

# MAP Distributed Co-Simulation Protocol

Martin Krammer  
DCP MAP Leader  
martin.krammer@v2c2.at

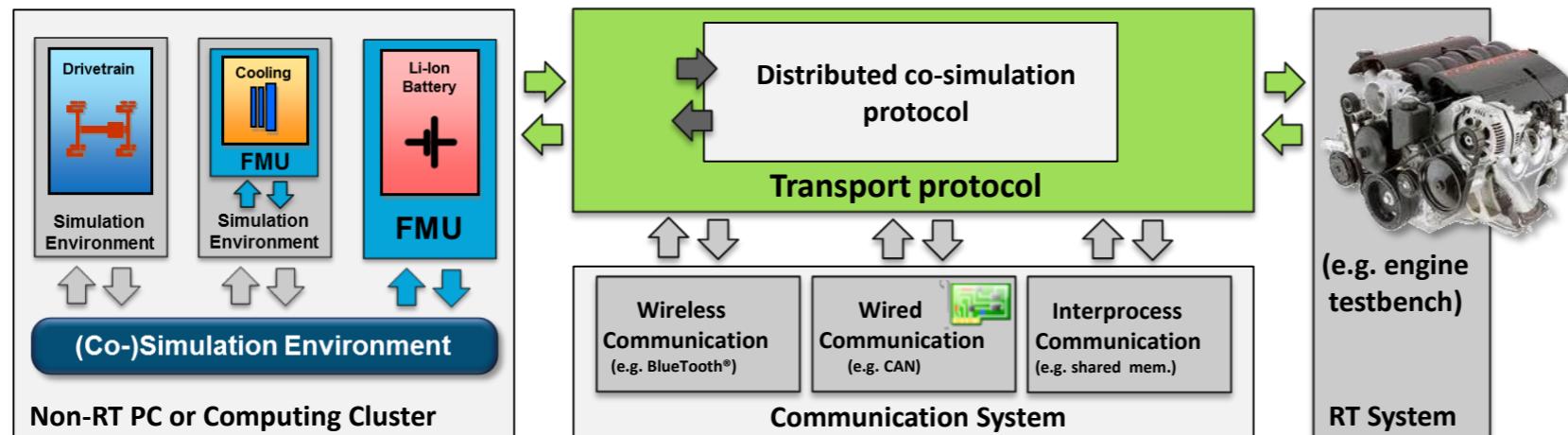
American Modelica Association User Conference  
October 11, 2018



- # Introduction
- # The Distributed Co-Simulation Protocol (DCP)
  - Communication Protocol
  - Architecture Description
  - Operating Modes
  - State Machine
  - Exchange of Input and Output Data
  - Use Case
- # Current Status
- # Outlook

