Embedded Multi-Core Systems for Mixed Criticality Applications in dynamic and changeable Real-time Environments

EMC² Living Lab Automotive

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DENSO AUTOMOTIVE Deutschland GmbH

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IQPC Automotive System Safety Europe
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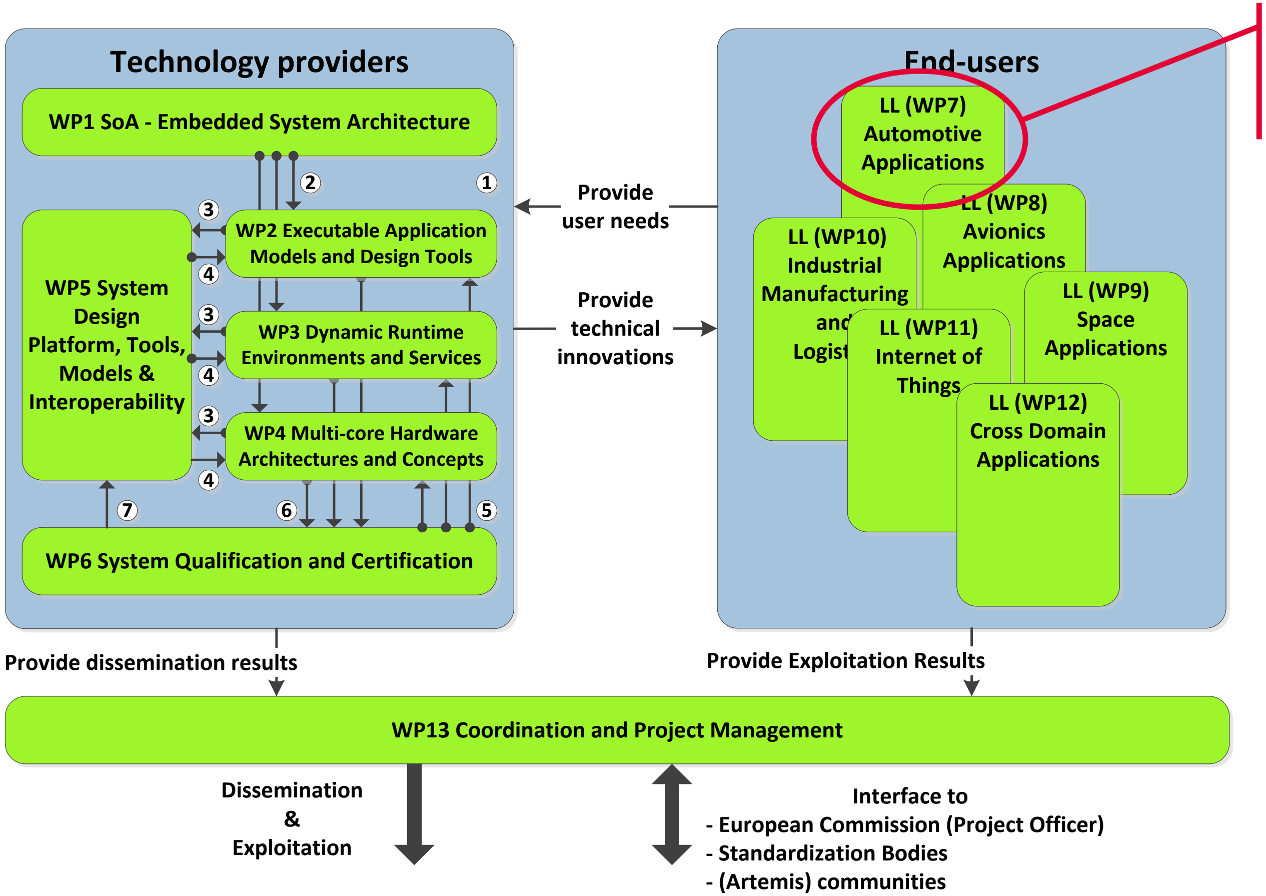
EMC² project structure and information flow



highlighted in this presentation

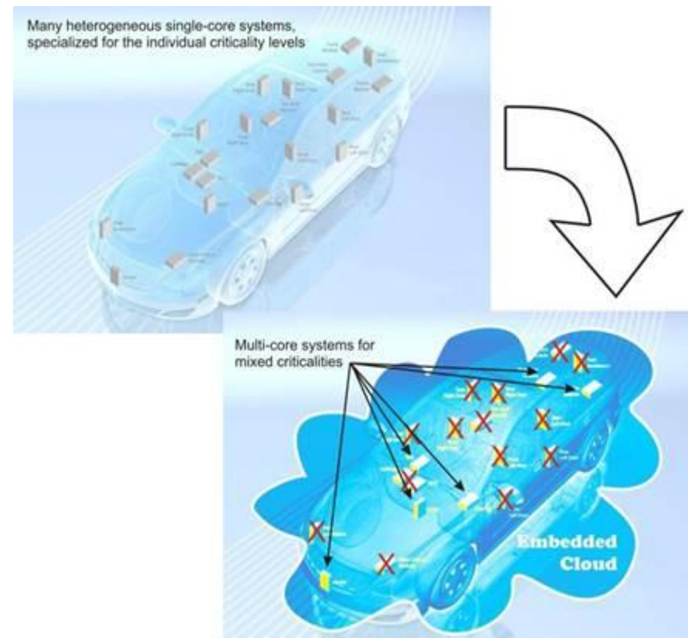
(1) Provide HW/SW solutions
(2) Provide framework for SoA
(3) Provide tools for HW/SW development
(4) Provide framework for component based systems engineering and for tool integration
(5) Provide framework for system qualificaation and certification
(6) Provide solutions for HW/SW components qualification and certification
(7) Provide framework for tool chain classification and qualification

