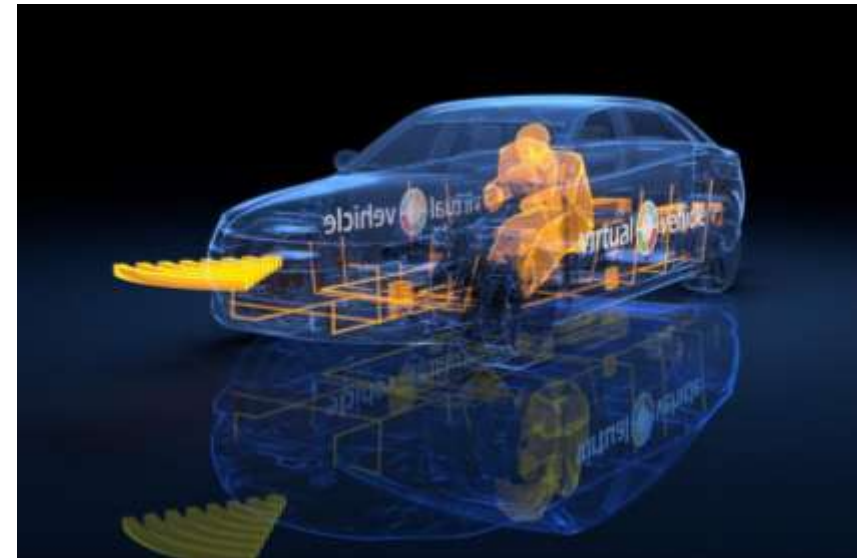
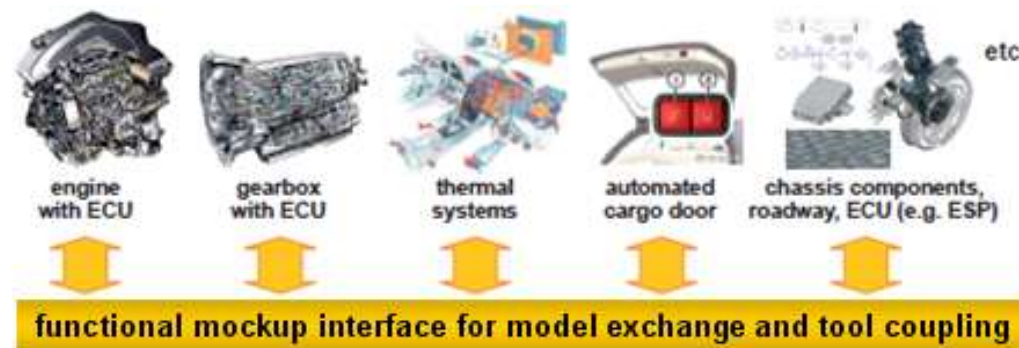


Co-Simulation and the Functional Mockup Interface

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VIRTUAL VEHICLE Research Center
Graz





Source: <https://www.fmi-standard.org/>

Challenges for a “Functional Mockup”:

- Different tools and languages are involved
- No standards for model interfaces and co-simulation available
- Protection of model IP and know-how of supplier

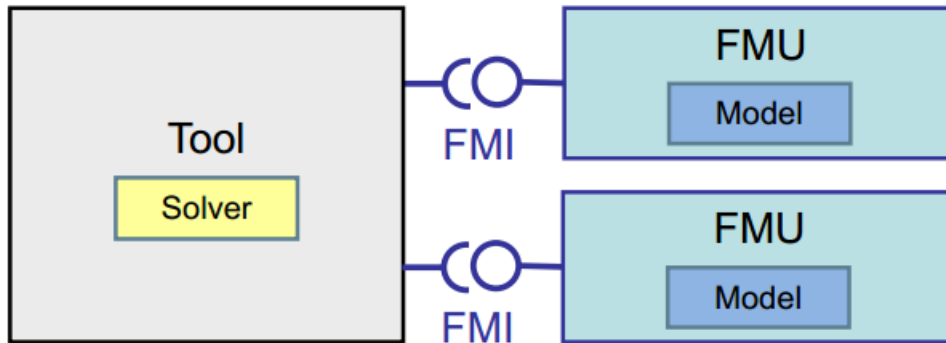
Modelisar project:

