Essential Elements of the Digital System Model

Sharing and Evolving Data Across the Acquisition Life Cycle

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Presentation Outline

- NDIA Systems Engineering Modeling and Simulation Committee – Subcommittee on the Topic
  - Charter
  - Participants
  - Process
- Data Collection Templates
- Definition of Essential Element
- Modeling the Information
- Next Steps
- Summary

Subcommittee on the Essential Elements of the System Model – Charter

- **Define the essential elements of the System Model as it evolves over the Defense Systems Acquisition Life Cycle**

- **Using the Identification of Modeling & Simulation Capabilities by Acquisition Life Cycle Phases as a basis:**
  - **For each major acquisition activity of each phase identify:**
    - The data the system model must contain to support initiating that activity
    - The new (or updated) information that can be put in the system model at the conclusion of that activity
  - **For each M&S capability that can support the major acquisition activities identify:**
    - The data for running that M&S capability that should come from the system model
    - The data from the M&S results that should get put into the system model

- **Identify existing standards, if any, for each essential element**

- **Provide a final report on the findings of the subcommittee**

Subcommittee Members

- Jeff Bergenthal (JHU/APL, Study Lead)
- Tyesia Alexander (Engility)
- David Allsop (Boeing)
- Bill Beavin (Boeing)
- Curtis Blais (NPS)
- Alex Boydston (AMRDEC)
- David Bottcher (Boeing)
- Christina Bouwens (MSCI)
- Jim Coolahan (JHU)
- John Daly (BAH)
- Steve Dam (SPEC Innovations)
- Bob Epps (Lockheed Martin)
- Tracee Gilbert (System Innovation)
- Allen Harvey (ARA)
- Greg Haun (AGI)
- George Hazelrigg (NSF)
- Craig Hugger (emSOLVE)
- David Kaslow (self)
- Jack Kelly (BAH)
- Claudia Kropas-Hughes (AFRL)
- Andrea Lora (Deloitte)
- Frank Mullen (SimVentions)
- Jane Orsulak (Raytheon)
- Chris Oster (Lockheed Martin)
- Greg Pollari (Rockwell Collins)
- Tim Tritsch (Engility)
- Crash Konwin (BAH)
- Hans Polzer (self)
- Frank Salvatore (Engility)
- Jayne Talbot (Raytheon)
- Bill Warner (Boeing)
- Beth Wilson (Raytheon)

Subcommittee Process

- Initial subcommittee formation at 20 August 2013 NDIA SE M&S Committee meeting
  - Formal Study Kick-Off at 11 February 2014 NDIA SE M&S Committee Meeting
- Sub-teams formed, one for each Phase of the DoD Acquisition Life Cycle
- Data collection spreadsheet designed and distributed
- Bi-weekly teleconferences scheduled
- Face-to-face meetings at numerous NDIA SE M&S Committee meetings
- Formal modeling of information initiated in May 2014

Data Collection Template (1 of 2)

Phase	Data Inputs	Level 2 Acquisition/SE Activity	Data Outputs
Technology Maturation and Risk Reduction	cost data for design, build, sustainment	Development & technology risk reduction	update cost model and ID cost reduction initiatives
	expected reliability		update reliability growth curves and
	success criteria		validate or correct the KPPs
	Functional Architecture	System integration	Validated Functional Architecture
	Physical Architecture		Validated Physical Architecture
	Functional Interface Definition		Validated Functional Interface Definition
	Physical Interface Definition		Validated Physical Interface Definition
	Operational Concept		Validated Functional Transformations
	Functional Transformations		
	Performance Requirements/Constraints		
	Operator Interface Definition		
	size, power, weight allocations to subsystems	Design	rebalanced size,weight and power allocations
	performance data		updated performance data
	allocations of reliability to subsystems		
	characteristics of usability		
	non-combat usecases		
	predicted non-recurring, recurring, and sustainment costs		
	tolerances (tooling) and variations (commonality)		
	material constraints		
	test cases		
	functional allocation to prototype	Prototyping	feedback from characterizing functions and
	performance expectations for prototype system		validated or corrected performance
	SOS architecture, interfaces		identify emergent behaviors
	operational environment, CONOPS, validated scenarios, mission description, threat representation	Military utility assessment	validated performance or performance gaps

Data Collection Template (2 of 2)