Automotive use cases

- **Living Lab Automotive coordinated by**
  - Thomas Söderqvist, VOLVO (Commercial vehicles), Sweden
  - Rutger Beekelaar, TNO, Netherlands
- **ADAS and C2x**: Dave Marples, Technolution, Netherlands
- **Highly automated driving**: Almudena Diez, IXION, Spain
- **Design and validation of next generation hybrid powertrain / E-Drive**: Eric Armengaud, Georg Macher, AVL, Austria
- **Modelling and functional safety analysis of an architecture for ACC system**: Alberto Melzi, CRF, Italy
- **Infotainment and eCall Multi-Critical Application**: Joao Rodrigues, CSOFT, Portugal
- **Next Generation Electronic Architecture for Commercial Vehicles**, Thomas Söderqvist, VOLVO, Sweden

EMC² Challenges

- Dynamic **Adaptability** in Open Systems
- Utilization of expensive system features only as **Service-on-Demand** in order to reduce the overall system cost.
- Handling of **mixed criticality** applications under real-time conditions
- **Scalability** and utmost flexibility
- Full scale deployment and management of **integrated tool chains**, through the entire lifecycle
- **Power** supply challenges from dynamic operational changes in MCMC real time systems



EMC² Anticipates the trend for higher ECU integration in automotive

EMC² Challenges – Use Case Examples

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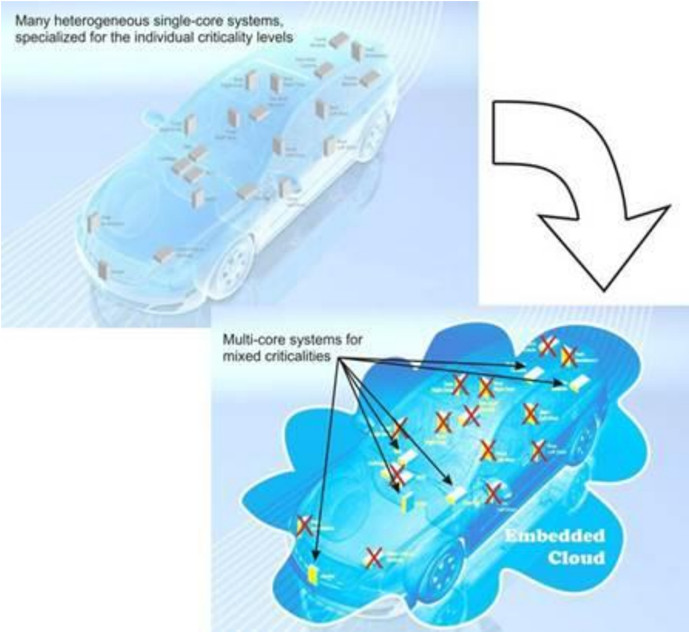

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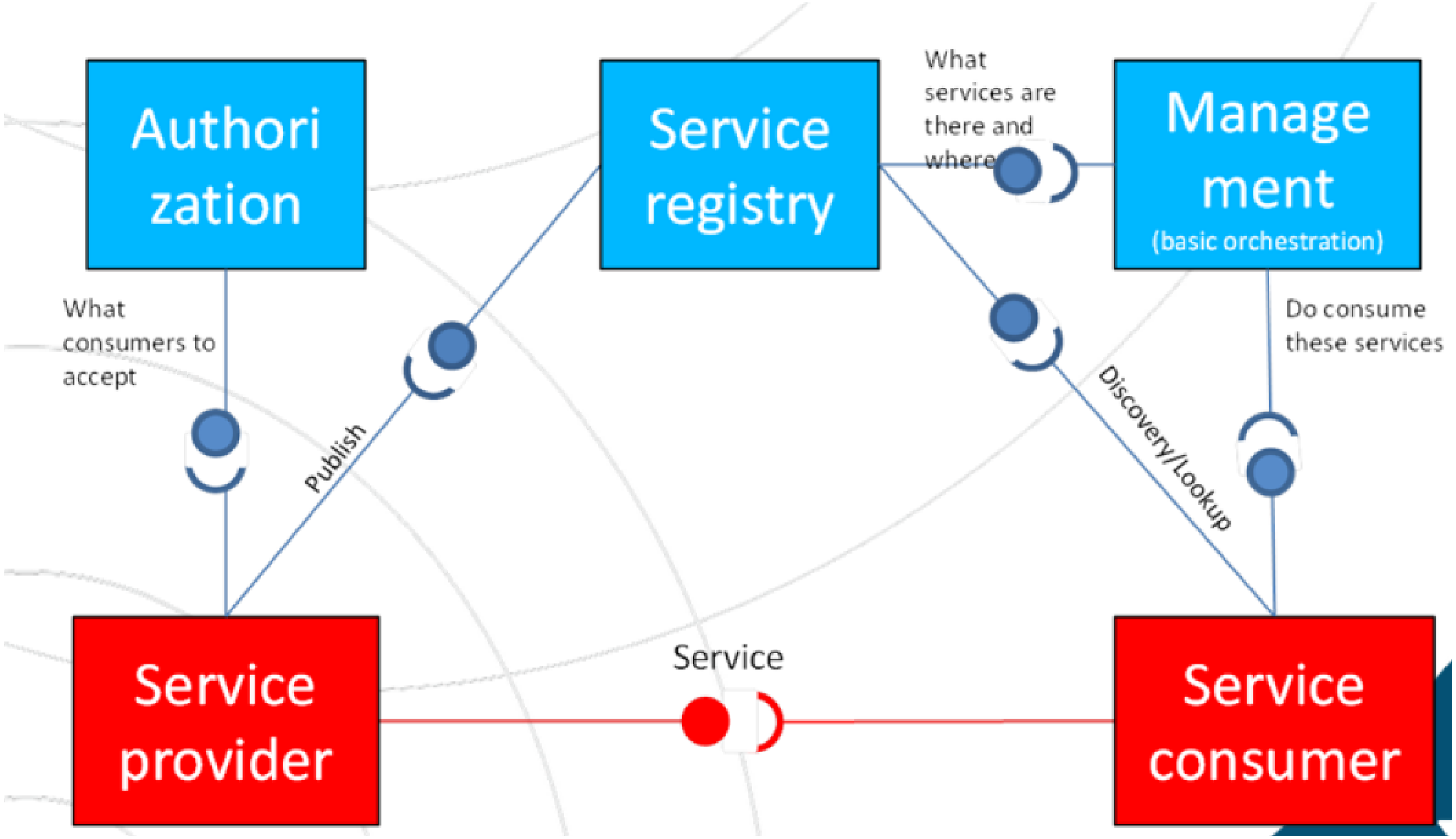
EMC² common principle of Service oriented Architecture

