Next Generation Systems Engineering and CMMI

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Current Situation

What we need to do better

Requirements

- Adapting to changing conditions
- Matching operational needs with systems solutions
- Overcoming biases of Services and others
- Moving to transform military

PPBES

- Laying analytical foundation for budget
- Aligning budgets with acquisition decisions

Sustainment

- Controlling O&S costs
- Reducing logistics tails

Acquisition

- Acquiring system-of-systems
- Making system decisions in a joint, mission context
- Transitioning technology
- Assessing complexity of new work and ability to perform it
- Controlling schedule and cost
- Passing operational tests
- Ensuring a robust industrial base

USD(AT&L) Imperatives

- “Provide a context within which I can make decisions about individual programs.”
- “Achieve credibility and effectiveness in the acquisition and logistics support processes.”
- “Help drive good systems engineering practices back into the way we do business.”

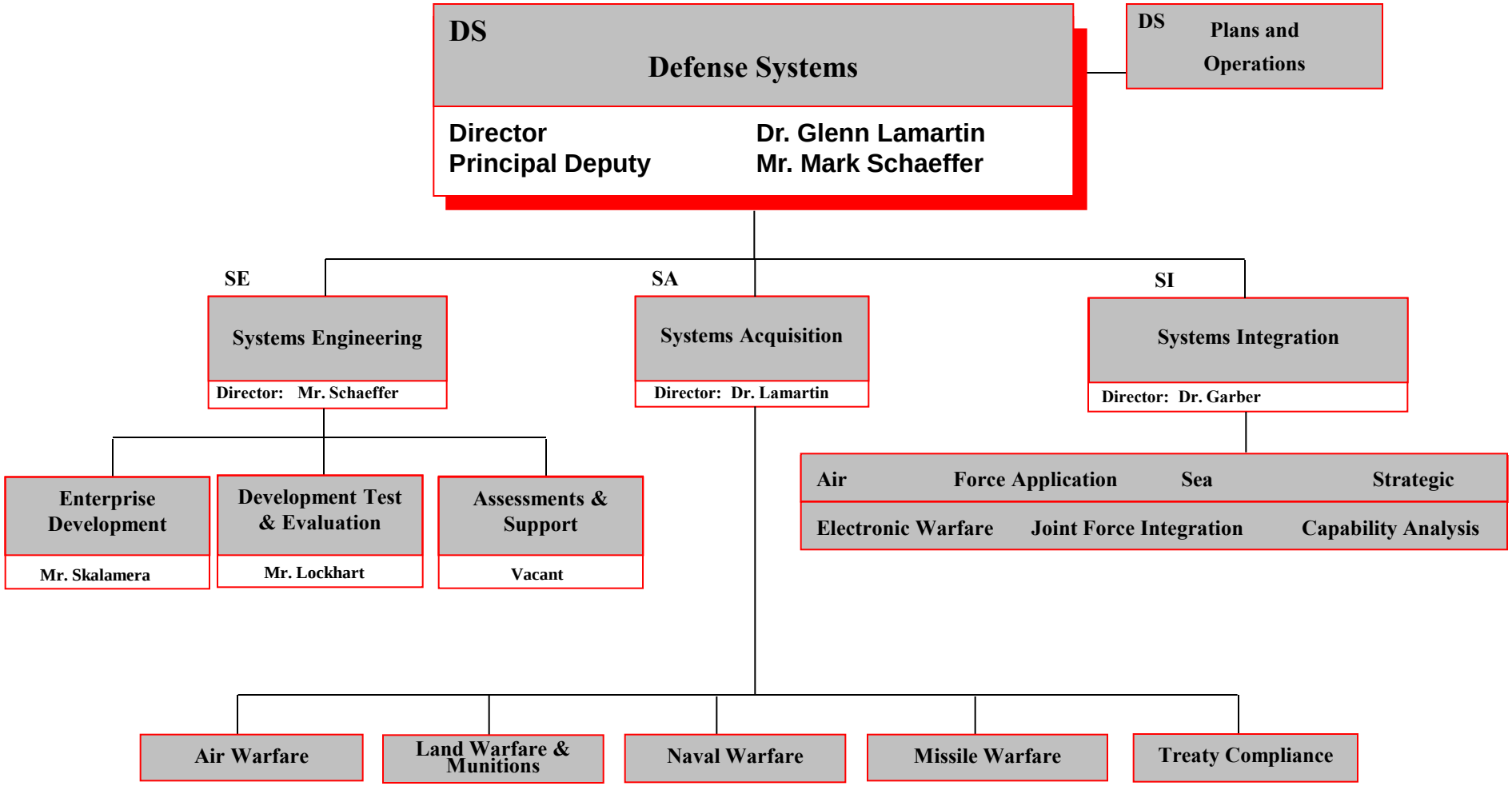
How Defense Systems is Responding

- Strategic and Tactical Systems recast as **Defense Systems**
  - Instituted a new Systems Integration organization
    - Extends and complements work of former Interoperability Office
    - Engaging OSD, Joint Staff, Services, and COCOM staffs to define joint integrated architectures
    - Synchronizing the requirements, acquisition, and budget processes
  - Warfare offices (formerly Strategic and Tactical Systems) tailoring the application of DoD 5000
    - Leading IPT process for program oversight and review
    - Role is to help programs succeed
  - Formed a new Systems Engineering organization
    - Institutionalizing Systems Engineering across the Department
    - Setting policy for implementation, capturing best practices, setting standards for training and education
    - Enhancing emphasis on systems assessment and support

Director, Defense Systems

- **Principal advisor to the Under Secretary of Defense (Acquisition, Technology & Logistics) through the Principal Deputy Under Secretary of Defense (Acquisition, Technology & Logistics)**