Level 2 Acquisition/SE Activity	Data Inputs	M&S Capability	Data Outputs
Development & technology risk reduction		Engineering-level simulation	
		Virtual system simulation	
		Mission-level simulation	
		Modeling of the natural environment	
System integration		Engineering-level simulation	
		Mission-level simulation	
		Virtual system simulation	
Design		Engineering-level simulation	
		Virtual system simulation	
		Modeling of the natural environment	
		Mechanical design modeling	
		Software modeling	
		Manufacturing process modeling/simulation	
		Reliability modeling	
		Maintenance simulation	
		Survivability simulation	
		Life-cycle cost modeling	
Prototyping		Engineering-level simulation	
		Mission-level simulation	
		Virtual system simulation	
Military utility assessment		Mission-level simulation	

Definition of an Essential Element (1 of 2)

- Conducted brainstorming session to help form a definition
- Characteristics:
  - Information and data
  - An atomic or aggregate set of data elements
  - Each element is unique
  - Must have dimensions or units of measure (data)
- Uses:
  - Required by an acquisition activity or M&S capability for all types of systems
  - Information and data required to make decisions
  - Used in more than one acquisition activity
  - Used by more than one organization
- Impact:
  - Required by DoD acquisition policies and/or best practices
  - An element, that if changed, will impact other elements or the system
  - Data required to complete all activities in the acquisition process

Definition of an Essential Element (2 of 2)

- Developed an initial definition
  - Debate, revision, more debate

- Finalized the definition:

An essential element of the system model is information and/or data that:

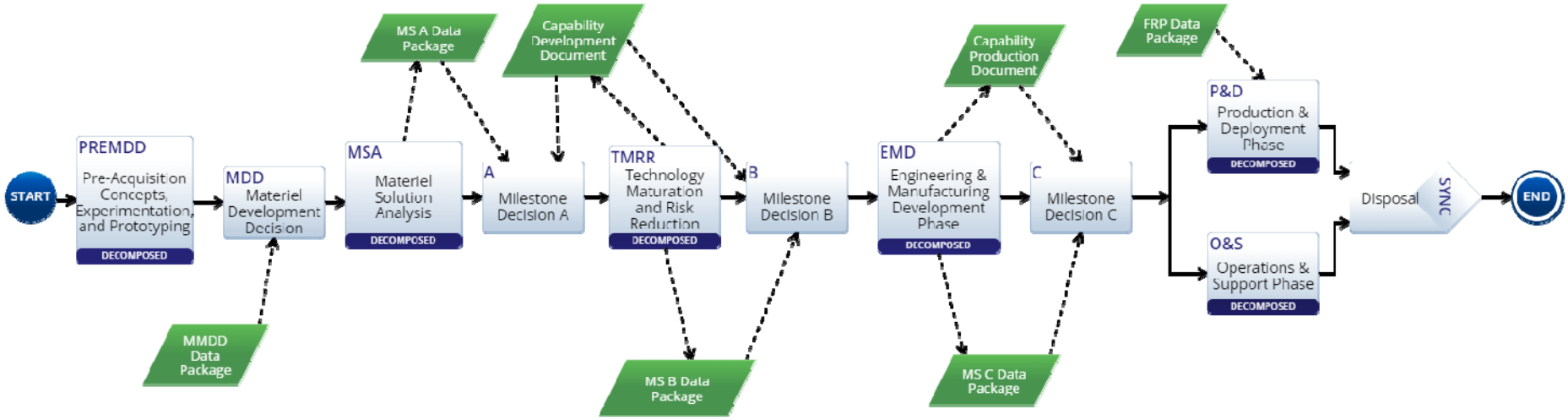
- if missing, prevents subsequent acquisition activities from being performed; or
- is required to make decisions at formal Decision Points and Milestone Decisions identified in the acquisition life cycle.

