SoSECIE Webinar

Welcome to the
2021 System of Systems Engineering Collaborators Information Exchange (SoSECIE)

We will start at 11AM Eastern Time

You can download today's presentation from the SoSECIE Website:

https://mitre.tahoe.appsembler.com/blog

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NDIA System of Systems SE Committee

- **Mission**
  - To provide a forum where government, industry, and academia can share lessons learned, promote best practices, address issues, and advocate systems engineering for Systems of Systems (SoS)
  - To identify successful strategies for applying systems engineering principles to systems engineering of SoS
- **Operating Practices**
  - Face to face and virtual SoS Committee meetings are held in conjunction with NDIA SE Division meetings that occur in February, April, June, and August

NDIA SE Division SoS Committee Industry Chairs:
Mr. Rick Poel, Boeing
Ms. Jennie Horne, Raytheon
OSD Liaison:
Dr. Judith Dahmann, MITRE

Join us for the NDIA's Virtual Systems and Mission Engineering Conference

Dates: Monday, December 6th through Wednesday, December 8th

- **Why Attend?**
  - Gain insight on improving acquisition and performance of defense programs and systems.
  - Hear from Program Managers, Systems Engineers, Chief Scientists, and Engineers and Managers.
  - Participate in Q&As with session speakers; getting your most pressing systems engineering questions answered.
  - View handouts to supplement and enhance your virtual experience.
  - Network and build relationships with like-minded professionals during virtual networking opportunities.
- **Topics**
  - Engineering and Manufacturing
  - Human Systems Integration
  - Systems Architecture
  - Systems Security Engineering
  - Systems of Systems Engineering

Register online at
https://www.ndia.org/events/2021/12/6/24th-sme-conference-virtual/registration

Simple Rules of Engagement

- I have muted all participant lines for this introduction and the briefing.
- If you need to contact me during the briefing, send me an e-mail at sosecie@mitre.org.
- Download the presentation so you can follow along on your own
- We will hold all questions until the end:
  - I will start with questions submitted online via the CHAT window in Teams.
  - I will then take questions via telephone; State your name, organization, and question clearly.
- If a question requires more discussion, the speaker(s) contact info is in the brief.

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2021-2022 System of Systems Engineering Collaborators Information Exchange Webinars

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November 2, 2021
Conceptual Models to Support Reasoning in Early Phase Concept Evaluation – a Subsea Case Study
Siv Engen

November 16, 2021
A Design Method for Collaborative Systems of Systems Applied to Metropolitan Multi-Mode Transport System
Pontus Svenson, Frida Reichenberg, and Jakob Axelsson

November 30, 2021
Should I Stay or Should I Go? How Constituent Systems Decide to Join or Leave Constellations in Collaborative SoS
Pontus Svenson and Jakob Axelsson

December 14, 2021
A Heterogeneous Autonomous Collaborative System for Powerline Inspection Using Human-Robotic Teaming
Srikanth Vemula, Jovany Avila, and Michael Frye

January 11, 2022
Approach for Complex Deterministic and Nondeterministic Systems (ACDANS)
Dr. Paul C. Hershey

https://www.mitre.org/capabilities/systems-engineering/collaborations/system-of-systems-engineering-collaborators

2021-2022 System of Systems Engineering Collaborators Information Exchange Webinars

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January 25, 2022
Applying SoSE in Healthcare: the case for a soft systems methodology approach to Digital-first Primary Care
Iqra Shahzad, Melanie King, and Michael Henshaw

February 8, 2022
Empowering Adaptive Human Autonomy Collaboration (DUAL) with Artificial Intelligence
Dr. Mark Chattington

February 22, 2022
System of Systems Engineering Conference (SoSE) and Industry Perspectives and the Role of SoSE: INCOSE and IEEE Collaborations
Paul Hershey, Garry Roedler, and Mo Jamshidi

March 8, 2022
An Event-based Microservice Platform for Autonomous Cyber-Physical Systems: the case of Smart Farming
Mara Nikolaidou

May 3, 2022
Cross-Domain Stakeholder-Alignment in Collaborative SoS – Lego Serious Play as a Boundary Object
Johann Shuetz, Julia Koehlke, and Sebastian Hanna

https://www.mitre.org/capabilities/systems-engineering/collaborations/system-of-systems-engineering-collaborators

Resilience in systems of systems: electrified transport systems

System of Systems Engineering Conference 2021

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Resilient (electrified) transport systems

