bmvit Bundesministerium für Verkehr, Innovation und Technologie

bmwfw Bundesministerium für Wissenschaft, Forschung und Wirtschaft

FFG

COMET Competence Centers for Excellent Technologies

Das Land Steiermark

SFG

TU Graz Graz University of Technology

VIRTUAL VEHICLE Research Center

Automotive

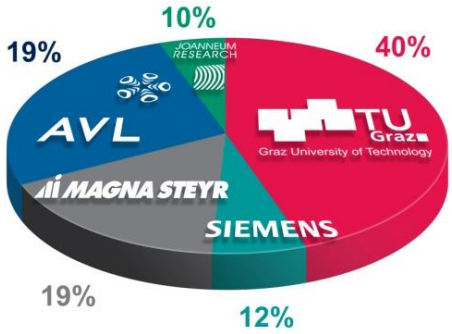
Rail

Aerospace

HARD FACTS

Founded:	**July 2002**
Staff:	**> 200 employees**
Turnover:	**EUR 22 million**
Location:	**Graz, Austria**

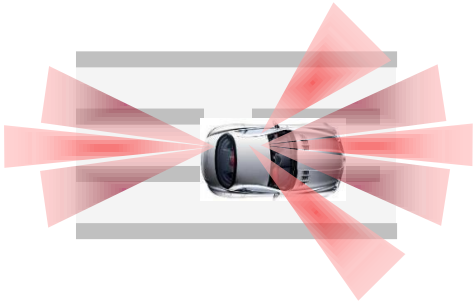
SHAREHOLDERS



Interdisciplinary Research Topics

Electrified Powertrain

Safety and Comfort in Lightweight Design



Integrated Safety / Autonomous Driving

- **HW-SW Co-Simulation (MIL-SIL-HIL) with new System Design Approach**
- **Integrated Safety: Tool Chain for passive and active Safety to comprehensively assess Driving Assistance Systems**
- **Control Strategy and Energy Management for Hybrid & Electric Vehicles**

Range of Expertise

FIELDS OF RESEARCH

Efficient Vehicle Development

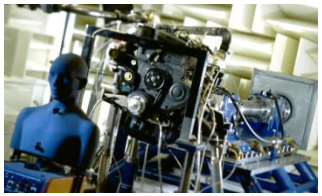
- Electrification
- Integral Safety & Automated Driving
- Energy Management
- Embedded Systems & Advanced Control
- Systems Engineering

Testing and Validation

- HVAC, Comfort, NVH & Friction
- Engine and Powertrain Optimization
- Battery
- Vehicle Safety
- Hybrid HW/SW-In-The-Loop

FACTORS OF SUCCESS

EU Research
- 25 EU Projects
- 9 leading



Non-K
- Contract Research
- FFG Projects

COMET
Competence Centers for Excellent Technologies

K2 Mobility
- The Solid Basis
- Steadiness

Visibility
- Congresses, Meetings
- GSVF, ISNVH, IAVSD…

Key Player
- In Project Consortia
- Technology Roadmaps

Selected Topics & Projects

OPTEMUS

Optimized and Systematic Energy Management in Electric Vehicles

Project Goal

Developing an efficient electric vehicle that requires 50% less energy for comfort and 30% less energy for component cooling

Responsibilities of VIRTUAL VEHICLE

- Supporting the **development of the CRU** (Compact Refrigeration Unit)
- **Simulating the refrigeration cycle** with different refrigerants
- **Modeling of the refrigeration cycle** integrated into the cooling system

Consortium leader
- Coordination
- Dissemination
- Exploitation

HARD FACTS

Volume: 6.4 m EUR

Duration: 06/2015 - 02/2019

Partners: 15 (Continental, CRF Fiat, ESI, Denso Thermal Systems, etc.)

Dependable Embedded Wireless Infrastructure

Project Goal

Developing wireless sensor networks and applications for citizens and professional users in industry-driven use cases (automotive, rail, aerospace and building)

- Providing tangible demonstrators all over Europe
- Boosting interoperability, standardization and certification of wireless sensor networks and wireless communications

Responsibilities of VIRTUAL VEHICLE

- Supporting the **development of automotive applications** (wireless update of ECU software, integration platform for wireless sensor networks, interoperability, technology bricks)
- Supporting the **development of aviation applications** (interoperability, technology bricks)
- Contribution to **overall system architecture** and **know-how transfer**

Consortium leader
- Coordination
- Dissemination
- Exploitation

HARD FACTS

Volume: 39.5 m EUR

Duration: 03/2014 - 02/2017

Partners: 58 (Airbus, AVL, Indra, NXP, Philips, Thales, Valeo, Volvo etc.)

