



Annual Systems Engineering Research Center Research Review

15 October 2009

**The Honorable Zachary J. Lemnios
Director, Defense Research and Engineering**

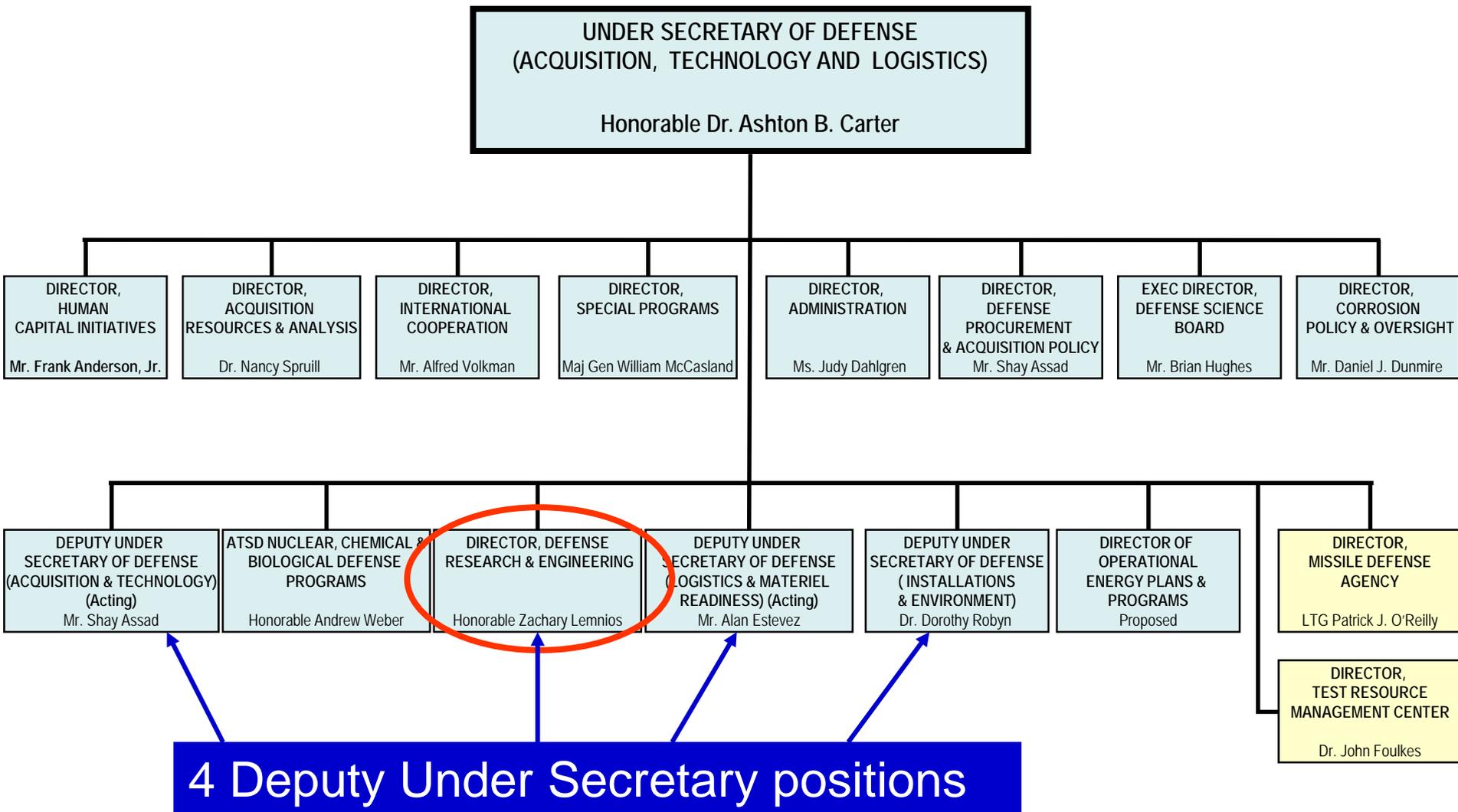


Our Guidance

- **Defense Budget Recommendation Statement**
Secretary of Defense Robert M. Gates, April 06, 2009
 - *reaffirm our commitment to take care of the all-volunteer force*
 - *rebalance this Department's programs*
 - *institutionalize and enhance our capabilities to fight the wars we are in today and the scenarios we are most likely to face in the years ahead*
 - *provide a hedge against other risks and contingencies*
 - *fundamental overhaul of our approach to procurement, acquisition, and contracting*
- **Economic Club of Chicago**
Secretary of Defense Robert M. Gates, July 16, 2009
 - *What is needed is a portfolio of military capabilities with maximum versatility across the widest possible spectrum of conflict*



