Systems of Systems Working Group
Business Meeting

2024
Annual **INCOSE**
international workshop
HYBRID EVENT
Torrance, CA, USA
January 27 - 30, 2024

SoSWG At IW24

Sunday, January 28 - 1-5: Working session on approaches to SoS Engineering

- The current SEBOK SoS knowledge area focuses on broad discussion of systems of systems (SoS) characteristics and systems of systems (SoS) challenges. When we look at progress which has been made in the last few years, it is time for a revision and a new focus on approaches to addressing SoS. This session will provide a venue for SoSWG members to share approaches they have implemented, and their lessons learned. The results of this session will provide input to the update of the SEBOK.

Monday, January 29: 9:30-12: SoSWG Business Meeting

- This meeting will review the status and plans for current activities of the SoSWG and open discussion of possible new initiatives.

Agenda

- Welcome and Introductions

- Webinars

- Upcoming Conferences – IEEE 2024, SoSE 2024, IS 2024

- SEBOK

- Collaboration with INCOSE WGs
  Systems and Software Interface Working Group (SaSIWG)- Macaulay Osaisai

- Review of IW 22 Actions

- Open discussion – What next?

- Close

SoS Webinars

https://connect.incose.org/Library/Webinars/
Pages/Working-Group-Webinars.aspx

- Monthly online webinars

- Recorded and posted on SoS WG Connect Site

- Contact Jason Sherey with recommendations for added webinars at Jason.sherey@gmail.com

  Suggestions?
  - Introduction to SoS
  - Harding SoSE 23 Keynote
  - Others?

Upcoming Conferences

IEEE Systems 2024

SYSCON 2024 | April 15-18, 2024
The 18th Annual IEEE International Systems Conference | Delta Hotels Montreal, Canada

APRIL 15 - 18, 2024 | MONTREAL, QC, CANADA

The 18th Annual International Systems Conference

IEEE SYSTEMS COUNCIL

https://2024.ieeesyscon.org/

SoSE 2024

June 23rd – 26th 2024

Venue: Murano Hotel, Tacoma, WA, USA

Conference Theme: AI Role in Systems of Systems Engineering

SOSE

https://sosengineering.org/2024/

INCOSE International Symposium

34th Annual INCOSE international symposium
hybrid event
Dublin, Ireland
July 2 - 6, 2024

INCOSE

https://www.incose.org/symp2024
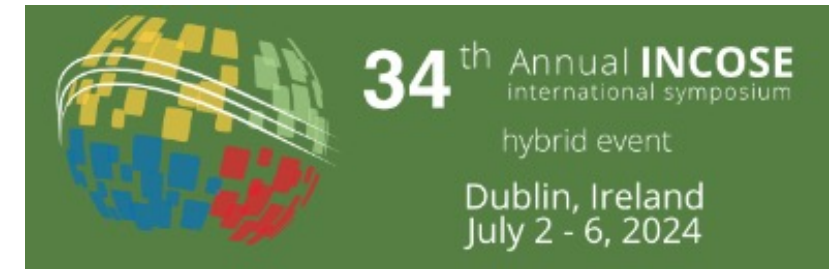
Conferences
IEEE SoSE Conference 2023 SoSWG Panel

18th Annual System Of Systems Engineering Conference

June 14th – 16th 2023

Polytech Lille, University of Lille ,Villeneuve d'Ascq, France
Conference Theme: A.I and Autonomous Robotics in System of Systems

- INCOSE is a partner in this conference
- Traditionally, the SoS WG has sponsored one or more sessions
  - 2021: SoS and Complexity
  - 2022: SoS and INCOSE Vision
  - 2023: SoS Pain Points