Configurable and Adaptable Trucks and Trailers for Optimal Transport Efficiency

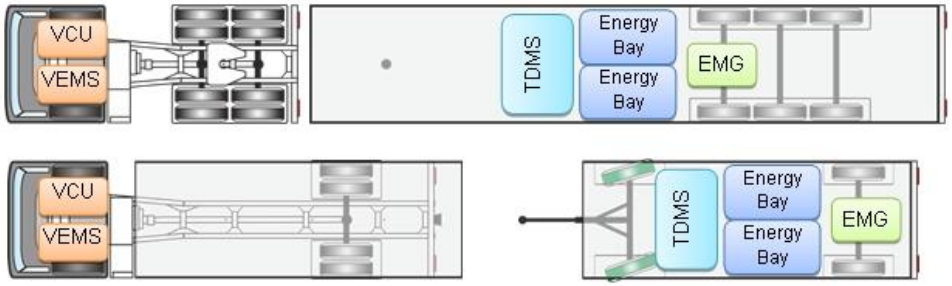
Project Goal

Developing and demonstrating innovative and energy efficient trucks and load carriers for long distance transport assignments

- Improved load efficiency leading to an overall 25% less energy consumption on a t.km basis
- Lower impact on the road infrastructure
- Hybrid-on-Demand (HoD) driveline

Responsibilities of VIRTUAL VEHICLE

- Modular full vehicle simulation based on a **model library** and **variant management**
- **Component variations** for the optimal design of the overall vehicle configuration
- Virtual evaluation of the **hybrid-on-demand framework** in terms of energy consumption



Modular hybridization with electrified trailers

HARD FACTS

Volume: 8.2 m EUR

Duration: 09/2013 – 02/2017

Partners: 14 (Volvo Technology AB, Bosch, TNO, Procter & Gamble, etc..)

Small Electric Passenger Vehicle with Maximized Safety and Integrating a Lightweight Oriented Novel Body Architecture

Project Goal

epsilon aims to conceptualize and prototype the electric small vehicle of 2020 - 2025

- Specific design for typical transport tasks in urban areas
- Lighter and more energy efficient vehicle that requires less road space than today's sub-compact cars

Responsibilities of VIRTUAL VEHICLE

- Design and development of the powertrain (battery, electric motor, transmission, cooling system)
- Design and development of vehicle thermal management system and heat-ventilation-air-conditioning

Exterior design of the epsilon car

HARD FACTS

Volume:	**3.5 m EUR**
Duration:	**11/2013 – 10/2016**
Partners:	**9** (fka Aachen, Autoliv, CRF/Fiat, HPL Prototypes, TU Graz, etc.)

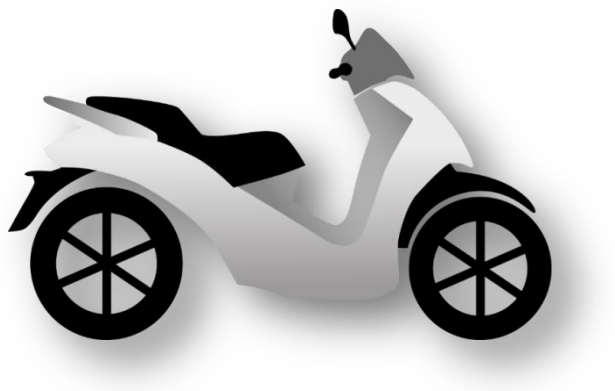
EU-Live

Efficient Urban Light Vehicles

Project Goal

Development and application of a systematic approach for efficiently designing, developing and constructing a wide range of L-category vehicles for the urban area (2-, 3- and 4-wheelers)

- Innovative solutions regarding cost-efficient, energy-efficient, low-emission and low-noise electrified powertrains
- Future-proof, flexible and scalable vehicle architectures
- Modular vehicle bodies for different usage scenarios (private, delivery services, sharing fleets, etc.)
- Efficient transfer of expertise from automotive to light vehicle industry



Responsibilities of VIRTUAL VEHICLE

- **Virtual demonstrators** (requirements, modeling of subsystems, modular simulation for PHEV 3-wheeler, BEV 2-wheeler and innovative 4-wheeler)
- **Model design** and **vehicle dynamics simulation** for PHEV 3-wheeler and BEV 2-wheeler
- Contributing to **HVAC** and **cooling concepts** for interior and in-wheel motors
- Test of the complete PHEV 3-wheel demonstrator on the acoustic test bench