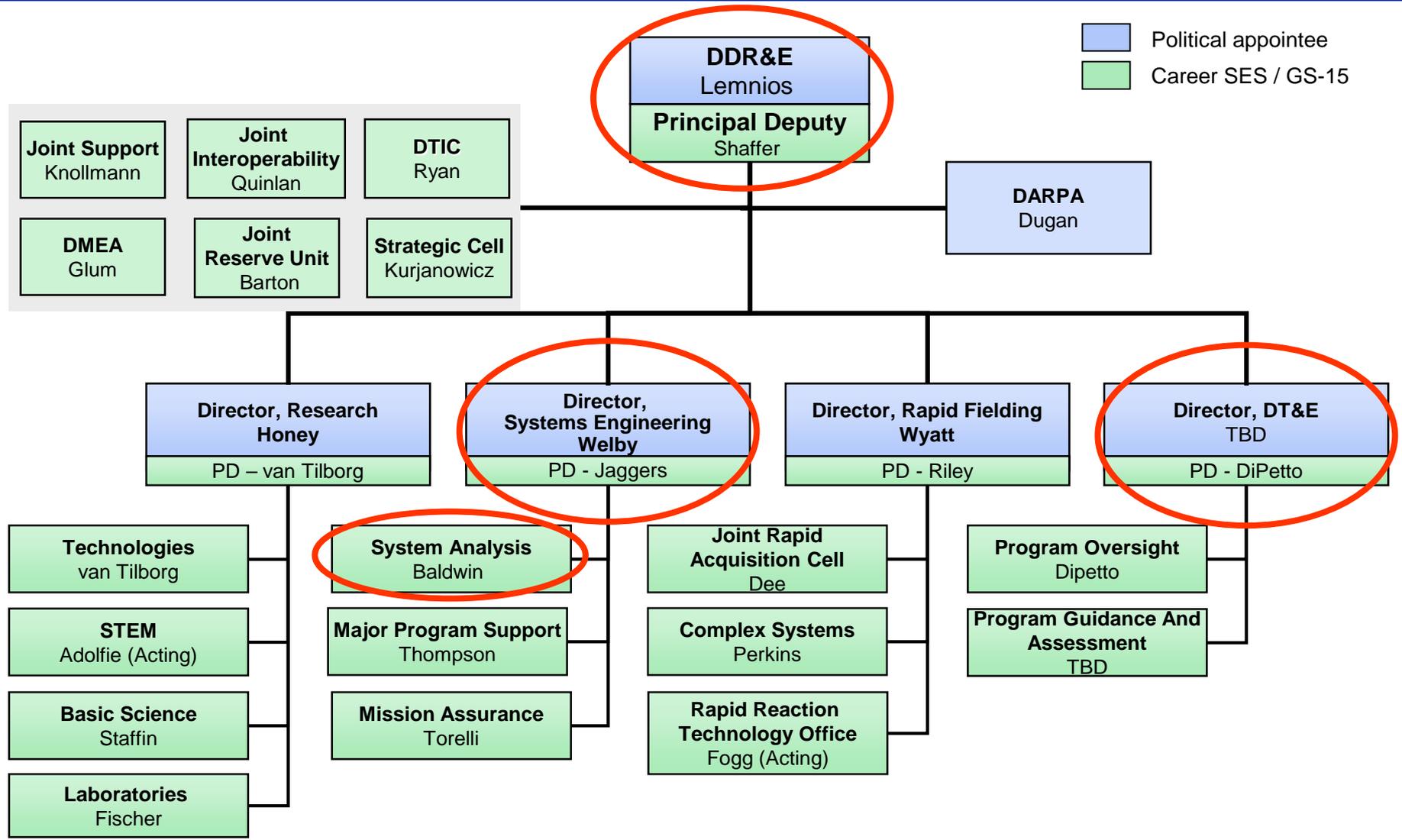
AT&L Organization



4 Deputy Under Secretary positions



DDR&E Organization





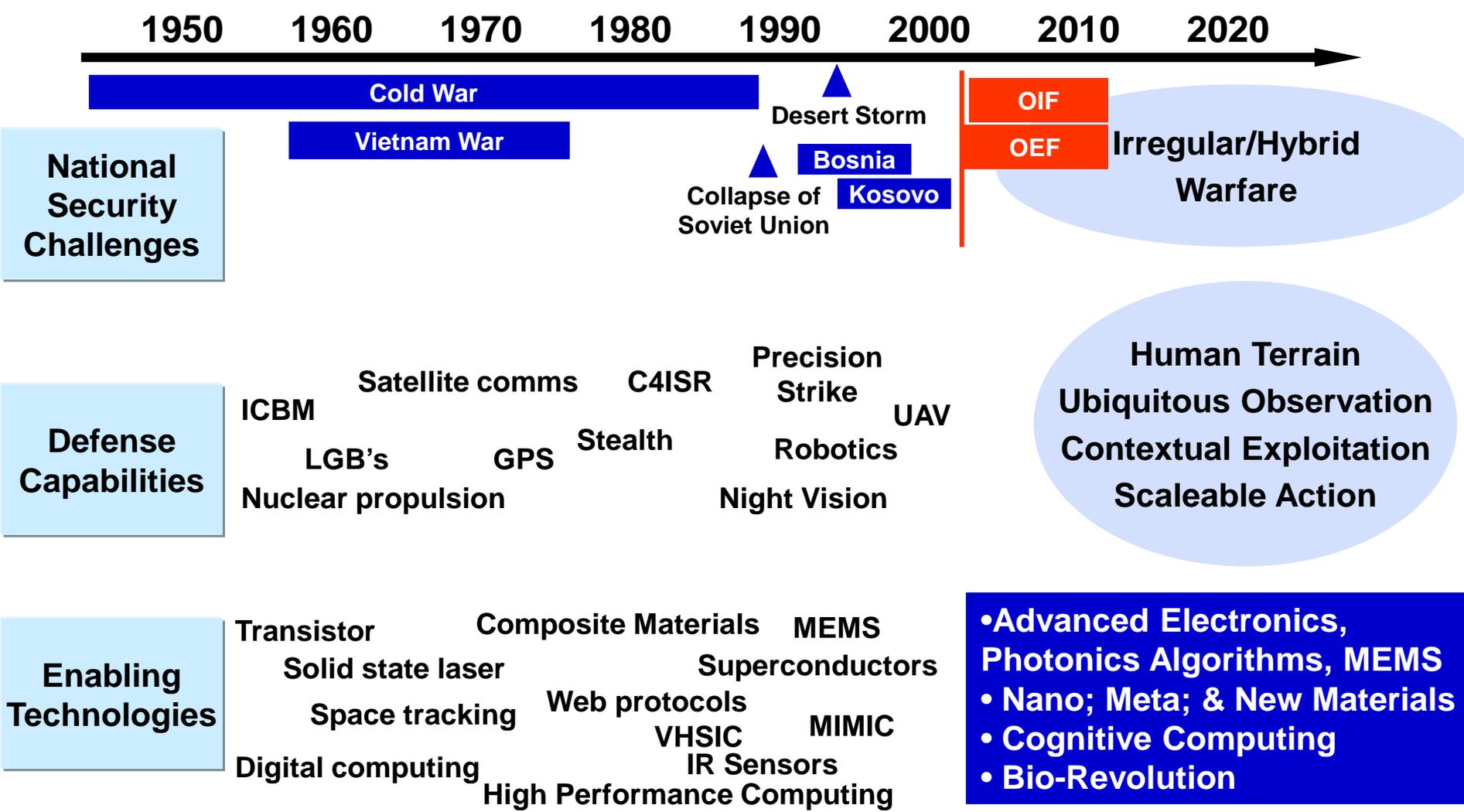
DDR&E Imperatives



- 1. Accelerate delivery of technical capabilities to win the current fight.**
- 2. Prepare for an uncertain future.**
- 3. Reduce the cost, acquisition time and risk of our major defense acquisition programs.**
- 4. Develop world class science, technology, engineering, and mathematics capabilities for the DoD and the Nation.**



Perspective for the Next Decade





Forces of Change... Irregular and Hybrid Warfare



*Operations in
Austere
Locations*

**Defense S&T for
Persistent /
Irregular Warfare**

