



Panel: Systems Engineering Considerations in Practicing Test & Evaluation *A Perspective from DoD*

**Mr. Stephen Welby
Director, Systems Engineering
Office of the Director, Defense Research and Engineering**

**26th Annual National Test & Evaluation Conference
March 3, 2010**

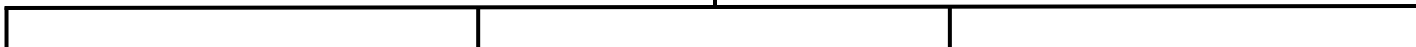


Defense Research & Engineering



**Undersecretary of Defense for
Acquisition, Technology and Logistics
Honorable Ashton B. Carter**

**Director, Defense Research
and Engineering (DDR&E)
Honorable Zachary J. Lemnios**



**Director,
Research**

Dr. David Honey

**Director,
Systems Engineering**

Mr. Stephen Welby

**Director,
Developmental
Test & Evaluation**

Mr. Chris DiPetto (A)

**Director,
Rapid Fielding**

Mr. Earl Wyatt



Support from the Top for Change



Weapon Systems Acquisition Reform Act of 2009 (Public Law 111-23)

- Establishes *Director, Systems Engineering (D, SE)* and *Director, Developmental Test and Evaluation (D, DT&E)* as principal advisors to the SECDEF and the USD(AT&L)
- Mandates documented assessment of technological maturity and integration risk of critical technologies for MDAPs
- Establishes D, DT&E and D, SE Congressional reporting on MDAP achievement of measurable performance criteria
- Mandates competitive prototyping and MDA completion of a formal Post-Preliminary Design Review Assessment for all MDAPs before MS B
- Strengthens technical analysis of cost and schedule breaches during Technology Development (pre-MS B) and Engineering and Manufacturing Development (post-MS B)



President Barack Obama hands a pen to U.S. Rep. Robert Andrews (D-NJ) as he signs the Weapons Systems Acquisition Reform Act in the Rose Garden at the White House Friday, May 22, 2009. Standing from left are: Andrews, Rep. John McHugh (R-NY), Sen. Carl Levin (D-MI), Rep. Ike Skelton (D-MO) and Rep. Mike Conaway (R-TX). Official White House Photo by Samantha Appleton

MDAP - Major Defense Acquisition Program (USC 2430)
MDA - Milestone Decision Authority



Systems Engineering Mission



We execute substantive technical engagement throughout the acquisition life cycle with major and selected acquisition efforts across DoD.

We apply best engineering practices to:

- Help program managers identify and mitigate risks
- Shape technical planning and management
- Support and advocate for DoD Component initiatives
- Provide insight to OSD stakeholders
- Identify systemic issues for resolution above the program level
- Support Knowledge Based Decision Making

We are the “E” in DDR&E





Pre-MS A Technical Engagement and Authority



- Major acquisition programs are being initiated without adequate technical foundation, resulting in cost and schedule growth
- Acquisition policy has been updated to require Pre-MS B systems engineering engagement and technical risk reduction activity (e.g. Preliminary Design Review, prototyping)
- There remains a Gap in pre-MS A and pre-MDD engagement
- WSARA directed the D, SE to oversee Component Development Planning which can address this gap
- **Solution strategy:**
 - Clear policy and guidance for Component Development Planning activities
 - Identify resources to perform these activities
- **The goal**
 - Informed investment decision and engineered alternatives with sufficiently understood technical risk
 - Improved technical planning for post-MS A risk reduction and system solution development activities resulting in more accurate early cost and schedule estimates



Development Planning

- OSD Development Planning leadership is required by WSARA
 - The D, SE shall oversee Development Planning activities of major defense acquisition programs, and periodically assess Component Development Planning capabilities*

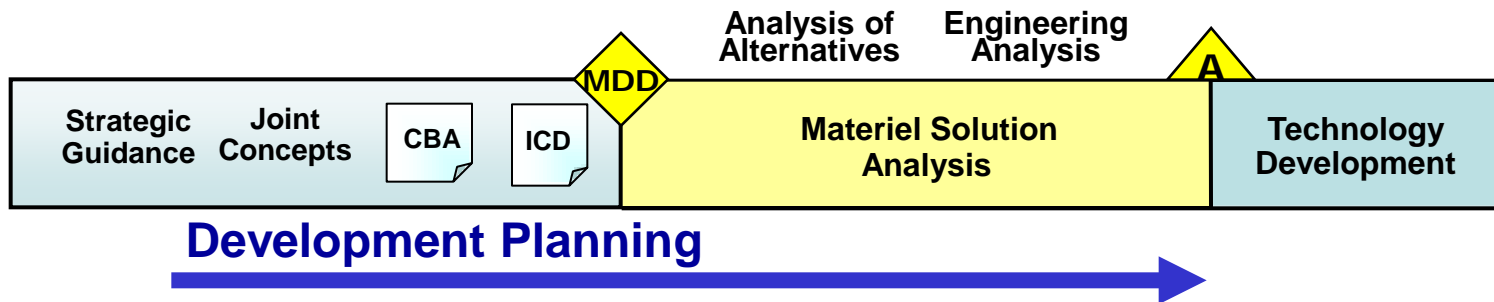
Analysis of future user needs and engineering of new system concepts in a System of Systems (SoS) operational environment

