Defense Research and Engineering: The Path Ahead

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

12th Annual NDIA Systems Engineering Conference
October 27, 2009
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
Weapon Systems Acquisition Reform Act of 2009

- Establishes Director, Systems Engineering (SE) and Director, Developmental Test & Evaluation (DT&E) as principal advisors to the SECDEF and the USD(AT&L)

- Mandates documented assessment and competitive prototyping

- Strengthens technical analysis of cost and schedule breaches during development

*President Barack Obama signing the Weapons Systems Acquisition Reform Act in the Rose Garden at the White House Friday, May 22, 2009.*

Official White House Photo by Samantha Appleton
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.
Defense Program Support within the AT&L Organization

UNDER SECRETARY OF DEFENSE (ACQUISITION, TECHNOLOGY AND LOGISTICS)
Honorable Dr. Ashton B. Carter

DIRECTOR, HUMAN CAPITAL INITIATIVES
Mr. Frank Anderson, Jr.

DIRECTOR, ACQUISITION RESOURCES & ANALYSIS
Dr. Nancy Spruill

DIRECTOR, INTERNATIONAL COOPERATION
Mr. Alfred Volkman

DIRECTOR, SPECIAL PROGRAMS
Maj Gen William McCasland

DIRECTOR, ADMINISTRATION
Ms. Judy Dahlgren

DIRECTOR, DEFENSE PROCUREMENT & ACQUISITION POLICY
Mr. Shay Assad

EXEC DIRECTOR, DEFENSE SCIENCE BOARD
Mr. Brian Hughes

DIRECTOR, CORROSION POLICY & OVERSIGHT
Mr. Daniel J. Dunmire

DIRECTOR, INTERNATIONAL COOPERATION
Mr. Alfred Volkman

DIRECTOR, DEFENSE RESEARCH & ENGINEERING
Honorable Zachary Lemnios

DEPUTY UNDER SECRETARY OF DEFENSE (ACQUISITION & TECHNOLOGY) (Acting)
Mr. Shay Assad

ATSD NUCLEAR, CHEMICAL & BIOLOGICAL DEFENSE PROGRAMS
Honorable Andrew Weber

DEPUTY UNDER SECRETARY OF DEFENSE (LOGISTICS & MATERIEL READINESS) (Acting)
Mr. Alan Estevez

DEPUTY SECRETARY OF DEFENSE (INSTALLATIONS & ENVIRONMENT)
Dr. Dorothy Robyn

DIRECTOR OF OPERATIONAL ENERGY PLANS & PROGRAMS
Proposed

DIRECTOR, MISSILE DEFENSE AGENCY
LTG Patrick J. O'Reilly

DIRECTOR, CORROSION POLICY MANAGEMENT CENTER
Dr. John Foulkes
New Coordinates

Innovation

Speed

Agility
“Comments from COCOMs

“We need to detect IEDs 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 IEDs…we need to find a solution to reliably detect and defeat IEDs at range…

“I like the 1-year acquisition cycle rather than the standard 5- to 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…”

Perspective for the Next Decade

National Security Challenges
- Cold War
- Vietnam War
- Desert Storm
- Collapse of Soviet Union
- Bosnia
- Kosovo
- OIF
- OEF

Defense Capabilities
- ICBM
- Satellite comms
- LGB’s
- Nuclear propulsion
- GPS
- C4ISR
- Stealth
- Precision Strike
- UAV
- Robotics
- Night Vision

Enabling Technologies
- Transistor
- Solid state laser
- Space tracking
- Digital computing
- Composite Materials
- Superconductors
- MEMS
- Web protocols
- VHSIC
- IR Sensors
- MIMIC
- High Performance Computing
- Advanced Electronics
- Photonics Algorithms, MEMS
- Nano; Meta; & New Materials
- Cognitive Computing
- Bio-Revolution

Human Terrain
Ubiquitous Observation
Contextual Exploitation
Scaleable Action

Irregular/Hybrid Warfare

Timeline:
- 1950
- 1960
- 1970
- 1980
- 1990
- 2000
- 2010
- 2020

- Cold War
- Vietnam War
- Desert Storm
- Collapse of Soviet Union
- Bosnia
- Kosovo
- OIF
- OEF

- 1990: Desert Storm
- 2000: Collapse of Soviet Union
- 2010: OIF
- 2020: OEF

- 1970: Vietnam War
- 1980: Desert Storm
- 1990: OIF
- 2000: OEF

- 1950: Cold War
- 1960: Vietnam War
- 1970: Desert Storm
- 1980: OIF
- 1990: OEF
- 2000: Kosovo
- 2010: OIF
- 2020: OEF
Four Key Challenges to our Technical Base

1. Shift in Technical Talent Base
2. Increase in Commercial Tech Areas
3. Foreign Global Access to Technology
4. Impact of Increasing Pace of Innovation
We are in Competition for the Best and Brightest

China

Japan

U.S.