*Humanitarian
Assistance /
Provincial
Reconstruction
Teams*

**NEW TECHNOLOGY NEEDED
Affecting the Hearts and Minds...**



The Timeline has Collapsed!

Conventional Warfare

USAF Capability

High Altitude Aircraft



Electronic Countermeasures



Endgame Countermeasure



Engage SAM



Adversary Capability

High Altitude SAM



Monopulse SAM



SAM with ECCM



Response loop measured in years

Counter-Insurgency Warfare

US Capability

Jammers



Mine Resistant Ambush Protected (MRAP)



Adversary Capability

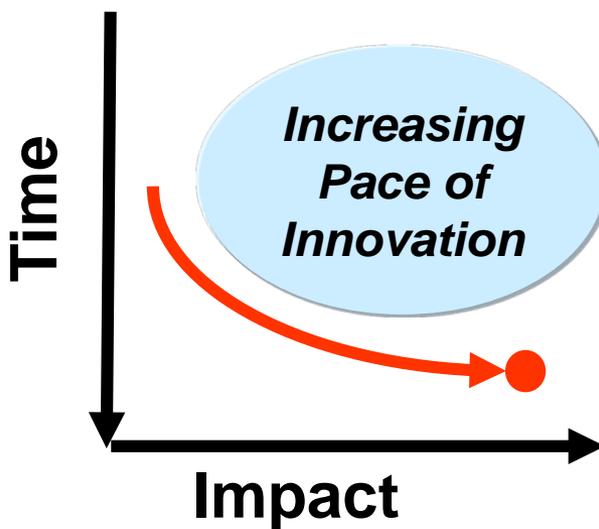
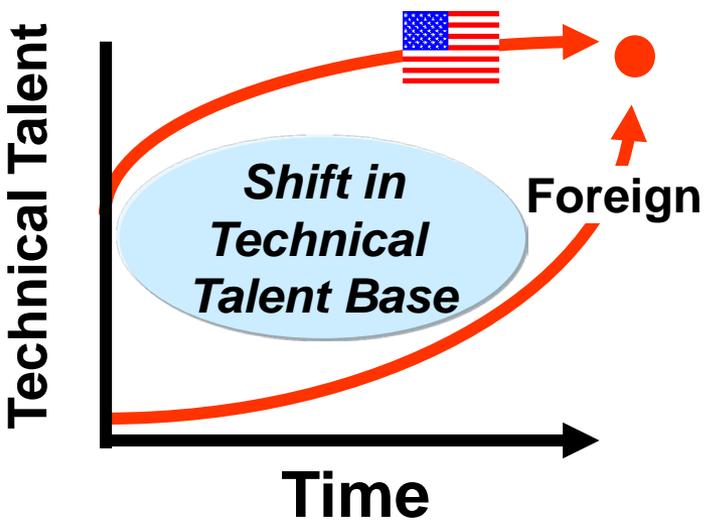
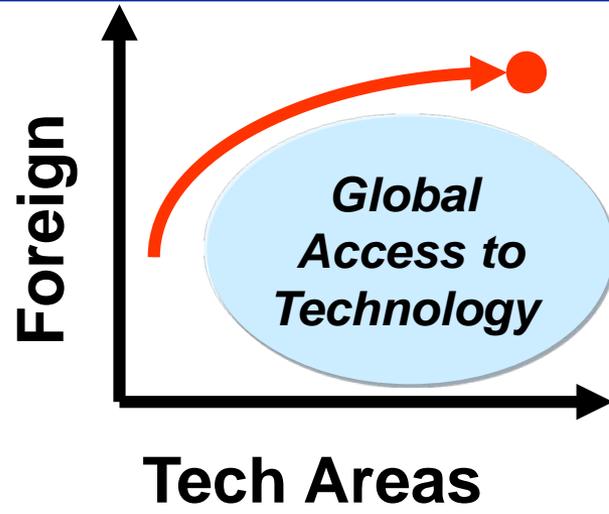
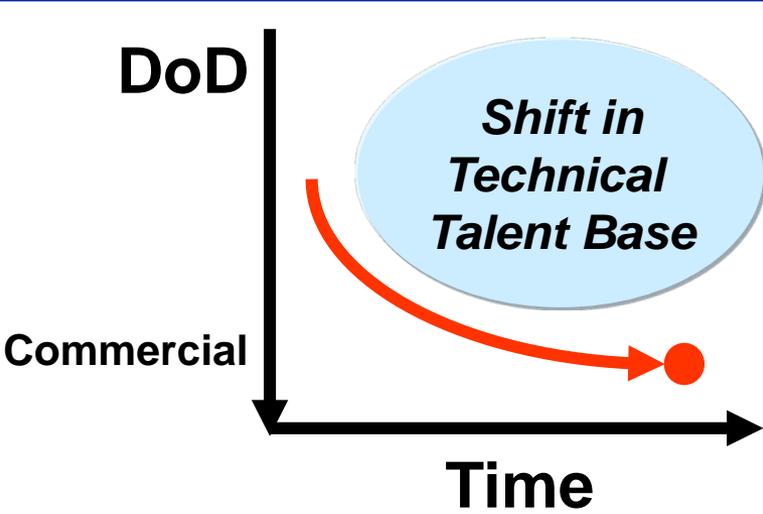


