



Systems 2020

Strategic Initiative Overview Briefing

**Office of the Director, Defense Research
and Engineering**

June 1, 2010



Need for Systems 2020



- **With the growth in system complexity, the Department needs to make a comprehensive push to develop new system engineering foundations for the next decade.**
- **New engineering tools and approaches are needed to develop and field interoperable systems. Compared to the systems of today, future systems will have to:**
 - Use a much greater development tempo
 - Operate with greater performance and agility
 - Operate in far more complex environments
 - Address deep cost and reliability constraints
- **The Systems 2020 initiative will provide new capabilities and approaches for faster delivery of flexible and adaptive systems that are trusted, assured, reliable and interoperable.**



Challenges Across the Spectrum

1. Development takes too long.
2. Change takes too long.
3. Replacement takes too long.
4. The environment is highly uncertain and complex.
5. System complexity is growing.



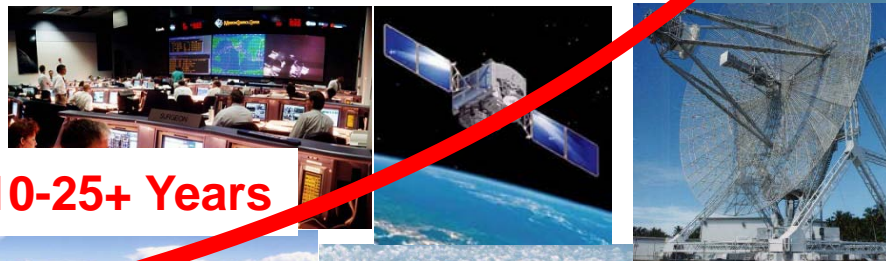
Software: Months to Years



Electronics: 1-5 Years



Mobile Weapons: 5-20+ Years

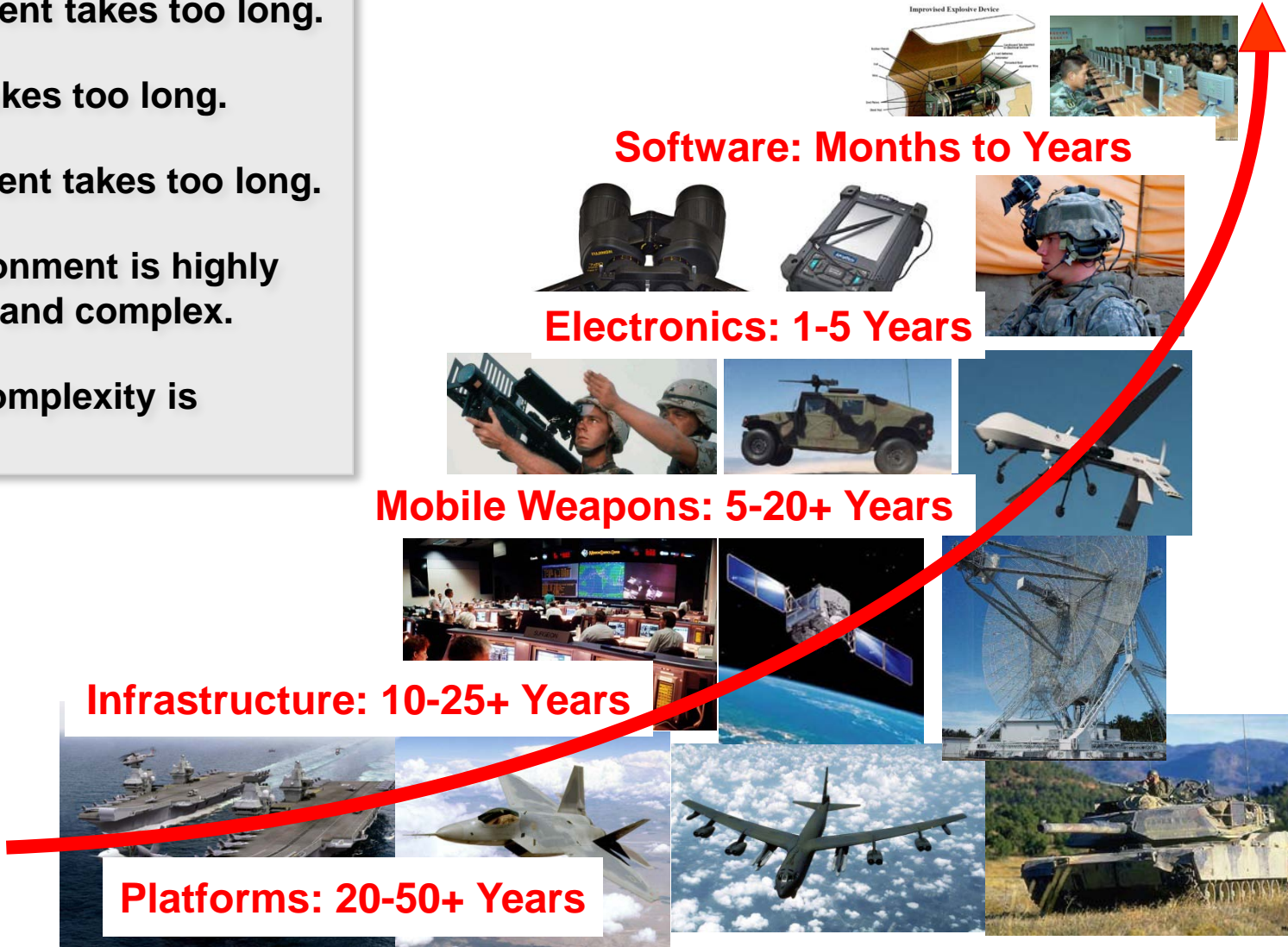


Infrastructure: 10-25+ Years



Platforms: 20-50+ Years

Rate of Change





Systems 2020 Objectives and Constraints

OBJECTIVES

- **DEVELOP FAST:** Reduce by 3x the time to acquisition of first article for systems and solutions – **DEVELOP FAST**
- **FLEXIBLE:** Reduce by 4x the time to implement planned and foreseen changes in systems – **FLEX**
- **ADAPTABLE:** Embed within systems the ability for changes at the tactical edge, as the mission evolves in unplanned and unforeseen ways, e.g., IED threat – **ADAPT**

CONSTRAINTS

- **Achieve the objectives while maintaining or enhancing:**
 - **Trust and Assurance** – Able to withstand exploitation before or after fielding, enabling the leveraging of global supply chains
 - **Reliability** – Across a range of changing operational conditions
 - **Interoperability** – Working with other systems to meet user needs