Multiple sufficiently robust materiel options to address gap

Defined costs and benefits of the options

Preferred solution with clear evidence and understanding of risk

Sufficiently robust materiel solution and solid TD planning



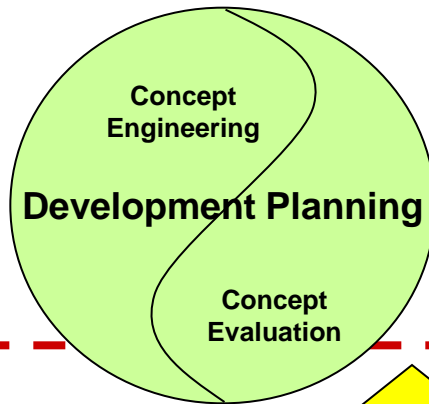
Development Planning is the upfront technical preparation to ensure successful selection and development of a materiel solution



Development Planning

**Translating
User Needs
and
Opportunities
Into
Viable Solutions**

**Concept
Development and
Engineering**



**Concept
Evaluation and
Refinement**

Strategic
Guidance

Joint
Concepts

CBA

ICD

MDD

Analysis of
Alternatives

Engineering
Analysis

ASR

A

Matériel Solution
Analysis

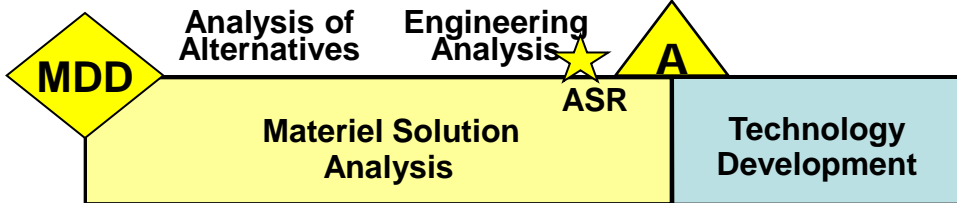
Technology
Development

DoD 5000



Significant Technical Issues Pre-MS A

ISSUE	IMPACTS
<ul style="list-style-type: none"> Lack of technical engagement with the operational user <ul style="list-style-type: none"> To make user aware of potential solutions To ensure technical developer fully understands user performance needs 	<ul style="list-style-type: none"> Missed solution opportunities System requirements growth due to lack of understanding
<ul style="list-style-type: none"> Program-focused analysis, when solutions will impact broad sets of systems and SoS 	<ul style="list-style-type: none"> Delivery of capability that will not integrate, or that has reduced benefit because of external system issues
<ul style="list-style-type: none"> Lack of technical modeling and assessment of concepts that enter into the AoA 	<ul style="list-style-type: none"> Increased AoA time and cost



DoD 5000



Benefit of Development Planning Engagement

	IMPACTS
<ul style="list-style-type: none"> Lack of operational context To ensure user understands user performance needs 	<ul style="list-style-type: none"> Missed solution opportunities System requirements growth due to lack of understanding CONOP
<ul style="list-style-type: none"> Program-focused analysis, when solutions will impact broad sets of systems and C&S 	<ul style="list-style-type: none"> Delayed integration Benefits Issues
<ul style="list-style-type: none"> Lack of concept 	<ul style="list-style-type: none"> Increased AoA time and cost due to late evaluation of solutions that are not feasible