Advanced Technology

Response loop measured in months or weeks

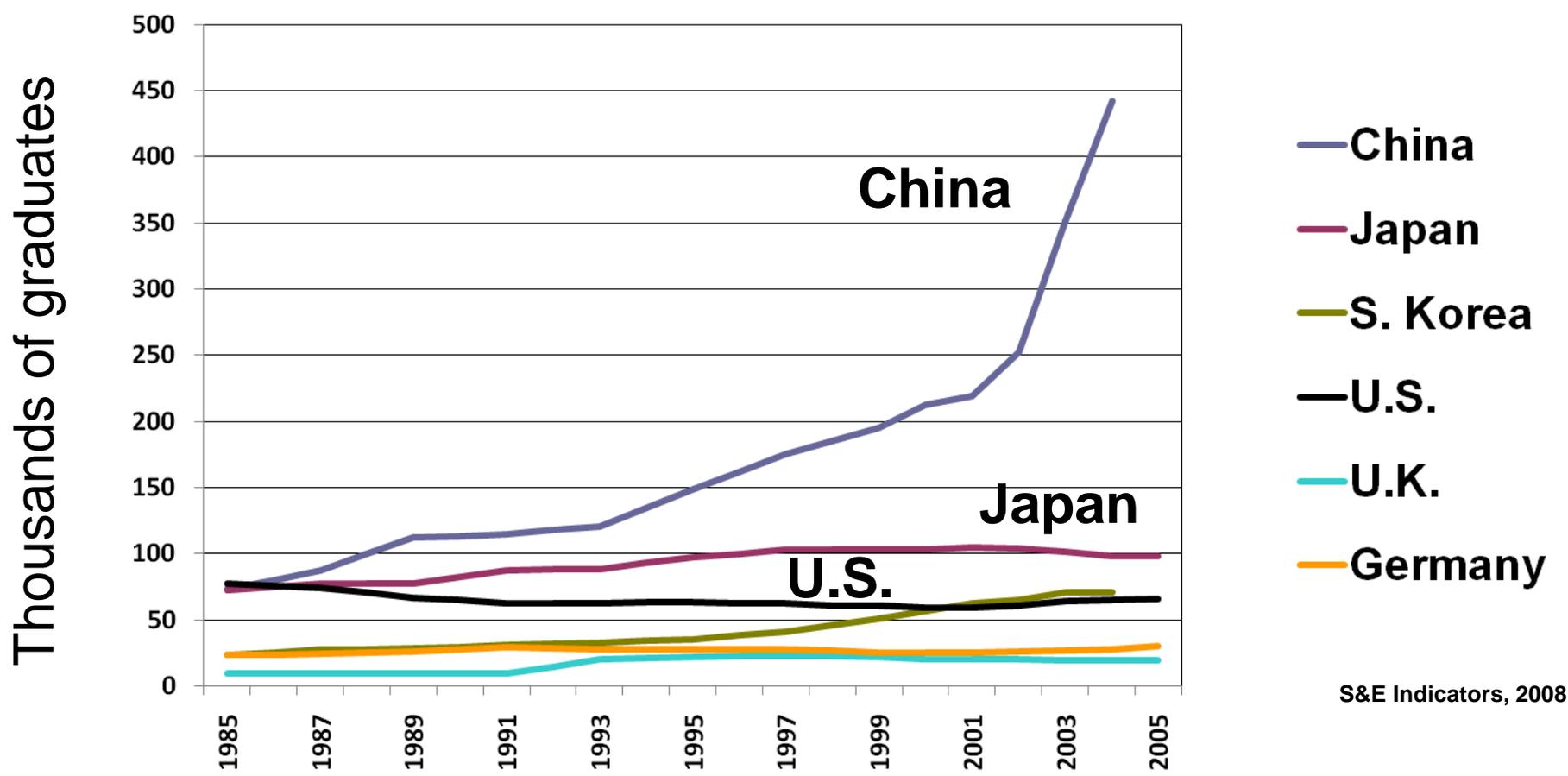


Four Key Challenges to our Technical Base





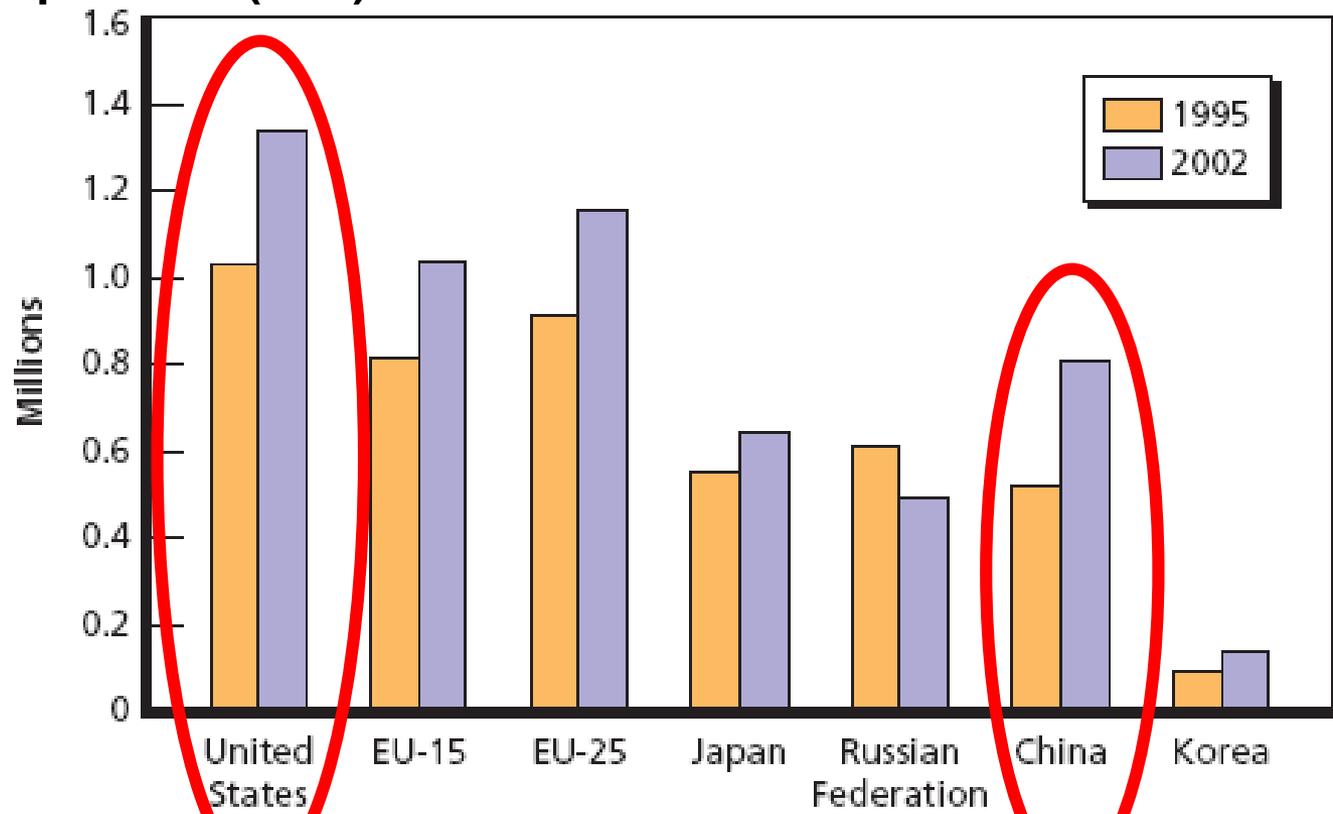
We are in a competition for the best technical talent





The Shifting Research Base

Full-Time Equivalent (FTE) Researchers



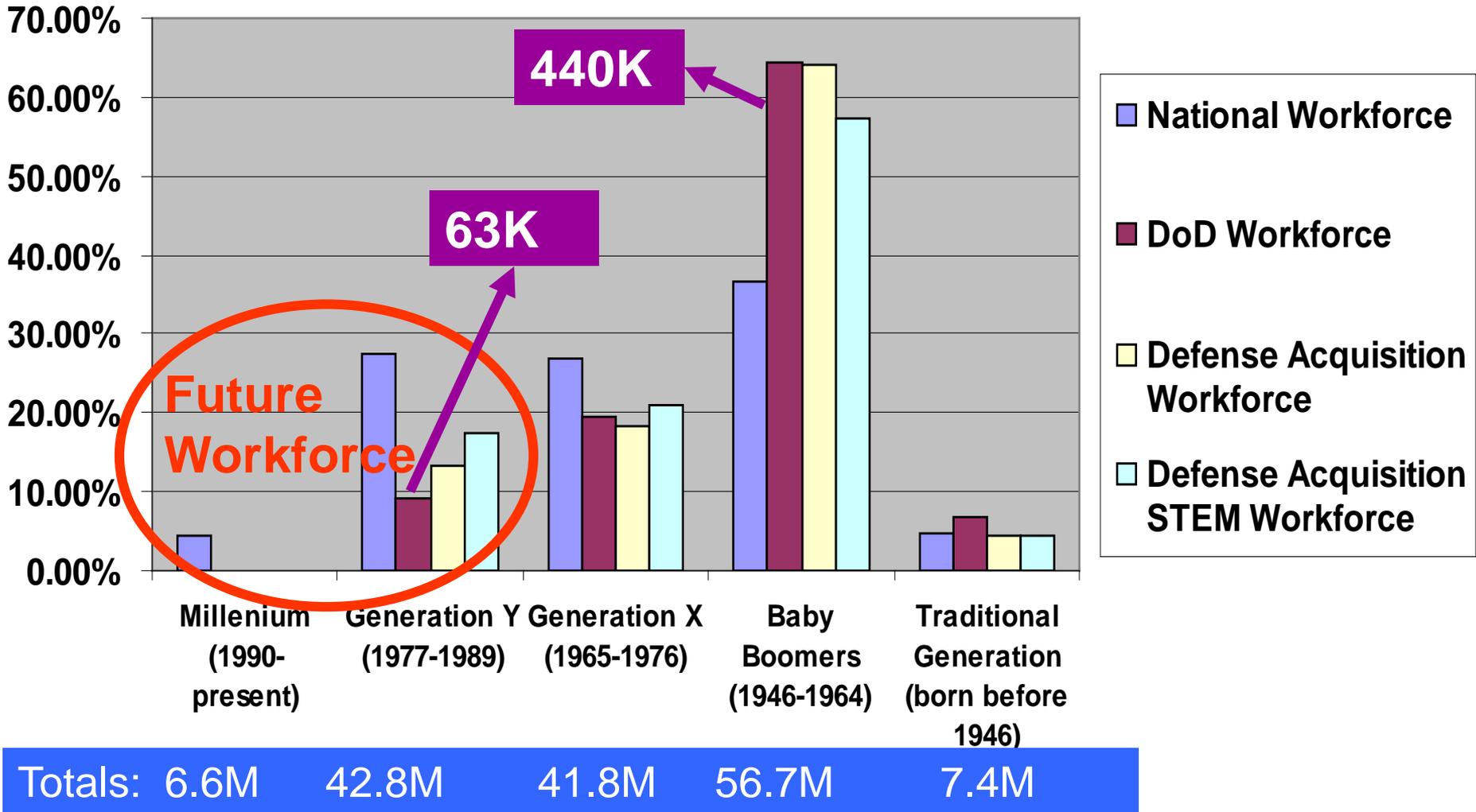
3.7%
Growth / Year

6.5%
Growth / Year

Source: OECD Science, Technology and Industry Outlook (2006)



Workforce Breakdown by Generation





The Big Three



Innovation

Speed

Agility



Comments from COCOMs



“We need to detect IED’s at range... I am willing to test technologies in the field... We need persistent communications on the move...”

