Systems of Systems: Why Model Based Approaches to System of Systems Engineering?

Dr. Judith Dahmann
The MITRE Corporation

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System of Systems

Set of systems that interact to provide a unique capability that none of the constituent systems can accomplish on its own. Each constituent system is a useful system by itself, having its own management, goals, and resources, but interacts within the SoS to provide the unique capability of the SoS.

Systems of Systems Engineering

The process of planning, analyzing, organizing, and integrating the capabilities of a mix of existing and new systems into a system-of-systems capability that is greater than the sum of the capabilities of the constituent parts.
SoS SE in US DoD
... And Beyond
And Today?

IEEE – 13th System of Systems Engineering Conference
SoSE 2018
Also Today ..... 

Model-Based Systems Engineering:
The formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases. (INCOSE 2007)
Why Model Based Approaches to SoSE?
Time to Stop Admiring the Problem?

Pain Points

SoS Authority
What are effective collaboration patterns in SoS?

Leadership
What are the roles and characteristics of effective SoS leaders?

Capabilities & Requirements
How can SE address SoS capabilities and requirements?

Constituent Systems
What are effective approaches to integrating constituent systems?

Testing, Validation & Learning
How can SE approach SoS validation, testing, and continuous learning in SoS?

Autonomy, Interdependencies & Emergence
How can SE address the complexities of interdependencies and emergent behaviors?

SoS Principles
What are the key SoS thinking principles?
Each constituent system brings its own perspective to the SoS

Constituent Systems

What are effective approaches to integrating constituent systems?

Constituent Systems Have Their Own Constraints

Constituent Systems

What are effective approaches to integrating constituent systems?

Shared Venue for Understanding the SoS and Its Constituents

A standards-based SoSE model provides a common, unambiguous, structured, executable, digital representation of the SoS architecture.

Constituent Systems

What are effective approaches to integrating constituent systems?

“SysML Executable Systems of Systems Architecture Definition: A Working Example”
Lack of Top-Level Authority Calls for Effective Collaboration

SoS Authority

What are effective collaboration patterns in SoS?

http://rrppmaster.uab.es/comunicacion-interna-la-columna-vertebral-una-organizacion/
Collaboration Begins With Communication

Models provide a common basis for consistent and coherent views of the SoSE to communicate across stakeholders

SoS Authority

What are effective collaboration patterns in SoS?

http://2017.ieeesyscon.org/
Effective SoSE Requires Trades Across Multiple Interdependent Considerations

Capabilities & Requirements

How can SE address SoS capabilities and requirements?

https://www.economist.com/buttonwoods-notebook/2016/03/02/a-trade-off-between-sovereignty-and-economics
Effective SoSE Requires Trades Across Multiple Interdependent Considerations

Linked models addressing different aspects of the SoS through a common set of core data supports concurrent analysis across competing dimensions.

Capabilities & Requirements

How can SE address SoS capabilities and requirements?
SoSE Needs Mechanisms to Express and Address Complexity

Autonomy, Interdependencies & Emergence

How can SE address the complexities of interdependencies and emergent behaviors?

https://cmns.umd.edu/news-events/features/3491
Effective SoSE Needs Mechanisms to Express and Address Complexity

Autonomy, Interdependencies & Emergence

How can SE address the complexities of interdependencies and emergent behaviors?

Giammarco et al. 2017
Testing, Validation and Learning

How can SE approach SoS validation, testing, and continuous learning in SoS?


“Wack-a-Mole”
Testing, Validation and Learning

How can SE approach SoS validation, testing, and continuous learning in SoS?

Wheeler, 2016
So ... why Model-Based Approaches to SoSE?

**SoS Principles**
What are the key SoS thinking principles?

**Leadership**
What are the roles and characteristics of effective SoS leaders?
Questions?

Dr. Judith Dahmann
MITRE Corporation
jdahmann@mitre.org