  - **Technical review, evaluation, and oversight of strategic and tactical DoD development and acquisition programs**
  - **Chairs Overarching Integrated Product Teams in the Defense Acquisition Board process**
  - **Enables effective joint and combined operations through the development of system of systems capabilities**
  - **Integration and implementation of policies regarding system integration and interoperability of systems used in coalition warfare**
  - **Facilitates timely and affordable fielding of effective warfighting capabilities by promoting the application of a sound engineering management approach to the Department's acquisition process**

Defense Systems Organization



Systems Engineering
Assessment and Support

- Focal point for outreach to individual programs
- Directs, manages, and coordinates special studies and reviews addressing systems engineering and software
- Leads special projects and DoD studies relating to software issues
- OSD focal point for software acquisition process improvement
  - Leads the OSD Tri-service Assessment Initiative providing independent assessments to DoD program managers
- Recommends changes to Department systems engineering policies and procedures

Systems Engineering
Enterprise Development

- Define “good systems engineering”
  - How to plan. How to gauge progress.
- Find, capture, and share best practices
- Educate the workforce (industry and government)
- Develop systems engineering tools
- Engage industry, services, academia, professional associations, allies
- Establish systems engineering policy and procedures

Systems Engineering
Development Test & Evaluation

- A critical part of good systems engineering
- Ensures thorough test planning and assignment of resources
- Provides indication of technical maturity
- Verifies system performance
- Confirms the design meets specifications
- Stressing expanded use of models and simulation, especially for system of systems
- Recommends changes to Department DT&E policies and procedures
- Key determinant of successful OT&E

SE Challenges and Opportunities

“Help drive good systems engineering practices back into the way we do business.”