2023 INCOSE Panel: SoS Pain Points
10-year retrospective
Roedler, Dahmann, Harding, Axelsson

INCOSE Panel

Systems of Systems Perspectives on the INCOSE SE Vision 2035

Garry Roedler	Alan Harding
• Senior Fellow, Lockheed Martin (Retired) • 35+ years experience of systems engineering across defence and aerospace domains • Editor for several standards for SE and SoSE • Past President of INCOSE • Past Vice Chair of NDIA SE Division • girjar@gmail.com	• Head of SE/Engineering Fellow, BAE Systems • 37 years experience of systems engineering across defence domains, focus areas include SOS, Architecting, Capability, DEI • Past President of INCOSE and INCOSE UK • Founder and cochair of INCOSE SoS WG • alandharding@gmail.com
Dr. Judith Dahmann	Kerry Lunney
• Technical Fellow, The MITRE Corporation • Over 25 years experience in modelling and simulation, SE, systems of systems, and mission engineering • INCOSE Fellow • Founder and cochair of INCOSE SoS WG • jdahmann@mitre.org	• Eng Director/Chief Engineer, Thales Australia • Over 30 years experience in industry, across multiple industries, working in 5 countries, setting strategies, delivering system solutions & implementing governance programs • Immediate Past President of INCOSE • kerry.lunney@thalesgroup.com.au

2021 SoSE INCOSE Panel
Systems of Systems & Complexity Panelists
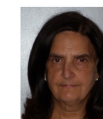
Judith Dahmann | Eric Honour | Dan DeLaurentis | Ali Raz | Stephen Cook

SoSE 2024

MOU Signing Event between SoSE Conference and INCOSE

19th Annual System of Systems Engineering Conference

June 23rd – 26th 2024

Venue: Murano Hotel, Tacoma, WA, USA

Conference Theme: AI Role in Systems of Systems Engineering

April 1st 2024	April 30th 2024	May 15th 2024
Papers Submission (Online)	Acceptance Notification	Final Camera Ready Manuscript due

Keynotes:
- Marilee Wheaton, INCOSE Past President
- Sky Matthews – IBM
- John Palmer - Boeing

INCOSE SoS Panel
- "The Impact of Advanced Technologies on SoSE"

Engagement with Other WGs - Opportunities

➤ Complexity

Long time partner; Sunday afternoon collaboration session;

 ❖ Review New Complexity Primer for SoS Implications

- **Is there still interest in engaging with these working groups?**

- **Volunteers to lead these engagements?**

➤ Smart Cities

Recognizing the SoS aspects of smart cities, Jennifer Russell has invited SoSWG members to join online Smart Cities monthly meetings

➤ Agile WG:

There was WG interest in Scaled Agile Framework/DEVSECOPS Lessons for/applications to SoSE expressed during IW22 discussions

❖ Review Agile Primer for SoS Implications

➤ DEIX WG:

Digital thread through SoS was a topic raised during IW22 discussions, with proposal for follow-up with an exchange with DEIX WG

➤ Productline WG Engagement (Hoehne)

Relationship to Productline WG recognized as area of interest

SEBoK: SoS and Complexity

- Article in 'Emerging Knowledge' on SoS and Complexity
- Based on work of SoS and Complexity Working Groups

https://sebokwiki.org/wiki/System_of_Systems_and_Complexity

SEBoK: SoS Knowledge Area (KA)

Systems of Systems (SoS)

Guide to the Systems Engineering Body of Knowledge (SEBoK) > Systems of Systems (SoS) > Socio-Technical Features of Systems of Systems > Architecting Approaches for Systems of Systems > Systems of Systems (SoS)

Lead Authors: *Mike Henshaw, Judith Dahmann, Bud Lawson*

System of systems engineering (SoSE) is not a new discipline; however, this is an opportunity for the systems engineering community to define the complex systems of the twenty-first century (Jamshidi 2009). While systems engineering is a fairly established field, SoSE represents a challenge for the present systems engineers on a global level. In general, SoSE requires considerations beyond those usually associated with engineering to include socio-technical and sometimes socio-economic phenomena.

