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The Center for Education and Research in Information Assurance and Security

Increasing robustness and resilience: assessing disruptions and dependencies in analysis of System-of-Systems alternatives

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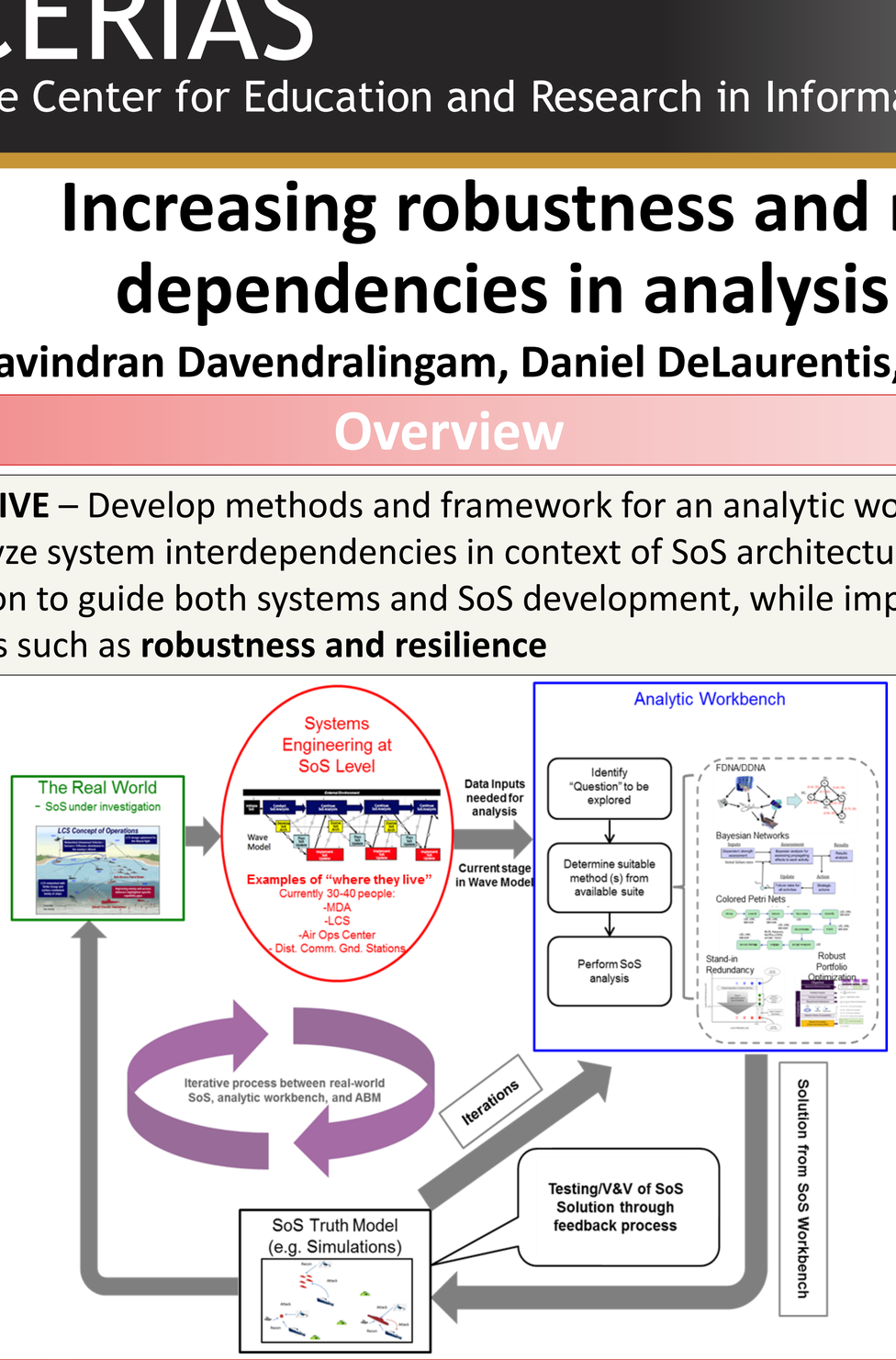
Overview

