A System of Systems view in Aerospace Product Development

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Agenda

- The S2TEP Research Project
- Research Problem
- Aim and Goals
- Methods
- Key Results and Activities
- Conclusions and Future Work

The S2TEP Research Project

- System-of-Systems - Trade space Exploration (S2TEP)
- NFFP7 project funded by VINNOVA and SAAB
- Participating in the Swedish Aerospace Research Center (SARC)
- Why System-of-Systems – Trade space Exploration?

Research Problem

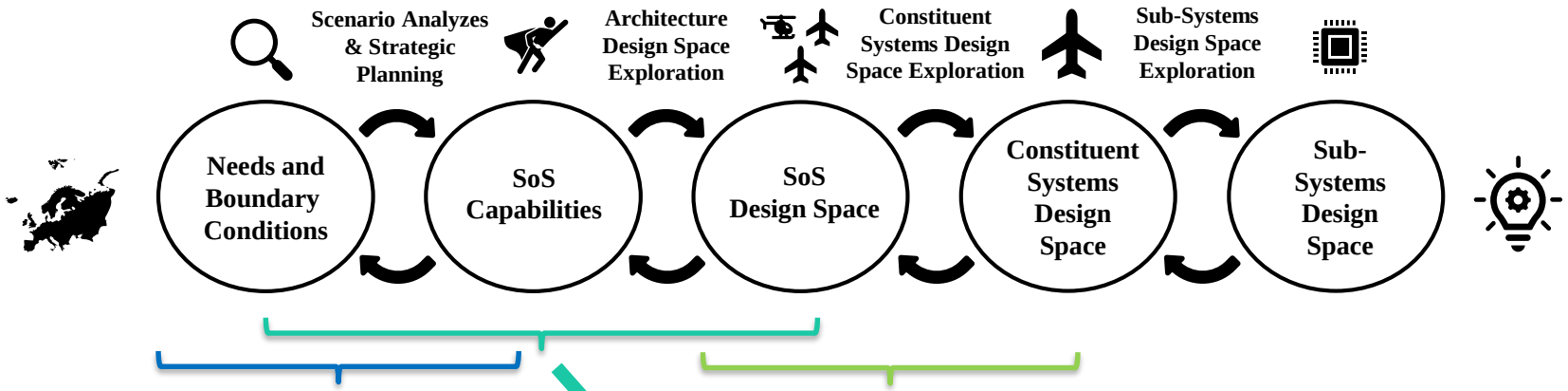
- Aerospace systems are becoming more and more connected with the operational environment, but also other systems in general
  - More interconnections and higher levels of complexity
- Constantly changing operational environments
  - Higher risks and uncertainties during development
  - Aerospace product development: Long lead times and expected lifespans
  - Changes in requirements might render solutions under development obsolete
- Holistic forecast analyses needs to be incorporated early in the design process
  - Desire to deliver capabilities over time to facilitate the system's survivability, rather than optimizing design against fixed requirements

Aim and Goals

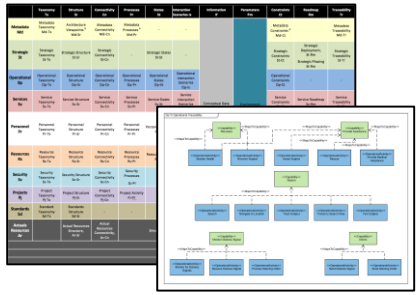
- A system-of-systems engineering perspective in aircraft conceptual design
- Produce methods for performing holistic design and trade space explorations on complex systems and system-of-systems in product development
- Allow designers to analyze system-of-systems design spaces early in the development process and make elaborate decisions
- **Research questions:**
  1. How can a design space for system-of-systems be represented in a flexible manner that allow explorations?
  2. How can a large design space for system-of-systems be reduced and explored in an efficient and traceable way?
  3. In what way should a visual analytics approach be incorporated to trade space explorations on system-of-systems for decision support?