→ Functional Mockup Interface for Model Exchange and Co-Simulation

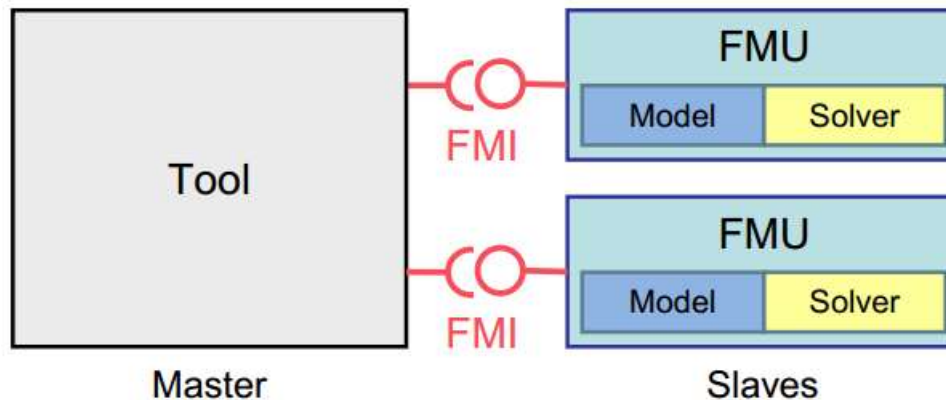
| | |
|-------------|--|
| Programcall | ITEA 2 Call 2 07006 |
| Title | From System Modeling to S/W running on the Vehicle |
| Period | Jul 2008 - Dec 2011 |



