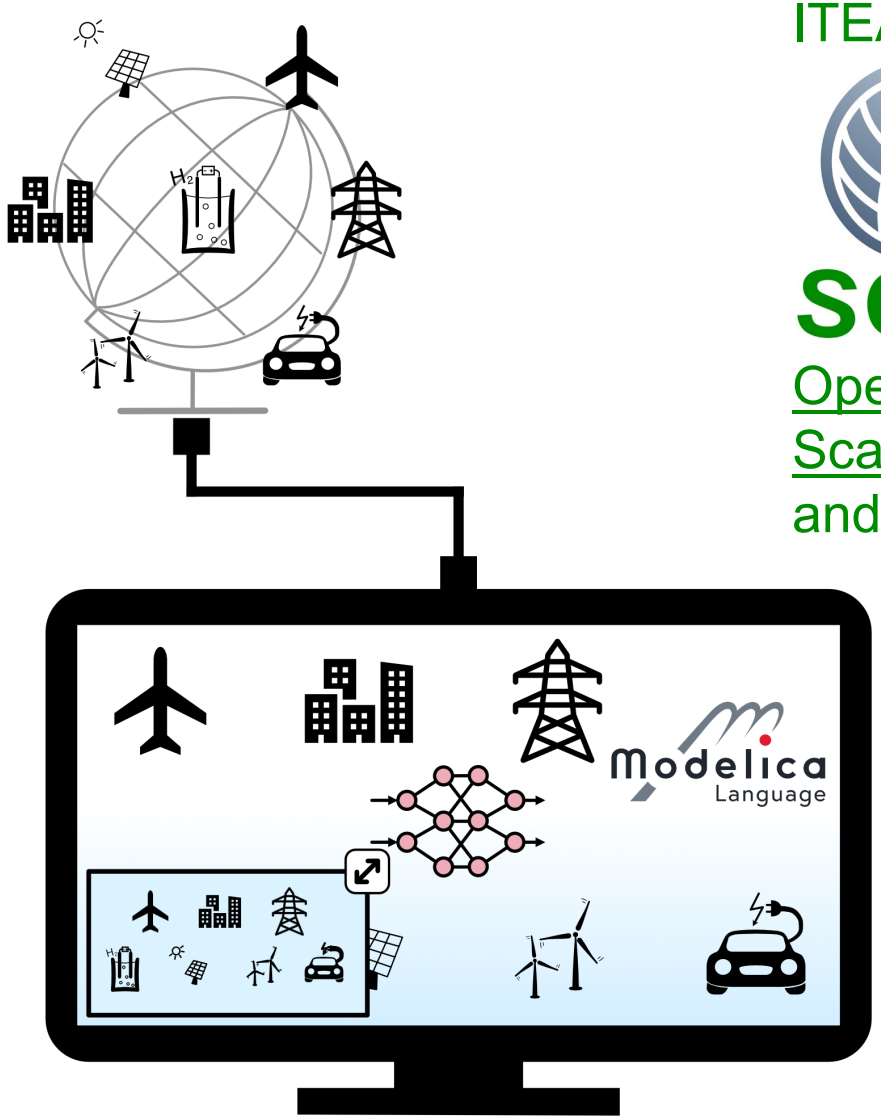
OpenSCALING

A European effort to scale-up model-based systems engineering to the needs of carbon neutral transformation

Oliver Lenord (Bosch)
Martin Otter (DLR)
Lars Mikelsons (UNA)
with contributions from all partners

MODPROD Workshop
Linköping, 06./07.02.2024



ITEA4 22013

Open SCALING

Open standards for Scalable Virtual Engineering and Operation

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Funded by
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Content

