine, bioengineering, nano systems, telecommunications and information technology**
- **\$400M funded by state of California ... 2X matching funds by Institutes**
- **The 4 research centers operate as a partnership among the University, state government, and industry,**
  - **Calit2 (California Institute for Telecommunications and Information Technology)**
    - » UC San Diego & UC Irvine
  - **QB3 (California Institute for Quantitative Biomedical Research)**
    - » UC San Francisco, UC Berkeley & UC Santa Cruz;
  - **CNSI (California Nanosystems Institute)**
    - » UCLA & UC Santa Barbara
  - **CITRIS (the Center for Information Technology Research in the Interest of Society)**
    - » UC Berkeley, UC Davis, UC Merced, & UC Santa Cruz.

# Jacobs School of Engineering

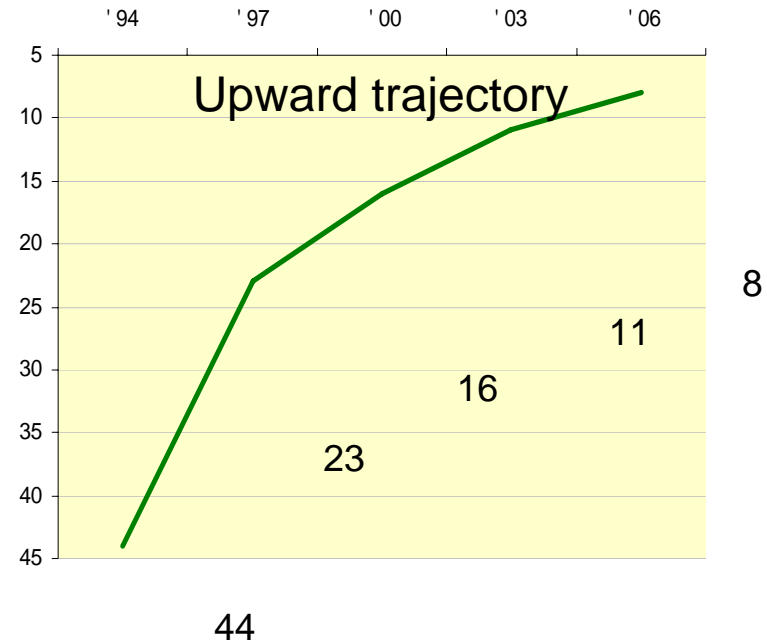
**Youngest & fastest rising engineering school**

**# 2 in total research \$ per faculty**

**925K per faculty**

**# 5 in the nation for federal R&D**

**\$ 110M by Irwin Jacobs**

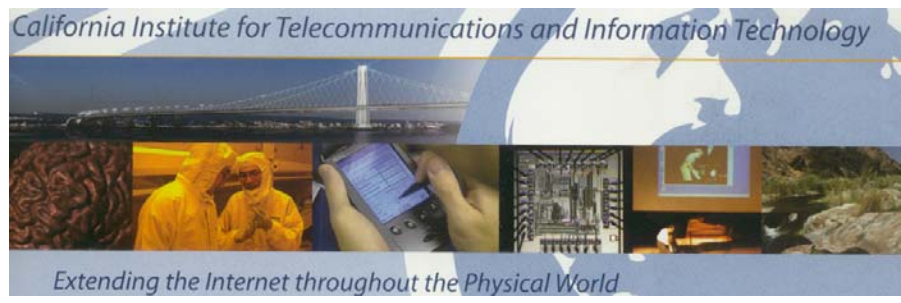


# SSC – Calit2 Strategic Partnership



- Calit2 “Lives in the Future” by:
  - Building Systems of Emerging Disruptive Technologies
  - Integration of Technology Consumers and Producers

- To be the Nation’s pre-eminent provider of integrated C4ISR solutions for warfighter decision superiority



Provide collaborative and better solutions to the Fleet & Joint Warfighter

# *SSC SD \_ Calit2 Strategic Partnership*



# Collaborative work

- **Co-operative Agreement**
  - the Federal Grant and Cooperative Agreement Act of 1977
  - assistance agreements in which substantial involvement between the DoD and the recipient is anticipated
  - awards to universities to support research studies in subject areas consistent with the awarding agency's mission



- **Agreement thru September 2009**

- **Graduate Seminar**
  - CSE 290: Service Composition in Ultra-Large Scale Systems
  - Speakers (via VTC) from MIT, NCSU, NPS, SRI, SSC SD & Charleston, Vanderbilt & UCSD
- **JTRS Project .. FY08**
  - Increment 3 networks and radios
- **DARPA .. BAA .. LANdroids Proposal ..Aug '07**
- **ONR .. BEAMS Network Comms Gathering .. May '07**
- **DARPA .. RFI .. Feb 07**
  - Assurable Global Networking



# Conclusion



**SSC & Calit2 are developing key strategic partnership to**

- provide the best solutions to the warfighter**
- grow workforce competencies**
- develop a highly credentialed workforce**

**Plan is to continue to nurture this partnership and collaborate with additional partners**



# Improving Developmental & Operational Test Integration via Technology

**Brian M. Simmons**

**Director  
US Army Evaluation Center**

**15 April 2008**





# Agenda

- ATEC Mission
- OSD & Army Acquisition Initiatives
- Benefits of DT/OT Integration
- DT/OT Integration in the Army and Technologies that May Help



# ATEC Mission

- Plan, conduct, and report the results of tests, simulations, experiments, and evaluations to Acquisition decision makers in order to ensure our Army's Warfighters have the right capabilities for success across the entire spectrum of operations.
- Conduct rapid testing in direct support of the GWOT warfighter in order to provide capabilities and limitations of weapon systems issued directly to Soldiers conducting combat operations (Iraq/Afghanistan).



# OSD T&E Initiatives

- **Focus on measuring improvements to capability and operational support**
- **Experiment to learn strengths & weaknesses - impact on capabilities**
- **Integrate Developmental Testing & Operational Testing**
- **Start early, be operationally realistic, continue throughout the life cycle**
- **Evaluate in mission context at time of fielding**
- **Compare to current mission capabilities**
- **Use all available information**
- **Exploit benefits of Modeling & Simulation**





# Army Acquisition Initiative

## Reliability Improvements

- Significant number of U.S. Army systems are failing to demonstrate established reliability requirements during operational testing

### ***Effective Immediately:***

- A System Development and Demonstration (SDD) reliability test threshold will be established
- Applies to programs in pre-MS B phase
- Applies to Information Technology systems that include hardware development
- Threshold to be established before entrance into MS B
- Must detect and report threshold breaches
- Must implement Reliability Best Practices





# Army T&E

## **Developmental Testing**

- to find faults, implement corrective actions, and mature the design
- to confirm technical capabilities/functionality and manufacturability

## **Operational Testing**

- to provide information on integration of the Soldier, the support system, training & doctrine, and materiel in an operational environment
- to confirm/demonstrate operational suitability requirements



# Benefits of DT/OT Integration

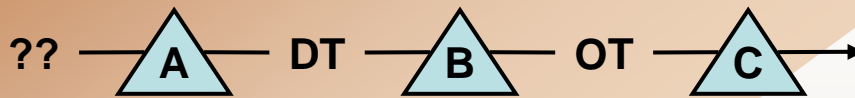
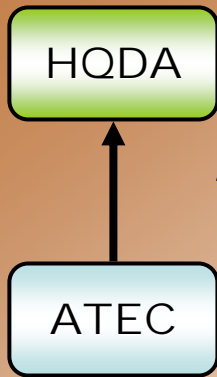
- **Reduced Risk**
  - Ensure capabilities are tied to mission
  - Systems deficiencies identified
  - Test data is shared
- **Reduced Cost**
  - Sharing resources
  - Eliminate duplicative testing
  - Early deficiency identification and correction
- **Reduced Acquisition Timeline**
  - Combined vs. sequential testing
  - Sharing of high-demand testing assets



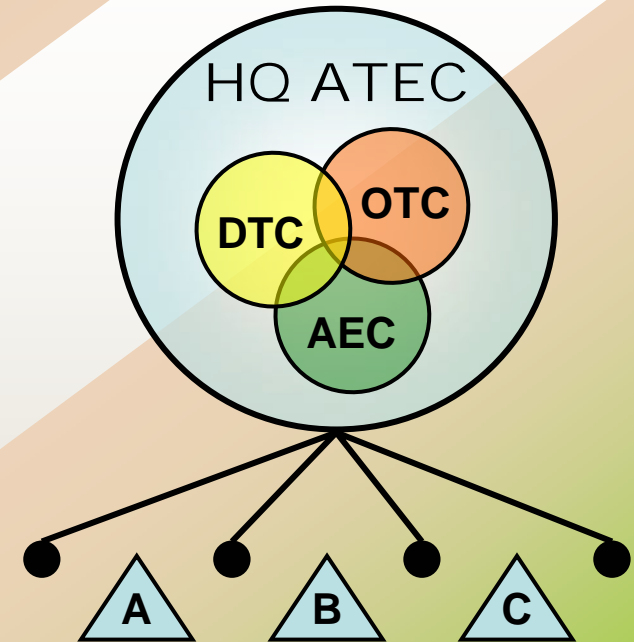
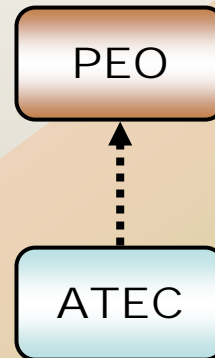
# Strategic Organizational Construct

FROM:

TO:



→ Saves Time & Money  
→ Does Not Compromise Org Independence

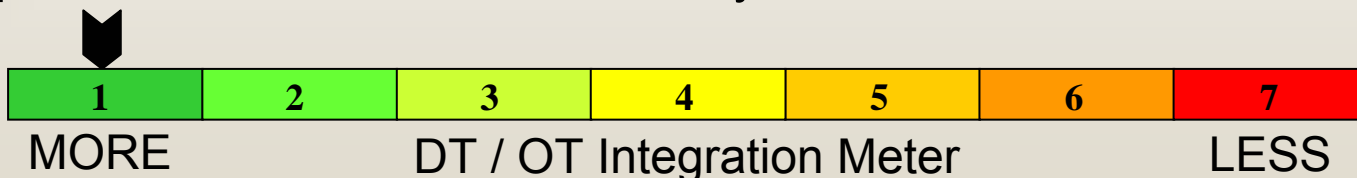




# DT/OT Integration in the Army

## Ballistic Missile Defense

- DT/OT Integration is widely used, but not in “traditional” definition
- DT is all planned, executed, and reports written by the PM (not ATEC/DTC); has significant system contractor influence/input
- No planned IOT, BMDS OTA arranges for Warfighter participation during DT events, using operationally realistic scenarios and DIA threat representation in HWIL and digital M&S
- Warfighter participation in flight and ground test events
- Proposed end-of-block OT will likely include contractor involvement





# Technology That May Improve DT/OT Integration

## **Ballistic Missile Defense**

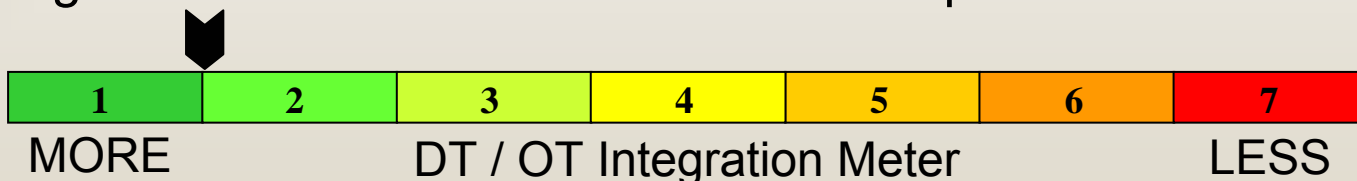
- Screen capture / frame-grabbing devices
- Automated data capture and transfer; data reduction
- Shared analysis tools



