RT-108: Assessing Development Disruptions and Dependencies in Analysis of Alternatives of System-of-Systems

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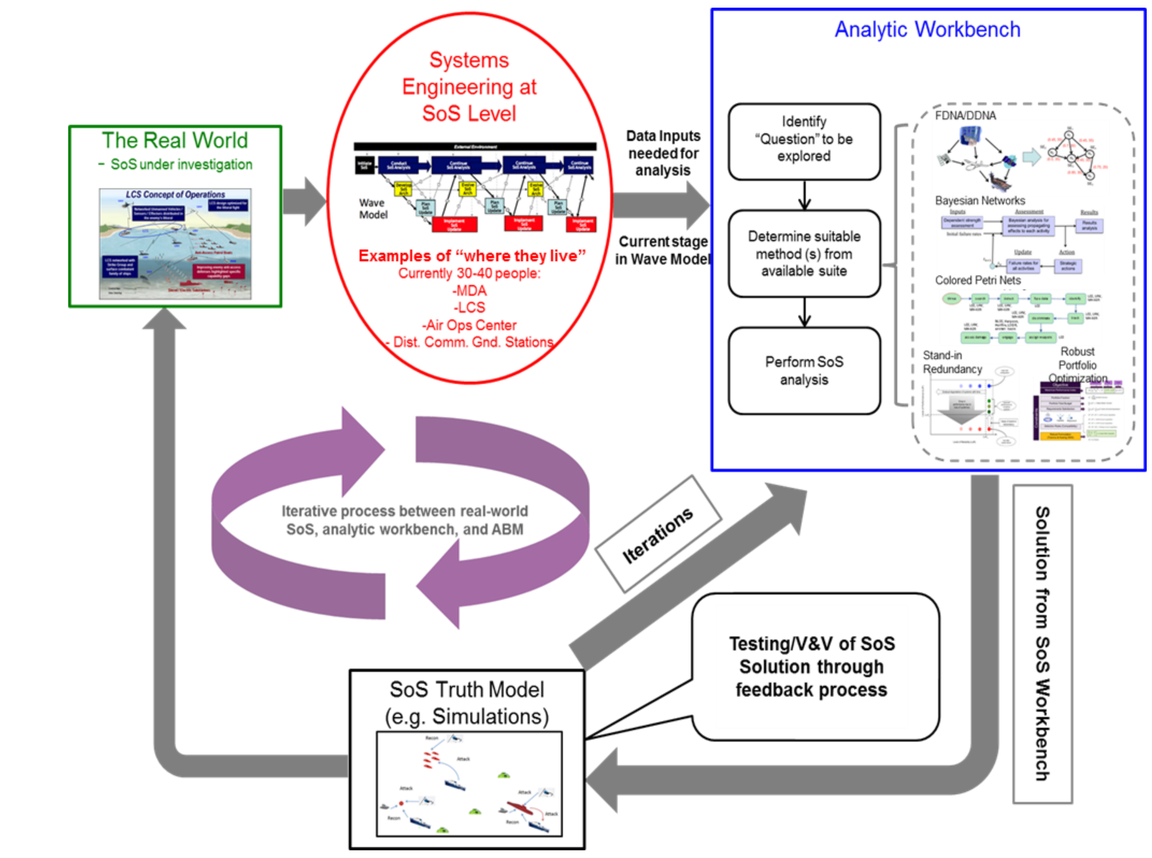
Overview

OBJECTIVE – Develop methods and framework for an analytic workbench to analyze system interdependencies in context of SoS architecture and evolution to guide both systems and SoS development.