SE Education and Training Summit (October 2003)

- Brainstorming session
  - **What's working**
  - **What needs to be fixed**
  - **Significant barriers**
  - **Required actions**
- Formed five working groups, assigned leads
  - **Policy**
  - **Processes**
  - **Tools and Guides**
  - **Resources**
  - **Education and Training**

Lack of Uniform Understanding of SE at the Department Level

- Lack of coherent SE policy
- Lack of effective SE implementation - no “forcing function” for PM or contractor SE activities
- Program teams incentivized by cost and schedule, not execution of disciplined SE
- Products and processes not in balance (emphasis on speed; fix it in the next spiral)
- Inconsistent focus across life-cycle, particularly prior to Milestone B
- SE inadequately considered in program life cycle decisions

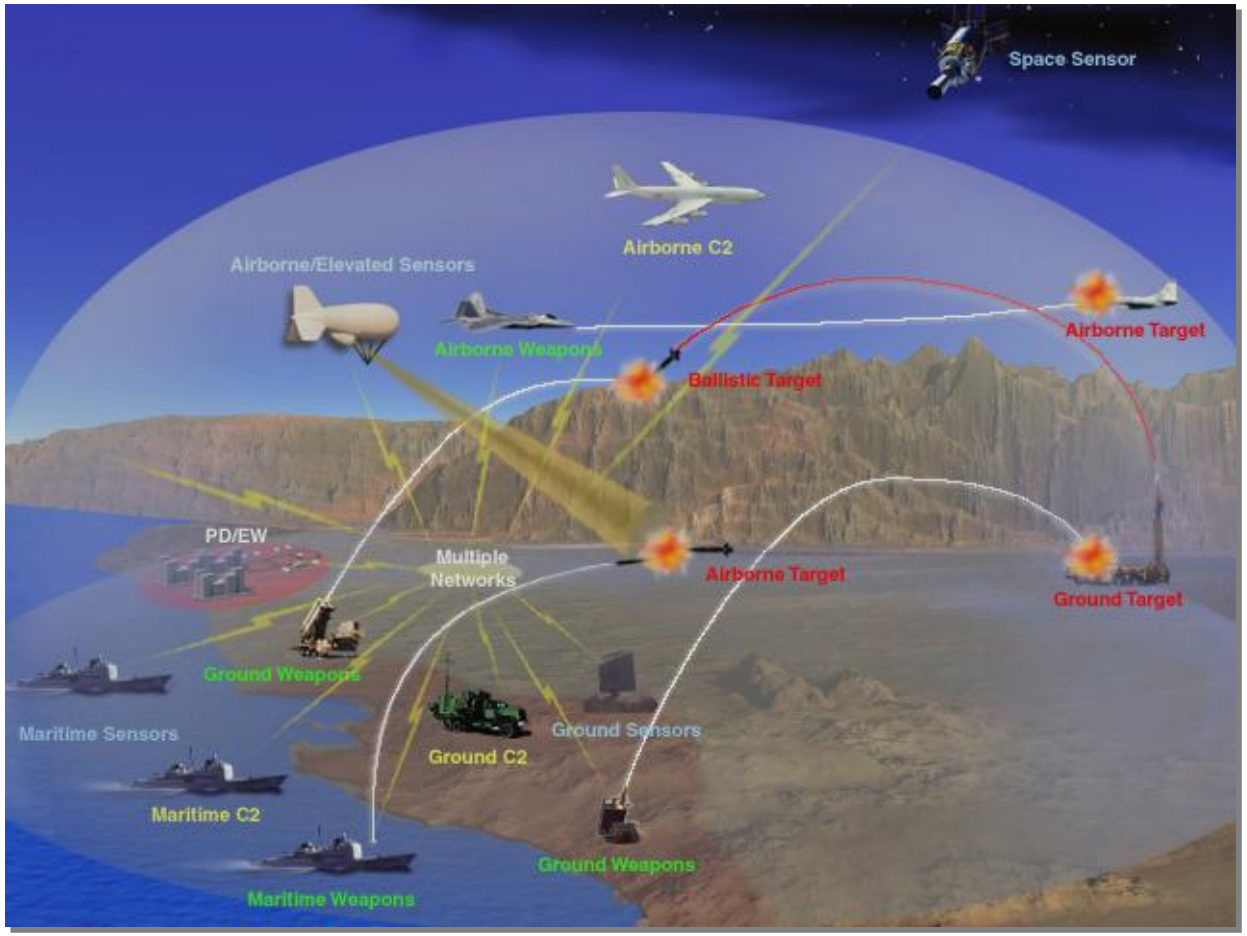
Lack of Uniform Understanding of SE in the Community-at-Large