# DT/OT Integration in the Army

## Medical / Business Information Technology (IT) Systems

- A “hybrid DT/OT” usually, depends on product size, system complexity, software maturity
- Developer Integration Testing in laboratory test bed using production-representative hardware
- Not “ad hoc” – firm processes and procedures
- More Commercial Off The Shelf (COTS) - based products in use
- DOT&E process for determining level of OT – ranges from ATEC looking over shoulder of DT tester to a full operational test







# Technology That May Improve DT/OT Integration

## **Medical / Business Information Technology (IT) Systems**

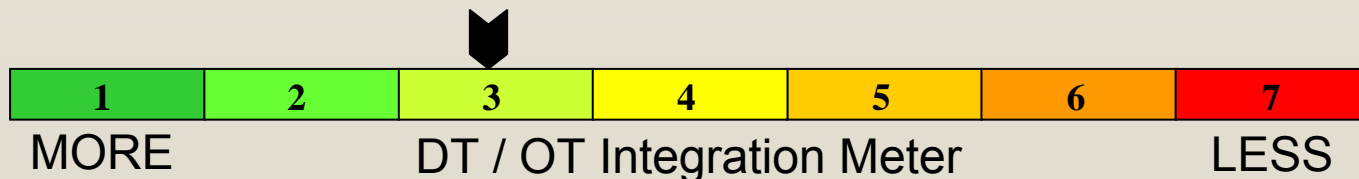
- Improve Modeling of networks (currently using none)
- Better Data Management and sharing



# DT/OT Integration in the Army

## Chemical / Biological Defense

- All live BWA & actual CWA testing is done in chamber in DT
- For Oversight systems Chem/Bio Policy defines this as DT-OT
- Many OTs are conducted in partnership with DT Community on outdoor ranges (mostly DPG) that operates and manages instrumentation to determine simulant concentration
- Key effectiveness evaluation hinges on integrating results from chamber testing with actual agent and operational testing





# Technology That May Improve DT/OT Integration

## **Chemical / Biological Defense**

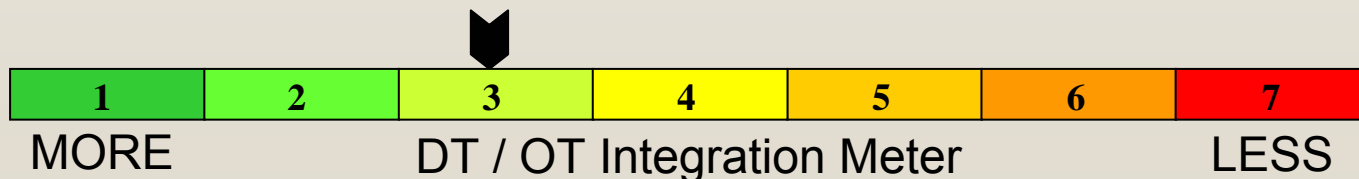
- Increase use of HWIL to stimulate detector sensors
- Real need for more accurate simulants of live agents; ALO (Agent-Like Organism)
- Better Data Management and sharing



# DT/OT Integration in the Army

## Aviation

- DT/OT widely used for subsystem evaluation (i.e. CMWS)
- Hardware-in-the-Loop Simulations
- Soldiers used in DT, especially moving from component level to subsystem level tests
- Combined test teams - Air Worthiness Release restricts introducing operational pilots early on.
- Operational Testing conducted at DT ranges





# Technology That May Improve DT/OT Integration

## Aviation

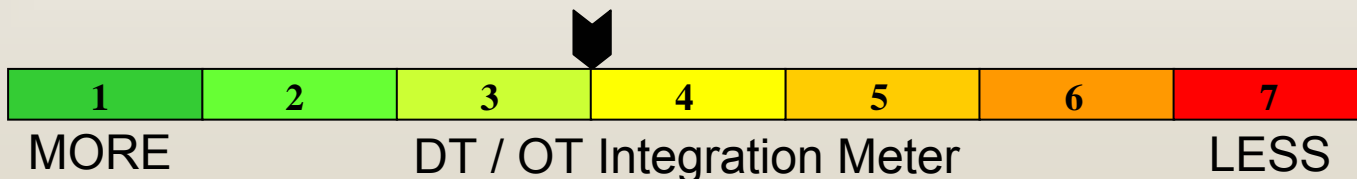
- Improved models and simulations; cockpit simulators
- Automated instrumentation for Real Time Casualty Assessments
- GPS- (or other geometric pairing) based RTCA systems
- Collaborative tools / personal communicators



# DT/OT Integration in the Army

## Infantry Weapons and Soldier Systems

- Non-oversight ACAT III systems: usually integrated DT/OT in a single location
- DT done first for safety/performance check; OT phase with Soldiers follows
- Rapid Acquisition systems: usually just DT, then theater
- Some OT at technical test sites (hot/cold regions, etc)
- OT = Soldiers in lanes







# Technology That May Improve DT/OT Integration

## **Infantry Weapons and Soldier Systems**

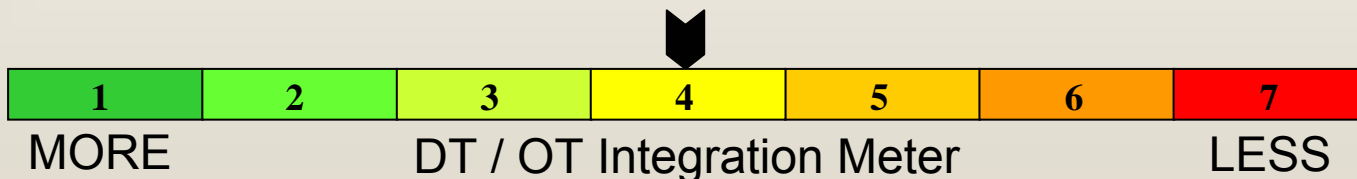
- Improved commonality of instrumentation
- Common data reduction protocols at all test sites



# DT/OT Integration in the Army

## Unmanned Aerial Vehicles (UAV)

- DT always for component-level building and assessment and Air Worthiness Release
- Soldiers used in DT, especially moving to subsystem level tests to obtain early user feedback
- DOTE requires greater operational realism in OT – tactical personnel using approved doctrine





# Technology That May Improve DT/OT Integration

## Unmanned Aerial Vehicles (UAV)

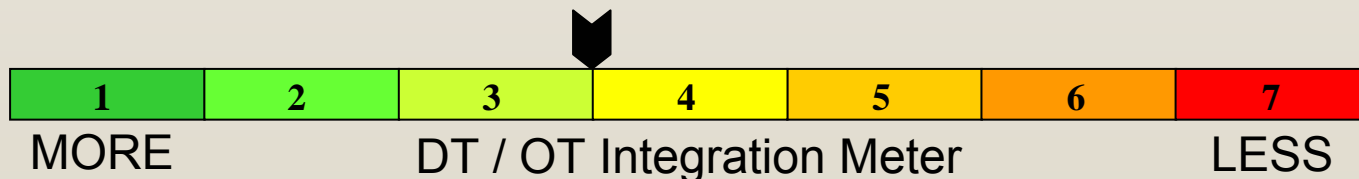
- Improved availability of models
- Improved Operator simulators
- Improved communication equipment to keep Combined Test Team in the loop
- Develop common instrumentation and data reduction protocols at all sites



# DT/OT Integration in the Army

## Missiles (Direct / Indirect Fire)

- Extensive firings early without operators
- Extensive Developmental Testing
- Extensive HWIL
- Extensive M & S
- Formal OT's





# Technology That May Improve DT/OT Integration

## **Missiles (Direct / Indirect Fire)**

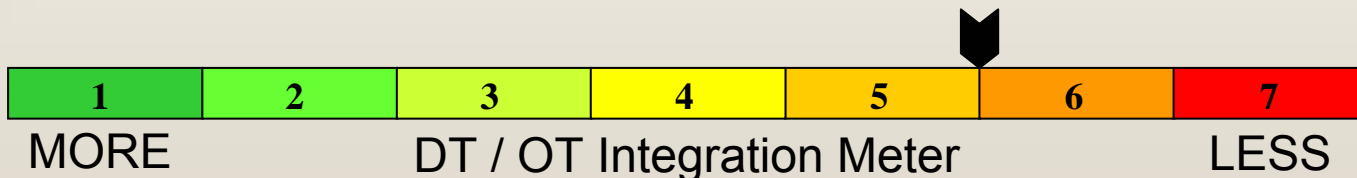
- Continued heavy emphasis on M&S and HWIL
- Improved data collection, data reduction to speed up test reports to the evaluator
- Better threat replication (consistency between DT & OT) and usage in virtual environment



# DT/OT Integration in the Army

## C4 Systems

- Limited Gov't DT – shock, vibration testing, interoperability; message completion rates
- Communications systems – performance centers on stress testing and operational environment
- Field testing is most useful integrated event – soldiers and developers working together to establish system configuration and achieve optimization
- Field tests are cost prohibitive – need for architecture for system to create the environment







# Technology That May Improve DT/OT Integration

## C4 Systems

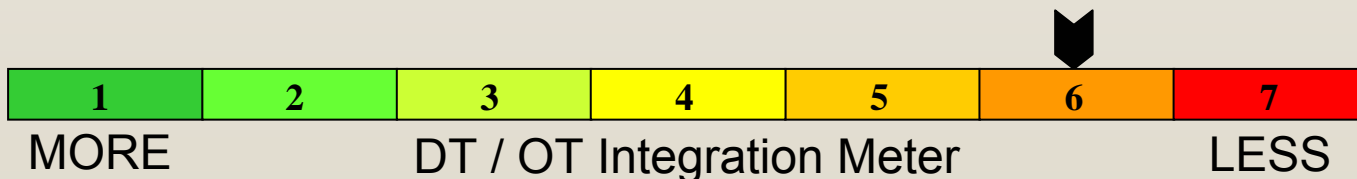
- Improve available models and simulations
- Invest in jammers / Electro-Magnetic Environment generators
- Improved data management (storage, retrieval, sharing)



# DT/OT Integration in the Army

## Counter IED

- non-typical development process
- from Laboratory to DT Ranges to Theater – fielding decisions based on DT results and production timelines
- for Jammers – DTs are technical tests on instrumented ranges; PM data considered when available
- DOT&E has not been involved in this commodity area





# Technology That May Improve DT/OT Integration

## Counter IED

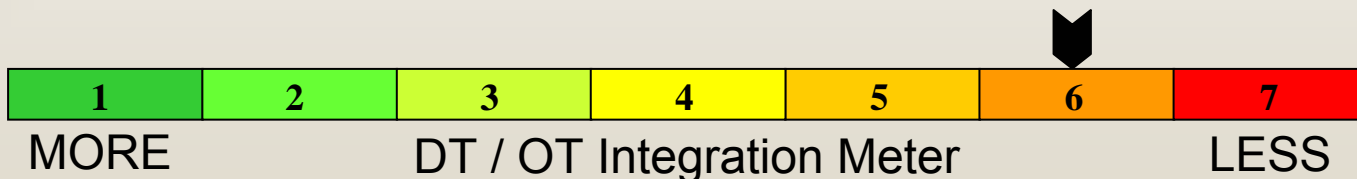
- Increase investment in S&T / R&D before T&E
- Invest in in-line jammers / Electro-Magnetic Environment generators
- Better threat replication (consistency between DT & OT)
- Commonality of instrumentation
- Instrumentation sharing between DT & OT organizations



