

# SoS Modeling Needs

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MBSE FOR SOS-IW 2015

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# Optional Requirement From UPDM v3.0 RFP

Submitters may define a set of viewpoints and provide the end users with an ability to develop views for System of Systems (SoS) life cycle processes that support analyses needed to answer SoS review questions detailed in:

- European Space Agency Architecture Framework for Systems of Systems:  
[http://link.springer.com/chapter/10.1007%2F978-3-642-25203-7\\_24](http://link.springer.com/chapter/10.1007%2F978-3-642-25203-7_24)
- <https://dag.dau.mil/Pages/Default.aspx>
- <https://acc.dau.mil/CommunityBrowser.aspx?id=638295>

# Analysis of Information Needed to Develop a Useful SoS Model (1/6)

Analyzed and compared a number of relevant resources:

- [ESA/ESTEC, 2012], “System of Systems Development Environment Consolidation – ESA-AF Reference V 1.2,” SOSDEC.REP.001, 07 May 2012
- [IEEE, 2010] Dahmann, J. ; Rebovich, G. ; Lane, J.A. ; Lowry, R., “Systems Conference, 2010 4th Annual IEEE, DOI: 10.1109/SYSTEMS.2010.5482491, 2010 , Page(s): 13-17
- [IEEE, 2011] Dahmann, J. ; Rebovich, G. ; Lowry, R. ; Lane, J. ; Baldwin, K., “An Implementers’ View of Systems Engineering for Systems of Systems,” , Systems Conference (SysCon), 2011 IEEE International, DOI: 10.1109/SYSCON.2011.5929039, 2011, Page(s): 212-217
- [ISO, 15288] ISO/IEC 15288, Systems and software engineering -- System life cycle processes, Draft Annex X Systems of Systems (SoS), Aug, 2013, stage 90.92: International Standard to be revised (after review)
- [OMG, 2014] Business Motivation Model, Version 1.2 OMG Document Number: formal/2014-05-01, May 2014, Standard document URL: <http://www.omg.org/spec/BMM/1.2/>
- [TTCP, 2014] TR – JSA/TP4 -1- 2014, Recommended Practices: System of Systems Considerations in the Engineering of Systems, The Technical Cooperation Program, August 2014

# Analysis of Information Needed to Develop a Useful SoS Model (2/6)

Determined gaps and overlaps

Identified unique elements and relationships needed to model SOS that are not already covered in UPDM

Grouped new elements into areas of concern:

- Policy concerns
- Capability and objectives
- SoS Program Management
- SoS Cost analysis and budgeting
- SoS Risk analysis and mitigation plans
- Security-classification of data/content (will be covered in UAF v1.0)

# Analysis of Information Needed to Develop a Useful SoS Model (3/6)

Most elements needed are already covered (3 out of 47) maybe unique:

- Influencer, Potential Impact, Benefit/Potential Reward

Elements that are not already covered in UPDM are covered by OMG's Business Motivation Model (BMM)

Element in JP- JP 3-0, Joint Operations, 11 August 2011 but NOT in BMM: Operations (BMM's strategy, tactic)

Some elements are out of scope of SysML/UPDM modeling and need to be covered with other modeling tools and techniques:

- Policy concerns (constraints on model)
- Capability and objectives (covered)
- SoS Program Management capability (tools such as MS Project)
- SoS Cost analysis and budgeting (financial analysis tools such as...MindTools)
- SoS Risk analysis and mitigation plans (risk analysis tools such as...SAP)

For all elements listed above, UAF defines elements, constraints or relationships that are needed to link output elements from one tool to inputs to the next tool (through industry exchange standards): such as....or through APIs

# Analysis of Information Needed to Develop a Useful SoS Model (4/6)

## Agreement Processes

- Agreement Processes address the requirements for the establishment of agreements with organizational entities external and internal to the organization responsible for engineering the system of interest.

## Organizational Project-Enabling Processes

- Processes are applied to the particular considerations of systems of systems engineering; that is the planning, analyzing, organizing, and integrating the capabilities of a mix of existing and new systems into a system-of-systems capability.

