
Welcome to 15th MODPROD Workshop 2021!
In collaboration with
Digital engineering for a resource efficient and circular industry
MODPROD

Note: MODPROD News

- teamed-up with ICES,
  the Innovative Centre for Embedded Systems,
  KTH, Stockholm

- in future two MODPROD venues:
  - Linköping
  - Stockholm

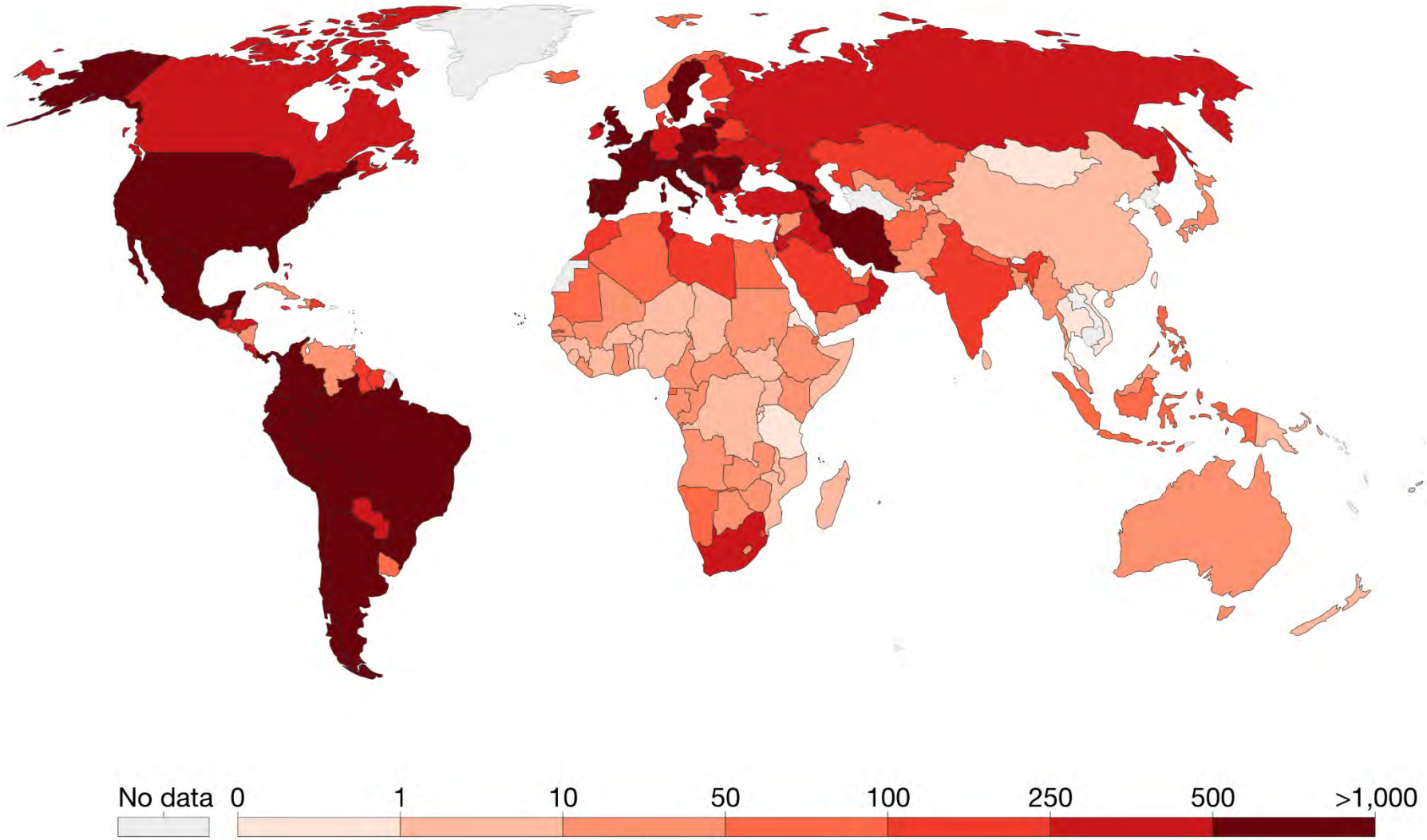
www.ices.kth.se

- attract a wider audience, giving MODPROD a slightly different focus each time (more software/embedded, more hardware/mechanical engineering)

Cumulative confirmed COVID-19 deaths per million people, Jan 1, 2021

Limited testing and challenges in the attribution of the cause of death means that the number of confirmed deaths may not be an accurate count of the true number of deaths from COVID-19.

Our World in Data



Source: Johns Hopkins University CSSE COVID-19 Data – Last updated 2 January, 06:06 (London time)

This Year is Different…

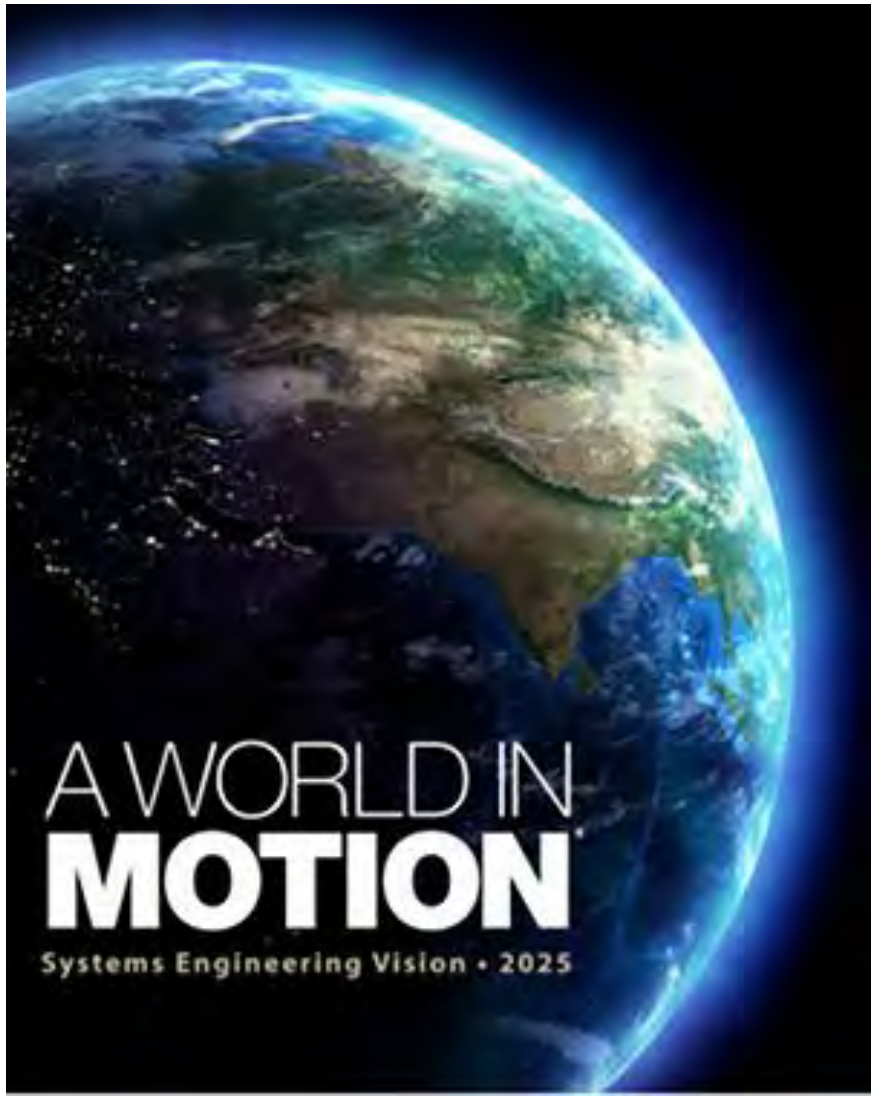
So we had to adapt as well:

- Teaming up
- meeting online
- missing all the coffee breaks, small-talk, interactions, hands-on, discussions, exhibitions, social event/visits etc.!
- Let´s make the best of it!