# DT/OT Integration in the Army

## Tracked & Wheeled Vehicles

- Usually Separate DTs and OTs; higher risk – more oversight
- OMS/MP miles driven by contract, over known, precise courses
- Extensive data collection in DT
- DOT&E wants “free play” in OT; freedom of maneuver, much of which can be done at Soldiers’ home station





# Technology That May Improve DT/OT Integration

## **Tracked & Wheeled Vehicles**

- Increase number of instrumented test articles
- Embedded instrumentation
- Common instrumentation and data reduction protocols at all sites
- Technology for tracking in GPS-denied environments



# Integration Roll-Up

**Ballistic Missile Defense**

**Medical/Business IT Systems**

**Chemical/Biological Defense**

**Aviation**

**Infantry Weapons/Soldier Systems**

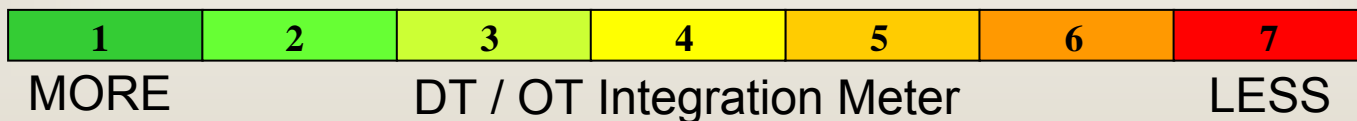
**Missiles (Dir/Indirect Fire)**

**Unmanned Aerial Vehicles**

**C4 Systems**

**Counter IED**

**Tracked/Wheeled Vehicles**







# Summary

To further improve DT & OT integration,

T&E technology needs include:

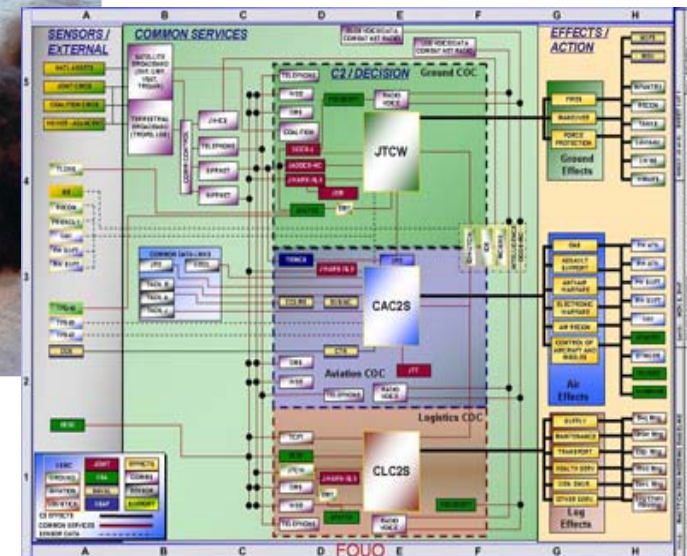
- Data management (repository, reference models)
- M&S advances (physical system models, simulations, networks)
- Network Models
- Distributed operations & systems
- Embedded / common instrumentation



Brian M. Simmons  
(410) 278-0370  
[brian.simmons@us.army.mil](mailto:brian.simmons@us.army.mil)



# Marine Corps Systems Command Brief to NDIA



April 16, 2008

Dave Ungar

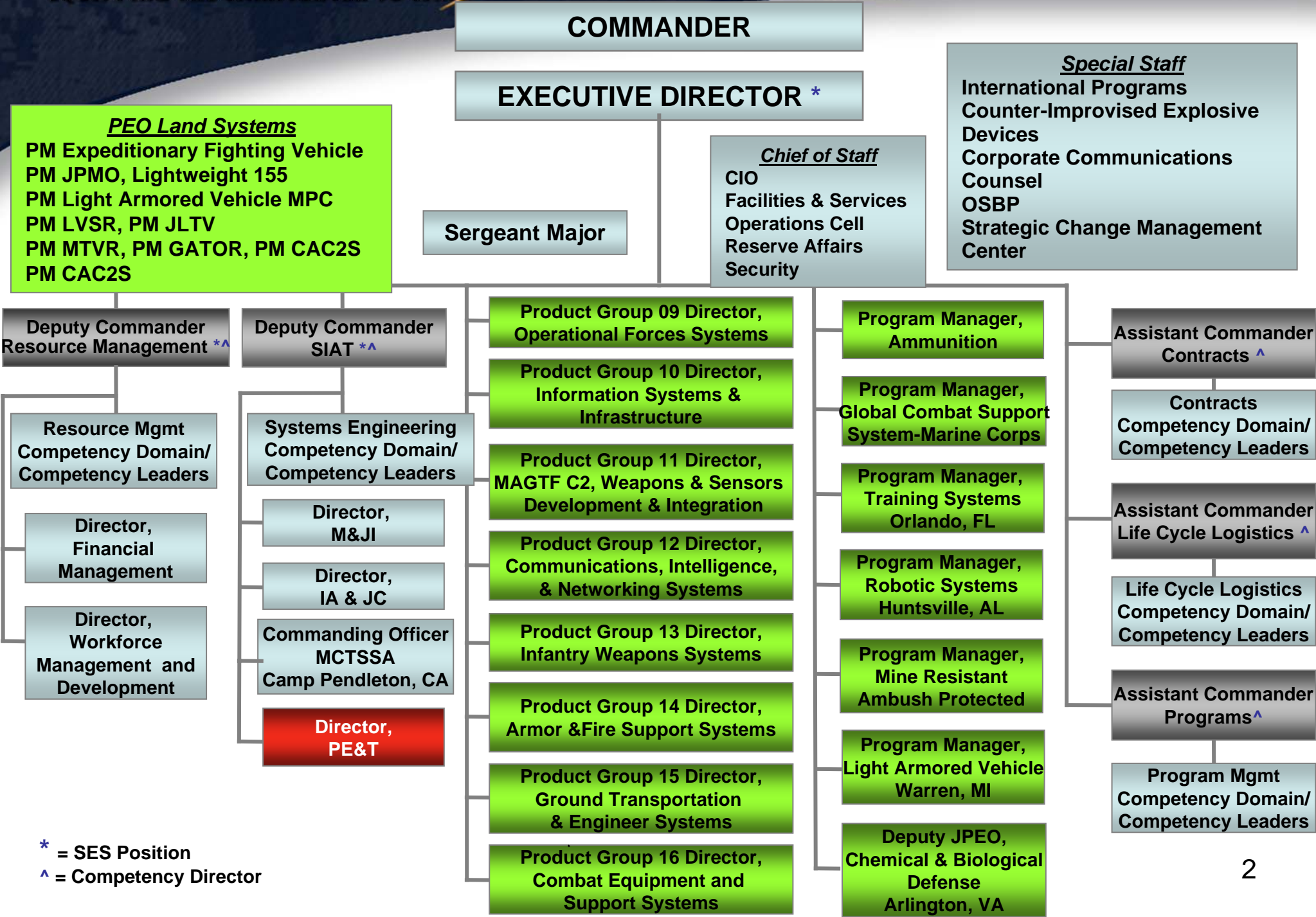
Director Program Engineering & Technology







**EQUIPPING THE WARFIGHTER TO WIN**



\* = SES Position  
 ^ = Competency Director



## Industry Forums

- Briefs to Industry (Open) 13-14 May 2008
- Modern Day Marine Sept
- Force Protection Equipment Demonstration
- POC Gloria Prior (703) 432-3930

## Technology Transitions

- Hundreds of Programs
- Established Technology Leads
- POC Jim Johnson  
(703) 432-3327

# Assault Breaching System Technologies



**Presented to**  
**9<sup>th</sup> Annual Science & Engineering**  
**Technology Conference / DoD Tech**  
**Exposition**  
**15-17 April 2008**

*Mr. Brian Almquist*

*Ocean Engineering & Marine Systems*

*Office of Naval Research*

*(703) 696-3351 almquib@onr.navy.mil*

*LtCol Tim McLaughlin*

*APM for ABS*

*PMS 495 Mine Warfare Program Office*

*(202) 781-4457 tim.j.mclaughlin@navy.mil*



# Mine Warfare Research Area Strategic Vision

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***Provide rapid, standoff mine countermeasures capability to support the unencumbered maneuver of combatants throughout the littoral penetration area (sea shield), to enable sea strike operations in the littorals from the sea (i.e. STOM), and to assure access to the sea base, intermediate staging bases, and Sea Ports of Debarkation (SPOD) to ensure strategic mobility and sustainment.***

## Investments Address Critical Capability Gaps

- Supports Development of an Organic Capability
- Supports Sea Shield Undersea Warfare (MIW) Gap Analysis

## Goal is to Decrease the MCM Timeline & Eliminate the Requirement for Manned Ops in Minefields

- Highly Cluttered, Littoral Environment Provides Challenge
- Sensors, Automated Processing, Unmanned Systems Focus
- Air Deployable Mine and Obstacle Breaching System
  - Unique effort in support of amphibious assault

# Organic Mine Counter Measures FNC Program

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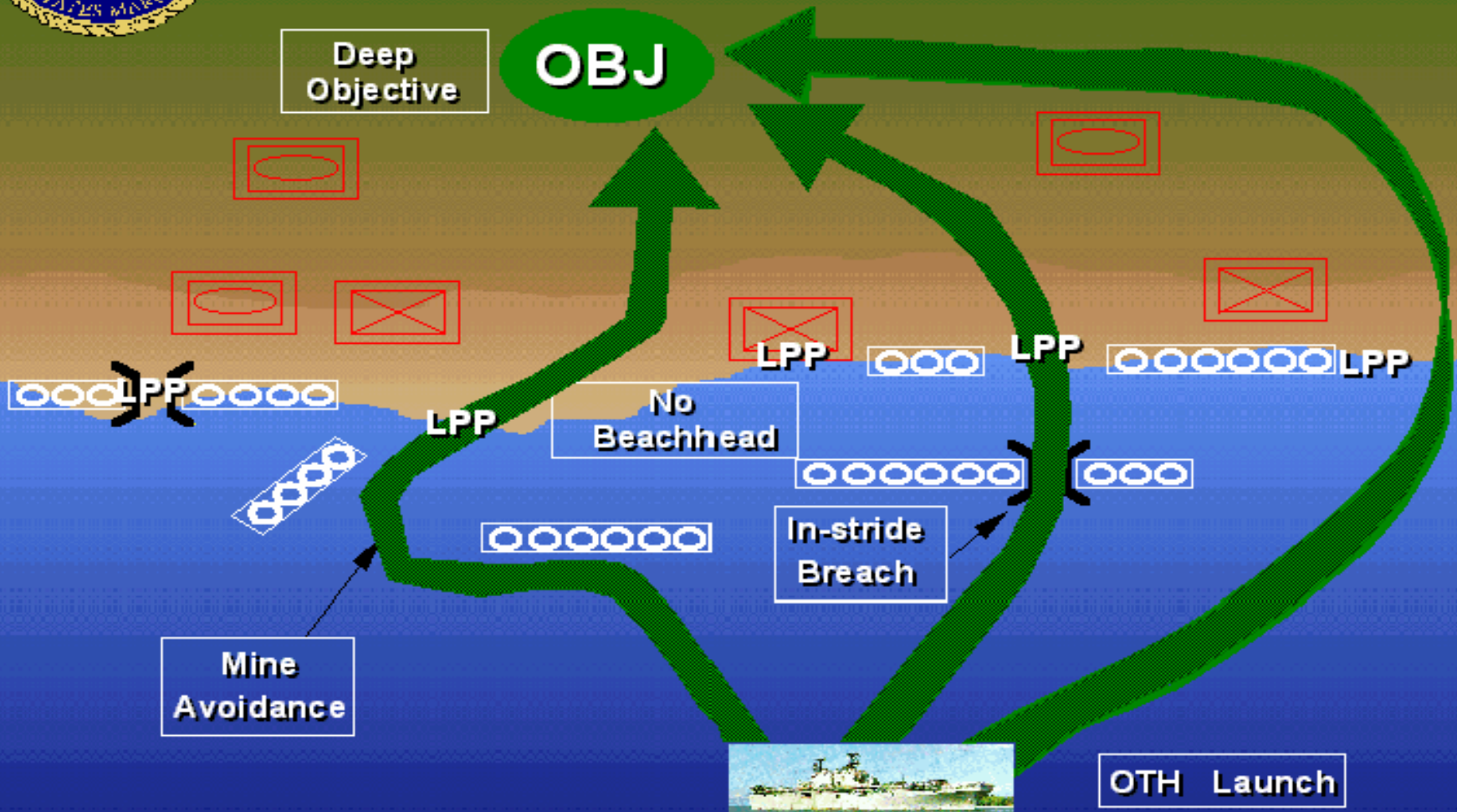
## POM 06 / PR07 / POM08 Capability Gaps

- **Gap 1:** Capacity to clear large areas of mines without cued ISR

- **Gap 2:** Destruction of mines in areas through which Marine Corps and Joint Forces must maneuver, ranging from deep water through the surf and beach exit zone.



