Transitioning S&T Programs

Defense Systems Acquisition Management Course

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Office of Director, Defense Research and Engineering


If a great technology is developed in the lab but no one uses it, does it make a difference ….

DoD S&T Has Developed Technologies That Changed Warfighting

- **Disruptive technologies resulting from technology push:**
  - Internet
  - GPS
  - Night vision
  - Lasers
  - Stealth
  - Predator
  - Global Hawk

All provided dominant capability

- ***None of these emerged from requirements***

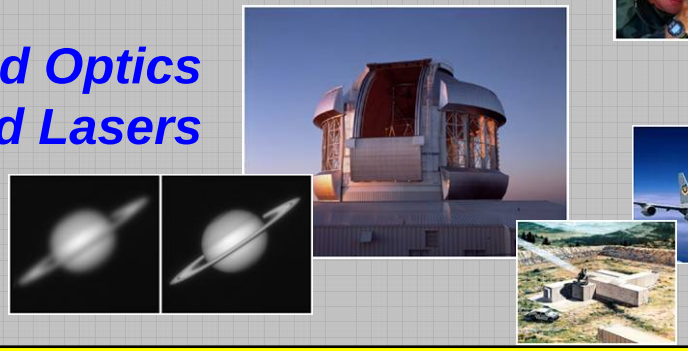
Stealth

UAVs

GPS

Night Vision

Advanced Optics and Lasers



Yesterday's Investment in S&T Provided Today's Capability Advantage

Air Armament Transformation

Accuracy

1943

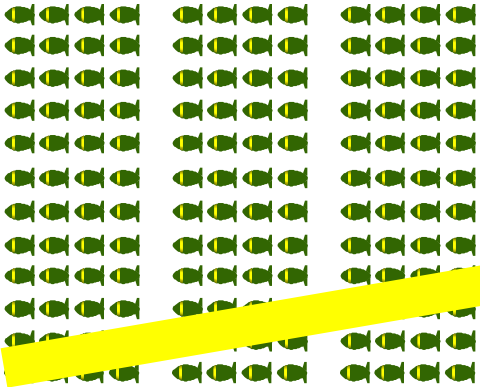
1500 B-17 sorties

9000 bombs (250#)

3300 ft CEP

One 60’ x 100’ target

W.W.II



1970

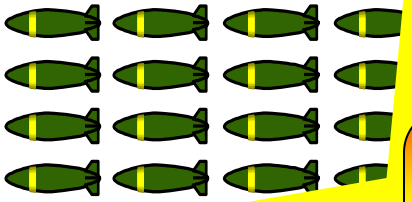
30 F-4 sorties

176 bombs (500#)

400 ft CEP

One Target

Vietnam



1991

1 F-117 sortie

2 bombs (2000#)

10 ft CEP

Two Targets per Sortie

Desert Storm

1999

1 B-2 sortie

16 bombs (2000#)

20 ft CEP

16 Targets per Pass

All Weather

Revolutionary Technologies

Laser Guidance

GPS Guidance

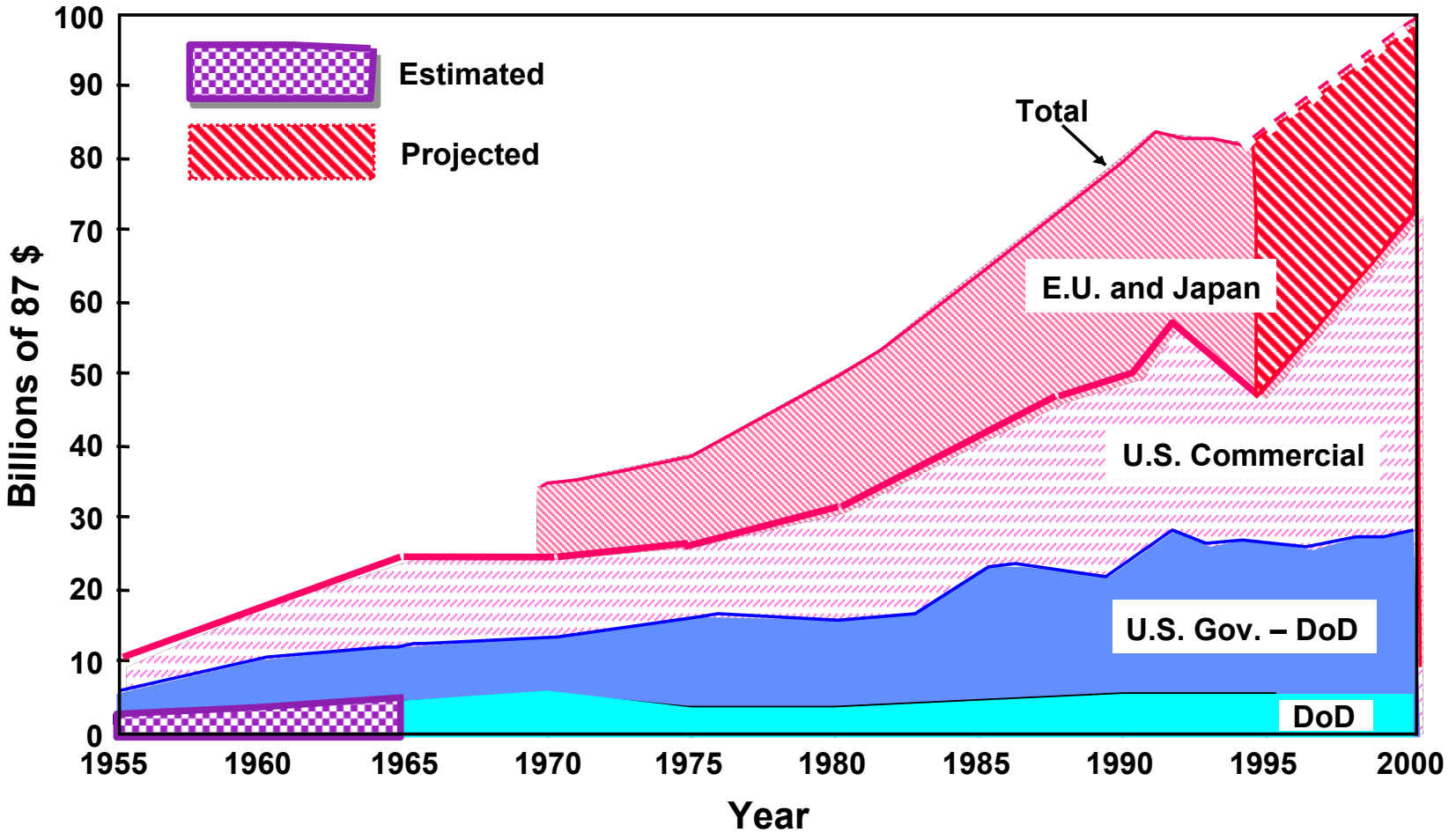
B-2 Drop of 80 JDAMs

Sep 10, 2003: Precisely Struck 80 Different Targets in One 22 Second Pass

Outline

- The Need to Focus on Technology Transition Issues
- Capabilities Based Acquisition
- Focus of the DoD S&T Program
- Technology Transition Thrusts and Opportunities
- Service Focus Areas
- Technology Readiness Assessments

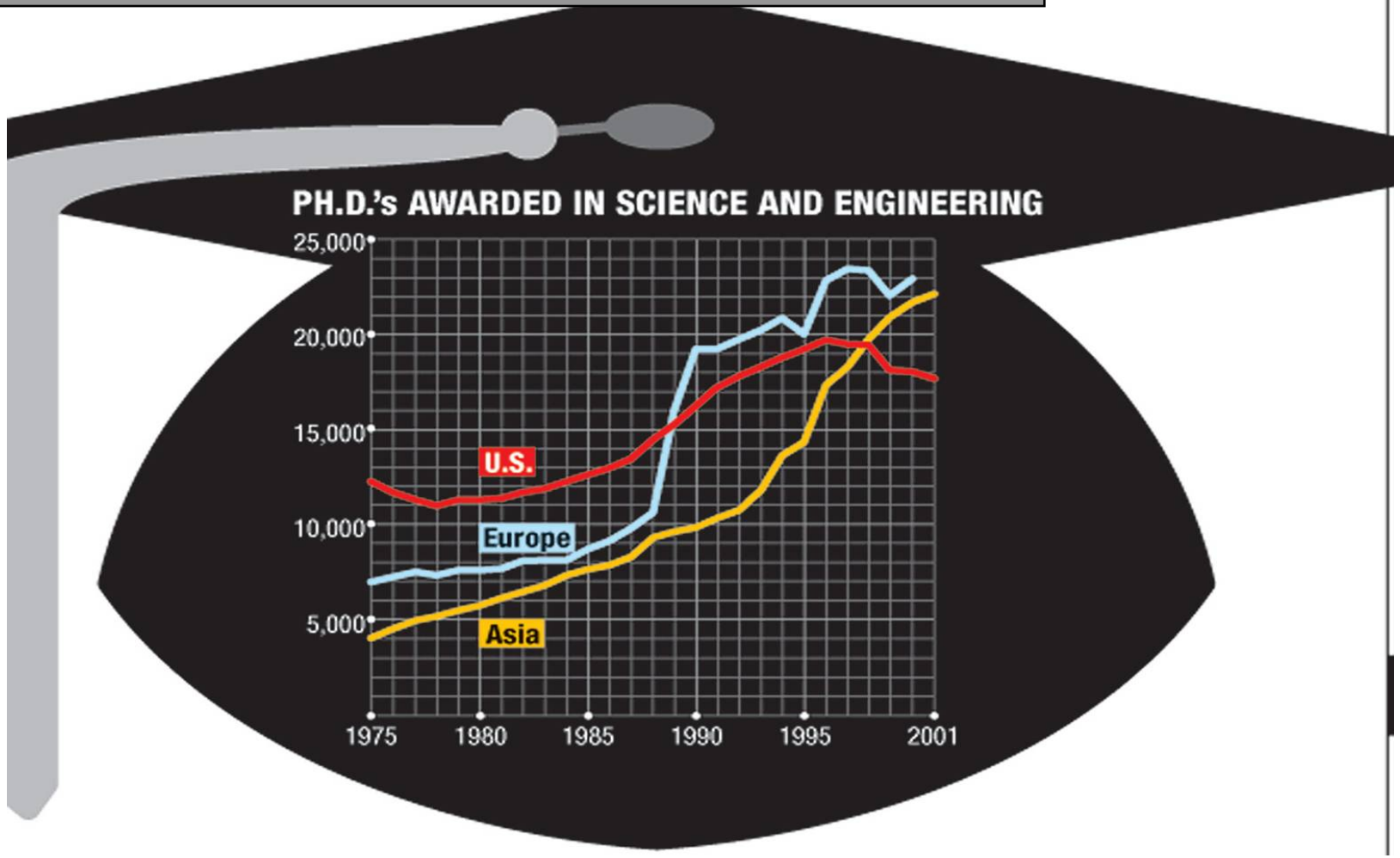
U.S. and Worldwide Research Base Since WWII



Source: Report of the Defense Science Board Task Force on the Technology Capabilities of Non-DoD Providers; June 2000; Data provided by the Organization for Economic Cooperation and Development & National Science Foundation

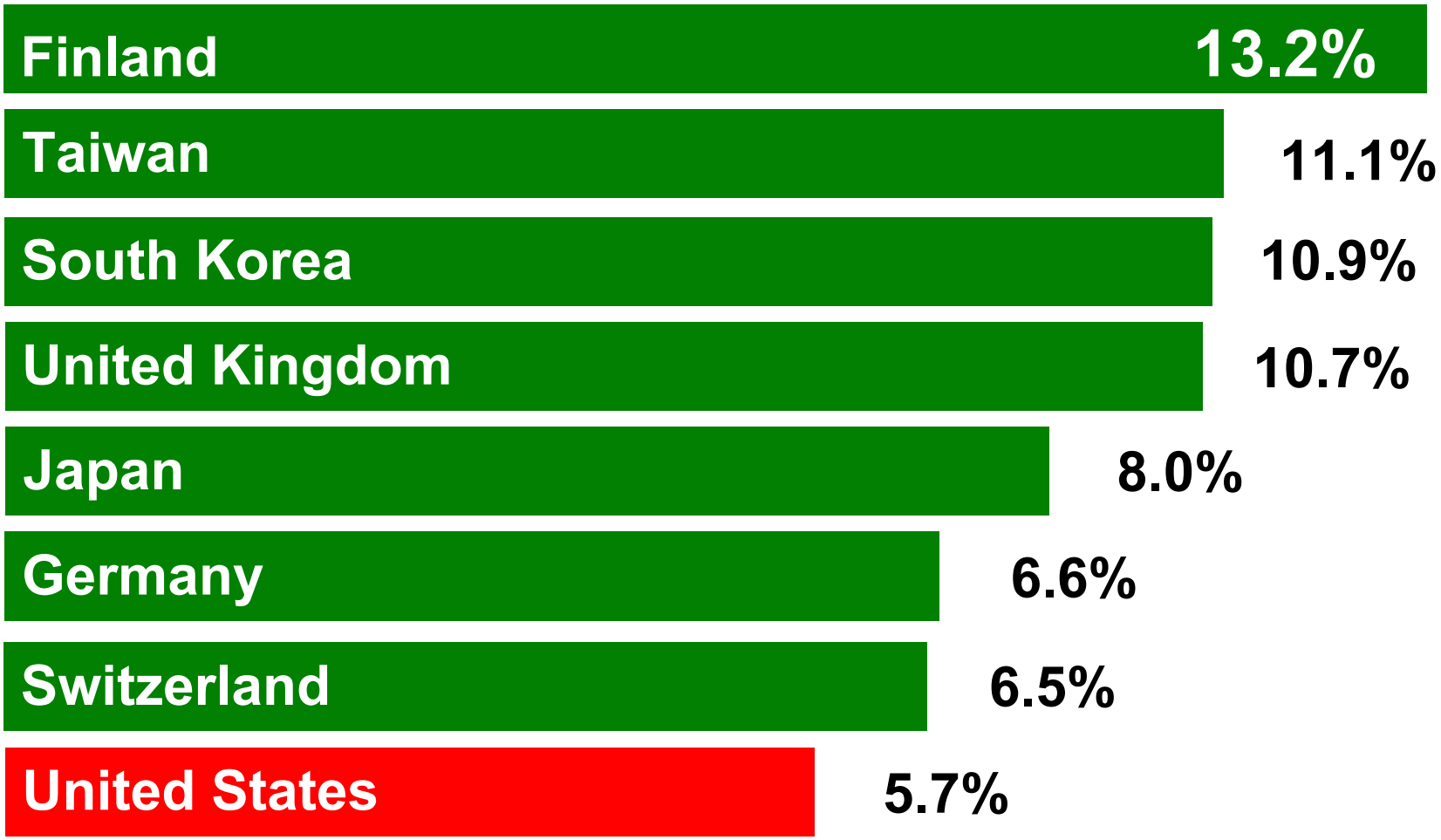
Comparison of Scientists & Engineers (S&Es)

The Rest of the World is Getting Smarter



Source: Money Magazine

Percentage of 24-year-olds with a Science or Engineering Degree



Source: *Money Magazine*, Oct 2004, pg 124

The Globalization of S&T

"In 2001, India graduated almost a million more students from college than the United States did. China graduates twice as many students with bachelor's degrees as the U.S., and they have six times as many graduates majoring in engineering. In the international competition to have the biggest and best supply of knowledge workers, America is falling behind."

"The World is Flat", Friedman, 2005

China had 15 companies on Forbes Global 500 list in 2004, up by 4 from the 2003 rankings.

India had only 1 company on the Global 500 in 2003. In 2004, there are 4 Indian companies.

IBM Global Services India unveiled its global delivery centre in Hyderabad on June 14, 2005, the fifth IBM center in India.

China's Gross Domestic Product is now 2nd in the world to the U.S.

" 14 of the top 25 IT Companies are based in Asia—6 of 25 are based in the US"
March 27, 2006 IS NEWS and World Report

For the first time ever, all members of China's Politburo Standing Committee, the highest tier within the Communist Party, are card-carrying engineers.

