Systems Engineering for Systems of Systems: Update

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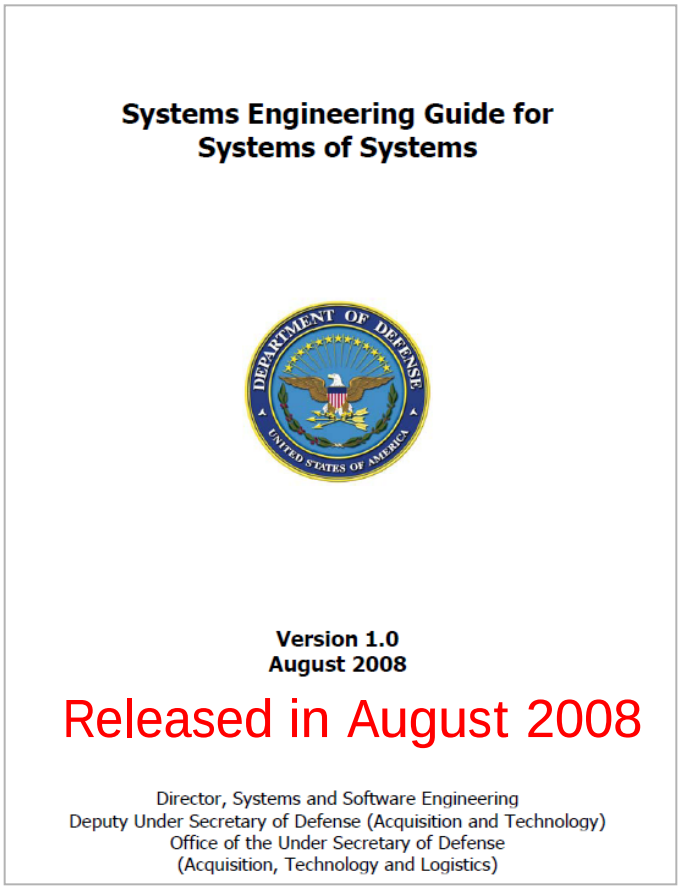
Purpose and Topics

- Purpose
  - Provide an update on current SoS SE initiatives
- Topics
  - Applying current guidance
  - Current Initiatives
  - Relationships

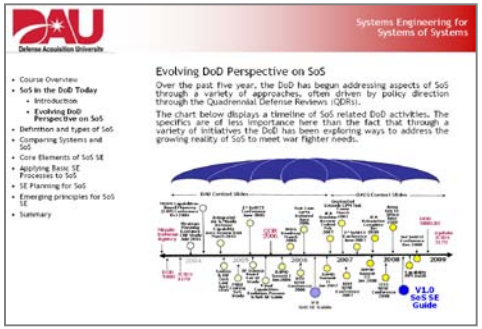
DoD System of Systems SE Guide

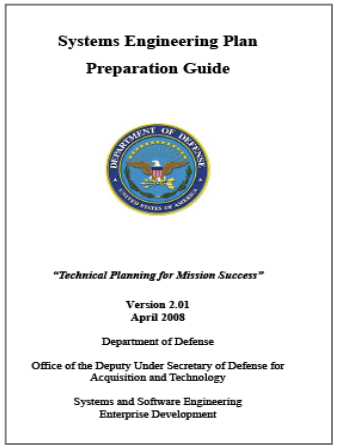


- Initiative of the Office of the Secretary of Defense
- Collaborative approach with DoD, Industry, Academia
- Purpose:
  - Focus on technical aspects of SE applicable to SoS
  - Characterize SoS in DoD Today
  - Describe Core Elements of SoS SE
  - Translate application of basic SE processes for SoS SE
- Audience: PMs and Lead/Chief Systems Engineers

Guidance is based on structured reviews of ongoing SoS SE efforts to identify successful patterns of practice across recent practitioner experience

Applying and Sharing Current Guidance




Systems Engineering Plan
Preparation Guide

"Technical Planning for Mission Success"