# Ship-to-Objective Maneuver



*Assured Access to Enable OMFTS/STOM*

# Ship To Objective Maneuver

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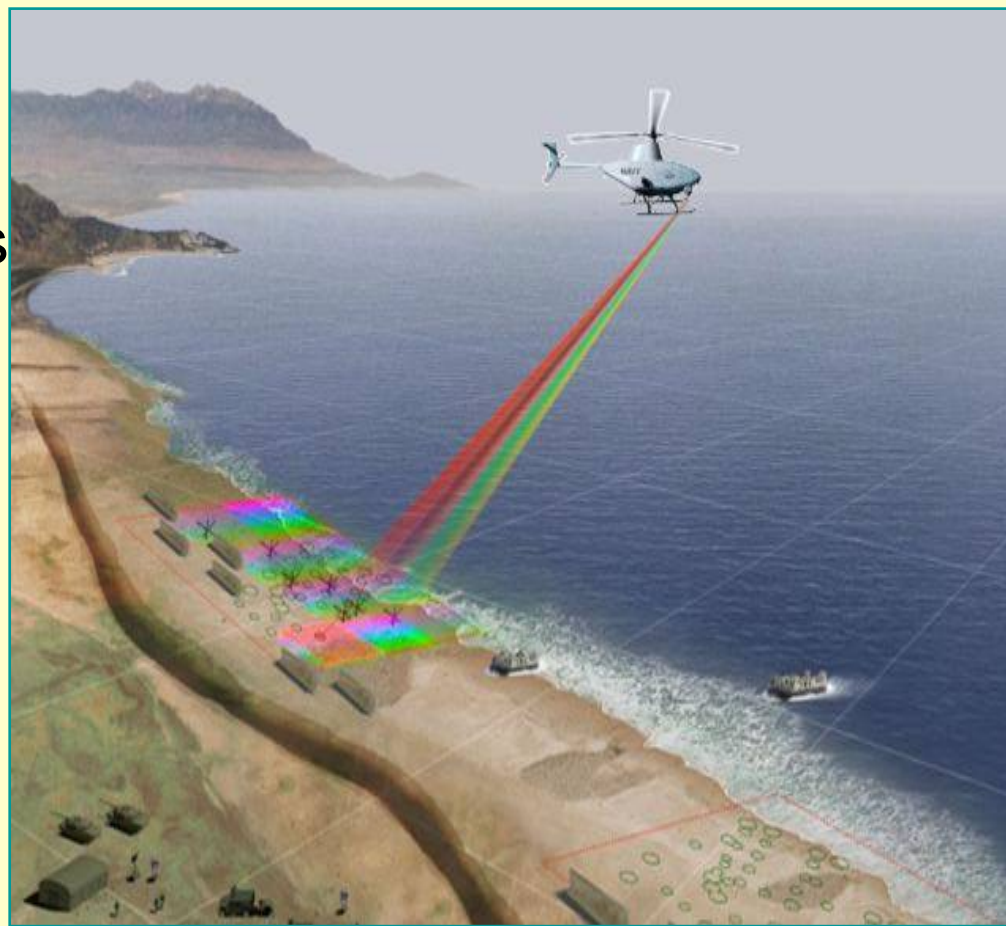
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## Capabilities:

- Wide area surveillance to enable maneuver
- Clandestine reconnaissance to prepare the battlespace
- Rapid overt mine and obstacle reconnaissance
- Data Fusion to accelerate the planning process
- Timely MCM Common Tactical Picture to enable maneuver
- Stand-off neutralization of individual mines in VSW
- Stand-off breaching of mines and obstacles
- Autonomous, high speed compact influence sweep
- Precision localization and navigation from VSW to BEZ
- Rapid Follow On Clearance

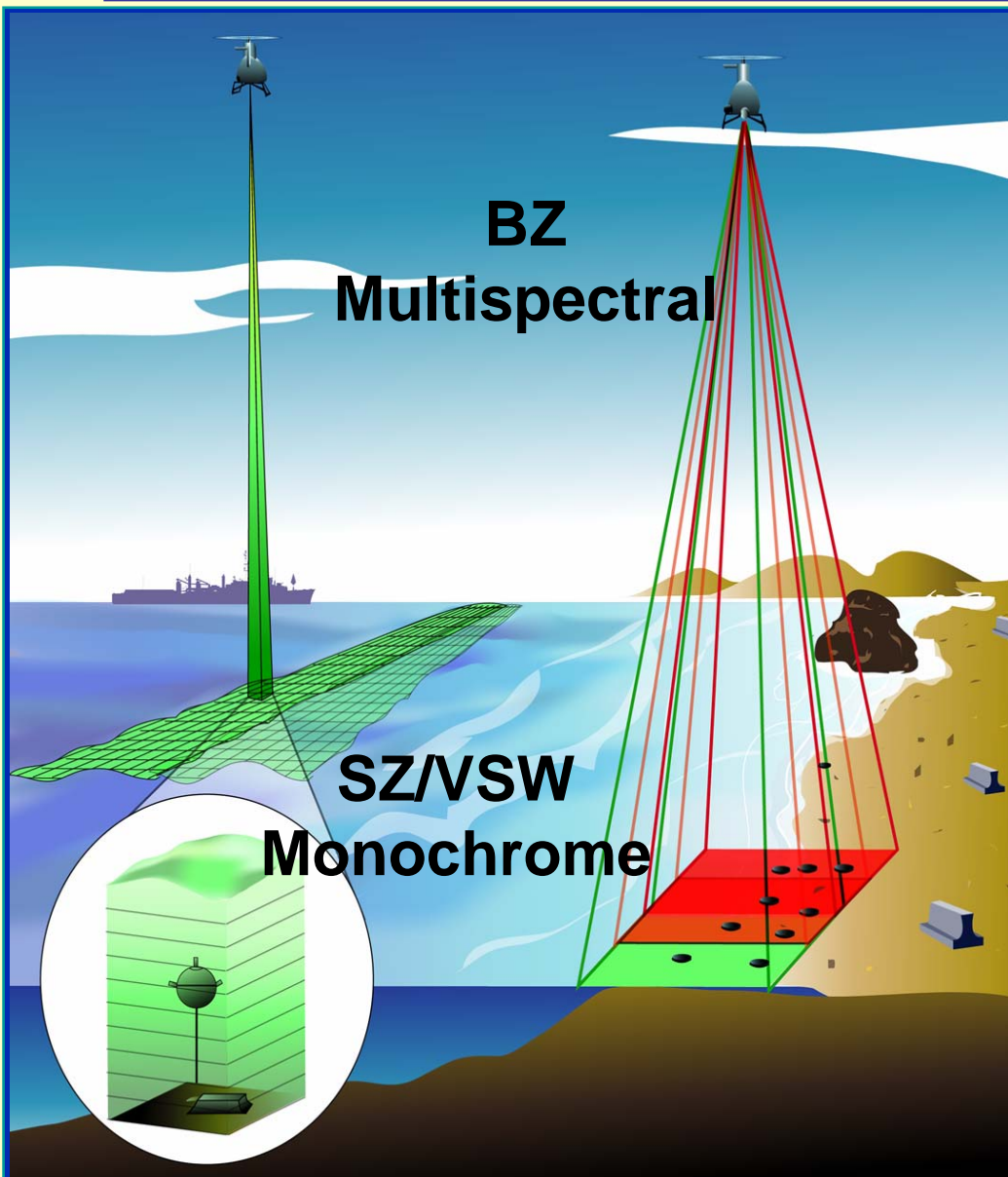
# Spiral Development of COBRA

- **Block I (FY09) limited:**
  - Daytime operations
  - Surface mines & obstacles
  - Detection in BZ
- **Block II (FY13)**
  - Night operations
  - Full detection in surf zone
- **Block III (FY16)**
  - Buried mine line detection
  - Near real-time processing





# Rapid, Overt, Airborne, Reconnaissance (ROAR)



## General

- Day / Night Operation
- Altitude: 3,000 feet
- Speed: 75 knots
- Swath: 200 meters

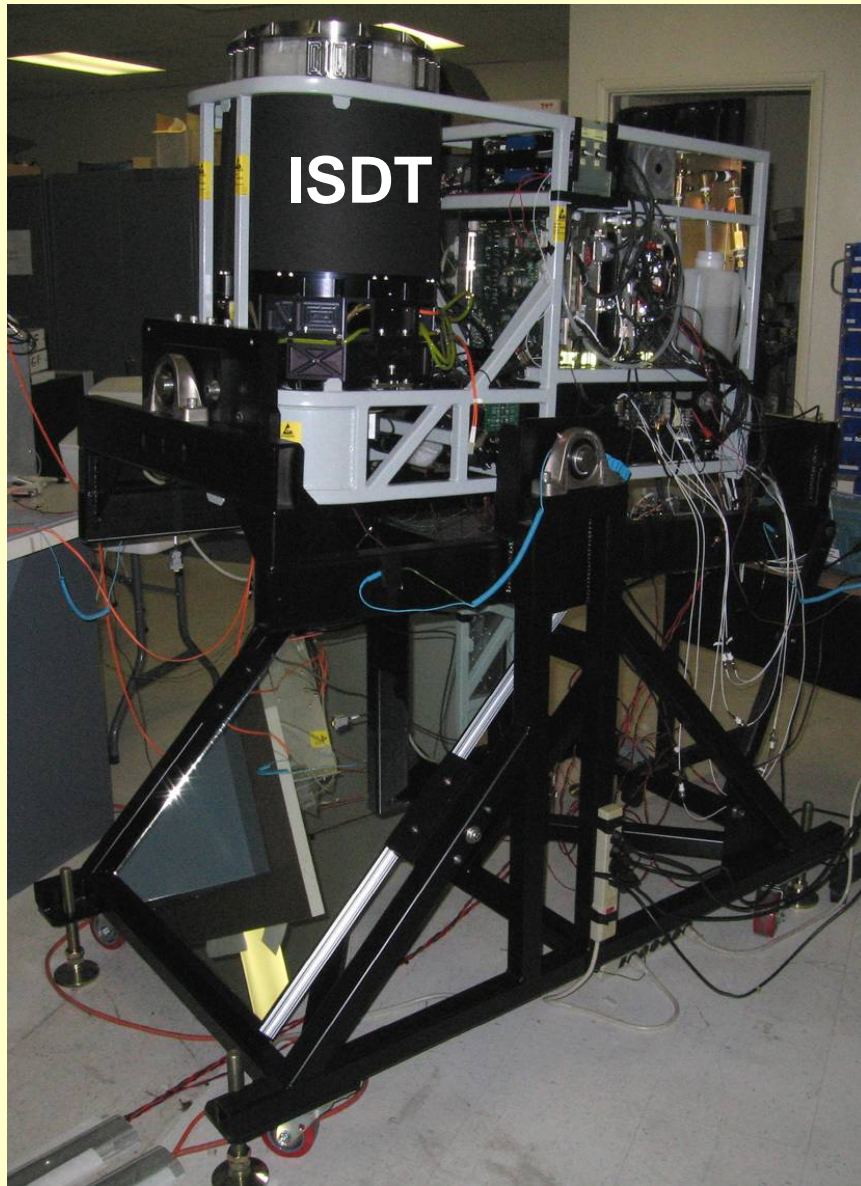
## Surf Zone (SZ)