THE MODPROD VISION

A World In Motion…

- Need for fast, interactive, adaptable & upgradable holistic models
  - including (individuals') behaviour
  - addressing emergent behaviour
  - requiring new, just-in-time solutions, outside the SOTA
  - change & innovation
  - SoS engineering
  - Extended use of AI and means of automation (Industry 4.0)
- Still in the focus: Environmental / Sustainable Society → Circular Economy!



The OpenModelica Effort

- Comprehensive **modeling, simulation and systems engineering** environment for research, teaching, and industrial usage
- **Open-source** for both **industrial** and **academic** usage
- Invitation for **open-source cooperation** around OpenModelica, tools, and applications
- **Increased** emphasis on **industrial** usage

Current Main Industrial OpenModelica Usage (not including research usage)

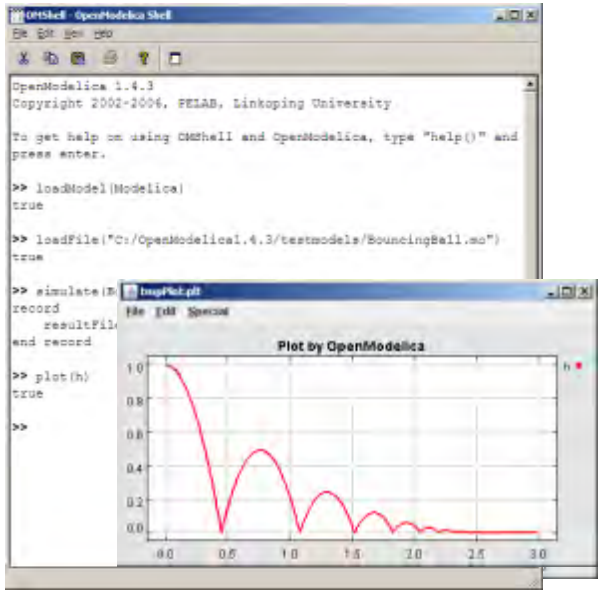
- ABB OPTIMAX – Process control, generating code controlling almost 10% of German power production
- DHI, OEM usage of OM compiler frontend in DHI product
- Bosch-Rexroth, in-house product usage for Modelica model import and simulation
- EDF – ThermoSysPro Library and Applications
- Politecnico di Milano – Innovative sCO2 cycle power plants models
- Politecnico di Milano – National gas distribution network simulation and optimization
- ABB – fluid sub-model of a district heating plant is running in production
- Modelicon – Model-based Control of UAVs and Robots

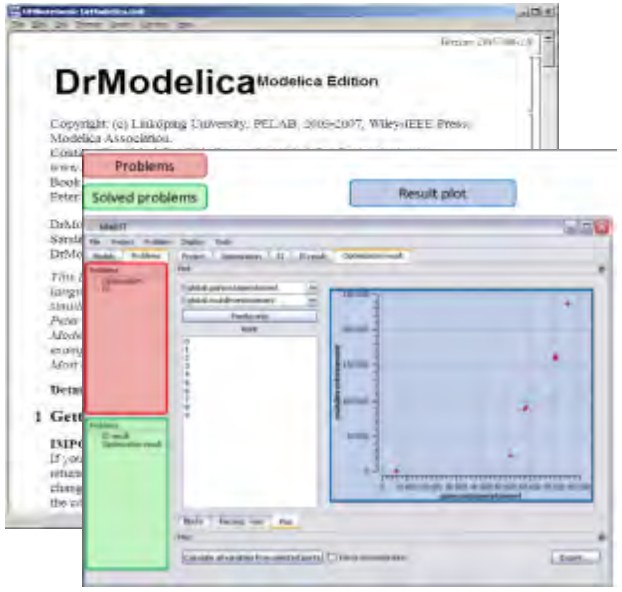
The OpenModelica Open Source Environment

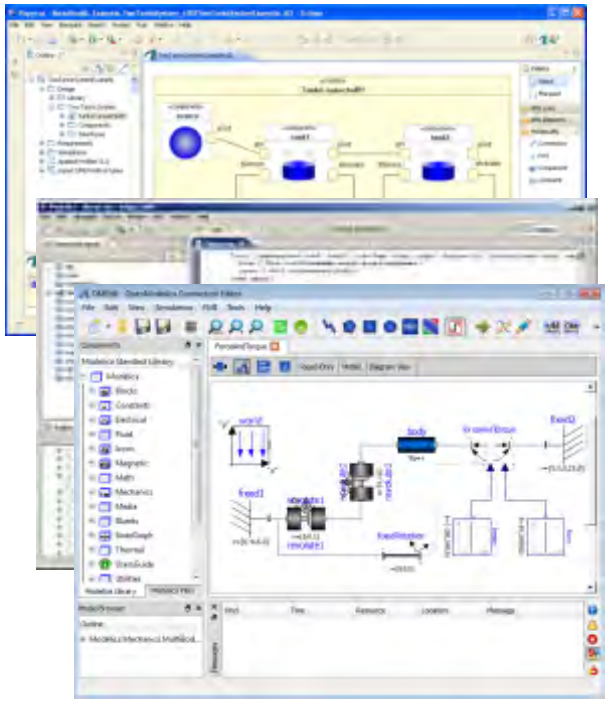
www.openmodelica.org

- Advanced Interactive Modelica compiler (OMC)
  - Supports most of the Modelica Language
  - **Modelica, Python, Julia, and Matlab scripting**
- OMSimulator – FMI Simulation/Co-simulation
- Basic environment for creating models
  - **OMShell** – an interactive command handler
  - **OMNotebook** – a literate programming notebook
  - **MDT** – an advanced textual environment in Eclipse

- **OMEdit** graphic Editor
- **OMDebugger** for equations
- **OMOptim** optimization tool
- **OM Dynamic optimizer** collocation
- **ModelicaML** UML Profile
- **MetaModelica** extension
- **ParModelica** extension







Some Supporting Research Projects 2020 (2021)

- PARADOM, German national project including ABB, Bosch-Rexroth, Siemens AG,TU Dresden, FHBielefeld. Ended 2020.
- PHyMoS - Proper Hybrid Models for Smarter Vehicles. German national project including Bosch, LTX, XRG, TLK, ESI ITI GmbH, Modelon, TU Braunschweig, Universität Augsburg, FH Bielefeld. Starts 2021
- ITEA3 project EMPHYSIS, 2018-2021
- Swedish project EMISYS, 2019 – 2021
- Swedish project LargeDyn, 2019 – 2022
- ITEA3 project EMBRACE, 2019-2022
- EU project HUBCAP, 2020-2022

Conclusions and Summary 2020/Febr 2021

- Oct 24, 2020. OpenModelica **1.16.0**
- Dec 21, 2020. OpenModelica **1.16.2**
- February, 2020. OpenModelica **1.17.0**
- 2021. Good prospects for the future
- Towards a standard **high performance**, **quality, compliant** open source Modelica implementation in Modelica, increased tool support for integrated systems engineering.