Version 2.01
April 2008

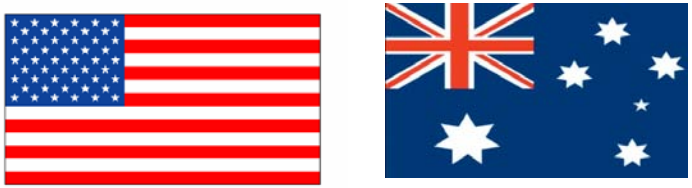
Department of Defense

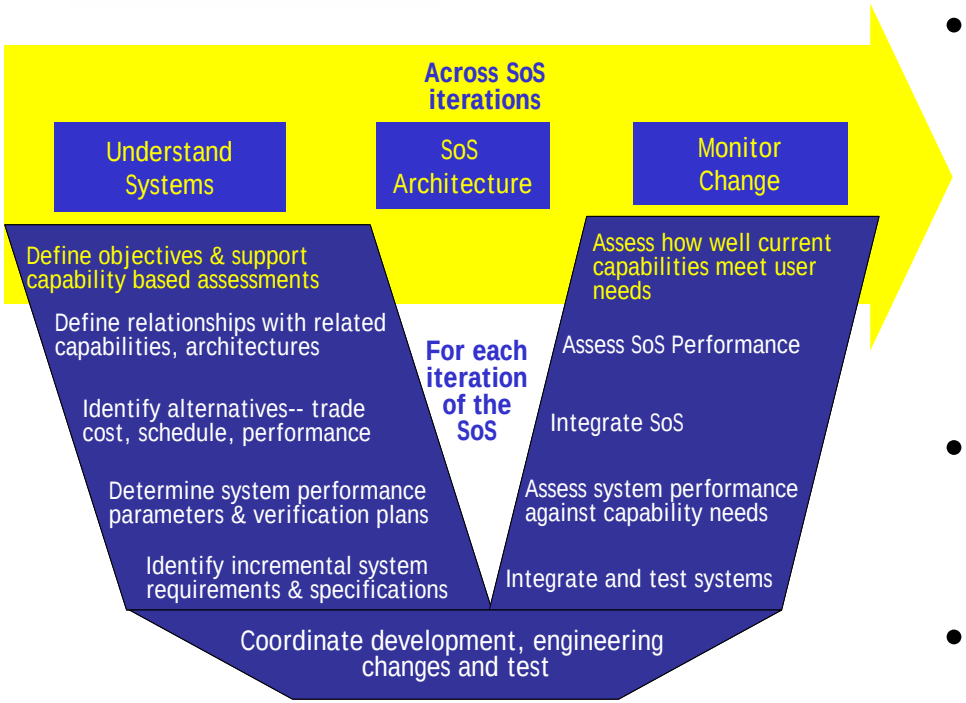
Office of the Deputy Under Secretary of Defense for Acquisition and Technology

Systems and Software Engineering
Enterprise Development

- Defense Acquisition Guide (DAG) Update
  - DAG was updated with the changes in 5000.02; interim DAG is now on line (URL)
  - Section 4.1.4 on SoS SE was updated and links to SoS SEG
- Education and Training
  - DAU Continuous Learning Module (CLM) is in development
  - Online offering, 3 hour course
  - Course objectives and outline are complete, materials being assembled
- SEP and Program Assessment and Support
  - SoS team is participating in SE reviews of SEPs and program support reviews of systems and SoS
  - Currently examining possible options for guidance for SoS SEPs