Consortium leader
- Coordination
- Dissemination
- Exploitation

HARD FACTS

Volume: 6.7 m EUR

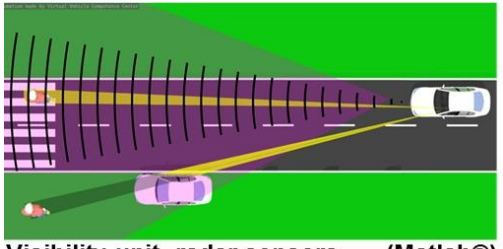
Duration: 06/2015 – 05/2018

Partners: 12 (PSA, Peugeot Motorcycles, Continental, Magna Steyr Battery Systems, etc.)

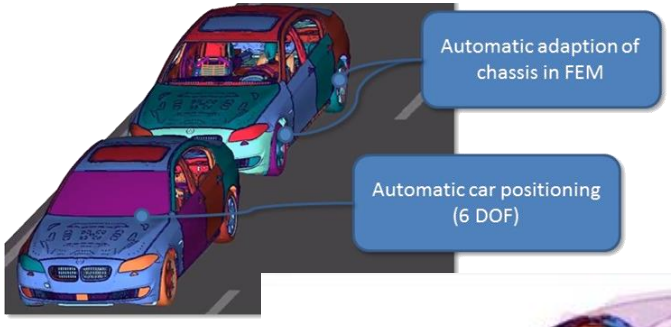
Integrated Safety Systems

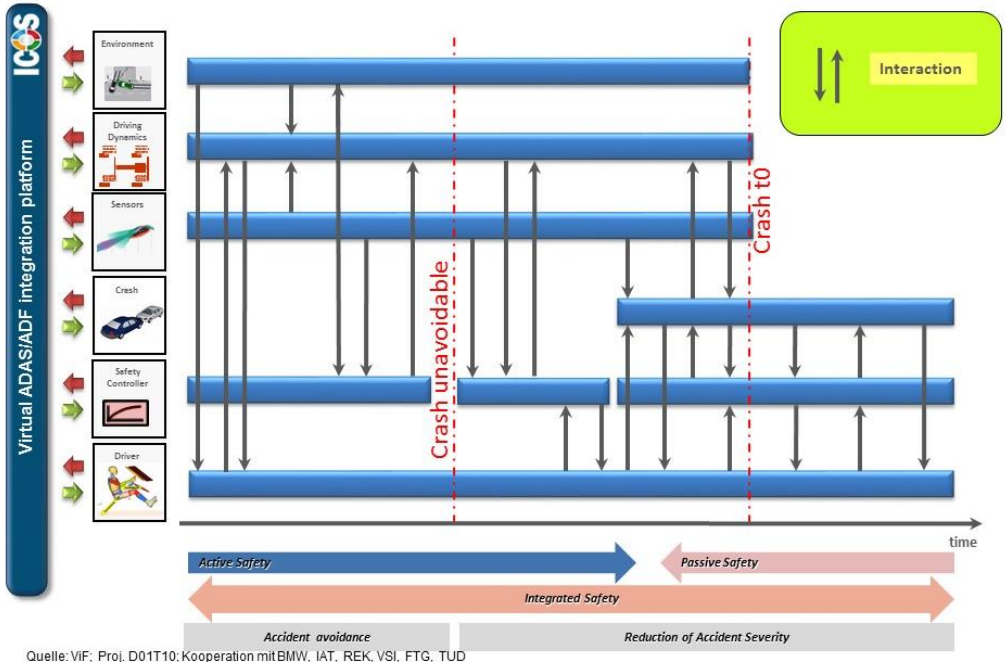
EFFECTIVENESS ASSESSMENT

- Based on **real world** or **generic accident scenarios**
- **Modular simulation framework**
- **Continuous simulation** from uncritical driving to IN-crash
- **Automatic batch processing**
- Assessment based on **injury criteria** (occupant and VRU) using FEM crash simulations

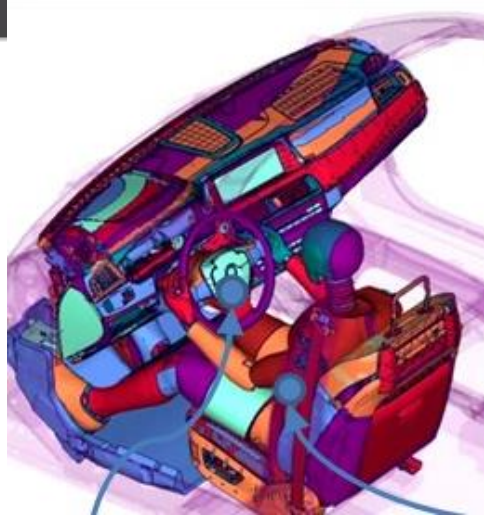


Visibility unit, radar sensors, … (Matlab®)