- **Expected OpenModelica 1.18.0 and 2.0.0 (?)** in 2021

Questions?

www.openmodelica.org

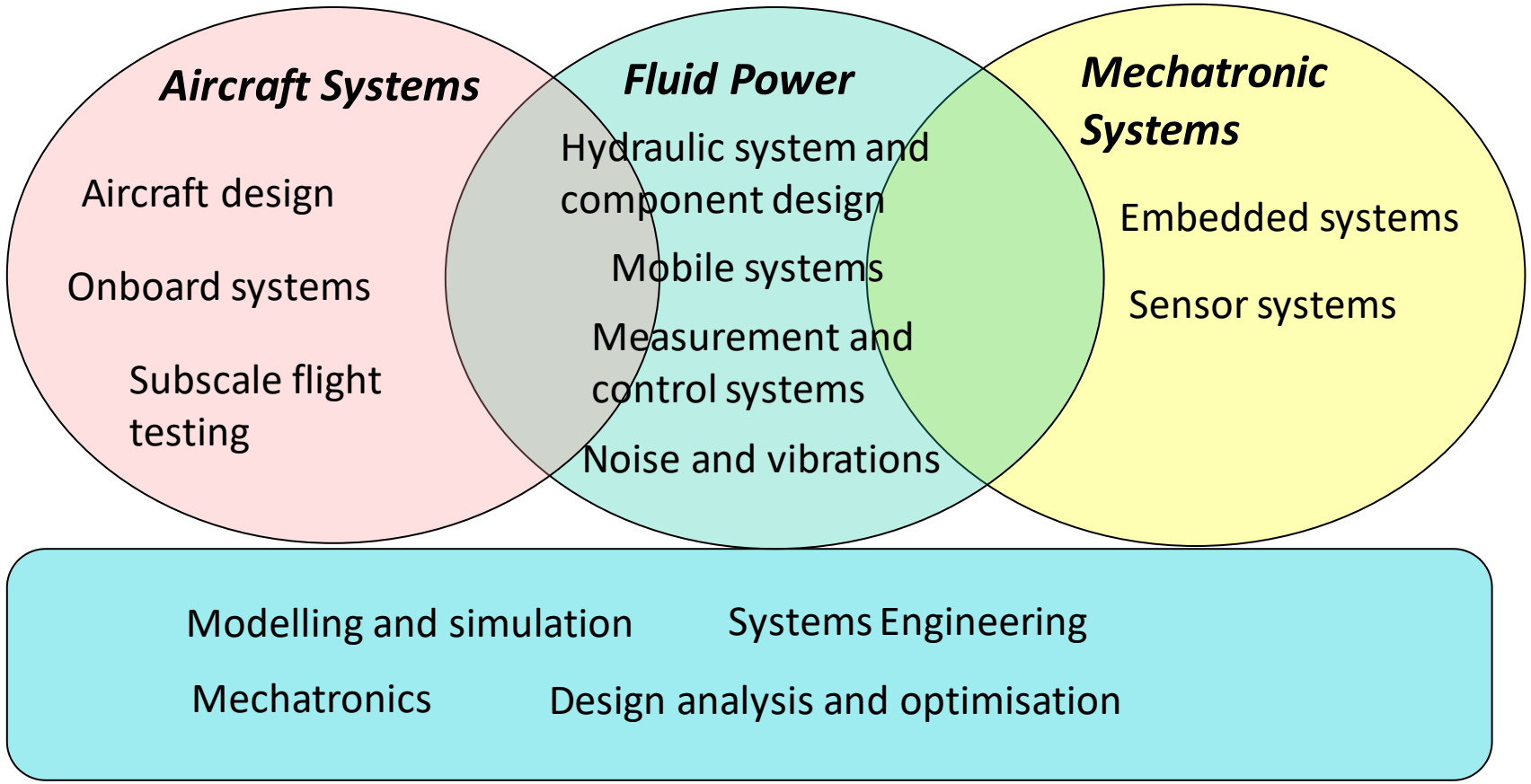
The
Fluid and Mechatronic Systems (FLUMES)
part of MODPROD

Department of
Management and
Engineering (IEI)

by Petter Krus,
Ingo Staack &
Robert Braun

Ongoing Research 2020/21

Flumes Overview



Ongoing Topics / Research Domains

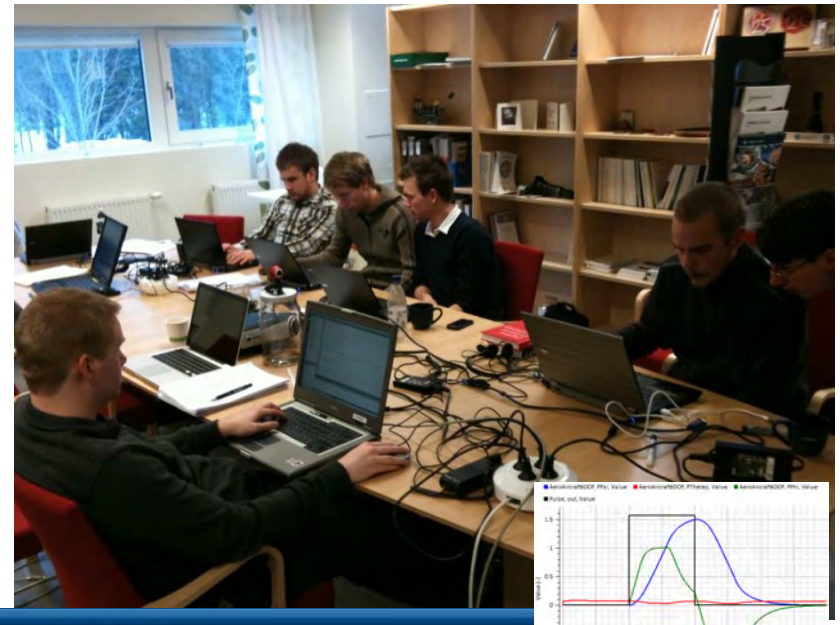
- High-performance CPS simulation
  In-house HOPSAN tool further refinements & model library validation
- SoS Engineering and behavior modelling
- Systems architecture design
- Subscale flight testing (for model verification & validation)
- Actuator Technologies (technology shift, innovative approaches)