S. Korea

U.K.

Germany

S&E Indicators, 2008
The STEM Workforce Challenge

Future Workforce

- Millenium (1990-present)
- Generation X (1965-1976)
- Baby Boomers (1946-1964)
- Traditional Generation (born before 1946)

Totals:
- National Workforce: 6.6M
- DoD Workforce: 42.8M
- Defense Acquisition Workforce: 41.8M
- Defense Acquisition STEM Workforce: 56.7M
- Traditional Generation: 7.4M

440K
63K
The Timeline has Collapsed!

Conventional Warfare

**USAF Capability**
- High Altitude Aircraft
- Electronic Countermeasures
- Endgame Countermeasures

**Adversary Capability**
- High Altitude SAM
- Monopulse SAM
- SAM with ECCM
- Engage SAM

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
An Effective Process for Major Defense Systems – but not very agile
### Scope of DDR&E Acquisition Program Oversight Efforts*

<table>
<thead>
<tr>
<th>Program Category</th>
<th>Increasing cost/risk</th>
<th># of Progs</th>
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<tbody>
<tr>
<td>ACAT ID**</td>
<td>$$ $$ MDA = AT&amp;L</td>
<td>93</td>
</tr>
<tr>
<td>ACAT IC**</td>
<td>$$ $$ MDA = CAE</td>
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<td>Special Interest**</td>
<td>Any $s Risk</td>
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<td>MAIS, ACAT IA</td>
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<tr>
<td>Pre-MDAP</td>
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<td>ACAT III</td>
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<tr>
<td><strong>Total</strong></td>
<td>**</td>
<td>274</td>
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*Based on 2009 T&E Oversight List (Jan 5, 2009)

**Major Defense Acquisition Program (MDAP)
+ Major Automated Information System (MAIS)

% Distribution of MDAPs by Domain

- **Land** 20%
- **C2-ISR** 11%
- **Unmanned** 14%
- **Ships** 9%
- **Munitions** 3%
- **Rotary Wing** 15%
- **Comms** 6%
- **Space** 6%
- **Business** 2%
- **Missiles** 20%
- **Fixed Wing** 2%
- **Other** 3%

MDA – Milestone Decision Authority
TMA – Technology Maturity Assessment
CAE – Component Acquisition Executive
Defense Acquisition Approach

Systems Engineering is a key discipline

Typically 5 to 15 Years

Concept Engineering
- Intel review
- Op needs
- Tech objectives
- SCR

Material Solution Analysis
- DP/Early Systems Engr
- 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

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

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

NDIA SE Conference Keynote Address
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UNCLASSIFIED
DDR&E Rapid Fielding Office: Accelerating Delivery of Capabilities

**Problem Identification**
- JUONS (65)
- IPLs (96)
- STIPL (90)
- COCOM Requests
- Anticipated Needs
- Other

**Solution Matching**
- Services
- US GOVT
- DDR&E
- Rapid
- Fielding Office
- DARPA
- IC
- Coalition
- Other

**Implementation Tools**
- US Army REF JIEDDO
- JCTD
- RRTD
- SCO
- DAC
- FCT
- DARPA
- Other

**Transition**
- Program of Record
- Prototype Capability
- Terminate

**Lessons Learned Feedback**
Pushing the Bounds of Innovation and Development

Performance – Sustainability – Adaptability - Robustness of Solution

Tomorrow’s Rapid Capability Projects

Rapid Capability Projects

Warlock Blue

MRAP

Development & Deployment Time

Days

Months

Years

Decades

70% Solution

More “Complete” Solution

Traditional platform acquisition programs, (e.g. F-22)

Traditional platform acquisition programs, (e.g. F-22)
A New Generation of Concept Engineering Tools

- Conceptual Designs
- CONOPs
- TTPs
- Detailed Design Models

Accelerated Concept Engineering Environment

Iterative Virtual and Real Prototyping

- 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

Warfighter Needs

Anticipatory Opportunities
Summary: Challenges Ahead

- Develop tools to shorten the Acquisition cycle without diminishing the quality of solutions
- Evolve Systems Engineering to design systems for adaptability and to embrace complexity
- Expand the aperture of Defense Engineering to address 21st century technical challenges
- Expand the Defense Engineering human capital resource base