SoSECIE Webinar

Welcome to the
2019 System of Systems Engineering Collaborators Information Exchange (SoSECIE)

We will start at 11AM Eastern Time

Skype Meeting +1 (703) 983-2020, 46013573#

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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
  - SoS Track at NDIA 22nd Annual Systems Engineering Conference, Grand Hilton Tampa Downtown, Tampa, FL, October 21-24, 2019
    - Conference Info: http://www.ndia.org/events/2019/10/21/22nd-annual-systems-and-mission-engineering-conference

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

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 Skype.
  - 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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2019 System of Systems Engineering Collaborators Information Exchange Webinars

Sponsored by MITRE and NDIA SE Division

October 8, 2019
An Analysis of Systems-of-Systems Opportunities and Challenges Related to Mobility
Mr. Jakob Axelsson

October 22, 2019
Modeling Process for the Design of System of Systems Evolution
Dr. Jeremy Buisson, Dr. Isabelle Borne and Mr. Franck Petitdemange

November 5, 2019
Irrational System Behavior in a System of Systems
Mr. Douglas L. Van Bossuyt, Mr. Bryan M. O'Halloran and Mr. Ryan M. Arlitt

November 19, 2019
Multi-Dimensional Classification of System-of-Systems
Dr. Bedir Tekinerdogen

December 3, 2019
Digital Twin Strategies for System of Systems
Mr. Michael Borth

January 14
Framework for Improving Complex System Performance
Mr. Chuck Keating

SoS Opportunities and Challenges Related to Mobility in Smart Cities

SoSCIE Webinar 2019-10-08

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Introduction

- How can SoS be used to improve urban mobility?
- What challenges exist and what aspects to consider for SoSE?

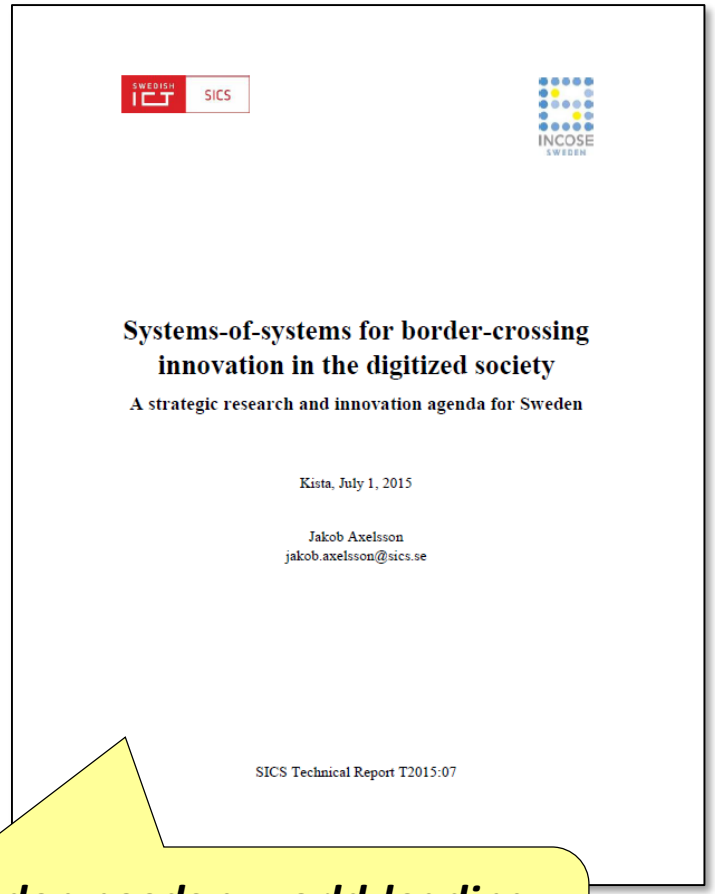
Overview:

- Background: Why we did this study.
- Smart city transportation today.
- Characteristics of smart urban mobility.
- SoS challenges.