Quelle: ViF; Proj. D01T10; Kooperation mit BMW, IAT, REK, VSI, FTG, TUD



Independent Co-Simulation Platform

MULTI-TOOL SYSTEM DESIGN

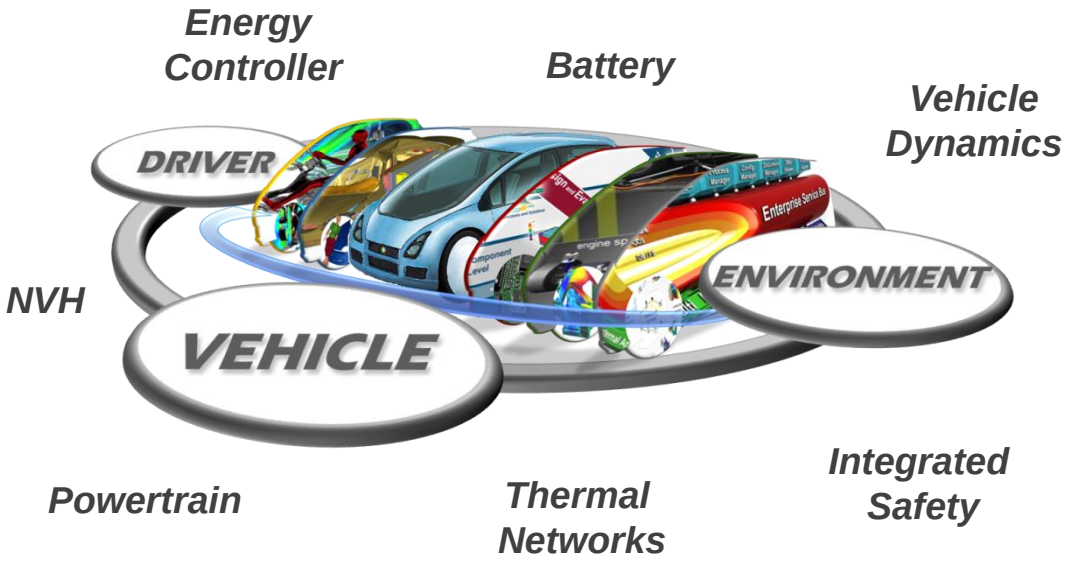
- **Cross-Domain Co-Simulation**
- **Integration platform for virtual prototype design**
- **Automated evaluation of Co-Simulation results**
- **Real-time Co-Simulation**

ICOS is an independent Co-Simulation platform for the dynamic integration of CAE modeling tools from various domains.

The complex interaction between the subsystems is realized by advanced coupling algorithms which enables a global system optimization.

A Continuous Development Process

- Designed for a **continuous support of the virtual development process** → the overall system behavior can be analyzed at any time
- Depending on their availability sub models from **different development iterations** and in **different modeling depths** are coupled to form the overall system model