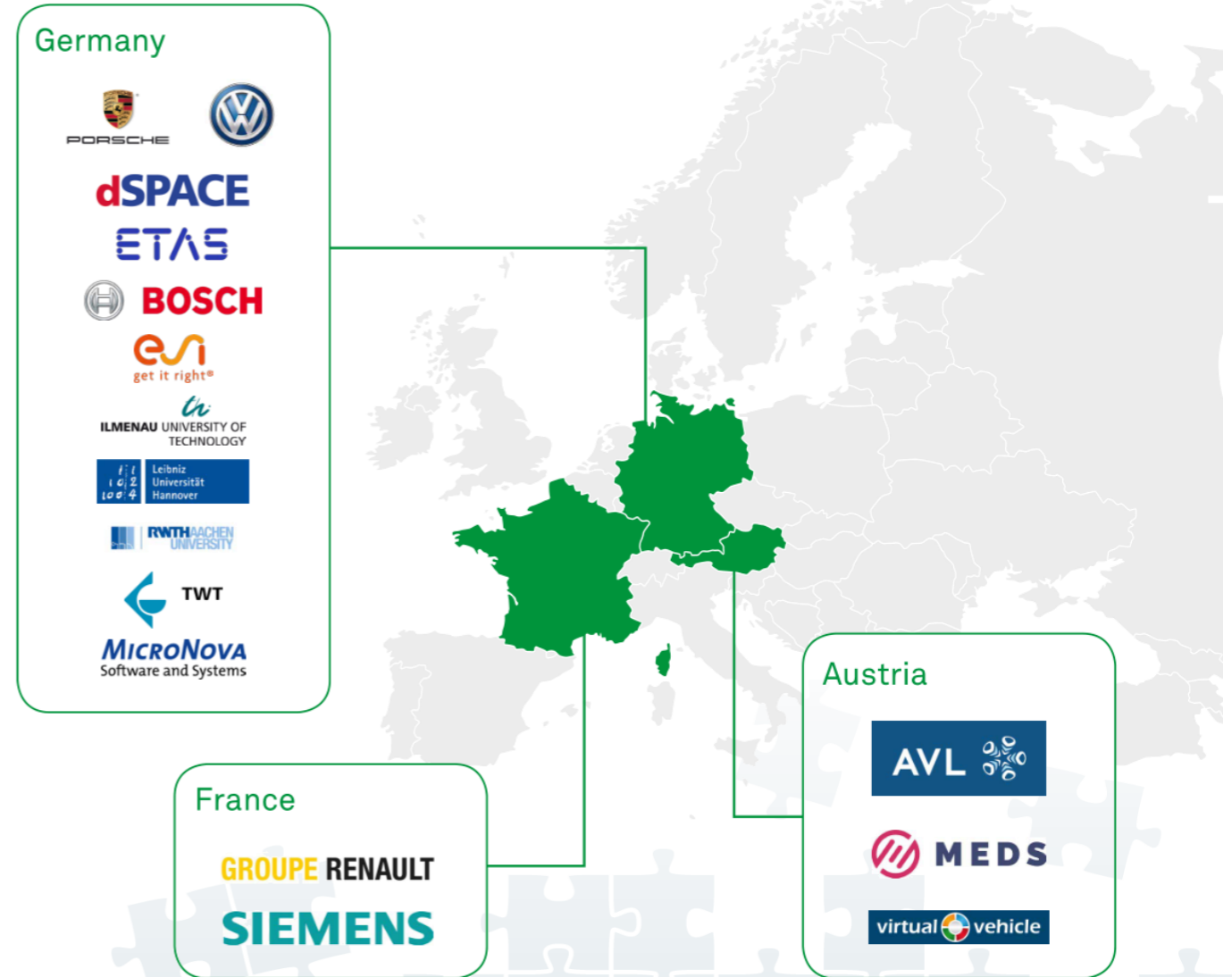


- ✦ The Functional Mock-up Interface (FMI, MODELISAR project) standardizes integration of simulation models, tools and solvers
- ✦ But what about distributed setups?