- SoA is a set of **architectural principles** expressed independently of any product



slide picked from Next Generation Electronic Architecture for Commercial Vehicles (VOLVO)

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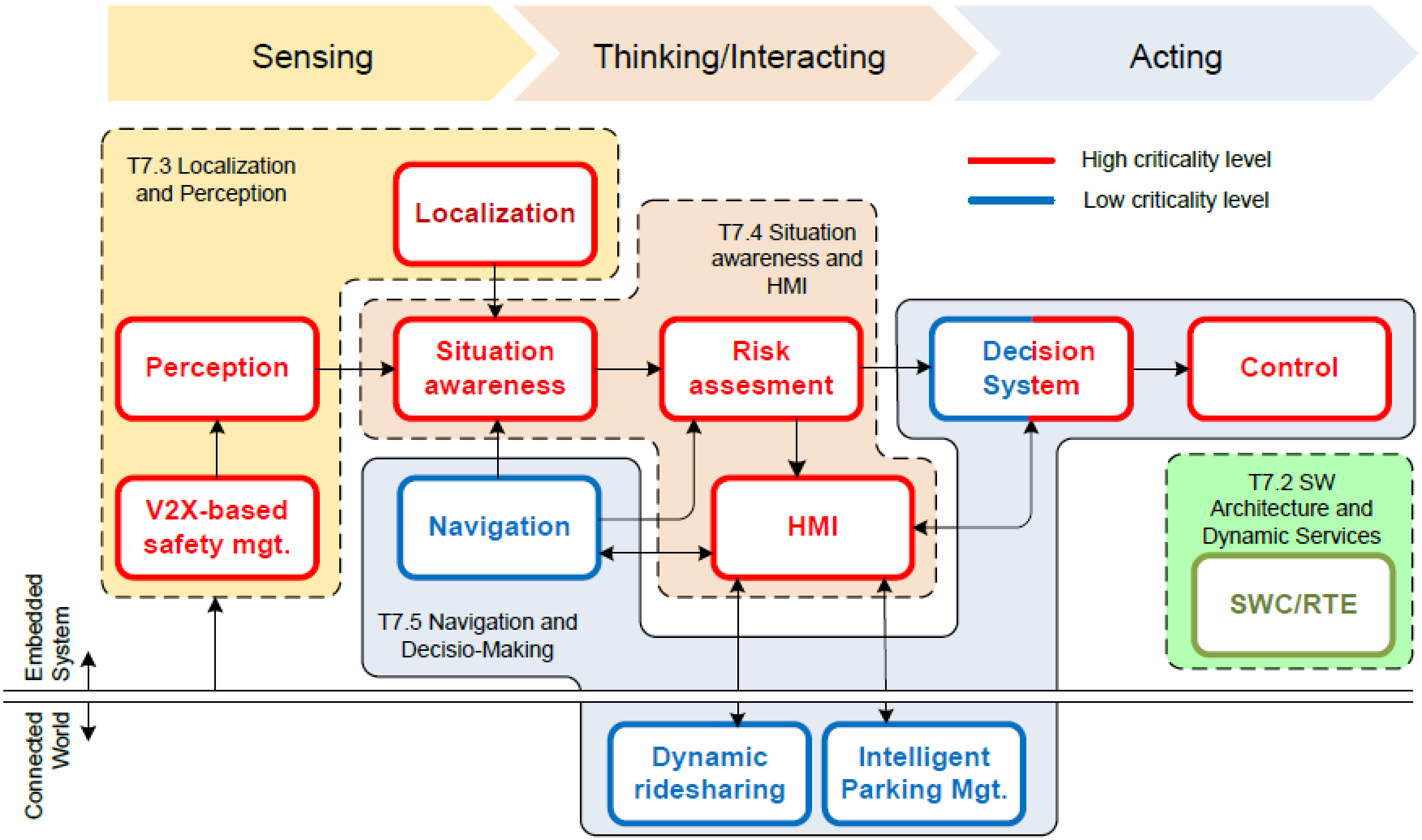
Highly automated driving