Swedish SoS Research & Innovation Agenda

SoS general **challenges**:

1. Theoretical foundations
2. Socio-technical aspects
3. Architecture
4. Modeling and simulation
5. Interoperability
6. Trustworthiness
7. Business models and legal aspects
8. Processes, methods and tools



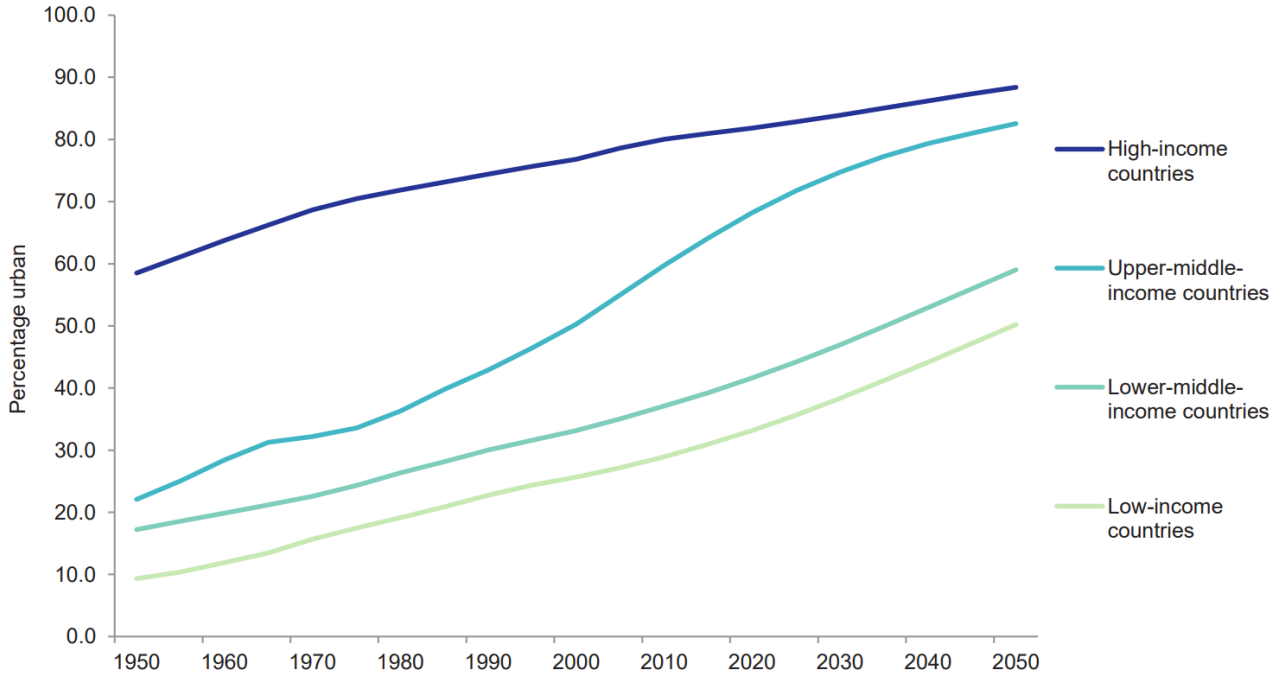
Sweden needs a world-leading capability to rapidly develop trustworthy systems-of-systems!

https://www.sics.se/sites/default/files/pub/sics.se/upload/groups/sse/sos_agenda.pdf

Swedish Strategic Vehicle Research & Innovation Program (FFI)

- Research program funded by government (~50%) and industry (~50%).
- Annual turn-over ~1BSEK (~100 MUSD).
- Main industrial partners: Volvo Cars, Volvo Group (trucks and buses), Scania (trucks and buses), and Scandinavian Automotive Supplier Association.
- Government agencies: Vinnova (Innovation agency), Swedish Energy Agency, and Swedish Transport Administration.
- Active (in various forms) since 1994.

Urbanization trends



Data source: United Nations, Department of Economic and Social Affairs, Population Division (2018a). *World Urbanization Prospects 2018*

”Smart” cities

- ”Smart” = IT systems with real-time awareness and advanced analytics to help people make intelligent decision.
- In smart cities, these systems are used both for improving current situation in real-time, and for gathering data for long term improvements.
- Smart cities are SoS!