- ✦ Until now, this is done manually

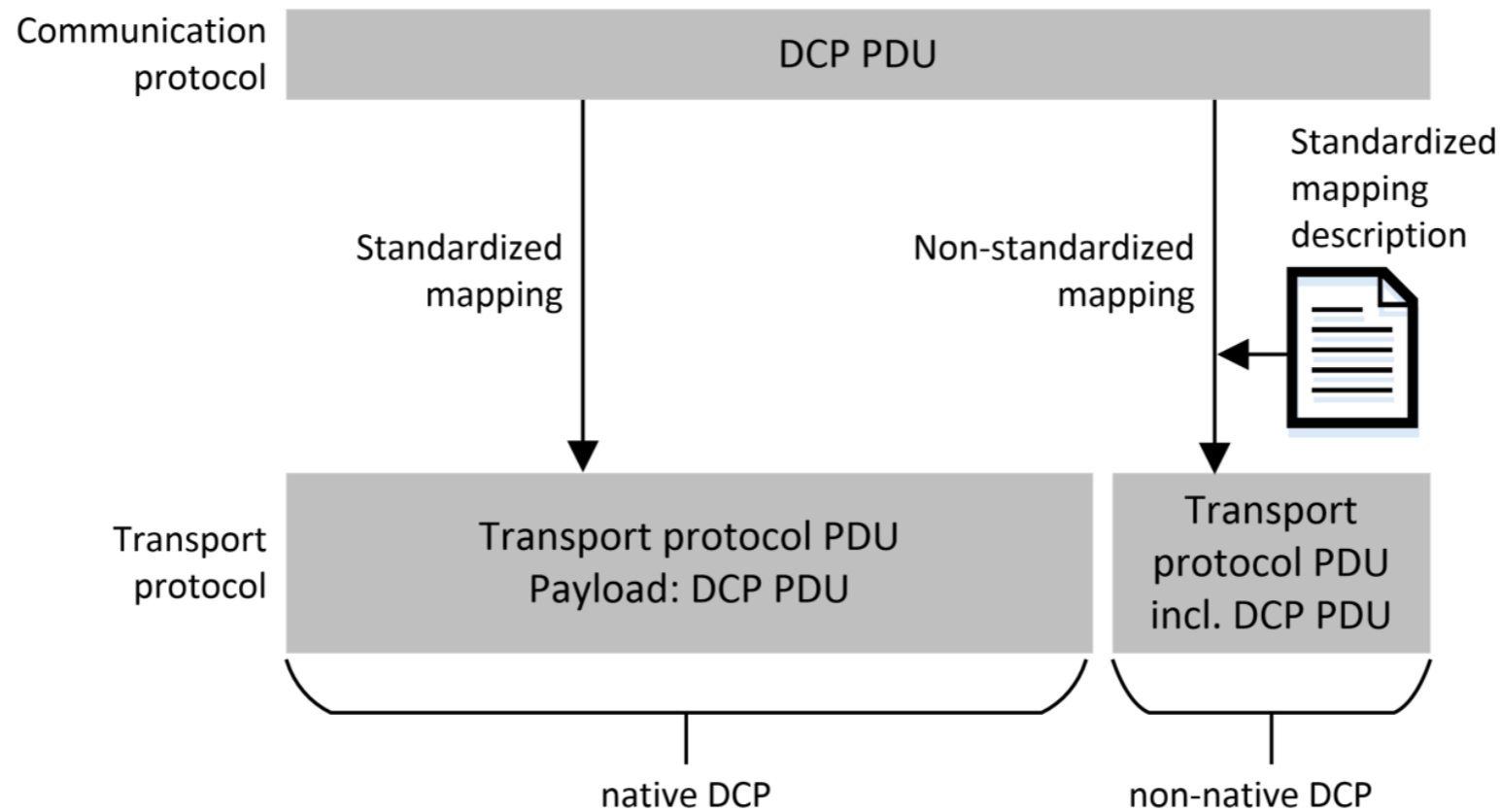
- ✚ The ACOSAR project
  - *Advanced Co-Simulation Open System Architecture*
  - Duration: 09/2015-08/2018
  - Costs: 8,123k€
  - Effort: 60 PY
- ✚ ACOSAR focuses on integration of
  - Real-time and real-time, and
  - Real-time and non-real-time systems
- ✚ **Primary goal: Negotiate technical specification of communication protocol intended for standardization**



