Systems Engineering to Enable Capabilities Based Planning

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Systems Engineering
Capabilities Based Planning (CBP)

Objectives

CBP should be a top-down, competitive approach to weigh options vs. resource constraints across a spectrum of challenges

CBP should:

- Link DoD decision-making to the Defense Strategy
  - Encompass the full set of DoD challenges

- Inform risk tradespace -- identify joint capability gaps, redundancies and opportunities
  - Generate common framework for capability trades
  - Couple programmatic capability development to operational needs

- Facilitate the development of affordable capability portfolios
A Perspective for Acquisition

- Defense acquisition has traditionally focused at the program level
- Under CBP, acquisition will widen its perspective
  - Shape, engineer, and validate solutions to capability needs
  - Make decisions on systems within a capabilities context (systems perspective)
  - Engineer the relationships across the set of systems that together satisfy the need (systems of systems)
  - Synchronize the interaction among programs to satisfy multiple capabilities (capability roadmaps)
  - Incorporate an integrated sustainment approach (total lifecycle systems management)
DoD End-to-End Capabilities Based Planning Process

Capability Area Reviews (CARs)

Capabilities Based Assessment
- Capabilities
- Gaps
- Tasks
- Shortfalls
- Attributes
- Redundancies
- Metrics
- Risk areas
- Non-materiel solutions
- Materiel solutions
- S+T initiatives
- Experimentation
- Refined concept
- Analysis of Alternatives
- Technology Strategy
- Systems Engineering Plan
- Affordable military-useful increment
- Technology demonstrated
- Initial KPPs
- Revise KPPs
- LRIP
- IOT&E
- FOT&E
- Deployment
- Sustainment
- Disposal

Select a Joint Integrating Concept

Develop Concept
- OSD/JCS
- COCOM

Functional Area Analysis

Functional Needs Analysis

Functional Solutions Analysis

ICD
- Analysis of Alternatives

Technology Development

System Development

Single Step or Incremental Development

Full Rate Prod DR

MS “A”

MS “B”

MS “C”

Services

DoD 5000 Acquisition Policy

Joint Capabilities Integration and Development System (JCIDS)
Acquisition Engagement Across Strategy, JCIDS and Acquisition Processes

**Strategy**
- Joint Concepts
- Functional Area Analysis
- Functional Needs Analysis

**JCIDS Assessment**
- Functional Solutions Analysis
- Concept Decision

**Acquisition**
- Analysis of Alternatives
- Technology Development

**MS “A”**
- System Development
- Incremental Development

**MS “B”**
- System Development

**MS “C”**
- Production
- O&S

**Planning, Programming, Budgeting and Execution**

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**Support Capability Based Assessments**
- Define relationships with related capabilities, architectures (e.g., GIG)
- Identify alternatives; trade cost, sched, perf

**Determine system performance parameters and verification plans**
- Identify incremental, system specifications

**Operational**
- Develop, test, and assess increments of capability

**Demonstrate capabilities meet user needs**
- Assess portfolio performance (CAR)
- Integrate SoS; assess cost, sched, perf

**Assess system performance against capability needs**
- Integrate and test

**Systems Engineering Across the Lifecycle**

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**Capability Based Acquisition**

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**S&T**
- Basic Research (TRL 1-3)
- Applied Research (TRL 4-5)
- Advanced Technology Development (TRL 6-9)
What have we learned?

- Rigorous, top-down determination of joint capabilities takes time
  - Requires sound analysis of alternatives, and
  - Cooperation from multiple communities that have not traditionally worked together
- Capabilities will be satisfied by grouping of legacy, new systems and technology insertion – Systems of Systems
  - Solutions will cross organizational and funding “stovepipes”
  - Solutions must integrate with other related capabilities and enterprise architectures (e.g., Global Information Grid)
- System designs should be extensible to support future, yet to be defined, capabilities
- Management oversight of capabilities has ripple effects on individual programs
- Early and continuous involvement of acquisition in requirements determination allows for greatest leverage to determine optimal, joint solutions

Systems Engineering is an enabler of Capabilities Based Planning
Certain capabilities only appear in a System-of-Systems context

- How do we systems engineering these SoS capabilities?
- How do we perform testing (V&V) of these SoS capabilities?
- How do we sustain capabilities over time?

Example

- Capabilities such as Combat Identification must be implemented in numerous systems across all Services and Agencies to enable the joint warfighter to use that capability in combat
Task
- Characterize ongoing systems engineering efforts within the Services and Agencies to develop and field capabilities that extend beyond individual platforms or systems
  - Include both the enterprise level SE processes and the cross systems engineering initiatives

Objective
- Capture current experience base and assess implications for DOD policy, regulations and best practices

FY05 Progress
- Completed a first order review of pool of examples based on available data
Study Observations

Three general classifications of SoS SE:

1. Engineering a ‘collective’ from legacy systems
   - Majority of the cases
   - Ranged from integration of new and existing systems for better interoperability to addressing new top-down requirements by integrating existing systems

2. Clean Sheet Developments
   - One case -- Future Combat Systems

3. Organizational, enterprise-wide engineering initiatives
   - New, limited experience
   - Focus on planning, developing, and integrating systems to meet broad ‘enterprise needs’
Engineering a “ Collective” from Legacy

Some Observations:

- Authority
  - PMs continue to own individual systems
  - No owner of the collective
  - Program success is independent of ability to integrate successfully

- Technical approaches attempt to minimize impact on internal system functionality and limit changes to interfaces
  - Degree to which this can be done, and changes stay with interfaces, the smoother the process
  - …but this may not be the most optimal solution

Examples appear in two quadrants

As you address new capabilities (vice integrate existing systems) changes are needed in both system interfaces and in the internals of the systems
Organizational efforts that focus on strategic objectives through
- Investment decisions
- Architecture principles
- Standards and protocols
- Engineering practices

Measured, and/or motivated by a different set of priorities
- Goal-oriented, organizational and stakeholder issues

Characterized by multiple constituents with different goals and priorities
- Requires systems engineering application to address multiple systems and SoS constraints and objectives
FY06 Activities to address SoS – SoS SE Definition and Optimization Project

- **Task**
  - Codify SoS SE and determine any unique SE considerations
  - Establish relevant SE process metrics
  - Experiment with models to optimize technical program resource drivers

- **Objective**
  - Pull together expertise from academia, industry, government to identify research, tools, training needs

- **Progress**
  - Conducted 1st in a series of SoS SE workshops
    - Reviewed current policy
    - Discussed perspectives and motivations
    - Identified key issues for definition, requirements processes, and other issues
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