- The transport system is a system of systems (SoS)
- Electrification induces changes in the old, familiar transport system
- Transports are vital for society
- Increased focus on defence and security policy, gray zone problems, increased tension in Europe -> Total defence resurgence in Sweden
- Must ensure that the future transport system is resilient
- Note: not only electrification – many changes affect future transport system

Method and objectives

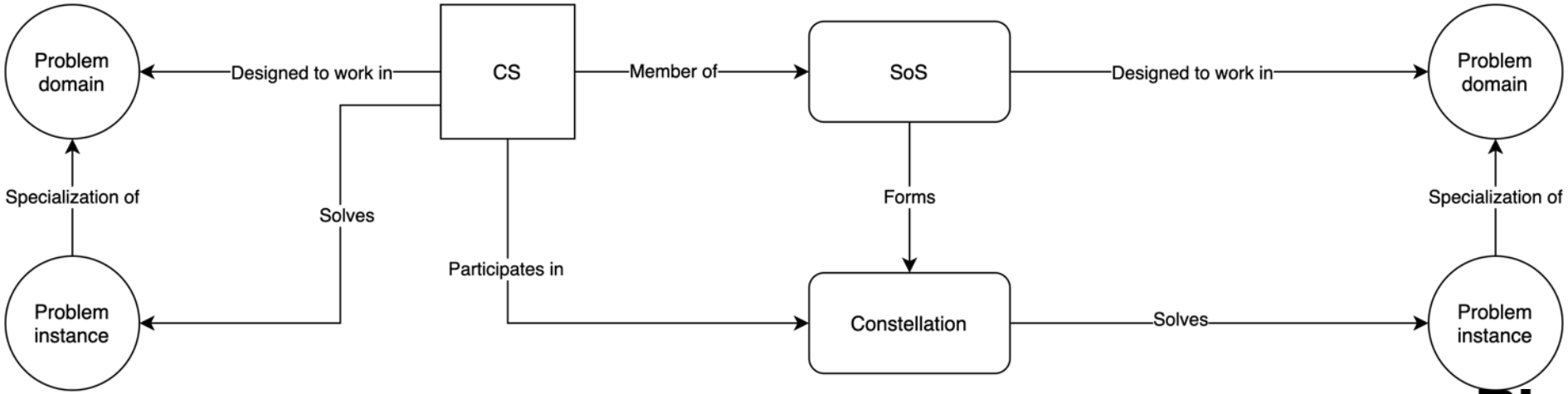
- Focus of this pre-study was to produce a simplified systems of systems model of the electrified goods transport system
- Interviews with subject domain experts
  - Security / risk experts
  - Energy experts
  - Transport and mobility experts

Resilience

- Not just risk analysis or robustness -- cannot predict all risks beforehand
- The ability of a system to keep functioning during duress and handle surprises.
- Hollnagel: “intrincic ability of a system to adjust its functioning prior to, during, or following changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions”
- An emergent property of the SoS