Contents [hide]

1 Topics
2 Characteristics and Definition of Systems of Systems
3 Types of SoS
4 SoSE Application Domains
5 Difference between System of Systems Engineering and Systems Engineering
6 SoSE Standards
7 References
  7.1 Works Cited
  7.2 Primary References
  7.3 Additional References
  7.4 Relevant Videos

Contents [hide]

1 The Role of System of Systems Architecting
2 Challenges in Architecting SoS
3 Architecture Analysis
4 The Open Approach to SoS Engineering
5 Networks and Network Analysis
6 Interoperability
7 References
  7.1 Works Cited
  7.2 Primary References
  7.3 Additional References

Contents [hide]

1 The Socio-Technical Nature of Systems of Systems
2 SoS Governance
3 Situational Awareness
4 References
  4.1 Works Cited
  4.2 Primary References
  4.3 Additional References

https://sebokwiki.org/wiki/Systems_of_Systems_(SoS)

- Micheal Henshaw and Judith Dahmann Co-Editors of SoS KA

- Plan to update SoS KA in 2024

- Retain/Update basic information

- Update and replace other content with a focus on approaches to implementing SoSE

Sunday, January 28 - 1-5: Working session on approaches to SoS Engineering

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Sunday SEBOK/SoSE Approaches Session

Agenda
- Welcome and Introductions
- SEBOK Update – Tom McDermott and Garry Roedler
- SEBOK System of Systems (SoS) Knowledge Area (KA)
- 'SoS and Complexity' in Emerging Knowledge
- Plans for SoS KA Update
- SoS Implementation Approaches – Examples to Begin Discussion
- Open Discussion
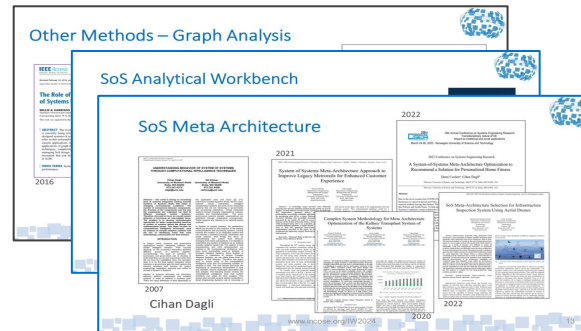
• Data analytic methods for understanding SoS performance

Stephen Cook
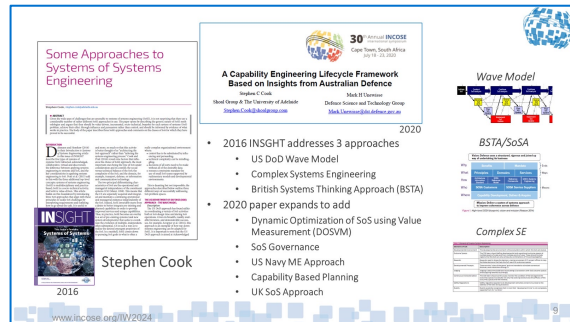
• Leverage/update some longstanding approaches (e.g., wave model)
• Build on emerging complexity materials (e.g., most recent Complexity Primer)

Mike Yokell

Judith Dahmann
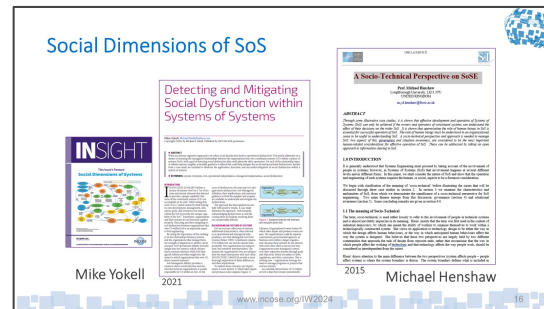
• Address issues beyond technical
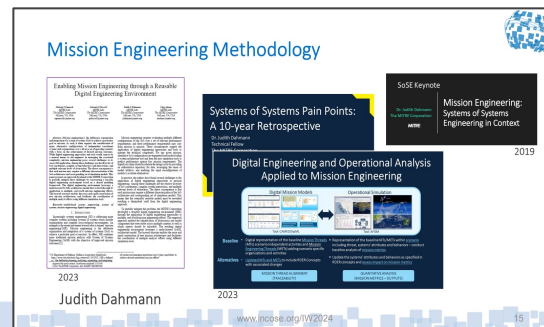
• Relevant but needs to be translated to non-Defense language