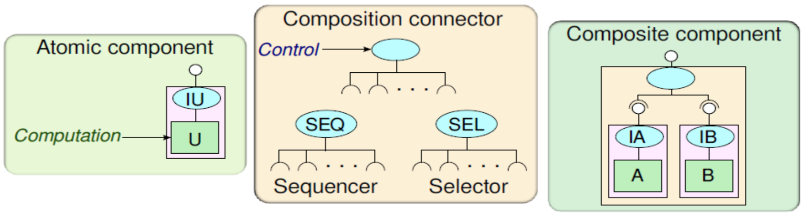
Use Case Overview

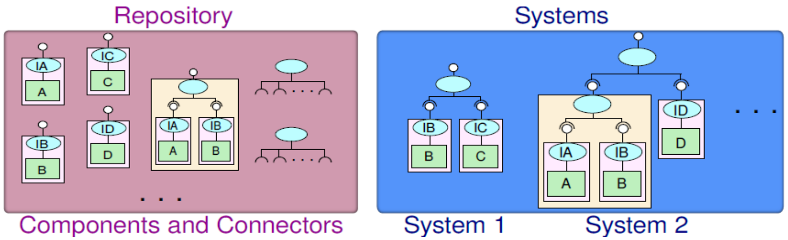


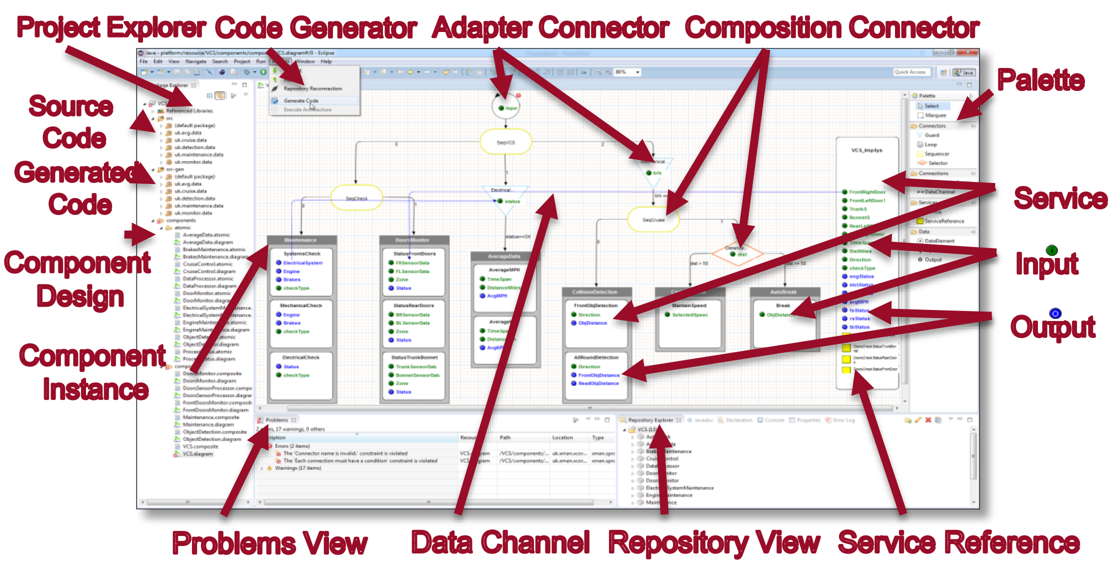
Highly Automated Driving

SW architectures and dynamic services

- **X-MAN: a SOA oriented component-based modelling tool**
  - (Hierarchical) SOA architecture
  - Extension of X-Man to support real-time system modelling
  - Allocation of components onto CPU/cores
  - Transformation of IXION atomic/composite components to X-MAN syntax
  - Task scheduling policy
  - Shared resources policy
  - Tool for further analysis and code generation







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- **Infotainment and eCall Multi-Critical Application**: Joao Rodrigues, CSOFT, Portugal

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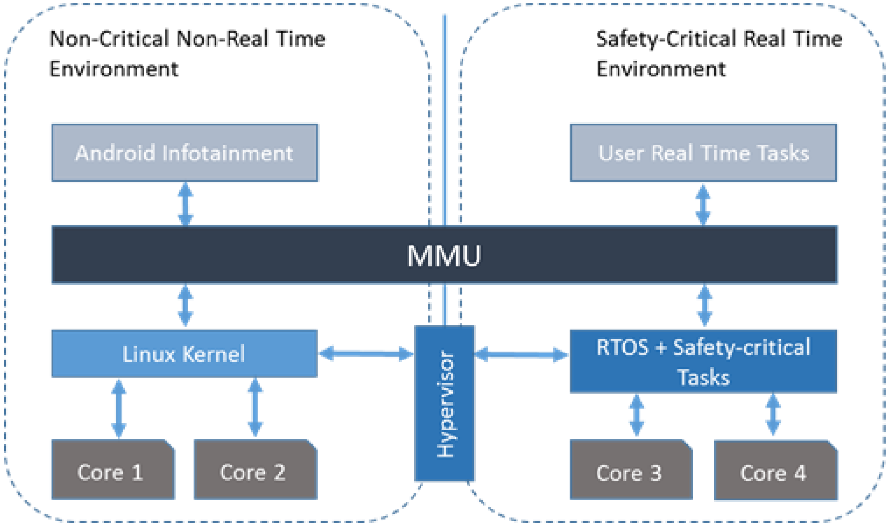
Infotainment and eCall Multi-Critical Application

We intend to demonstrate:

- The platform hardware and software isolation
- The mixed-criticality multi-core task scheduling
- The resource securing and sharing features
- The online monitoring and fault injection capabilities
- The secure communication mechanism
- The infotainment running as a non-critical guest OS

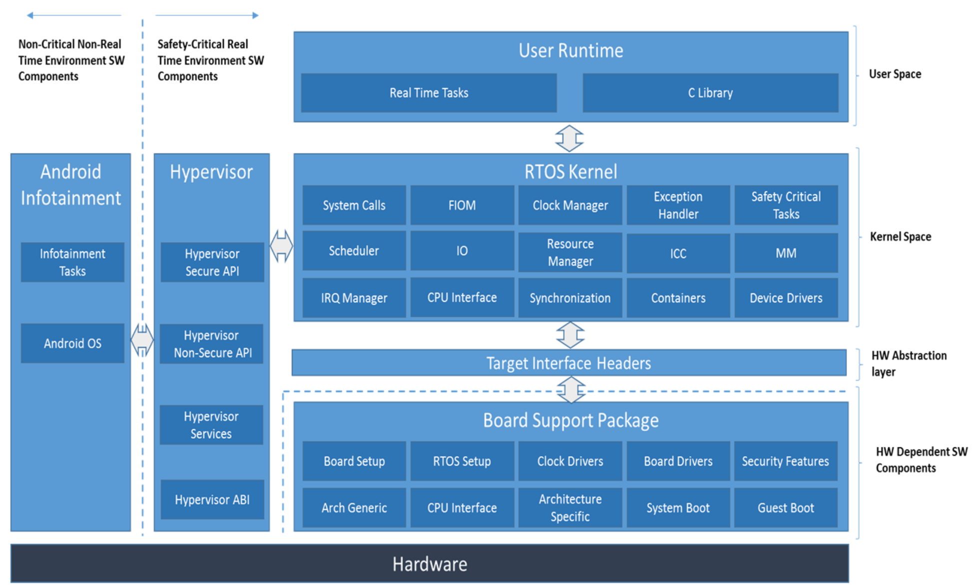


Infotainment and eCall Multi-Critical Application RTOS Platform

RTOS Platform Provides:

- Hardware abstraction layer
- Global device management
- Device driver API classes
- Mixed-criticality task management
- Memory management with page allocation
- User and kernel task C library
- Comprehensive list of system calls
- Fault injection online monitoring API
- Inter-core communication API for static components (scheduler, hypervisor,…), user and kernel tasks

Detailed Architecture



aicas realtime; CISTER Research Center in Real-Time & Embedded Computing Systems; inesc id lisboa; CRITICAL SOFTWARE

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- **Next Generation Electronic Architecture for Commercial Vehicles**, Thomas Söderqvist, VOLVO, Sweden

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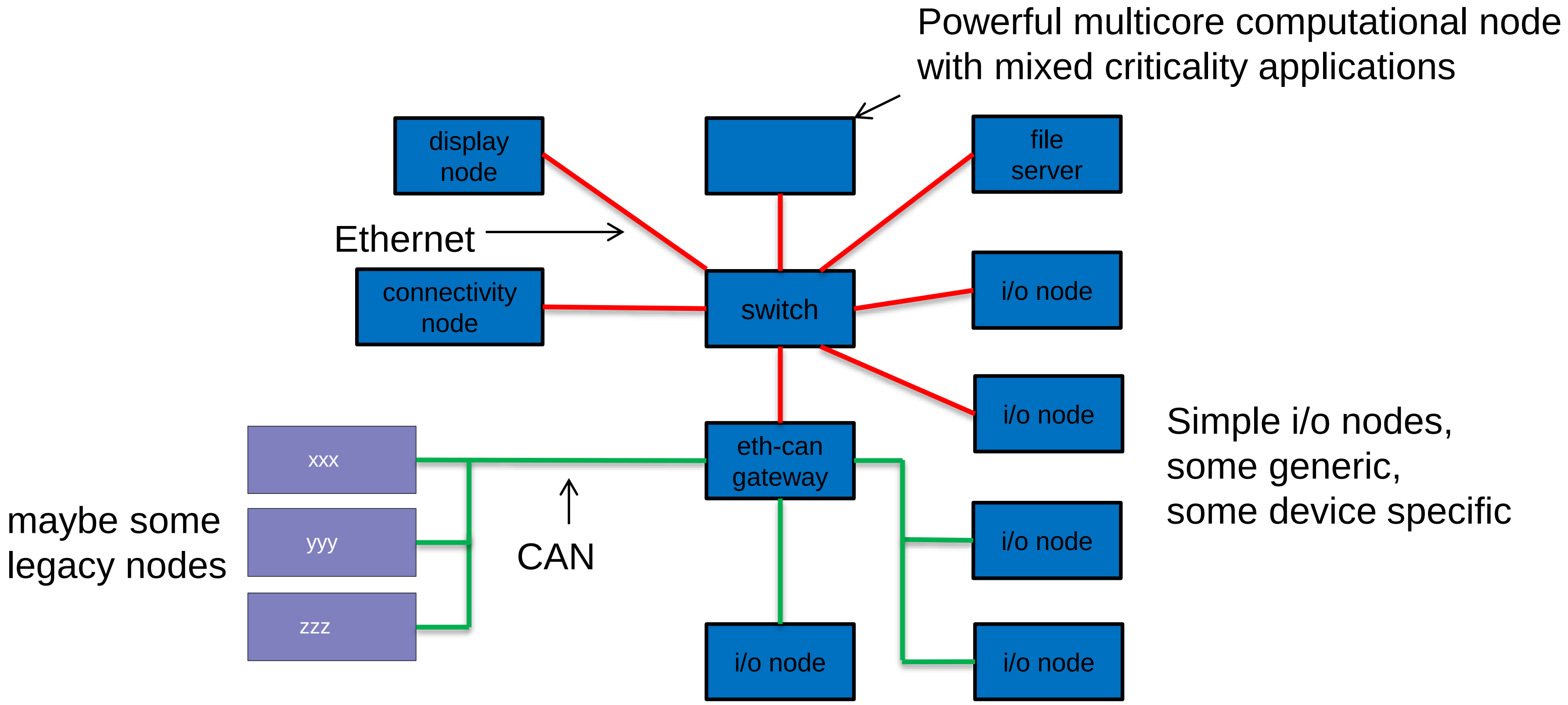
Architecture concepts for future truck embedded electronic architecture