The Pace of Technology Development

"Moore's Law" → Computing doubles every 18 months

"Fiber Law" → Communication capacity doubles every 9 months

"Storage Law" → Storage doubles every 12 months

Defense Acquisition Pace

F-22	Milestone I:	Oct 86	IOC:	Dec 05*
Comanche	Milestone I:	Jun 89	IOC:	Sep 09

* Computers at IOC are 2,000 X faster, hold 130,000 X bits of information than they did at MS I

Technology growth is non-linear…
Acquisition path has been linear

Trends

- International Science and Technology
- Globalization
- Intellectual Capital Advantage of the US
- Pace of Technology Development
- Disruptive Technology

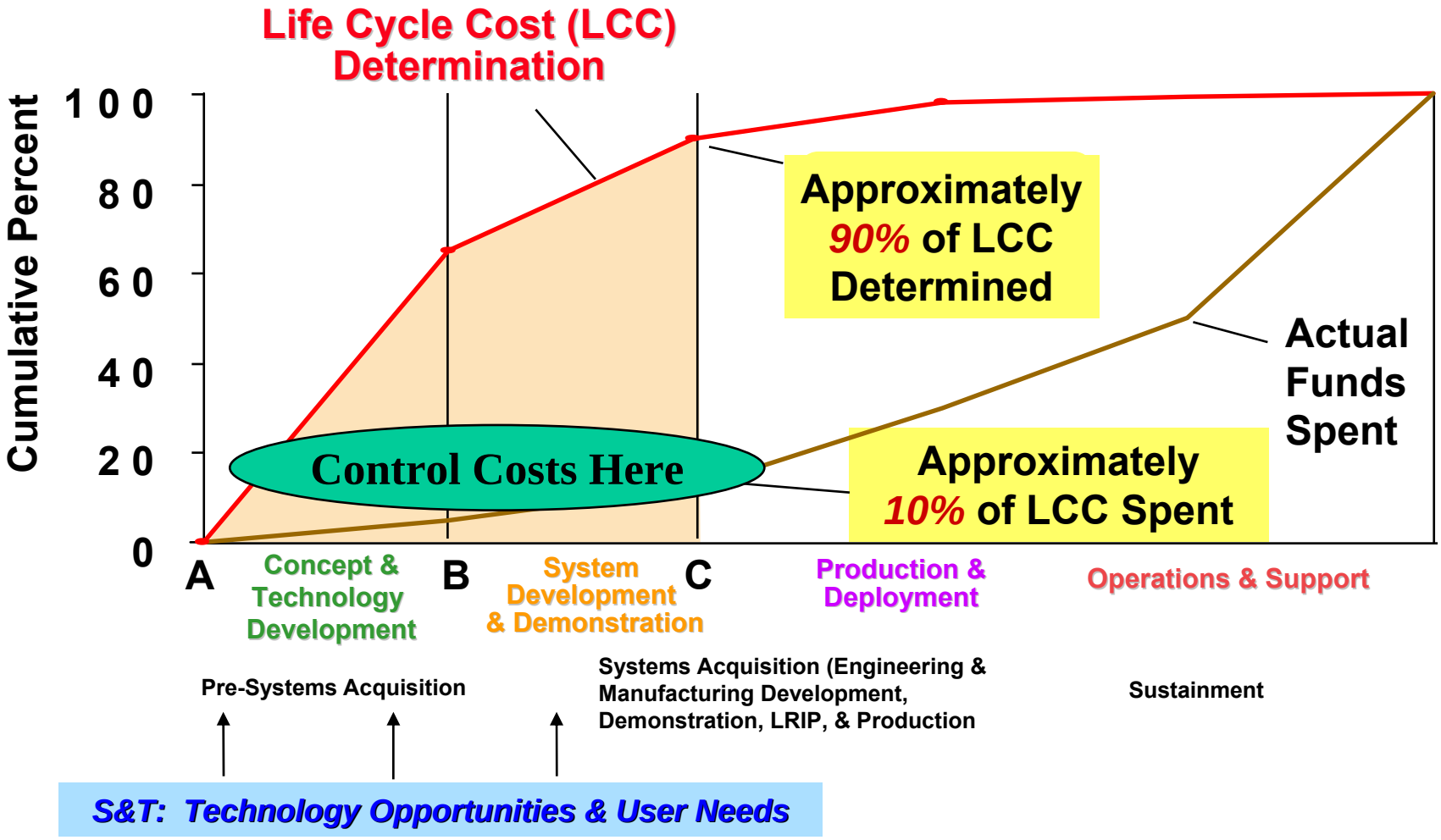
Net Equation—Uncertainty Increasing

Intellectual Advantage of US Declining

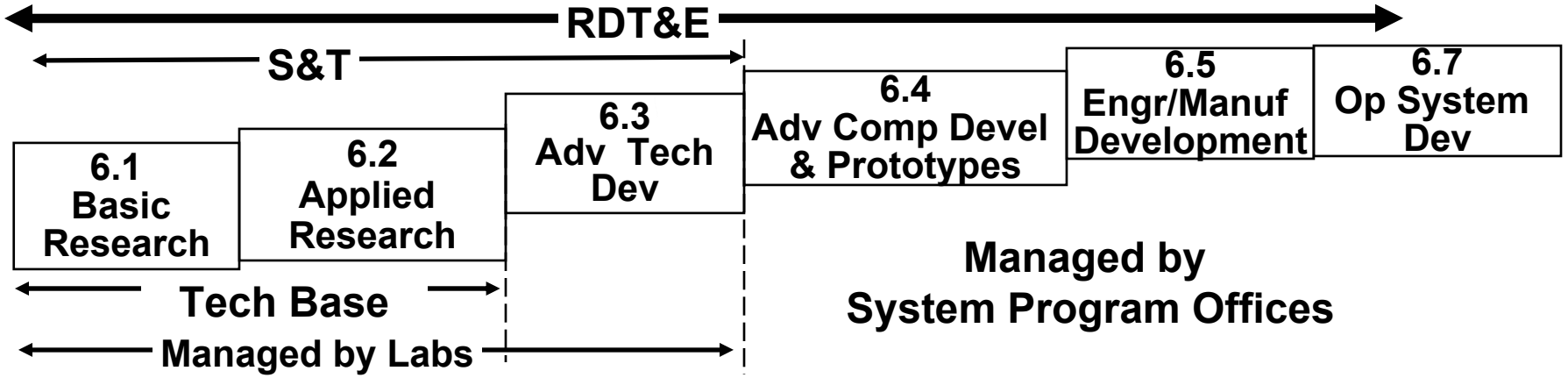
US Needs to Make Changes

The Need to Transition Technology Early

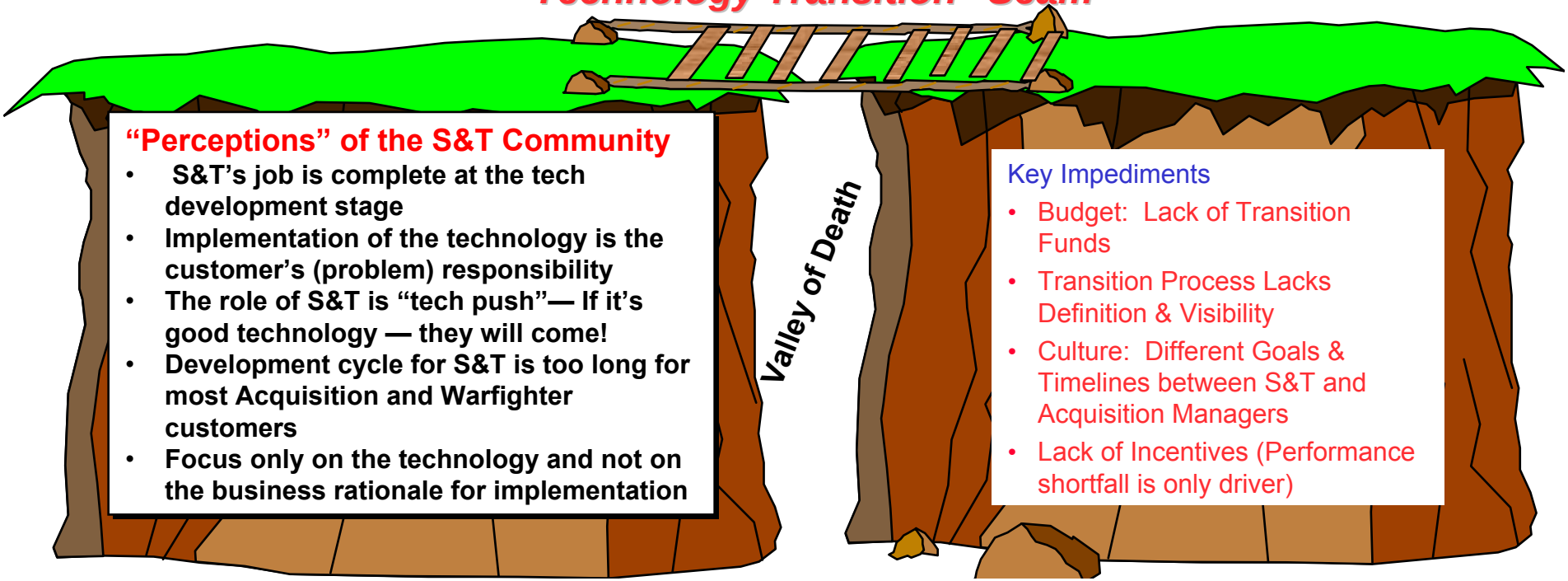
Acquisition Community is Focused on Cost Reduction Throughout Life Cycle



The Challenge of Technology Transition



Technology Transition "Seam"



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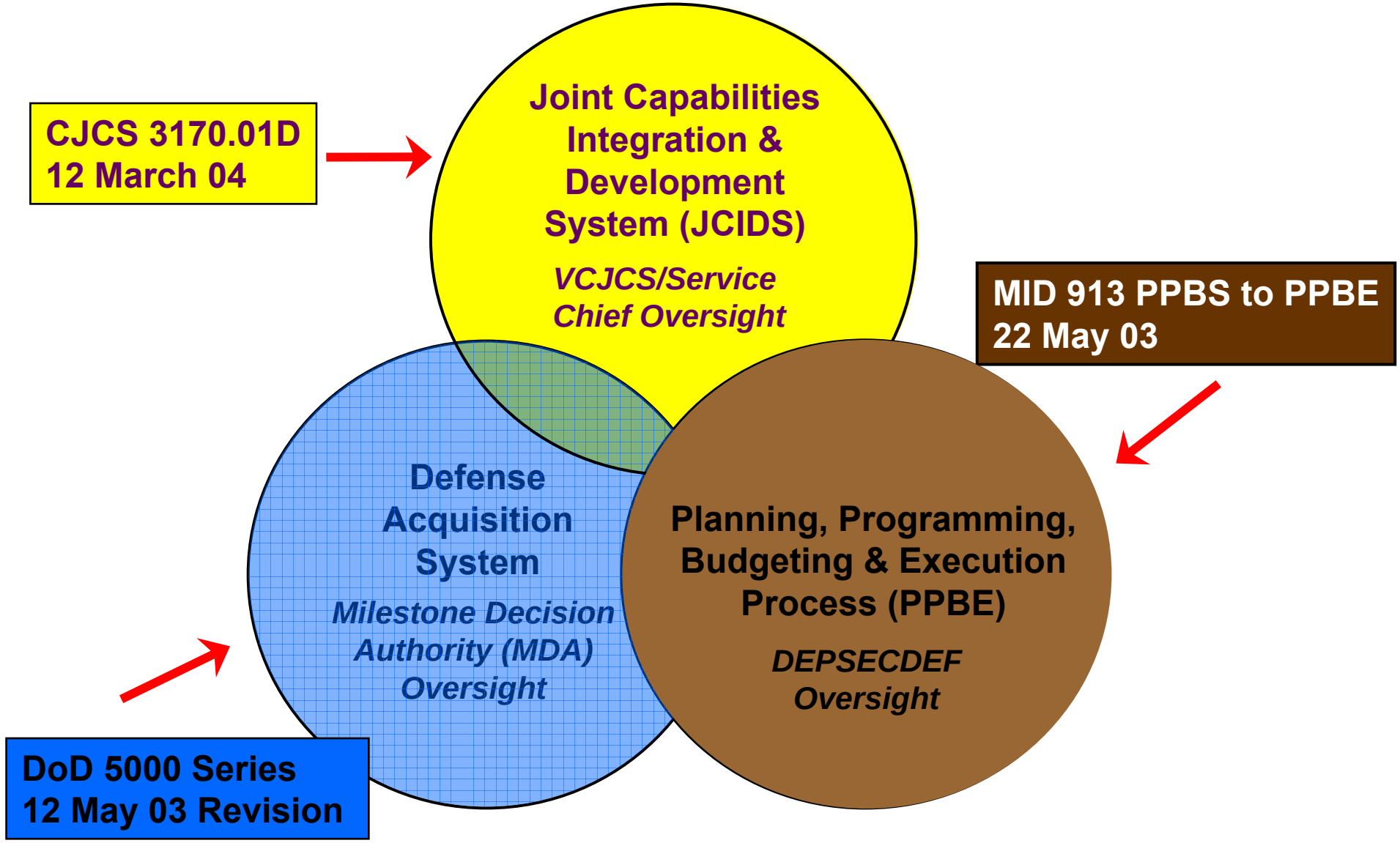
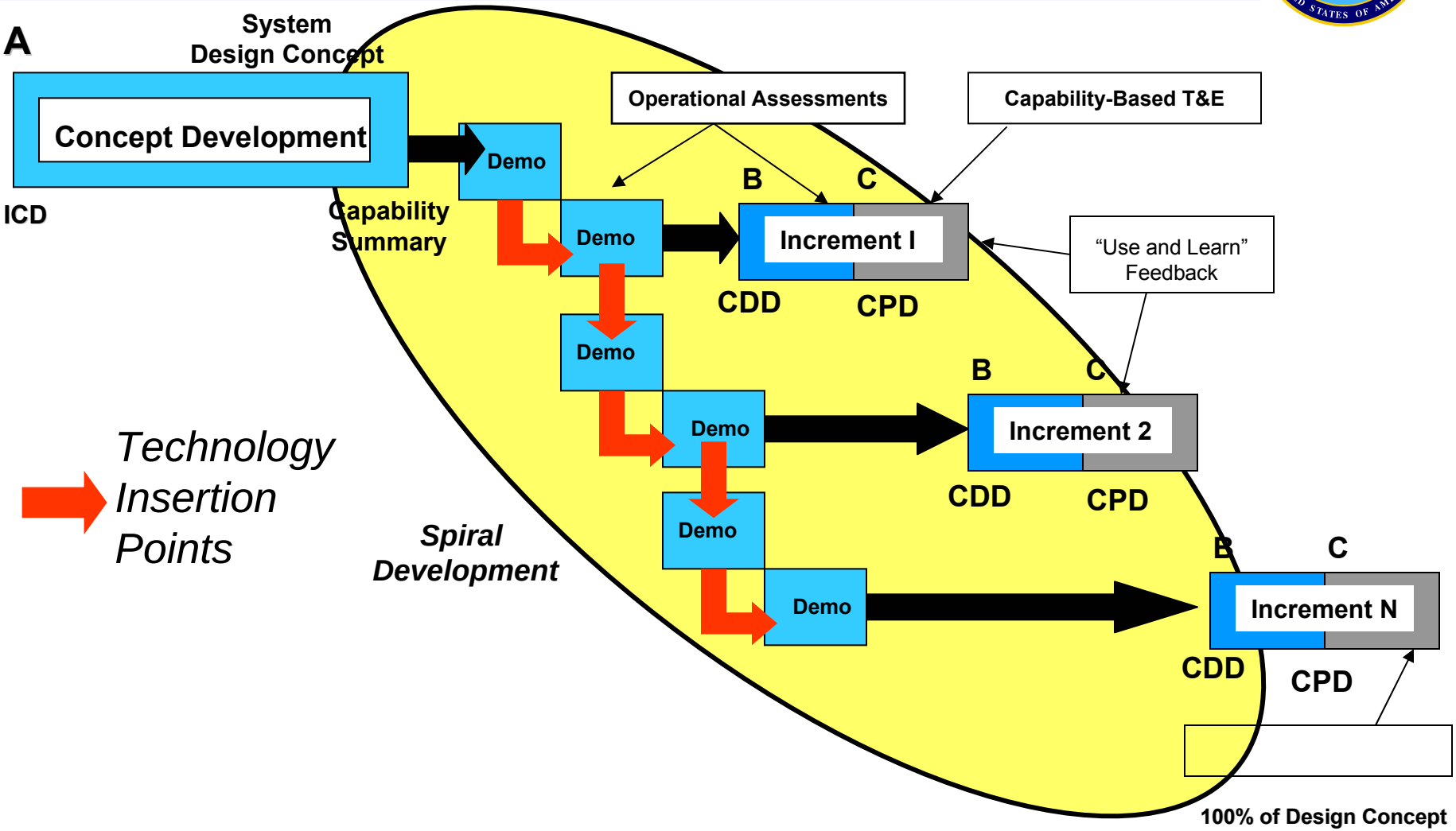
US Capabilities-Based Planning

"A central objective of the Quadrennial Defense Review was to shift the basis of defense planning from a "threat-based" model that has dominated thinking in the past, to a "capabilities-based" model for the future. This capabilities-based model focuses more on how adversaries might fight, rather than specifically whom the adversary might be or where a war might occur. It recognizes that it is not enough to plan for large conventional wars in distant theaters. Instead the United States must identify the capabilities required to deter and defeat adversaries who will rely on surprise, deception, and asymmetric warfare to achieve their objectives."