Smart city transportation today

Reducing congestion in smart cities

Direct measures

- Monitor traffic flows to control or redirect traffic.
- Inform residents so that they can choose alternative routes or means of transportation.
- Incentives to reduce traffic (e.g. congestion or toll fees).

Real-time travel data required.

Indirect measures

- Improve public transportation.
- Make public transportation free.
- Public bike rental systems.
- Charging stations for electric mopeds.
- Bike lanes.

Aggregated travel data required.

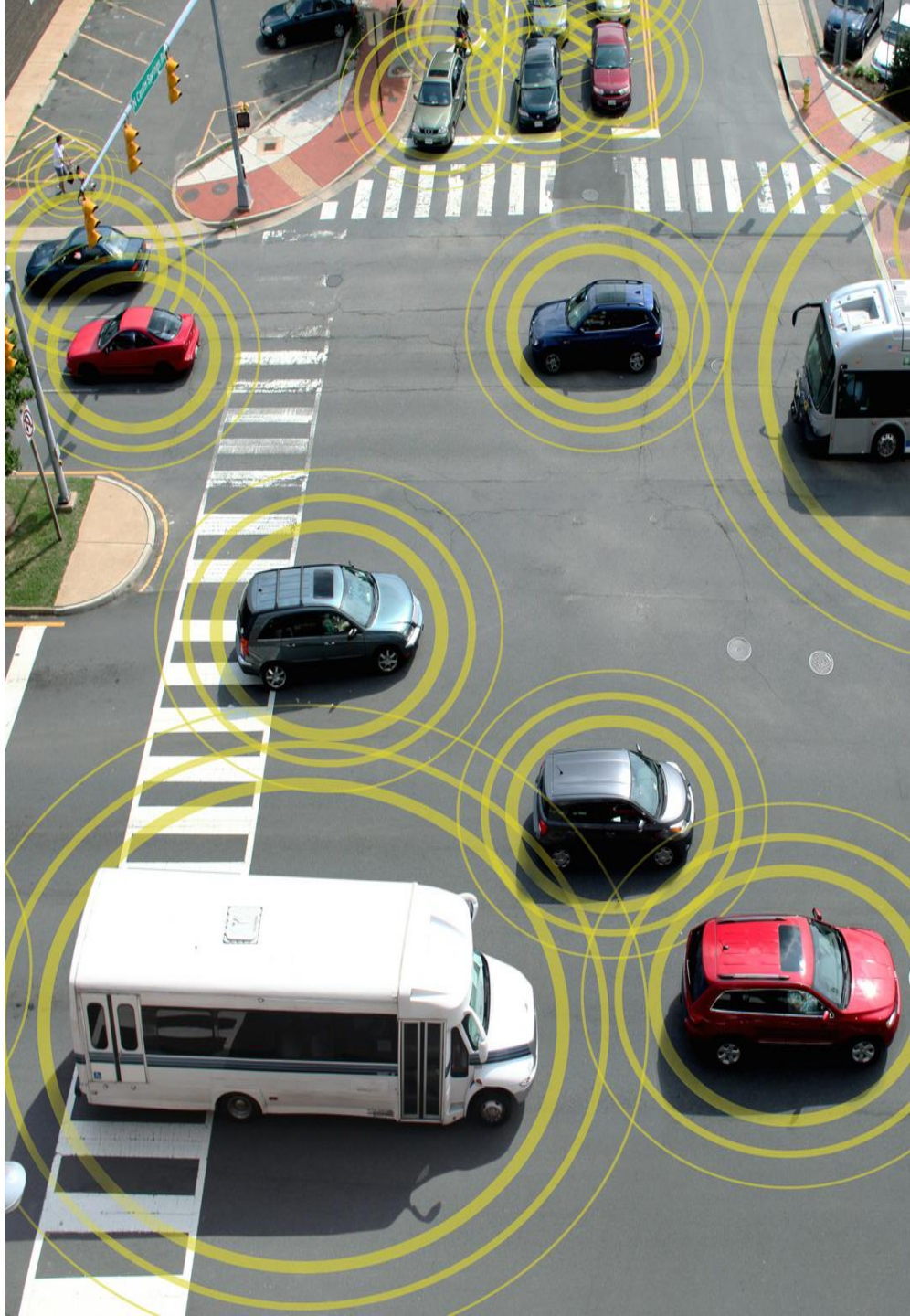
Smart transportation examples

- Electric scooter sharing (everywhere).
- Road tolls (Singapore, Stockholm).
- Operations centers (Rio, New York).
- Bike sharing (Hangzou, Taipei, Paris).
- Air quality monitoring (various).
- Parking place search (San Francisco, Singapore, Barcelona, Tel Aviv).
- Transit signal priority (New York, Stockholm).
- Smart trash cans (various).
- Public data for third-party applications.

Characteristics of smart urban mobility

Challenges in urban mobility

- **City growth**: Densifying and sprawling
- Desired **transportation characteristics**:
  - *Efficiency*: Fast and cost-effective