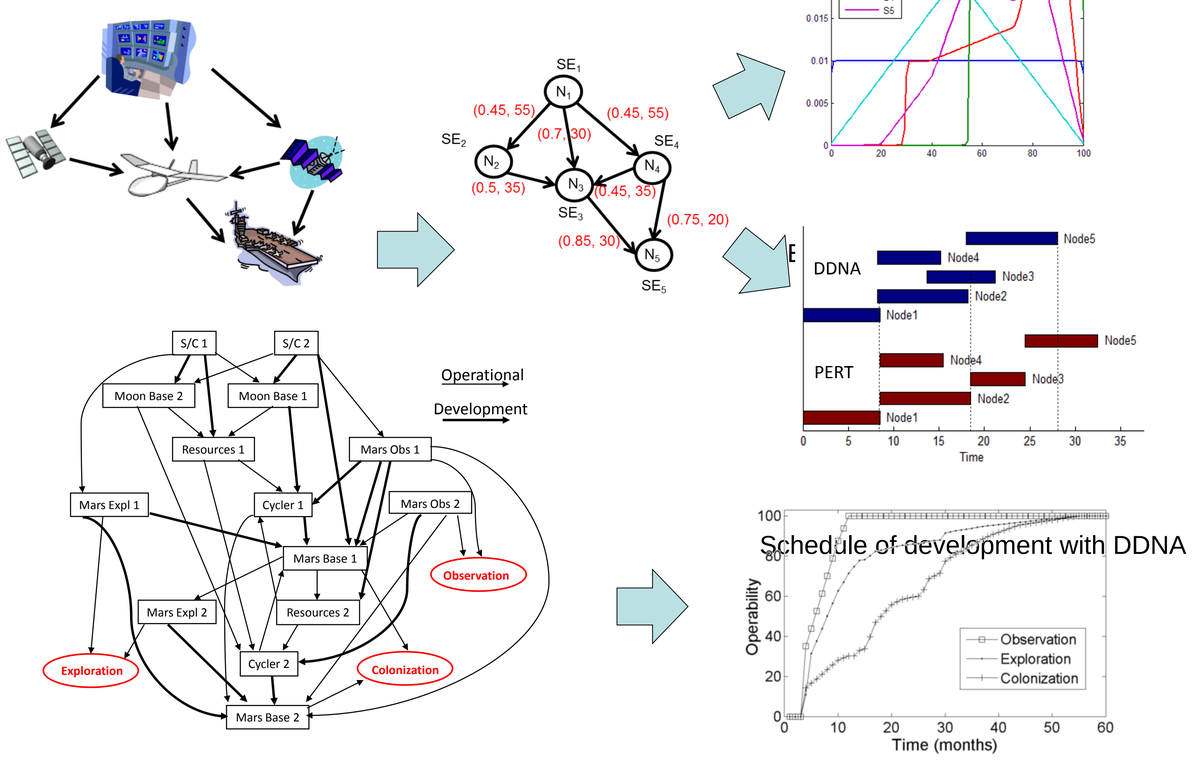


Computational Methods

Functional/Developmental Dependency Network Analysis (FDNA/DDNA)

Methods to analyze and quantify interdependencies and cascading effects of risks through networks of systems.

FDNA/DDNA Analysis of 5 Node System



Combined FDNA/DDNA for analysis of Mars Exploration SoS partial capabilities

Bayesian Networks for Interdependency Analysis

Inputs:

- Failure probabilities of constituent systems
- Conditional probabilities
- Architectures

Bayesian Networks Model

Assumption:
- Directional graph

Req. 1 (Mine counter-measure (MCM))
Req. 2 (Surface warfare (SUW))
Req. 3 (Anti-submarine warfare (ASW))
Capability

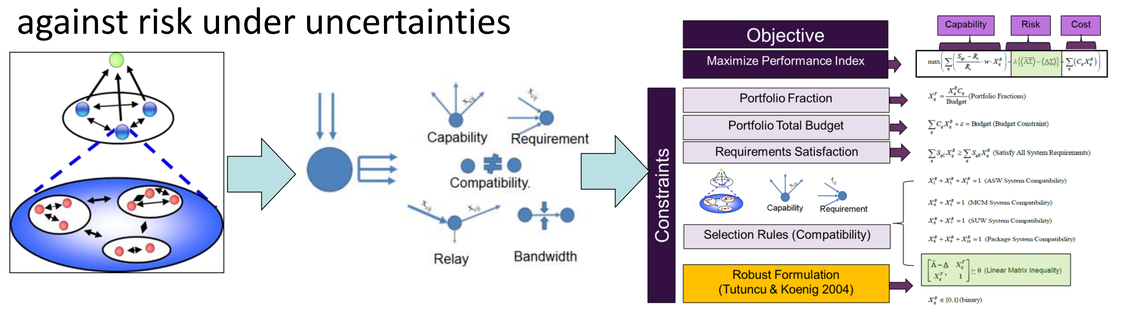
Outputs:

- Criticality of systems
- Resilience patterns

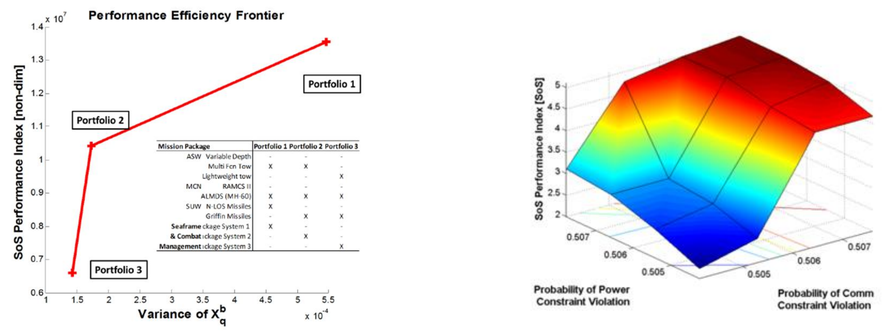
Computational Methods

Decision Tools: Robust Portfolio Optimization

Decision support approach from financial engineering/operations research to identify 'portfolios' of systems by leveraging performance against risk under uncertainties