Consortium

Rational

- Problem Statement
- Solutions & Challenges
- Market Perspective by Sector

Technological View

- Solution Concept
- Technological Innovation

Project Outcomes

- Quantified objectives and KPIs
- Tool Support
- Demonstrators

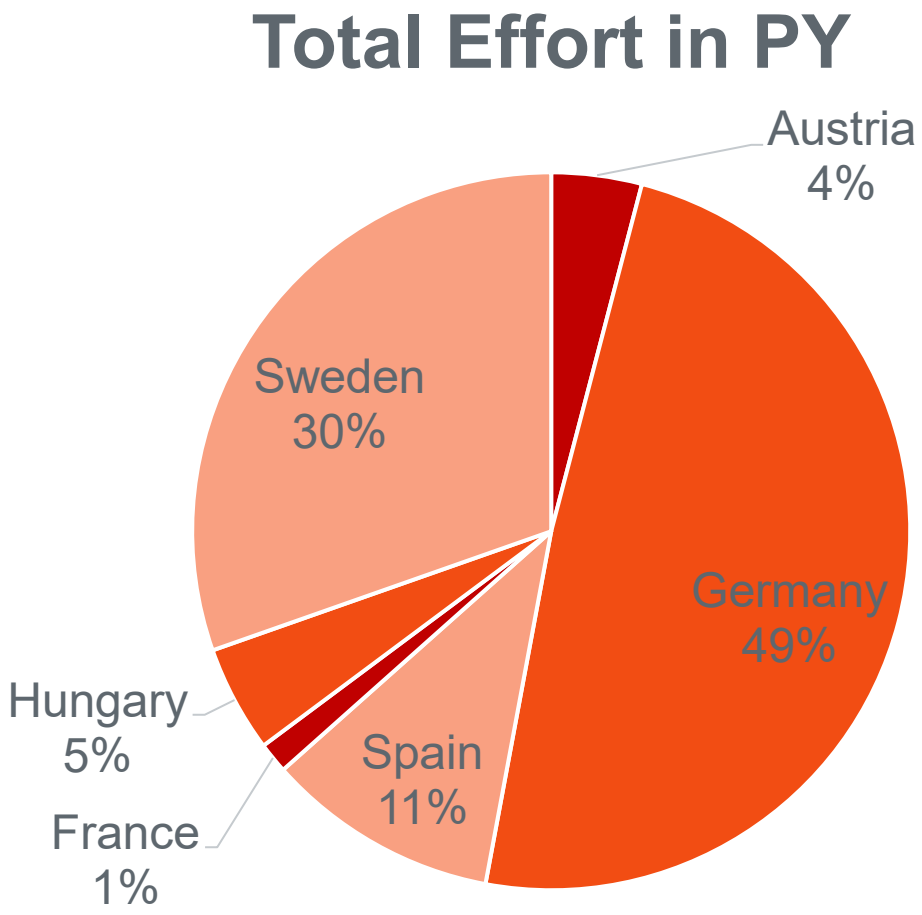
Project Structure

- Work Packages
- Milestones & Deliverables
- Demonstrators

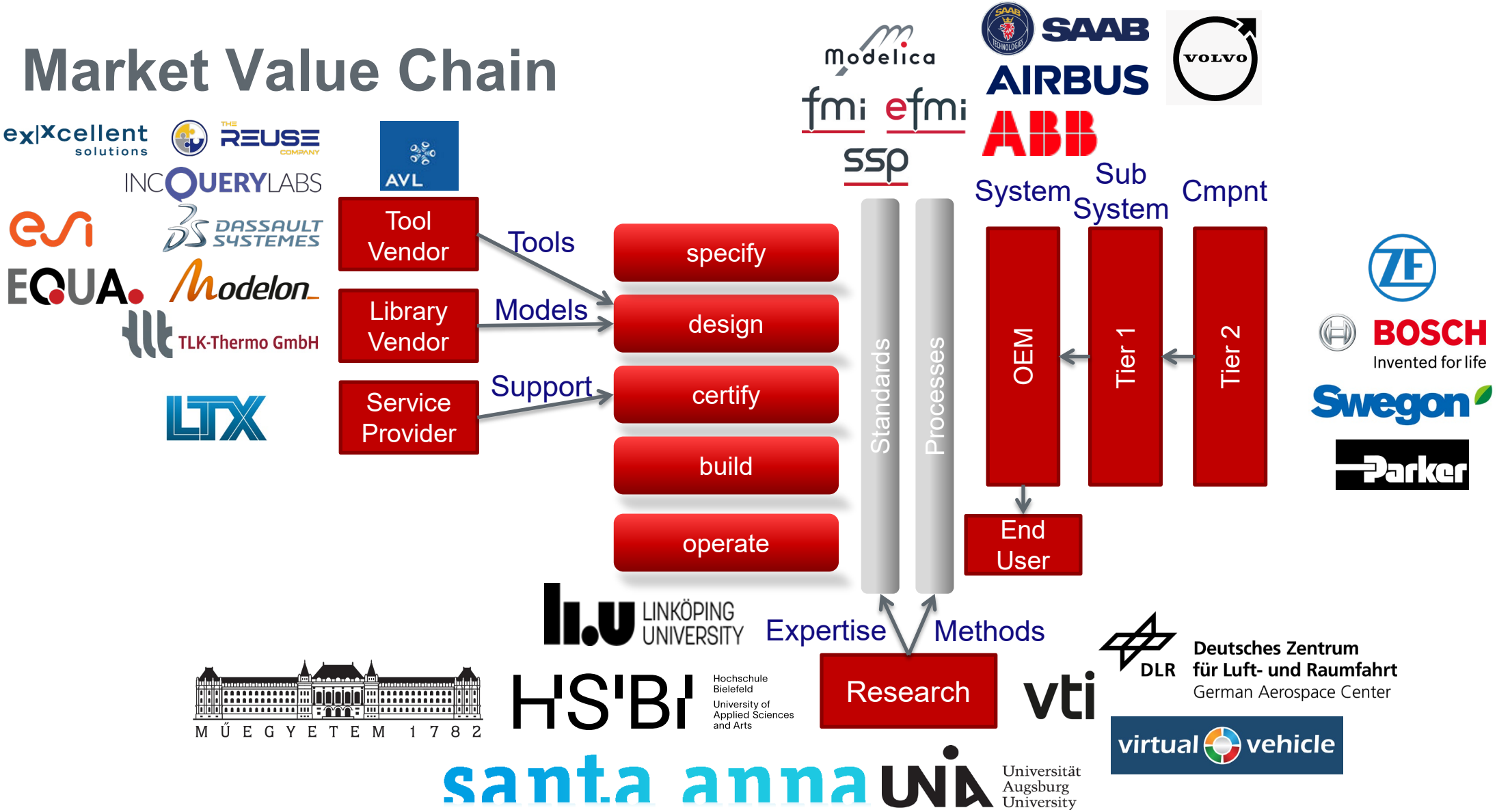
Consortium

Total Effort: 86.7 PY (~29 HC, 10.8 Mio.€)

