SoSECIE Webinar

Welcome to the 2019 System of Systems Engineering Collaborators Information Exchange (SoSECIE)



We will start at 11AM Eastern Time Skype Meeting +1 (703) 983-2020, 46013573# You can download today's presentation from the SoSECIE Website: <u>https://mitre.tahoe.appsembler.com/blog</u> To add/remove yourself from the email list or suggest a future topic or speaker, send an email to <u>sosecie@mitre.org</u>

NDIA System of Systems SE Committee

Mission

- To provide a forum where government, industry, and academia can share lessons learned, promote best practices, address issues, and advocate systems engineering for Systems of Systems (SoS)
- To identify successful strategies for applying systems engineering principles to systems engineering of SoS

• Operating Practices

- Face to face and virtual SoS Committee meetings are held in conjunction with NDIA SE Division meetings that occur in February, April, June, and August
- SoS Track at NDIA 22nd Annual Systems Engineering Conference, Grand Hilton Tampa Downtown, Tampa, FL, October 21-24, 2019
 - Conference Info: <u>http://www.ndia.org/events/2019/10/21/22nd-annual-systems-and-mission-engineering-conference</u>

NDIA SE Division SoS Committee Industry Chairs:

Mr. Rick Poel, Boeing

Ms. Jennie Horne, Raytheon

OSD Liaison:

Dr. Judith Dahmann, MITRE

Simple Rules of Engagement

- I have muted all participant lines for this introduction and the briefing.
- If you need to contact me during the briefing, send me an e-mail at sosecie@mitre.org.
- Download the presentation so you can follow along on your own
- We will hold all questions until the end:
 - I will start with questions submitted online via the CHAT window in Skype.
 - I will then take questions via telephone; State your name, organization, and question clearly.
- If a question requires more discussion, the speaker(s) contact info is in the brief.

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2019 System of Systems Engineering Collaborators Information Exchange Webinars Sponsored by MITRE and NDIA SE Division

August 13, 2019 Systems of Systems, An Overreaching Paradigm Mr. Reggie Cole

August 27, 2019 Understanding and Shaping the Future of Systems of Systems Engineering Mr. Garry Roedler

September 10, 2019 An Analysis of Systems-of-Systems Opportunities and Challenges Related to Mobility Mr. Jakob Axelsson

September 24, 2019 Modeling and Simulation for Internet of things as System of Systems Dr. Paul C. Hershey

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October 22, 2019 Modeling Process for the Design of System of Systems Evolution Dr. Jeremy Buisson, Dr. Isabelle Borne and Mr. Franck Petitdemange

November 5, 2019 Irrational System Behavior in a System of Systems Mr. Douglas L. Van Bossuyt, Mr. Bryan M. O'Halloran and Mr. Ryan M. Arlitt

> November 19, 2019 Multi-Dimensional Classification of System-of-Systems Dr. Bedir Tekinerdogen

December 3, 2019 Digital Twin Strategies for System of Systems Mr. Michael Borth

System-of-Systems as an Overarching Paradigm

Rethinking how we engineer systems in a world where IoT, Agile and DevOps are disrupting the way we think about systems

Reggie Cole Senior Fellow, Lockheed Martin

Systems engineering is a methodical approach for managing complexity and producing trusted systems



Systems engineering has become a bedrock of practices for developing some of the worlds most sophisticated systems

A key element in the practice of systems engineering is defining the context for what's inside the system of interest and what's outside



Outside the System of Interest

We recognize that the system of interest is often part of a larger system-of-systems — and we manage those interfaces accordingly



The field of system-of-systems engineering emerged as a way to deal with the peculiar nature of systems-of-systems





As the systems-of-systems engineering field has evolved, we treated it like a specialty of systems engineering, a special case if you will

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I am starting to wonder if we don't have it backwards.

A nonlinear system analogy:

The system is nonlinear...

...but we can conveniently linearize it.

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A nonlinear system analogy:

As our nonlinear system becomes time-compressed...



...opportunities for linearization are limited



What if this is what's happening to systems engineering?

The distinction between systems and systems-of-systems is not hard and fast — it really is a continuum



Added to this continuum are the disruptive factors of IoT, Agile and DevOps

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Internet of Things



The extension of internet connectivity into physical and cyber devices is driving widespread and accelerating change into system environments.

Agile Development



Agile development is creating a system environment in which the velocity of the "lather-rinse-repeat cycle" results in nearly-continuous change

DevOps Delivery

Seamless Pipeline of Releases to Uses



Daily and Even Hourly Releases

Adds Additional Velocity on Top of Agile Development

The velocity of the DevOps delivery model adds another level of velocity — turbo-charging the agile development model — on top of an already chaotic system environment

Key Disruptions in the Systems Engineering Environment



Increasing Technological Volatility



Increasing Operational Volatility



How is the system environment changing?



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One More Big Change

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Collectively, these lead to a fourth big implication



Porous System Boundaries Distinct boundaries between systems is starting to erode, creating porous system boundaries that is leading to an erosion in system context

Destabilization of System Context



Destabilization of System Context Changes Everything!

The Basic Anatomy of a Traditional System



The Anatomy of a Traditional System — With People



A More Realistic Traditional System



Our System in a System-of-Systems



This is Really What Our System Looks Like



What is the Difference?



What is the Difference?

System-of-Systems



- This is (at a minimum) an acknowledged SoS
- Perhaps it's even a directed SoS
- There is an acknowledged chief engineer
- The chief engineer may have directive authority
- There is an acknowledged system manager
- The system manger may have directive authority
- The system manger may have budgetary authority

Traditional System



- This is a defacto SoS, like it or not
- Some of the participants may understand that
- Other participants probably will not
- It might even be a collaborative SoS
- ✤ No chief engineer or system manager
- No governed management of interfaces
- SoS-level design is based on consensus

What is the Difference?

An "Official" System-of-Systems



This is still an exceptional case

An "Unofficial" System-of-Systems



This is becoming more prevalent — in fact, it's becoming the norm

This is the New Anatomy of a System

The primary interfaces are still the primary interfaces but the secondary interfaces affect the overall dynamics of the system

system from another



System interfaces are often bundled as services and it becomes difficult to fully isolate them from other interfaces

System-of-systems dynamics becomes a primary concern for all systems, not just what we think of as systems-of-systems

How This Perspective Changes Systems Engineering



Requirements — Requirements allocation, management and decomposition must account for a loss of "control."

Analysis of Alternatives — Alternatives can no longer be evaluated from a closed-system perspective and need to be continuously re-evaluated.

System Design — System designs need to be evaluated from a system-of-systems perspective, i.e. system dynamics in a system-of-systems context.

Interfaces — System interface management needs to adjust to a more coupled and dynamic environment.

Test & Evaluation — System-of-systems evaluation needs to be the norm, not a special case or excursion.

Change Management — Change management will necessarily become more collaborative.



It's time to accept that very few (if any) systems actually exist outside of a system-of-systems.

It's time to consider system-of-systems engineering as an overarching paradigm for all of systems engineering.

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Thank you!

I can be reached for follow-ups via email:

reggie.cole@lmco.com

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