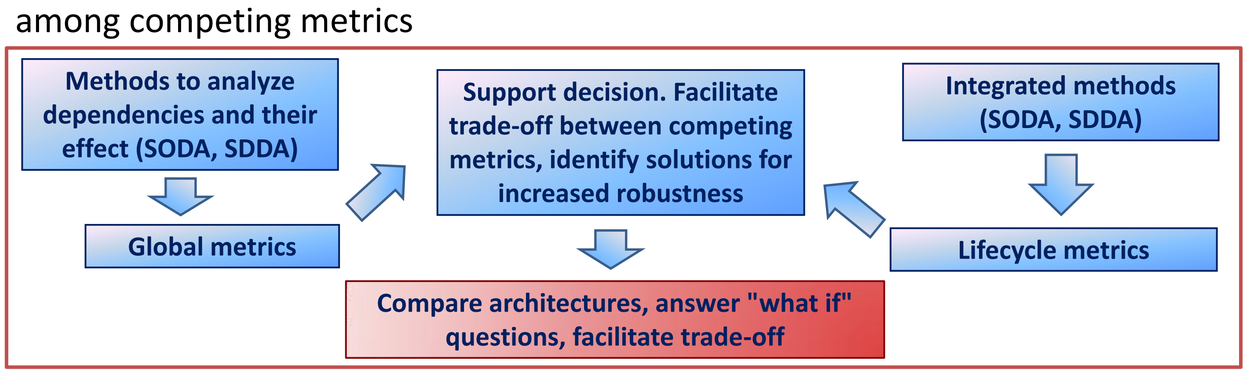
OBJECTIVE – Develop methods and framework for an analytic workbench to analyze system interdependencies in context of SoS architecture and evolution to guide both systems and SoS development, while improving features such as **robustness and resilience**

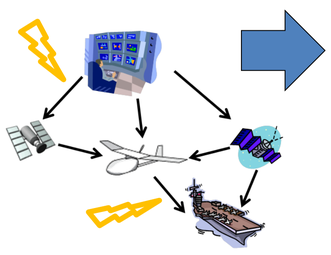


Computational Methods

Systems Operational/Development Dependency Analysis (SODA/SDDA)

Methods to analyze and quantify the effect of dependencies on the behavior of complex systems, to support architecture decision, evolution of SoS, and trade-off among competing metrics





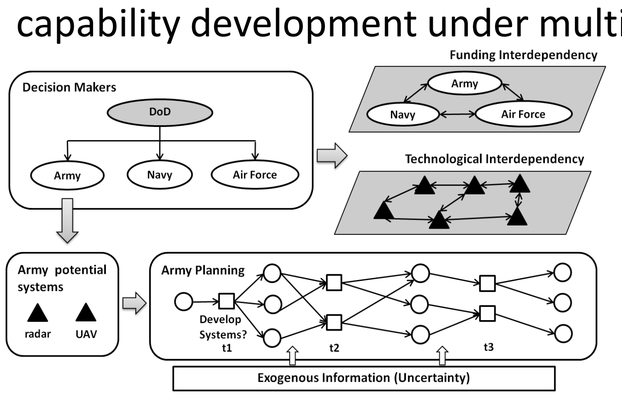
Disrupted link (successor receives 25% operability)	Variation in the operability of the carrier
1	-2.39%
2	-19.13%
3	-14.81%
4	-17%
5	-17%
6	-45%
7	-55%

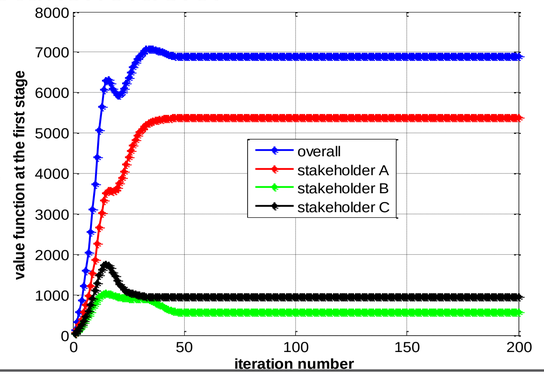
Disrupted node (25% operability)	Variation in the operability of the carrier
1	-31.68%
2	-2.92%
3	-14.34%
4	-21.25%
5	-15%

SODA/SSDA Analysis of 5 Node System for cyber-security → Identification of critical nodes and links → Informed decision to improve robustness against tertiary effect of cyber attacks

Multi-Stakeholder Dynamic Planning of SoS Evolution

Approximate dynamic programming and transfer contract mechanism are used to make an near-optimal sequence of decisions for SoS capability development under multiple stakeholders.