- **No single definition or agreement on the scope of SE**
- **Lack of common understanding of how SE is implemented on programs**
  - Is SE done by the systems engineer?
  - Does the systems engineer lead the SE effort?
- **No uniform understanding of what makes a good systems engineer**
- **No consistent set of metrics/measures to quantify the value of SE**
- **Cost and schedule estimation and risk management processes inconsistently aligned with SE processes**
- **Resistance to harmonization of multiple standards and models**
- **Multiple practitioner communities not aligned**
  - Hardware
  - Software
  - Information Technology
  - Telecommunications
  - Program Management

System Complexity

- System complexity is ever increasing – Moore's Law at the system scale – Family of Systems/System of Systems interdependencies
- Integrated systems (software with embedded hardware) vice platforms (hardware with embedded software)
- Network centric, spiral development, extension of system applications are driving higher levels of integration

Execute the "Big Picture"



"He thinks we can do it."

The Problem

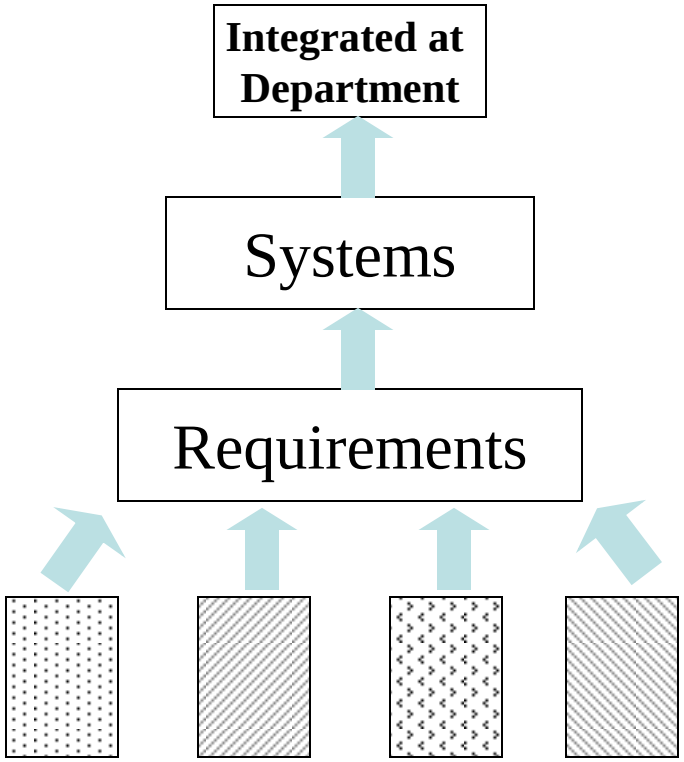
- The previous requirements and acquisition processes frequently produced stovepipe system solutions
  - Requirements were Service rather than Joint focused
  - Lacked construct for objective analysis
  - Systems not necessarily integrated
  - Duplication existed, particularly in smaller programs
  - Evolutionary acquisition not well institutionalized
  - Joint Warfighting needs not prioritized

“New Paradigm”

- DoD 5000 Series and CJCSI 3170.01C have been recast
- Both address **capabilities-based** approach to acquisition based on joint integrated architectures