- Great participation (~40 in-person and remote participants) and lively discussion
- Found good opportunities in the approaches included in the discussion slides
- Suggest include discussion of 'enablers' which are important for different approaches
- Identified additional near and long-term areas
  - Multi-Scale (socio-technical SoS)
  - Innovation Systems/ SoS
  - Methods from specific domains (e.g.. Rail, Energy)
  - Ultra-Large – Mega Systems
- Next steps
  - Review discussion for near-term SEBOK updates and options for SoSWG initiatives
  - Solicit volunteers to support these

Review of Opportunities identified at IW23

- INCOSE Handbook - Complete

- Cyber Security from SoS perspective – Beth Wilson - Complete

- SEBOK – SoS and Complexity - Judith Dahmann - Complete

- Relationship between SoS, Mission Engineering, Capability Engineering and Complexity - Pending

- SoS reflection on INCOSE products – Pending

- Heuristics (New - Kerry Lunney)

SoS Input to the INCOSE SE Handbook Update
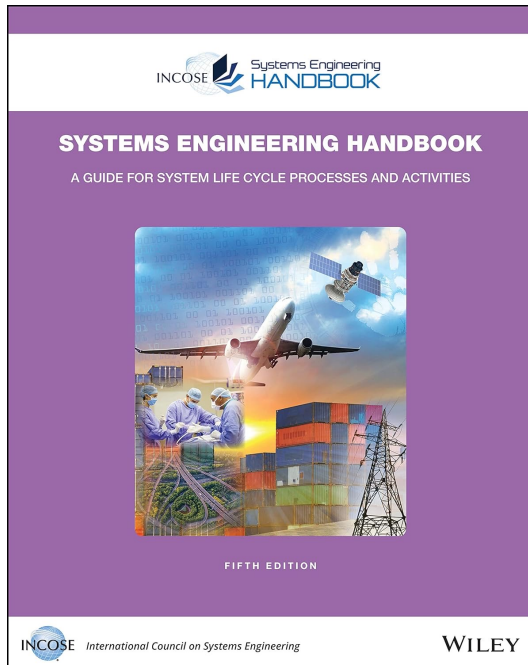
Released July 2023!

- The update to the INCOSE SE Handbook (SEH) is underway
- Working Groups had an opportunity to provide input
- Several SoSWG graciously provided comments
- Content was updated following INCOSE IS 21
- Additional updates were reviewed at IW22: Six additional comments submitted and accepted in principle by the SEH core group and one comment was deferred to the working group
- SoSWG comments were accepted and were included in the handbook

Cyber Security from SoS Perspective

- At IW22 SoSWG received a request SE Enablers lead

- SoS Working Group agree to develop a paper on SoS perspective on Cyber Security.

- This was implemented in partnership with the Complexity Working Group.

Completed

- ❖ Beth Wilson draft paper and shared draft with Complexity team
- ❖ Paper was reviewed and completed
- ❖ Paper is available

System of Systems (SoS) Perspective on SE for Cyber Contested Environment

Designing a cyber secure and cyber resilient system is challenging. Extending this design concept to a System of Systems (SoS) amplifies this challenge. This white paper explores the SoS perspective on systems engineering for the cyber contested environment. We identify cyber threats that are amplified in the SoS environment, identify systems security techniques that are difficult to implement in a SoS, and map these cyber security and cyber resiliency challenges to the SoS pain points and SoS Engineering core elements.

