

# A Method for System of Systems Tradespace Exploration

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**Biography**

Debarati Chattopadhyay received a S.M. degree in Aeronautics and Astronautics from MIT in 2009. Debarati has B.S. degrees in Computer Engineering (2005) and Astrophysics (2004) from Lehigh University. She has worked in mission operations for the Chandra X-ray Observatory at the Harvard-Smithsonian Center for Astrophysics and now works at the Jet Propulsion Laboratory in Pasadena, CA.

**Related Publications**

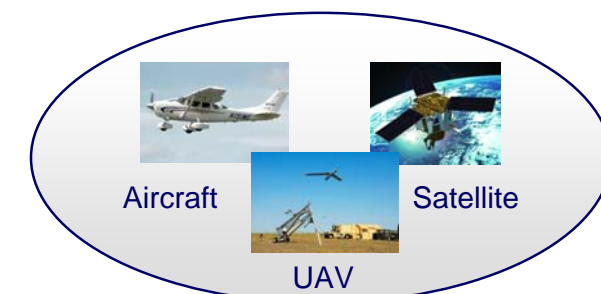
- Chattopadhyay, D., Ross, A.M., and Rhodes, D.H., "A Practical Methodology for System of Systems Tradespace Exploration," AIAA Space 2009, Pasadena, CA, September 2009.
- Chattopadhyay, D., Ross, A.M., and Rhodes, D.H., "Combining Attributes for Systems of Systems in Multi-Attribute Tradespace Exploration," 7th Conference on Systems Engineering Research, Loughborough University, UK, April 2009.
- Chattopadhyay, D., Ross, A.M., and Rhodes, D.H., "Demonstration of System of Systems Multi-Attribute Tradespace Exploration on a Multi-Concept Surveillance Architecture," 7th Conference on Systems Engineering Research, Loughborough University, UK, April 2009.
- Chattopadhyay, D., Ross, A.M., and Rhodes, D.H., "A Framework for Tradespace Exploration of Systems of Systems," 6th Conference on Systems Engineering Research, Los Angeles, CA, April 2008.

## What is a SoS?

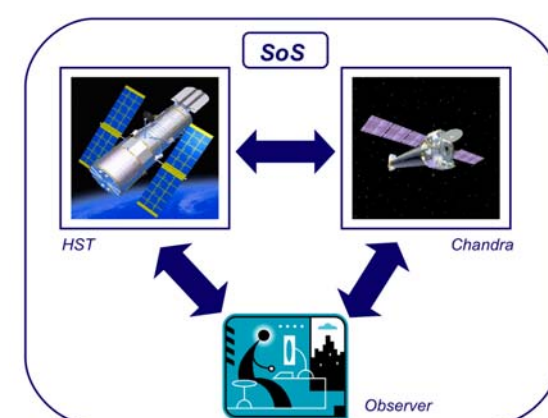
A system-of-systems (SoS) is a *set of collaboratively integrated systems* that possess two additional properties: *operational independence* of the components and *managerial independence* of the components. (Maier 98)

SoS is defined as a set or arrangement of systems that results when *independent and useful systems are integrated* into a larger system that delivers unique capabilities. (DoD 2008)

### Multi-Concept Responsive Disaster Surveillance



### Coordinating Observatories



## Motivation

- System of Systems design requires *sophisticated decision making under high uncertainty* to ensure selection of designs that maintain value over the operational lifetime
- A *quantitative method* is necessary to compare SoS design alternatives and understand the tradeoffs between diverse stakeholder preferences.