- 44 Range Gates
- Multiple Looks
- Track-and-Revisit Mode

## Beach Zone (BZ)

- 3-Color Active MSI
- 70% Spectral Overlap

# ROAR Technology Advances



- Integrated camera, scanner, receiver, and laser system in compact design for UAV
- True 3-D LIDAR system
- Multi-look scan pattern
- Active multi-spectral provides day / night capability
- Optimized for Surf Zone

# Tactical UAV Sensor for Detection of Minefields (Buried) in the BZ / SZ

## Description

- Detection of buried minefields
- Technical Approaches
  - Active and passive imagers
  - Synthetic Aperture GPR
  - Laser Interferometric Sensor
  - High Resolution 3-D Imaging
  - Resonant Radio Freq Location

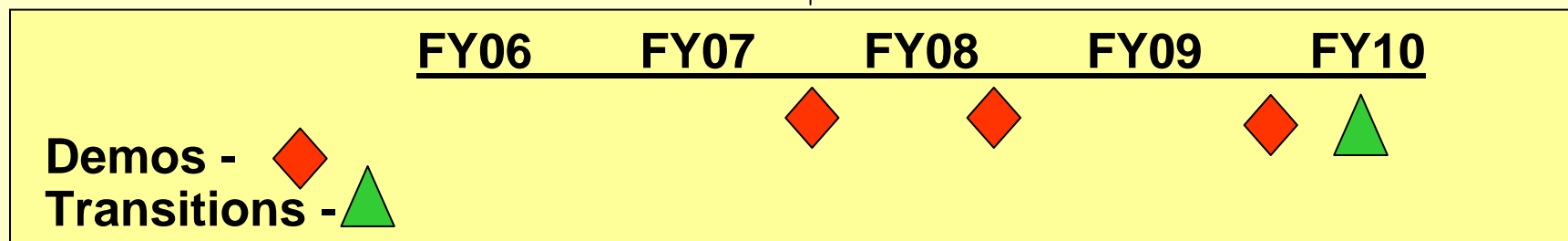


## Demos / Transitions

- PMS 495 COBRA BLOCK III

## Warfighting Payoff

- Rapid recon, day and night
- Supports targeting for ABS



# Mine & Obstacle Breaching S&T Strategy

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## Develop a Precision Breaching Capability

- Enabled by ISR and Weapon Precision Guidance
- Delivery by Naval TACAIR, USAF Bombers

## Spiral Development Approach

- JDAM Assault Breaching System (JABS): Exploit existing precision guided bombs for surface laid BZ/SZ mines and obstacles; VSW Mines
- Advanced Warhead Development: Countermine darts with greater kill radius & effectiveness vs. buried BZ / SZ mines in water and on land



# JDAM Assault Breaching System (JABS)



- **Requirements**

- OPNAV Letter
- Threshold and Objective

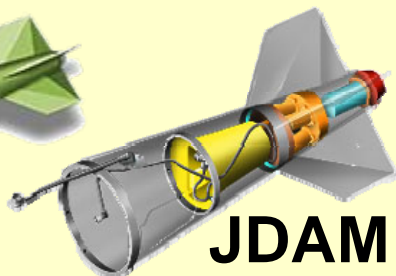
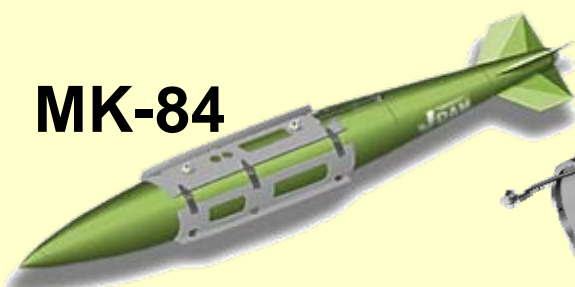
- **System Level Demos**

- Beach Zone
- Beach Zone / Surf Zone

- **Mission Planner**

- **Transitioned to PMS-495**

**MK-84**



**JDAM  
Tail Kit**

**GBU-31(V)2/B  
Precision Guidance**

[VIDEO](#)

[VIDEO](#)

# Mine and Obstacle Defeat System (MODS)



## • Requirements

- MCIA Mine Threat Letter
- ABS IPT Mine Matrix
- Mine "Kill" Criteria

## • Component Tests

- Chemical and HE Darts
- Sled Tests

## • System Level Demos

- Flight Tests with Darts

## • Transitioned to PMS-495

**Dispenser**

**CM Darts**



**SLED TEST**

**LIVE DEMO**



# Standoff Assault Breaching Weapon Fuze Improvement

## Description

- Demo JABS vs. VSW mines
- Program will address:
  - Weapon Trajectory in VSW
  - Time of weapon detonation
  - Lethality against VSW mines
  - Fuze options

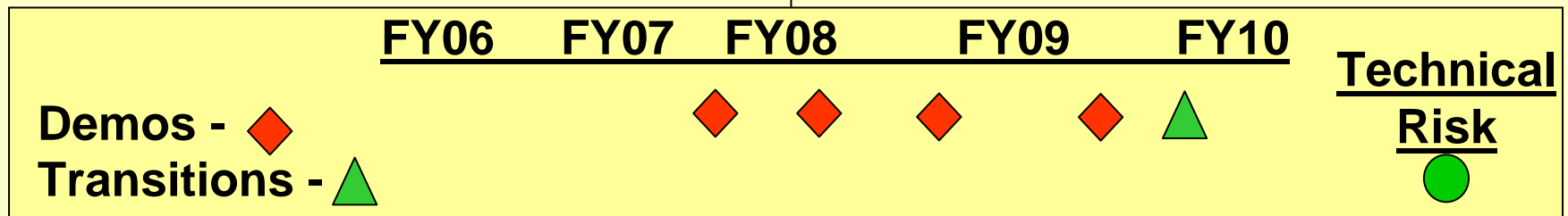


## Demos / Transitions

- ABS Program / PMS-495

## Payoff

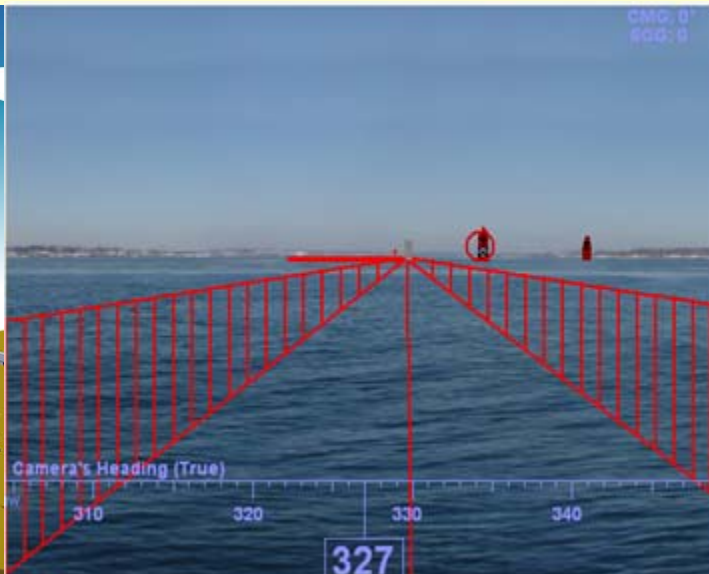
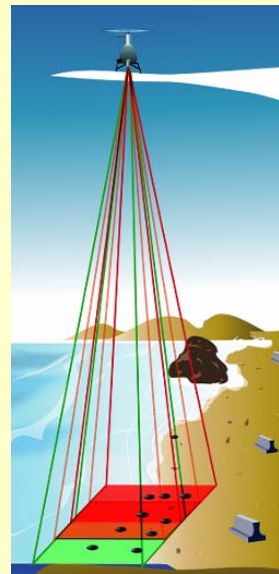
- Standoff clearance of VSW mines



# Precision Assault Navigation in Mined Environments and Assault Lane Marking

## Description

- Ensure Location Accuracy
  - GPS Augmentation
  - Zero Age of Data (ZOAD)
- Virtual Marking of Lanes
  - ARVCOP
  - Situational awareness
  - Virtual representation

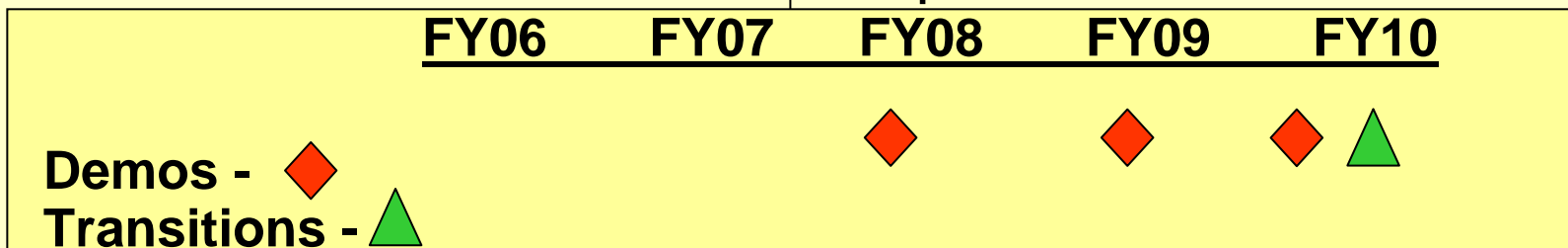


## Demos / Transitions

- ABS Program / PMS-495

## Warfighting Payoff

- Location accuracy for assets
- Improve TLE







# Mine and Obstacle Breaching Concept, Development, Transition




FY90-94 FY95-96 FY97-98 FY99 FY00 FY01 FY02 FY03 FY04 FY05 FY06 FY07

## ABS Studies

## Concept Exploration

M. Carpet   
 T. Road   
 Flying Sword   
 AM Projectile 

Development  
Categories:

 6.2  
 6.3  
 Acquisition

## Mine & Obstacle Vulnerability / Model Development



## Mine & Obstacle Defeat System w/ CM Darts

 BAA  PDR  Sled  Darts  Flt Tests  Demo

## JABS

 BAA  Demos  USAF MOA  MP

## JABS





Contingency →  FOC 

## EN ATD (6.3)

## DET & SABRE

 Concept  D&V  EMD  Termination

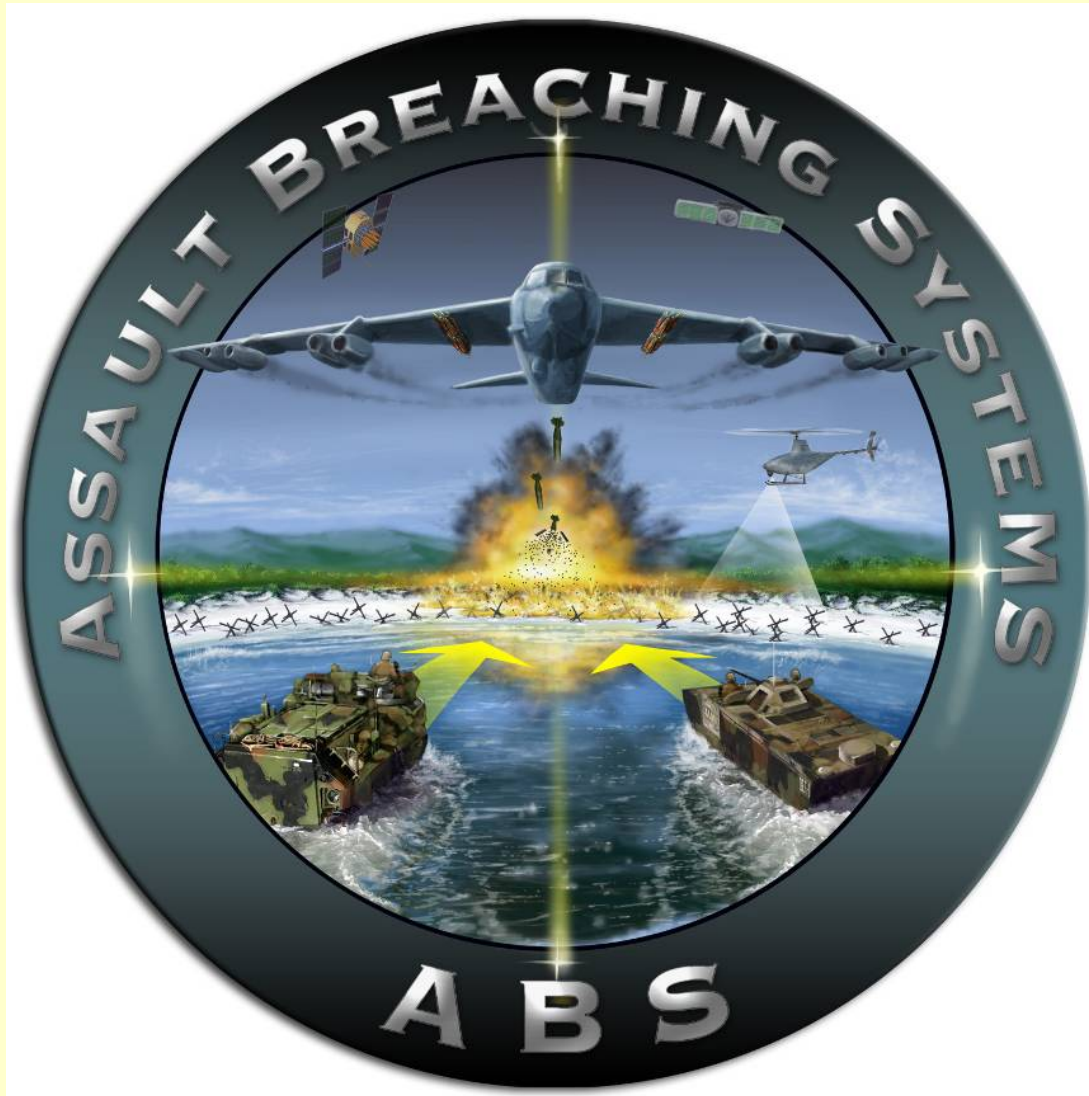
## ABS Far Term

 MAA  ICD  CDD  MS B



# Assault Breaching Systems (ABS) Program

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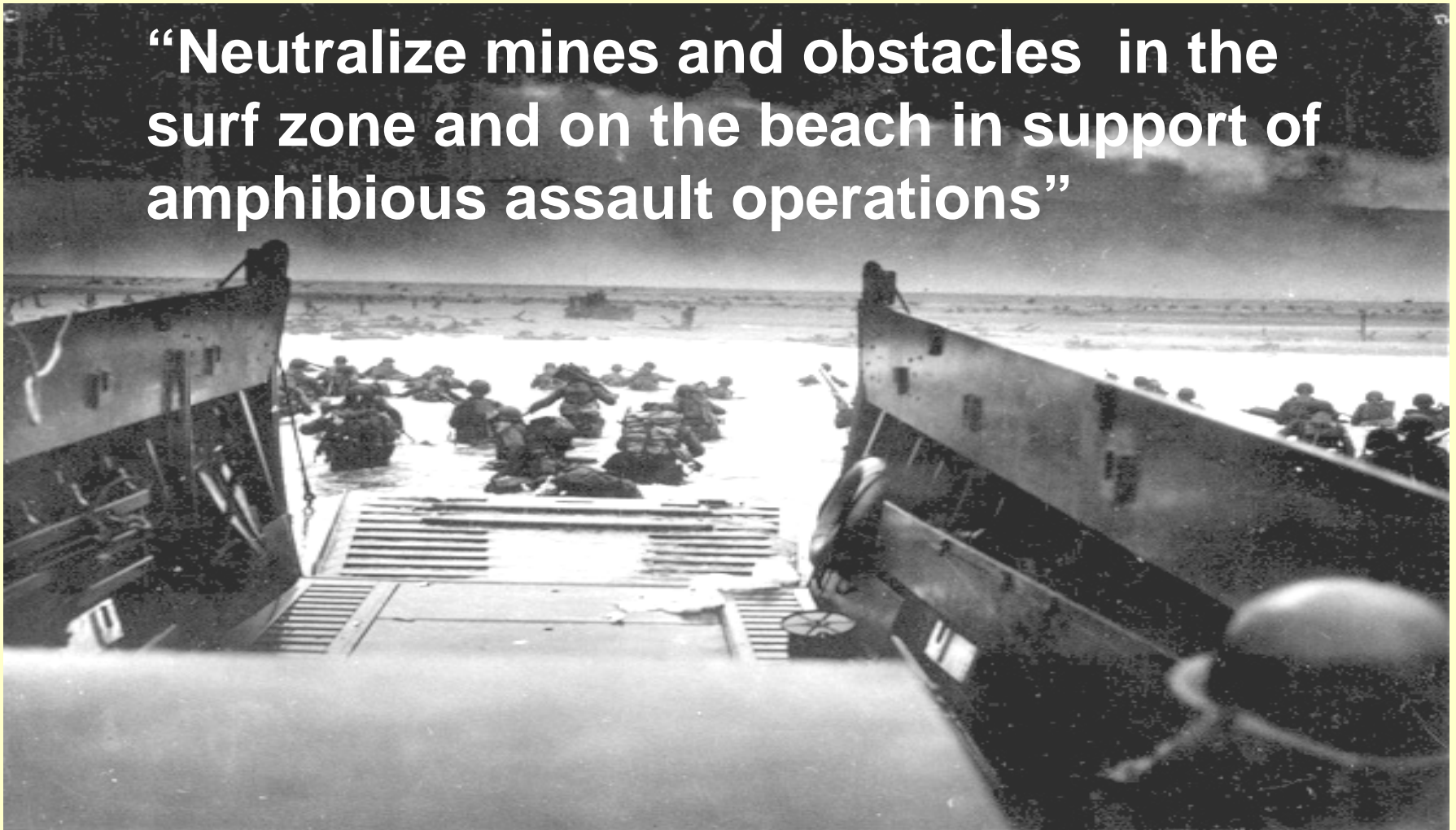


# Assault Breaching Systems Mission Statement

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**“Neutralize mines and obstacles in the surf zone and on the beach in support of amphibious assault operations”**





# Mission Need

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**“We can ill afford to move 3,000 miles to theater and be stymied by mines and obstacles in the last 3,000 yards.”**

**- General John Rhodes,  
Marine Corps Combat  
Development Command**

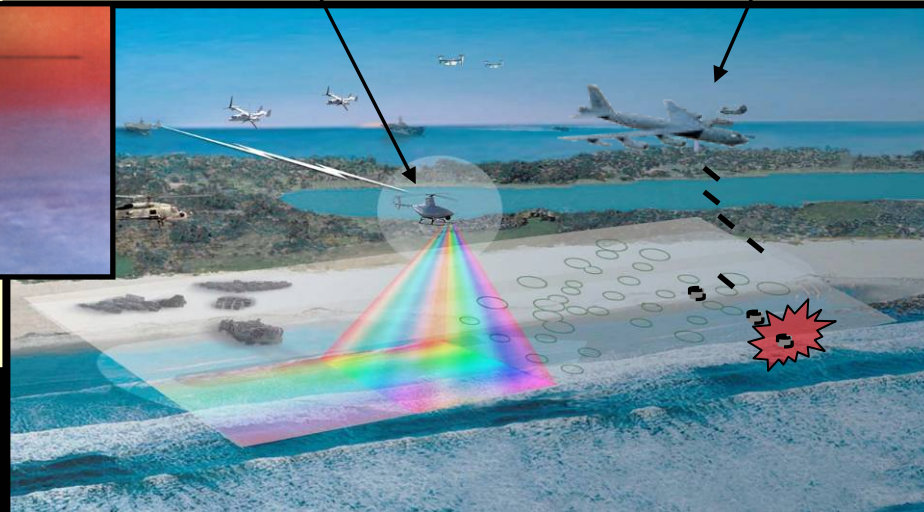




# ABS System-of-Systems

COBRA Sensor on Fire Scout Counter Mine/ Counter Obstacle (CMCO)

ISR&T Capabilities



**JABS**



**AAV/EFV**

**Precision Navigation / Lane Marking**



**MODS**



**COBRA**

AN/DVS-1







# COBRA Block I



Processing and Data Storage



Step Stare Gimbal with MSI Camera



Access Panels to Remove Mission Data



# COBRA System Description

## Block I, Spiral B

Ground Control Station



Airborne Control Processor (ACP)



COBRA PMA Station



Tactical UAV

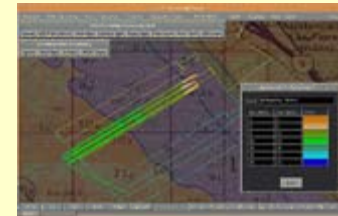


Payload Housing Group (PHG)