Contact: Beth Wilson wilsondrbeth@aol.com

System of Systems (SoS) Perspective on SE for Cyber Contested Environment

Cyber Threats Amplified in the SoS Environment
- Lateral Movement
- Insider Threat
- Evolving Threats

Systems Security Techniques Made Difficult for SoS
- Network Segmentation/Segregation
- Defense-in-Depth
- Patching Vulnerabilities
- Encryption
- Access Control

SoS Pain Points Amplified by Systems Security Concerns
- Testing
- Capabilities and Requirements
- Autonomy, Interdependence, and Emergence
- Constituent Systems

Core Elements in SoS Engineering Challenged by Systems Security
- Understanding Systems and Relationships
- Assessing Performance against Capability Objectives
- Developing and Evolving an SoS Architecture
- Monitoring and Assessing Changes/Orchestrating Upgrades

Summary

SoS Reflection on INCOSE Products In Progress

- At IW22, the working group decided to undertake a new line of effort, to provide an SoS perspective on INCOSE products.

- As the SE Vision 2035 interconnected systems – SoS – are becoming the norm which calls for an SoSE perspective as we move to the future.

- This provides an opportunity of the working group to support INCOSE writ large by bringing an SoS perspective to INCOSE products in several ways.

- By exposing products to the SoS community, the SoSWG can promote broader use of products from other working groups.

- In the process, the WG can assess whether there is a need for added guidance or advice on how to effectively leverage the products when address an SoS – possible creating a short addendum offing this perspective.

Summary of Project Progress
SoS Perspective on Requirements WG Products

Timeline	Activity	Results
July 2022	RWG Cafe	How does SoS use RWG products?
Aug 2022	SoS Project Kickoff	Decided against stand-alone option • GtNR = 120 pages, GtSoSNR would be ~150 pages • Would replicate content in ISO/IEC/IEEE 21840 *Decision: create a "Rosetta Stone"*
Jan 2023	First Draft	Identified SoS mapping for each of RWG terms *Sent to WG for comments after IW23*
Oct 2022 – Jan 2024	SSE WG	Similar project for Systems Security Sep 2023: Major change from Rosetta Stone format • Want SSEs to relate to RWG product content • Want SEs to create better security requirements • Changed to use RWG term, explain SSE focus
Jan 2024	Proposal	Similar approach for SoS Guide to Requirements
2024	PLANS	Develop Guide to SoS Needs and Requirements • Needs/Requirements/Verification/Validation Term • SoS Focus for activity

Guide to Security Needs and

NRVV Term: *Needs Analysis*
Process of eliciting stakeholder needs and requirements, identifying drivers and constraints, identifying risks, developing and maturing lifecycle concepts, deriving an integrated set of needs, and baselining those needs.

Security Focus:
The use of loss-driven analysis can aid stakeholders in determining the level of loss that can be tolerated. The analysis should produce a list of SOI capabilities and necessary constraints, which should be prioritized based on their potential disruption to the SOI's purpose, mission, or objectives, with the least tolerable loss being listed as the most disruptive and the most tolerable loss being listed as the least disruptive. In collaboration with the stakeholders, this list can be prioritized in various ways. The prioritization could be determined by factors such as the cost of protecting against specific capability losses, the time required to implement secure designs, and the expected increase in assurance that a mitigation will effectively protect against, or others.

INCOSE

Guide to Security
Needs and Requirements
TBD 2024

~12 pages of text
Jan 2024: Latest draft out for review, plan official INCOSE product in 2024

If you are interested to engage, contact Beth Wilson <wilsondrbeth@aol.com>

Relationship between SoS, Mission Engineering, Capability Engineering and Complexity - Pending

- The US Department of Defense has a new focus on "Mission Engineering" (ME) which applies systems engineering to defense missions drawing on SoSE capabilities along with mission analysis and digital engineering.