**Design of future SoS will require quantitative concept exploration methods to improve SoS selection decisions**

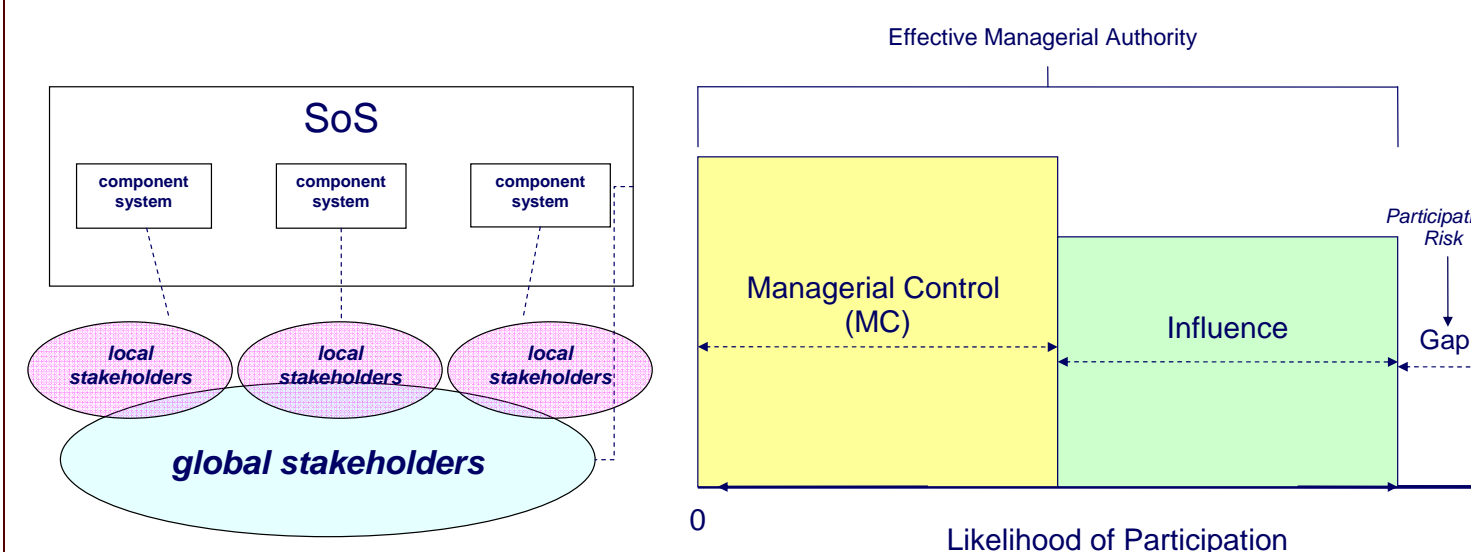
## Contributions

- Prescriptive, quantitative method for SoS tradespace exploration, called **System of Systems Tradespace Exploration Method (SoSTEM)**, which enables the comparison of a large number of diverse SoS designs on the same tradespace and the selection of value robust SoS designs
- Development of a framework for considering Managerial Control and Influence within SoSTEM during SoS conceptual design

## Research Questions

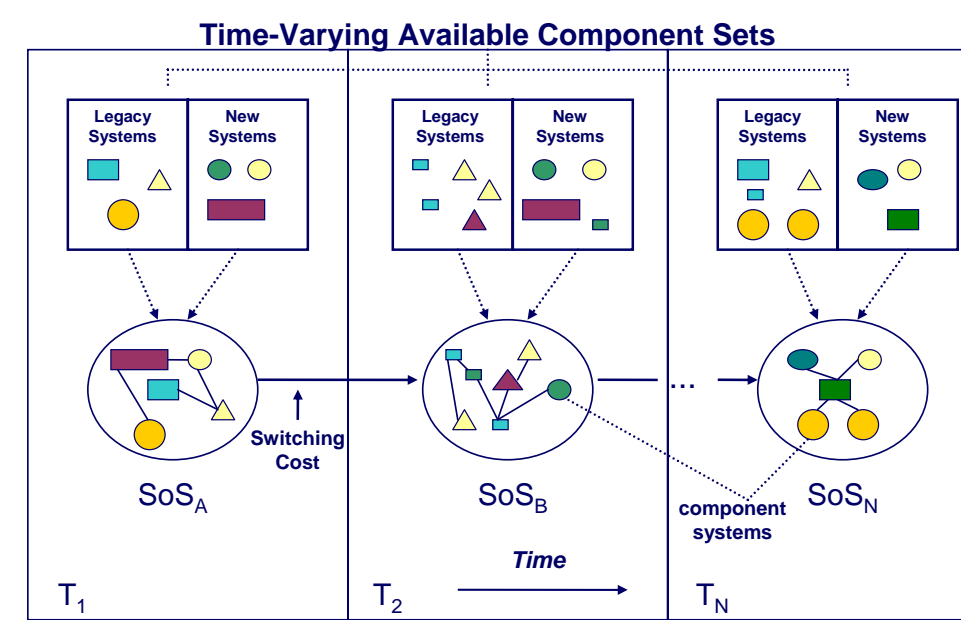
- What are the characteristics that distinguish SoS design from traditional system design?
- What is a practical framework for SoS tradespace exploration?
- How can the developed tradespace exploration framework be used to select SoS designs that are value robust through the SoS lifetime?