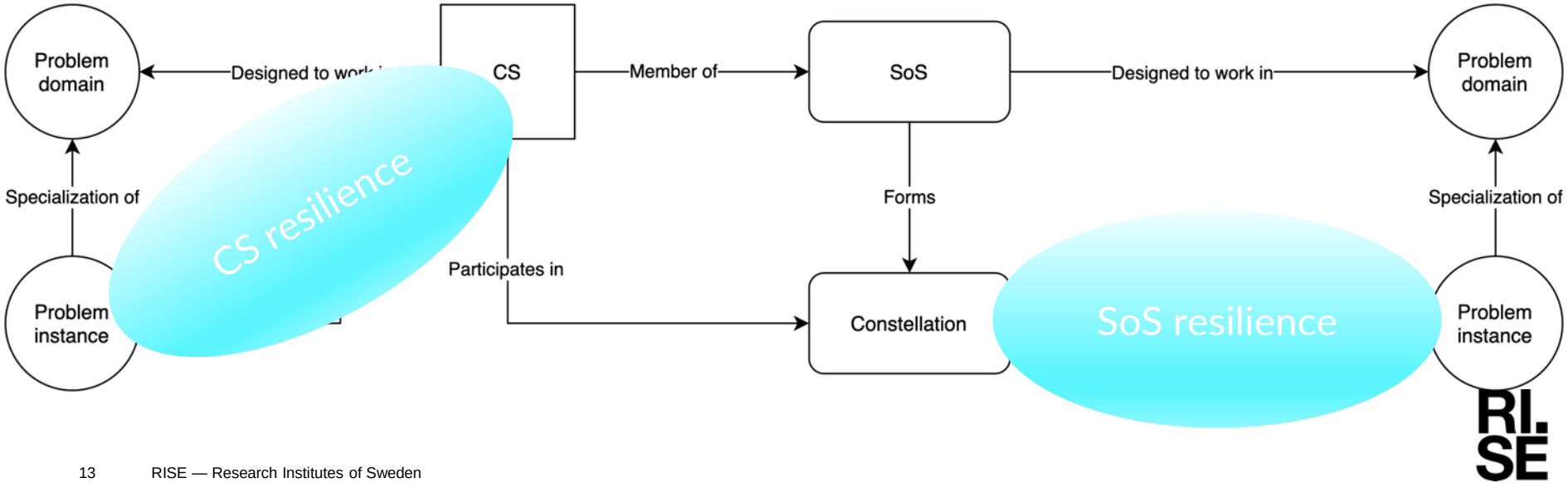
SoS

- Independent systems (CS, constitutent systems) that collaborate for mutual benefit
  - CS have their own purpose – intended intervention in (another) problem domain
  - Mediators – SoS elements that help CS collaboratore
- SoS has a purpose – is intended to do an intervention in some problem domain
- Constellation: set of CS that act as an instantiation of the SoS to do an intervention



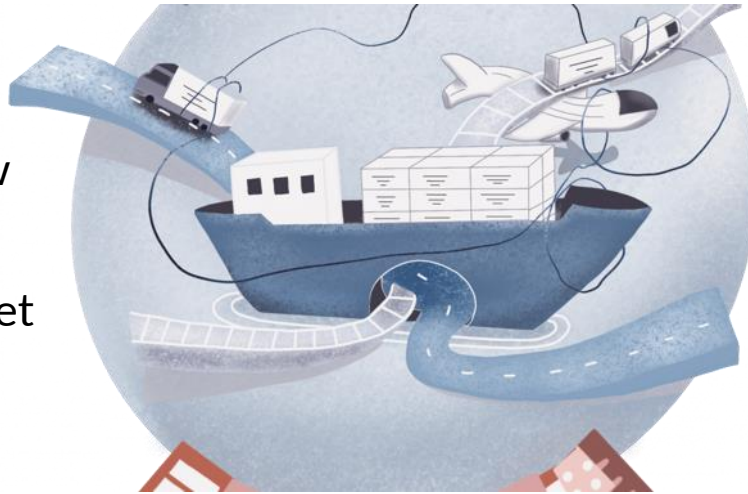
SoS and resilience

- Each CS must be resilient when operating independently
- SoS must be resilient when CS are working together