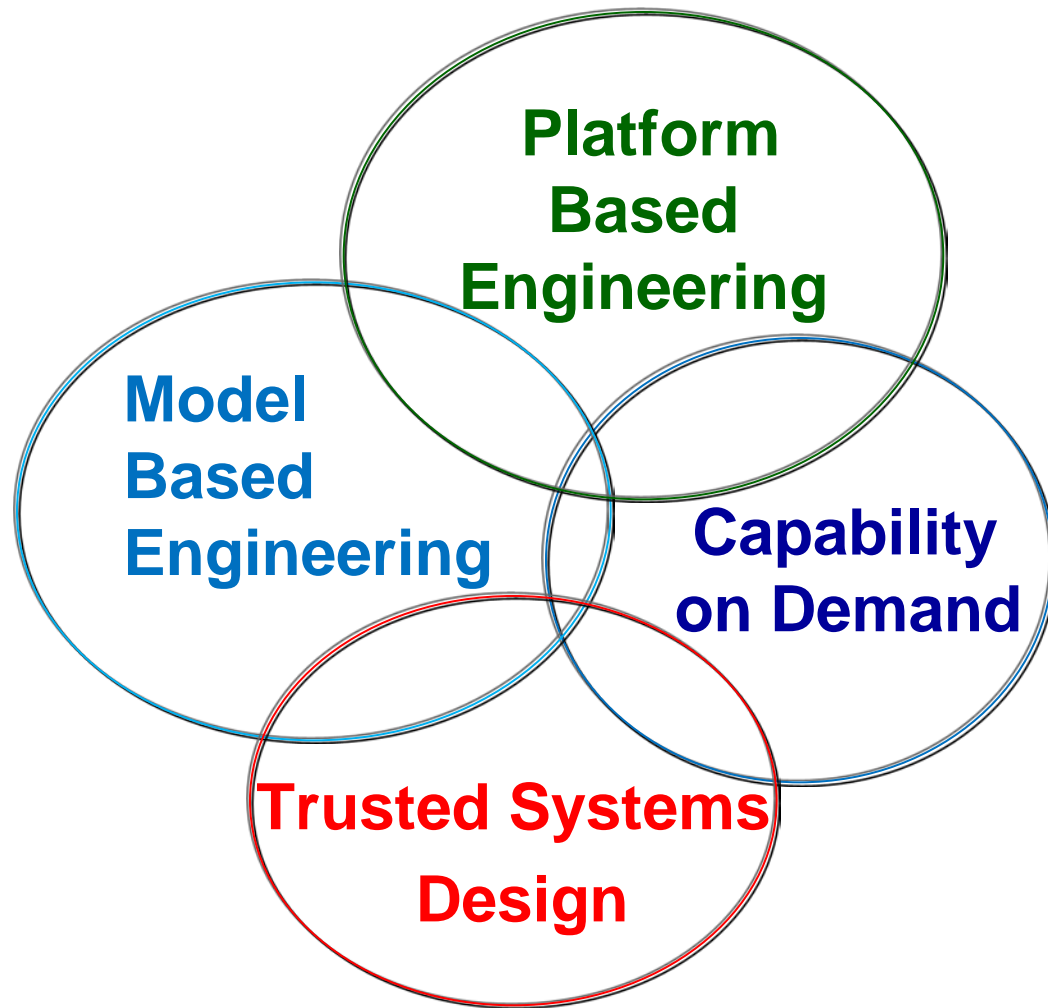
Key Studies

1. **Retooling Manufacturing: Bridging Design, Materials and Production, NAS 2001**
2. **Quo Vadis, SLD Reasoning About Trends and Challenges of System Level Design, Alberto Sangiovanni-Vicentelli, IEEE, 2007**
3. **Preliminary Observations on DoD Software Research Needs and Priorities: A Letter Report, NAS, 2008**
4. **DSB 2006 Summer Study on 21st Century Strategic Technology Vectors**
5. **Report of the DSB Task Force on Fulfillment of Urgent Operational Needs , 2009**
6. **Rapid Capability Toolbox Study Final Report , March 2010**

**Key Study Results Drive Critical Issues
Addressed by System 2020**



Big Ideas



Interrelated ideas:

- Build on pockets of experience while pushing advanced design and manufacturing concepts
- Apply across system conception, design, manufacturing, deployment and evolution

Provide opportunities to replace:

- Sequential development
- Fixed, single point user requirements

Concept
Engineering

Architecture
& Design

Development

Manufacturing

Deployment

Evolution



Systems 2020 Research Areas

Faster delivery of flexible and adaptive systems which are trusted, assured, reliable and interoperable

**Model
Based
Engineering**

Modeling and simulation tools for concurrent design, development & manufacture

**Platform
Based
Engineering**

Architectural and automated design tools to rapidly insert new capabilities

**Capability
on Demand**

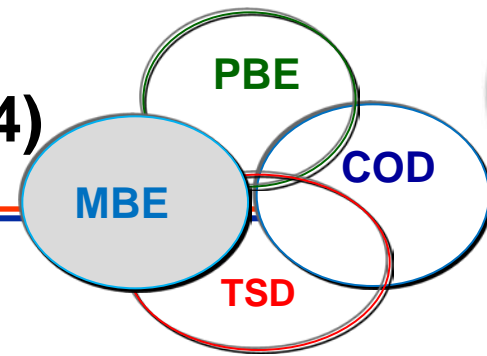
Systems embedded with organic adaption capabilities