“I need the 70% solution today, rather than the 100% solution in 5-8 years...”

“...we are concerned about our technological edge against a near peer competitor...”

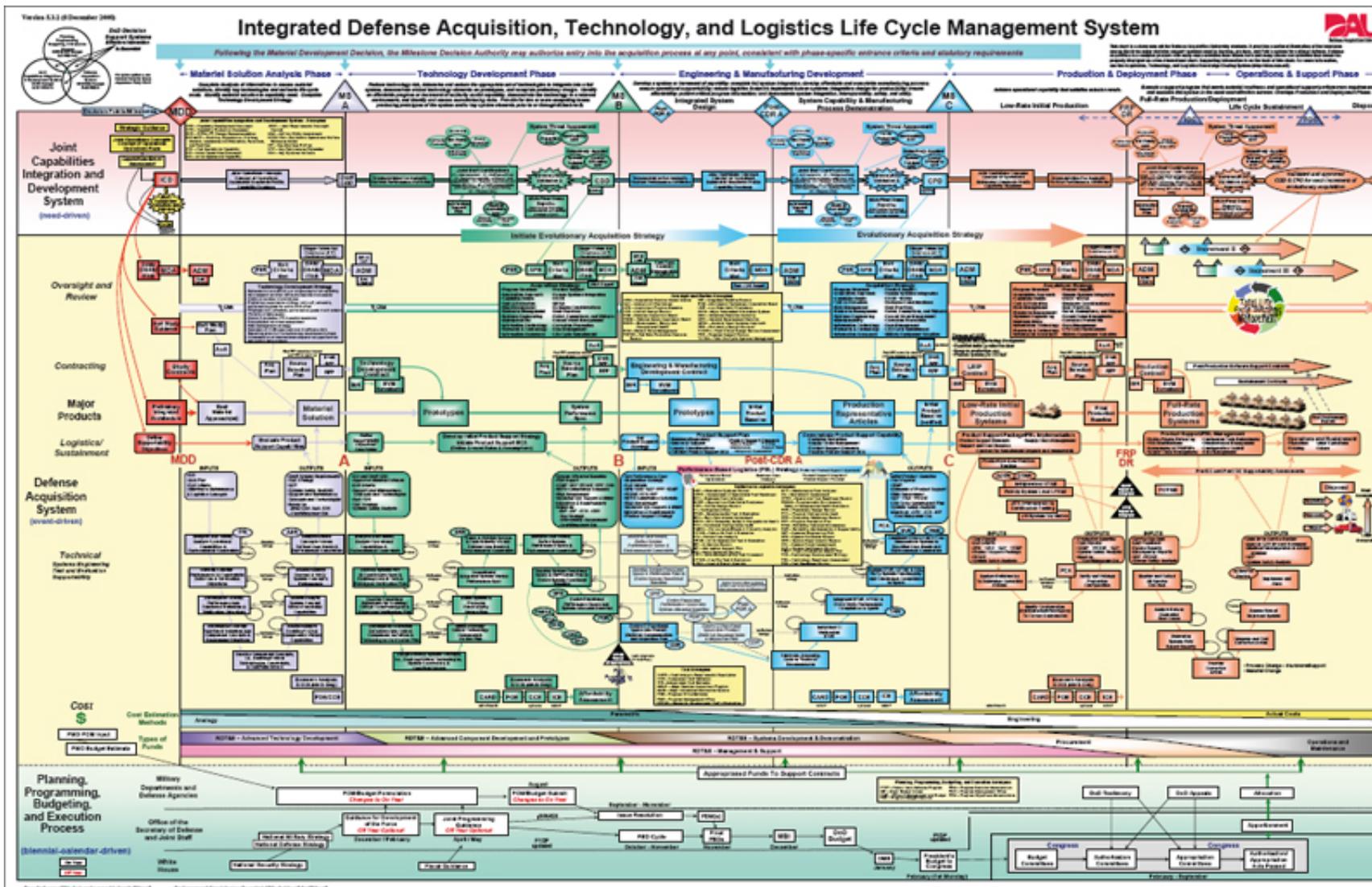
“It took us 10 years to get to the Moon, we are 8 years into our research efforts for defeating IED's...we need to find a solution to reliably detect and defeat IED's at range...”

“I like the 1 year acquisition cycle rather than the standard 5-8 year cycle, get the prototypes into the hands of the warfighters, turn the feedback into a quick redesign and deliver relevant capability now...”

“Often times we fail due to shortage of imagination...”