Acquisition Decision Support Systems Were Transformed

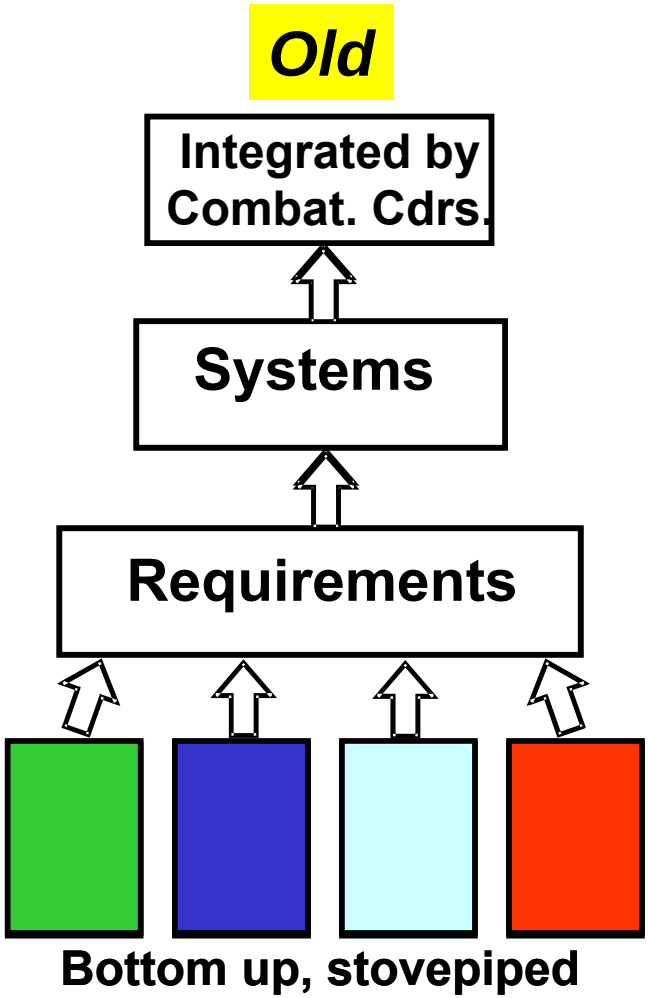


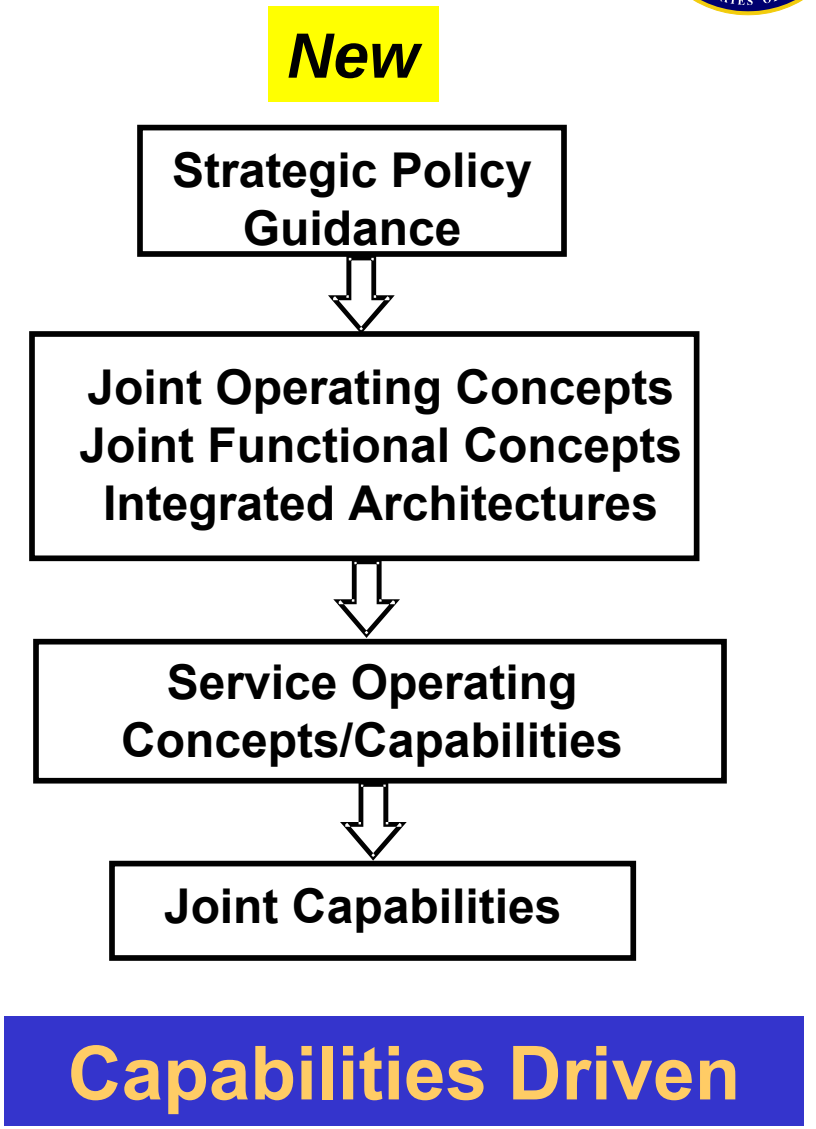
Evolutionary Acquisition and Spiral Development



Every Spiral Should Enhance Capability

New Planning Process





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DDR&E Vision

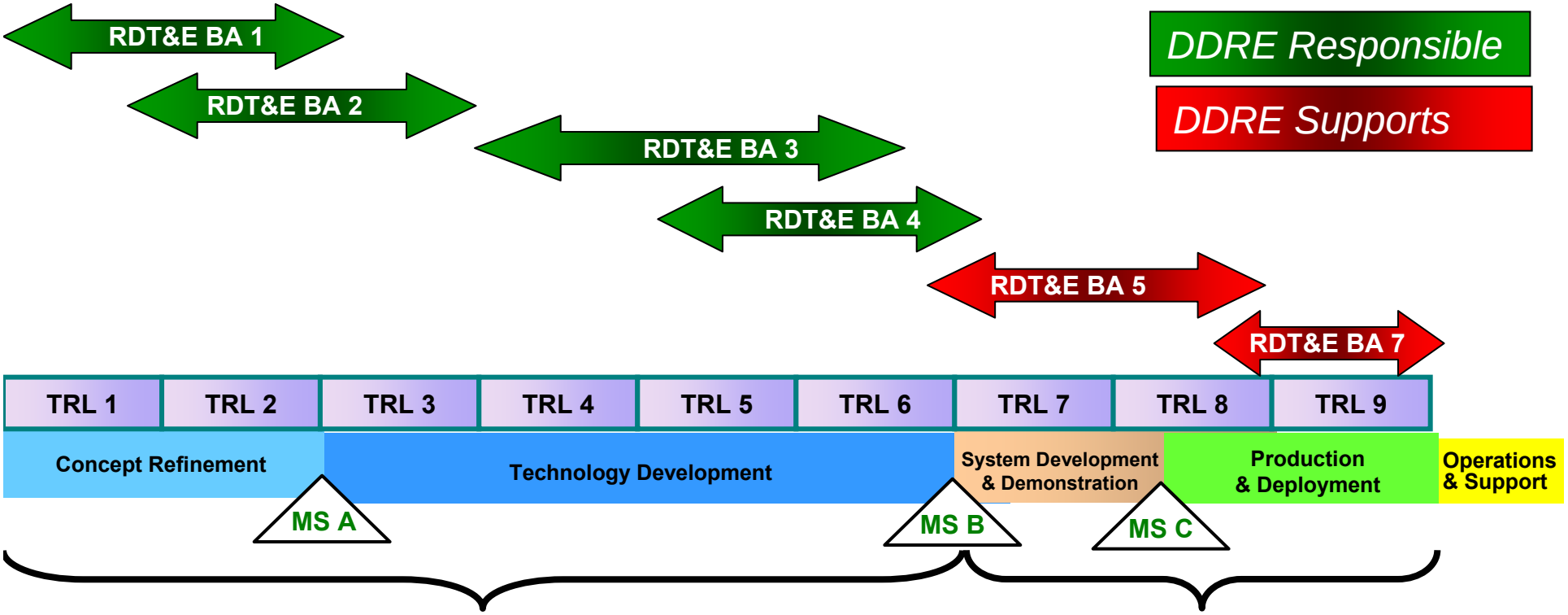
Develop Technology to Defeat Any Adversary on Any Battlefield

DDR&E Priorities for CY 2007

- 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

The "Domain" of DDRE

DDR&E's role in the Acquisition Life Cycle



DDR&E Lead –
Oversee Budget Activities 1-4

DDR&E Supporting Role –
DDR&E and Acquisition Manager share responsibility

Spiral development provides opportunities for technology insertion at multiple points during the life cycle.

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

National Defense Strategy—
Types of Programs Needing Technology

VULNERABILITY

Higher

Lower

Irregular

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

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*

Higher

Lower

LIKELIHOOD

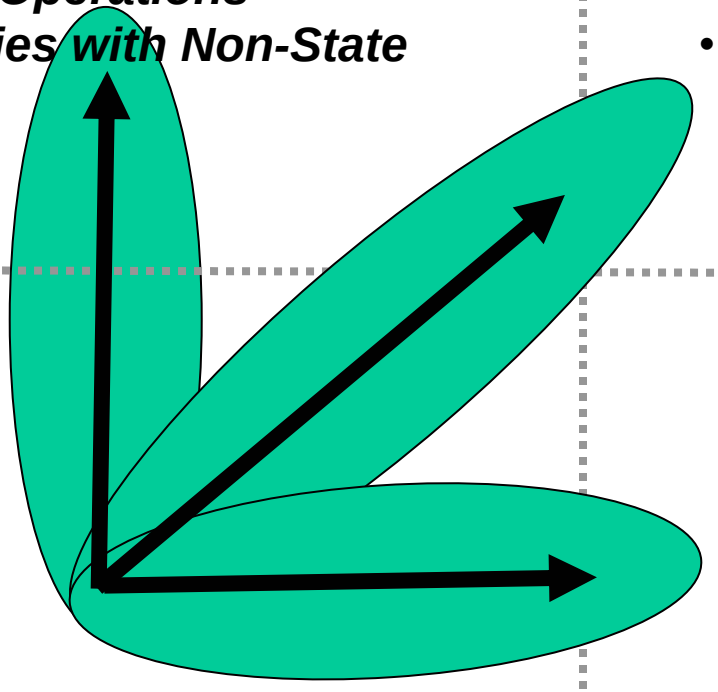
National Defense Strategy Drives Investment Strategy

Irregular

- *Combating Terrorism*
- *Urban Operations*
- *Activities with Non-State Actors*

Catastrophic

- *Protection Against Weapons of Mass Destruction (WMD)*
- *Protection Against Chem Bio Attacks*



Traditional

Decrease Investment in Platform Technologies

Disruptive

- *New Technology Investment that Provides New Capabilities*
  - Nanotechnology
  - Biotechnology
  - Information Technology…
- *Application of Technology that Provides New Capabilities*
  - Directed Energy
  - Hypersonics…..

VULNERABILITY

Higher

Lower

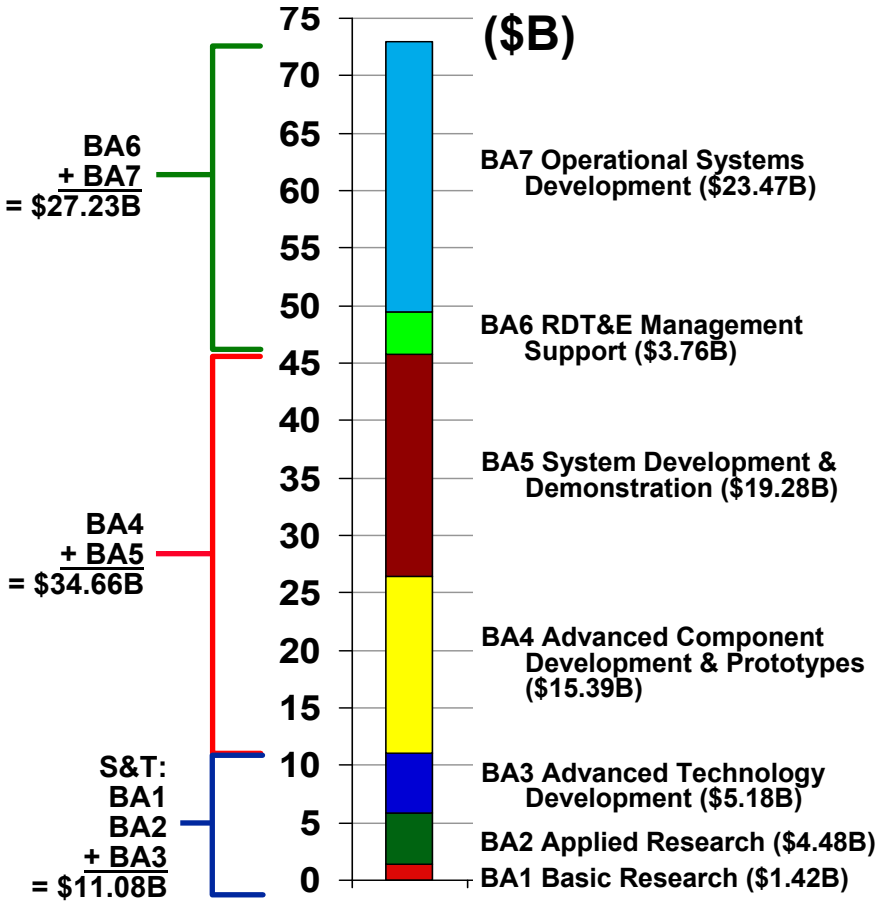
Lower

Higher

LIKELIHOOD

FY07 and FY08 RDT&E Budget Request Comparison
- in Then Year Dollars -

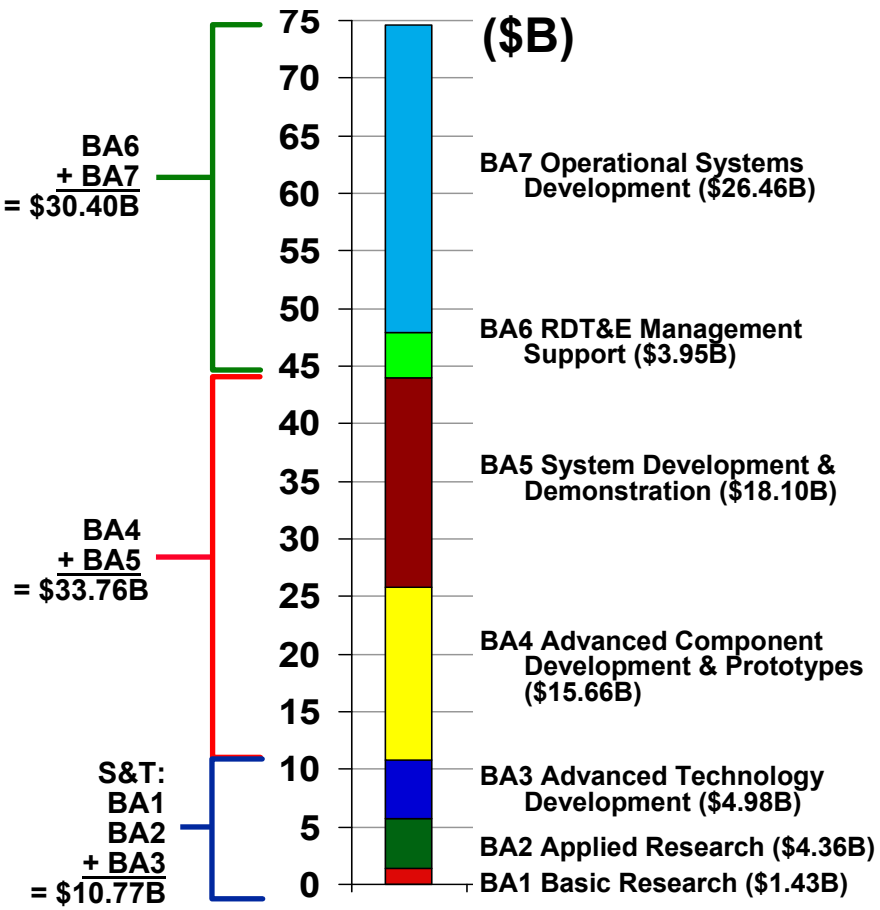
FY07 RDT&E request = $72.97B
(Budget Activities 1-7)