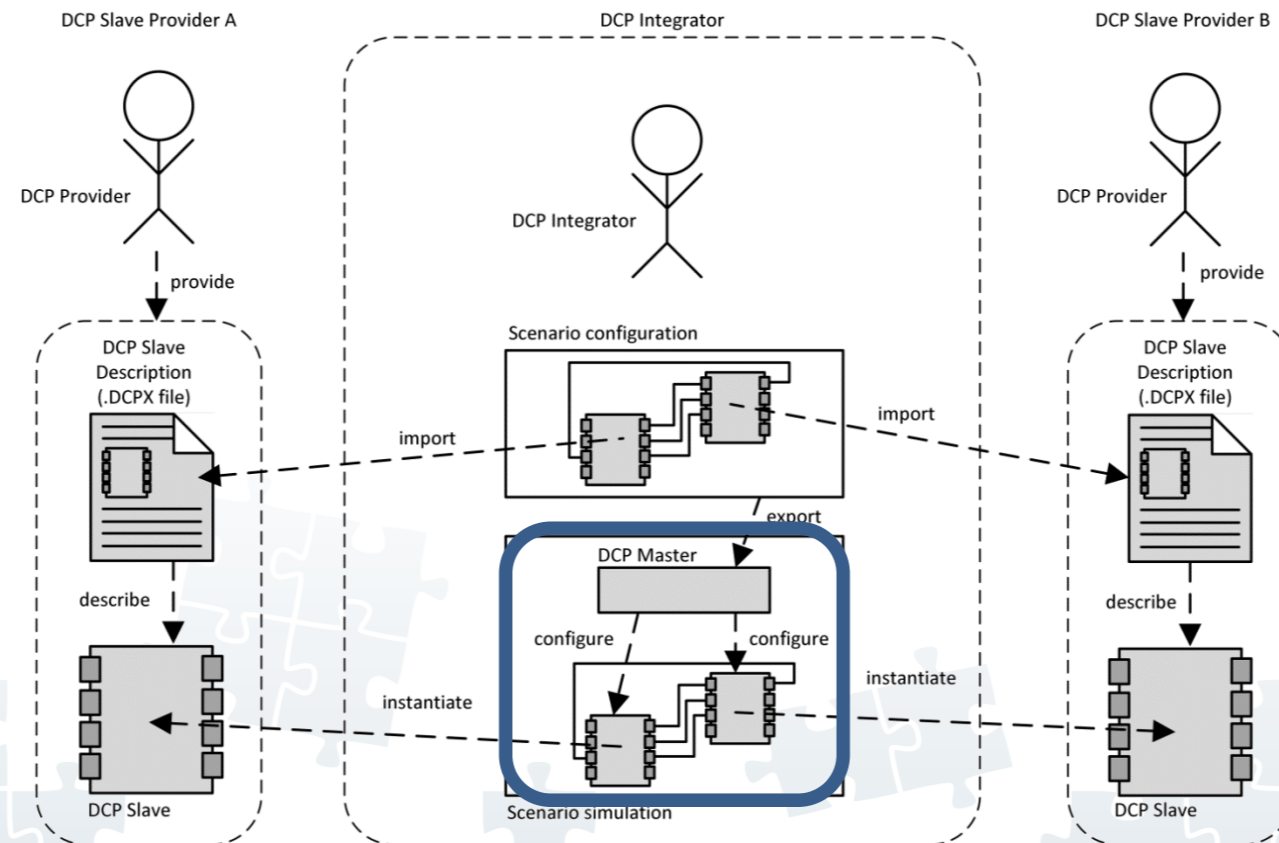
## ✚ Main design aspects

- Interoperability
  - Define a communication protocol
  - Goal: Pursue standardization with a recognized standardization body
- Compatibility
  - Support a broad range of systems, from small microcontrollers to large test rigs
  - Targets: Low overhead, low memory footprint
- Integration
  - Develop methodology for application in development processes
  - Master-Slave concept
- Communication
  - Support multiple transport protocols
  - Initially: UDP, CAN, USB, Bluetooth, and EtherCAT
- Economy
  - Reduce development time
  - Decrease computing cost
  - Accelerate time-to-market

## Architecture Description



- ✦ Default integration methodology
  - Defines provider-integrator relationship
  - Relies on DCP slave description file (.dcpX)



## ✚ Operating Modes

- The DCP covers three different time domains

Operating mode	Description
Soft real-time (SRT)	Simulation time should be synchronous to absolute time, tolerant against RT violations.
Hard real-time (HRT)	Simulation time synchronous to absolute time, intolerant against RT violations.
Non-real-time (NRT)	Independent from absolute time.



# The Distributed Co-Simulation Protocol

- ✚ DCP slave state machine for simulation control
- ✚ A typical simulation cycle
  1. Registration
  2. Configuration
  3. Initialization
  4. Run/Compute
  5. Stop
  6. (Error)