System simulation, Hopsan

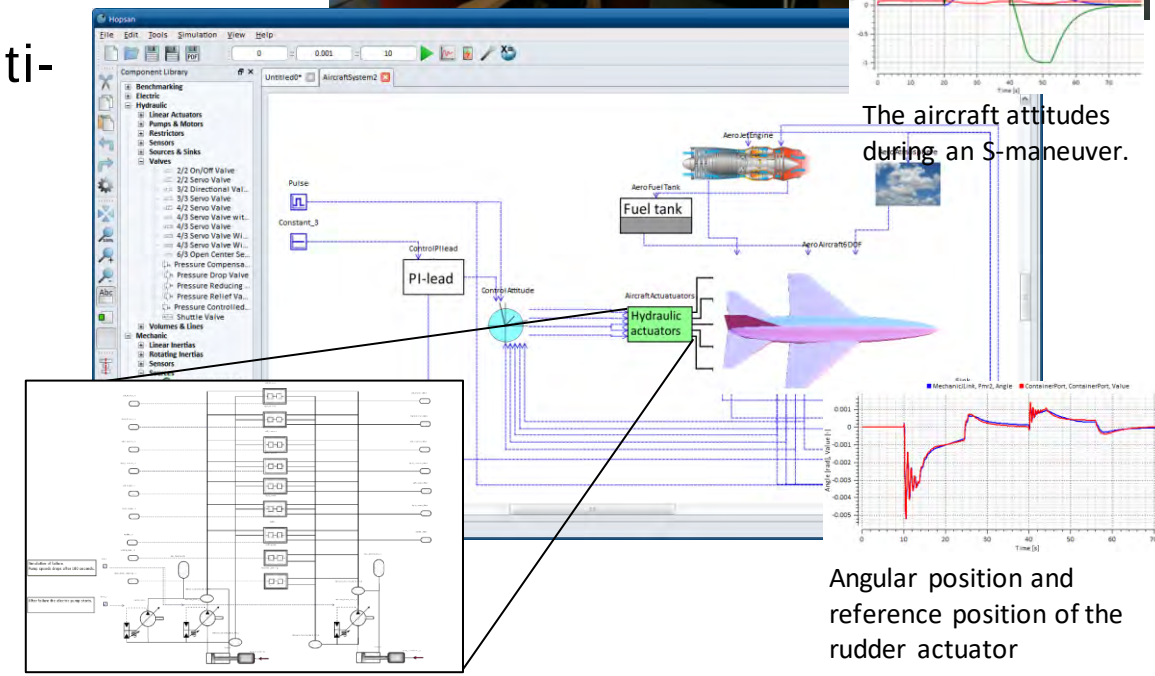
- Real-time Simulation (RTS), and Faster than Real Time Simulation (FRTS) Technologies
  - Distributed modeling
  - Parallelization of simulation models for multi-core processors
  - Hardware in the loop simulation
- Using bilateral delay line (transmission line modelling, TLM) for model partitioning

$$p_1(t) = p_2(t-T) + \frac{T}{C}[q_1(t) + q_2(t-T)]$$

$$p_2(t) = p_1(t-T) + \frac{T}{C}[q_2(t) + q_1(t-T)]$$

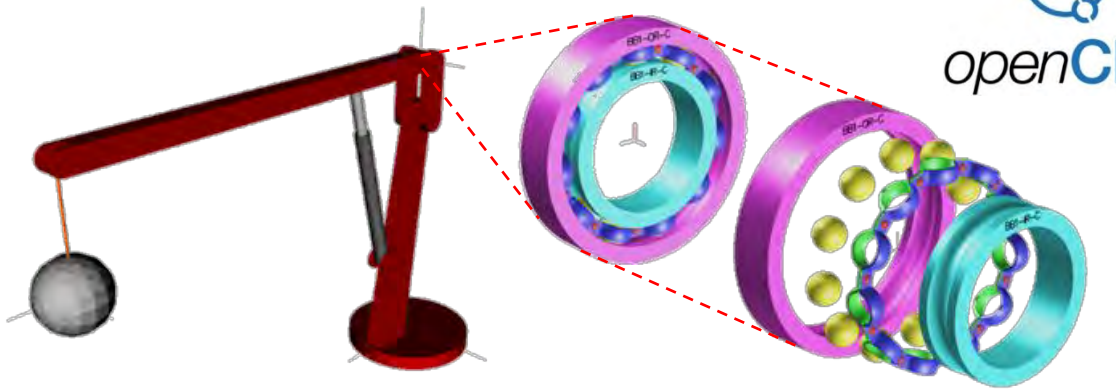


The aircraft attitudes during an S-maneuver.

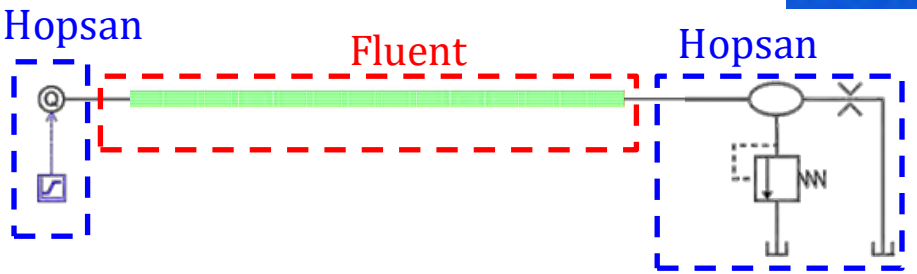


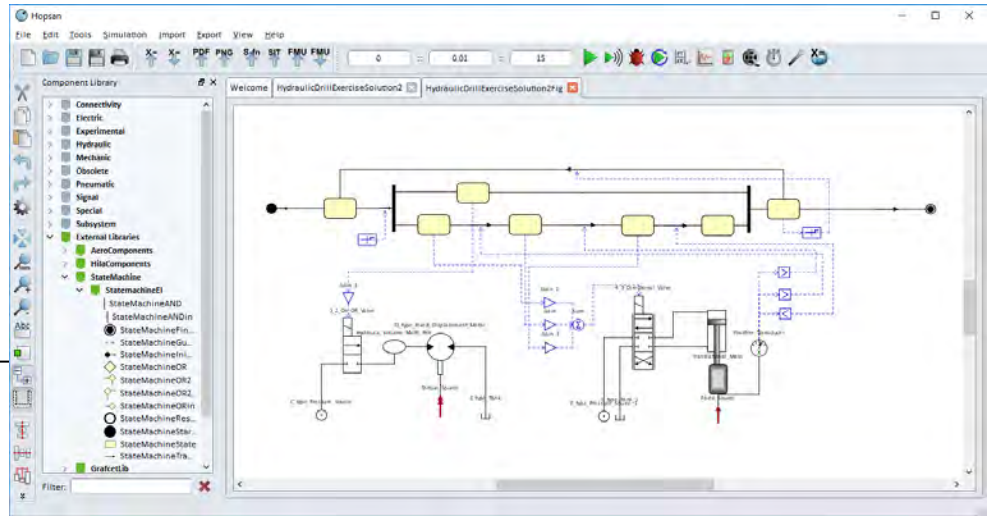
Angular position and reference position of the rudder actuator