Technology Base (BA1 + BA2) = $5.90B

PBR07 S&T is 15.2% of RDT&E

FY08 RDT&E request = $74.94B
(Budget Activities 1-7)

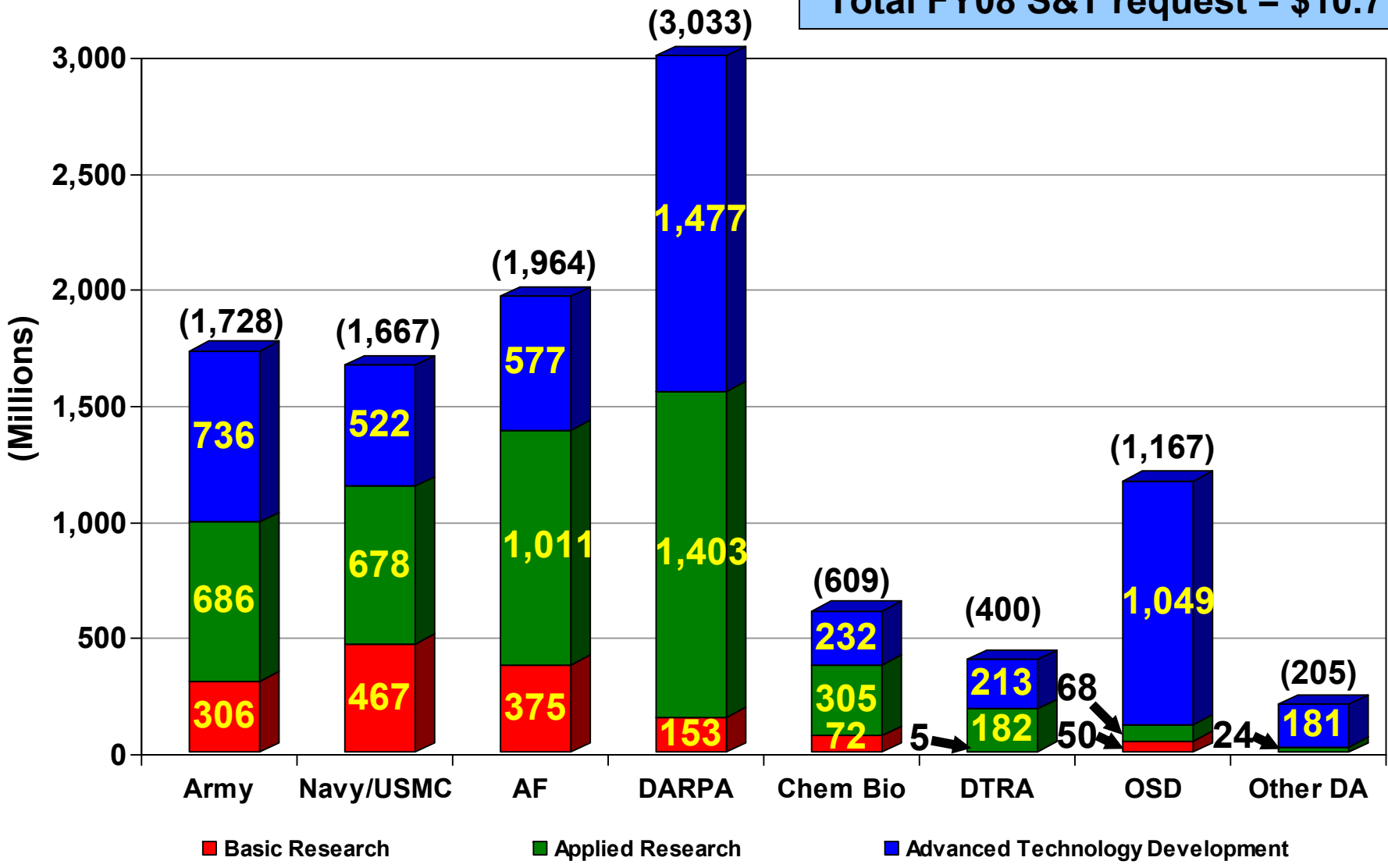


Technology Base (BA1 +BA2) = $5.78B

PBR08 S&T is 14.4% of RDT&E

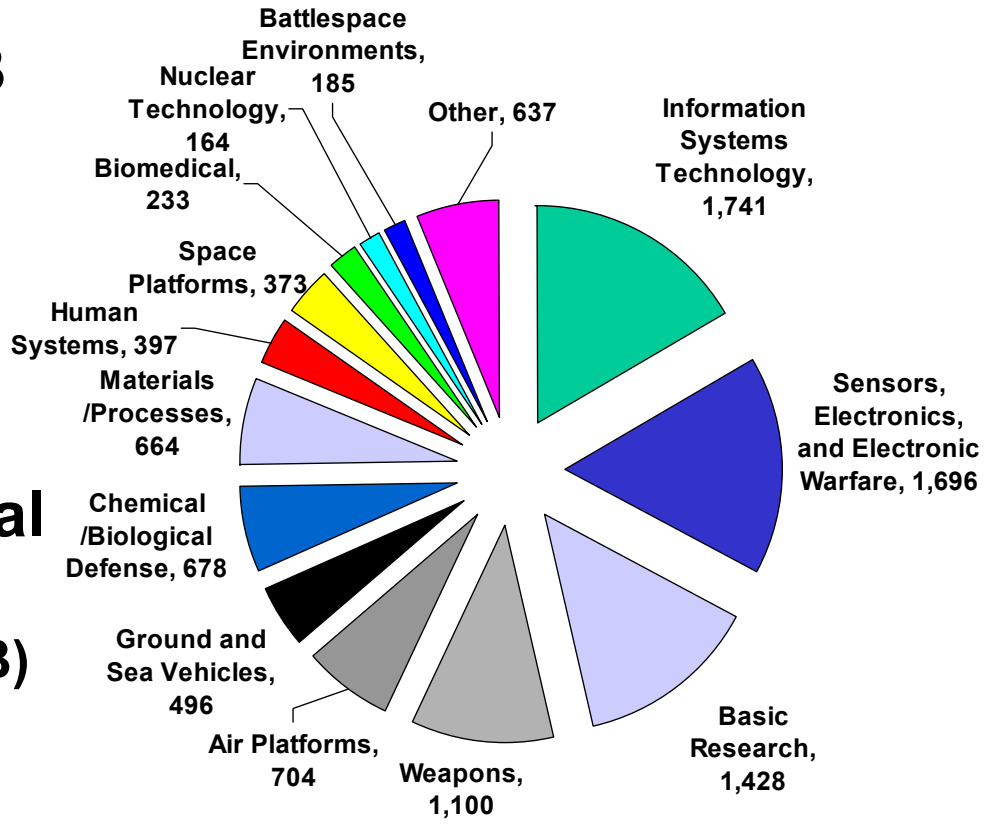
FY08 DoD S&T Budget Request

Total FY08 S&T request = $10.772B



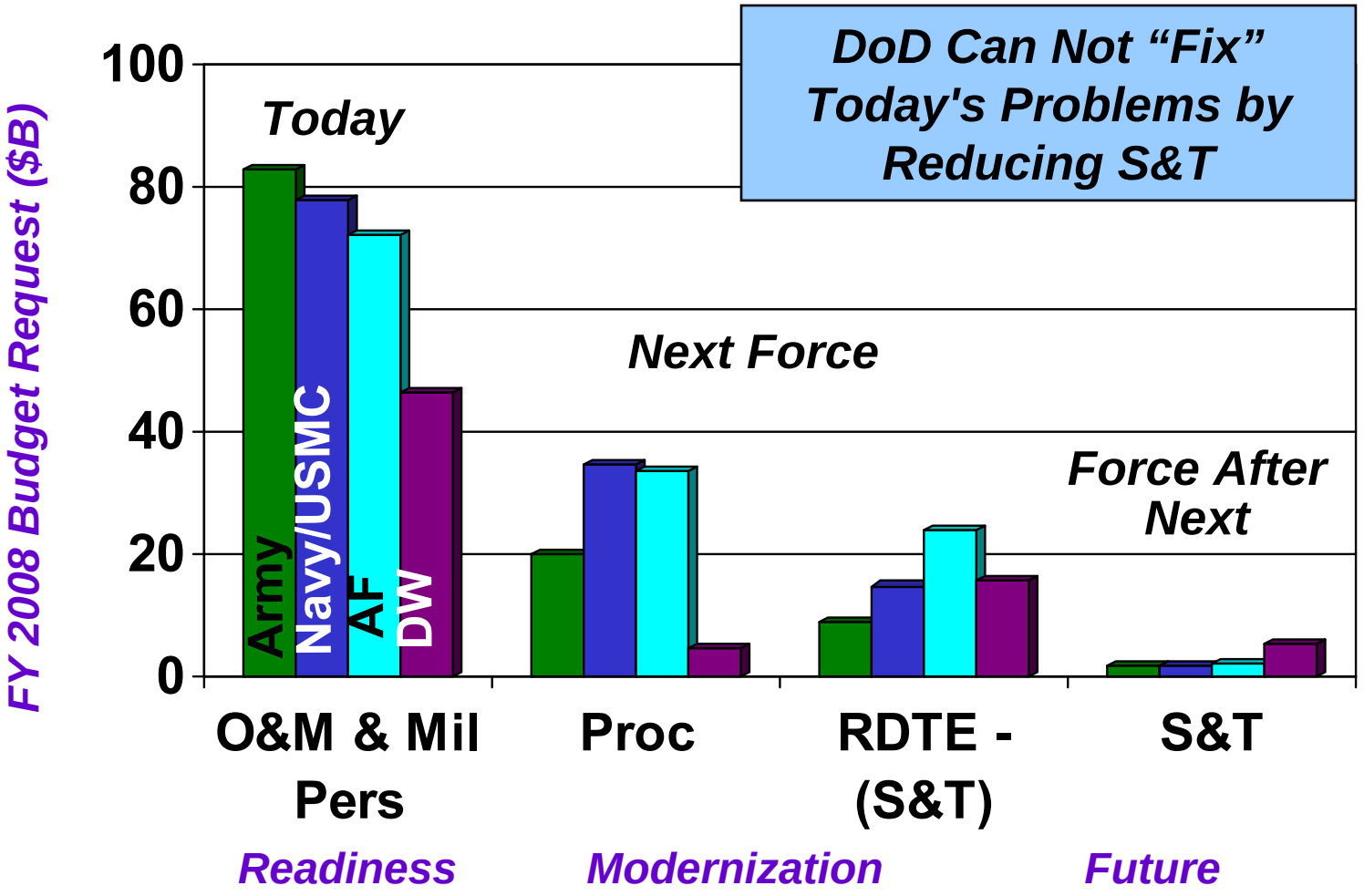
Characterization of the FY08 DoD S&T Program

- **Funding**
  - **Then year S&T dollars: $11.08B FY07 to $10.77B FY08**
  - **Percent of total DoD funding: 2.52% FY07 to 2.24% FY08**
  - **Over 50% of total investment in 4 functional areas:**
    - **Information Systems (1.7B)**
    - **Sensors, Electronics / EW (1.7B)**
    - **Basic Research (1.4B)**
    - **Weapons (1.1B)**



DoD S&T Program is focused on "Sensing and Shooting"

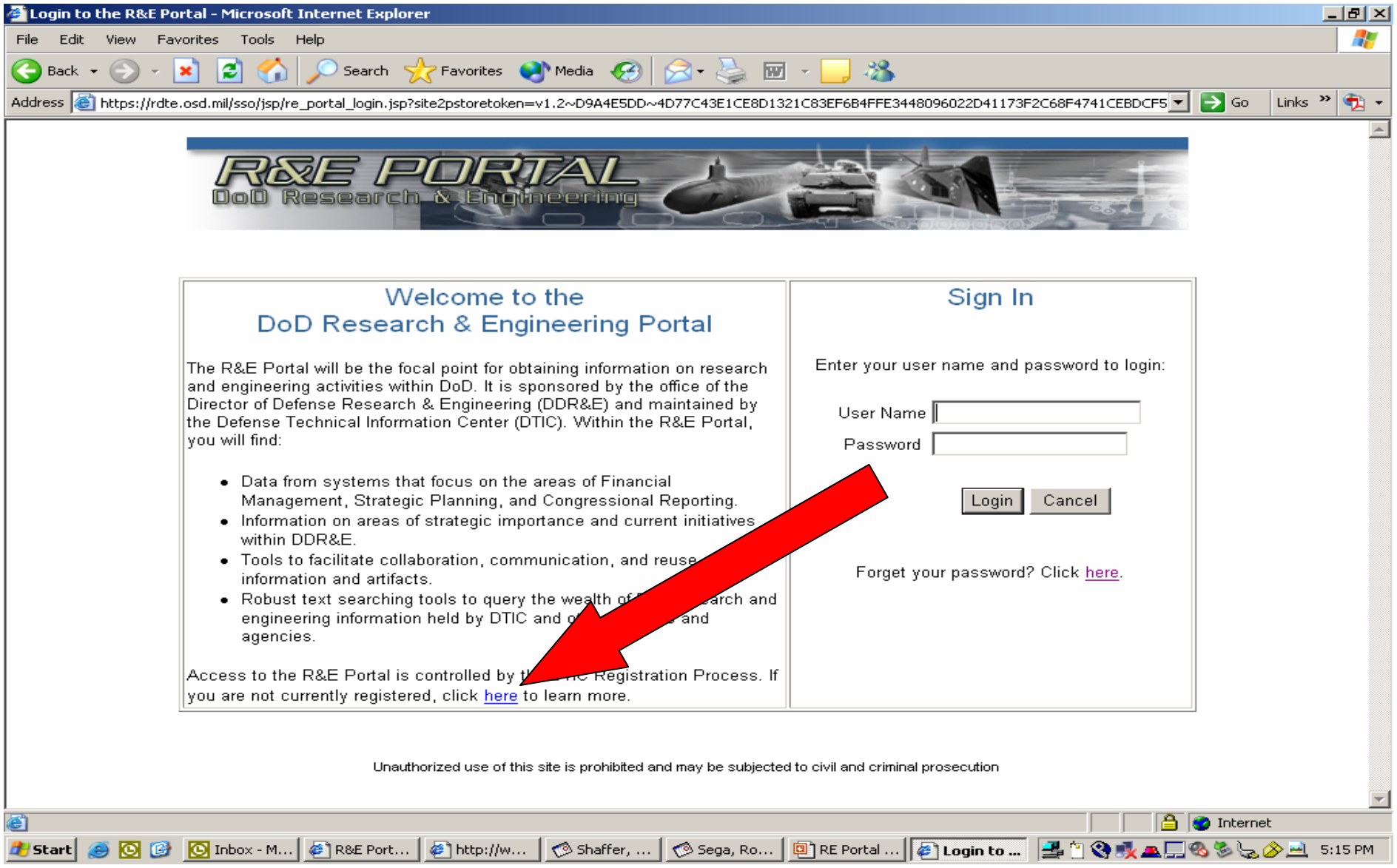
Technology Investment Compared to Other DoD Categories



The R&E Portal (https://rdte.osd.mil)

- Provide single-point access to:
  - All current R&E electronic information
  - New E-Gov database
  - News Service
  - DDR&E general information
  - Links to useful sites
- Be able to intelligently search all R&E data
- Have Single sign-on capability (one password)
- Customer base: DoD R&E community (civil service, military, approved contractors)

(https://rdte.osd.mil)



R&E Portal Home Page - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media

Address https://rdte.osd.mil/portal/page?_pageid=53,38931,53_38982:53_58493,53_40388&_dad=portal&_schema=PORTAL

Go Links

R&E PORTAL
DoD Research & Engineering

Portal Home | R&E News | DDR&E Initiatives | E-Gov Initiative | Financial Management | S&T Planning Docs & Reports | R&E Communities

R&E Portal Updates

The Defense Technology Search now includes new libraries for the DTIC Research Summaries and the consolidated data from the E-Gov 2005 Data Call. Also added recently are libraries for the DTIC Technical Reports (TR), the Total Electronic Migration System (TEMS), and the Independent Research & Development (IR&D) database (restricted to DoD only).