## Technical Management Processes (Project Planning, Project Assessment and Control, Decision Management, Risk Management Process, Configuration Management, Information Management, and Measurement)

- Implemented at multiple levels. For the systems of systems as the system of interest, Technical Management Processes are applied to the particular considerations of systems of systems engineering; that is the planning, analyzing, organizing, and integrating the capabilities of a mix of existing and new systems into a system-of-systems capability. In parallel, the constituent systems organizations retain responsibility for engineering their systems and they will each have their own Technical Management Processes for planning and management of their systems.

Technical Processes: **Already covered**

# Analysis of Information Needed to Develop a Useful SoS Model† (5/6)

Capability Objectives (Vision, goal, objective)

Outcomes: Desired Result

CONOPS (mission, vision)

Requirements

Asset/Resource: System info (constituent system and service architecture models)

Performance Measures

Performance data

Assessment: SoS Technical Baselines

SoS Architecture [includes: processes, use cases, rules/constraints, course of action (COA)\*]

SE Planning Elements

- Master Plan
- Agreements (among system owners and SOS PMO)
  - Policy, regulation, rules, governance structure/Organization
- Technical plan
- Integrated Master Schedule (IMS)

Risks and Mitigations (COA‡ to mitigate risk)

- † sources: papers on SOS, BMM, and briefings, see references slide
- \* Course of Action (COA): includes **means** that is an approach or plan for configuring some aspect of the enterprise involving things, processes, locations, people, timing, or motivation undertaken to achieve **ends**
- ‡ COA: an approach or plan for working with constituent system's PMOs or independently to mitigate identified risks.

# Elements Needed and already Defined in Business Motivation Model (BMM) (6/6)

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## BMM Elements

- Influencer
- Potential Impact (effect)
- Benefit/Potential Reward
- Strategy
- Tactic

The elements defined above are missing an **Operational level, see figure from JP3-0**



# Some Definitions of Key SoS Information Artifacts

Element	Definition	BMM: OMG dtc-13-08-24
<b>Agreements</b>	Focus is on managing relationships among multiple organizations. Agreements support SoS evolution including specific commitments to execute SoS increment development. [IEEE, 2011]	
<b>Agreements (among system owners and SOS PMO)</b>	Focus is on managing relationships among multiple organizations. Agreements support SoS evolution including specific commitments to execute SoS increment development. [IEEE, 2011]	
<b>Architecture</b>	A shared framework primarily aimed at informing analysis and decisions for developing or evolving SoS capabilities. A context for understanding the relationships among constituent systems and developing implementation options for meeting capability requirements. Includes key constituent systems information, connectors and protocols used to communicate and/or synchronize processing across the constituents, key data elements/structures that cross interfaces, and key data conversions to facilitate data sharing and communications between constituents. [IEEE, 2011]	

Element	Definition	BMM: OMG dtc-13-08-24
<b>Assessment: SoS Technical Baselines</b> <b>In UPDM analysis from Model?</b>		<b>An Assessment is a judgment of some Influencer that affects the organization’s ability to employ its Means or achieve its Ends. In other words, an Assessment expresses a logical connection (i.e., fact type) between Influencers and the Ends and/ or Means of the business plans. In this way, an Assessment indicates which Influencers are relevant to which Ends and/or Means.</b>
<b>Asset/Resource: System info (constituent system and service architecture models)</b>	Resource: UPDM: Abstract element placeholder to indicate that resources can be exchanged in Operational and Systems views. MODAF: NA DoDAF: Data, Information, Performers, Materiel, or Personnel Types that are produced or consumed.  system — A functionally, physically, and/or behaviorally related group of regularly interacting or interdependent elements; that group of elements forming a unified whole. (JP 3-0)	‘things’ that are used in operating the enterprise often have to be considered. They are represented in the Model as Assets, of two kinds: • Fixed Assets: things that are kept long-term, maintained, reused, and perhaps eventually replaced. They can be tangible, such as equipment and buildings, or intangible, such as patents and licenses. • Resources: things that are consumed and replenished, such as raw materials, parts, finished goods, and cash.
<b>Benefit/Potential Reward (DoD Desired Effect)</b>		Benefit/Potential Reward: Potential impact that indicates the probability of gain. Something that is given in return for good or evil done or received and especially that is offered or given for some service or attainment.
<b>Capability Objectives</b>	Focused on capabilities at the SoS-level. Solution(s) typically require multiple constituent systems, not all of which may be known in advance. Scope typically initially defined in the charter for the SoS. [IEEE, 2011]	