Hopsan



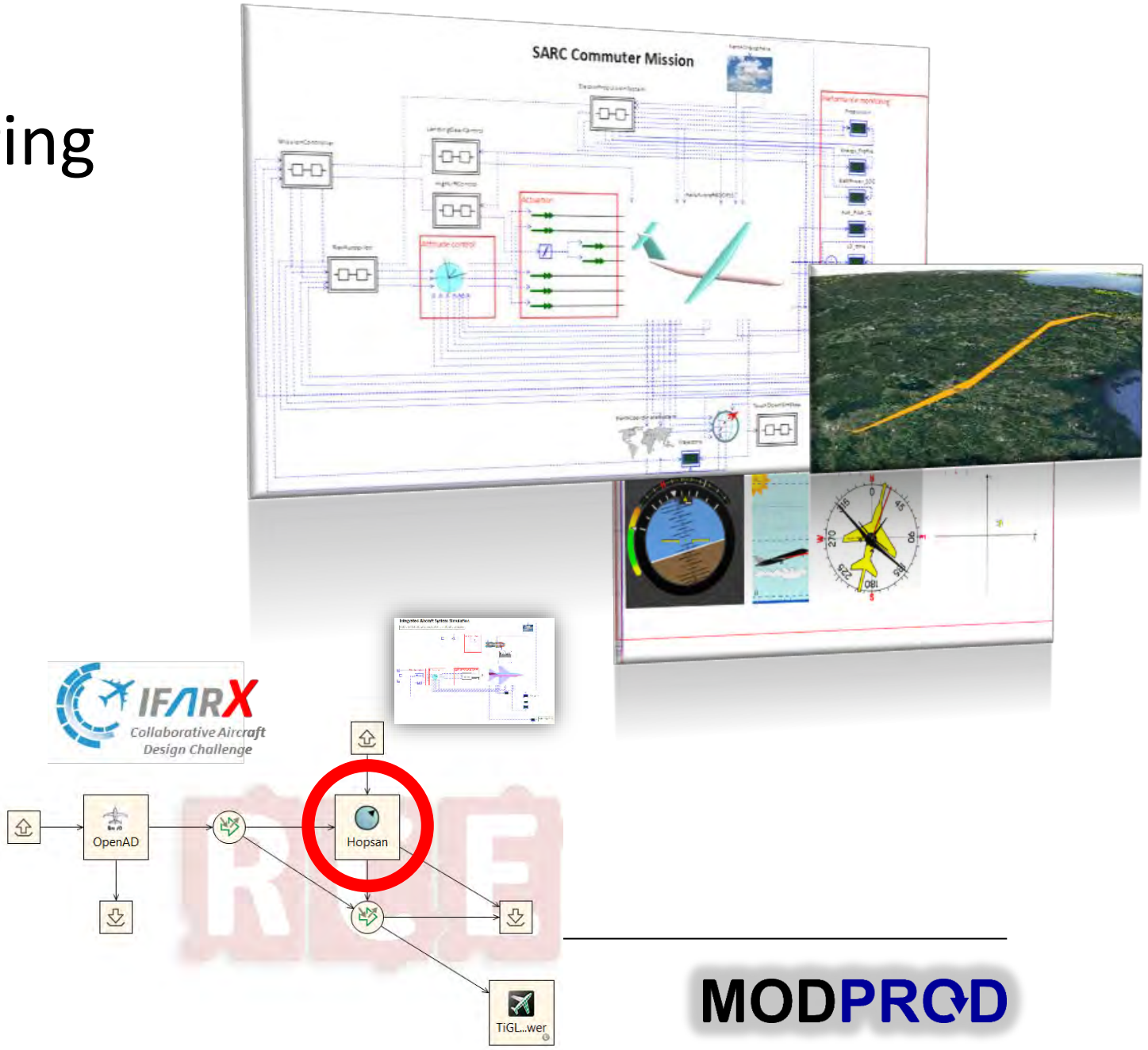
- Open-source
- Pre-compiled components
- Connectivity:
  - FMI-support (import-export), Matlab S-function export.
- Build-in, Frequency analysis, Optimization etc
- Used by Epiroc (former Atlas Copco) and many SME, Used extensively in our courses.
- Statemachine library for hydbrid system simulation.
- also library for Grafcet





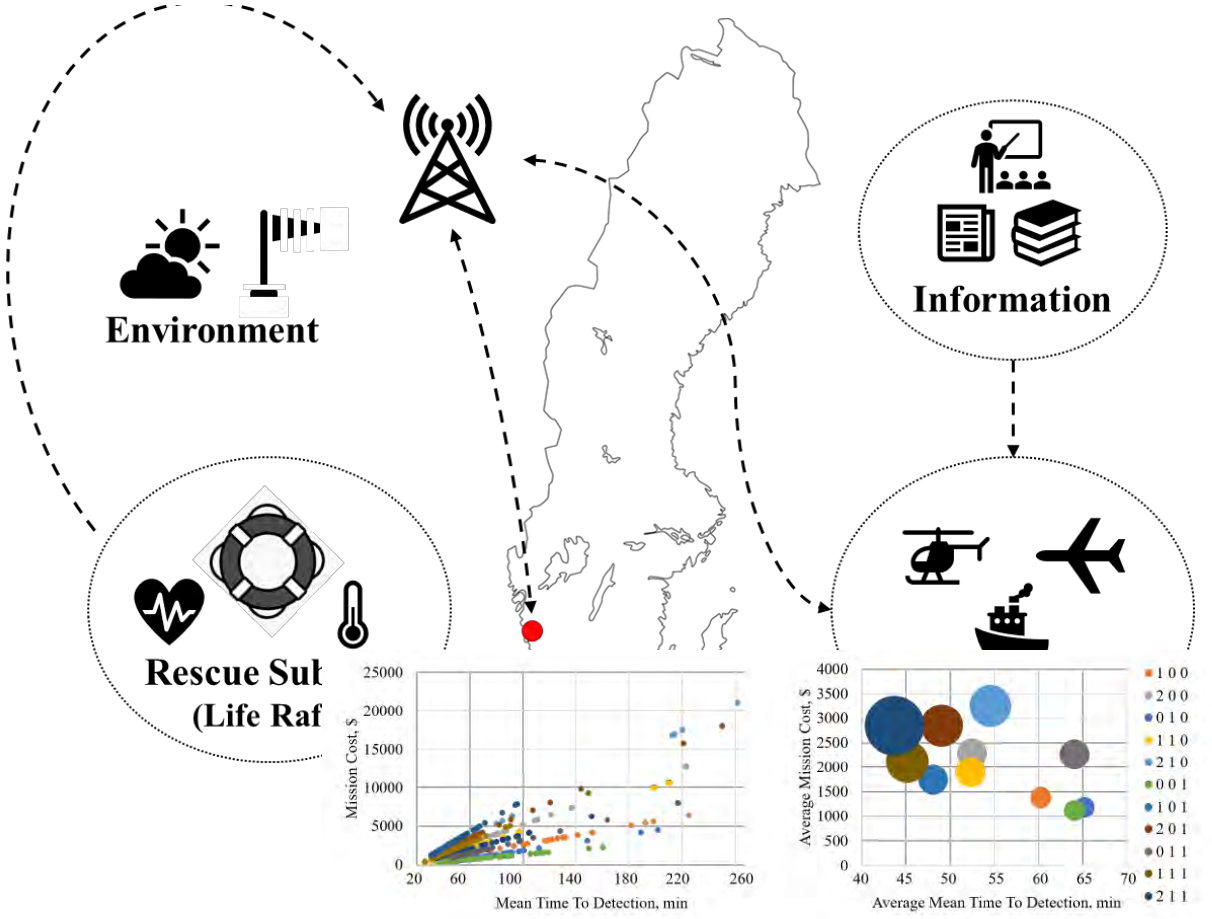
Modellering & Simulering

- model-based design
- workflow-driven design processes
- contribution to industrial standards and best practices
- model-based optimisation & machine learning
- just started: ITEA 3 project DEAFAINE