2006 TARA Guidance documents are now available at the bottom of the S&T Comp Review page under S&T Planning Docs and Reports.

A Guide Through The Portal

DDR&E Initiatives

As the Chief Technology Officer for the Department of Defense, the DDR&E develops strategies to exploit technology

DDR&E Initiatives

New Tab

Announcements | Calendar | Forums

Files | Feedback | Help

Spotlight on R&E Success

A weekly article highlighting outstanding R&E Success Stories. These articles are randomly selected by DTIC from all Success Stories posted on DOD S&T Laboratory Web Sites.

DefenseLink Top News

SECURITY PATROL – U.S. Marine Corps Lance Cpl. Miez, a radio operator, and Cpl. Brad Adams, both with Lima Company, 3rd Battalion, 1st Marine Regiment, keep watch while on a security halt during a patrol down a riverbed in Barwana, Iraq, Jan. 15, 2006. U.S. Marine Corps photo by Cpl. Michael R. McMaugh Hi-Res Photo | Lead Photo Archive

Bush: Surveillance Plan Necessary, Lawful

WASHINGTON, Jan. 24, 2006 – President Bush yesterday called his terrorist surveillance plan a lawful, necessary step in the war against terrorism. Speaking at Kansas State University in Manhattan, Kan., Bush said he made the move to allow the National Security Agency to listen in on calls to terrorists as a means of protecting the American people. Story | Remarks

- Threats Must Be Taken Seriously, President Says

Industry Tapped for Ways to Counter IED Threat

WASHINGTON, Jan. 24, 2006 – Deputy Defense Secretary Gordon England called on what he called some of the best minds in the country today to help come up with new solutions to the threat improvised explosive devices pose to U.S. troops. Story

Department Sets Record With Charitable Giving

WASHINGTON, Jan. 24, 2006 – The Defense Department raised a record-high $15.1 million in the 2005 Combined Federal Campaign, exceeding the department's goal by $2.3 million Story

Piracy Incident Reflects International Problem

WASHINGTON, Jan. 24, 2006 – A U.S. Navy ship captured a suspected pirate vessel in the Indian Ocean about 54 miles off the coast of Somalia Jan. 21. Story | Suspected Pirates Captured Off Somali Coast

Info Is as Important as Ammo in 'Long War'

WASHINGTON, Jan. 24, 2006 – In the so-called "Long War," information will be as important as ammunition, U.S. Army Lt. Gen. Ray Odierno said. Story | Military Culture Must Change for 'Long War'

DDRE

Go to the DDR&E Website

Search DTS | Search Science.gov | Search Firstgov.gov | Search DDR&E | Search DefenseLink

Enter the DEFENSE TECHNOLOGY Search

Search digital libraries of comprehensive reports and data on DoD planned, ongoing and completed R&E efforts.

When prompted use your R&E Portal username and password. This will persist until you change your password or it expires. If your user password has changed since the last time you logged into the Defense Technology Search, click here to reset your password.

R&E Applications

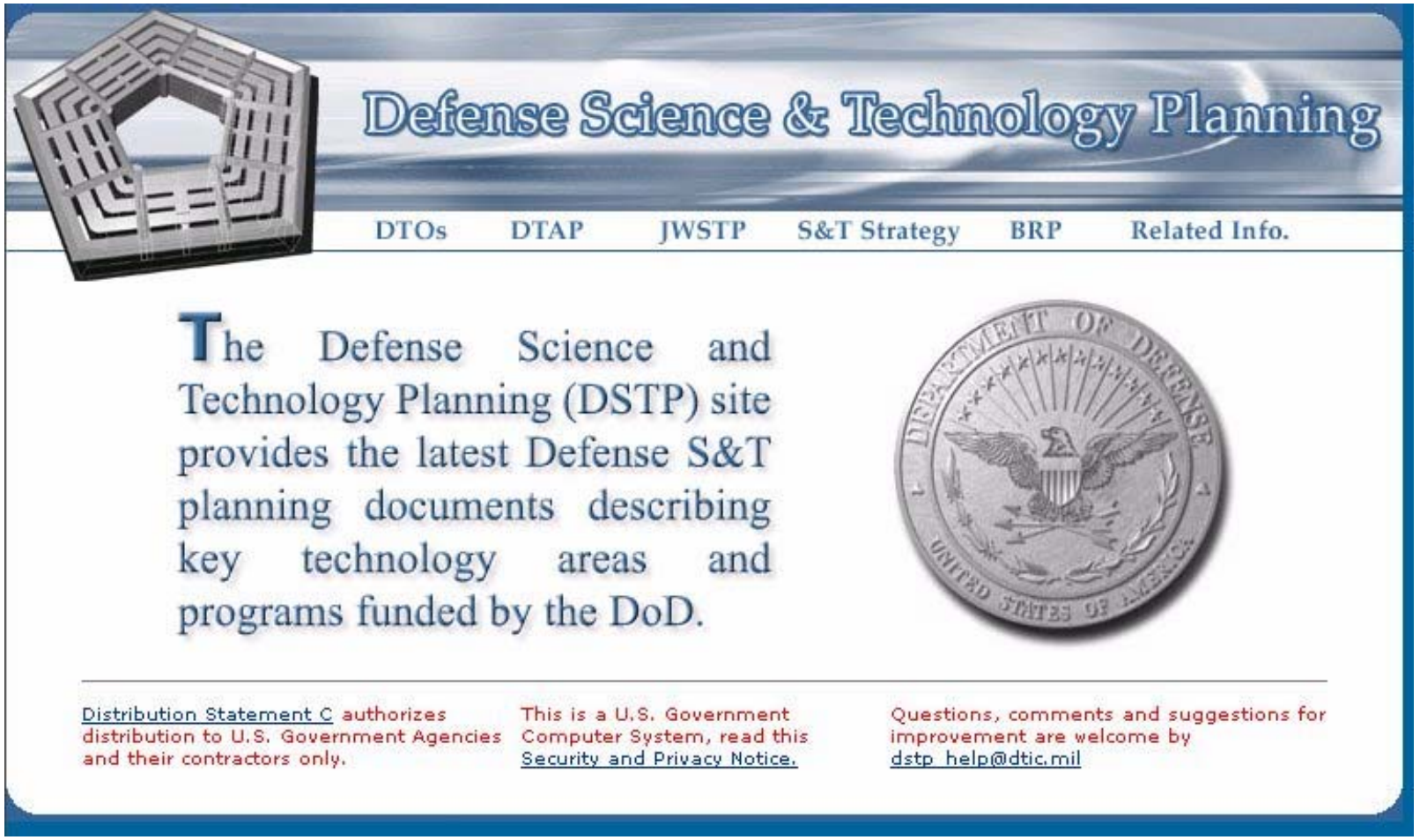
Biomedical Research Database
Congressional Budget Queries
DDR&E Applications Feedback Form
Defense Science & Technology Planning
Defense Technology Search
IAC TEMS
In-House S&T Activities Report
Lab Demographics
Militarily Critical Technologies List (Restricted)
Private STINET
RDT&E Budget Resource Queries
Virtual Technology Expo

R&E Links

AFIS Early Bird
Advanced Concepts Technology Demonstrations
Air Force Office of Scientific Research
Army Research Office
DefenseLink
DefenseLink List of DoD Sites
Defense Advanced Research Projects Agency
Defense Technical Information Center
DoD TechMatch
Militarily Critical Technologies List
Office of Technology Transition
Office of Naval Research
OUSD (AT&L)
OSD Comparative Testing Office (CTO)
National Aeronautics and Space Administration
National Science Foundation
Research & Development Descriptive Summaries
Science.gov
S&T Acquisition Workforce

Local intranet

Defense S&T Planning Documents



S&T Plans and Reliance 21

Defense Science and Technology Strategy and Plans

- ***Defense S&T Strategy (Replaced with DoD R&E Strategic Plan)***
- ***Basic Research Plan (6.1) - BRP - (Biennial, odd years, expected Sep. 2007)***
- ***Defense Technology Area Plan (6.2, 6.3) - DTAP - (Being 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 (Going away)***

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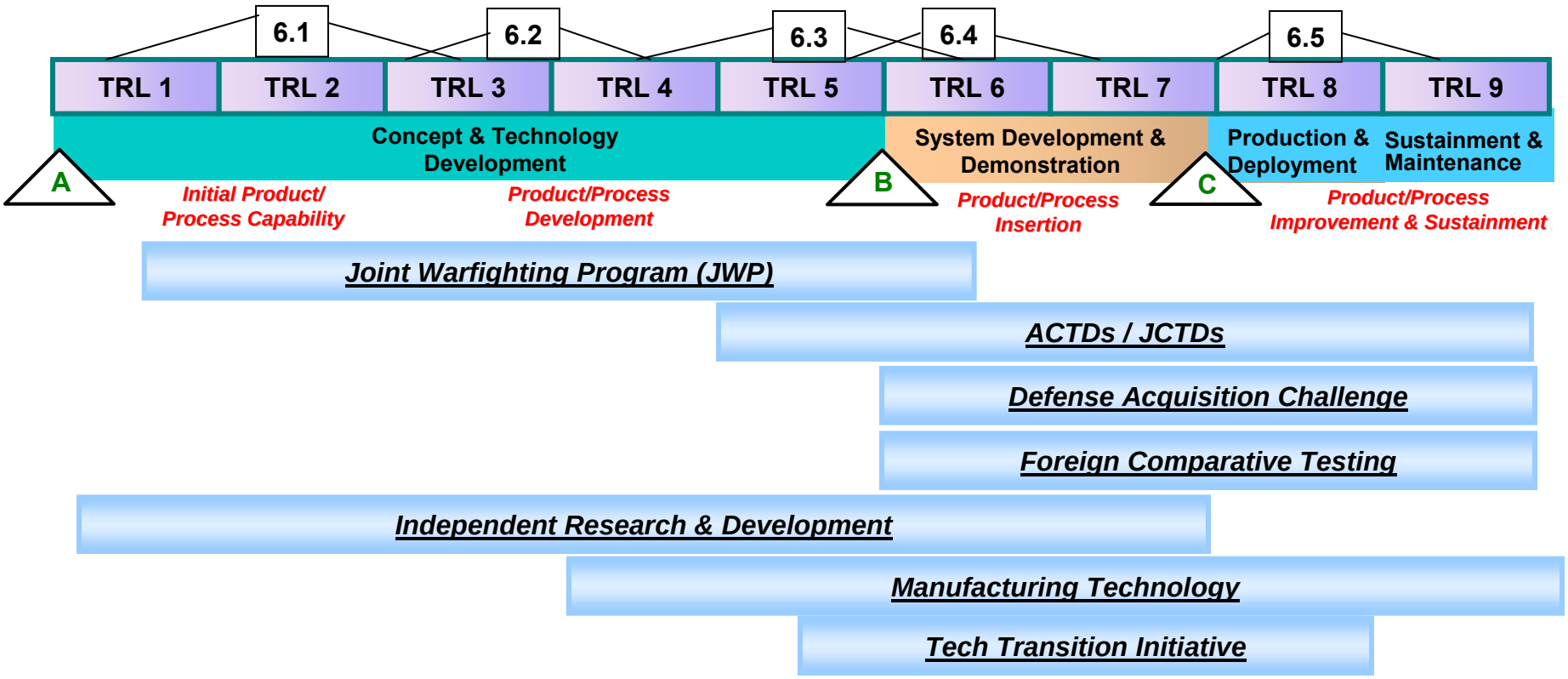
DDR&E Response to Improving Technology Transition

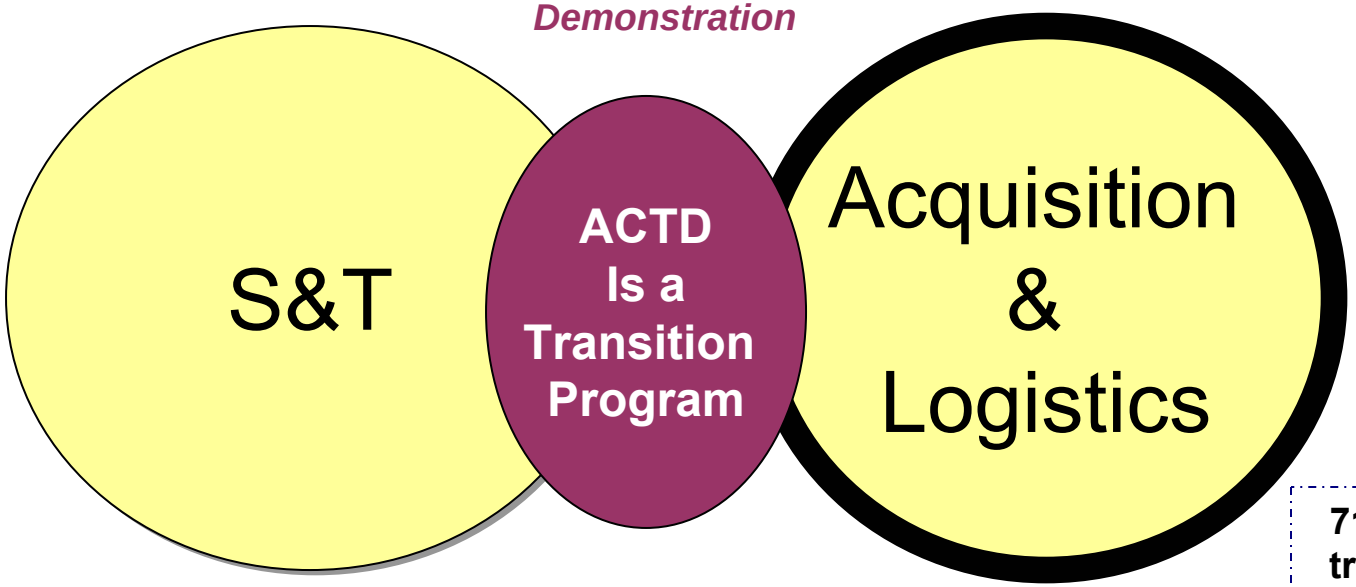


ACTD Projects Positioned between S&T & Acquisition

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

Advanced Concept Technology Demonstration

"Try before you buy"



"The 80% Solution"

71% of all ACTDs transition at least one product into a warfighting capability

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

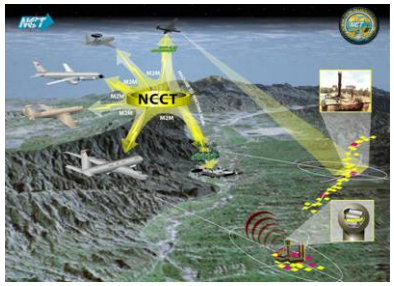
Joint Capability Technology Demonstration (JCTD)

- **Improves ACTD process/replaces ACTDs (Oversight--not Program Management)**
- **Designed to speed transformational, joint and coalition capabilities**
- **Works with combatant commands to identify solutions emerging/validated needs**
- **Partners with services/agencies to push technology solutions**
- **Final demonstration phase reached in two years for most JCTDs**
- **Majority of JCTD start up and transition costs centrally funded in DDR&E/AS&C**

Transformational

The SPARTAN ACTD demonstrates a multi-mission unmanned surface vessel (USV) capability that will can transform the way our forces provide ship/harbor security.