- Project start: Nov. 1, 2023 (Duration 3 years)
- 27 Partners
- 6 Countries

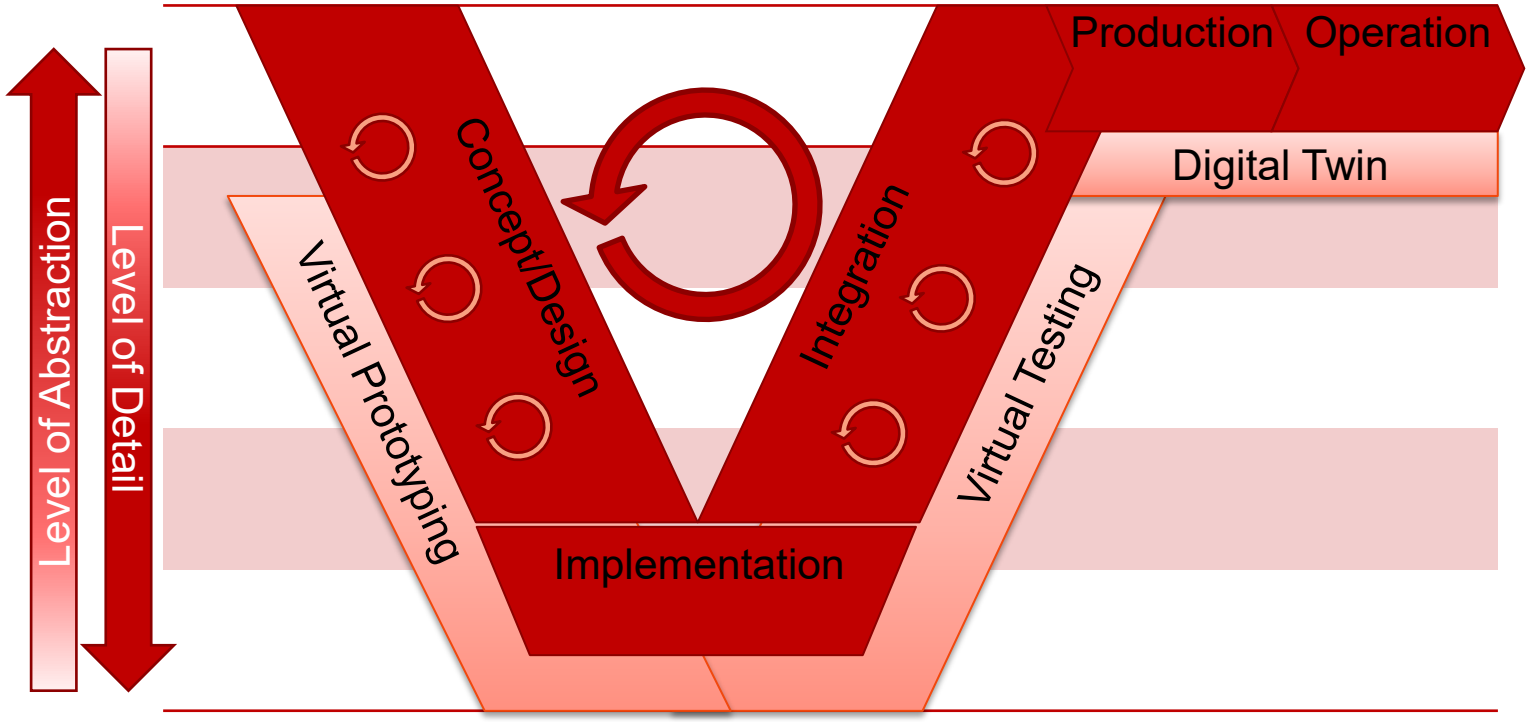


Market Value Chain



Problem Statement

Simulations and model reuse do not scale to the challenges of model-based systems engineering



Due to:

- Large scale systems:
  - Compilers scale poorly and might fail.
  - Excessive total execution time.
- Limited reuse:
  - Mismatch of the level of detail for the task (error vs. effort).
  - Lack of flexibility of deployed models for highly configurable products and targets.
  - Lack of confidence in the model quality and results.

Solutions & Challenges

Increase scalability of models

- Tools & methods for large scale system simulation.
- Highly flexible pre-compiled models.
- Efficient model quality assessment and UQ* for large and/or high dimensional systems.
- Built-in simulation AI* support.