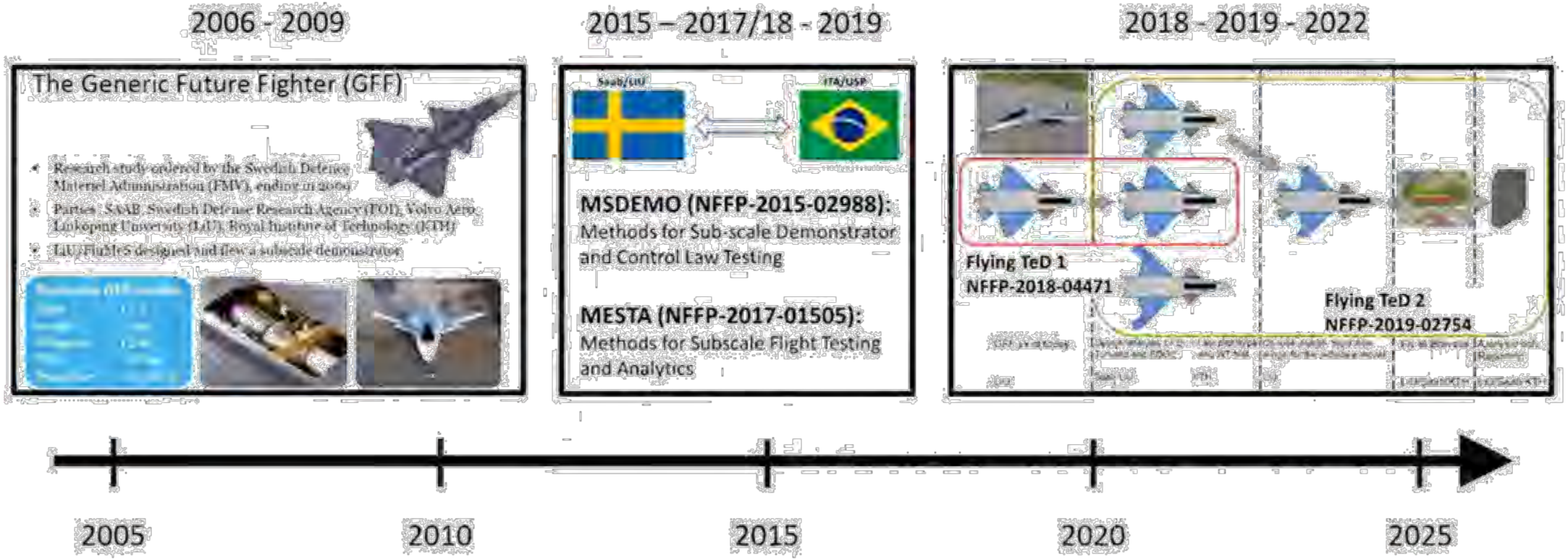


System of System (SoS) Engineering

- application-driven strategy, setup and vehicle design
- multi-modal epoch/scenario analysis for robust design
- system life cycle management: adaptability, replacement, system upgrades and replacement
- Ongoing projects:
  - Search & Rescue Missions (SAR)
  - Wildfire Spotting and Fire Fighting



Subscale Flight Testing



The Generic Future Fighter (GFF)

Some Industrial Partners and Applications

Aircaft
Saab AB

Hiab, Sunfab etc

Construction Machines
Volvo CE

Rock drills
Epiroc (formerly Atlas Copco)

The ICES Centre

INDUSTRY NETWORK # INNOVATION HUB

The Guiding Vision

To achieve a prospering eco-system for industry and academia within software intensive embedded and cyber-physical systems. With a mission to catalyze world class business creation, education, research and innovation with a local and European dimension.

The Network in Short

Quick Facts

- Founded in 2008 by KTH and 6 Industrial Partners
- A KTH Competence Centre
- Official DIH HUB since 2019
- Daily operation hosted by KTH Mechatronics Division
- 25+ Industry Members
- 220 associated Students from 3 Programs
- 1 Yearly Conference
- 8 Industrial Competence Groups
- 25+ Annual Seminars

The Core

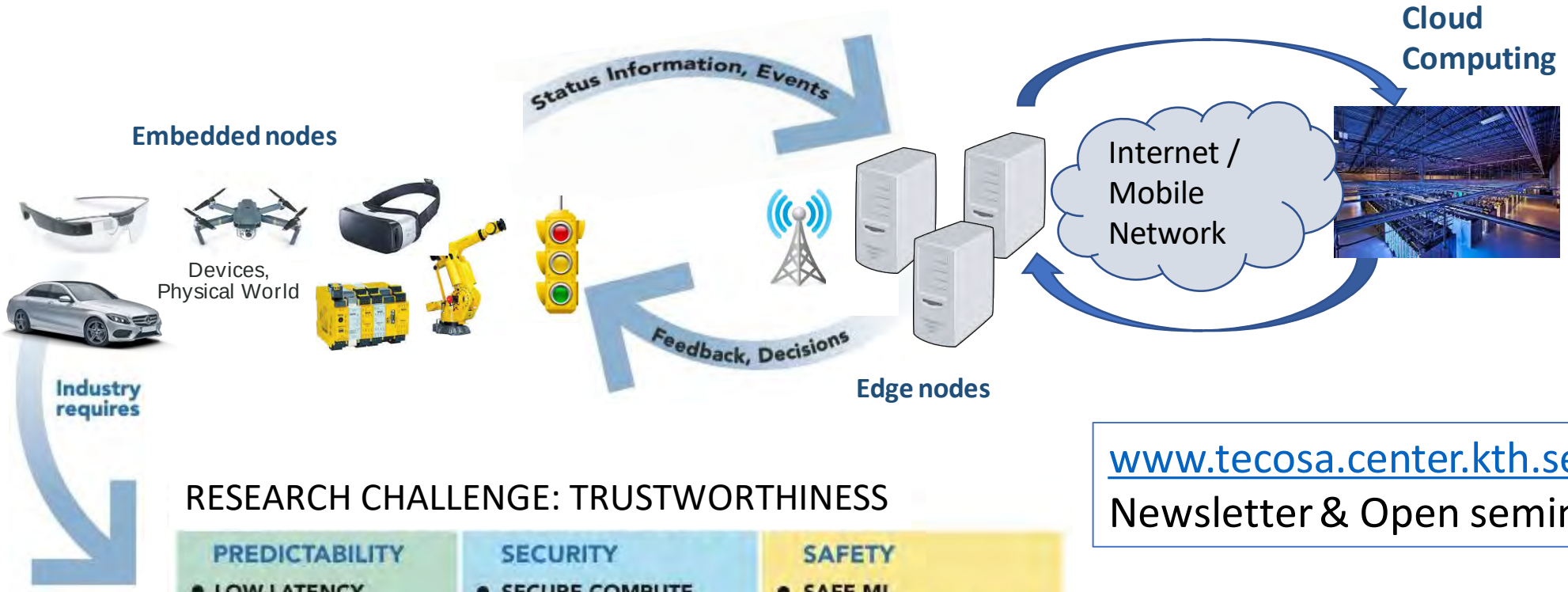
- Oriented around Embedded Systems
- An active player in the ecosystem
- A meeting ground for Industry and Academia
- Strong focus on Professional Education / The PECA Initiative
- Skill provisioning / Student Interaction
- Involvement in Projects
- Linking funding opportunities

