9th Annual Systems Engineering Research Center (SERC) Sponsor Research Review

November 8, 2017

Mary J. Miller
Acting Assistant Secretary of Defense for Research and Engineering
Technology Transforming the Battlespace

- Increased rate of investment in military R&D from near-peers

- Easy proliferation of knowledge and technology has eroded US historic advantages
  - Increasing systems capabilities
  - Advanced production capabilities
    - Driving lower costs
    - Decreasing the “time to market”

- Speed and cycle time

- Increasingly Competitive National Security Technical Environment

China is the world’s second largest investor in R&D with a forecast spending of $396.3 billion for 2016
Threats Exist Across All Domains

- Adversaries are moving to next generation capabilities across all domains: Air, Land, Maritime, Space, & Cyber
- Advanced materials, ranges, speed, and lethality seen across Russian and Chinese platforms – approaching/at parity
- Increased ability to project power
  - We are now on-par or outranged by Russian and Chinese rocket and artillery capabilities
- China and Russia can hold U.S. and allied positions at risk
  - 10 years ago, China only had the ability to strike Taiwan

Comparing U.S. Army Systems with Foreign Counterparts: Identifying Possible Capability Gaps and Insights from Other Armies, RAND, 2015 – For Illustrative Purposes Only

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What we are doing about it..
Secretary of Defense
Focus Areas

- Strengthen military readiness by increasing **lethality** of the force

- Strengthen our **alliances** and collaborate with allies whenever and wherever possible

- **Reform** the Department of Defense through budget discipline and increased accountability

“When it comes to security, no one goes their own way in this world alone. Security is always best when provided by a team.”
– Secretary Mattis, Munich Security Conference, February 2017
ASD Research & Engineering (R&E) Mission

The United States depends on science, technology and innovative engineering to not only protect the American people but to advance our national interests and to prepare us to meet the challenges of an uncertain future.

– ASD(R&E) Mission

Mitigate current and anticipated threat capabilities.

Affordably enable new capabilities in existing and future systems.

Create technology surprise through science and engineering.

Pursuing Sustained Technological Advantage
“First Offset Strategy” – 1950s
Nuclear deterrence to avoid a large increase in defense expenditures to conventionally deter Warsaw Pact forces during the 1950s.

“Second Offset Strategy” – 1970s
Development of precision-guided munitions to deter both conventional and unconventional aggression from Soviet Forces.

Capabilities from the 2\textsuperscript{nd} offset strategy continue to enable U.S. technological superiority today.
Technology Offset Approach

Seeks to deny adversary objectives, and strengthen conventional deterrence by:

- Leveraging autonomy and artificial intelligence
  - Get inside an adversary’s decision cycle

- Greatly expanding manned-unmanned combat
  - Extend our attack surface

- Re-amplifying our guided-munitions advantage
  - With ‘raid-breaking’ capabilities

- Creating new mass
  - Disaggregating complex systems to deliver combined effects

- Developing ‘inside-out’ and ‘over-under’ capabilities
  - Leverage dispersal, sanctuaries, and speed

- Developing new forms of distributed maneuver
  - Combining kinetic, Electronic Warfare, cyber
How does S&T Contribute?
What is “Science & Technology”

- **Basic Research (6.1):**
  - Investigation and analysis of basic laws of nature and phenomenon to increase scientific knowledge

- **Applied Research (6.2):**
  - Application of knowledge to develop useful materials, devices and systems or methods

- **Advanced Technology Development (6.3):**
  - Development of components and subsystems to integrate into system prototypes for field experiments and/or tests in a simulated environment
From Basic Research to Multiple Applications

Lord Kelvin proposed keeping time using atomic transitions

Isidor Rabi suggested atomic beam magnetic resonance as the basis for a clock

The Atomichron – 1st commercial atomic clock. 50 sold between 1956 - 1960

Isidor Rabi suggested atomic beam magnetic resonance as the basis for a clock

Lord Kelvin proposed keeping time using atomic transitions

Late 1990s: Major advances in optical clock research to increase accuracy – including laser cooling and trapping of atoms

1949 – 1st atomic clock built, an ammonia maser device
U.S. DoD PB 2018 S&T Request
Technology Development Budget