Modeling the Information

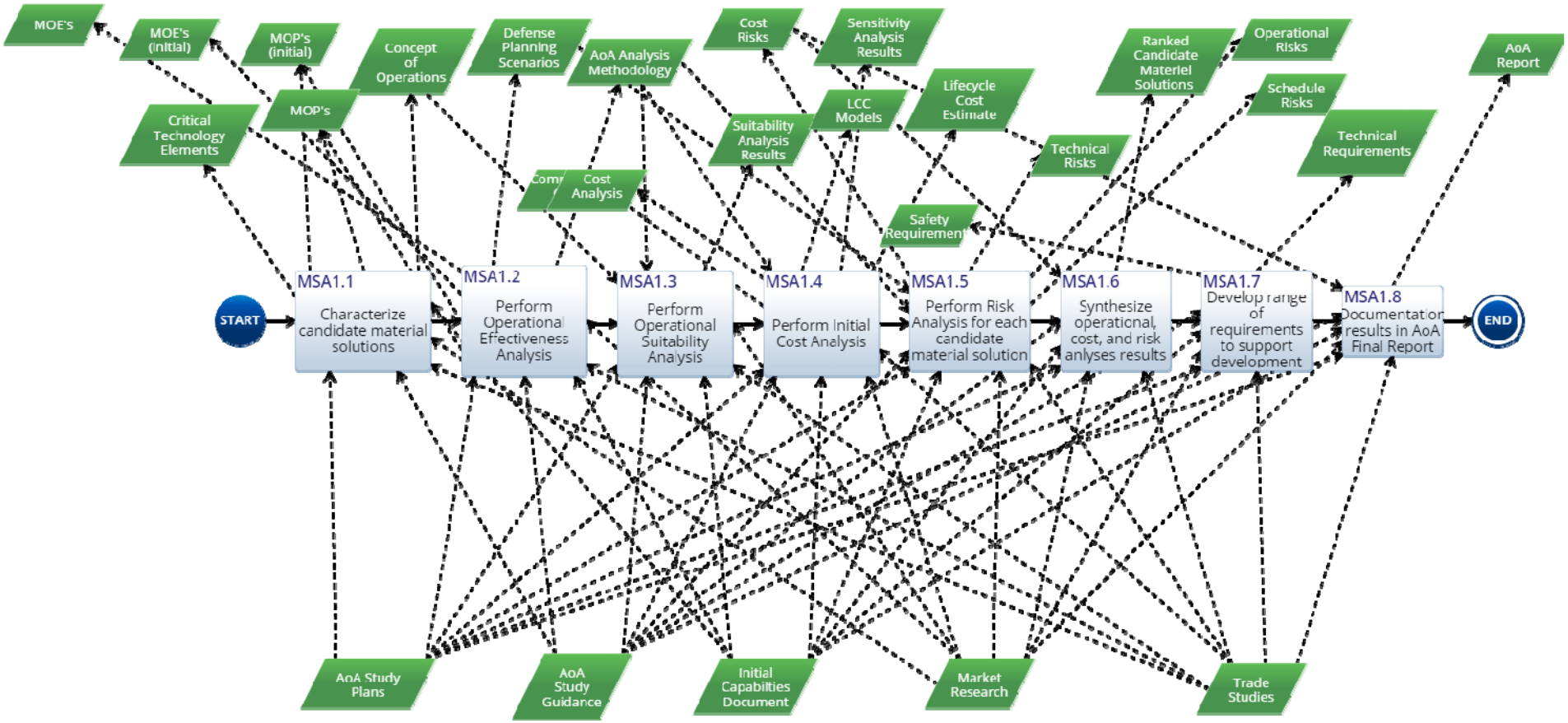
- **Spreadsheets quickly became too cumbersome**
  - **Integrating the data was challenging**
  - **Analyzing the data was difficult**
- **Offer from Steve Dam, SPEC Innovations, for free use of Innoslate® by the entire Study Team**
- **Demonstration session and development of initial set of modeling conventions**
  - **Modeling conventions have continued to evolve**
- **Technical interchange with MITRE on the Acquisition Guidance Model (AGM)**
  - **Useful information contained in AGM that can be folded into the model the Study Team is developing**