FMI for Model Exchange

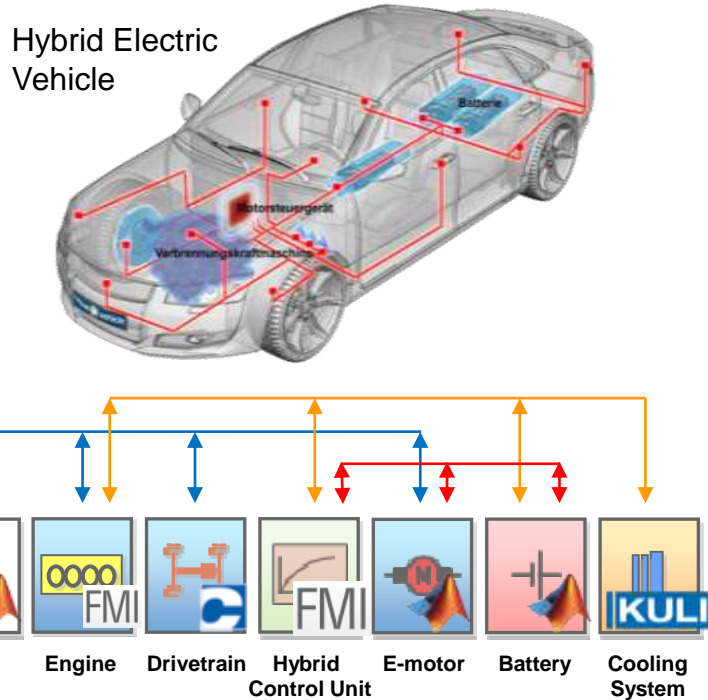


FMI for Co-Simulation



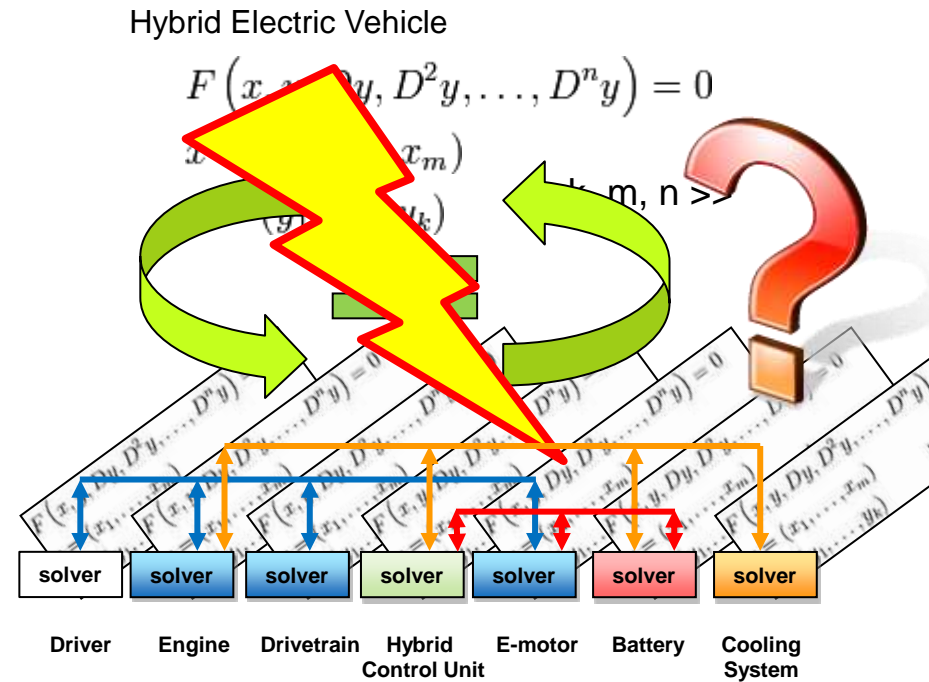
Source: <https://www.fmi-standard.org/>

Technical view



- Multi-domain development
- Multi-tool approach
- Multi-vendor
- Dynamic coupling
- Virtual prototype representation

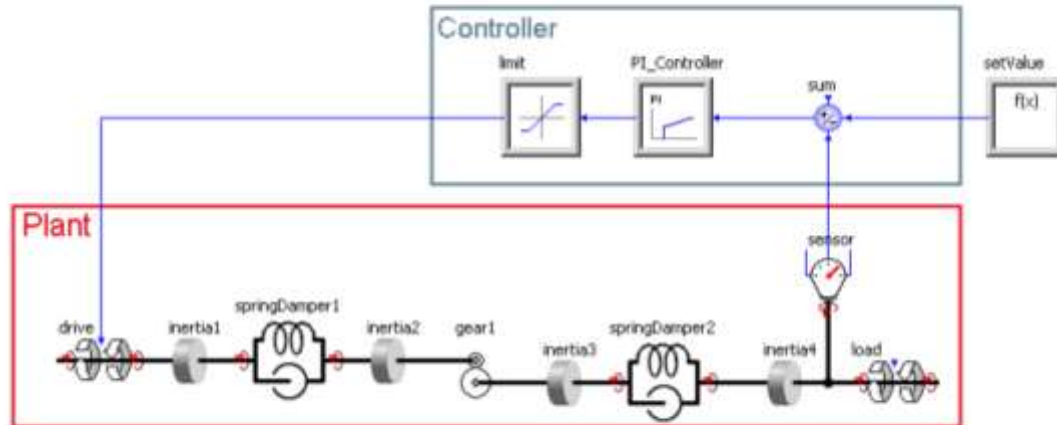
Mathematical view



- Multi-method
- Multi-solver
- Multi-rate
- Dynamic coupling
- Coupling error

2.3. Closed Loop

These FMUs can be used to test the connection of two sub models. The following SimulationX model consists of a PI-controller and a plant model.



Controller and Plant were separated and exported to the respecting FMUs (Controller.fmu and Plant.fmu). After re import to SimulationX we get the following model.

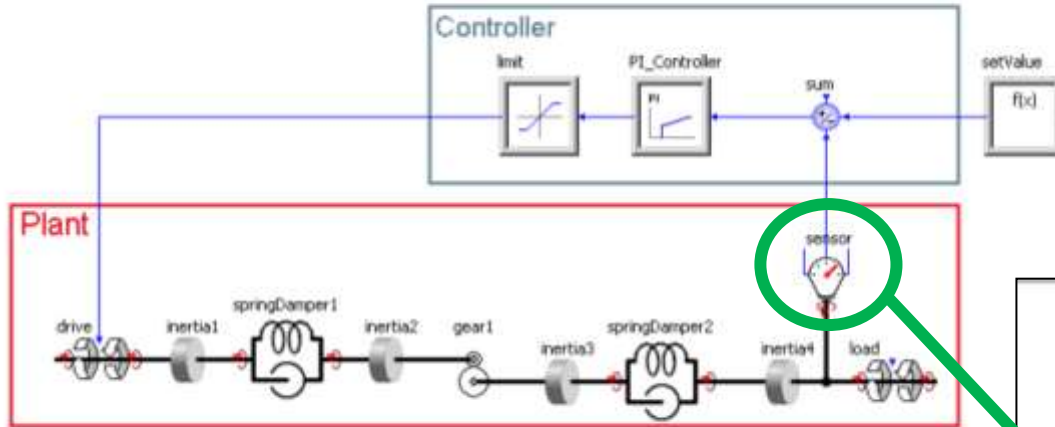
Standard FMI example: Speed control of rotating drivetrain