- **U.S. DOD S&T**
  - **TOTAL**
  - **$13.2B**

- **BA 1 – Basic Research**
  - **$2.2B**

- **BA 2 – Applied Research**
  - **$5.0B**

- **BA 3 – Advanced Technology Development**
  - **$6.0B**

- **DARPA $3.1B**
- **USAF $2.6B**
- **USA $2.4B**
- **USN & USMC $2.2B**
- **Remaining 4th Estate* $2.9B**

*NOTES:

4th Estate includes Chem Bio, DTRA, OSD, and other DA.
DoD RDT&E – PB 1995-PB 2018

Today's Force

Next Force

Largely Flat 8-20 years

Force After Next

DOD RDT&E (FY 17 Constant Year Dollars in Billions)

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Leveraging the Entire R&E Ecosystem

Engaging with all partners to ensure technological superiority...

Global Partners

Academia & Industry Partners

Federally Funded R&D Centers (FFRDCs) & University Affiliated Research Centers (UARCs)

DoD Labs, Engineering & Warfare Centers

Win today’s fight

Design and acquire for the next fight

Force acceleration of science and engineering – driving ideas to capability
63 Department of Defense laboratories and engineering centers provide expertise and insight to enhance our warfighter’s capability.
**U.S. Communities of Interest**

*Cols lead the innovation and the acceleration of advanced concepts and prototypes across three main focus areas:*

<table>
<thead>
<tr>
<th>Mission Focus</th>
<th>Counter-Improvised Explosive Devices (IED)</th>
<th>Counter-Weapons of Mass Destruction (WMD)</th>
<th>Biomedical (ASBREM*)</th>
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<tr>
<td>Capabilities enabled by advanced technologies &amp; systems</td>
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<th>Systems / Capability Focus</th>
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<td>Multiple technologies are integrated into complex systems to achieve mission impact</td>
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<th>Technology Focus</th>
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<td>Technology goals with multiple applications</td>
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<td>Alumni CoIs: Engineered Resilient Systems</td>
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<td><em>ASBREM: Armed Services Biomedical Research Evaluation and Management</em></td>
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Looking Forward...
Continuously Refine our Strategic Thinking and Planning

“Where we are going and who we will be”

Mission

Vision

“Where we are and who we are now”

“How we get there”

- Refine our Mission, Strategic Plan, and Vision for Technical and Enterprise Priorities
- Continuous look at the Technology, Focus Areas, Cols, and Partnering

Are we addressing the right problems?
Long-Range Research & Development Planning Program (LRRDPP)

- **Purpose:** Identify **high-payoff enabling technology investments** to provide U.S. forces with decisive advantage in the operations in the **2030 timeframe**

- An opportunity to:
  - **Shape** key future U.S. materiel **investments**
  - **Ensure** sustained U.S. **technology superiority**, and
  - **Seize** the initiative in **shaping** a competitive future national security environment

- Focused on identifying **critical technologies** that can drive materiel concepts with potential to contribute to a **technology offset strategy**

- **Unconstrained** by current U.S. materiel inventory, plans, or investments

- Will be re-accomplished every **four years to inform Defense Strategic Review**

**Bottom Line:** Study and prioritize new or unconventional technology that could provide significant U.S. national security advantages
Capability Gaps
Opportunities for Collaboration

INPUT FACTORS

Threats
Planning - LRRDPP
Hard Problems - A2/AD
Tech Trends - Globalization
Affordability

LRRDPP – Long-Range Research & Development Planning Program
A2/AD – Anti-Access/Area Denial

Lethality
Survivability/Protection
Speed
Range
Training Fidelity
Situational Awareness
Ability to Communicate
Weight/Mobility

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Research and Development
— On-going Activities—

- Autonomy & Robotics
- Artificial Intelligence / Man-Machine Interface
- Micro-electronics
- Hypersonics
- Directed Energy
- Manufacturing
- Electronic Warfare
- Cyber

- Future of Computing
- Novel Engineered Materials
- Precision Sensing: Time, Space, Gravity, Electromagnetism
- Emerging Biosciences
  - Synthetic Biology
- Understanding Human and Social Behavior
- Human Performance
Enhancing Capabilities

Prototyping

Experimentation

Manned, Unmanned and Dismounted Soldier Systems Models and Simulations

Megacity Environment

New Approaches; Problems, Environments

Cross-Service Research
Systems Are Changing

From:

• Systems built to last
• Heuristic-based decisions
• Deeply integrated architectures
• Hierarchical development organizations
• Satisfying requirements
• Automated systems
• Static certification
• Standalone systems