1. Iterative, rapid, anticipatory interface between operational and technical community

2. Mature, valid concepts and technical models from broad set of options to enter and bolster the AoA

3. Engineering analysis that considers strategic direction, operational context, SoS and legacy integration

Strategic Guidance Joint Concepts CBA ICD

MDD Analysis of Alternatives Engineering Analysis A

Material Solution Analysis ASR Technology Development

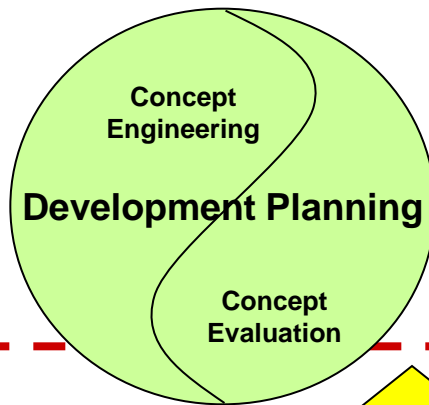
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Opportunities

- **Acquisition reform efforts have recognized criticality of strong Systems Engineering focus for program success**
 - *Systems Engineering toolkit focused on identifying and managing risk – development risk, production risk and life-cycle*
- **Growing focus on addressing “early-acquisition” phases - requirements definition, development planning, and early acquisition system engineering support**
 - *Leading to more informed decisions at MS B*
- **Our development processes need to evolve to provide faster product cycles, more adaptable products and address emerging challenges**
- **Future US Defense capabilities depend on a capable US engineering workforce in and out of government**
 - *Need to create opportunities to grow future “Engineering Heroes”*