- **Plant:** drivetrain consisting of two shafts, gearset, two masses per shaft, one spring-damper-element per shaft
- **PI controller:** control shaft speed 2 through torque input on shaft 1

Example: FMI, Functional Mockup Interface

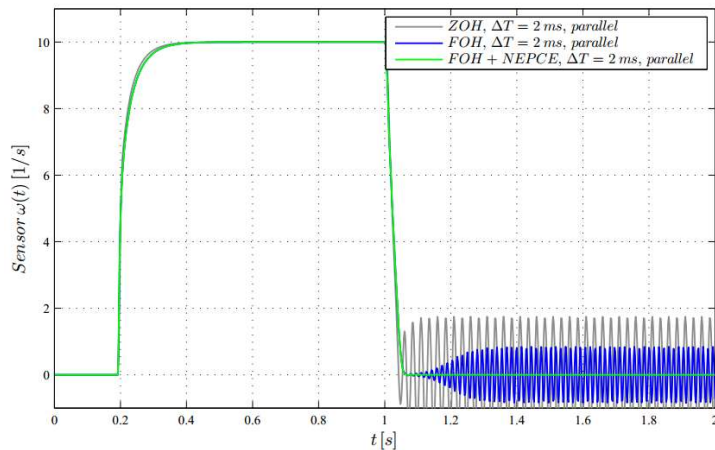
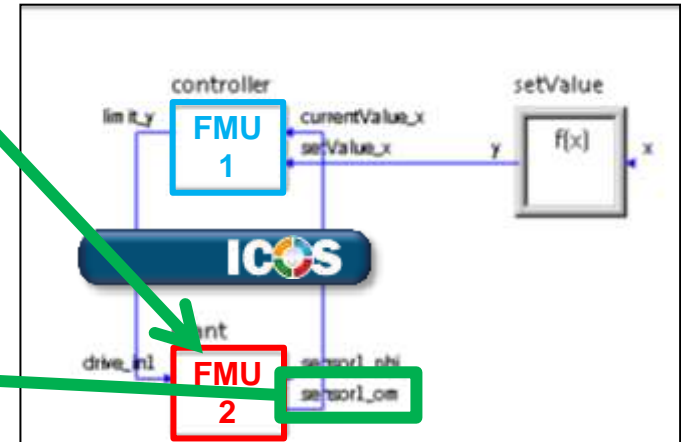
2.3. Closed Loop