Joint



U.S. Army, Navy, and Air Force are working with UK on the Network Centric Collaborative Targeting ACTD to horizontally integrate intelligence, surveillance, and reconnaissance platforms for target identification and geolocation.

Coalition

Pakistani troops deploying for Tsunami relief effort with help from Coalition Theater Logistics ACTD

***"We are encouraged by recent actions taken by DOD to initiate a Joint Capabilities Technology Demonstration business process as it is intended to meet joint and coalition forces needs we have outlined." GAO*--Michael Sullivan, Director Acquisition & Source Mgt, HASC sub-committee on Tactical Air and Land Forces Subcommittee, 9 March 2005.**

Quick Reaction Special Projects (QRSP)

(PE 0603826D8Z~$115M/Yr)

- **Technology Transition Initiative – For DoD S&T Community**
  - Establishes a Technology Transition Council
  - Jump starts selected components/subsystems into systems
  - Bridges the "Valley of Death"
- **Quick Reaction Fund**
  - Provides flexibility to respond to emergent DoD needs within budget cycle
  - Takes advantage of technology breakthroughs in rapidly evolving technologies
  - Completion of projects within a 6-12 month period
- **Rapid Reaction Fund**
  - Develops, procures, tests, and fields critical force protection needs in Iraq
  - Enhances force protection to counter Improved Explosive Devices (IEDs)

Example of Quick Reaction Efforts
Thermobaric Weapons

Rapid Technology Transition

- A “Quick Reaction” type development, enabled by base S&T program and ACTD Framework
- Chronology: Program Approved 21 Sept
  - **Small Quantity Lab Testing – Oct 01**
  - **Full Up Static Test – Nov 17**
  - **Flight Tested - Dec 14**
- Funding: Approximately $6M

Theory → ***Weapon***

3 months

Independent Research & Development (IR&D)

DoD/Industry Interaction

DoD		Industry
Provide information on DoD's R&D activities & plans, mission needs, & operational requirements	→	Plan, fund, and conduct IR&D
Review IR&D activities and provide feedback to contractors	↔	Provide technical information about IR&D
Review IR&D database to identify IR&D of interest	←	Provide IR&D project descriptions

Example: Army After Next

- Program efforts in areas of battery technology, hybrid electric vehicle programs, and energy storage technologies
- Estimate savings: $50M

Manufacturing Technology (ManTech)

Objective: **Improve Affordability of DoD Systems by Investing in New & Improved Manufacturing Processes & Equipment Across The Weapon System Life Cycle**

Program Attributes

- **Improve Cycle Time & Process Capabilities**
- **Demonstrate Key Information Technologies**
- **Adopt Best Commercial Practices for Military Applications**

Example: Optics Manufacturing

1990

- **Optics Processing Was Labor Intensive**
  - **Artisan Based**
- **Industry Was Moving "Off Shore"**

2000

- **Processing uses CNC Machines**
- **U.S. has become a world leader**
- **5x grinding + 4x better surface = 4x faster polishing**

Outline

- The Need to Focus on Technology Transition Issues
- Capabilities Based Acquisition
- Focus of the DoD S&T Program
- Technology Transition Thrusts and Opportunities
- Service Focus Areas
- Technology Readiness Assessments

Best Practices: Services' Response

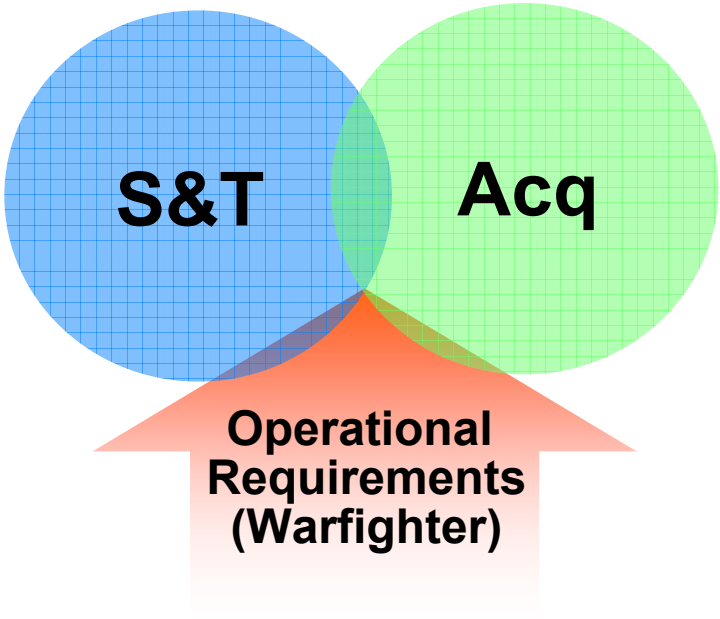
All Services have changed their acquisition processes

FROM

S&T

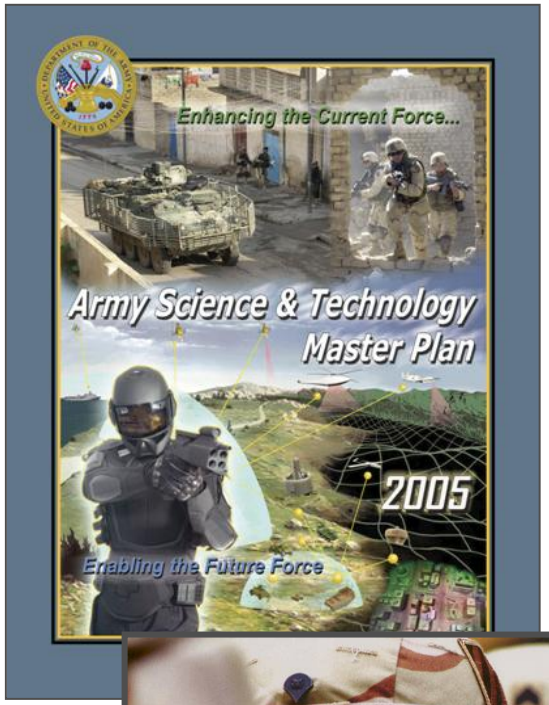
Acq

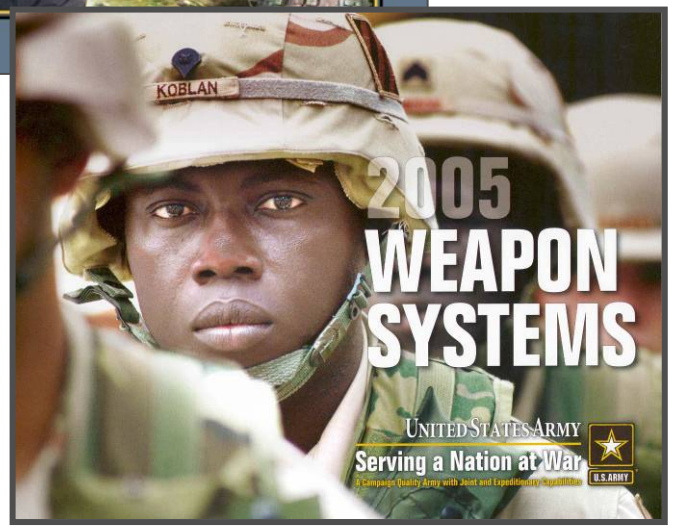
TO



Enhanced Linkage Between the S&T, Acquisition, and Requirements Communities

A Look at the Army…





Capabilities for a Joint & Expeditionary Army

Smarter, Lighter, Faster

Current Force

~100 lb. load

70+ tons

< 10 mph

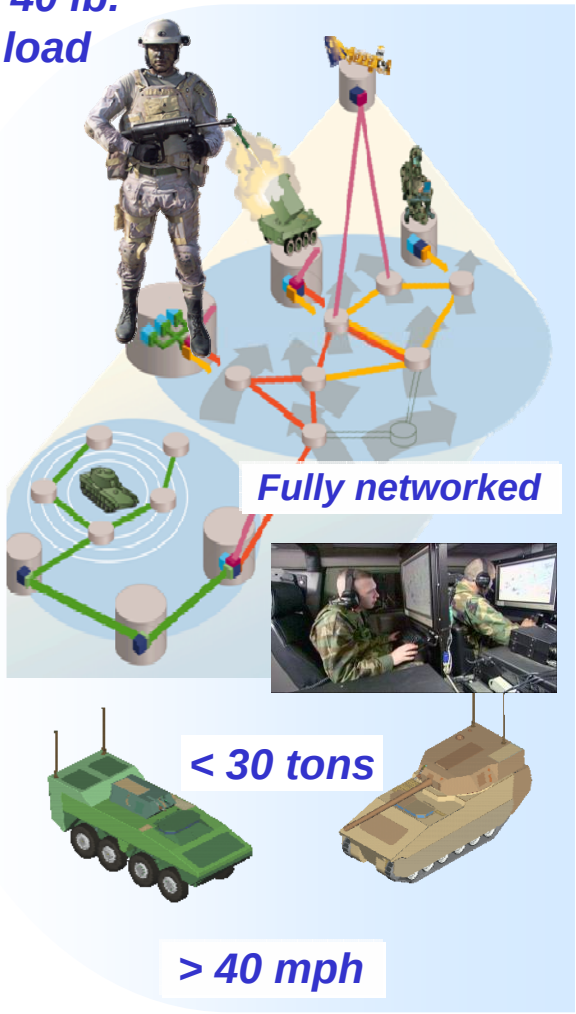
Enabling the Future Force

Science and Technology—develop and mature technology to enable transformational capabilities for the Future Modular Force while seeking opportunities to accelerate technology directly into the Current Modular Force

Enhancing the Current Force

Future Force

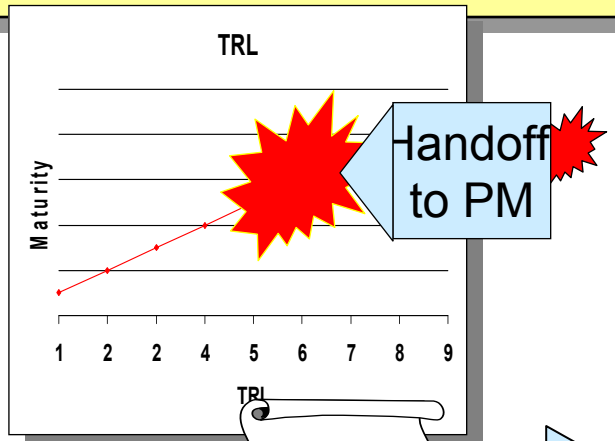
< 40 lb. load



Army Transition Plans

Develop directive from senior stakeholders requiring:

- Transition plans synchronized/supported in S&T & PM budgets
- Achievement of key Technology Readiness Levels as an exit criteria
- Use of affordability as an exit criteria



Mgmt Plan

$

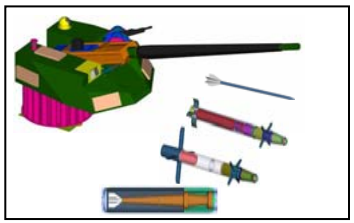
Science & Technology

Acquisition Program

Army ATD Management Plans
Accelerating Transition

- ***Coordinated and Documented partnership between Warfighting Customer, Technology Developer and Acquisition Buyer***
- ***Proposed by Technologists and Tacticians***
- ***Approved by GO/SES***
  - ***HQ TRADOC Combat Developer***
  - ***HQDA Chief Scientist***
  - ***HQDA, G8 Force Development***
  - ***PEO/PM***

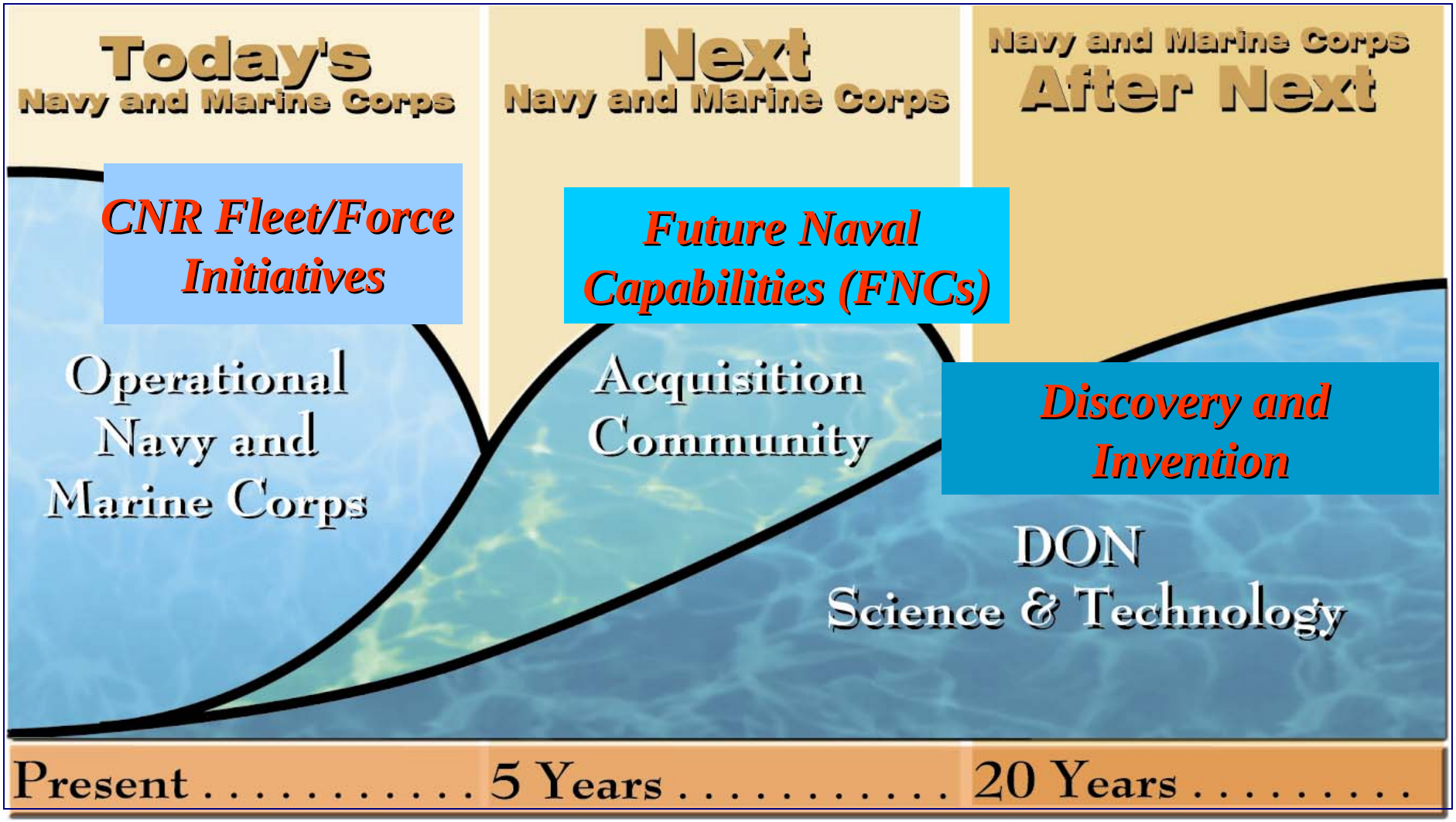
ATD Management Plan



Commitments to Transition needed Technology as Fast as Possible

The Way Ahead for Naval S&T

…a look at tomorrow through the porthole of today...