  - *Quality*: Predictability, reliability, flexibility, etc.
- Transportation **side effects on society**:
  - *Environment*: Global and local
  - *Safety*: Accident reduction
  - *Resource usage*: Land, energy, public funding
- **SoS usage**: Connected vehicles **collaborate** with each other and with infrastructure to provide smart solutions



Transportation needs

People

- Daily commuting.
- Travel as part of work.
- Rare traveling (e.g. events).

Goods

- Groceries.
- Small goods (households).
- Large goods (industrial).
- Waste removal.

Multi-modal people transportation

Actors and stakeholders

Benficiaries of transportation
- People needing to move.
- Senders or receivers of goods.

Transport service suppliers
- Vehicle owners.
- Transportation operations.
- Logistics companies.
- Hubs.

Mediators
- Logistics coordinators.
- Service brokers and orchestrators.
- Platforms for data sharing.
- Aggregators of information.

Vehicle suppliers
- Vehicle OEMs.

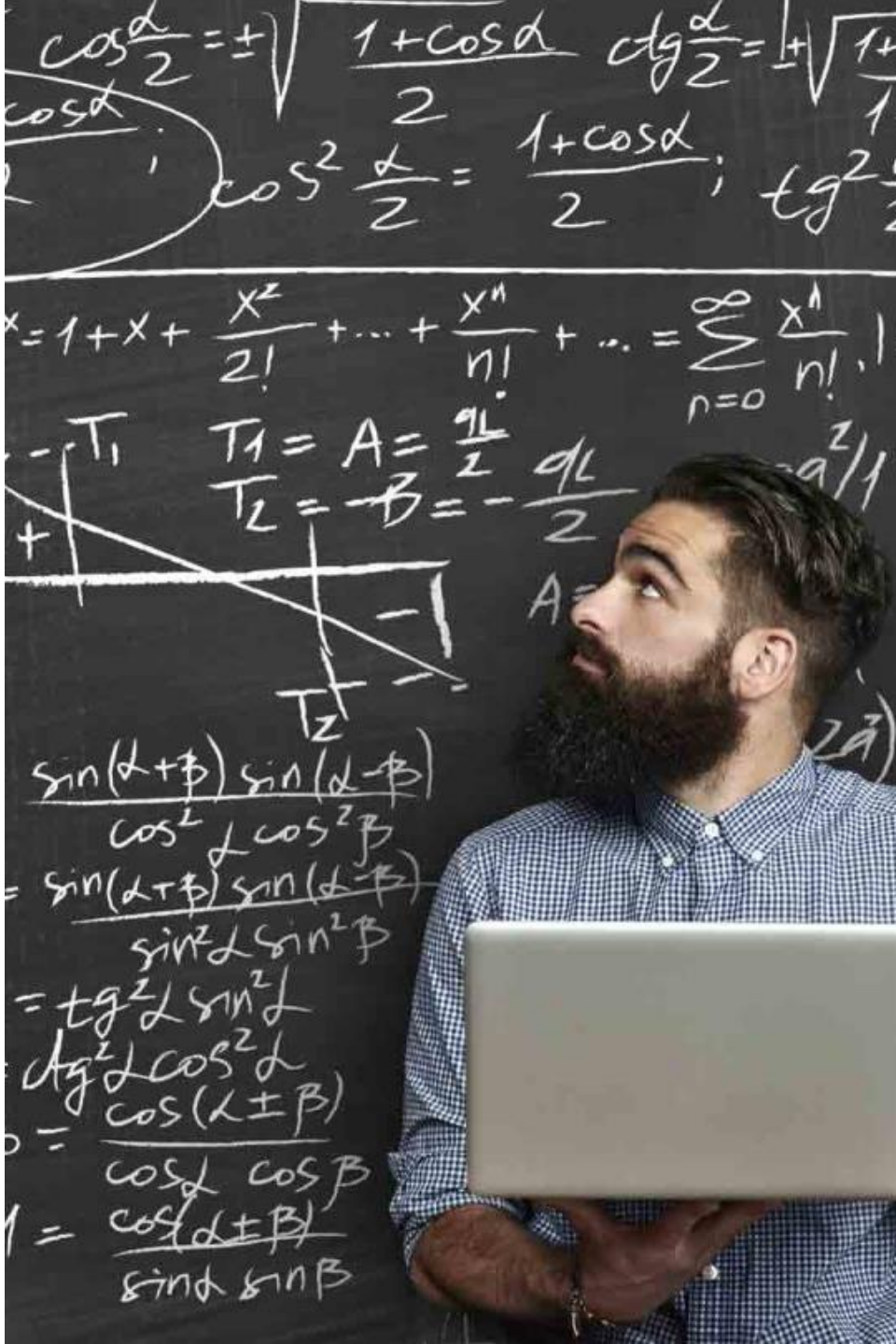
Infrastructure suppliers
- Road administration and other agencies.
- IT and telecommunication suppliers.
- Energy suppliers (electric, fossil).
- Parking providers.
- Insurance companies.