Increase scalability of processes

- From manual modeling to model generation.
- Meta data enriched model exchange standards.
- Traceable model credibility as integral part of model-based systems engineering

UQ: Uncertainty Quantification
AI: Artificial Intelligence

Market Perspective by Sector

Energy

- Transformation to CO_2 neutrality requires new plants to be designed from scratch based on entirely new concepts in a short time.

Buildings

- Certification of heating systems needs to cover a large variety of designs and boundary conditions with overwhelming testing effort.

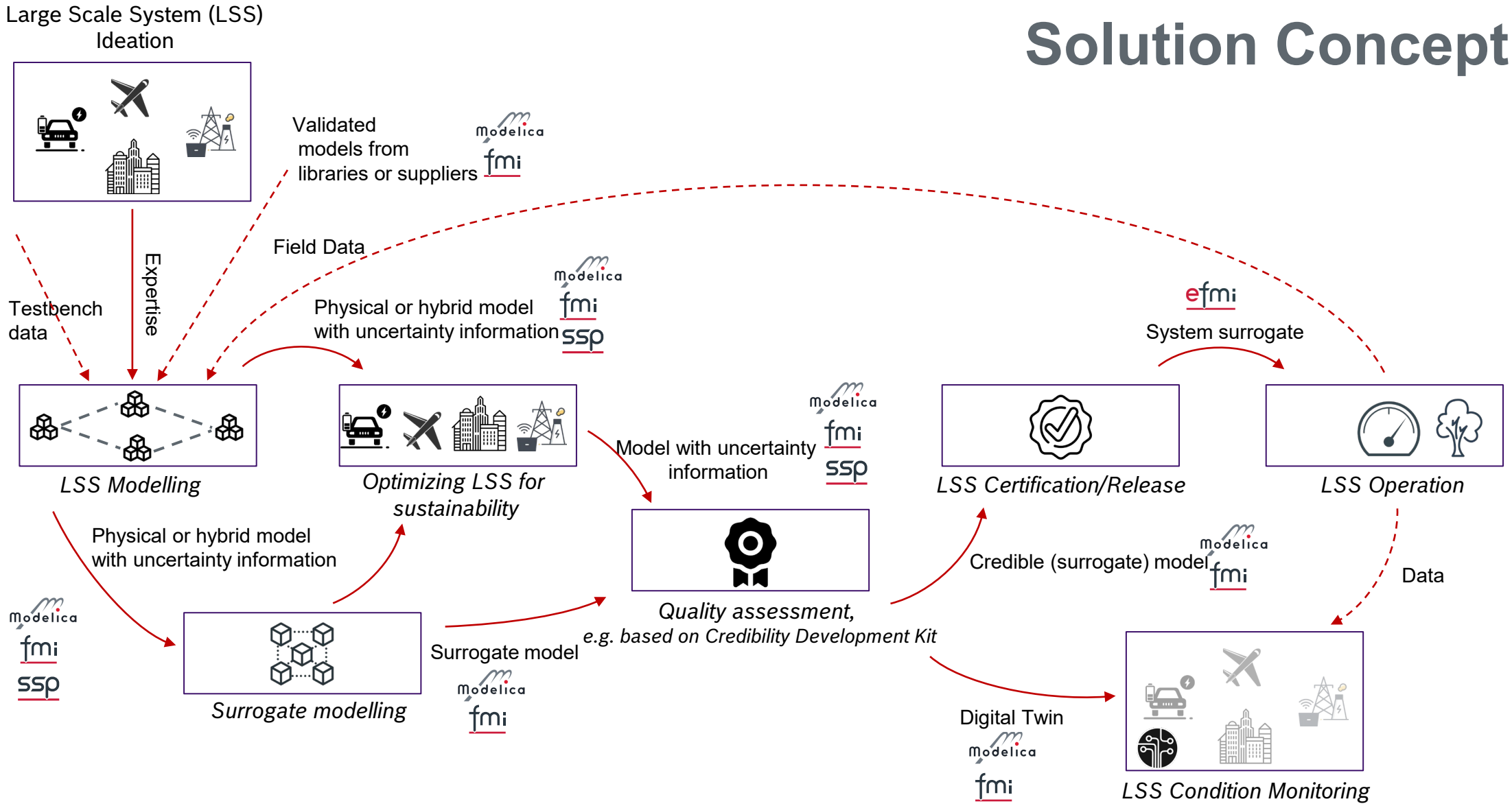
Aviation

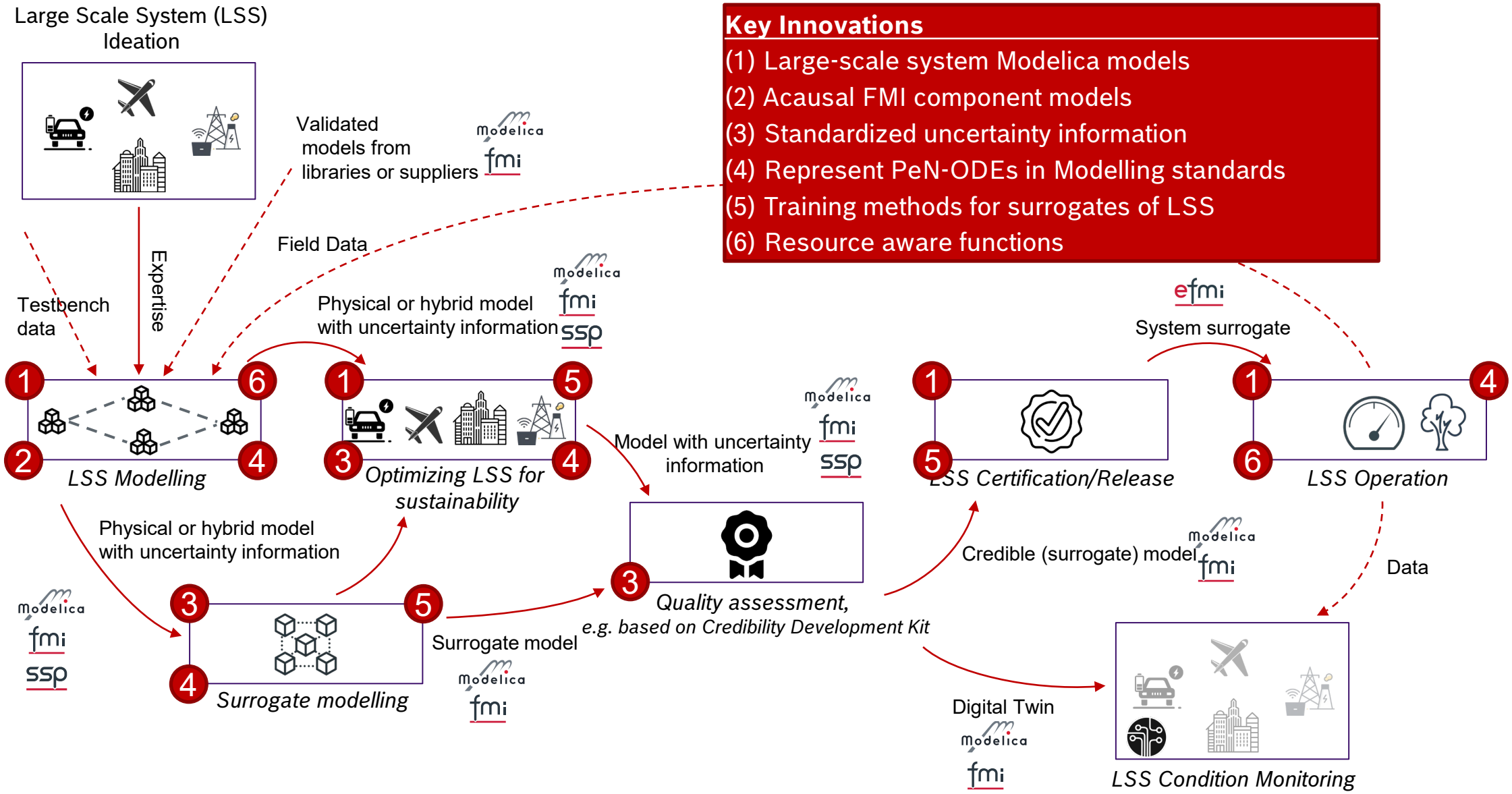
- Safety critical applications require credible simulation models including large scale systems

Automotive

- Design of control strategies shall guarantee robustness against uncertain parameters.

Solution Concept





Quantified Objectives and Key Performance Indicators

10x larger models (Modelica, FMI, eFMI, SSP)

- Reduction of code size and memory consumption during compilation.

100x faster start-up (Modelica compile time reduction)

- of large scale systems with recurring structures
- of large scale systems using pre-compiled subsystems

10x faster simulations

- of surrogate models (PeN-ODE[1)]s)

[1)] Physics enhanced Neural Ordinary Differential Equations

Quantified Objectives and Key Performance Indicators

Enabling of

- Array resizing w/o recompilation (Modelica, FMI, eFMI).
- FMUs with changing connection causality (FMI, SSP).
- Model uncertainties applicable to credibility assessment and PeN-ODE[1)] model training (Modelica, FMI, eFMI, SSP).
- Visualization and navigation in large multi-disciplinary/multi-aspect object diagrams.