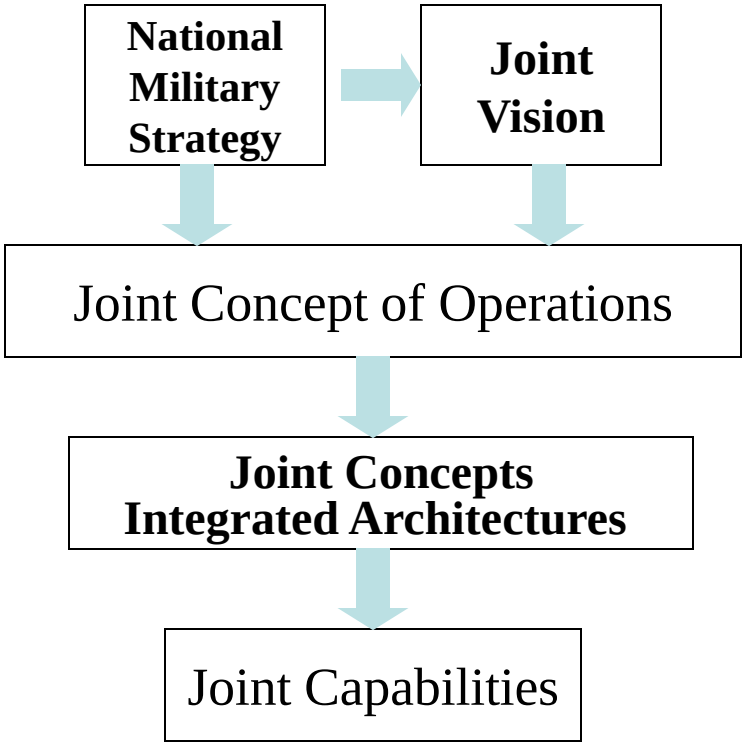
Capabilities Acquisition

RGS



Bottom Up, Often Stovepiped

JCIDS



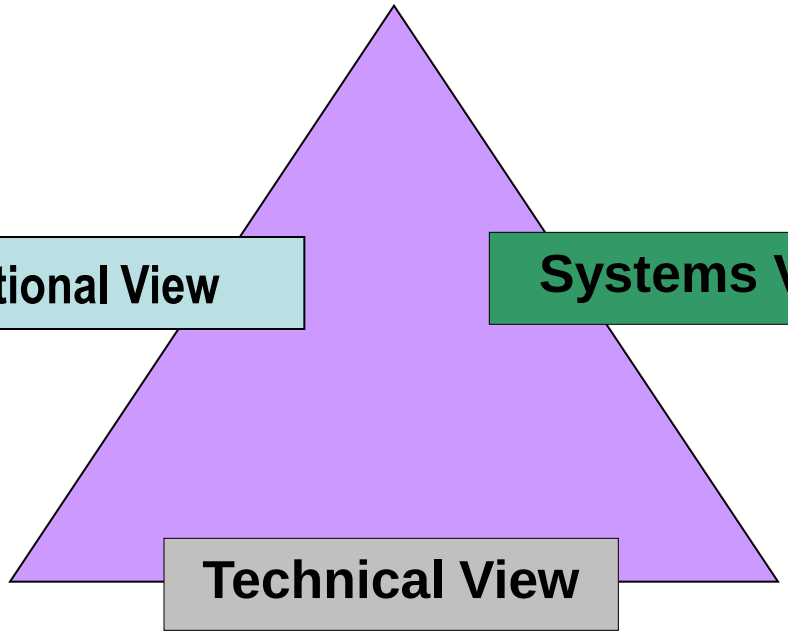
Top Down, Born Joint

DoD Architecture Framework

An architecture is

"the structure of components, their interrelationships, and the principles and guidelines governing their design and evolution over time."