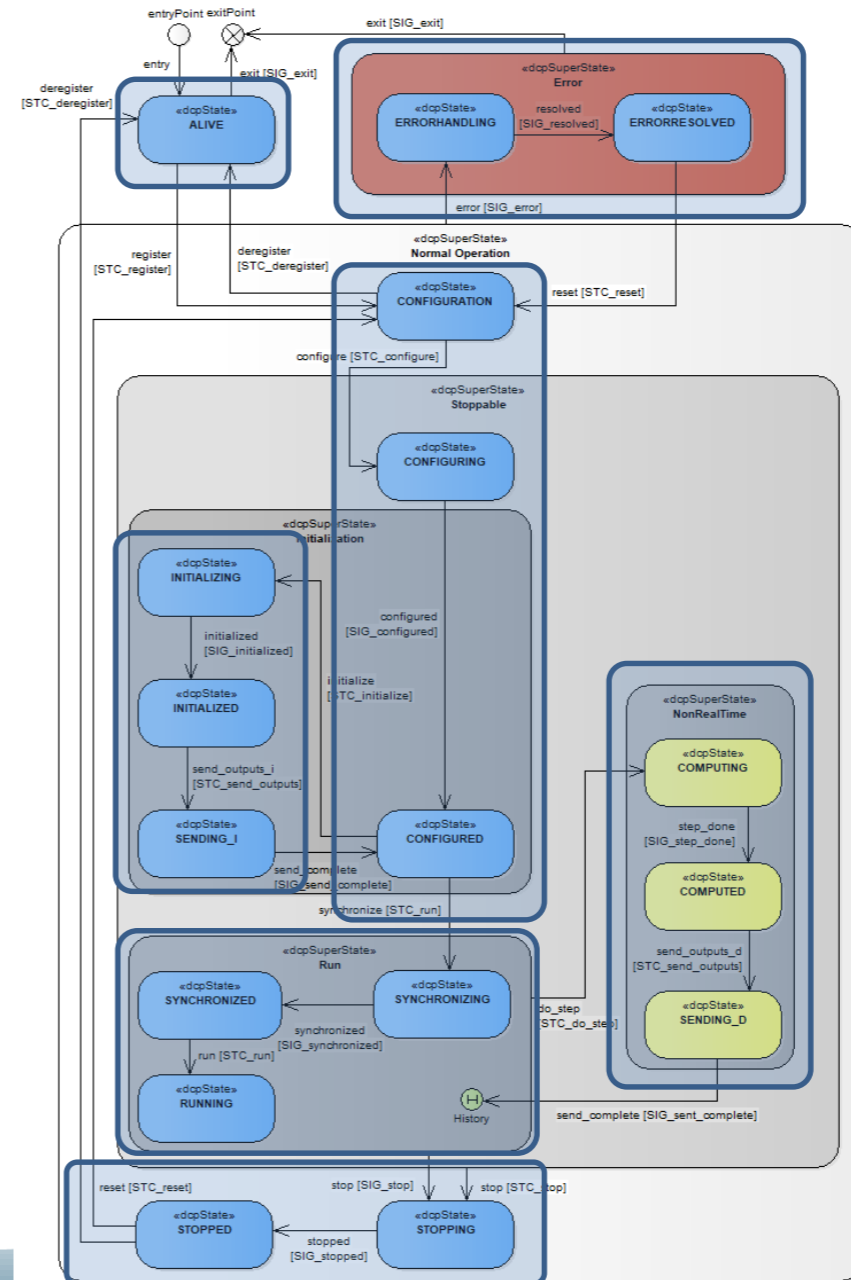


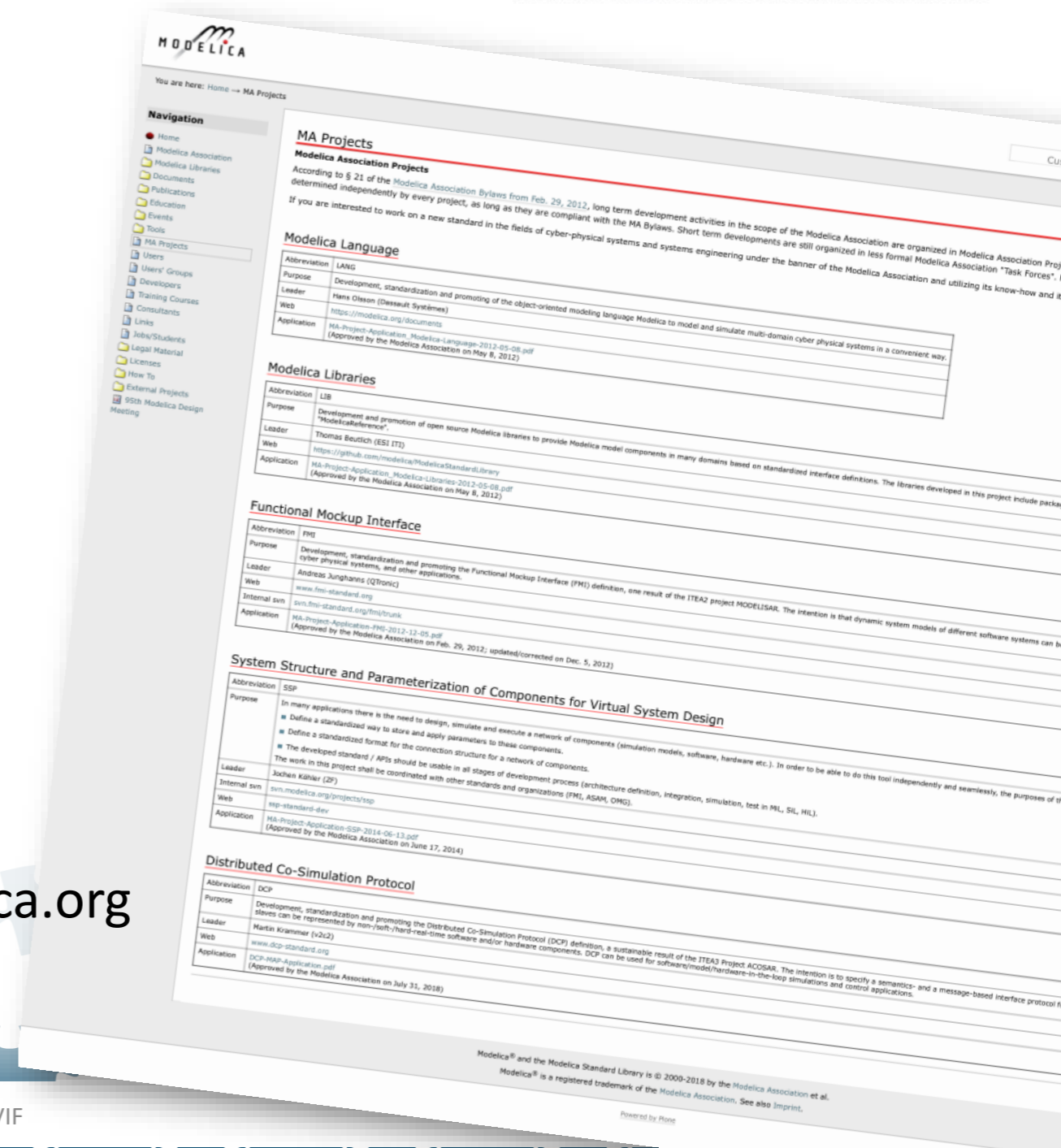
Image source: DCP specification v1.0 RC 2

## DCP and FMI: Commonalities and Differences

Aspect	FMI	DCP
Character	Specification for advanced programming interface (API)	Specification for application level communication protocol
Specification focus	Slave only	Slave only
Entity	FMU (software component)	DCP slave (hardware and/or software)
Integration aid	modelDescription.xml	DCP slave description file (.DCPX)
Controlled by	Master	Master
Data exchange	Master only	Slave-master-slave and slave-to-slave
Execution	Function calls	Exchange of PDUs
Real-time	n/a	SRT/HRT/NRT
Logic	State machine driven	State machine driven
Language	C	Language independent
Reference code	C	C++
Communication layer	n/a	UDP, CAN bus, USB, Bluetooth

# Future of DCP - Standardization

- ✚ The DCP 1.0-RC1 was submitted to **Modelica Association** for standardization
- ✚ Will be maintained as **Modelica Association Project (MAP)**
- ✚ Most recent version is DCP 1.0-RC3
- ✚ Sustainable ACOSAR project result
  - The DCP will be freely available
  - Open for everyone!
- ✚ Website: [www.dcp-standard.org](http://www.dcp-standard.org) (coming soon)



[www.modelica.org](http://www.modelica.org)

## 🔧 Release

- Turn RC (release candidate) document into Standard 1.0 document
- Release final DCP 1.0.0 specification document (expected eo Q4/2018)
- Set up steering committee/advisory committee, management of visitors
- Move from ACOSAR to MA infrastructure
- Next design meeting in 3 weeks

## 🔧 Dissemination

- website [www.dcp-standard.org](http://www.dcp-standard.org)
- conferences and events, e.g. Modelica 2019 conference <https://www.modelica.org/events/modelica2019>

## 🔧 Goals

- Establishment of long-term activities
- Establishment of new working groups, as needed
- Discover new DCP applications
- Management of end-user feedback
- Support additional transport protocols





**BOSCH**



**GROUPE RENAULT**

**dSPACE**

**ETAS**



**SIEMENS**



**TWT**



**Any questions?**

Martin Krammer

[martin.krammer@v2c2.at](mailto:martin.krammer@v2c2.at)

**MICRONOVA**  
Software and Systems



**RWTH AACHEN UNIVERSITY**