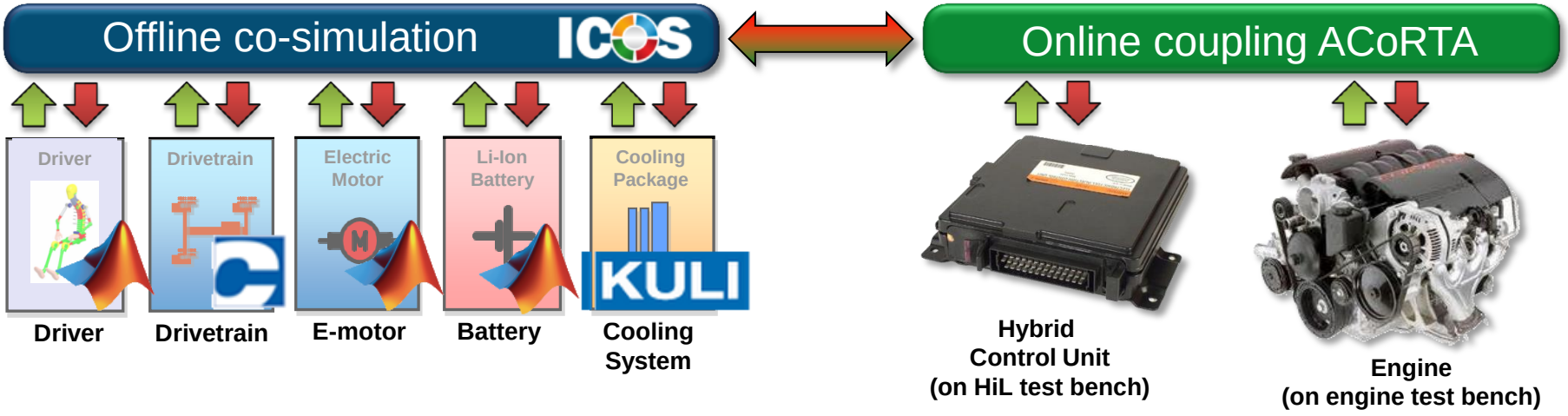


Advanced Co-Simulation Methods for Real-Time-Applications

- SW/HW Co-Simulation
- Real-time coupling methodologies
- Open System Integration
- Consistent & modular development process

ACoRTA ensures the consistent application of the co-simulation approach during the whole V-Model.

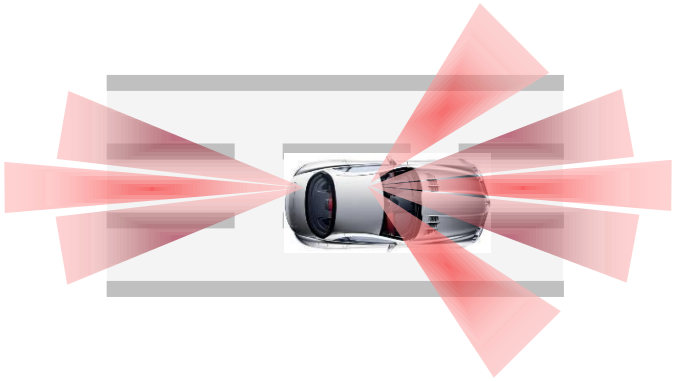
Occurring coupling imperfections, like introduced communication time delays, noisy measurements and data-losses, caused by the incorporation of real-time systems are handled via model-based coupling algorithms.



Automated Driving

RESEARCH TOPICS
in national and international multi-firm research projects

- **Functional design and virtual validation of automated vehicles in the concept phase (high speed area)**
- **Networking of vehicles: Requirements for open source software platform**
- **Virtual full vehicle protection by simulating the environment**



Using real-time Linux

- Analyzing and defining **requirements for the architecture** of the areas **reliability, availability, safety, security** and **efficiency**
- Implementing an **open source software platform** based on real-time Linux for high performance computing
- Creating a **qualification process** for open source software in safety-related automated driving functions
- Considering **dynamic software components** in close cooperation with AUTOSAR for future standards

Virtual Validation ADAS

- **Requirements definition** for specific ADF: e.g. motorway assistant (**Level 2**), motorway chauffeur (**Level 3**),
- **Implementation** of ADF in **simulation** at **system level** (Algorithms: C and Simulink, Simulation: CarMaker) (decision making, path and trajectory planning, low level control lateral and longitudinal)
- Creating virtual validation and test environment for ADAS/ADF functions.

FACTS4WORKERS

Worker-Centric Workplaces in Smart Factories

Project Goal

Leveraging the large potential added value of manufacturing data, information and knowledge in a worker-centred way

- Developing worker-centric solutions through which workers become the smart element in smart factories, interacting by deploying a flexible smart factory infrastructure
- Increasing problem-solving and innovation skills of workers by providing individual information and using modern information tools
- Increasing cognitive job satisfaction as well as average worker productivity by 10%

HARD FACTS

Volume: **7.9 m EUR**

Duration: **12/2014 – 11/2018**

Partners: **15** (Johnson Control, Schaeffler, ThyssenKrupp, etc.)

Consortium leader
- Coordination
- Dissemination
- Exploitation

Responsibilities of VIRTUAL VEHICLE

Participation in all work packages (particularly in terms of **requirements, rolling out, system design** and **industrialization**)

Systems Engineering & Model-Based Systems Engineering

Systems Engineering at VIRTUAL VEHICLE

- Identification and analysis of **potentials and benefits** in the application of MBSE
- **Consulting and supervision** in the adaption of development processes, development methodologies and IT infrastructure for MBSE introduction
- Development of an **enterprise-specific MBSE environment** (methodology, training and IT tooling)
- **Embedded coaching** and **training** for futureSE users and managers

Cross-Industry Key Success Factors

- Enabling system thinking, handling of complex systems
- Providing consistent information & data, re-using knowledge, sustainable cross-linking of information
- Enabling multi-disciplinary collaboration