System of Systems Engineering



MITRE works with sponsors to research, design, and deploy complex systems of systems for the 21st century.

In today's heavily networked world, many systems must function as part of larger systems of systems (SoS) with complex integration requirements. MITRE's sponsors recognize the criticality of effective end-to-end performance of SoS that support their operations, and they continually invest in new and modernized systems that must integrate into their SoS. When integrating new systems into an SoS, sponsors must ensure that users can continue to support current operations. MITRE's SoS approach addresses these challenges by providing a deliberate, data-driven methodology for verifying that an SoS meets user requirements and that new systems are integrated with minimal disturbance to existing capabilities.

Adapting Systems Engineering for Systems of Systems

SoS engineering enables users to achieve their mission, ensuring relevant systems are engineered for success. Systems may each have their own management, resourcing, and objectives, but all contribute to larger enterprise goals. Trades must be made to preserve acceptable levels of performance and affordability. MITRE is developing methods, processes, and tools to make SoS effectiveness a reality.

Sytem of system engineering ensures that complex, integrated capabilities operate together to meet users' needs.

MITRE

Systems of Systems Engineering

Addressing Systems Engineering for SoS

Complex SoS engineering techniques increase the likelihood of successful results when classical methods can't produce reliable outcomes. MITRE bridges the gap between theory and practice, enabling systems to operate under unpredictable conditions. We work across our technical centers to develop techniques that harness the complexity in our sponsors' environments, including modeling and simulation approaches that shed light on complex interdependencies and trade spaces. Our researchers routinely collaborate with our sponsor-facing engineers to understand these problems in practical terms.







Approaches for Addressing the Challenges of SoS

SoS Best Practices and Guidance: MITRE is leading the development of standards and recommended practices for SoS engineering. These practices have proven invaluable across a variety of applications including the management of multiple concurrent systems, the structuring of multi-organizational shared services, and the design of new approaches to address emerging security threats.

SoS Pain Points: MITRE is leading the International Council on Systems Engineering (INCOSE) systems engineering community articulation of SoS "Pain Points"—the challenges in applying systems engineering to SoS, which are different in degree or kind from engineering individual systems.

Model-based Engineering of SoS: Model-based engineering addresses complexities of SoS. MITRE integrates executable models of sponsors' SoS with an operational effects simulation to assess the impact of different improvement options on the SoS end-to-end capability. This enables data-driven, end to-end capability investment decision making. MITRE has applied model-based engineering to areas as diverse as assessing cybersecurity options in deployed SoS, integrating multiple stove piped systems into an effective cross-cutting military capability, and developing requirements for a new information system that addresses the impacts of integration into existing SoS. In each case, capturing the key interdependencies reduced risk for new and enduring capabilities.

Mission Engineering: Mission engineering is the systematic modeling and analysis of warfighter mission. MITRE supports our sponsors in applying digital engineering and operational analysis to assess the mission impact of SoS in priority scenarios.

Technical Management of Complex Interdependencies: The MITRE SoS Wave model is an agile, evolutionary approach to engineering SoS capabilities in the face of change, uncertainty, and complexity.

For information about MITRE's work in Systems Engineering, contact systemsengineering@mitre.org.

For more information about MITRE, visit www.mitre.org.

MITRE's mission-driven teams are dedicated to solving problems for a safer world. Through our public-private partnerships and federally funded R&D centers, we work across government and in partnership with industry to tackle challenges to the safety, stability, and well-being of our nation.

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