**Trusted
Systems
Design**

Design methods and tools for system assurance that detect malice or enable self awareness



Big Ideas (1 of 4)



• Model Based Engineering (MBE)

- Application of modeling and simulation throughout the development process to foster more effective concept engineering and concurrent design, development, manufacturing, deployment and evolution
- Achieve S-2020 objectives through innovation in MBE area, e.g.,
 - **Virtual Design and Manufacturing (VLSI at higher levels)**
 - **Manufacturing on Demand**
 - **Test Driven Design**
 - **Model Based Systems Engineering**
- MBE will enable real time assessment of system changes, robust evaluation of different approaches
- Will impact **DEVELOP FAST** and **FLEX**

Research Challenges

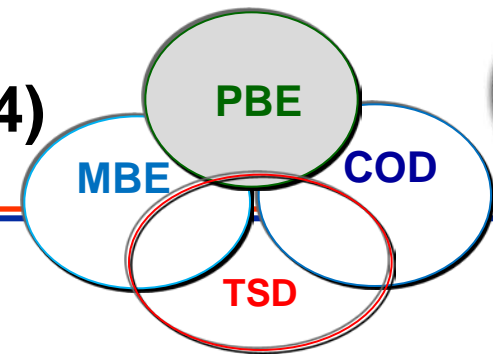
Trust and Assurance

Reliability

Interoperability



Big Ideas (2 of 4)



• Platform Based Engineering (PBE)

- Applying architectural and automated design tools to the development of hybrid hardware, software, and networked systems as an enduring “platform” for evolving user capabilities
- Achieve S-2020 objectives through innovation in PBE area, e.g.,
 - **Architecture Patterns**
 - **Intelligent Design Automation**
 - **Product Line Methodologies**
 - **Open Systems**
- PBE will enable rapid changes to extensible product families to meet changing user environments and missions
- Will impact **DEVELOP FAST, FLEX** and **ADAPT**

Research Challenges

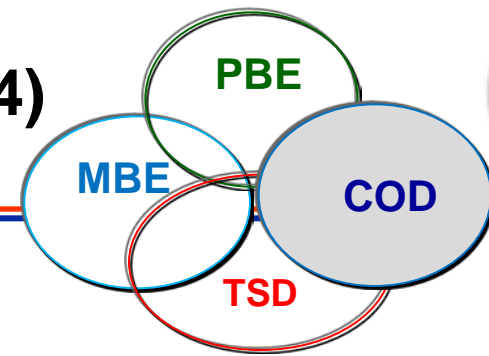
Trust and Assurance

Reliability

Interoperability



Big Ideas (3 of 4)



• Capability on Demand (COD)

- Designing systems or services with the express intention of supporting adaptation in response to changes during operations
- Achieve S-2020 objectives through innovation in COD area, e.g.,
 - **Service Oriented Design and Development Methodologies**
 - **Self Healing Systems**
 - **Adaptive Algorithms**
 - **Autonomic Computing**
- COD will allow fielded systems to rapidly respond to a changing environment as the mission evolves in unplanned, unforeseen ways
- Will impact **ADAPT**

Research Challenges

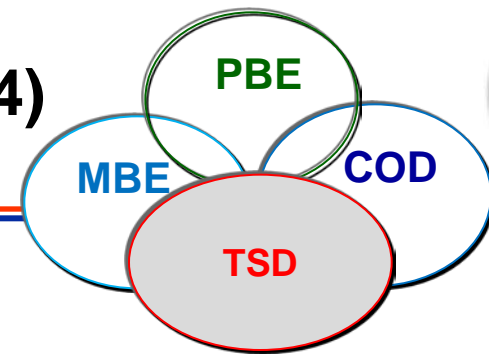
Trust and Assurance

Reliability

Interoperability



Big Ideas (4 of 4)