Overview of the Model

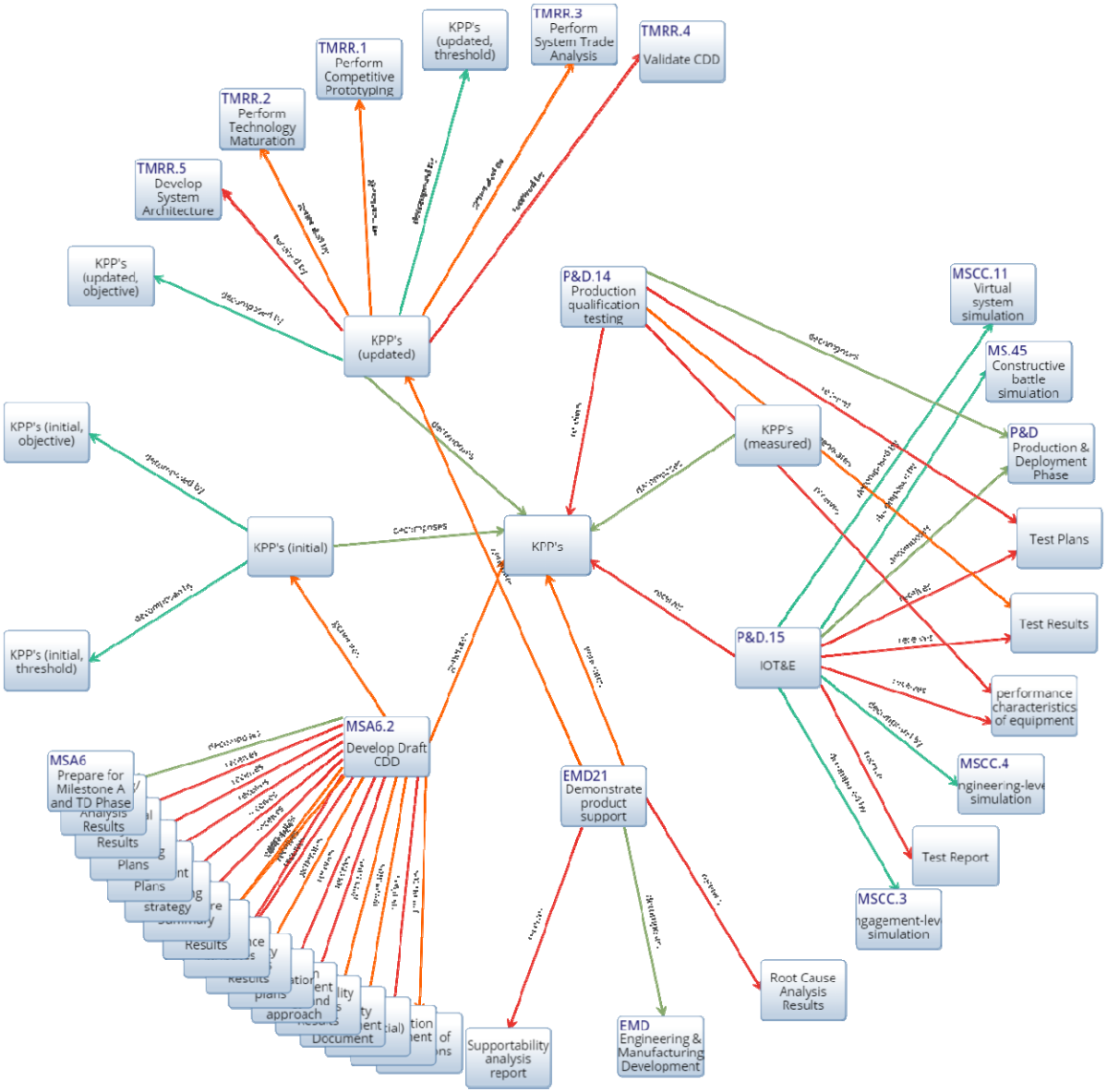
- All phases of the DoD acquisition lifecycle
- 283 distinct acquisition and modeling & simulation activities
- 7 milestones / decisions
- 588 distinct input/output items
  - 211 of which have been tagged as “essential elements”



