Engineering Autonomy

Mr. Robert Gold
Director, Engineering Enterprise
Office of the Deputy Assistant Secretary of Defense
for Systems Engineering

20th Annual NDIA Systems Engineering Conference
Springfield, VA | October 25, 2017
Outline

• Defense Research & Engineering (R&E) Strategy
• Key Research and Development Areas
• Background
• Engineering Challenges
• Summary
Focus on Technical Excellence
Deliver Technologically Superior Capabilities
Grow and Sustain our S&T and Engineering Capability

Mitigate current and anticipated threat capabilities
Enable new or extended capabilities affordably in existing military systems
Create technology surprise through science and engineering
Key Research & Development Investment Areas

- Autonomy & Robotics
- Electronic Warfare / Cyber
- Microelectronics
- Hypersonics
- Directed Energy
- Manufacturing
- Artificial Intelligence / Man-Machine Interface
- Future of Computing
- Novel Engineered Materials
- Precision Sensing: Time, Space, Gravity, Electromagnetism
- Emerging Biosciences
- Understanding Human and Social Behavior
Background

• DoD emphasis on the increased use of autonomous systems
• DASD(SE), in collaboration with Services, assessed current autonomy efforts and associated engineering challenges
• The purpose was to ascertain the ramifications of autonomous systems on DoD engineering practice
Engineering Challenges

• Increase Level of Experimentation
  – Understand autonomy trade-space for architecture/conceptual designs
  – Engage Warfighter in experimentation to set expectations
  – Engage Industry Partners to conduct mission-specific experiments

• Standardize Taxonomy
  – Develop autonomy-consistent terms, definitions, and phraseology (e.g., authorized/control entities, flexible/supervised autonomy, human on/outside the loop)

• Refine Requirements Development
  – Apply tools to translate natural language into logical and mathematical statements usable for logic definitions
  – Advance methods to encode interactions between operators and the system for requirements traceability
Engineering Challenges

• **Understand/Manage Human-Machine Interaction**
  – Allocation of functions between human and machine
  – Explore techniques for ensuring operators trust autonomous systems

• **Facilitate Trust and Social Interactions**
  – Develop software assurance tools to enhance ‘trust’
  – Define techniques for monitoring and bounding autonomous system behaviors
  – Understand social dynamics of autonomous systems to effectively communicate and collaborate with humans
Engineering Challenges

- **Enhance Analysis, Evaluation, and Certification**
  - Explore use of formal methods to analyze autonomous systems
  - Enable rapid evolution of autonomous capabilities thru:
    - Rapid deployment of software upgrades
    - Perform system certifications concurrently with design
    - Use of modular open systems architecture

- **Synchronize Technology Development with Life Cycle Planning**
  - Rapid autonomous system development and technology transition will mandate effective coordination between engineering and product support activities.
Engineering Challenges

• **Understand Consequences of Self-Learning Systems**
  – Evaluate consequences of autonomous system behavior being dictated by hardware, software, and system data.
    o Artificial intelligence will allow new levels of autonomy

• **Understand Impact to the Work Force**
  – Develop the Body of Knowledge for autonomous systems to support competency development
  – Mission-specific work force education and experience
  – Establish Science, Technology, Engineering, and Mathematics relationships with academic institutions
Summary

• Fielding Autonomy-Enabled Warfighting Capability will require close collaboration with:
  – Research, Engineering, and Test & Evaluation
  – Acquisition and Operational Communities
  – Our Industry Partners

• Collaboration needs to occur through planned demonstrations and prototyping, especially at Engineering Commands where these systems are currently designed.

• Autonomy technologies will impact the collective workforce, inclusive of the challenges unique to the engineering community.
Systems Engineering: Critical to Defense Acquisition

Defense Innovation Marketplace
http://www.defenseinnovationmarketplace.mil

DASD, Systems Engineering
http://www.acq.osd.mil/se
For Additional Information

Mr. Robert Gold
ODASD, Systems Engineering
703-695-3155
robert.a.gold4.civ@mail.mil