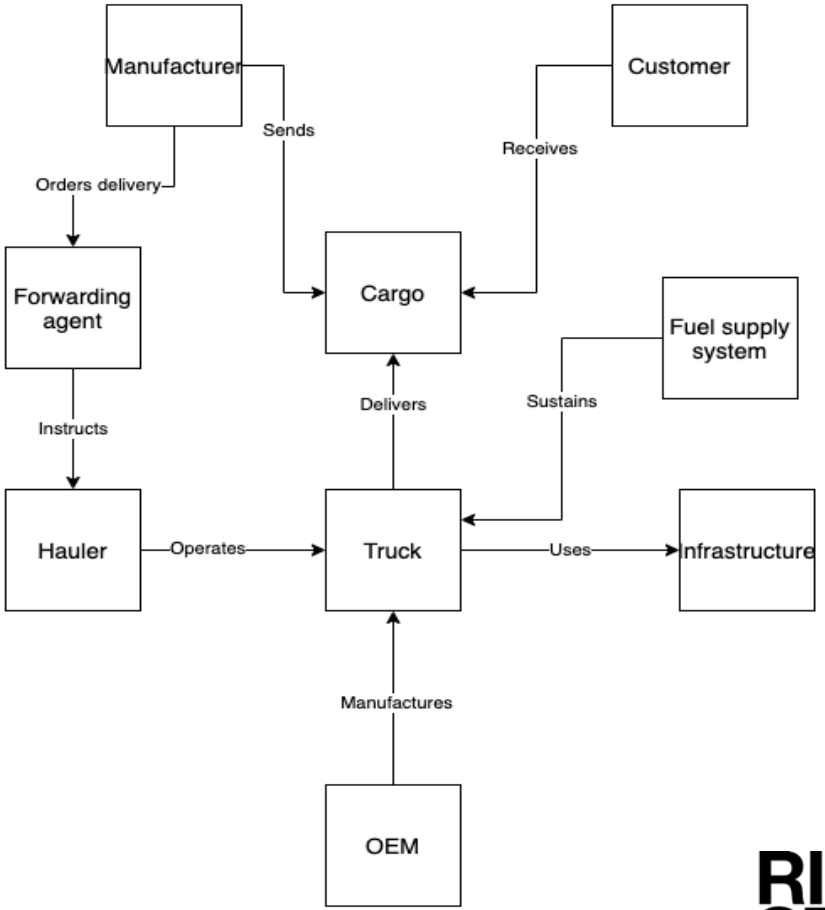
Transport systems

- A system of systems – independent systems collaborating
- Transitions – new technology, new organisation, new behaviour
  - Electrification, shared transports/physical internet
  - Changed e-shopping behaviours
  - Climate change
  - Environmental needs

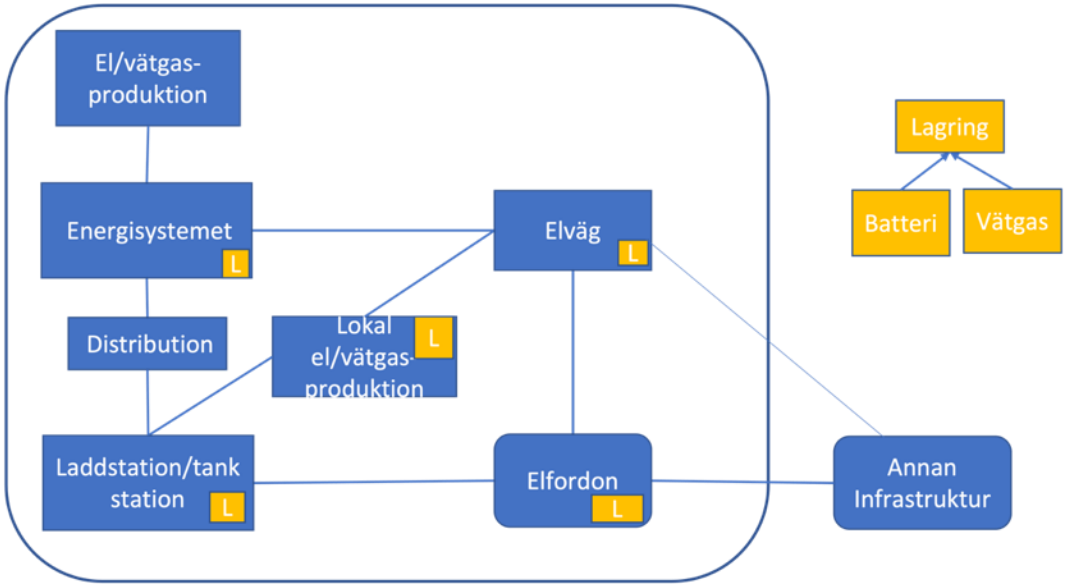


Who is involved in a goods transport?