[1)] Physics enhanced Neural Ordinary Differential Equations

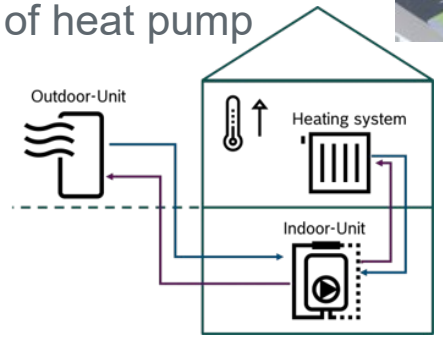
Tool Support (planned prototype development)

Tool	Vendor	Support of standard extensions
CATIA ESP	Dassault Systèmes	eFMI (production/binary code)
Dymola	Dassault Systèmes	Modelica, FMI, eFMI (algorithm code), SSP
easySSP	eXXcellent solutions	FMI, SSP
FMI.jl & FMIFlux.jl (OS*)	University of Augsburg	FMI
ICOS	Virtual Vehicle	FMI
IDA SE	Equa Simulation AB	FMI
IncQuery Suite	IncQuery Labs	FMI, SSP
ModelConnect	AVL	FMI
Modelon Impact	Modelon AB	Modelica, FMI, SSP
OpenModelica (OS*)	LiU, HSBI	Modelica, FMI, eFMI (equation code), SSP
SES Studio	Knowledge Centric Solutions	Modelica, FMI
SimulationX	ESI Group	Modelica, FMI, eFMI (specification)

Demonstrators

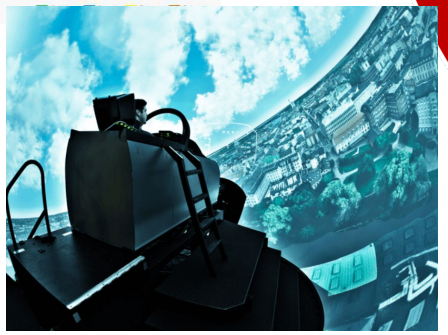
Large-scale green hydrogen

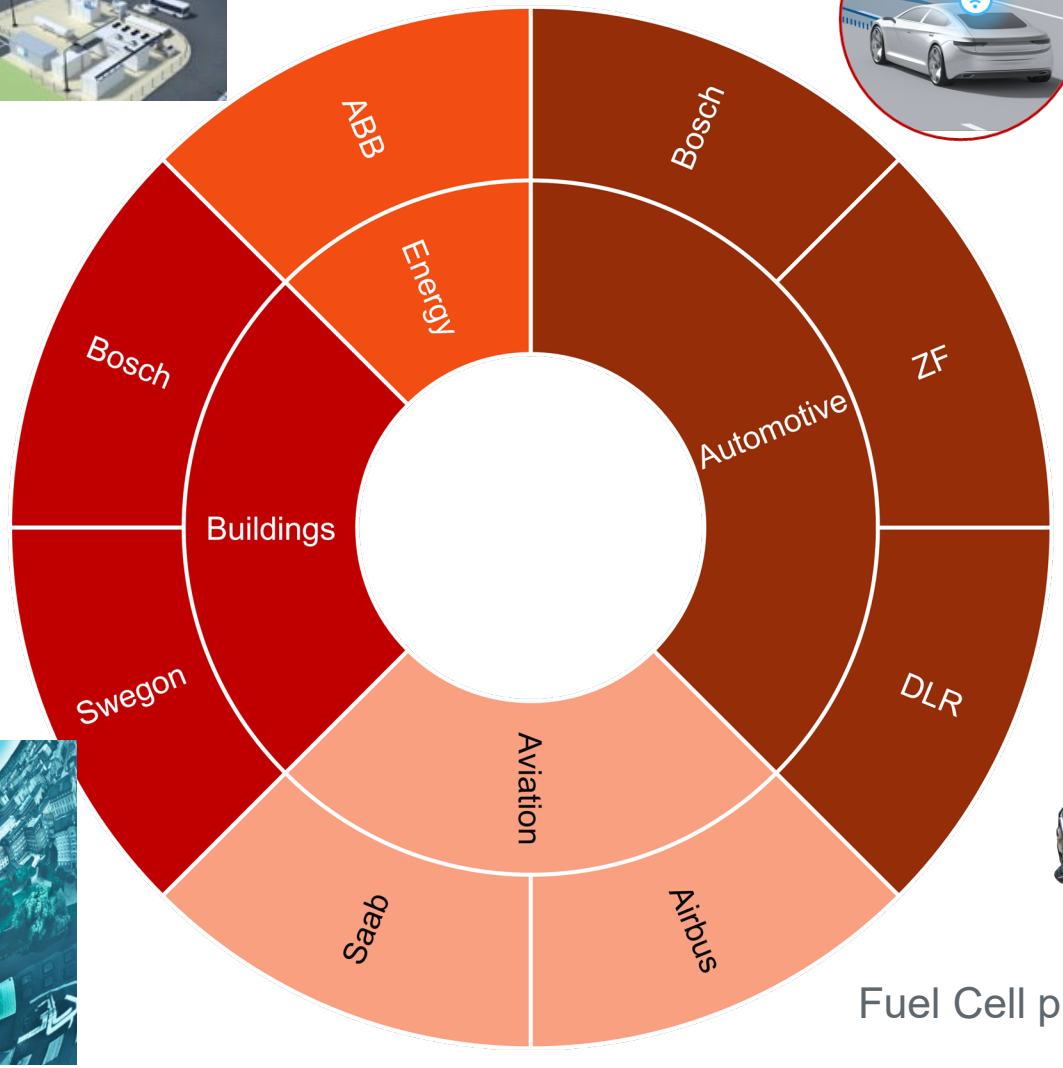
Virtual testing of heat pump systems



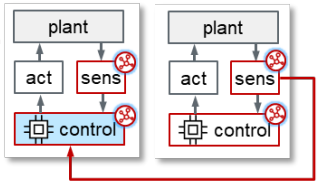
Precompiled, flexible models for HVAC of buildings