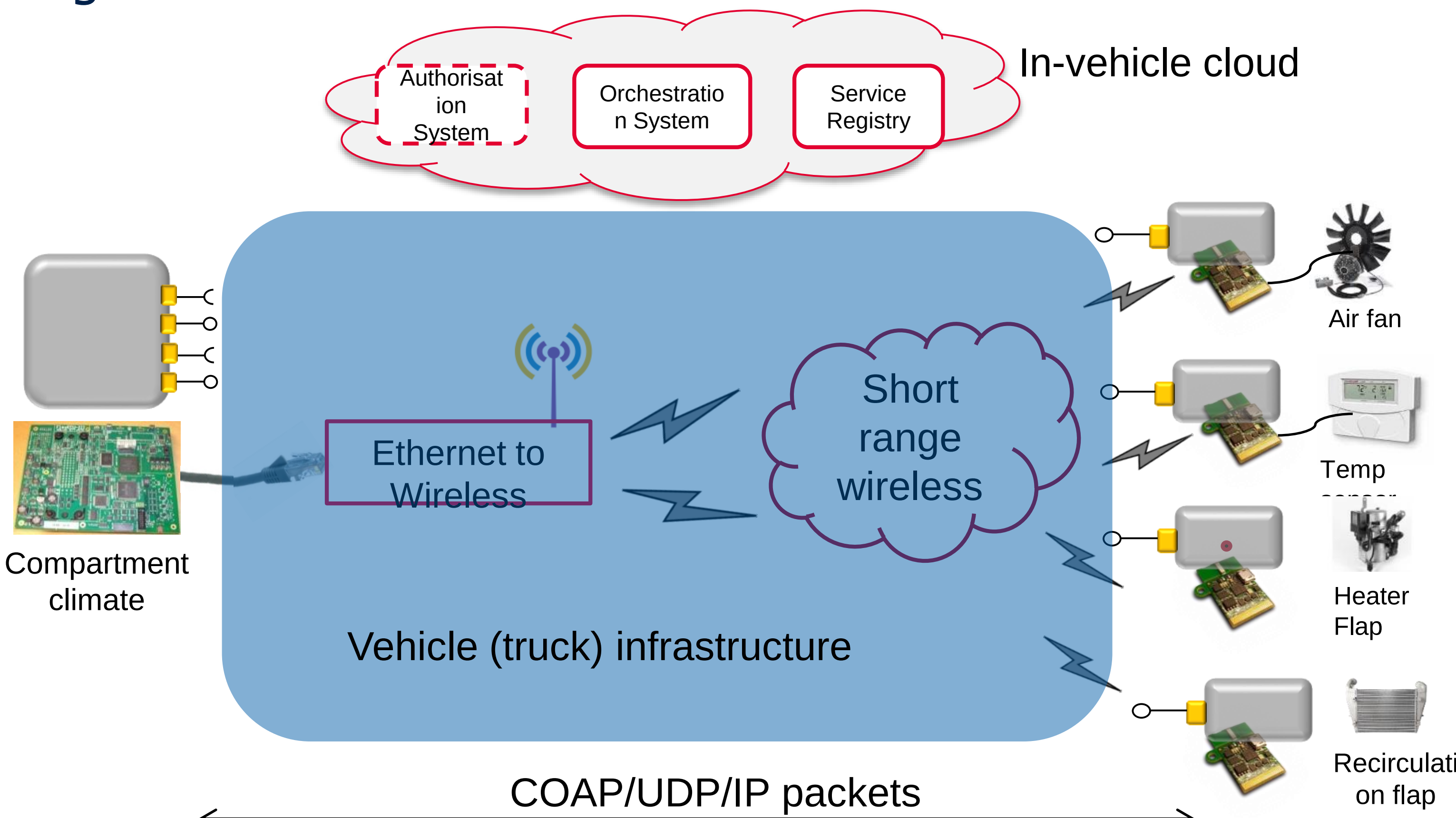
- Envisioned future truck embedded architecture principle



Next Generation Electronic Architecture for Commercial Vehicles

Service-oriented Architecture for future truck embedded electronic architecture

- Demonstrator: Simplified truck climate control
- Modelling in SoAML



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Different development phases

Stage 1: SW integration

- BSW and OS for multi-core computing platform deployed
- Independent (mixed criticality) applications integrated on multi-core computing platform

Stage 2: Validation aspects

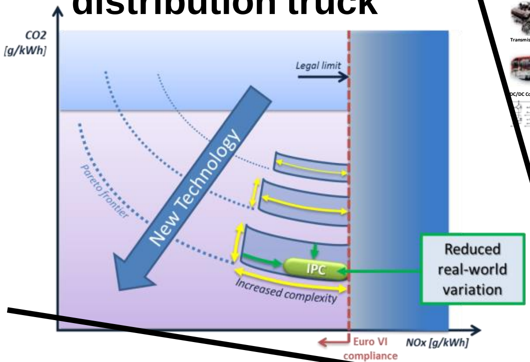
- Mixed criticality applications consolidated
- Simulation and test systems for multi-core applications introduced
- Safety framework for multi-core systems introduced

Stage 3: Consolidation

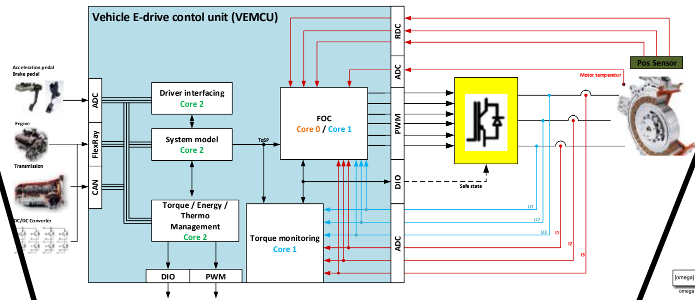
- All solutions consolidated

Design and validation of next generation hybrid powertrain / E-Drive

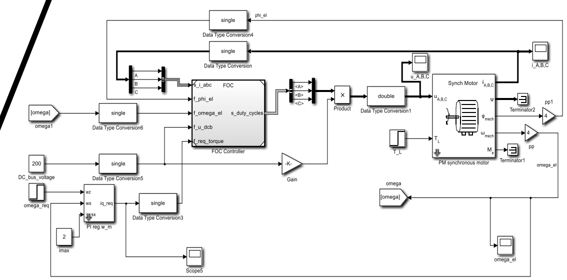
ASW1: Powertrain Control for 118kW HD parallel hybrid distribution truck



ASW2: Integration vehicle control unit / e-drive

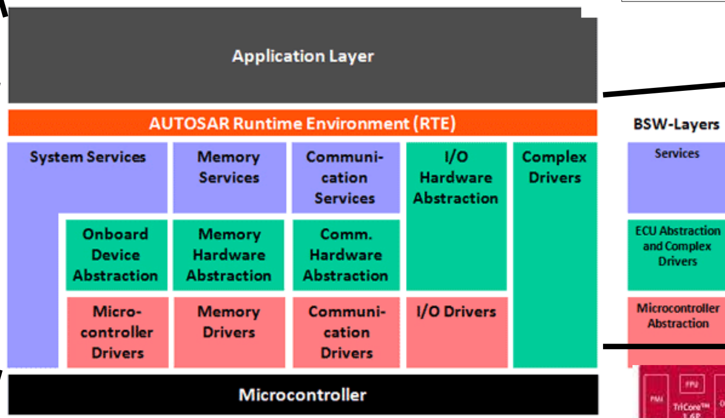


ASW3: E-motor control PIL co-simulation



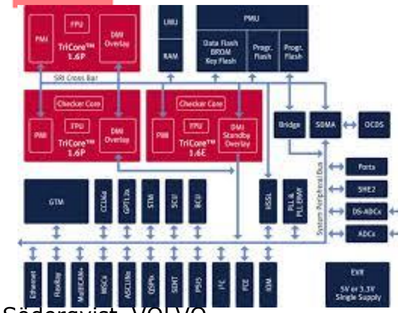
BSW:

AUTOSAR stack, config tools



HW platform:

multicore, MCAL



Safety assurance case, integration, calibration and V&V

All partners

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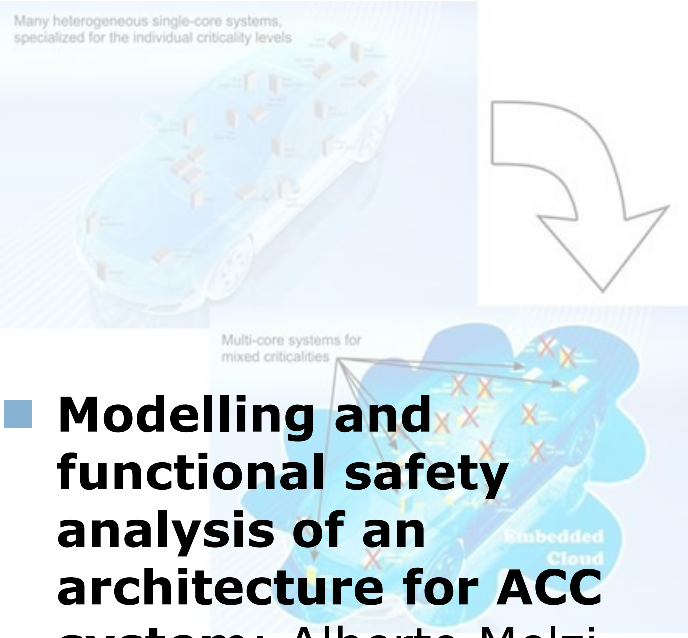

- **Modelling and functional safety analysis of an architecture for ACC system**: Alberto Melzi, CRF, Italy

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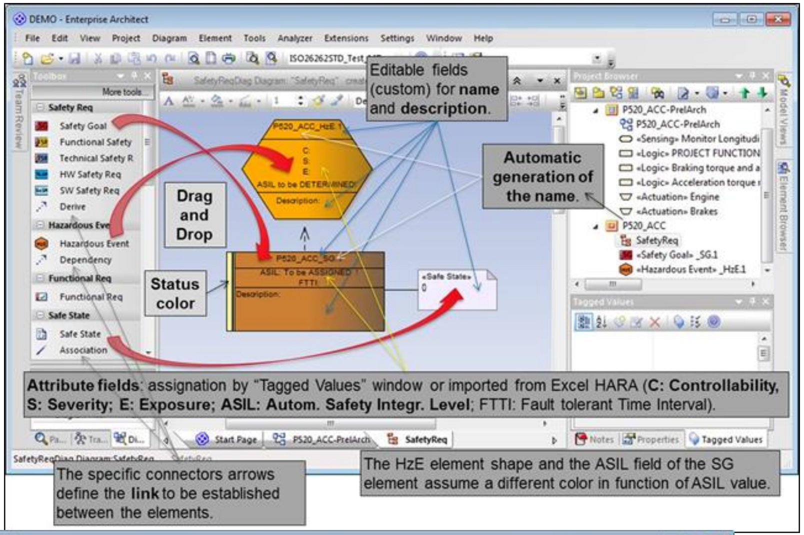
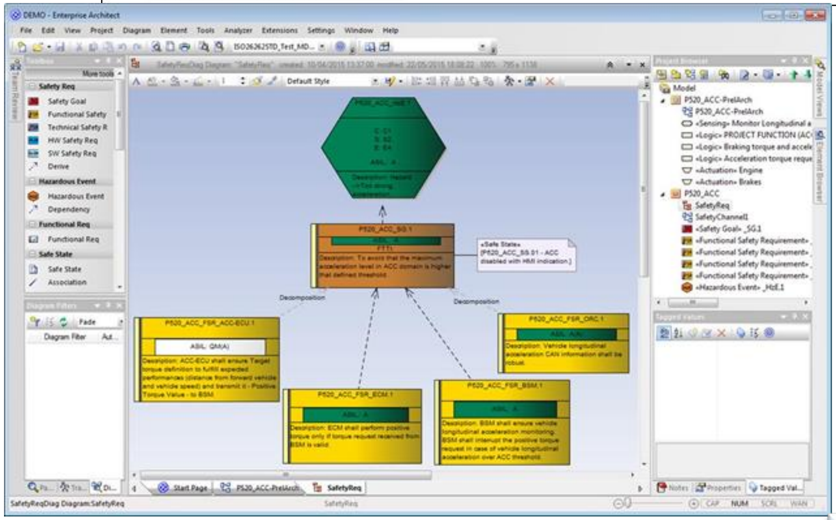
Modelling and functional safety analysis of an architecture for ACC

- Objective: development of a tool chain for supporting the functional safety process (ISO 26262 conformant) applied to a safety mixed (safety/security) criticality systems, exemplified by an ACC system
- Technologies: modeling artifacts based on SysML in Enterprise Architect framework integrated with Visual Basic Add-Ins in Visual studio
- Key achievements/solutions: implementation of a meta-model/tool chain to support ISO 26262 prescriptions for the deployment of the Safety Requirements





