Engineering Autonomy

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Outline

- Defense Research & Engineering (R&E) Strategy
- Key Research and Development Areas
- Background
- Engineering Challenges
- Summary

Defense Research & Engineering Strategy

Mitigate current and anticipated threat capabilities

Enable new or extended capabilities affordably in existing military systems

Create technology surprise through science and engineering

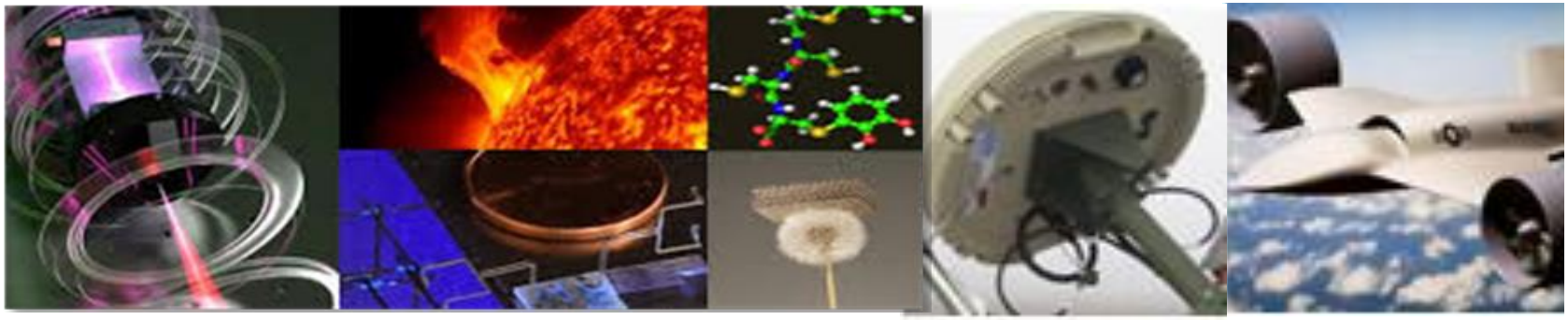
Focus on Technical Excellence

Deliver Technologically Superior Capabilities

Grow and Sustain our S&T and Engineering Capability

Key Research & Development Investment Areas

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

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