Society
- City authorities.
- City planners.
- Traffic control centers.
- Regulators.
- Property owners.
- Neighbors.
- Tax payers.

SoS challenges in urban mobility

Complexity management

- Scalability
- Architecture
  - Archetype: Central coordinator/mediator?
  - Information infrastructure
  - Vehicle data access
- Evolution
  - Modeling and simulation
  - Sharing of engineering data



Socio-technical effects

- Applications are often technology driven.
- Early adopters not representative of population.
- It is uncertain that they are willing to adapt in terms of:
  - Means of transportation.
  - Time to travel.
  - Route.
  - Data sharing.
- Emergent effects are not always foreseen.
  - Example: Successful road congestion actions could move congestion to subway.
- Systems thinking and simulations to address complex dynamics.

Data and trust

- Usage:
  - Real-time situational awareness.
  - Data archives to detect patterns, as a basis for evaluating proposed infrastructure investments.
- Risks:
  - Privacy – GDPR.
  - Cyber-security.
- Sources:
  - Open data, public-private partnerships.
  - Crowd sourcing.

Business models and incentives

- All actors need positive cost-utility-balance!
- Compensation for contributing data?
- Distribution of responsibility among actors:
  - Private vs. public roles.
  - Ownership and funding for mediating systems.
- Societal mechanisms: legislation, taxes, incentives, standards, open data.
- Sustainability of SoS over time.

The road ahead

The SoSSUM program

- A strategic initiative within FFI:
  - 50 MSEK Vinnova funding
  - 50 MSEK industry co-funding
  - Active 2018-2021
- Objectives:
  1. Urban mobility solutions based on SoS.
  2. Knowledge base for SoS engineering.
- Around 10 application projects funded.
- Core activities for SoS knowledge and program coordination.

Conclusions

- City mobility includes many challenges as urbanization continues.
- SoS can be a foundation for solutions.
- SoS challenges related to complexity; socio-technical effects; data and trust; and business models and incentives.

Further information:

Jakob Axelsson and Stina Nylander. ”An Analysis of Systems-of-Systems Opportunities and Challenges Related to Mobility in Smart Cities.” In Proc. IEEE Intl. Systems-of-Systems Engineering Conference, Paris, June 2018.