Vehicle systems





V2X communication between vehicles / infrastructure



Resource-aware function of distributed control system

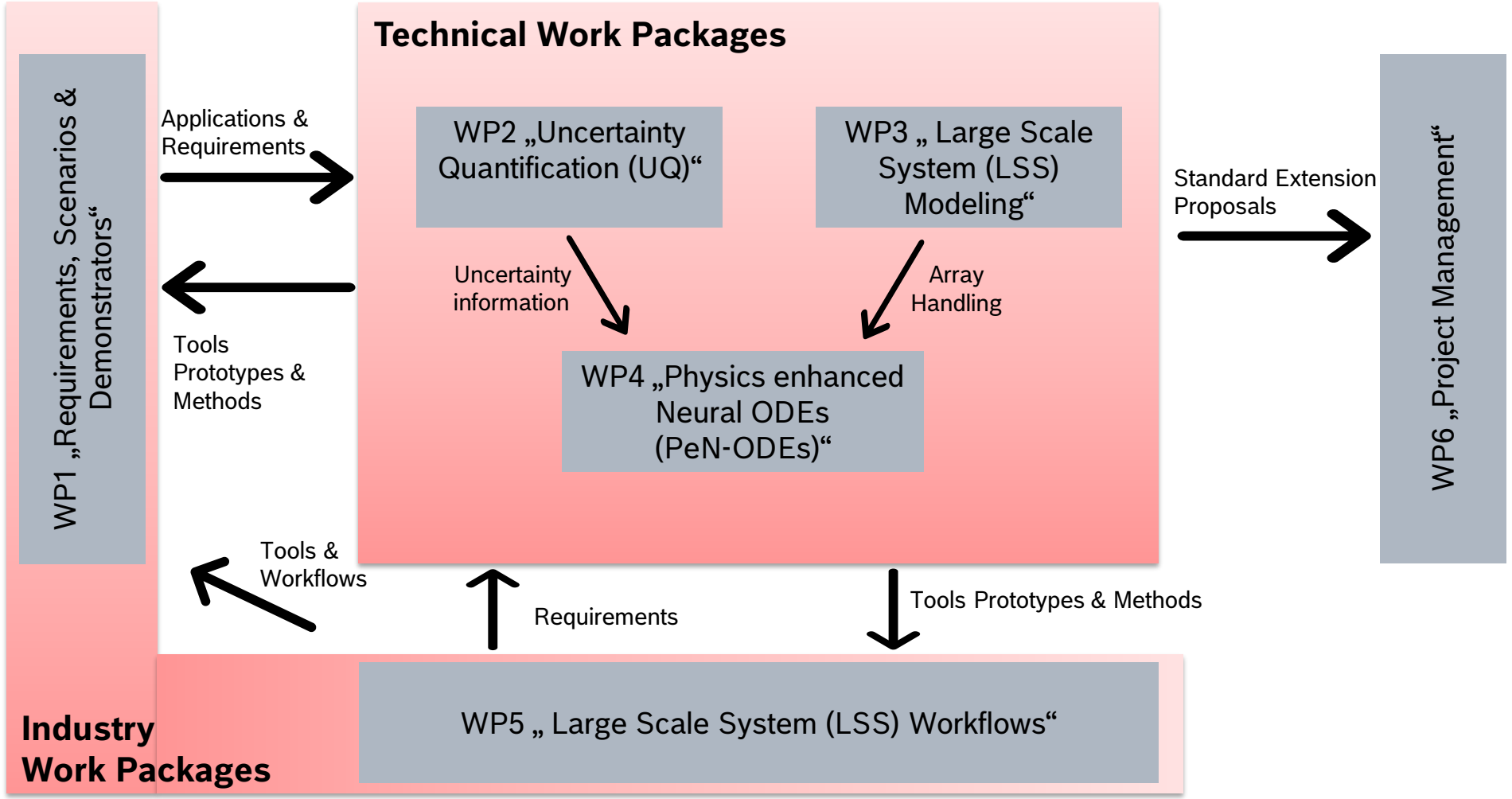
Part-specific performance prediction of advanced steering systems

Source: https://passivesafety.com

PeN-ODEs for Autonomous Vehicle

Fuel Cell propulsion

Work Packages



Milestones & Deliverables

MS3: Tool prototypes

D2.3 Tool and validation summary of prototypes (M30)