12 Future Naval Capabilities (FNCs)

- Time Critical Strike
- Organic Mine Countermeasures (MCM)
- Autonomous Operations
- Littoral Anti-Submarine Warfare (ASW)
- Electric Warship and Combat Vehicle
- Littoral Combat/Power Projection
- Total Ownership Cost
- Missile Defense
- Capable Manpower
- Warfighter Protection
- Fleet Force Protection
- Knowledge Superiority and Assurance

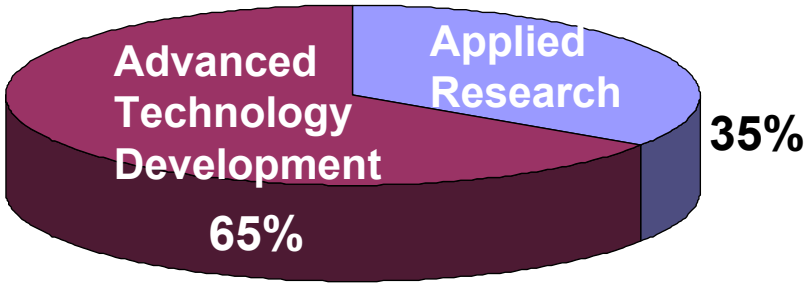
Navy FNC IPT Approach

- **Industry Board of Directors Model**
- **Principal Members:**
  - **Chair -- Requirements community -- Office of Chief of Naval Operations (OPNAV)/Marine Corp Combat Development Center (MCCDC)/Fleet/Force rep.**
  - **Transition Lead -- Acquisition community -- Systems Command (SYSCOM)/Program Executive Officer (PEO) rep.**
  - **Execution Manager/Technical Working Group Leader -- S&T community rep.**
  - **Executive Secretary -- S&T Resource Sponsor Rep.**

FNC Investment

Investment by Research Type

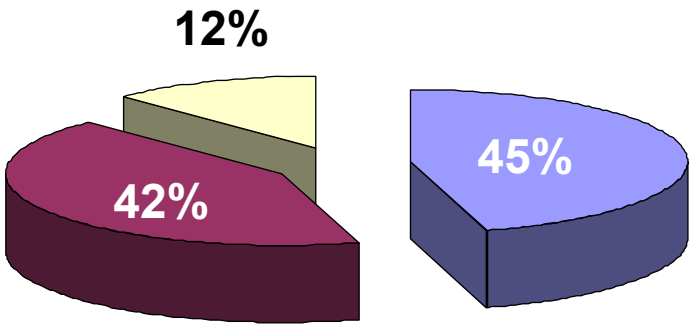
6.3



6.2

Investment by Performer

6.2



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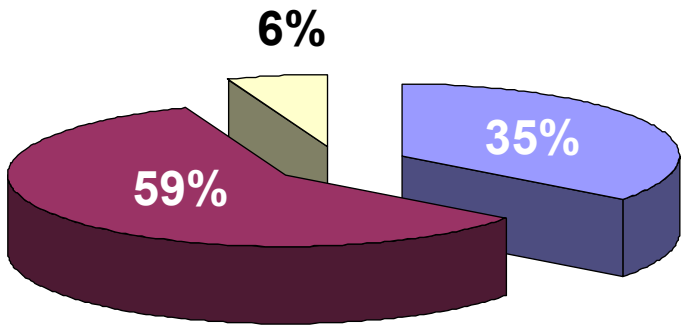


- FNCs leverage technologies that can be matured over the FYDP.
- FNCs are delivery oriented.

FNC IPT Charter

- The IPT is Responsible for:
  - **Transition Management**
  - **Developmental Assessment**
  - **Coordination with Sea Trials**
  - **Transition Resource Programming**
  - **Preparation of Required Acquisition Documentation**

FNC IPTs provide the alignment to speed transition

AIR FORCE S&T OVERVIEW
&
TECHNOLOGY TRANSITION PATHS

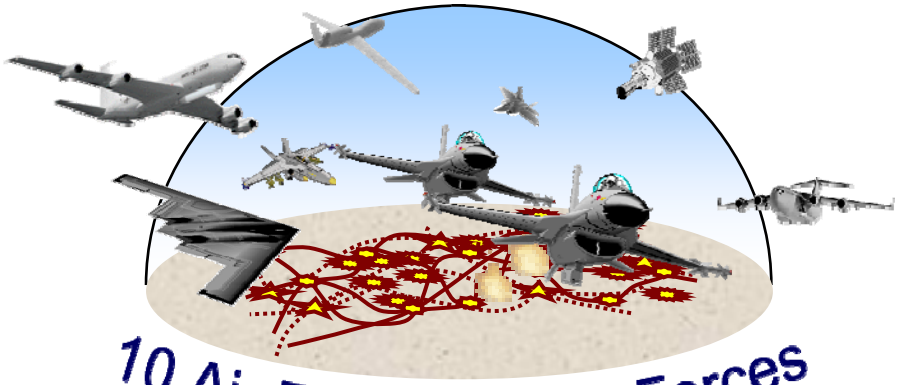
AF Capabilities-Based CONOPS Drive Everything We Do

National Strategies

SECDEF Planning Guidance

Joint Concepts

Planning



Joint Integrated Capability is the absolute requirement.
To be effective, you must be able to "plug and play"

Programming
Budgeting
Execution

Capability Review and Risk Assessment (CRRA)

Global Strike CONOPS	Homeland Security CONOPS	Global Mobility CONOPS	Global Persistent Attack CONOPS	Nuclear Response CONOPS	Space and C4ISR CONOPS

Agile Combat Support CONOPS

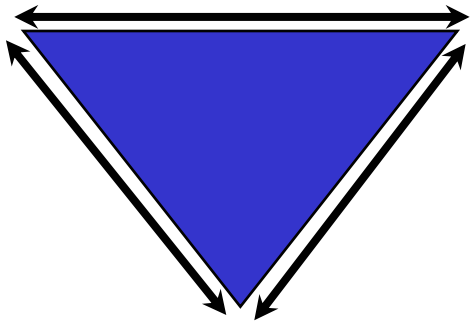
Applied Technology Council

MAJCOM ★★★

- Define requirements
- Lead steering group

Product Centers ★★★

- Interpret requirements
- Establish transition plan



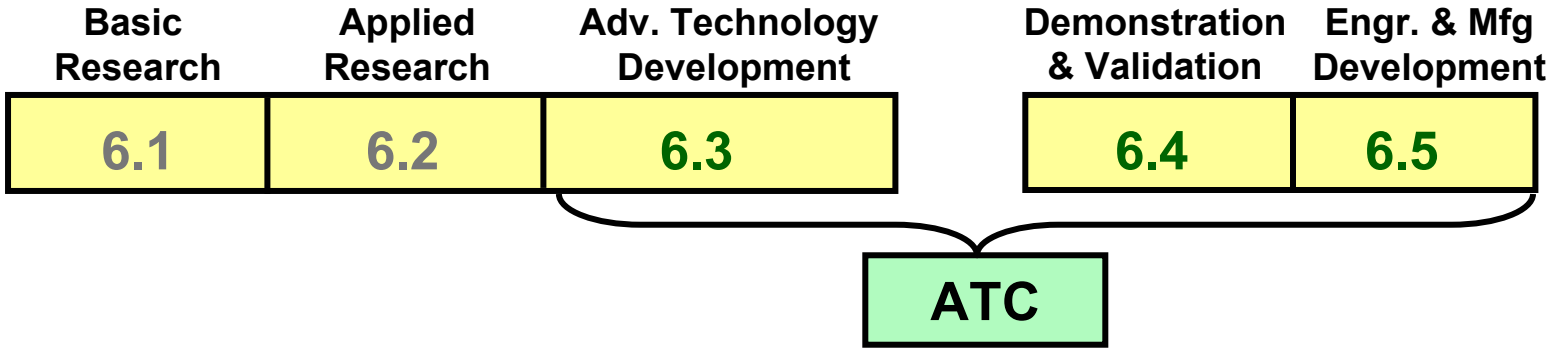
Air Force Research Laboratory ★★

- Develop/Demonstrate technologies for future warfighting capabilities
- Identify Advanced Technology Demonstration (ATD) candidates

Air Force
Applied Technology Council (ATC)

- Tech transition process should be a 3-legged stool
  - AFRL, Product Centers, and Users
- Recurring participation at senior levels is mandatory
  - MAJCOM/CVs, Product Center/CCs, and AFRL/CC
- Funding commitments for both S&T and transition program development are the key to technology transition
- Process Focuses on Advanced Technology Demonstration (ATD) Programs
- Developing an Air Force Instruction to standardize procedure

Air Force ATC

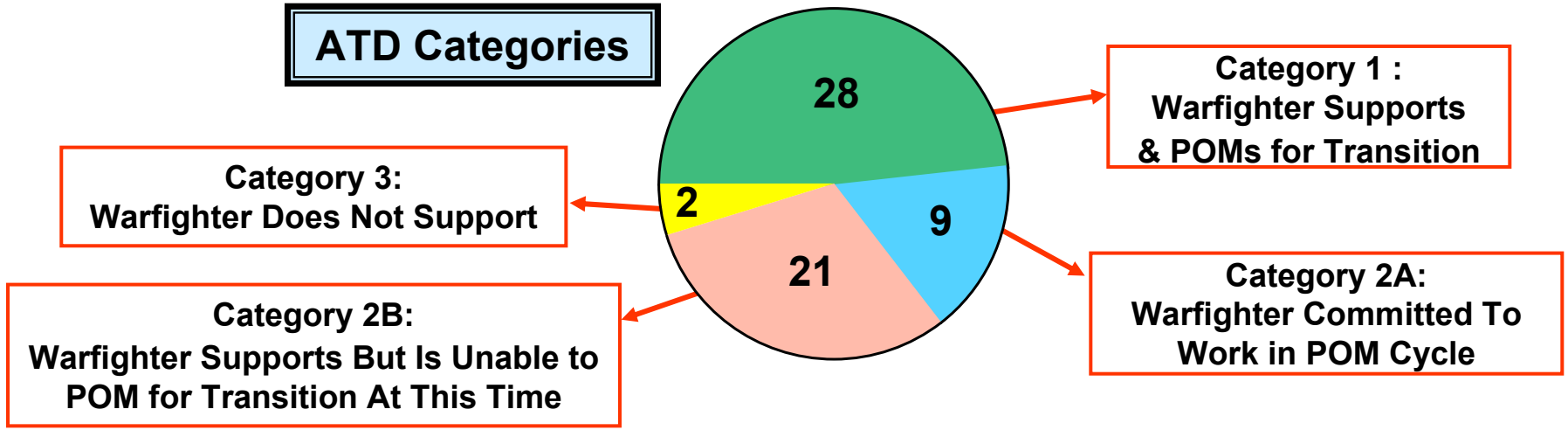


Lab (☝)
- Identifies ATD Candidates
- Budgets for Technology
- Develops Transition Strategies

Product Center (☝☝)
- Interprets Requirements
- Builds the Transition Program
- Integrates Technology into Systems

MAJCOM (☝☝☝)
- Defines Requirements
- Budgets for Development & Production Funds

ATD Categories

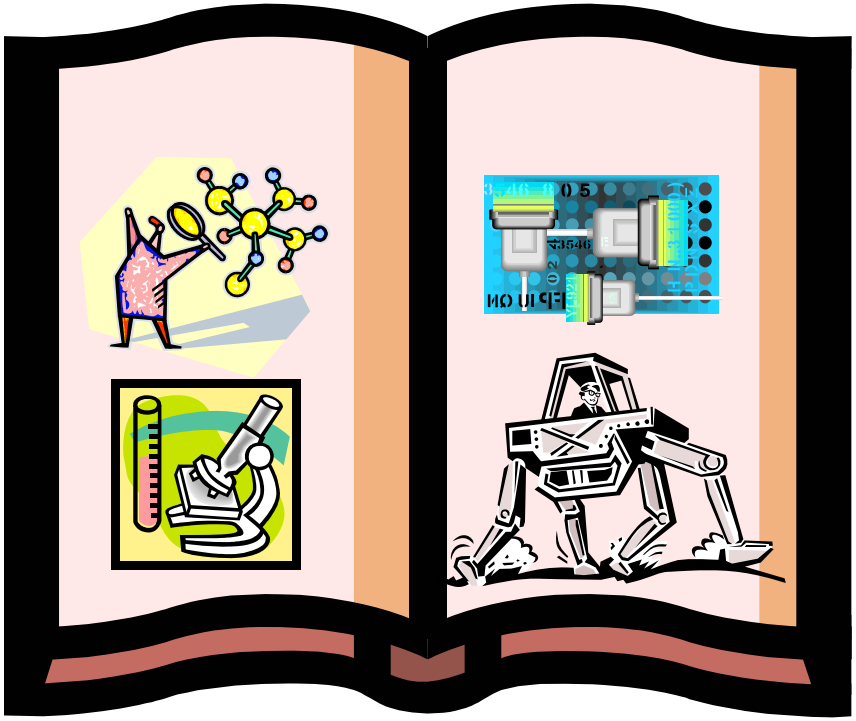


Outline

- The Need to Focus on Technology Transition Issues
- Capabilities Based Acquisition
- Focus of the DoD S&T Program
- Technology Transition Thrusts and Opportunities
- Service Focus Areas
- Technology Readiness Assessments

What is a TRA?

- **Systematic, metrics-based process that assesses the maturity of Critical Technology Elements (CTEs)**
  - **Uses Technology Readiness Levels (TRLs) as the metric**
- **Regulatory information requirement for *major* acquisition programs**
  - **Submitted to DUSD(S&T)**



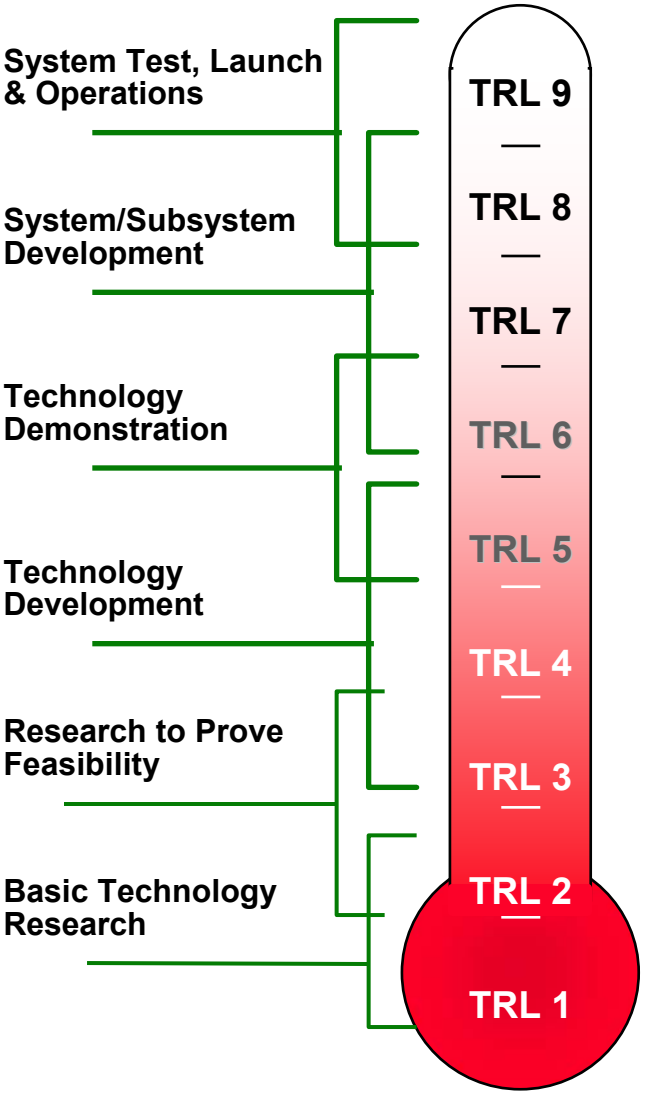
≠ Not a risk assessment

≠ Not a design review

≠ Does not address system integration

Measuring Technology Maturity

Technology Readiness Levels



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 a 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

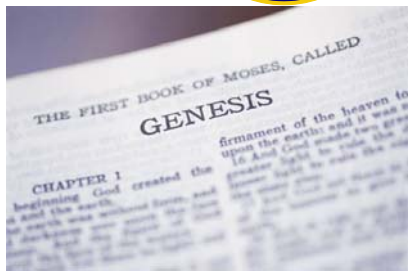
TRL 3 — Analytical and experimental critical function and/or characteristic proof-of-concept