Element	Definition	BMM: OMG dtc-13-08-24
<p><b>Capability Objectives (Vision, goal, objective)</b></p>	<p>The ability to perform a function, task, or action (SEBoK 1.2)  A capability is defined by Joint Staff-J8 as: The ability to execute a specified course of action. (A capability may or may not be accompanied by an intention.) (CJCSI 3170.H)  MODAF: A high level specification of the enterprise's ability. DoDAF: The ability to achieve a desired effect under specified [performance] standards and conditions through combinations of ways and means [activities and resources] to perform a set of activities.</p>	<p>A Vision describes the future state of the enterprise, without regard to how it is to be achieved.  A Goal is a statement about a state or condition of the enterprise to be brought about or sustained through appropriate Means. A Goal amplifies a Vision — that is, it indicates what must be satisfied on a continuing basis to effectively attain the Vision.  An Objective is a statement of an attainable, time-targeted, and measurable target that the enterprise seeks to meet in order to achieve its Goals.</p>
<p><b>CONOPS</b></p>	<p>Multiple system focus. Often developed after constituent systems have been fielded; Evolves over time, sometimes substantially. [IEEE, 2011]</p>	
<p><b>CONOPS (mission, vision)</b></p>	<p>concept of operations —A verbal or graphic statement that clearly and concisely expresses what the joint force commander intends to accomplish and how it will be done using available resources. Also called CONOPS. (JP 5-0)  mission — 1. The task, together with the purpose, that clearly indicates the action to be taken and the reason therefore. (JP 3-0) 2. In common usage, especially when applied to lower military units, a duty assigned to an individual or unit; a task. (JP 3-0) 3. The dispatching of one or more aircraft to accomplish one particular task. (JP 3-30)</p>	<p>A Mission indicates the ongoing operational activity of the enterprise. The Mission describes what the business is or will be doing on a day-to-day basis.</p>

Element	Definition	BMM: OMG dtc-13-08-24
<b>Influencer</b>		<b>Influencer (motivation element) Definition something that has the capability of producing an effect without apparent exertion of tangible force or direct exercise of command, and often without deliberate effort or intent</b>
<b>Integrated Master Schedule</b>	Set of SoS SE activities and milestones plus key single system activities and milestones that are driving SoS critical path. Focus is on key synchronization points among SoS constituents and pointers to development schedules of constituent systems for the current SoS increment. [IEEE, 2011]	
<b>Integrated Master Schedule (IMS)</b>		
<b>Master Plan</b>	Focus is on SoS-level view across multiple increments and touch points for constituent systems. Reflects the SoS evolution strategy. Focus is often on continuous improvement versus achievement of a defined end state. [IEEE, 2011]	
<b>Operational (level of war)</b> <b>In UPDM the Operational model layer</b>	operational level of war — The level of war at which campaigns and major operations are planned, conducted, and sustained to achieve strategic objectives within theaters or other operational areas. See also strategic level of war; tactical level of war. (JP 3-0)	

Element	Definition	BMM: OMG dtc-13-08-24
<b>Outcomes: Desired Result</b>	<p>effect — 1. The physical or behavioral state of a system that results from an action, a set of actions, or another effect. 2. The result, outcome, or consequence of an action. 3. A change to a condition, behavior, or degree of freedom. (JP 3-0)</p>	<p><b>Desired Result:</b> end that is a state or target that the enterprise intends to maintain or sustain a favorable outcome of an undertaking or contest</p>
<b>Performance Data</b>	<p>Often collected in operational environment. Used to support continuous improvement of the SoS.</p>	
<p><b>Performance Measures (metrics)</b> <b>Performance data</b></p>	<p>measure of effectiveness — A criterion used to assess changes in system behavior, capability, or operational environment that is tied to measuring the attainment of an end state, achievement of an objective, or creation of an effect. Also called MOE. See also combat assessment; mission. (JP 3-0)</p> <p>measure of performance — A criterion used to assess friendly actions that is tied to measuring task accomplishment. Also called MOP. (JP 3-0)</p>	<p>Measures of performance are defined in an enterprise's Business Motivation Model as objectives. They may be based on risks and potential rewards identified in assessments. Key Performance Indicators (KPI) / Critical Success Factors (CSF) are not especially distinguished in the model; enterprises can make the distinction if they choose to.</p>
<b>Performance Measures and Methods</b>	<p>Focus is on performance of SoS solution. As independent as possible of the specific systems to allow for assessment of alternative implementation approaches. [IEEE, 2011]</p>	