## SoS Specific Considerations

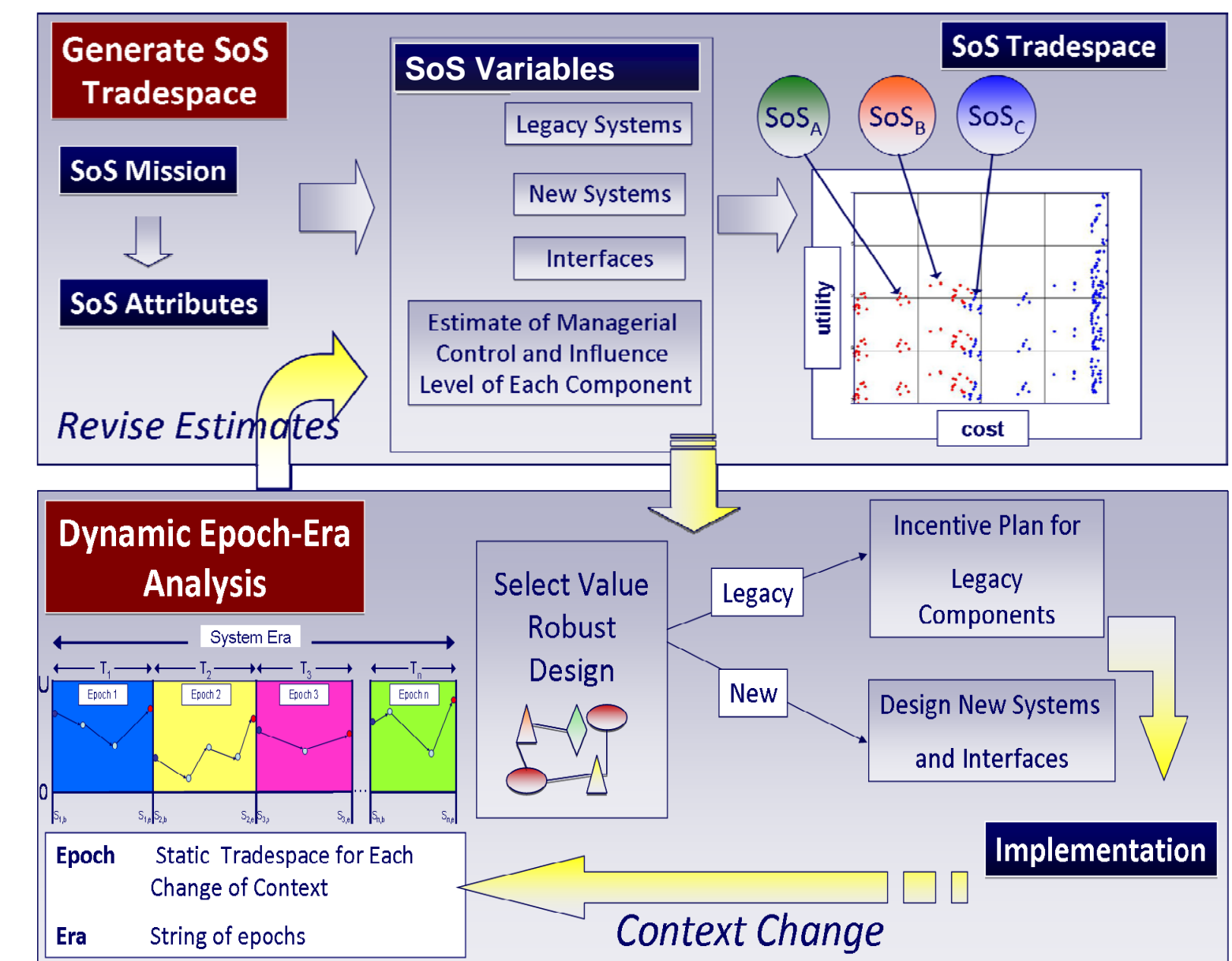


**Local and Global Stakeholder Sets**  
Legacy and New Systems  
Dynamic Composition

**Consider managerial authority during SoS design**  
**Study SoS value delivery over time, accounting for dynamic composition**



## System of Systems Tradespace Exploration Method (SoSTEM)



## References

- Maier, M.W., "Architecting Principles for Systems-of-Systems", *Systems Engineering*, 1, 4, pp. 267-84, 1998.
- Director, Systems and Software Engineering, "Systems Engineering Guide for Systems of Systems", Technical Report, Office of the Undersecretary of Defense (Acquisition, Technology and Logistics), Washington, D.C., 2008.
- Ross, A.M., and Rhodes, D.H., "Architecting Systems for Value Robustness: Research Motivations and Progress," Annual IEEE Systems Conference, Montreal, Canada, April 2008.