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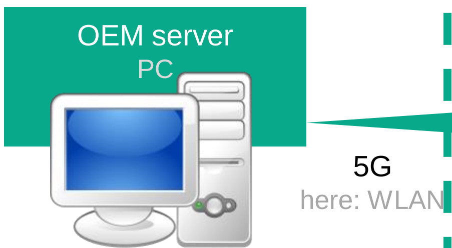
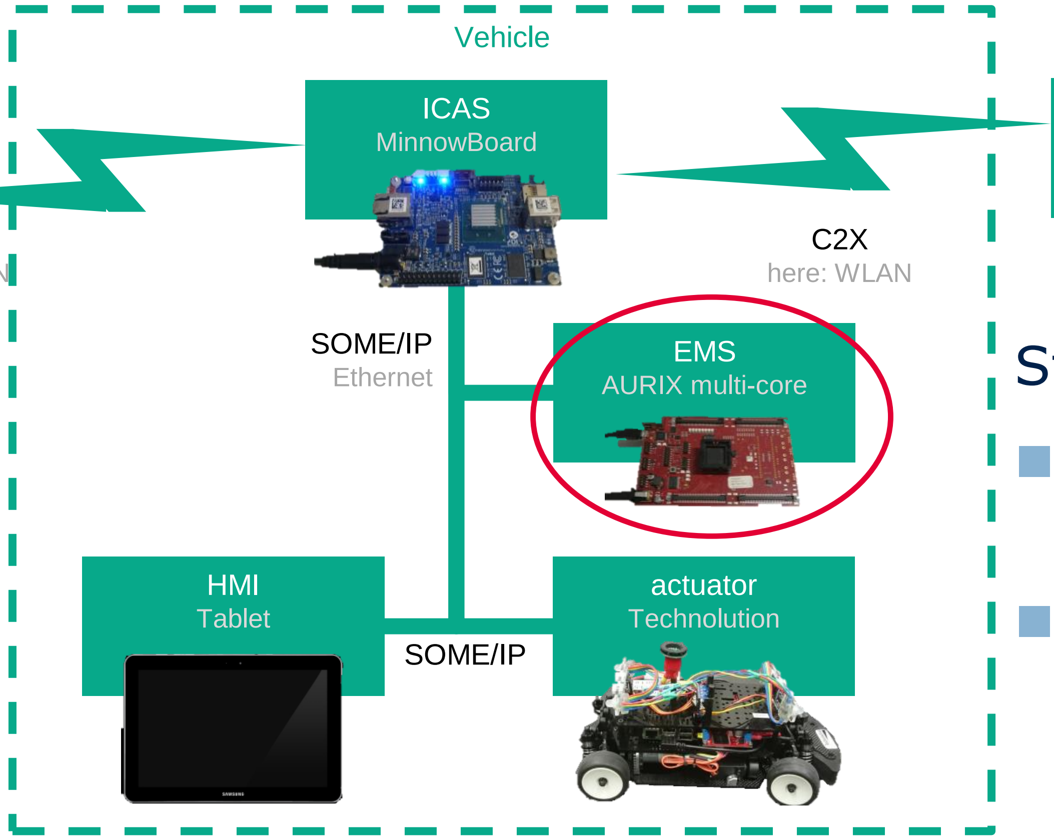
ADAS and C2X

Use Case - Traffic Light





Demonstration

- AUTOSAR adpaptive
- safe and dynamic updates
- Automatic software migration to multi core

Story line

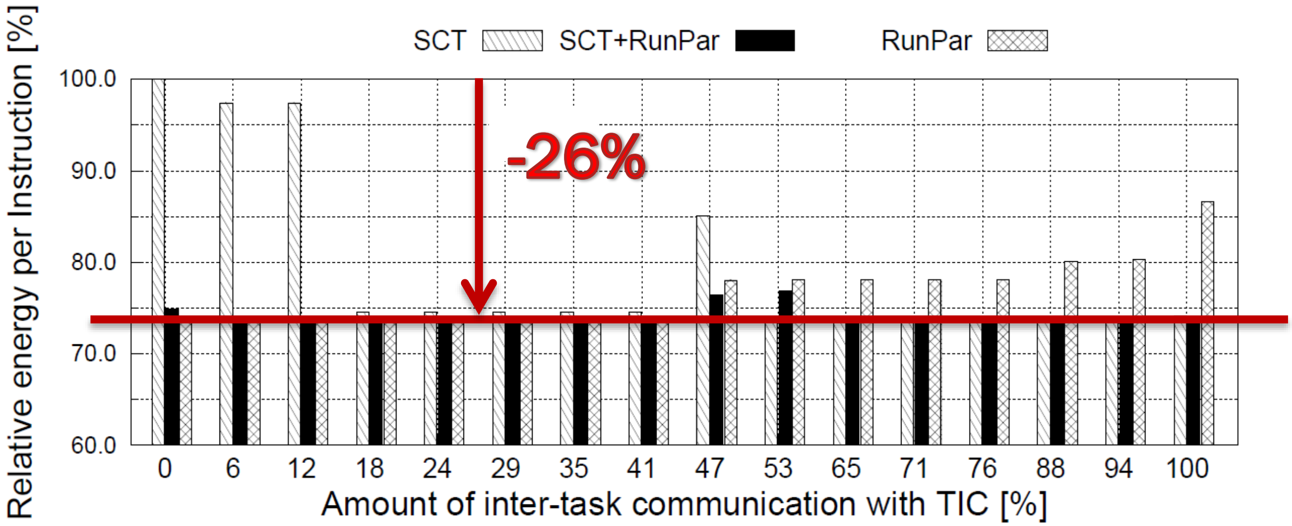
- initial manual drive
- 1st update: traffic lignt phase indication
- 2nd update: optimal speed for green light

DENSO Technolution Elektrobit Infineon

ADAS and C2X

Multi Core for Energy Efficiency

- Use different parallelization methods
  - Task level: Timed Implicit Communication (TIC)
  - Runnable (function) level: RunPar
- Automatic Optimization
  - Based on genetic algorithm
  - Use Energy Efficiency as optimization criterion



SCT single-core task using TIC (no RunPar task)

SCT+RunPar coordination with RunPar tasks (6 tasks showed best results)

RunPar all tasks execute on 4 cores

Summary

Examples of common topics and technologies studied in automotive use cases

- Many single core ECUs → Fewer multicore ECUs
- Mixed criticality
- Support for mixed operating sy…
- Freedom of interfere…
- Virtualization
- Hypervisors
- Predictable, low late… …andwidth communication
- Service-oriented architecture
- Energy efficiency using multicore

For details, please visit us at the EMC^2 public days:

May 31st / June 1st 2017
Granada