An Effective Process for Major Defense Systems – but not very agile



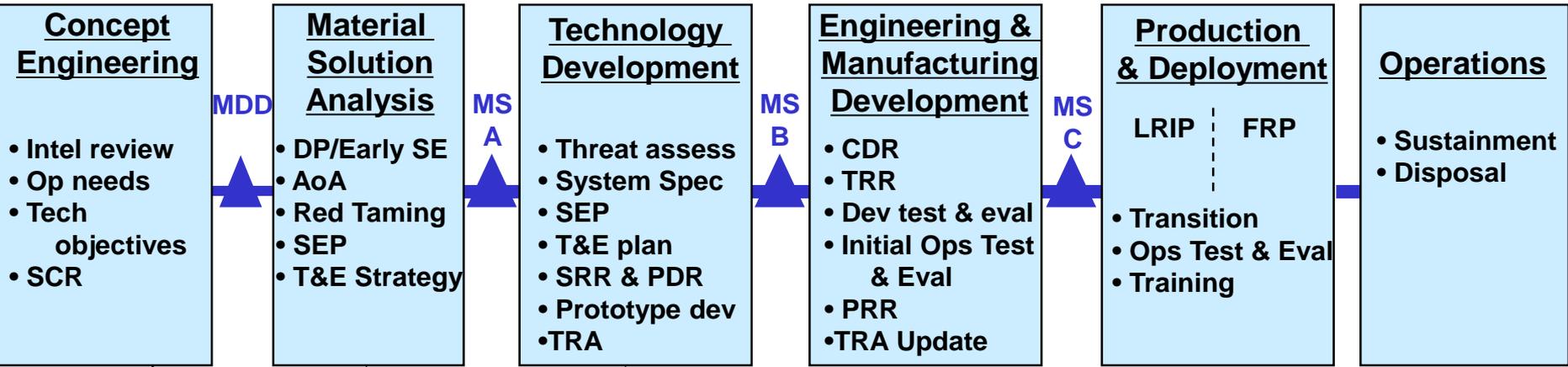


Defense Acquisition Approach

Systems Engineering is key discipline



5 to 15 Years



Concept Engineering

- Intel review
- Op needs
- Tech objectives
- SCR

Material Solution Analysis

- DP/Early SE
- AoA
- Red Taming
- SEP
- T&E Strategy

Technology Development

- Threat assess
- System Spec
- SEP
- T&E plan
- SRR & PDR
- Prototype dev
- TRA

Engineering & Manufacturing Development

- CDR
- TRR
- Dev test & eval
- Initial Ops Test & Eval
- PRR
- TRA Update

Production & Deployment

LRIP | FRP

- Transition
- Ops Test & Eval
- Training

Operations

- Sustainment
- Disposal

Technology and Risk Reduction

- Technology “push” investment
- Technology maturation
- Phenomenology measurements

- AoA – Assessment of Alternatives
- DP – Developmental Planning
- MDD – Material Development Decision
- SCR – System Concept Review
- SRR – System Requirements Review
- SEP – System Engineering Plan
- PDR – Preliminary Design Review
- CDR – Critical Design Review
- TRR – Test Readiness Review
- PRR – Production Readiness Review
- LRIP – Low-Rate Initial Production
- FRP – Full Rate Production

70-75% of Cost Decisions Made Prior to Milestone A
Impact 72% of Total Life Cycle Costs



Scope of DDR&E Acquisition Program Oversight Efforts*



Program Category	Increasing cost/risk	SE	DT&E	TMA
ACAT ID**	\$\$\$ MDA = AT&L	93	93	70
ACAT IC**	\$\$\$ MDA = CAE	29	29	52
Special Interest**	Any \$\$ Risk	17	17	19
MAIS, ACAT IA	\$-\$\$\$\$, AIS	15	15	30
Pre-MDAP	\$\$\$ pre-MS B	44	44	53
Pre-MAIS	\$-\$\$\$\$, AIS pre-MS B	9	9	10
ACAT II	\$\$ < ACAT I	0	8	0
ACAT III	\$ < ACAT II	0	3	0
Total		207	218	234

DABs in next 90 days

- BAMS IPR
- MUOS DAE Review
- FCS Follow-on
- EA-18G FRP
- JTRS MIDS MS C
- WIN-T Increment II MS-C
- SSN 774 Virginia Class MS III
- Global Hawk IPR
- HC/MC-130 MS C
- SBIRS DAE Review
- JTRS HMS MS C
- JHSV (pre-MDAP)
- JSF (F-35) LRIP

*Based on 2009 T&E Oversight List (Jan 5, 2009)

**Major Defense Acquisition Program (MDAP)

+Major Automated Information System (MAIS)