• Trusted Systems Design (TSD)

- Designing secure systems from unsecured vendors and subsystems
- Achieve S-2020 objectives through innovation in TSD area, e.g.,
 - **Composite Health Monitoring Systems**
 - **Design for Test Methodologies**
 - **Feedback Control (observability theory)**
- Trusted Systems Design will allow us to take advantage of innovation in the global supply chain, while ensuring that our systems operate as intended. Composing assured systems from COTS will allow speedy adoption of COTS for the war-fighter
- Will impact **DEVELOP FAST**

Research Challenges

Trust and Assurance
Reliability
Interoperability



Challenge of Assurance for COD: An Example

Constraint ↓

	Trust/Assurance	Reliability	Interoperability
Model-based Engineering (MBE)			
Platform Based Engineering (PBE)			
Capability on Demand (COD)			
Trusted Systems Design (TSD)			

- Bringing arbitrary resources together to meet a new demand, how do you ensure you can trust the result?
- How can you assure trust in the field during operation even if you vetted components in the lab?

Big Idea →



Next Steps

Big Idea	Objective	State of the Art	State of the Practice	Technical Challenges	Non-Tech Challenges
Model Based Engineering (MBE)	DEVELOP FAST FLEX				
Platform Based Engineering (PBE)	DEVELOP FAST FLEX ADAPT				
Capability on Demand (COD)	ADAPT				
Trusted System (Design)	DEVELOP FAST				

- **Review each area to address**
 - **Current state of the art and state of the practice**
 - **Technical and non-technical challenges**
- **Provide the framework for the summer study**
 - **Review current implementations/innovations**
 - **Assess challenges**
 - **Identify promising approaches**
- **Basis for creating Systems 2020 Plan**



Backup



Big Ideas



- **Model Based Engineering (MBE)**

- Application of modeling and simulation throughout the development process to foster more effective concept engineering and concurrent design, development, manufacturing, deployment and evolution
- Will impact **DEVELOP FAST** and **FLEX**

- **Platform Based Engineering (PBE)**

- Applying architectural and automated design tools to the development of hybrid hardware, software, and networked systems as an enduring “platform” for evolving user capabilities
- Will impact **DEVELOP FAST, FLEX** and **ADAPT**

- **Capability on Demand (COD)**

- Designing systems or services with the express intention of supporting adaptation in response to changes during operations
- Will impact **ADAPT**

- **Trust Systems Design (TSD)**

- Designing assured systems composed from unsecured components
- Will impact **DEVELOP FAST**