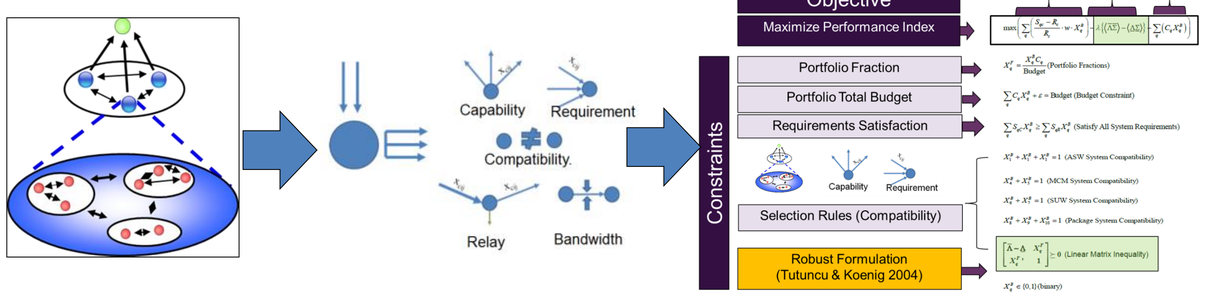




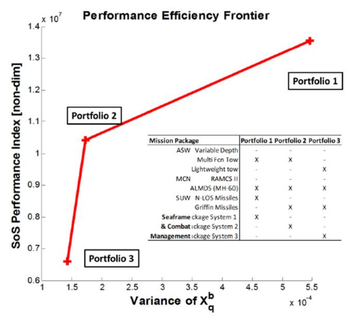
Computational Methods

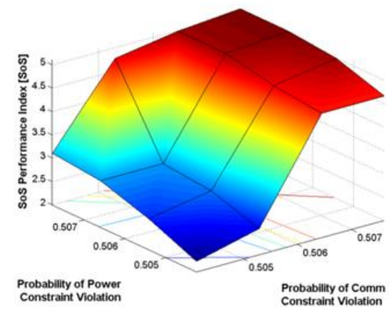
Robust Portfolio Optimization

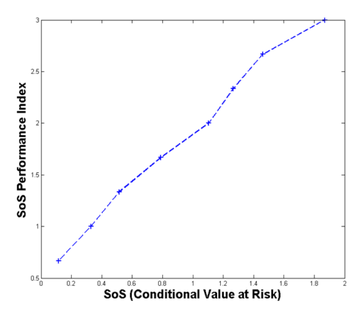
Decision support approach from financial engineering/operations research to identify 'portfolios' of systems by leveraging performance against risk under uncertainties



Performance Efficiency Frontiers for Tradespace Analysis

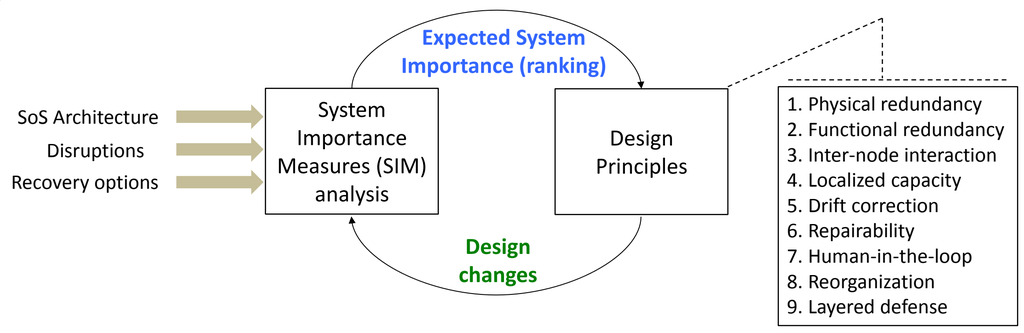






System Importance Measures

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



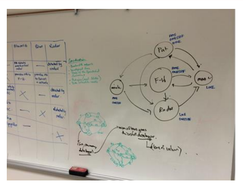
Illustrative example: SIMs for physical redundancy

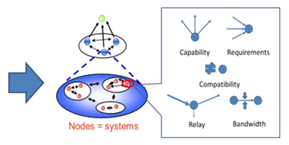
SDI (what is the expected impact on the mission when a system is disrupted?)			*SRI (How important is a system to mission recovery?)*		
System	**E(*SDI*)**	**Disruption Impact**	**System**	**E(*SRI*)**	**Recovery Importance**
LCS	0.80	High	$MH\text{-}60_{backup}$	0.50	High
UAV	0.40	Medium	LCS	0	Low
USV	0.30	Medium	MH-60	0	Low
MH-60	0.15	Low	UAV	0	Low
$MH\text{-}60_{backup}$	0.10	Low	USV	0	Low

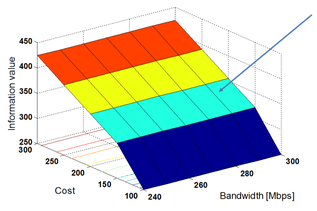
Pilots of the Analytic Workbench Underway

- AWB pilot on Army Always-On/On Demand application study –on site visit to ARL facility in Orlando proved best practice for pilots
- AWB pilot with NSWC Dahlgren Division, to examine interstitial space in Navy Integration & Interoperability studies; enabled by CRADA
- AWB pilot with MITRE Corporation on customer-inspired problems, to ensure quick feedback on the AWB

RT-108 team will use all pilot feedback to improve effectiveness of the AWB.







	DIS	HLA
PAT-Missile	0	1
Missile-RADAR	0	1
RADAR-MAOC	1	0
F-16-RADAR	0	1
F-16 MAOC	0	1
MAOC-F-16	0	1
MAOC-PAT	0	1
PAT-MAOC	0	1
PAT-RADAR	1	0

	AME	ONESAF	FMS	LIVE
Missile	0	0	1	0
Patriot	0	0	1	0
F-16	0	0	0	1
MAOC	0	0	1	0
RADAR	1	0	0	0

Contacts/References

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