ITEA 3

Project Results

ACOSAR

Advanced Co-simulation Open System ARchitecture

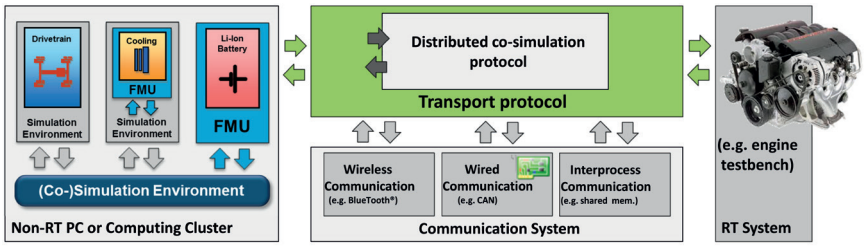
EXECUTIVE SUMMARY

The ITEA 3 project ACOSAR has developed the Distributed Co-simulation Protocol (DCP), which focuses on the efficient integration of distributed real-time systems and simulation environments. This leads to a significant improvement of development processes and accelerated time to market.

PROJECT ORIGINS

Modelling and simulation represent key methods for the successful development of technical devices and machines. With computational power and memory capacities having increased significantly in recent decades, fast simulation of high-fidelity models in a wide range of technical domains has become possible. The introduction of co-simulation methodologies and interoperability of simulation tools and infrastructure have taken root but currently no standardised way for the integration of distributed simulation and test environments exists. This represents a significant bottleneck in terms of modular system integration, wasting valuable development time. The aim of ACOSAR was to develop both a non-proprietary "Distributed Co-simulation Protocol" (DCP) for integration of simulation and test environments, and an according integration methodology.

In order to develop a standardised approach for data exchange and control of co-simulation that enables information about system behaviour to be exchanged, ACOSAR had a look at existing communication protocols. The consortium learned from them and specified a new communication protocol, which works on top of existing transport protocols. In targeting these issues, the ACOSAR project focused largely on the automotive domain, with a consortium comprised of partners from all levels of the automotive supply chain, together with research and academic partners.



Seamless integration via ACOSAR's Distributed Co-simulation Protocol (DCP)

TECHNOLOGY APPLIED

ACOSAR's main technological focus centred on specification of the Distributed Co-Simulation Protocol (DCP), to provide a formal description for simulation tool and testbed integration. Besides the formal DCP specification, special attention was devoted to providing a DCP reference implementation and the development of an according test suite. This test suite aims at the verification of DCP slaves, indicating the compliance of DCP implementations with the specification.

ACOSAR also established a methodology for the integration of simulation tools and real-time systems for setup of mixed virtual/real virtual validation environments, leading to a systematic reduction of time consuming integration efforts. A method to derive coupling configurations supported by MBSE (model-based systems engineering) means system configurations can be automatically derived. A "System Integration Methodology" handbook provides 1) a compact overview of development processes, requirements and interfaces, 2) MBSE techniques for system integration and 3) design aspects for system integration. Finally, a white paper on the application of DCP to industrial use-cases was written.

MAKING THE DIFFERENCE

Results of the ACOSAR project have significant implications for the automotive industry. The number of systems and subsystems in vehicles realising complex functions are increasing. At the same time, budgets are being squeezed. The introduced test suite enables tests of different and diverse implementations, and significantly reduces integration effort through front-loaded testing. Project partners and use-case providers figured out that within the upcoming five years an automotive original equipment manufacturer (OEM) could save potential integration efforts amounting to 13,000 hours. This represents an

ITEA 3

equivalent of €5-7 million. On a global scale these numbers are subject to extrapolation.

Another key outcome of ACOSAR is the establishment of a community around the DCP. This includes members from inside and outside of the ACOSAR consortium. The aim is to grow this community to 500 or more users, in order to achieve a high market penetration. Furthermore, it is planned to collaborate with other industry sectors besides automotive. The goal is to translate ACOSAR's technology innovations to further domains, to advance solutions for interoperability challenges.

So far, the ACOSAR consortium experienced a huge interest in the DCP from large automotive companies, as well as the semiconductor, aerospace, and maritime industry. Not only from Europe, but also the United States and Asia. Several companies are already implementing the DCP, realising first industrial prototypes, getting ready for adoption into their products. It is also expected that the demand for DCP implementations at the integrator level will rise very soon. In turn, the need for advanced master algorithms, which are not in focus of the DCP specification, will open a new market segment. This will stimulate the market for simulation tools, real-time systems and test equipment.

In the final year of the ACOSAR project the DCP was adopted by the Modelica Association. The Modelica Association operates several Modelica Association Projects (MAP), including the Functional Mock-Up Interface, the Modelica language and libraries. The DCP represents the most recent addition to the portfolio of MAPs. It was accepted unanimously by vote of Modelica Association members in July 2018. This step ensures a sustainable project outcome and that work on the standard will be continued after closure of the ACOSAR project. It is worth to mention that the Modelica Association fosters development and improvement of this non-proprietary and vendor-neutral specification, reference code, and other accompanying materials, which are released under an open source license.

The standardisation proposed tentatively at the project's beginning has now become a reality. The DCP Standard is freely available at: www.dcp-standard.org

MAJOR PROJECT OUTCOMES

Dissemination

- 100+ industrial talks and presentations
- 10+ contributions to major scientific conferences related to modeling and simulation
- Transfer of findings in follow-up research projects like OBELICS, ENABLE-S3 & 3Ccar

Exploitation (so far)

New products:

- 14 prototypical DCP implementations (TRL 4-5), to be developed further for integration to industrial tools (target TRL 9)
- Prototype "Physical Converter Module" available for DCP-compliant access to existing hardware
- DCP reference implementation in C++, supporting 3 different transport protocols, freely available under open source license
- DCP slave description scheme files, freely available under open source license
- DCP test suite, to be published under open source license

New services:

- Established eco-system for sustainable DCP support
- Adaptions of academic courses & lectures, lab setups modification for teaching DCP application
- Extension of co-simulation related consulting w.r.t. DCP for various industry sectors

Standardisation

- Setup of workshops with standardisation bodies (e.g. ASAM e.V., Modelica Association)
- Specification of the Distributed Co-simulation Protocol (DCP)
- Selection of Modelica Association as an appropriate standardisation body
- Successful initiation of MAP (Modelica Association Project) DCP, including Modelica membership, selection of licenses, preparation of legal documents, set up of infrastructure
- Release of DCP specification 1.0 as a Modelica Association Standard in March 2019

ITEA is a transnational and industry-driven R&D&I programme in the domain of software innovation. ITEA is a EUREKA Cluster programme, enabling a global and knowledgeable community of large industry, SMEs, start-ups, academia and customer organisations, to collaborate in funded projects that turn innovative ideas into new businesses, jobs, economic growth and benefits for society.

https://itea3.org

ACOSAR
14004

Partners

Austria

AVL List GmbH
Spath Micro Electronic Design GmbH
Virtual Vehicle Research Center

France

Group Renault
Siemens Industry Software SAS

Germany

dSPACE GmbH
ESI ITI GmbH
ETAS GmbH
Ilmenau University of Technology
Ks.MicroNova GmbH
Leibniz University of Hannover
Dr. Ing. h.c. F. Porsche AG
Robert Bosch GmbH
RWTH Aachen University
TWT GmbH
Volkswagen AG

Project start
September 2015

Project end
August 2018

Project leader
Martin Benedikt, Virtual Vehicle Research Center

Project email
martin.benedikt@v2c2.at

Project website
http://www.acosar.eu

DCP Standard website
http://www.dcp-standard.org