- A constellation of trucks and others solves the transport mission



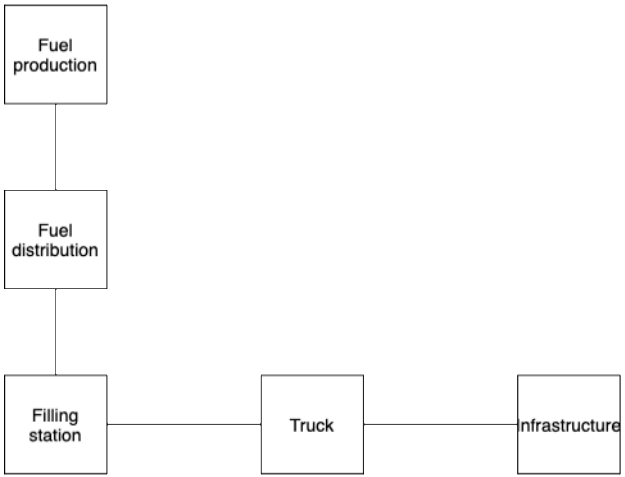
Electrification

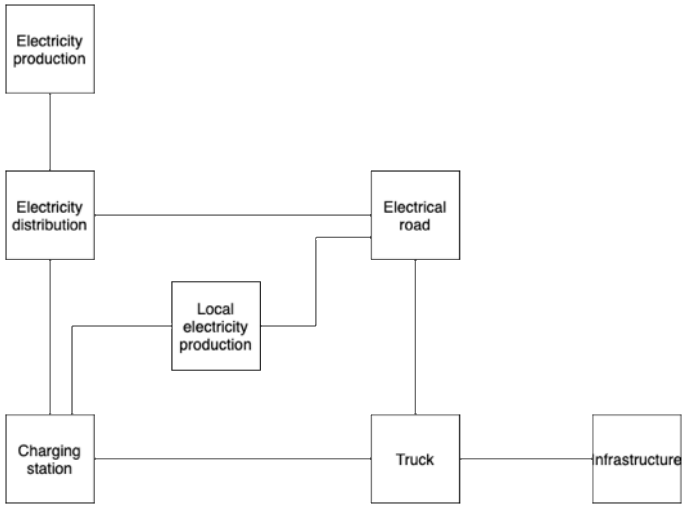


Transport system time scales

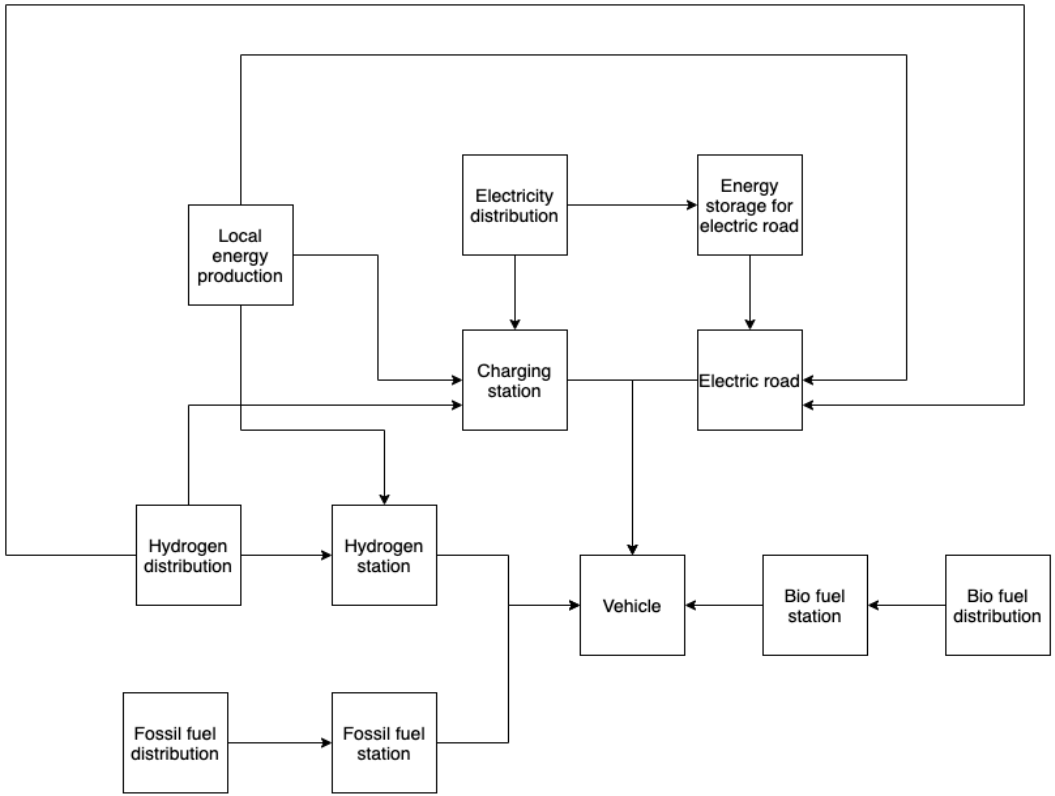
Similar but different

Current focus: energy system changes

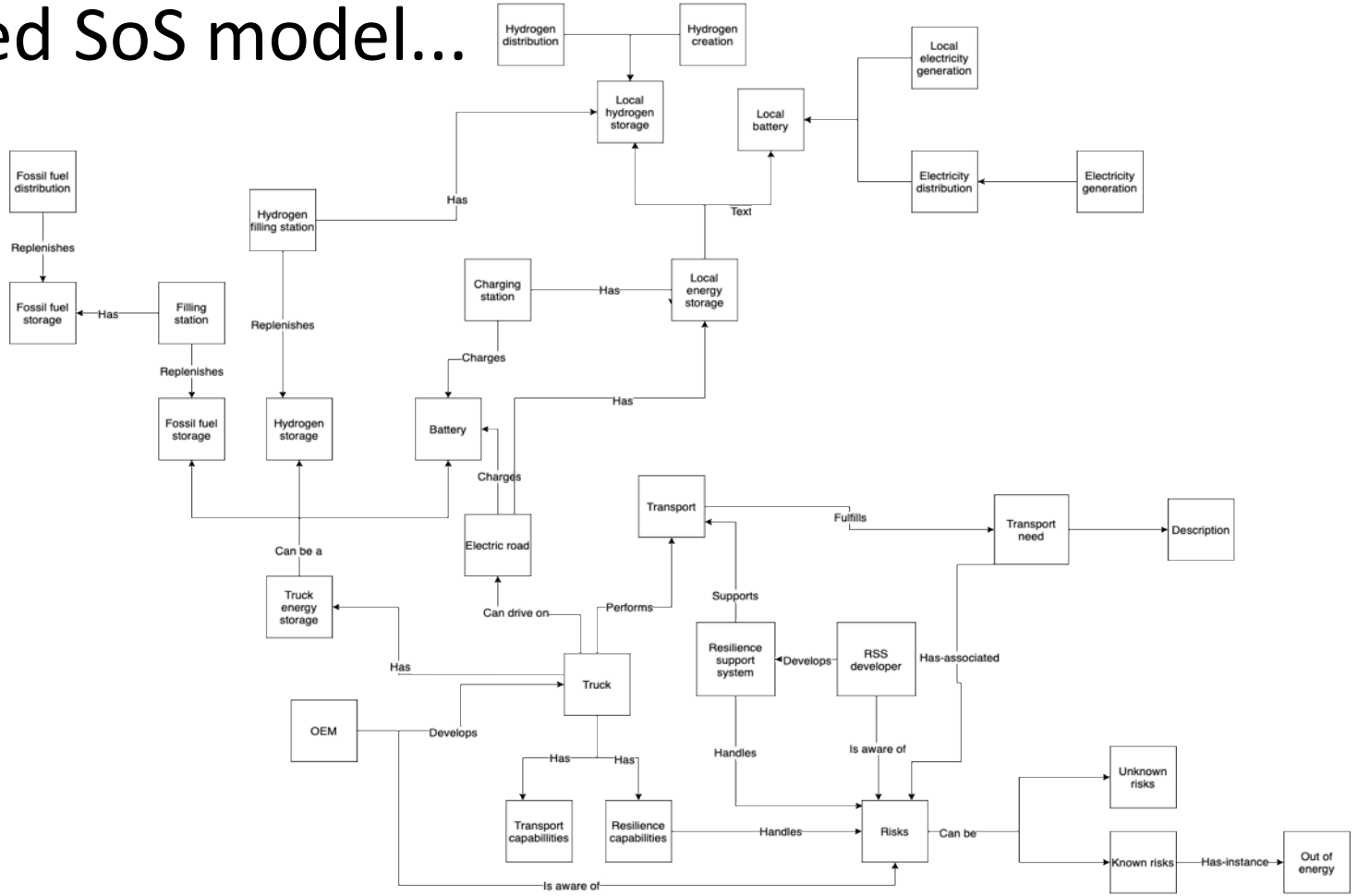




Tomorrow’s energy supply system will have multiple components



Simplified SoS model...



What can be done to ensure resilience?

- Technology
  - CS-level technology
    - Improved batteries
  - SoS-level technology
    - Local energy production

What can be done to ensure resilience?

- Organization
  - New roles and functions
    - CS-level
    - SoS level
  - Training and exercises
    - The only way test preparedness for surprises

Results from interviews

- Reduce micro-regulations, e.g., specify capability instead of specific equipment
- Increase collaboration between actors
- Sharing of information – need to share instead of need to know
- Training and exercises

Results

- More cooperation requires
- Responsibilities are unclear
  - Sweden: ”responsibility principle” – ”each actor is responsible for its work also in crisis/war”
- Time-scales different

Resultat

- Must include all energy sources
- System of systems perspective necessary

Future work

- Investigate possible models for sharing of responsibility
- Applying systems based models (e.g., STAMP) to the electrified goods transport system
- Explore mechanisms for collaboration and information sharing without revealing business-sensitive data
- Investigate the interplay between design rules for CS and effect on emergent behaviour

Questions and comments?

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