AN OPEN-SOURCE SOFTWARE PLATFORM FOR AUTONOMOUS DRIVING SYSTEMS
ITS SUCCESS AND ITS DIFFICULTIES

Lukas Bulwahn (joint work with Tilmann Ochs and Daniel Wagner)
BMW Car IT GmbH | February 5th, 2017
ABOUT BMW CAR IT GMBH

– Founded in 2001 as a wholly owned subsidiary of the BMW AG
– Strengthen BMW's software competence
  – View vehicles as software systems
  – Develop innovative software for future BMW Group vehicles
  – Prototype solutions for early and reliable project decisions
– Participate in several open-source communities and research projects

BMW Car IT GmbH is currently hiring!
http://www.bmw-carit.de/opportunities/
OUTLINE

– Motivation in 2013
– Better Understanding, Progress and Development in 2017
  – Business Cooperation Strategy
  – Communication Middleware
– Safety & Real-time
AUTOMOTIVE COMPUTING

Control Software
- state machine + controller
- mature state-of-the-art
- static software structure and configuration
- automotive microcontrollers

Cognitive Software
- dynamic models + AI
- rapidly evolving technology
- dynamic software structure and configuration
- high performance mainstream HW

advanced driver assistance, automated driving

manual driving, driver assistance, active safety
High-Performance Computing

Application Software

Unified and Standardized API

Software Platform

Hardware Acceleration
- GPU
- DSP
- FPGA

Performance CPU
- x64
- Cortex A57
- PPC e5500

External Memories
- DRAM
- NAND Flash

**decouple** application software from hardware technology

Dynamic Software Platform

- improved software
- vehicle manufacturer
- software distribution backend
- diagnostic field data
- delivery over-the-air

**support non-invasive rollout** of software into vehicles
BUSINESS COOPERATION STRATEGY

- **Customer Visibility**
  - Strategic Cooperation
  - Open Source

- **Automotive Specific**
  - Core Business
  - Gated Cooperation

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BUSINESS COOPERATION STRATEGY

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BUSINESS COOPERATION STRATEGY

- Operating System and Isolation Mechanisms
- Open Source
- Strategic Cooperation
- Gated Cooperation
- Core Business

- Customer visibility
- Automotive specific

- Vehicle-wide Software Update
- Model-based Development
- Diagnostics
- Communication Middleware
C Runtime Environment (RTE) from AUTOSAR
one standard, multiple proprietary implementations

SOME/IP protocol from AUTOSAR
one standard, multiple implementations

CommonAPI C++ from Genivi
open-source, developed mainly by BMW

Adaptive AUTOSAR Communication
one standard and reference implementation

ROS 1.x from Open-Source Robotics Foundation (OSRF)
open-source, developed by an open-source foundation, large community

ROS 2.0 from OSRF
open-source, based on DDS

DDS 1.x standard from OMG
Open and proprietary implementations from multiple vendors


automotive domain

robotics domain
CommonAPI C++ from Genivi
open-source, developed mainly by BMW

Adaptive AUTOSAR Communication
one standard and reference implementation

ROS 2.0 from OSRF
open-source, based on DDS

ROS 1.x from OSRF
open-source, large community

Convergence due to
same industry & development company
same protocol & similar terminology

Convergence intended by design

2017
Adaptive AUTOSAR Communication
one standard and reference implementation

automotive domain

ROS 2.0 from OSRF
open-source, based on DDS

robotics domain

Convergence?

- Use within same organisations:
  - BMW, Bosch et al. develop Adaptive AUTOSAR
  - BMW, Bosch et al. use ROS for research
- Complementary strengths:
  - AUTOSAR is strong on Specification
  - ROS is strong on Implementation and Tooling
- Adoption with next-generation employees:
  - ROS is used and taught in university
  - Automotive industry currently hires many graduates
- API design and behavior:
  - API follows similar design patterns
  - Slightly different service discovery
  - Different terminology
<table>
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<tr>
<th>Safety-Related Software</th>
<th>Real-Time Linux</th>
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<td>2013:</td>
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<td>– safety-related software development</td>
<td>– PREEMPT_RT patches out-of-tree</td>
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<td>in C with dedicated operating systems</td>
<td>– Minimal funding for maintenance by</td>
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<td>2017:</td>
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<td>– safety-related software development</td>
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<td>in C++14</td>
<td>– Linux Foundation funds Gleixner et</td>
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<td>– SIL2LinuxMP creates</td>
<td>al. to make PREEMPT_RT main-line</td>
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<td>SIL2 safety qualification for Linux</td>
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CONCLUSION

– General Perception on Linux & Open-Source has evolved:

“Linux is not good enough” → “Linux is good, but is not good enough for safety” → “Linux is good enough for safety, just did not prove it yet”

– Still Much Work ahead:
  – Convergence of Adaptive AUTOSAR’s communication specification and ROS 2.0 efforts
  – Long-term collaborative model for a safety-qualified Linux
  – Main-line work on real-time capabilities in Linux

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