SoS Artifacts



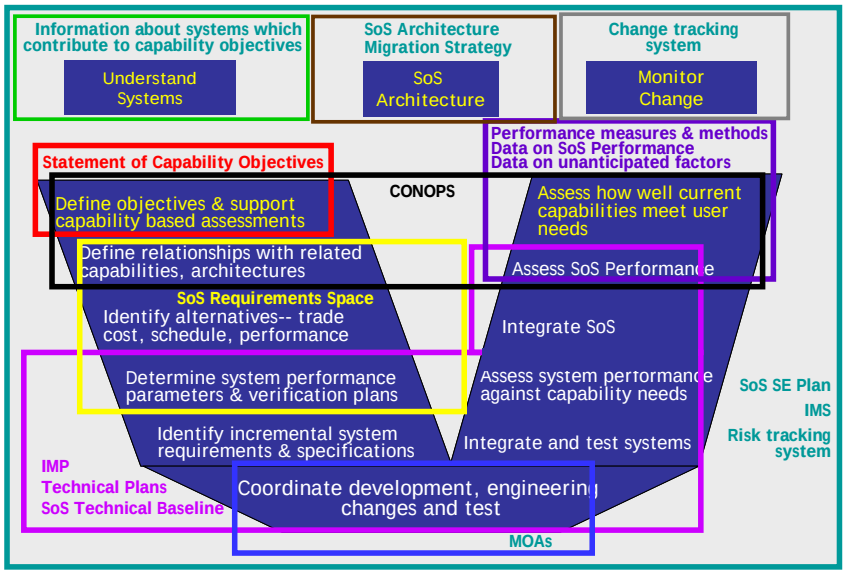


Initiated as a cooperative effort with Australia

- Why focus on "SoS SE Artifacts"?
  - Tangible
  - Evident ROI in terms of a useful product
- Anticipated results
  - Examples based on actual experience
  - Compare to SE artifacts
  - Understanding of the role of the artifacts in the SoS SE process (e.g. impact analysis)
  - Basis for SoS management commitment (governance, resourcing, etc)
- Initial set of artifacts have been developed
  - Shared with TTCP TP4 workshop
- TTCP-TP4 Follow-on
  - Continued development and application but the different nations

Candidate Artifacts

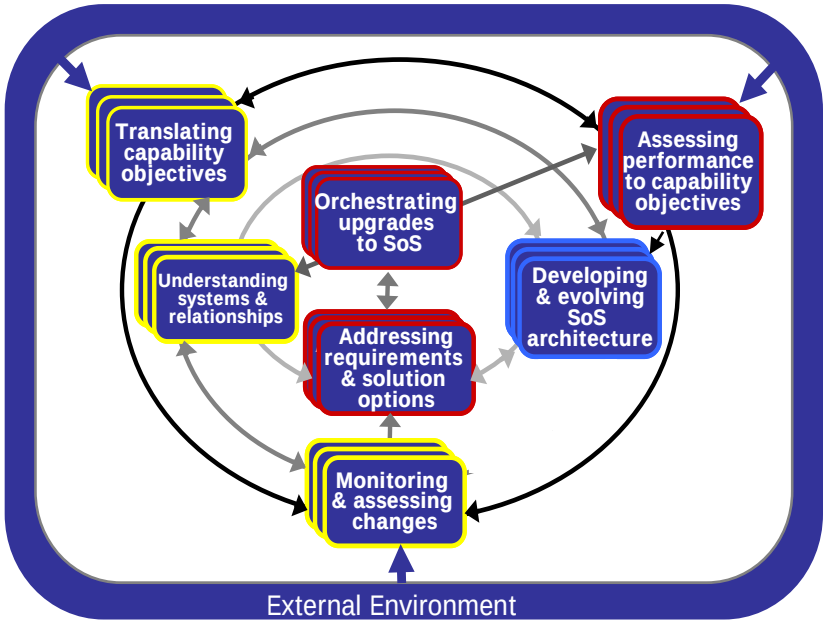
- **Currently working with selected pilots**
  - **Collect examples**
  - **Develop templates**
- **Ongoing exchange with UK, CAN and AUS**
  - **Share experiences as each nation applies these in their own context**



Overlay of Artifacts on Process

1	SoS SE Plan (SEP)
2	SoS Capability Objectives
3	Requirements space for the SoS
4	Concept of Operations (CONOPS)
5	Information about systems which contribute to capability objectives
6	Performance measures and methods
7	Data on performance of the SoS
8	Data on unanticipated factors
9	SoS Architecture
10	Migration Strategy
11	Change management artifacts
12	SoS technical baseline
13	Technical Plans
14	Integrated Master Schedule (IMS)
15	Integrated Master Plan (IMP)
16	Memoranda of Agreement (MOAs)
17	Risk tracking system