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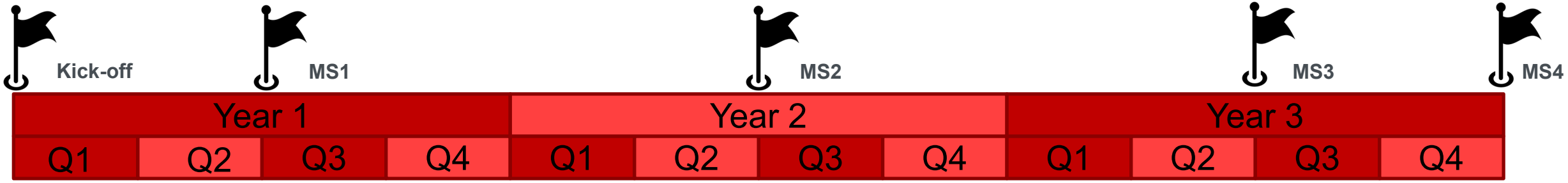
D4.3 Best-Practices for PeN-ODE modelling (M30)

D4.4 Tool and validation summary of prototypes (M30)



MS1: Requirements

D1.1 Requirements and scope of OpenSCALING solution (M6)

D6.1 Project Progress Report (M6 … every six month)

MS2: Draft standard enhancements

D2.1 Modelica, FMI, eFMI, SSP enhancements for UQ (M18)

D2.2 Open source benchmark models for UQ (M18)

D3.1 Modelica, FMI, eFMI and SSP enhancements for LSS (M18)

D3.2 Open source benchmark models for LSS (M18)

D4.1 Standard enhancements and tool features for PeN-ODEs (M18)

D4.2 Validation suite for PeN-ODEs training (M18)

D5.1 Requirement specification on LSS workflow and its enablers (M18)

MS4: Demos

D1.2-D1.9 Demonstrators (M36)

D5.2 Tools and validation summary of prototypes for LSS workflows (M36)

D6.2 Standardization documents for Modelica, FMI, eFMI and SSP (M36)

D6.3 Update of the ITEA living roadmap (will be iteratively delivered, e.g. with every PPR)

Enabling sustainable technologies on large scale

Thanks for your attention.

MODPROD Workshop

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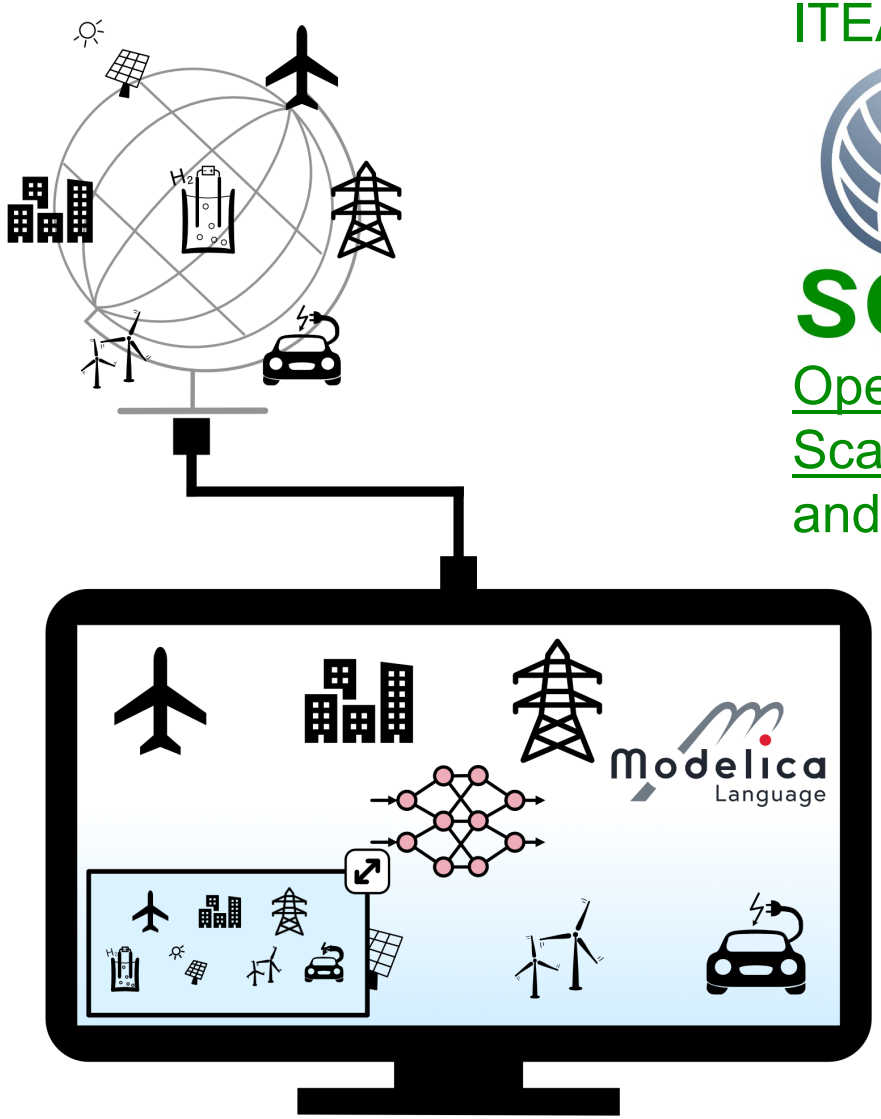

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