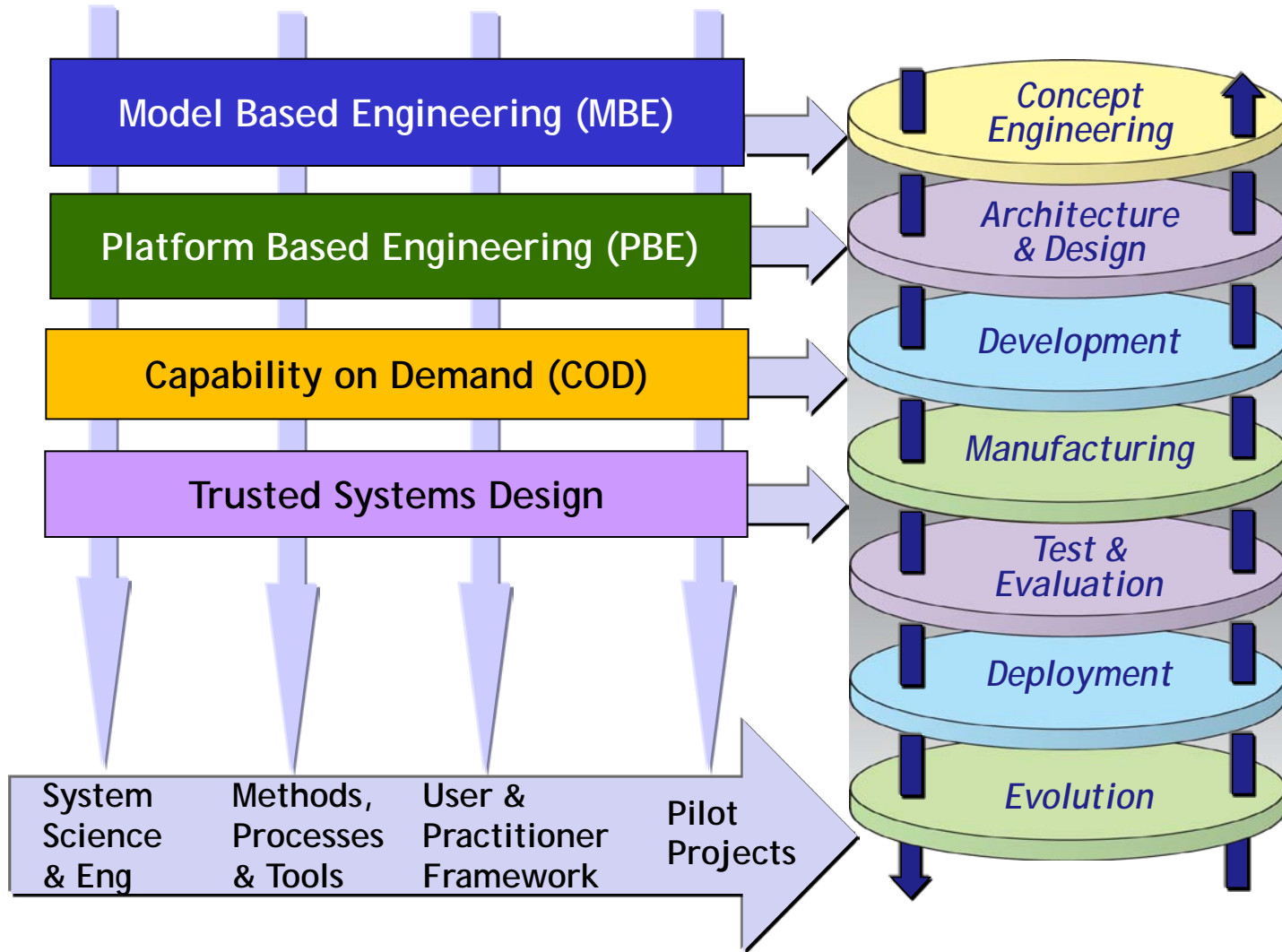
Notional Systems 2020 Approach

Systems 2020 Objectives

DEVELOP
FAST

FLEX

ADAPT





Systems 2020 Vision



- **“Systems 2020 will give the DoD S&T and manufacturing communities a decisive edge in the design and manufacture of complex systems....**
- **Like the commercial sector, the DoD needs to adapt to the growing complexity of our major acquisition systems while managing cost, schedule and performance risk...**
- **Our Very complex systems must be adaptable and interoperable with other fielded systems...**
- **Systems 2020 will develop new system engineering foundations in basic research, applied research, prototype development, and workforce development.....**
- **When realized, the new tools and processes will enable a number of new design, development, and manufacture capabilities across the DoD acquisition enterprise...”**

D, DDR&E, Congressional Testimony, May 18, 2010



Recurring Shortfalls We Will Address

1. Capture of development cycle intellectual capital:

Need to move from “black box” to “glass box” for many systems and subsystems

2. Reconfigure rigid product lines:

Need to have far greater fungability of product lines across sensor/weapons systems

3. Reduce long test build test cycles:

Need to improve our ability to predict complex system behavior across performance envelop

4. Enhance post deployment adaptivity:

Need mechanisms to ensure post fielding flexibility to address unanticipated needs