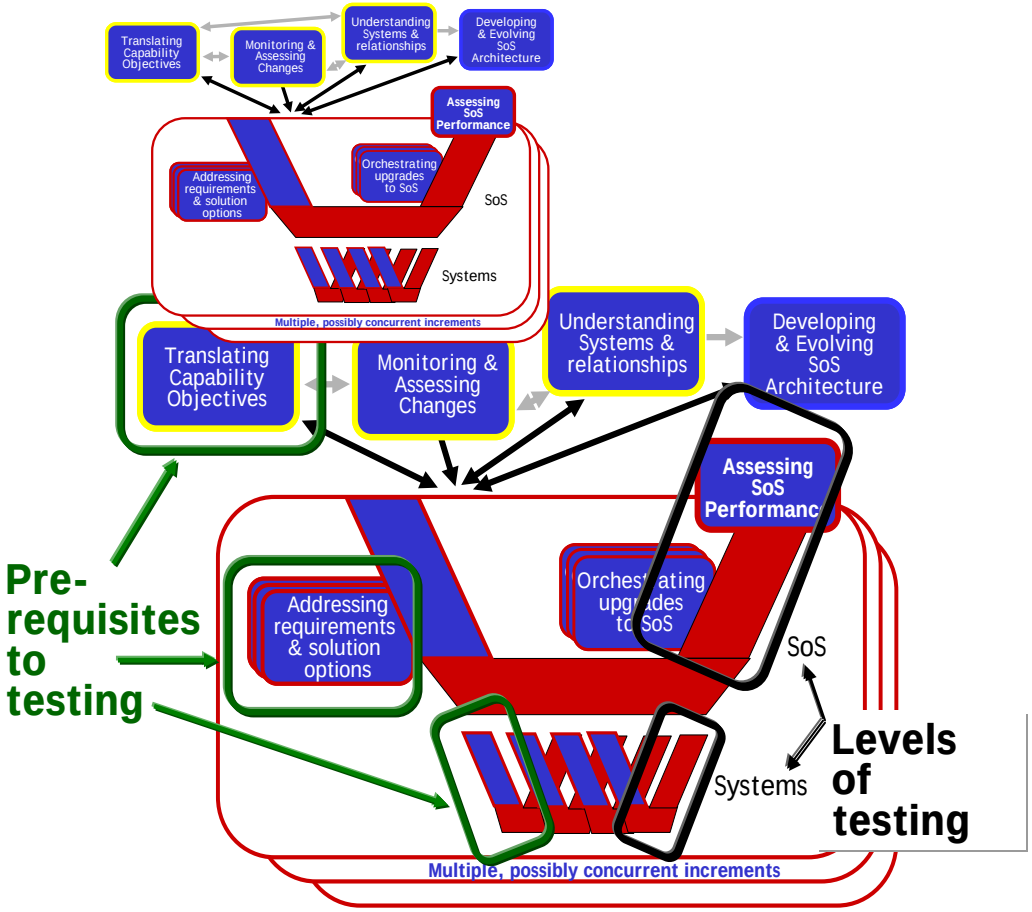
SoS SE and M&S



Identify Enablers & Inhibitors to the Effective Use of M&S for each core element of SoS SE

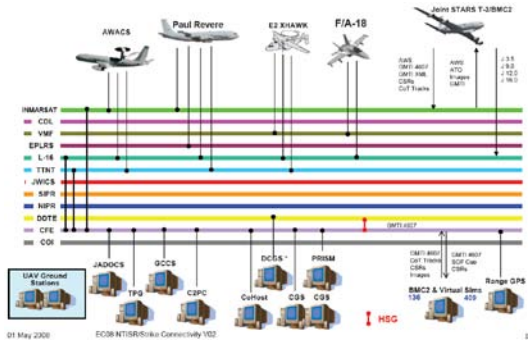
- SoS SEG v1 Practitioner inputs recognized potential of M&S but reported limited application
- Input provided by NDIA M&S Committee on M&S support for SoS Core Elements
  - See NDIA Presentation #9060 "Modeling and Simulation and Systems Engineering"
- New DSB on Modeling and Simulation for Defense may offer added insights