Focus Areas

- AI and Machine Learning
- Autonomous Systems
- Cyber Security
- Embedded Realtime Systems
- Interoperability
- R&D Mangers
- Safety
- Testing

TECoSA: Trustworthy edge computing systems and applications

- A KTH-based Vinnova competence center with industry, started March 26, 2020



RESEARCH CHALLENGE: TRUSTWORTHINESS

PREDICTABILITY	SECURITY	SAFETY
• LOW-LATENCY	• SECURE COMPUTE	• SAFE ML
• INTEGRATED COMM & COMPUTE	• TRUSTABLE STORAGE	• PROB. PROGRAMMING
• STATEFUL MANAGEMENT	• LIGHTWEIGHT CRYPTO	• SAFE ARCHITECTURES
	• ADVERSARIAL ML	• SAFE HCI

www.tecosa.center.kth.se
Newsletter & Open seminars!

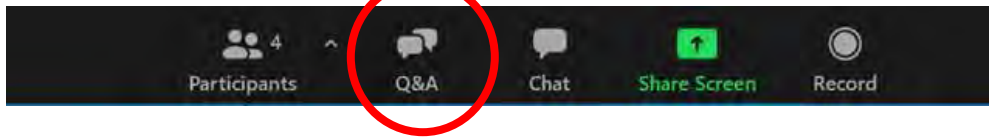
Session Rules and Tips

MODPROD
Center for Model-Based Cyber-Physical Product Development

- Zoom links
  - Zoom Room1 (main room): https://kth-se.zoom.us/j/62126053825
  - Zoom Room2: https://kth-se.zoom.us/j/61254374041

- Q&A sessions
  - Last 10 minutes dedicated to discuss your questions

- How do I direct questions to presenters?
  - Put any questions you want to direct to the presenters
  - Monitored and discussed during the last 10 minutes



- Zoom Chat
  - For open discussions
  - Put comments and have a dialogue among all attendees.
  - May not be discussed during the Q&A sessions.

Warm Welcome to our Keynote Presenters!

Richard Romano

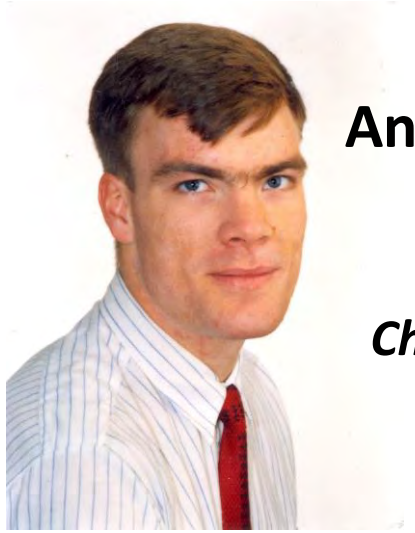
Model based design of Auto-mated Vehicles

Claes Nord

Factory of the future Sandvik Coromant Gimo

Lisen Schultz

A Resilience Perspective on Sustainability Transformations



Andreas Junghanns

FMI – Current Challenges, Trends and Developments

MODPROD

Cices

... as well as 22 of high-quality Presentations

... and 4 Tutorials!

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15th MODPROD Workshop on Model-Based Cyber-physical Product Development

Linköping University, February 3-4, 2021

www.modprod.se

"Digital engineering for a resource efficient and circular industry"

Final Program

Wednesday February 3

09.00-12.00 Zoom room 1

Tutorial 1

- Peter Fritzson and Adrian Pop, Linköping University. "Introduction to Object Oriented Modeling, Simulation, Debugging and Sensitivity Analysis/Optimization with Modelica using OpenModelica"

09.00-12.00 Zoom room 2

Tutorial 2

- Andreas Heuermann, Linköping University and Lennart Ochel, RISE. "FMI for Composite Modeling, Co-simulation and Model Exchange"

12.00-14.00

Break

14.00-14.20 Zoom Room 1

Plenary Session 1. Chair: Niclas Fock

- Welcome the MODPROD director. Niclas Fock
- Presentation of research at MODPROD center

14.20-15.00 Zoom room 1

Parallel Session 2a: Model-based Systems Engineering. Chair: Erik Herzog

- Jinzhi Lu and Jinzhi Lu. "Design Ontology Supporting Model-based Systems-engineering Formalisms"
- Yana Brovar and Clement Fortin. "Relationships Management for the Integration of OPM and Modelica"
- Arthur Zanfir, Jacopo Zamboni and Erwin Moerland, DLR. "CODEX – A Semantic Knowledge-based-engineering Framework"

14.20-15.00 Zoom room 2

Parallel Session 2b: Model-Based Vehicle Engineering. Chair: Gert Johansson

- Adebowale Odukoya, Alex Duffy and Ian Whitfield. "Verification and Validation in Complex Warship Systems Design Process"
- Athanasios Papageorgiou. "Development of System Models for the Evolution of Unmanned Airborne Early Warning Aircraft"
- Arvid Vagale and Robin Trulssen Bye. "Simulation-based Evaluation of Path Planning Algorithms for Autonomous Surface Vehicles"

15.00-15.10

Break

15.10-15.40 Zoom room 1

Plenary Session 2. Chair: Peter Fritzson

- Keynote: Claes Nord, Senior Visitor Experience Specialist at AB Sandvik Coromant. "Factory of the Future – Sandvik Coromant Gimo"

15.40-16.20 Zoom room 1

Parallel Session 3a: Sustainability & Circular Economy. Chair: Monica Bellgran

- Marco Mastrogio. "A brief examination of the sustainability of the Lost PLA method"
- Jolena Kurilova. "Importance of a Product Life-cycle Data Access to Facilitate Product Recirculation in a Circular Economy"
- Petter Krus. "Requirement Spaces for Sustainable Technologies"

15.40-16.20 Zoom room 2

Parallel Session 3b: Cyber-Physical Systems. Chair: Martin Törngren

- Hassan Sarjoughian, Chao Zhang and Xuanli Lin. "Control and Decision Communication Across Heterogeneous Model Types"
- Michael Winokur and Avi Zapuri. "Recent Advances in System Modeling and Simulation"
- Ordem Gunduz Ersoz. "Data as a Journey, not a Destination"