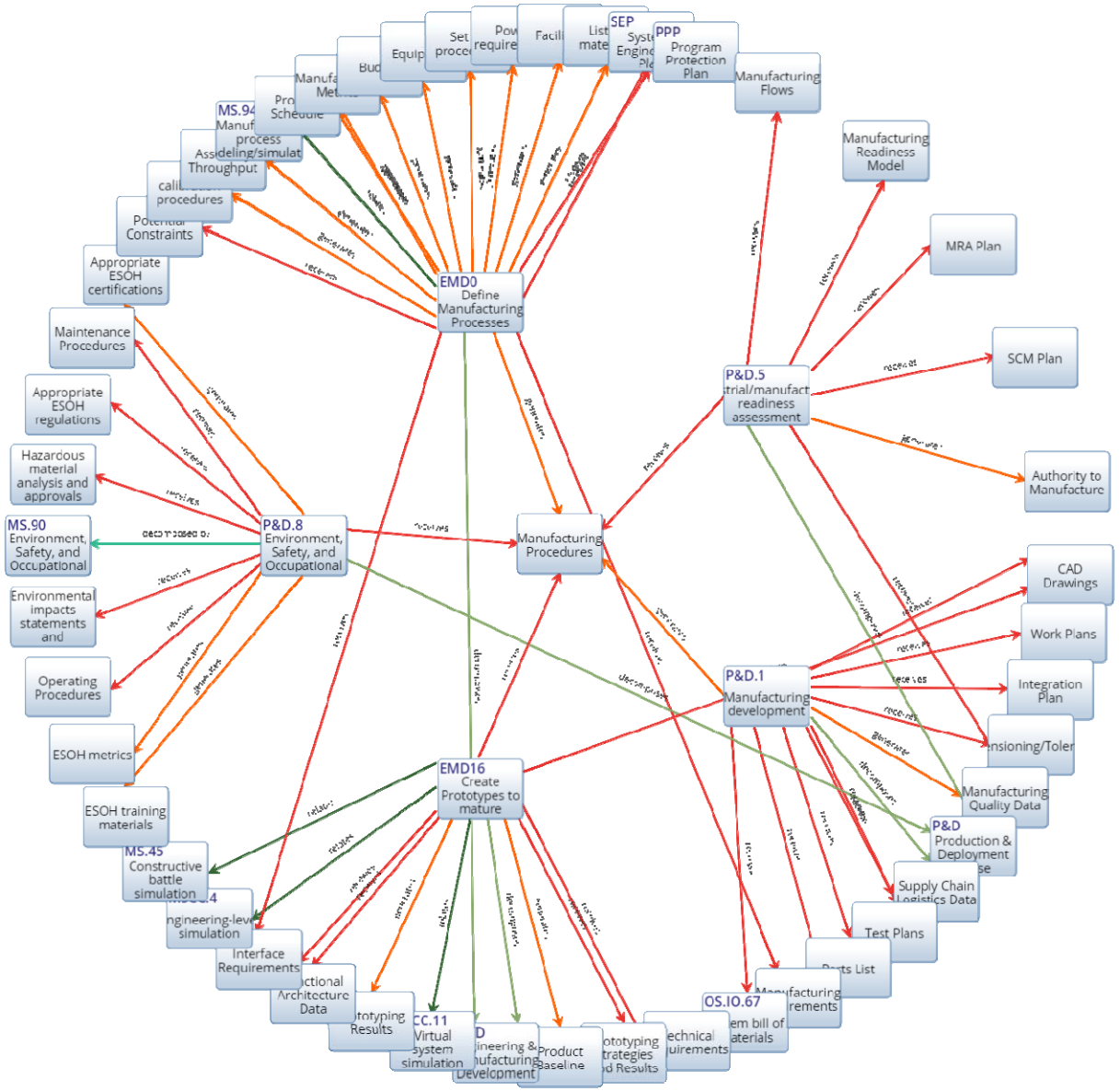
Conduct Analysis of Alternatives



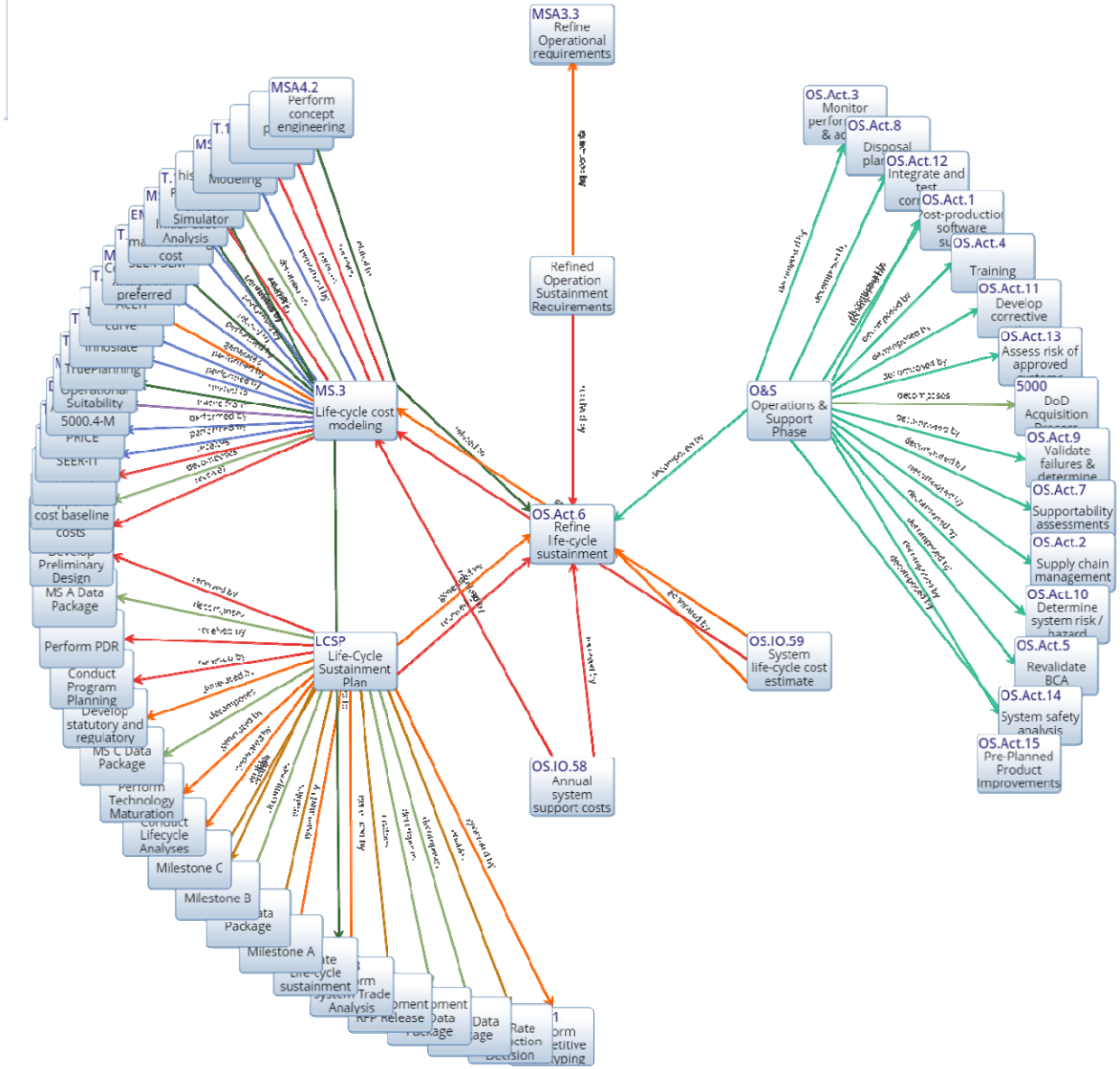
Key Performance Parameters



Manufacturing Procedures



Refine LCSP


MSA3.3
Refine Operational requirements
Refined Operation Sustainment Requirements
MSA4.2
Perform concept engineering
MS.3
Life-cycle cost modeling
OS.Act.6
Refine life-cycle sustainment
LCSP
Life-Cycle Sustainment Plan
O&S
Operations & Support Phase
OS.IO.59
System life-cycle cost estimate
OS.IO.58
Annual system support costs
OS.Act.3
OS.Act.8
OS.Act.12
OS.Act.1
OS.Act.4
Training
OS.Act.11
Develop corrective
OS.Act.13
Assess risk of approved
5000
DoD Acquisition
OS.Act.9
Validate failures & determine
OS.Act.7
Supportability assessments
OS.Act.2
Supply chain management
OS.Act.10
Determine system risk /
OS.Act.5
Revalidate BCA
OS.Act.14
System safety analysis
OS.Act.15
Pre-Planned Product Improvements
Simulator
Analysis
cost
preferred
Suitability
5000.4-M
PRICE
SEER-IT
cost baseline
costs
Preliminary Design
MS A Data Package
Perform PDR
Conduct Program Planning
statutory and regulatory
MS C Data Package
Technology Maturation
Lifecycle Analyses
Milestone C
Milestone B
Package
Milestone A
sustainment
Analysis

Summary

- The Study is an ambitious undertaking by a volunteer team
  - Aligned with similar initiatives underway within the DoD
  - Builds upon the results of the Committee's recent Identification of M&S Capabilities by Acquisition Life Cycle Phase study
- Development of a formal model provides many benefits:
  - Ease of access and configuration management
  - Ability to analyze the model and use the model to analyze the process
  - Maintenance and evolution of the model
- Anticipate completing the study and submitting the Study Report in Q4 2015