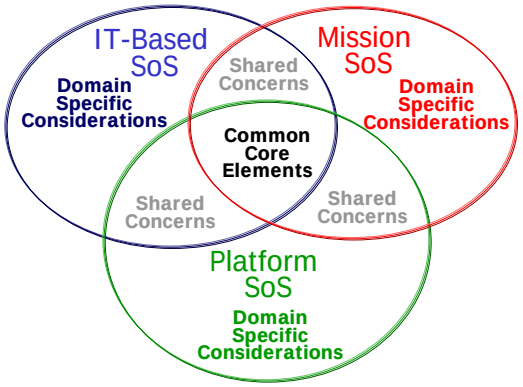
SoS SE and T&E



- SoS SE Guide addresses T&E in a limited way
- Area of strong interest for the NDIA SoS SE Committee
- White paper outlined key issues and made recommendations
- See NDIA Presentation #8935: "SoS and T&E"
- Under consideration with NDIA SoS SE Committee as a 2010 focus area with T&E Committee

New Initiatives



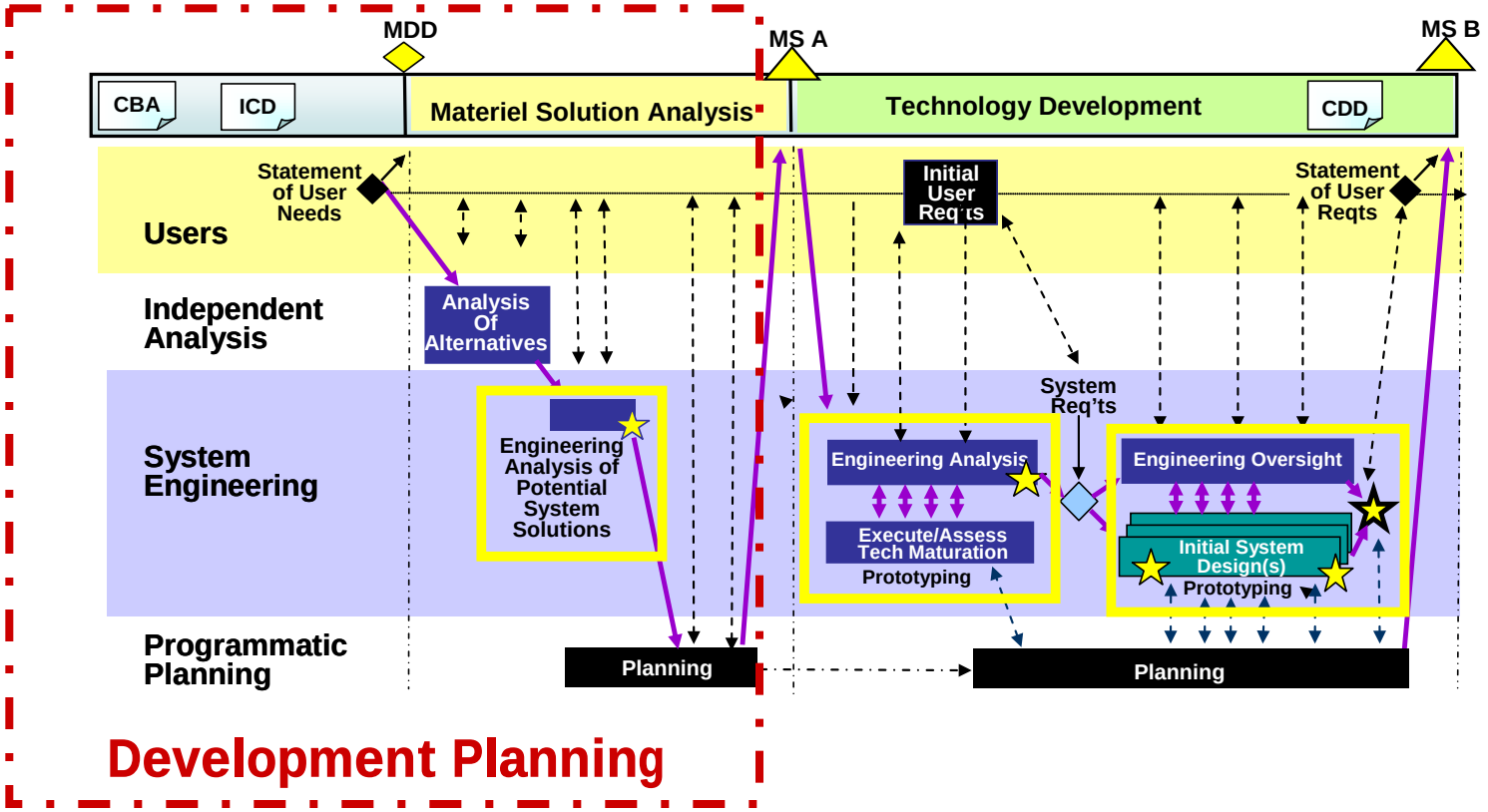


- Collaborative SoS
  - Beginning to look at cases of collaborative and better understand issues related to this type of SoS; Beginning with Ground Moving Target Indicator COI
- Managing Complex SoS
  - New study co-sponsored with ASD-NII on managing complexity in SoS
- SoS Domain Application Areas
  - Mission SoS – Platforms, weapons, sensors and C2 to meet operational mission objectives (e.g. BMDS, NIFC-CA)
  - Platform SoS– Configuration of SoS aboard a platform; Traditionally a Navy (e.g. submarines) consideration but with migration to open systems this will be come more widespread
  - IT-based SoS – Suites of C2, Battlespace Awareness systems or services (e.g DCGS, AOC); Net-centric or SOA based systems