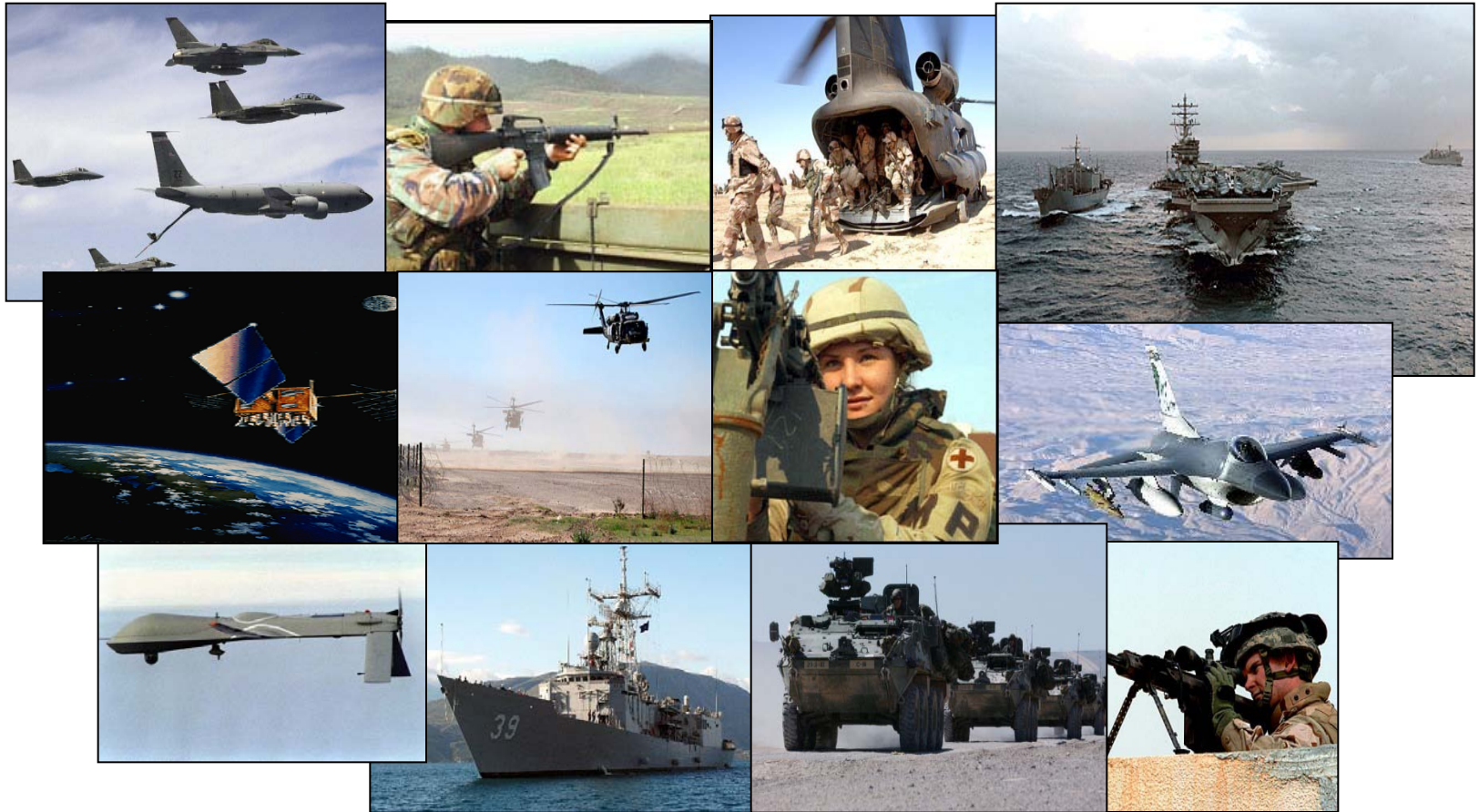


The Way Ahead

- **Quadrennial Defense Review Executive Summary, February 2010**
 - Further rebalance the capabilities of America's Armed Forces to prevail in today's wars, while building the capabilities needed to deal with future threats
 - Further reform the Department's institutions and processes to ***better support the current needs of the war fighter; buy weapons that are usable, affordable and truly needed; and ensure that taxpayer dollars are spent wisely and responsibly***
 - Preserve and enhance the All-Volunteer Force
 - Improve how it ***matches requirements with mature technologies, maintains disciplined systems engineering approaches, institutionalizes rapid acquisition capabilities, and implements more comprehensive testing***
- **Quadrennial Defense Review Report Preface Secretary of Defense Robert M. Gates, February 2010**
 - United States needs a broad portfolio of military capabilities with maximum versatility across the widest possible spectrum of conflict



Systems Engineering: Critical to Program Success



Innovation, Speed and Agility



Backup





Director, Systems Engineering



**Director, Systems Engineering
Steve Welby**

Terry Jagers, Principal Deputy

**Systems Analysis
Kristen Baldwin**

- System Complexity Analysis
- Red Teaming
- Modeling & Simulation Coordination Office
- Development Planning
- SE for Systems of Systems
- Program Protection/Acquisition Cyber Security
- SE Research Center

**Mission Assurance
Nicholas Torelli**

- Systems Engineering Policy, Guidance, Standards
- System Safety
- Reliability, Availability, Maintainability
- Quality, Manufacturing, Producibility
- Human Systems Integration (HSI)
- Technical Workforce Development
- Organizational Capability Assessment (WSARA)

**Major Program Support
James Thompson**

- Program Support Reviews
- Systems Engineering Plans
- Program Technical Auditing
- OIPT/DAB/DSAB Support
- DAES Database Analysis and Support
- Performance Measurement
- Systemic Root Cause Analysis

Responsible to provide technical support, systems engineering oversight, program development and mission assurance certification to USD(AT&L) in support of planned and ongoing acquisition programs



DDR&E Imperatives



- 1. Accelerate delivery of technical capabilities to win the current fight.**
- 2. Prepare for an uncertain future.**
- 3. Reduce the cost, acquisition time and risk of our major defense acquisition programs.**
- 4. Develop world class science, technology, engineering, and mathematics capabilities for the DoD and the Nation.**