MEDAL

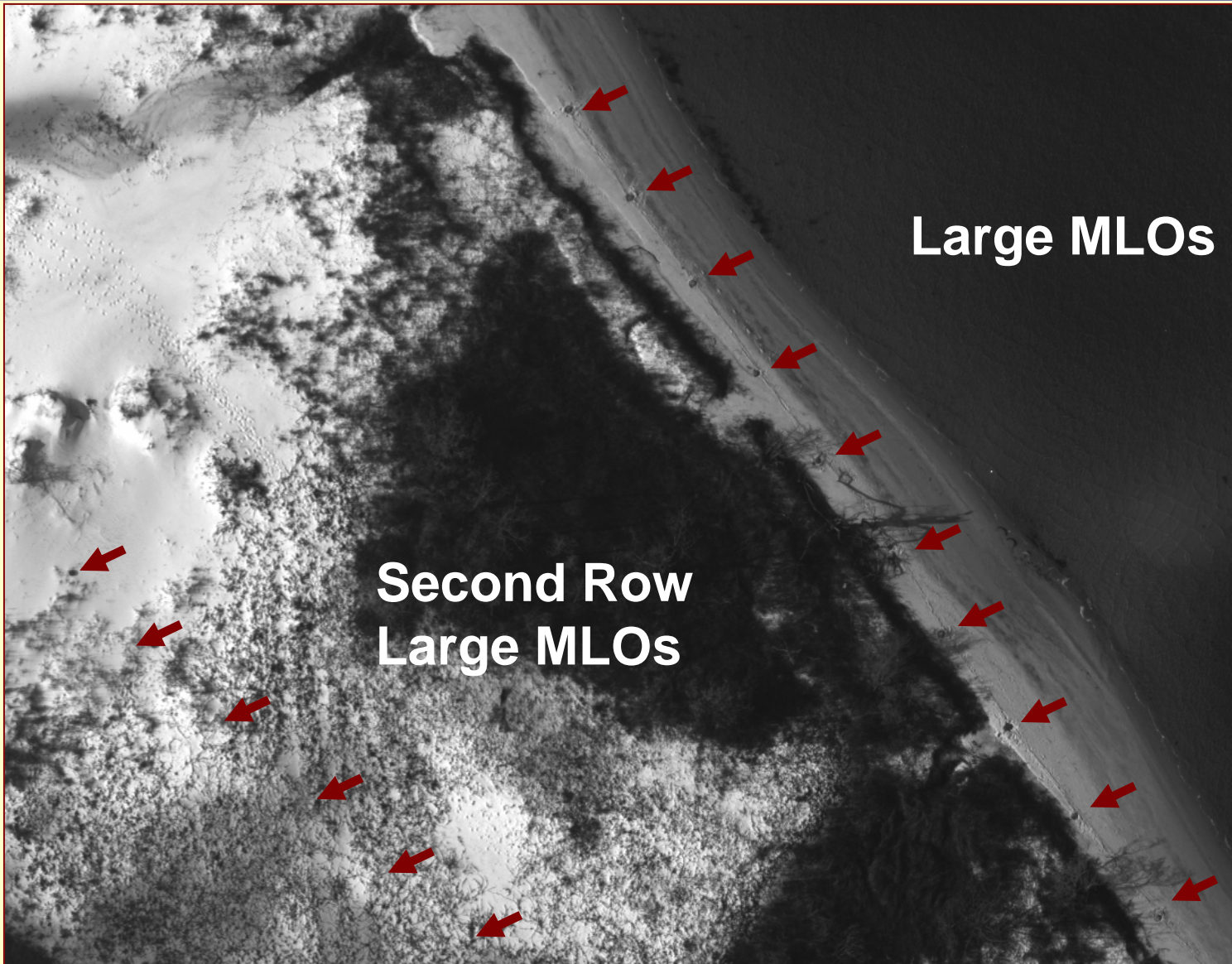
Airborne Sensor Group (ASG)







# Eglin Sound Area A15 Target Fields





# JDAM Assault Breaching System (JABS)

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# JABS Capabilities

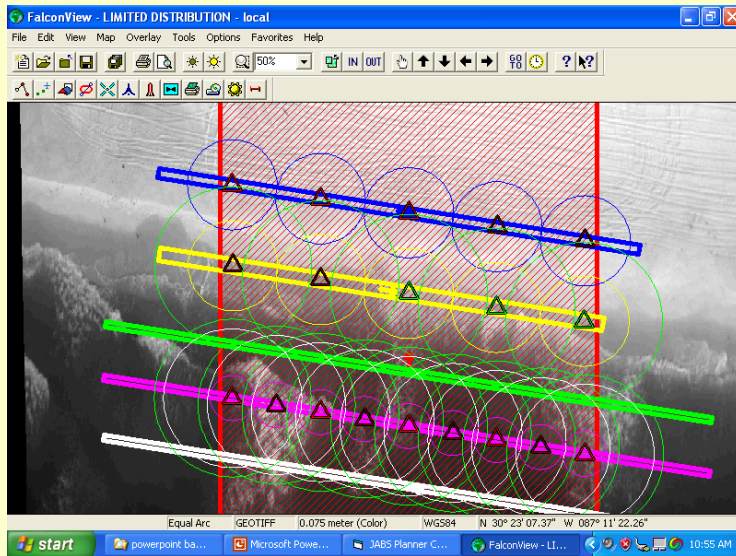
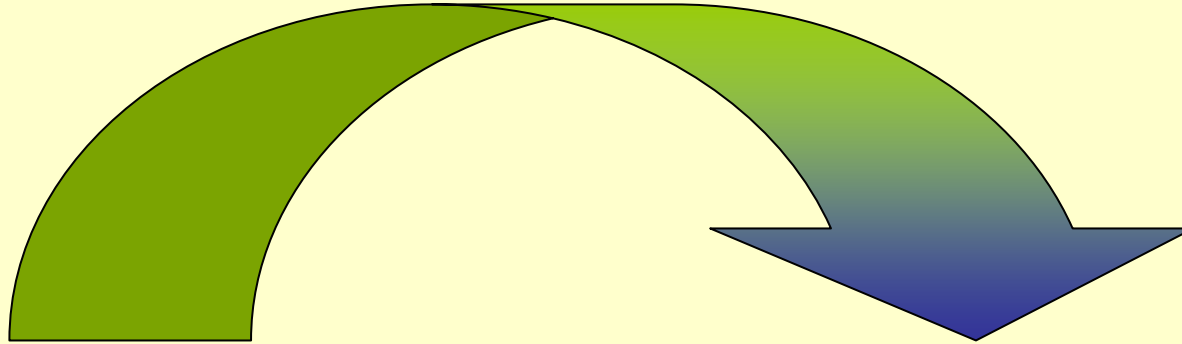
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- JABS leverages fielded JDAM weapon:
  - Effective vs. unburied mines / obstacles in the SZ & BZ
  - Limited lethality against buried mines
  - Day/Night Capability
  - Man out of the minefield
- MOA between USN-USAF
- JABS capability fielded through DOTMLPF Change Recommendation (DCR), approved by JROC May 06
- With accurate targeting information, JABS is the surf zone/beach zone breaching capability of today



# Aim Points Sent to Air Force



**Air Force Executes Mission**



# Countermine System (CMS)





# Countermine System (CMS)

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## Description

The CMS consists of a precision guided weapon and mission planning software. The weapon will be delivered by USAF bombers and Navy TACAIR. The CMS will be effective against surface laid and buried mines in the surf zone (SZ) and beach zone (BZ).

## Status

- Request for Proposals: 30 April 2007
- Proposals Received: 14 June 2007
- Contract Award Pending: May/June 2008





# Precision Navigation and Marking



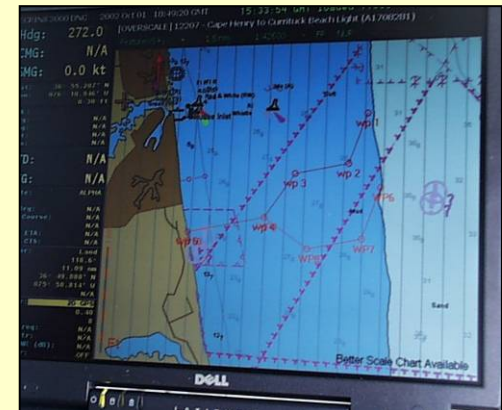


# Precision Navigation and Marking System

Improve survivability and reduce the required lane size by visually / electronically marking lanes and providing electronic aids to facilitate maneuver.



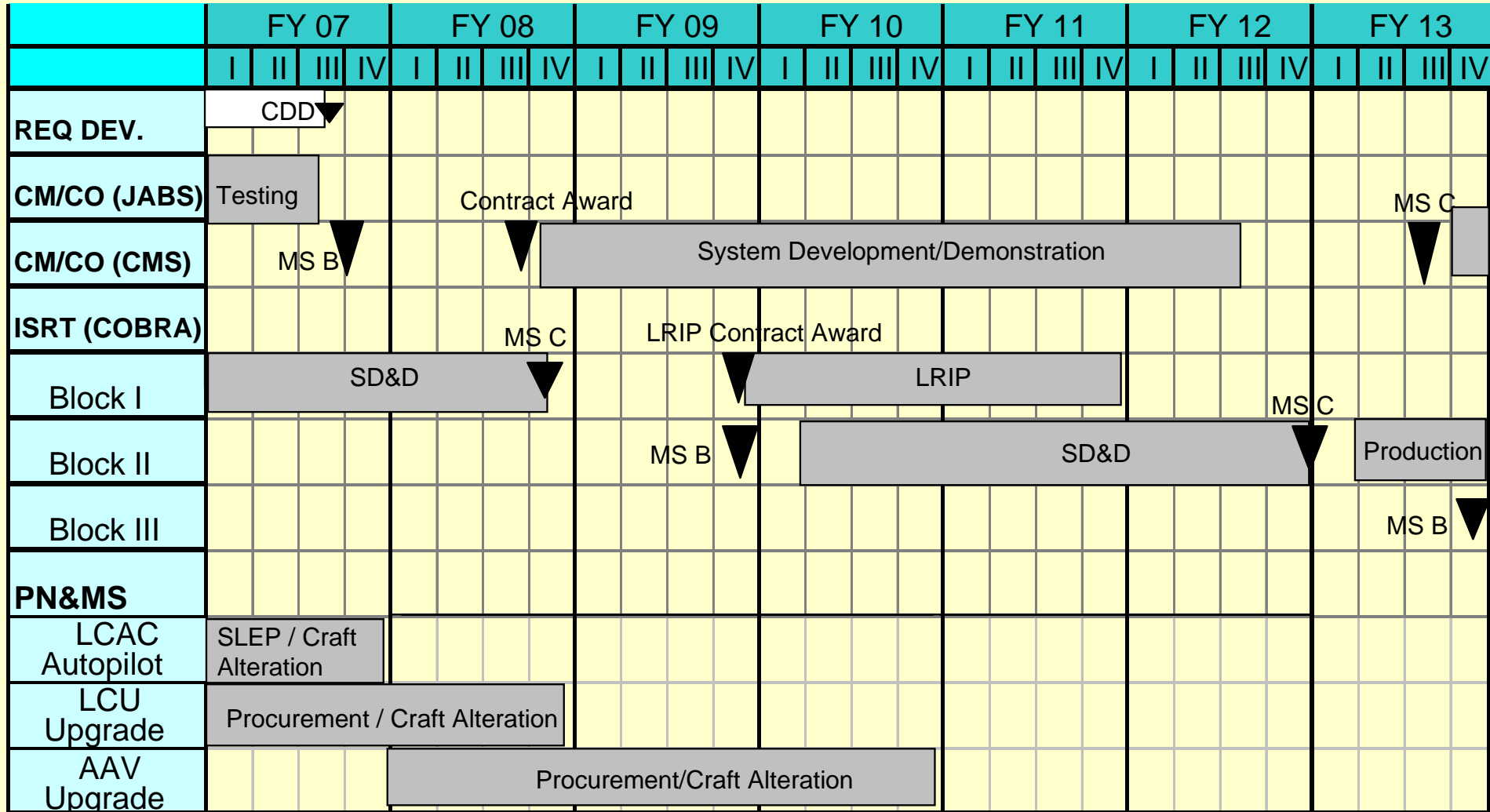
LCAC Autopilot "SKIPPER"







# ABS Schedule



- **Transitions Have Contributed to Closing Gap**
  - Minefield Breaching Weapons JABS & MODS
- **Current Technology Transition Agreements**
  - UAV-Based Mine Sensors
  - GPS Augmentation & Augmented Reality
- **Keys to Successful Transitions**
  - Close Coordination between OPNAV / ONR / PMS-495, Industry, Laboratory, and Academia
  - Clearly defined exit criteria
  - System-level demonstrations

# Assault Breaching System Technologies



**Presented to**  
**9<sup>th</sup> Annual Science & Engineering**  
**Technology Conference / DoD Tech**  
**Exposition**  
**15-17 April 2008**