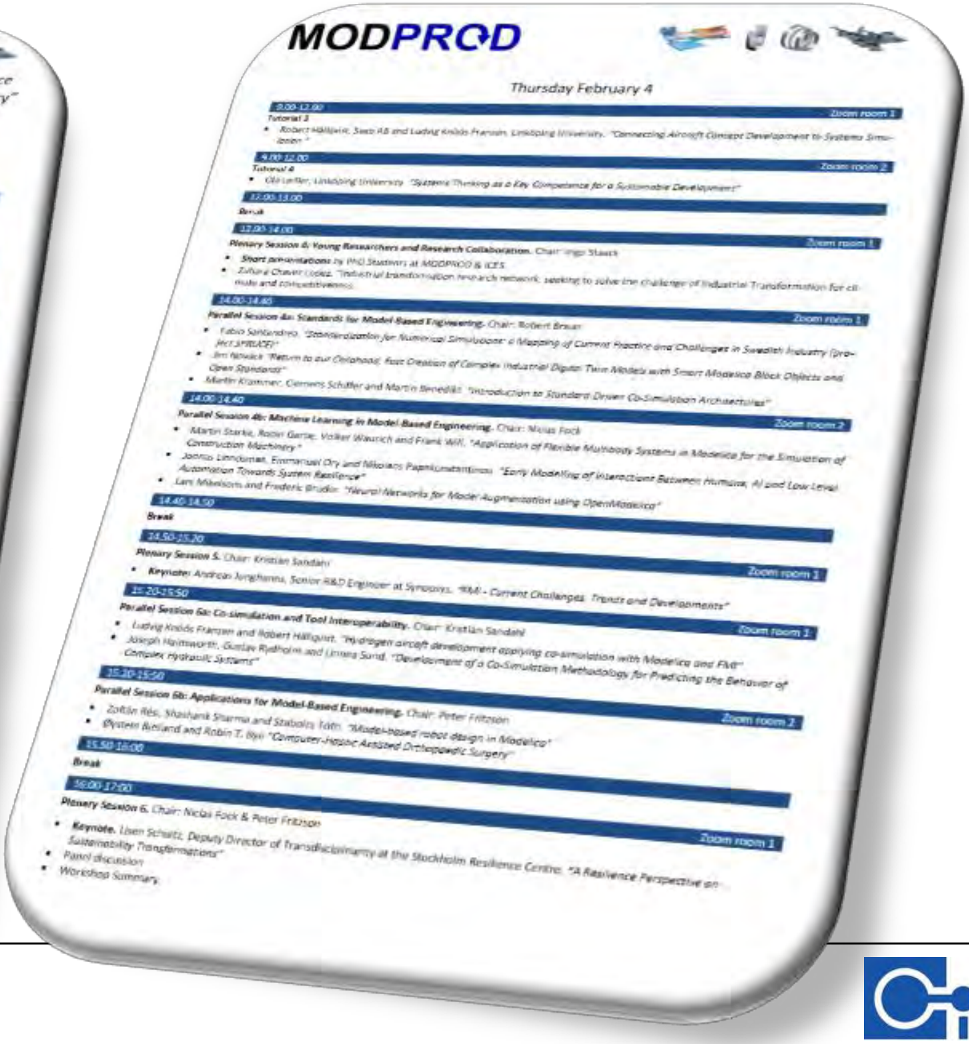
16.20-16.30

Break

16.30-17.00 Zoom room 1

Plenary Session 3. Chair: Martin Törngren

- Keynote. Richard Romano, Professor at University of Leeds, Chair in Driving Simulation. "Model-based Design of Automated Vehicles"



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Thursday February 4

9.00-12.00 Zoom room 1

Tutorial 3

- Robert Hällqvist, Saab AB and Ludvig Knöös Franzén, Linköping University. "Connecting Aircraft Concept Development to Systems Simulation"

9.00-12.00 Zoom room 2

Tutorial 4

- Ola Leifler, Linköping University. "Systems Thinking as a Key Competence for a Sustainable Development"

12.00-13.00

Break

13.00-14.00 Zoom room 1

Plenary Session 4: Young Researchers and Research Collaboration. Chair: Ingo Staack

- Short presentations by PhD Students at MODPROD & ICES
- Zuhara Chavez (ICES). "Industrial transformation research network, seeking to solve the challenge of industrial Transformation for climate and competitiveness"

14.00-14.40 Zoom room 1

Parallel Session 4a: Standards for Model-Based Engineering. Chair: Robert Braun

- Fabio Santandrea. "Standardization for Numerical Simulation: a Mapping of Current Practice and Challenges in Swedish Industry (project SPRUCE)"
- Jiri Nowack. "Return to our Celohood: Fast Creation of Complex Industrial Digital Twin Models with Smart Modelica Block Objects and Open Standards"
- Martin Krammer, Clemens Schiffer and Martin Benedikt. "Introduction to Standard Driven Co-Simulation Architectures"

14.00-14.40 Zoom room 2

Parallel Session 4b: Machine Learning in Model Based Engineering. Chair: Niclas Fock

- Martin Starke, Robin Garte, Volker Waurich and Frank Will. "Application of Flexible Multibody Systems in Modelica for the Simulation of Construction Machinery"
- Jonnie Lindqvist, Emmanuel Ory and Nikolaos Papakonstantinou. "Early Modelling of Interactions Between Humans, AI and Low Level Automation Towards System Resilience"
- Lars Mikelsson and Frederic Bruder. "Neural Networks for Model Augmentation using OpenModelica"

14.40-14.50

Break

14.50-15.20 Zoom room 1

Plenary Session 5. Chair: Kristian Sandahl

- Keynote: Andreas Junghanns, Senior R&D Engineer at Synopsys. "FMI – Current Challenges, Trends and Developments"

15.20-15.50 Zoom room 1

Parallel Session 5a: Co-simulation and Tool Interoperability. Chair: Kristian Sandahl

- Ludvig Knöös Franzén and Robert Hällqvist. "Hydrogen aircraft development applying co-simulation with Modelica and FMI"
- Joseph Hainsworth, Gustav Rydholm and Linnea Sund. "Development of a Co-Simulation Methodology for Predicting the Behavior of Complex Hydraulic Systems"

15.20-15.50 Zoom room 2

Parallel Session 5b: Applications for Model-Based Engineering. Chair: Peter Fritzson

- Zoltán Rész, Shashank Sharma and Stabolcs Tóth. "Model-based robot design in Modelica"
- Øystein Bjelland and Robin T. Bye. "Computer-Haptic Assisted Orthopaedic Surgery"

15.50-16.00

Break

16.00-17.00 Zoom room 1

Plenary Session 6. Chair: Niclas Fock & Peter Fritzson

- Keynote. Lisen Schultz, Deputy Director of Transdisciplinarity at the Stockholm Resilience Centre. "A Resilience Perspective on Sustainability Transformations"
- Panel discussion
- Workshop Summary

The 15th MODPROD Work Shop, 3rd-4th February 2021

"Digital engineering for a resource efficient and circular industry"

Welcome!

...and let's begin...

MODPROD

Cices