Methods

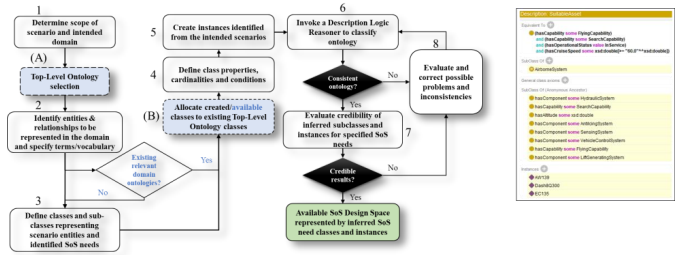
Holistic Design Process for analyzing a System-of-Systems (SoS)



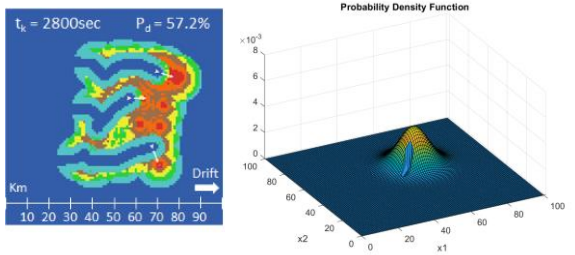
Architecture Frameworks



Ontology and Description Logic Reasoning

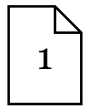


Agent-based Simulations (ABS)

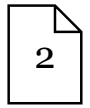


Key Results and Activities

- Two conference papers have been published
- Search and Rescue (SAR) operations are used as case studies to test developed methods
- Performed case studies show that:
  - Ontology and description logic reasoning can be used to generate and reduce an SoS design space representation
  - Agent-based simulations (ABS) can be used to evaluate the reduced design space and give performance measures for different SoS alternatives
- How is this done?



"An Ontological Approach to System-of-Systems Engineering in Product development"
Aerospace Technology Congress 2019, Stockholm



"A System of Systems Approach for Search and Rescue Missions"
AIAA SciTech 2020, Orlando

"A System of Systems View in Aerospace Product Development"
2020, Journal article

Key Results and Activities

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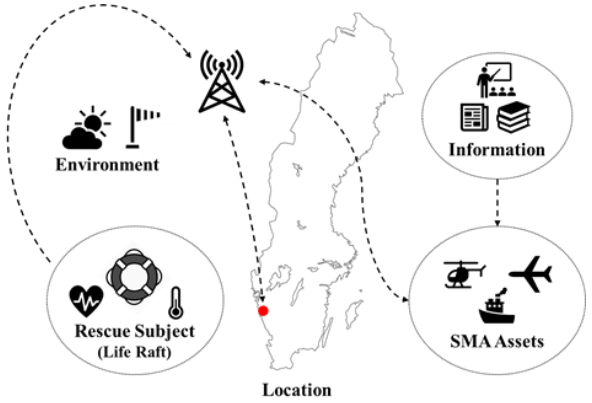
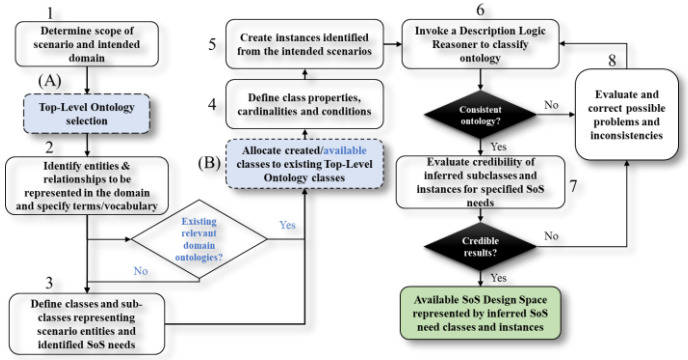
"A System of Systems Approach for Search and Rescue Missions"
AIAA SciTech 2020, Orlando