Systems Engineering Focus for Accomplishing DDR&E Imperatives



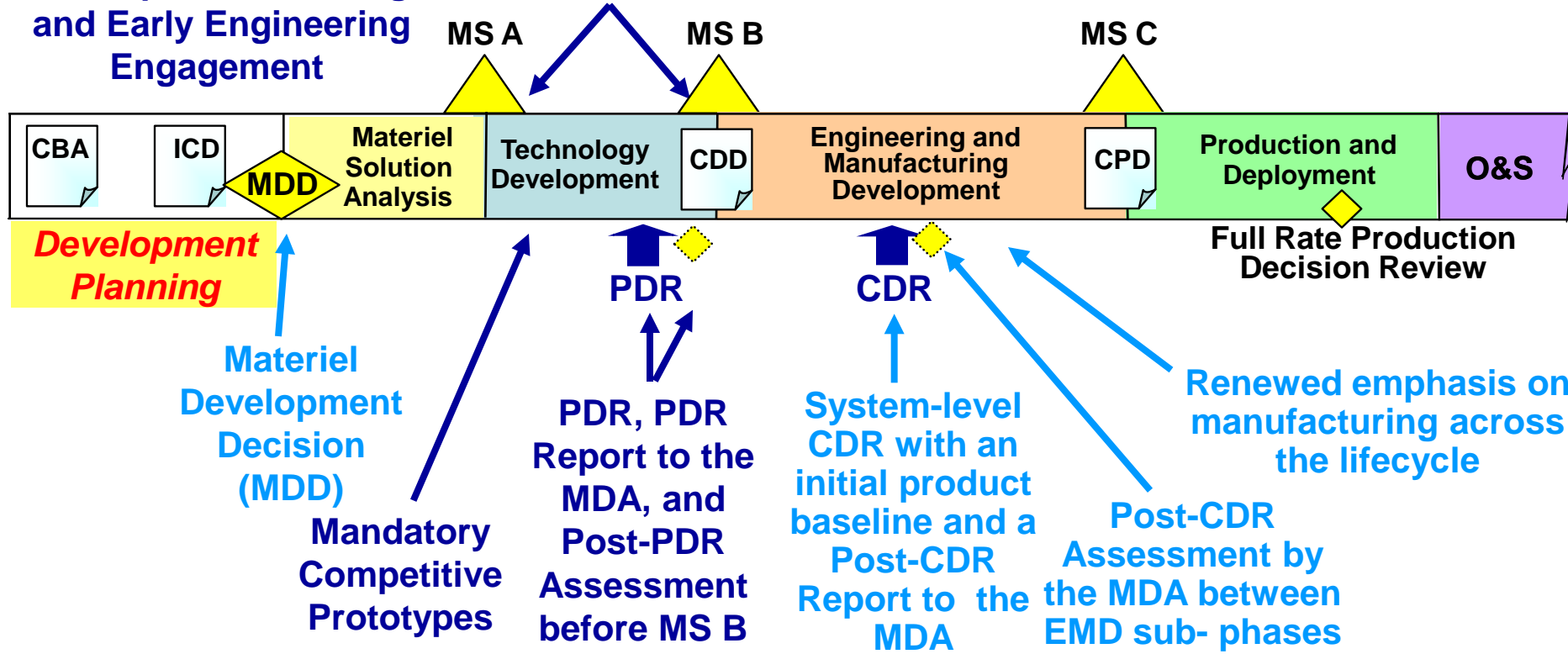
- 1. Accelerate delivery of technical capabilities to win the current fight**
 - Support the current fight, manage risk with discipline
- 2. Prepare for an uncertain future**
 - Grow engineering capabilities to address emerging challenges
- 3. Reduce the cost, acquisition time and risk of our Major Defense Acquisition Programs**
 - Champion Systems Engineering as a tool to improve acquisition quality
- 4. Develop World Class Science, Technology, Engineering and Mathematics capabilities for the DoD and the Nation**
 - Develop future technical leaders across the acquisition enterprise



DoD 5000.02 and PL 111-23 – the Changed Acquisition Landscape

Renewed Emphasis on Development Planning and Early Engineering Engagement

New 2366a & 2366b Certifications*



“Knowledge-based” Decision Making . . .making acquisition decisions when you have solid evidence and acceptable risk

* Director, SE supports MDA certifications including PDR Report assessment at MS B



Perspective for the Next Decade

1950 1960 1970 1980 1990 2000 2010 2020



Cold War

Vietnam War

Desert Storm

Bosnia

Collapse of Soviet Union
Kosovo

OIF

OEF

Irregular/Hybrid Warfare

National Security Challenges

Defense Capabilities

Enabling Technologies

**Human Terrain
Ubiquitous Observation
Contextual Exploitation
Scaleable Action**

ICBM Satellite comms C4ISR Precision Strike UAV
LGB's GPS Stealth Robotics Night Vision
Nuclear propulsion

Transistor Composite Materials MEMS
Solid state laser Superconductors
Space tracking Web protocols
VHSIC MIMIC
Digital computing IR Sensors
High Performance Computing

- Advanced Electronics, Photonics Algorithms, MEMS
- Nano; Meta; & New Materials
- Cognitive Computing
- Bio-Revolution



The Timeline has Collapsed!

Conventional Warfare

USAF Capability

High Altitude Aircraft



Electronic Countermeasures



Endgame Countermeasure



Engage SAM



Adversary Capability

High Altitude SAM



Monopulse SAM



SAM with ECCM



Response loop measured in years

Counter-Insurgency Warfare

US Capability

Jammers



Mine Resistant Ambush Protected (MRAP)



Adversary Capability



Advanced Technology

Response loop measured in months or weeks



Multi-Level Engagement

System Engineering

Policy & Guidance

- *Systems Engineering*
- *Software Engineering*

Program Support

- *Program Support Reviews*
- *OIPT and SE WIPTs*
- *AOTR, Post-PDR/CDR Review & Assessment*

Workforce Planning

- *Competency Models*
- *Certification Requirements*
- *Education & Training*

Emerging Concepts

- *Systems of Systems*
- *SE Research*

Outreach

- *SE Forum*
- *Engagement Strategy*