MDA – Milestone Decision Authority

TMA – Technology Maturity Assessment

CAE – Component Acquisition Executive



The Current SE Environment

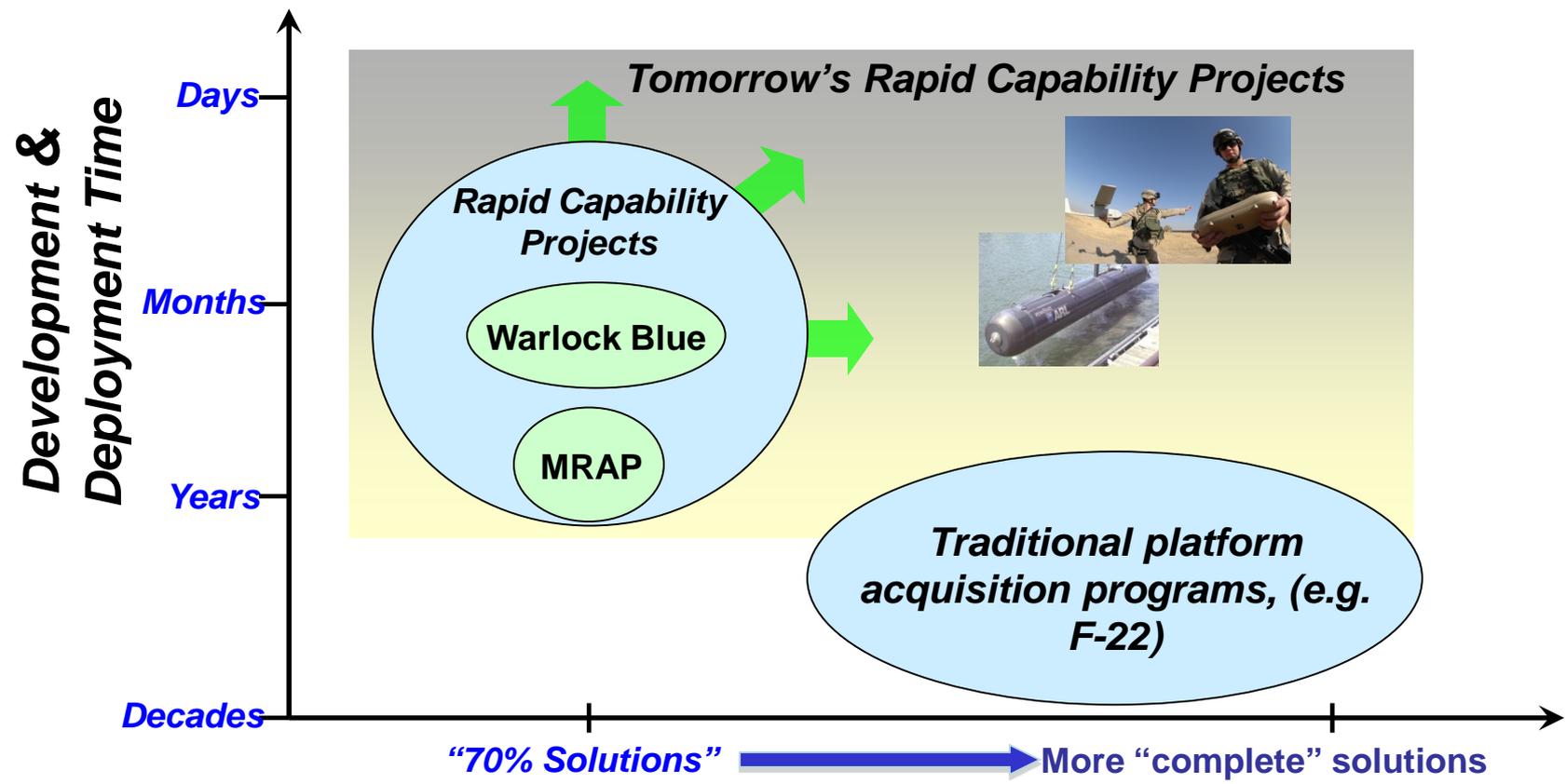


Systems Engineers confront a spectrum of issues that challenge “traditional” systems engineering

- **Complexity**
 - **Scope & Scale:** number and diversity of elements
 - **Connectivity:** interdependencies among the disparate elements
 - **Emergent behaviors:** nonlinear stochastic response functions
 - **Effects of non-technical attributes and characteristics**
- **Criticality**
 - **Systems to be continuously available**
 - **Able to deal with Security, Privacy, Authenticity, Accuracy, requirements “seamlessly” & without performance degradation**
- **Compatibility**
 - **Integrate the newest/fastest with the oldest/slowest**
- **Chronology**
 - **“Idea” to “IOC” measured in weeks/months versus years/decades**
- **Competency**
 - **Can the workforce develop the knowledge and abilities to adapt & survive?**



Rapid Capability "Toolbox"



"Performance", "Sustainability", "Adaptability", "Robustness" of Solution

DDR&E Rapid Capabilities Toolbox study will identify tools to enable more rapid, adaptive, robust, and sustainable solutions to the warfighter

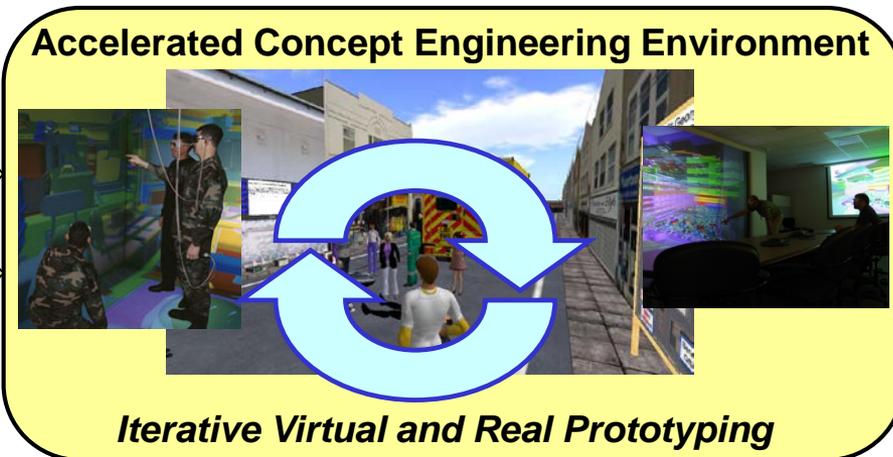


A New Generation of Concept Engineering Tools

Warfighter Needs



Anticipatory Opportunities



- Conceptual Designs
- CONOPs
- TTPs
- Detailed Design Models

- Immersive Virtual Environments
- Rapid Virtual Environment generation
- Virtual Environment to CAD tool translation
- Rapid Prototyping fabrication tools
- “Human-Centered Design” principles and tools
- Integrated engineering and virtual M&S

Immerse Users/Developers in a Rapidly-Configured Environment with Real and Virtual Prototypes: Accelerated Concept Engineering



How the SERC Adds Value



- **Brings focus and synergy across the broad technical / engineering community to address complex challenges**
- **Develops engineering methods, tools to reduce risk in acquisition**
- **Inspires and advances a national competency for Systems Engineering**
- **Provide direct supports the DoD and Intelligence Communities**
 - **To do this effectively, SE Research must be *Engaged* —this is a “Contact Sport”**



Summary: Challenges Ahead



- **Create the tools to enable Rapid Capability Delivery**
 - Shorten the time to deliver life-saving and war-winning technologies – without compromising SE integrity
- **Evolve SE to design systems for adaptability**
 - Capture agility, adaptability, responsiveness as design attributes
- **Expand the aperture of SE to address 21st century technical challenges**
 - Security, software-intensive, etc...
- **Embrace complexity**
 - Systems of Systems / Complex Adaptive Systems / Emergent behaviors
- **Expand the SE human capital resource base**
 - Reflect new insights in the curriculum to grow the next “crop” of SE