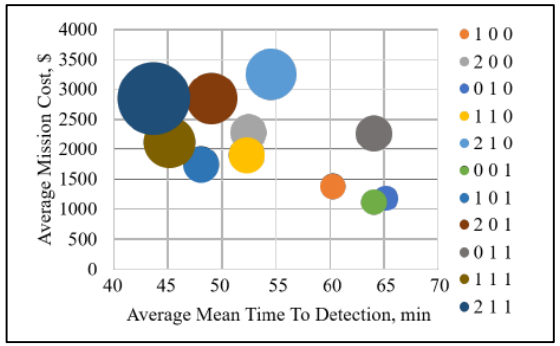
1. Search and Rescue scenario
2. Representation of the scenario in an ontology model
3. Description logic reasoning is used to automatically draw conclusions on suitable assets that fulfill SoS needs.
4. Suitable asset combinations are tested with ABS
5. Performance measures for all combinations are used to evaluate average mission cost against time to detect the rescue subject



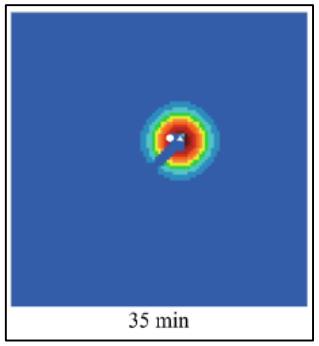
Scenario



Ontology Modeling



Measure of Effectiveness



Agent-Based Simulations

Suitable Assets

Conclusions and Future Work

- Research questions:
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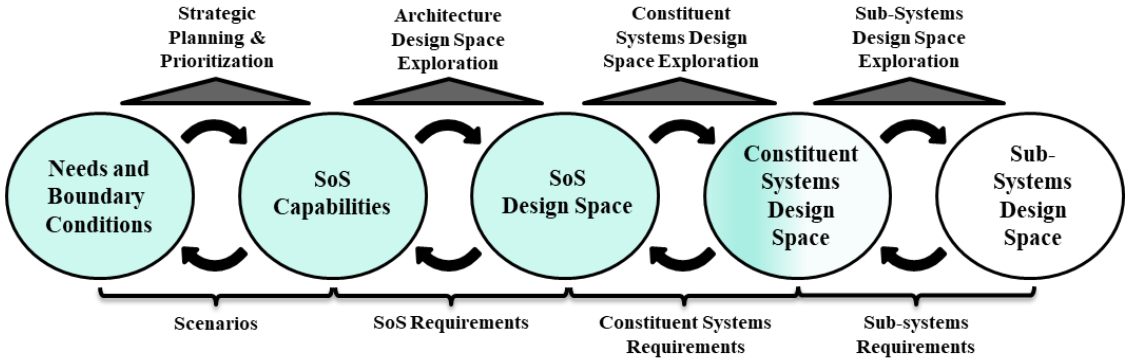
  3. In what way should a visual analytics approach be incorporated to trade space explorations on SoS for decision support?

Architecture Frameworks, Ontology and Description Logic Reasoning

Ontology, Description Logic Reasoning and Agent-based Simulations

Ongoing/Future work

Conclusions and Future Work



- Provide further answers to research questions
  - How to design and evaluate something new based on shown methods?
  - Analyses on system and sub-system levels
  - Changes in boundary conditions, such as environmental changes
- In conclusion
  - An ongoing research project
  - Benefits from seeing aerospace product development from a system-of-systems perspective
  - Develop the right aerospace solutions for an ever-changing future

Thank you for listening!

Questions or want to know more?

Contact me!

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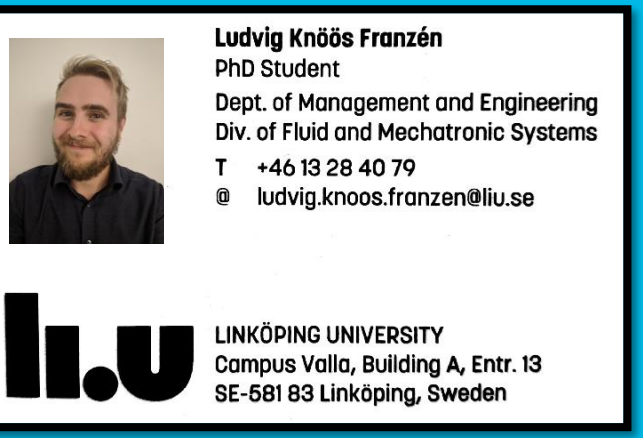

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