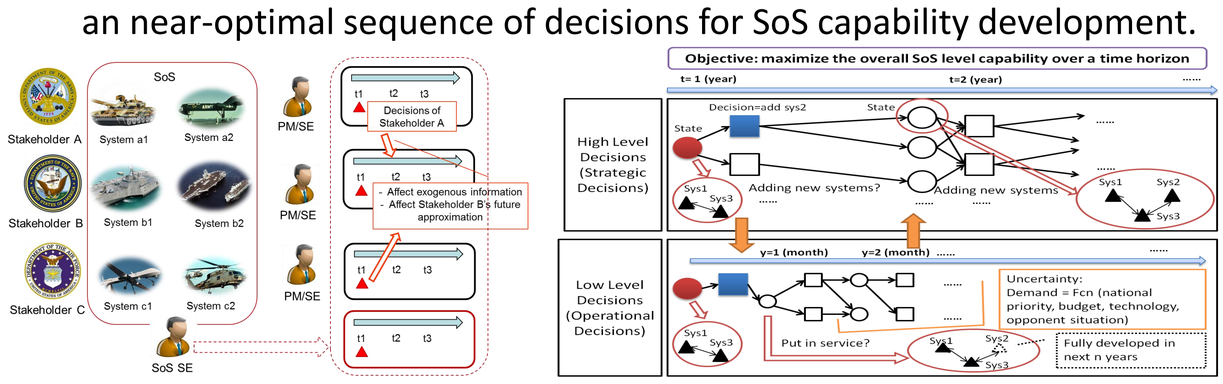


Performance Efficiency Frontiers for Tradespace Analysis



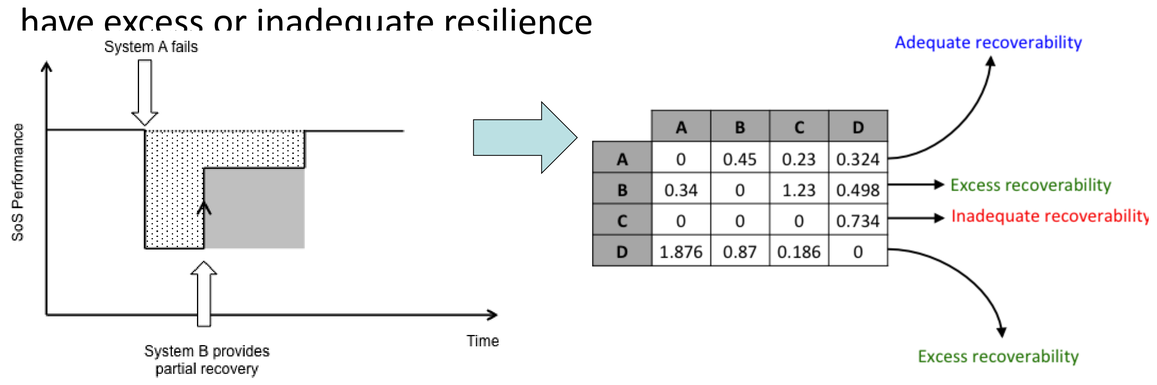
Decision-Tools: Dynamic Planning of SoS Architecture Evolution

Approximate dynamic programming (ADP) framework is used to make an near-optimal sequence of decisions for SoS capability development.



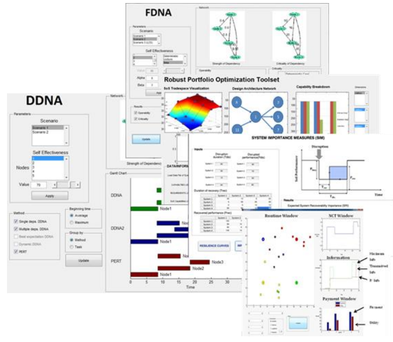
System Importance Measures

Family of measures that rank systems based on their impact on the overall SoS performance. SIMs help determine which areas of the SoS have excess or inadequate resilience



Future : Towards an Analytic Workbench

- Development of **Analytical Workbench** for analysis and evolution of SoS architectures with current collaborators – NSWCDD, MSCI, USAF Space Command.
- Further refinement and consolidation of computational methods towards open workbench environment to support dependency analysis and SoS evolution



Contacts/References

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