To:

• Systems built to evolve
• Data-driven decisions
• Layered, modular architectures
• Ecosystems of partners, agile teams of teams
• Constant experimentation and innovation
• Learning systems
• Dynamic, continuous certification
• Composable sets of mission focused systems

Credit: Derived from David Long, Former INCOSE President
Competition for Talent

- **Need** to continue to **attract** the **best** and **brightest** to national security service
- **Direct** competition for talent

- **Eliminate barriers** to service
- **Increase recognition** of unique and relevant technical work **and innovative thinking**
- **Leverage all sources** of **talent**
USD(AT&L) Reorganization...
2017 National Defense Authorization Act (NDAA), §901
Organization of the Office of the Secretary of Defense

“Establish policies on, and supervising...”:

Undersecretary of Defense (R&E)
- Defense research and engineering
- Technology development
- Technology transition
- Prototyping
- Experimentation
- Developmental testing activities and programs...
- Allocation of resources for defense research and engineering
- Unifying defense research and engineering efforts across the DoD

Undersecretary of Defense (A&S)
- Acquisition policy
  o system design, development, and production
  o procurement of goods and services
- Sustainment policy
  o logistics
  o maintenance
  o materiel readiness
- Defense industrial base policy
- Materials critical to national security
- Contract administration policy
- Modernization of nuclear forces
- Development of counter-WMD capabilities

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USD(R&E) Proposed Organization

Under Secretary of Defense (Research and Engineering)

- Sets and advances technology/innovation agenda for DOD to dominate battlespace

Defense Science Board

- Strategic Technology Objectives and Investment Strategy
- Foundational Research and Innovative Approaches for Warfighting Challenges
- Affordable & Assured Technology Development
- Global Technology Outreach and Leverage (academic/commercial/government/international)
- Laboratory Infrastructure and Workforce Policy

MDA

Assistant Secretary of Defense (Research & Technology)

- DASD (Research &Technology Investment)
- DASD (Laboratories and Personnel)
- DARPA

Strategic Intel Analysis Cell

- Kill Chain Analysis (US and threat)
- Red-Teaming and Vulnerability Analysis (Technology/Concepts)
- Global Technology Tracking
- Technology Forecasting

Assistant Secretary of Defense (Advanced Capabilities)

- DASD (Mission Engineering & Integration)
- DASD (Prototyping & Experimentation)
- Strategic Capabilities Office (SCO)
- DIUx

- Developmental Prototyping
- Experimentation / Concept Development
- Joint Enduring Operational Needs (JEON) & CCMD Support
- Developmental Planning and Mission Engineering Analysis (assured integration of capability)
- Acquisition Program Support
- Open Architecture / Cyber Security Policy & Standards
- Non-traditional Rapid Acquisition Pathways
USD(R&E) – Guiding Principles

USD(R&E) Key Concepts

• Provide Major Tech Investment Shaping & Strategic Direction
• Focus on Joint, Cross-Cutting Missions
• Tightly Couple with Warfighter
• Integrate Intelligence & Analysis to Inform Decisions
• Incentivize/Prove New Tech Solutions
• Mandate Technology Insertion Opportunities / Institutionalize MOSA
• Implement Cyber Resilience & Cross-Cutting Enablers
• Inform S&T & Prototyping Development with Sustainability/ Manufacturability
• Inform Requirements, Vice Waiting for JCIDS
• Identify New Pathways to Acquisition
• Ensure Transparency & Inclusion

Imperatives
1. Technical Superiority
2. Affordability
3. Accelerate Capability to the Warfighter
Maintaining Technology Superiority

- The U.S. military has long relied on high quality people, technological superiority, innovative operational and organizational constructs, and our unmatched ability to fight as a Joint Force.

- We are addressing the erosion of technological superiority by identifying and investing in innovative technologies and processes.

- We are pushing the envelope with innovative and cutting edge research.

- Beyond technical innovation, we are pursuing new practices and organizational structures to ensure future U.S. technical dominance.

- From basic research to advanced capabilities, the DoD R&E enterprise provides the technological foundations that ensures our military of the future remains the most capable in the world.

DoD R&E Enterprise: Solving Problems Today – Designing Solutions for Tomorrow
DoD R&E Enterprise
Solving Problems Today – Designing Solutions for Tomorrow