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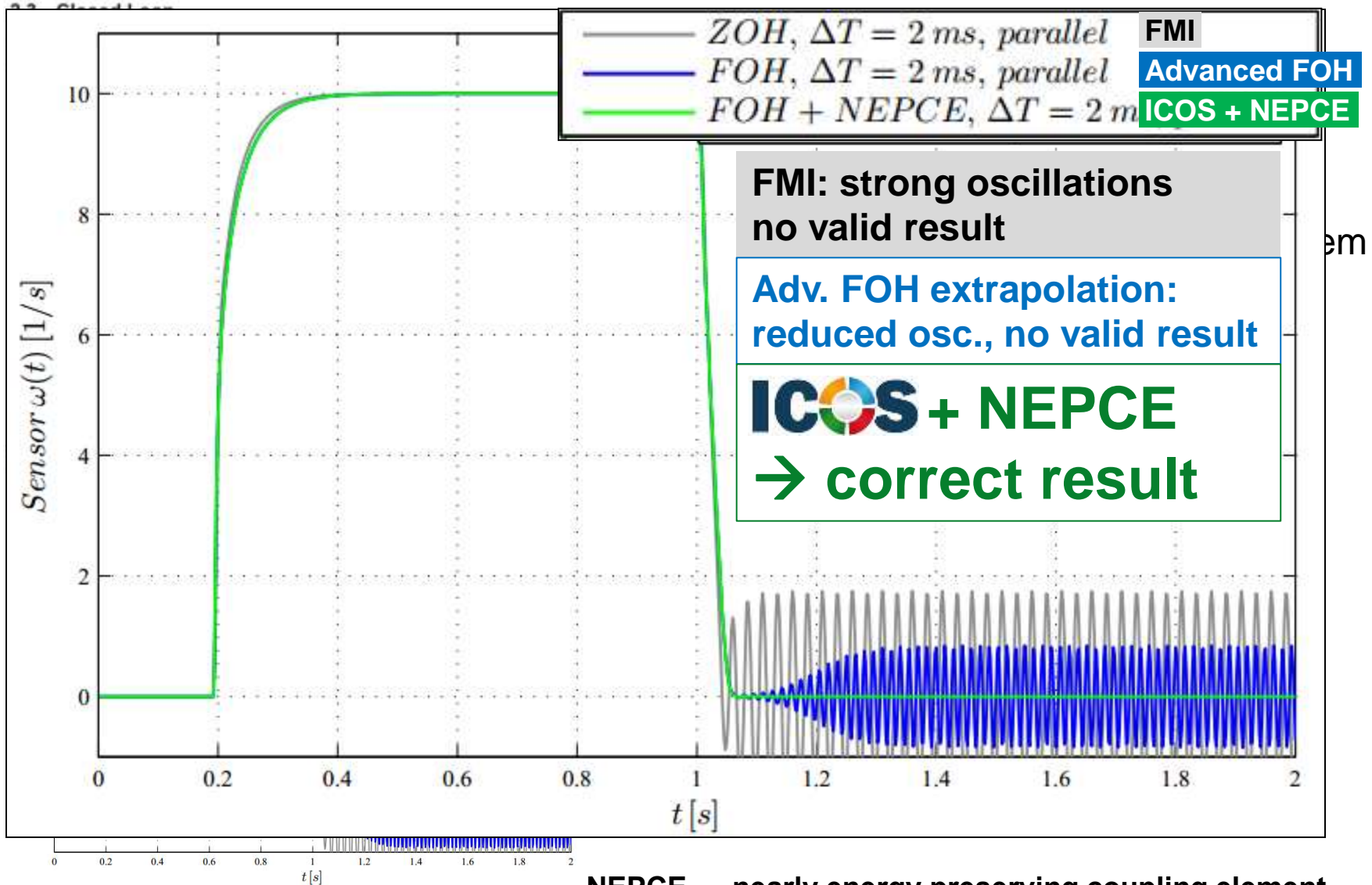


Closed loop control system

Controller and Plant were separated and exported to the respecting FMUs (Controller.fmu and Plant.fmu). After re import to SimulationX we get the following model.

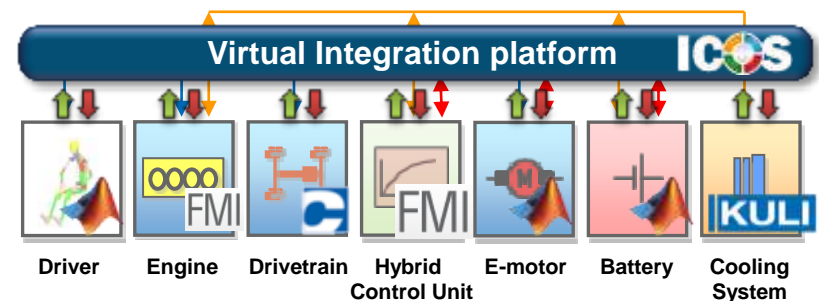
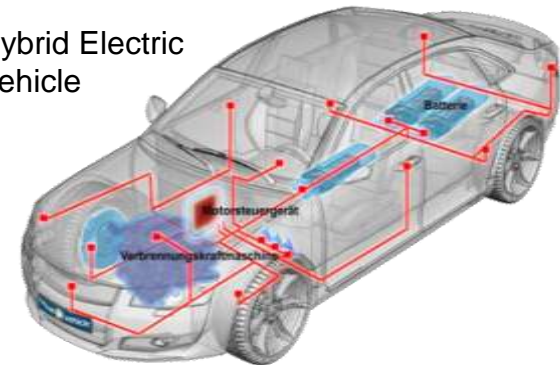


- Comparison of solution:**
- Standard FMI
 - **Co-simulation platform ICOS**



- FMI is a standardized interface for simulation models & tools
- FMI can not handle the coupling error
- Co-Simulation platform **ICOS** from Virtual Vehicle can handle:
 - Virtual prototype setup
 - Simulation tool coupling
 - Integration of FMI
 - Correction of the coupling error
- **ICOS** guarantees a stable Co-Simulation

Hybrid Electric Vehicle



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