SoS in Acquisition Process

- Most SoS efforts are not 'acquisition programs' per se
  - May be outside of acquisition altogether
    - Influence acquisition of new systems or changes/upgrades in current systems
  - When SoS are implemented as acquisition programs, specific acquisition increments are new SoS components (i.e. systems) or system upgrades/changes to address SoS needs
    - Examples include AIAMD, CANES, DCGS-AF
  - Most systems acquisitions do not explicitly consider the larger SoS context except for interfaces or interdependencies
- Recent legislation requires D/SE to address 'development planning' or early SE
  - Addressing SoS and its impact on systems will be a central part of the SE development planning initiative

Development Planning



- Begins before acquisition
- Natural application of systems engineering process
- Ensures that alternative system approaches evaluated during MSA are validated

Where Does Development Planning Fit?

Needs and Opportunities

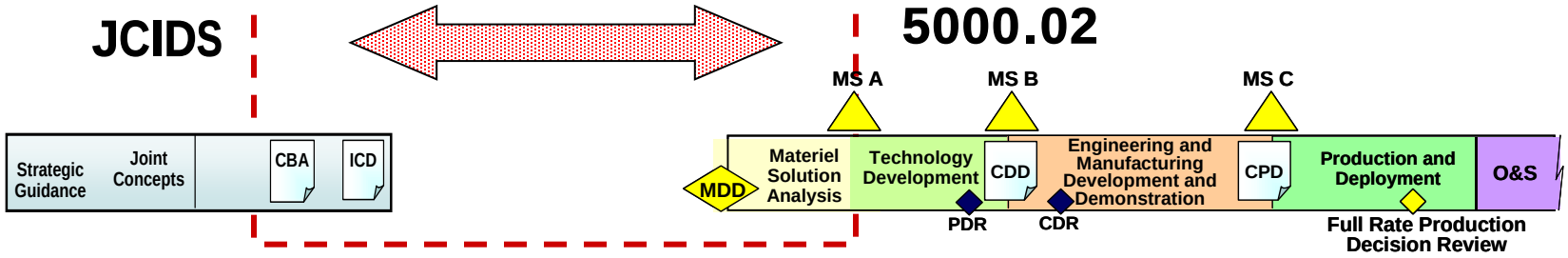
- IPL
- Urgent Need
- New Threat
- New Technology
- New Strategic Direction
- JCIDS