*Mr. Brian Almquist*

*Ocean Engineering & Marine Systems*

*Office of Naval Research*

*(703) 696-3351 almquib@onr.navy.mil*

*LtCol Tim McLaughlin*

*APM for ABS*

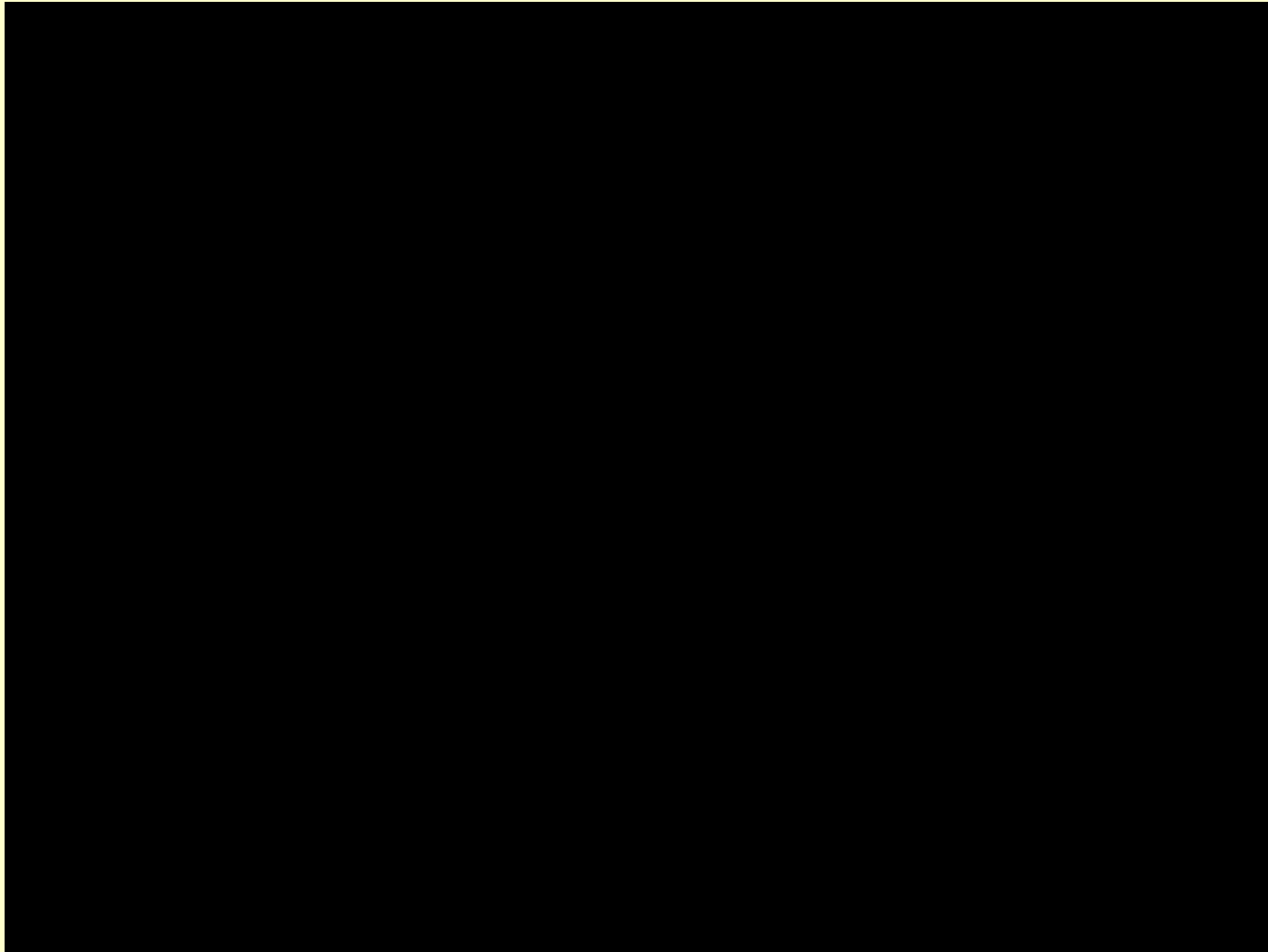
*PMS 495 Mine Warfare Program Office*

*(202) 781-4457 tim.j.mclaughlin@navy.mil*

# JABS Flight Test

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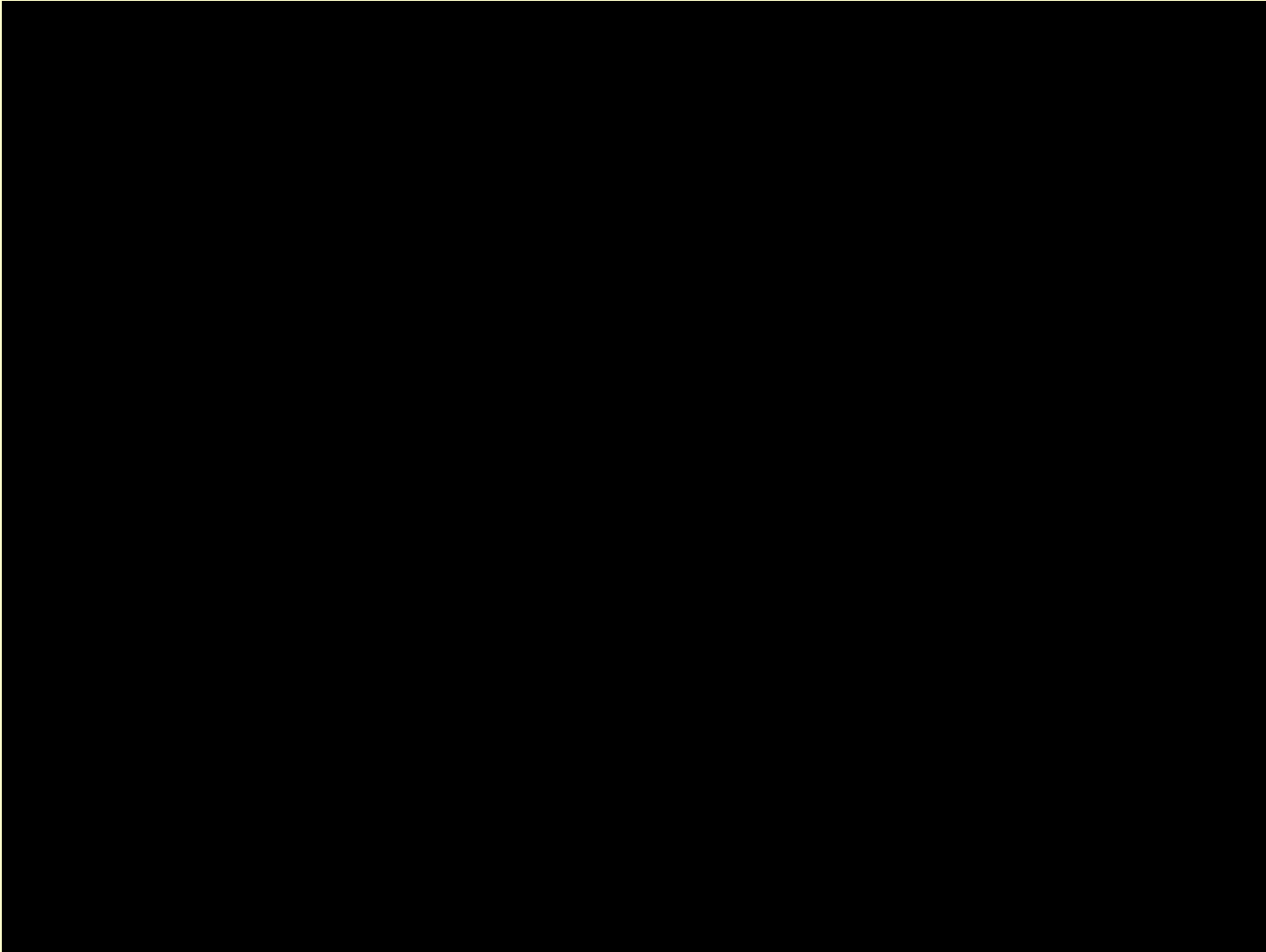


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# JABS Surf and Beach Flight Test

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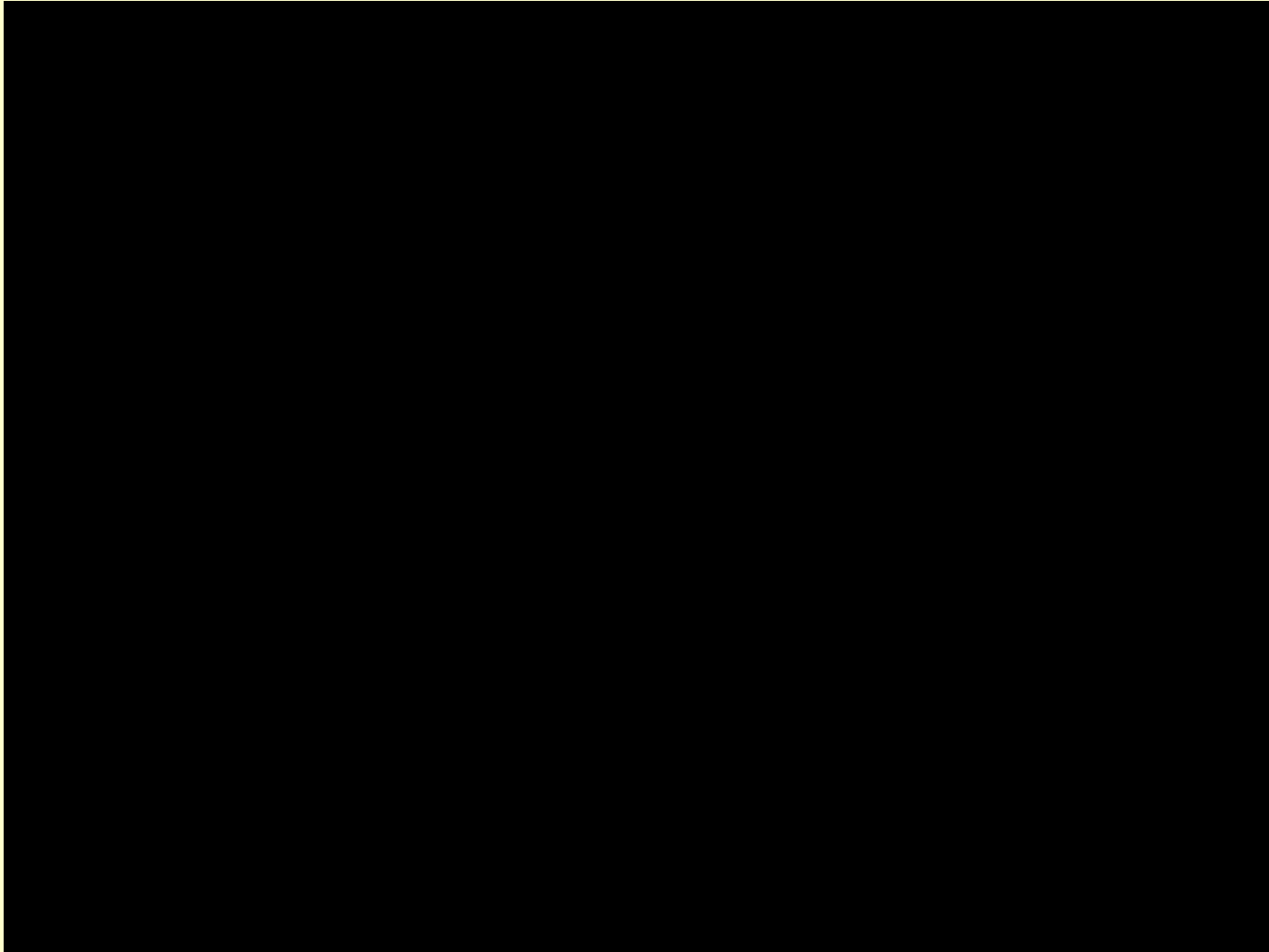


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# MODS Live Demo

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# Sled Test



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