TRL 2 — Technology concept and/or application formulated

TRL 1 — Basic principles observed and reported

As Defined in 5000.2-R

How Technology Readiness Assessments TRAs Began



- **"Program managers' ability to reject immature technologies is hampered by (1) untradable requirements that force acceptance of technologies despite their immaturity"** ***GAO/NSIAD-99-162***
- **"Identify each case in which a major defense acquisition program entered system development and demonstration … into which key technology has been incorporated that does not meet the technology maturity requirement … and provide a justification for why such key technology was incorporated and identify any determination of technological maturity with which the Deputy Under Secretary of Defense for Science and Technology did not concur and explain how the issue has been resolved."** ***National Defense Authorization Act for Fiscal Year 2002***
- **"The management and mitigation of technology risk, which allows less costly and less time-consuming systems development, is a crucial part of overall program management and is especially relevant to meeting cost and schedule goals. Objective assessment of technology maturity and risk shall be a routine aspect of DoD acquisition."** ***DoDI 5000.2, paragraph 3.7.2.2***

Stop launching programs before technologies are mature

Critical Technology Element (CTE) Defined

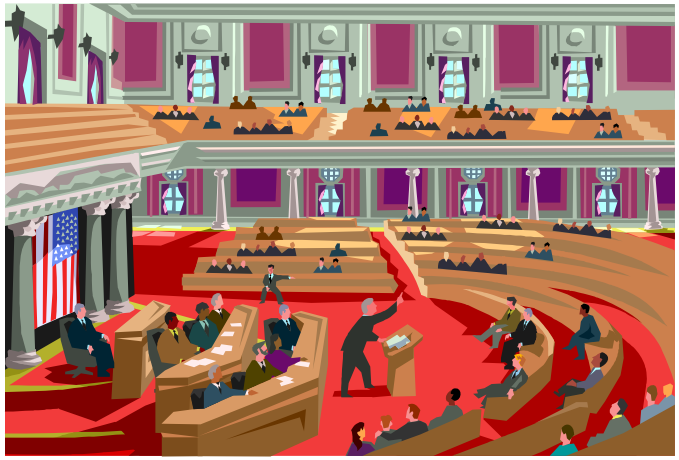
A technology element is "critical" if the system being acquired depends on this technology element to meet operational requirements with acceptable development cost and schedule and with acceptable production and operation costs *and* if the technology element or its application is either new or novel.

Said another way, an element that is new or novel or being used in a new or novel way is critical if it is necessary to achieve the successful development of a system, its acquisition, or its operational utility.

CTEs may be hardware, software, manufacturing, or life cycle related at the subsystem or component level

Why is a TRA Important?

- **The Milestone Decision Authority (MDA) uses the information to support a decision to initiate a program**
  - **Trying to apply immature technologies has led to technical, schedule, and cost problems during systems acquisition**
  - **TRA established as a control to ensure that critical technologies are mature, based on what has been accomplished**



- **Congressional interest**
  - **MDA must certify to Congress that the technology in programs has been demonstrated in a relevant environment at program initiation**
  - **MDA must justify any waivers for national security to Congress**

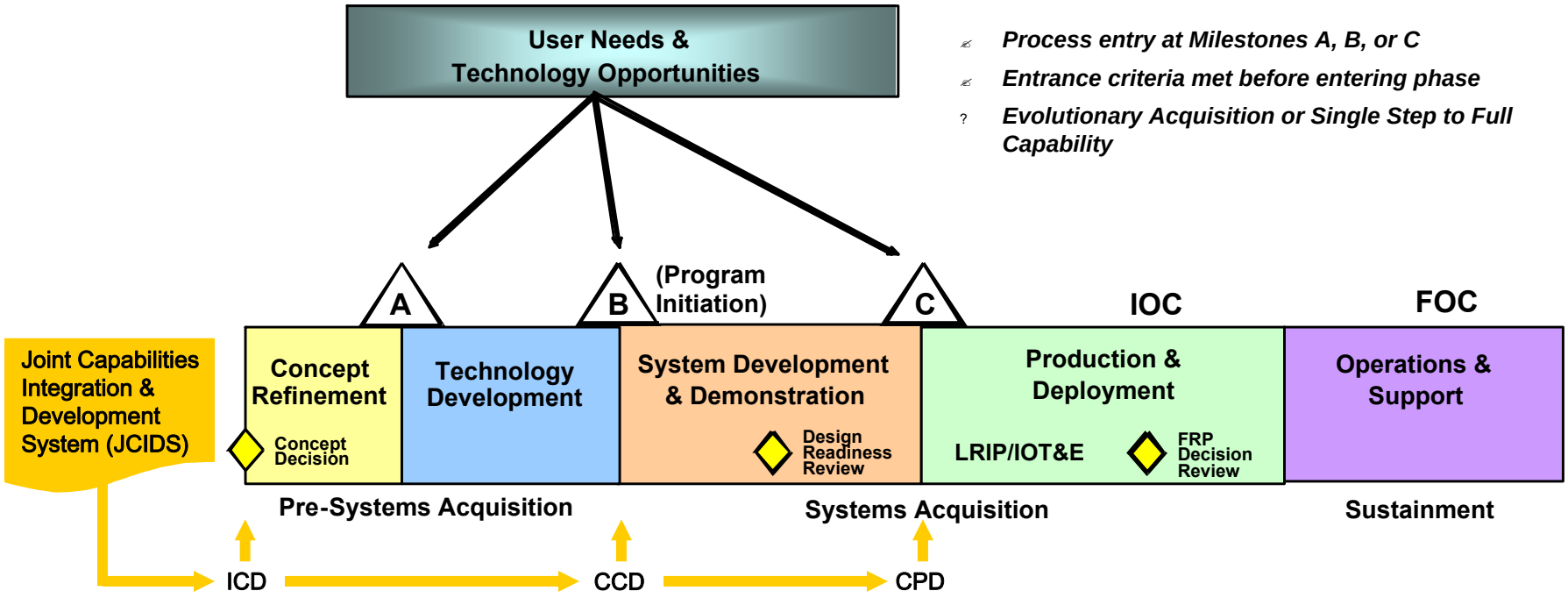
Quantifying the Effects of Immature Technologies

According to a GAO review of 54 DoD programs:

- **Only 15% of programs began MS-B with mature technology (TRL 7)**
  - **Programs that started with mature technologies averaged 9% cost growth and a 7 month schedule delay**
  - **Programs that did not have mature technologies averaged 41% cost growth and a 13 month schedule delay**

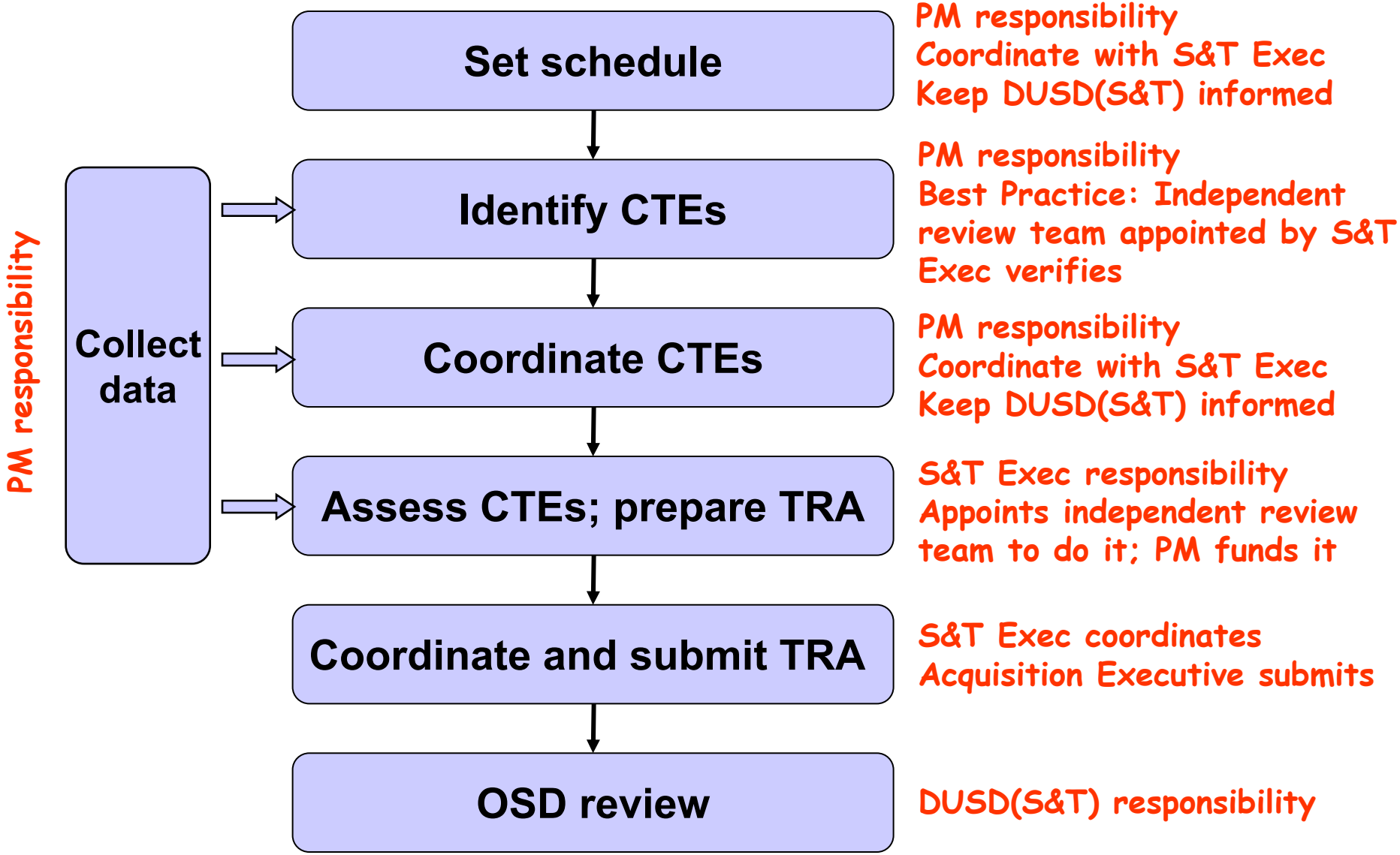
Source: Defense Acquisitions: Assessments of Selected Major Weapon Programs, GAO-05-301, March 2005

Overview of Technology Considerations During Systems Acquisition



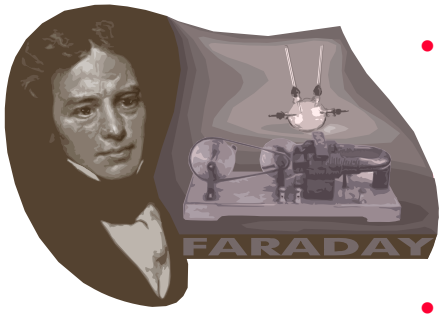
TRAs required at MS B, MS C, and program initiation for ships (usually MS A).

Process Overview

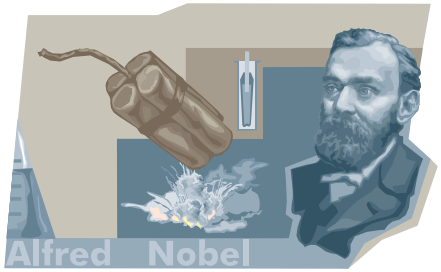


Component S&T Executives

- **Army**
  - Deputy Assistant Secretary (Research and Technology)
- **Navy**
  - Chief of Naval Research
- **Air Force**
  - Deputy Assistant Secretary (Science, Technology and Engineering)



- **DISA**
  - Chief Technology Officer
- **DLA**
  - Chief Information Officer
- **NSA**
  - Office of Corporate Assessments



Responsible for directing the TRA

Component S&T Executive Appoints; PM Funds

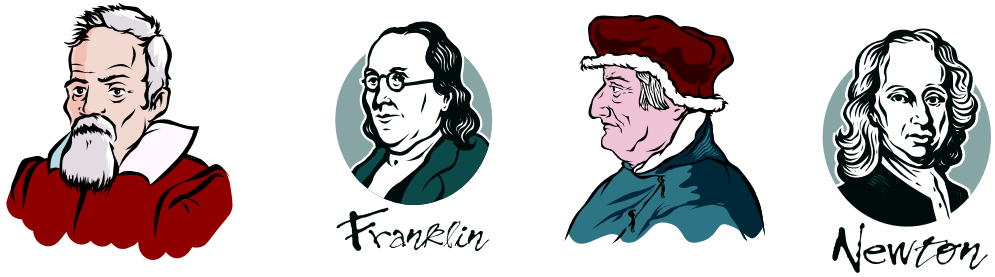
Independent Review Team

- **Selected from pool of recognized experts**
  - DoD Components
  - FFRDCs
  - Universities
  - Government agencies
  - Industry
  - National Laboratories

WBS Elements

Manufacturing	R&M
Sensors	Crew systems
Missile warning	Antennas
Communications	Structures
Architecture	Propulsion
Processing	Electrical systems
Survivability	Materials
Software	Security
Information systems	Navigation
Training	Safety
Logistics	●●●

- **Final Team membership based on work breakdown structure where CTEs are located**



Responsible for performing and preparing the TRA

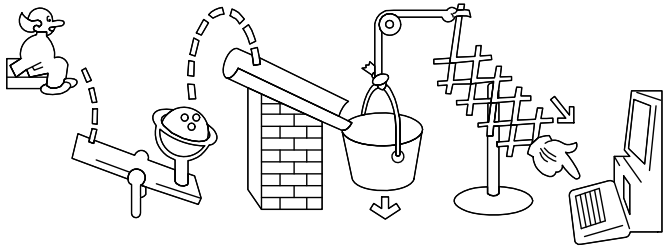
Hardware TRLs

Increasing maturity

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

TRL 4 Hardware
Minimum Maturity at Milestone A

- **Definition:** Component and/or breadboard validation in a laboratory environment.
- **Description:** Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared with the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.
- **Supporting Information:** System concepts that have been considered and results from testing laboratory-scale breadboard(s). References to who did this work and when. Provide an estimate of how breadboard hardware and test results differ from the expected system goals.



TRL 6 Hardware
Minimum Maturity at Milestone B

- **Definition:** System/subsystem model or prototype demonstration in a relevant environment.
- **Description:** Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in a simulated operational environment.

- **Supporting Information:** Results from laboratory testing of a prototype system that is near the desired configuration in terms of performance, weight, and volume. How did the test environment differ from the operational environment? Who performed the tests? How did the test compare with expectations? What problems, if any, were encountered? What are/were the plans, options, or actions to resolve problems before moving to the next level?

Demonstration or Validation of a Technology in a Relevant Environment

- **Requires successful trial testing that either:**
  - **shows that the technology satisfies functional need across the full spectrum of operational employments, or**
  - **shows that the technology satisfies the functional need for some important operational employment and uses accepted techniques to extend confidence over all required operational employments.**

TRL 7 Hardware
Minimum Maturity at Milestone C

- **Definition:** System prototype demonstration in an operational environment.
- **Description:** Prototype near or at planned operational system. Represents a major step up from TRL 6 by requiring demonstration of an actual system prototype in an operational environment (e.g., in an aircraft, in a vehicle, or in space). Examples include testing the prototype in a test bed aircraft.
- **Supporting Information:** Results from testing a prototype system in an operational environment. Who performed the tests? How did the test compare with expectations? What problems, if any, were encountered? What are/were the plans, options, or actions to resolve problems before moving to the next level?

Guidance for Immature Technologies

If the system does not meet pre-defined Technology Readiness Level scores, then a Critical Technology Element maturation plan is identified. This plan explains in detail how the Technology Readiness Level will be reached prior to the next milestone decision date or relevant decision point." (Defense Acquisition Guidebook Section 4.3.2.4.3. Technology Readiness Assessment (TRA))

- **TRL 6 required at MS B.**
- **TRL 7 required at MS C; TRL 8 for manufacturing CTEs.**

Bottom Line: Warfighter Confidence

Right Materiel, Right Place,
Right Time, at the Right Cost -

All The Time