Viable Solutions

Translating User Needs and Opportunities Into Viable Solutions

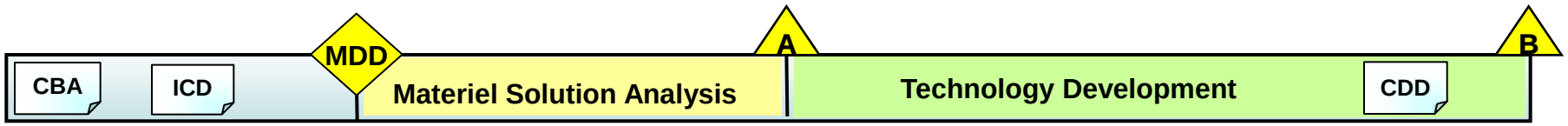
Delivery Options

- Rapid Fielding
- Technology Refresh
- O&S Upgrade
- Experimentation
- JCTDs
- 5000.02



- **Applies more broadly than JCIDS to 5000.02 acquisition**

Role of SoS in Development Planning



Development Planning

Engage-ment in AOA	Guidance
	Plan
	Analysis Activity
	Report
SE Analysis	Consideration of SOS/Interdepen dency, Interoperability Context
	SEP for MSA
	Input to TDS (CTE, CPI), TES, CCE
	SE in TD contract requirements
	Tech Reviews (ASR, Early SE Requirements)

Prototyping & Risk Reduction	Prototyping (Technology and Design)
	TRL Maturation
	Trade Studies
	SE Support for Technology Risk Reduction
	Oversight of Competitive Designs
	Risk Assessment
Input to Acquisition/ Planning, CARD, Budget and Other	SE in Contract Requirements
	SE Input into the pst-PDR Report, report to MDA, Acquisition Strategy, TEMP, CARD, and the ICE
Evidence of Strong SE Activity	PDR and Post-PDR Report and Assessment
	Tech Reviews up to and including PDR
	SEP
	Strong Reliability, Availability and Maintainability (RAM)
Inputs to Requirements	Systems Requirements Definition
	RAM and Sustainability
	Requirements Traceability Matrices
	Translation of Requirements to Contract
	Inform Capability Development Document (CDD)

*Reference DAG Sections 4.3.1 and 4.3..2

Relationships

- **Practitioners**
  - Practitioner experience provides foundation for developing guidance
- **Cooperation with Services (Navy, Army)**
  - Navy and Army have created SoS organizations and focused initiatives
- **Industry**
  - **SoS SE Committee NDIA SE Division**
- **International**
  - Australia: Under Software Intensive Systems SW Improvement Group (SISAIG) initiated SoS Artifacts project
  - TTCP TP4 – Systems Engineering For Modernization: May 2009 Workshop on SoS SE and ongoing development SoS Artifacts
  - UK: British liaison officer to AT&L, part of the UK Systems Engineering Integration Group, joining SoS SE effort
- **Research**
  - Conference participation and publications (IEEE, CSER)

In Sum

- **SoS SE Guide**
  - **Version 1 provides the foundation for ongoing development of an understanding of SoS SE as the basis for evolving guidance**
- **Current efforts focus on**
  - **Applying and sharing current understanding and guidance**
  - **Extending our understanding through a set of investigations of key open issues**
- **Importance of relationships**
  - **Large issue which is gaining in interest**
  - **Participate in existing for to share our work and capitalize on work of others**
  - **Important to be part of this larger community as together we develop a better appreciation and understanding of SE for SoS**