Source: DoD Integrated Architecture Panel, 1995
Based on IEEE STD 610.12

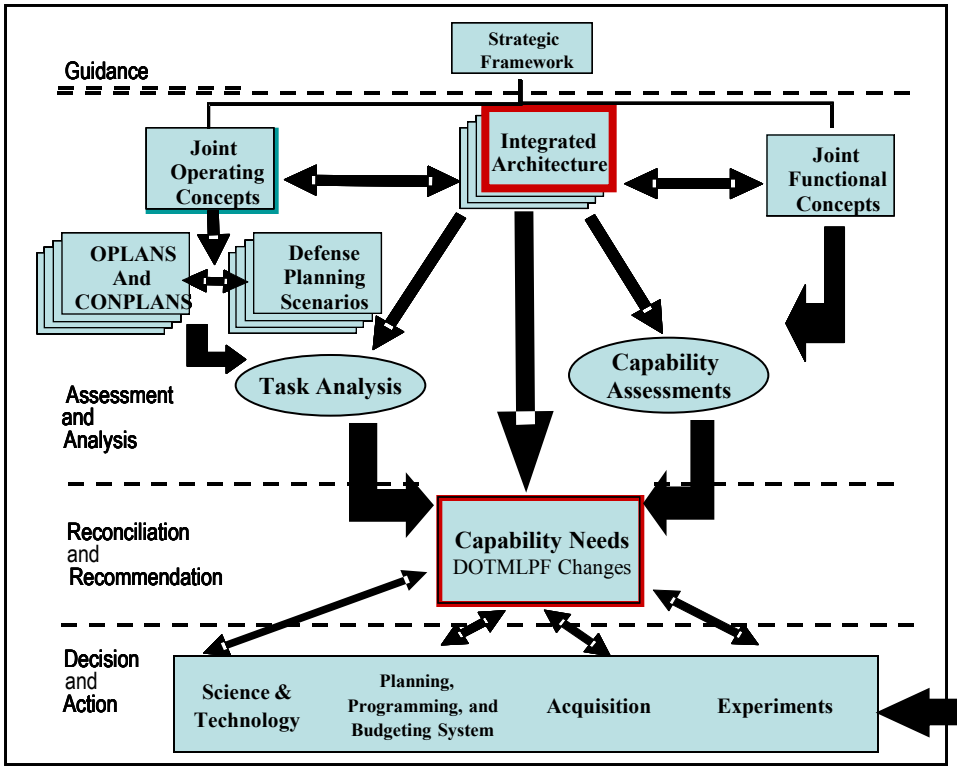


What the warfighter wants to do and how

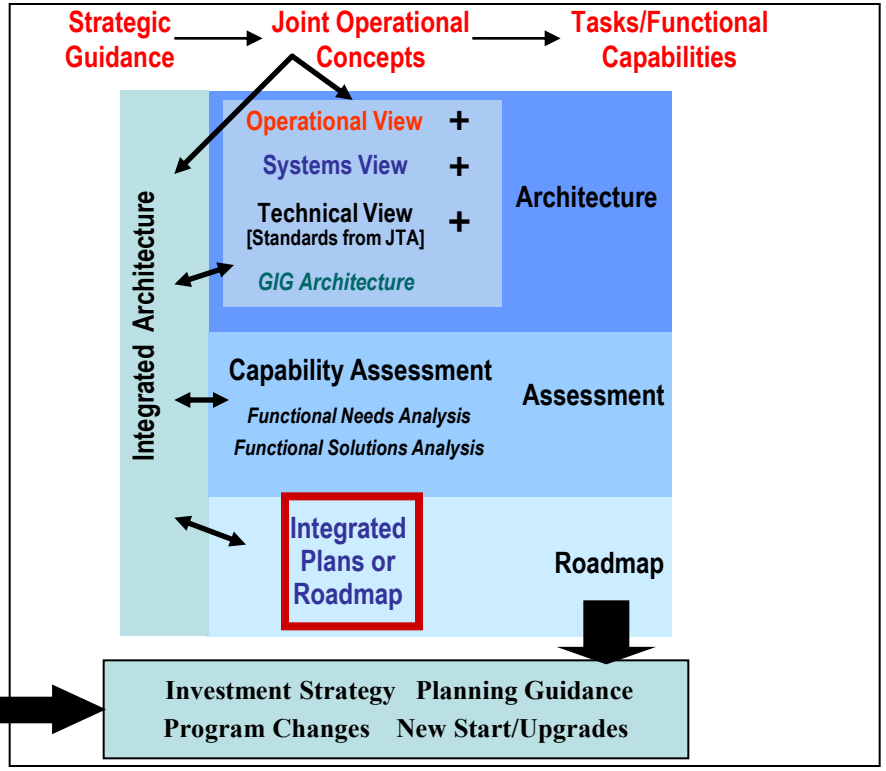
What systems to bring together and how to organize them to provide capability