- Mission Engineering shares core characteristics with 'Capability Engineering" in the UK. Both Mission Engineering and Capability Engineering recognize complexity challenges.

- Based on the discussion at the joint session with Complexity, it was agreed that we would look at the relationship among SoS, Capability Engineering, Mission Engineering & Complexity.

Update

- Due to time conflicts, this task is still pending

- Recommend initiate now given continued interest in this area (Dahmann, Kemp, Delicado)

Contact Judith Dahmann
jdahmann@mitre.org
if you are interested to engage

Heuristics

- Does the SoS WG have things to offer the Heuristics Initiative?

Abstract

Complex systems are challenging for engineers. In considering the challenges in addressing complex problems as well as designing and developing complex systems, the INCOSE Complex Systems Working Group (CSWG) Heuristics Focus Team, in conjunction with the INCOSE Heuristics Team, has considered a range of systems engineering heuristics that guide the engineering of complex systems. These heuristics provide some initial insight for understanding the engineering of complex systems. This work aims to identify, develop, analyze and curate these heuristics and their potential use in dealing with complexity and developing complex systems. This paper concludes that a range of beneficial heuristics have been identified that cover the breadth of complex problems, as assessed from multiple perspectives. This initial or preliminary set of heuristics needs to be tested through practice and use across the INCOSE community before effort is expended to make them more memorable, either individually, or as a set.

Supporting the INCOSE Heuristics Initiative

Risk Management Working Group (RMWG) Meeting

Tuesday, November 7, 2023

2:00 – 3:00 PM EST (Eastern Time, US and Canada)

11am-12pm PST | 1-2pm CST | 7-8pm GMT (London) | 8-9pm CET (Paris)

Meeting Purpose: Discuss collaboration between the INCOSE Risk Management WG and the INCOSE Heuristics Team.

Presentation Topics:
- Quick summary of the INCOSE Heuristics effort to date
- Why Working Groups (WGs) are being asked to help
- Benefits to the Risk Mgmt WG and participating members
- What processing heuristics entails
- Question and Answer time

This is a virtual (Zoom) meeting. Registration is required to obtain the Zoom "Join" and "Add to Calendar" links:

REGISTER TO ATTEND

Presenters: D. McKinney and S. Jackson, INCOSE Fellows and original members of the Heuristics Team

Dorothy has over 45 years of aerospace and research experience. She worked over 34 years at Lockheed Martin and heritage companies, retiring from there as a Fellow Emeritus. After her retirement, she has started and closed two companies, one a dot com start-up, Considered Thoughtfully, and the second Advanced Systems Thinking, a systems engineering consulting firm. She started her career at Stanford Research Institute and worked for several years at ArgoSystems (bought by Boeing during her tenure). While working full time at Lockheed Martin, she also served over 15 years as an adjunct professor, first at San Jose State University and later at Portland State University. Her undergraduate degree is from Prescott College in English and Systems Sciences, and graduate degrees are an MS in Computer Engineering from Stanford University, and an MBA from Pepperdine University.

Dorothy McKinney

Abstract

AbstractSystems engineering (SE) is a transdisciplinary discipline that links all the engineering disciplines involved in defining a system throughout its lifecycle. As such, SE involves heuristics to a significant extent. A heuristic relates to a formulation based on experts' experience serving as a guide in the investigation or solution of a problem. To be usable, heuristics should be memorable and pithy. A team of INCOSE Fellows created the INCOSE Systems Heuristics Application Repository, or I-SHARE in short, in which over 600 SE-related heuristics are curated and shared, covering subjects that include SE competencies, lifecycle stages, expertise, operational domains, and system attributes. In this paper, we describe the I-SHARE, the motivation and stages of its creation and compilation, and ways through which this knowledge base can be an invaluable service to the SE community.

Contact Judith Dahmann
jdahmann@mitre.org
if you are interested to engage

What is next for the SoS WG?

Open Discussion

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