Element	Definition	BMM: OMG dtc-13-08-24
<b>Policy, regulation, rules, governance structure/Organization</b>	<b>Set of SoS SE activities and milestones plus key single system activities and milestones that are driving SoS critical path. Focus is on key synchronization points among SoS constituents and pointers to development schedules of constituent systems for the current SoS increment. [IEEE, 2011]</b>	
<b>Potential Impact</b>		Potential Impact: (motivation element) Definition evaluation that quantifies or qualifies an assessment in specific terms, types, or dimensions
<b>Requirement</b>	A statement that identifies a system, product or process' characteristic or constraint, which is unambiguous, clear, unique, consistent, stand-alone (not grouped), and verifiable, and is deemed necessary for stakeholder acceptability. (INCOSE SE Handbook v3.2)	
<b>Requirement</b>	Requirements space versus set of specific requirements. Defined at a level of detail that enables trades among potential and actual constituent systems and interfacing external systems. [IEEE, 2011]	

Element	Definition	BMM: OMG dtc-13-08-24
<b>Risks and Mitigations</b>	<b>Focus is on desired capabilities and undesirable emergent behaviors of the SoS. Includes single system risks or dependencies related to SoS capabilities and plans. [IEEE, 2011]</b>	
<b>Risks and Mitigations (COA‡ to mitigate risk)</b>	COA: an approach or plan for working with constituent system’s PMOs or independently to mitigate identified risks	
<b>SE Planning Elements</b>	Focus is on determining rhythm, organizational structure, technical reviews, and decision processes across SoS evolution. Ability and willingness of constituent systems to support SoS plans is an important consideration. [IEEE, 2011]	
<b>SoS Architecture [includes: processes, use cases, rules/constraints, course of action (COA)*]</b>	Course of Action (COA): includes means that is an approach or plan for configuring some aspect of the enterprise involving things, processes, locations, people, timing, or motivation undertaken to achieve ends (BMM-dtc-13-08-24)	
<b>Technical Plan(s)</b>	Focus is on planning the implementation and test of changes to constituent systems to execute an SoS increment. [IEEE, 2011]	

Element	Definition	BMM: OMG dtc-13-08-24
<p><b>Strategy,</b>  <b>Strategic (level of war)</b>            In UPDM the Capability definitions and desired effects</p>	<p><b>strategic level of war — The level of war at which a nation, often as a member of a group of nations, determines national or multinational (alliance or coalition) strategic security objectives and guidance, then develops and uses national resources to achieve those objectives. See also operational level of war; tactical level of war. (JP 3-0)</b></p>	<p><b>Strategy: course of action that is an element of a plan devised through the science and art of business leadership exercised to ensure the most advantageous conditions</b></p>
<p><b>Systems Information</b></p>	<p>Focus is on system-level information that affects SoS level capability objectives. Extends beyond technical issues to include operational, fiscal, organizational, and planning issues. [IEEE, 2011]</p>	
<p><b>Tactic (level of war)</b>            In UPDM the solution/systems model layer (people and H/w and S/w)</p>	<p>tactical level of war — The level of war at which battles and engagements are planned and executed to achieve military objectives assigned to tactical units or task forces. See also operational level of war; strategic level of war. (JP 3-0)</p>	<p>Tactic: Definition course of action that is a device or expedient to be employed as part of a strategy</p>
<p><b>Technical Baselines</b></p>	<p>Focus is on SoS-level description plus identification of constituent system baselines that are part of the SoS baseline. [IEEE, 2011]</p>	