How to put the pieces together

The Joint Capabilities Integration and Development System and Acquisition Processes



CJCSI 3170.01C
Joint Capabilities Integration and Development System



DODI 5000.2
Operation of Defense Acquisition System

JCIDS – Acquisition Integration A Few Things to Resolve

- Role of integrated architectures
- Scope / scale of problem
  - All capabilities, not just C4ISR
  - All systems, but to what level
  - Not just materiel solutions – DOTMLPF
  - How are cost and effectiveness integrated?
- Merger of top-down capabilities needs with bottom-up platform requirements
- Trade-off process
- Practical limitations to support decision timelines

CMMI
"The Beginning"

- Multiple capability models being sponsored/built
- Software Capability Maturity Model (SW-CMM) most well known
- Systems Engineering Capability Maturity Model (SE-CMM) under development
- Significant investment in both Development and Assessment Infrastructure on both models
- Two communities on independent paths
- Fundamental need to integrate SE and SW models
- OSD direction/sponsorship initiated integration
- NDIA Systems Engineering Committee accepted challenge to lead integration efforts.

CMMI v1.02 released Dec 2000

CMMI v1.1 released Dec 2001

Role of CMMI

- The initial vision for CMMI was to integrate the competing maturity models and provide more consistent process improvement
- What CMMI really does is cause integration of the *functional disciplines* in their application in organizations and on programs
- It has also caused tremendous increases in *systems engineering* process maturity as organizations migrate from the sunsetting SW-CMM to CMMI

Role of CMMI
(cont'd)

- This increase in systems engineering process, focus, and application throughout the organization and on programs has already started to show benefits by improving program performance
  - Improved CPI/SPI
  - Increased efficiency
  - Increased throughput
  - Decreased cycle time and build cycles
  - Decreased rework
  - Reduced fielded defects
  - Increased customer satisfaction (and award fees!)
- CMMI is showing a positive return on investment!
- CMMI also causes consistency of systems engineering application across DoD programs
- CMMI brings systems engineering awareness - and greater involvement - to Program Managers

Defense Systems "Way Ahead"

- Provide effective SE policies, practices, procedures, methods, and tools
- Improve the systems engineering environment
- Provide for a professional SE workforce
- Lead the development of systems views for an integrated architecture
- Conduct systems assessments to improve balance of cost, schedule, performance, and risk in programs

Defense Systems "Way Ahead" (cont'd)

- Reduce the life cycle cost of defense systems
- Assess system technical maturity and readiness for operational test, based on developmental test results
- Lead the development of integrated plans and/or roadmaps
- Establish a broader context for DAB reviews
- Foster interoperability, jointness, and coalition capabilities

Systems Engineering Today

- Is Systems Engineering still relevant? Absolutely
- Has the role of SE changed? Absolutely
- Are there new challenges? Absolutely
- Does Industry have a role in the evolution of DoD's SE Set of Challenges? Absolutely
- Does SE Education and Training need to change? Absolutely
- Do we have all the answers? Absolutely not!
- But CMMI is definitely a tremendous step forward

It's a great time to be engaged with Systems Engineering!