Engineered Resilient Systems - DoD Science and Technology Priority

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5 October 2011

Engineered Resilient Systems (ERS): A DoD Perspective

Resilience: Effective in a wide range of situations, readily adaptable to others through reconfiguration or replacement, with graceful degradation of function

ERS: a DoD-wide science and technology priority

- Established to guide FY13-17 defense investments across DoD Services and Agencies
- Ten year science and technology roadmap under development
- Five technology enablers identified

"...our record of predicting where we will use military force since Vietnam is perfect. We have never once gotten it right.

There isn't a single instance ... where we knew and planned for such a conflict six months in advance, or knew that we would be involved as early as six months ahead of time.

… we need to have in mind the greatest possible flexibility and versatility for the broadest range of conflict..."

The Honorable Dr. Robert M. Gates
22nd Secretary of Defense
24 May 2011

Engineered Resilient Systems Goals

Transform the engineering design and development of defense systems by providing the technical methods, processes, technologies & tools to:

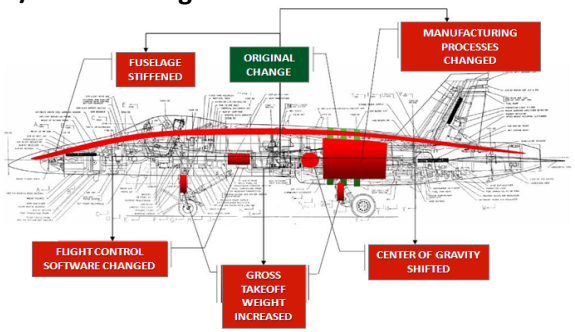
- Reinvigorate **engineering science and technology** to enable timely, affordable delivery of complex and adaptable systems
- Develop **advanced engineering tools** for efficient, integrated design and development across the full range of product life cycles
  - From rapid fielding to traditional acquisitions
- Advance **collaborative design and engineering** capabilities
  - Geographically dispersed engineers across a diverse set of technical specialties
- Increase the **efficiency and effectiveness** of system design, test and transition to production of trustworthy systems

Meet the challenges of today's dynamic, uncertain defense environment with advanced engineering

Example Engineering Challenges and Opportunities

- Dynamic threats and missions outstripping our ability to specify, design and build responsive systems
- New concepts of operations not discovered until late in design, or until operational test
- "Small" engineering changes with unintended consequences
- Suboptimal trades in performance, reliability, affordability, schedule
- Late discovery of defects
- Mismatched engineering tools
- Building trusted systems with untrusted components

F/A-18 – Changes from USN to Swiss Versions



Significant research opportunities to improve engineering productivity

Engineered Resilient Systems
Key Thrust Areas

- **Systems Representation and Modeling**
  - Physical and logical structures, behavior, interaction with the environment, interoperability with other systems
- **Characterizing Changing Operational Contexts**
  - Deeper understanding of warfighter needs, directly gathering operational data, better understanding operational impacts of alternative designs.
- **Cross-Domain Coupling**
  - Better interchange between “incommensurate” models. Resolve temporal, multi-scale, multi-physics issues across engineering disciplines.
- **Data-driven Tradespace Exploration and Analysis**
  - Generating and selecting among alternative designs, evaluating options in multi-dimensional tradespace.
- **Collaborative Design and Decision Support**
  - Enables more-informed design decisionmaking among engineers, warfighters, other stakeholders. Human-system interaction, collaboration, visualization, virtual environments.

What Constitutes Success?

- **Adaptable (and thus robust) designs**
  - Diverse system models, easily accessed and modified
  - Potential for modular design, re-use, replacement, interoperability
  - Continuous analysis of performance, vulnerabilities, trust
- **Faster, more efficient engineering iterations**
  - Virtual design – integration of 3D geometry, electronics, software
  - Find problems early:
    - Shorter risk reduction phases with prototypes
    - Fewer, easier redesigns
  - Accelerated design/test/build cycles
- **Decisions informed by mission needs**
  - More options considered deeply, broader trade space analysis
  - Interaction and iterative design among collaborative groups
  - Ability to simulate and experiment in synthetic operational environments

ERS Panel Discussion

- **Questions:**
  - What are challenging systems application domains?
  - How does practice diverge from theory, and how do we connect?
  - Where are relevant technologies to be found?
  - What would be the most critical tools and products?

- **Panelists:**
  - Mr. Terry Edwards, Director, Office of the Chief Systems Engineer, U.S. Army
  - Mr. Robert Keane, former Chief Architect, U.S. Navy
  - Dr. Janos Sztipanovits, Vanderbilt University
  - Dr. Robert Hummel, Vice President of Research, Potomac Institute