

Retrofitting SDN to classical in-vehicle networks: SDN4CAN

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Retrofitting SDN to classical in-vehicle networks

Agenda

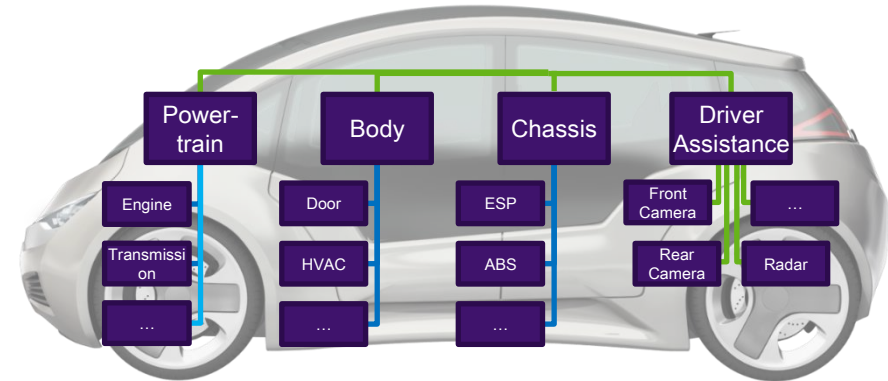
- ▶ Automotive networks today
- ▶ Our approach: SDN4CAN
- ▶ Status, Future Work and Remaining Challenges



Retrofitting SDN to classical in-vehicle networks

Automotive Networks today

- ▶ Lots of specialized networks
 - ▶ Controller Area Network (CAN)
 - ▶ Local Interconnect Network (LIN)
 - ▶ Media Oriented Systems Transport (MOST)
 - ▶ FlexRay
 - ▶ Automotive Ethernet (IEEE802.3bw–2015 100BASE-T1)
- ▶ Lots of Heterogeneity
 - ▶ Up to 80 electronic control units
 - ▶ E/E architectures strongly vary from OEM to OEM, from model to model and variant to variant
- ▶ Static development approach
 - ▶ All communication relationships, signals and messages are defined, tested and implemented at design time

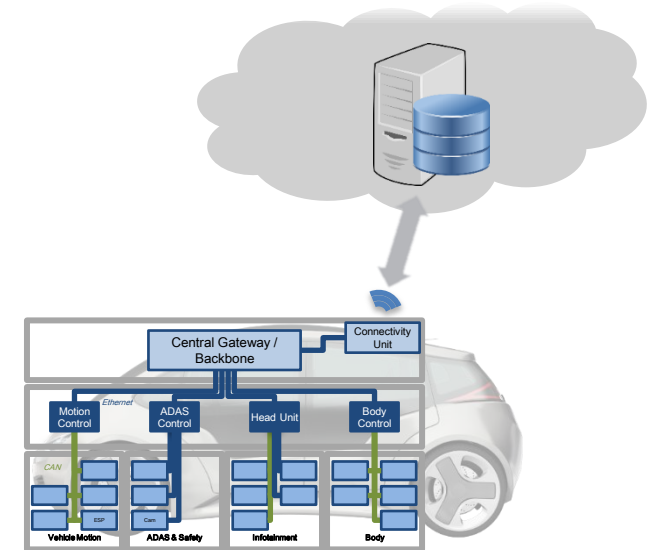
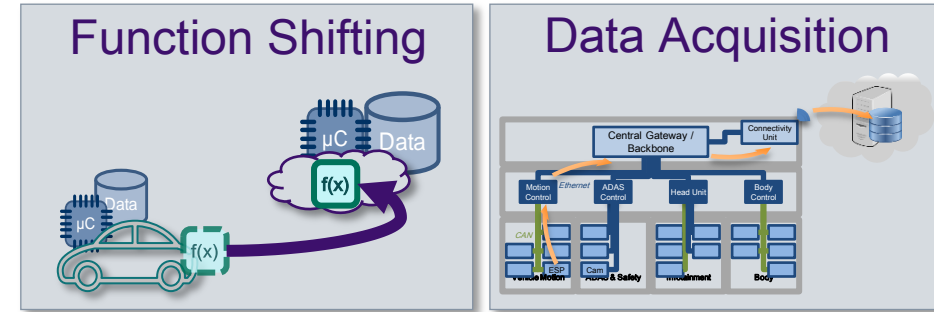


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Automotive Networks today

Current trends and new use cases

- ▶ New use case are coming up
 - Shifting functions to the cloud
 - Acquiring vehicular data from the cloud
- ▶ New architectural styles are emerging
 - Less but more powerful ECUs
 - Introduction of Ethernet backbones
 - Partial break out from domain-oriented structures
 - New architectural approaches for automated driving functions
- ▶ New requirements regarding in-vehicle communication
 - Seamless, service-oriented communication model from the ECU to the cloud
 - Flexible communication mechanisms to transmit data only when needed

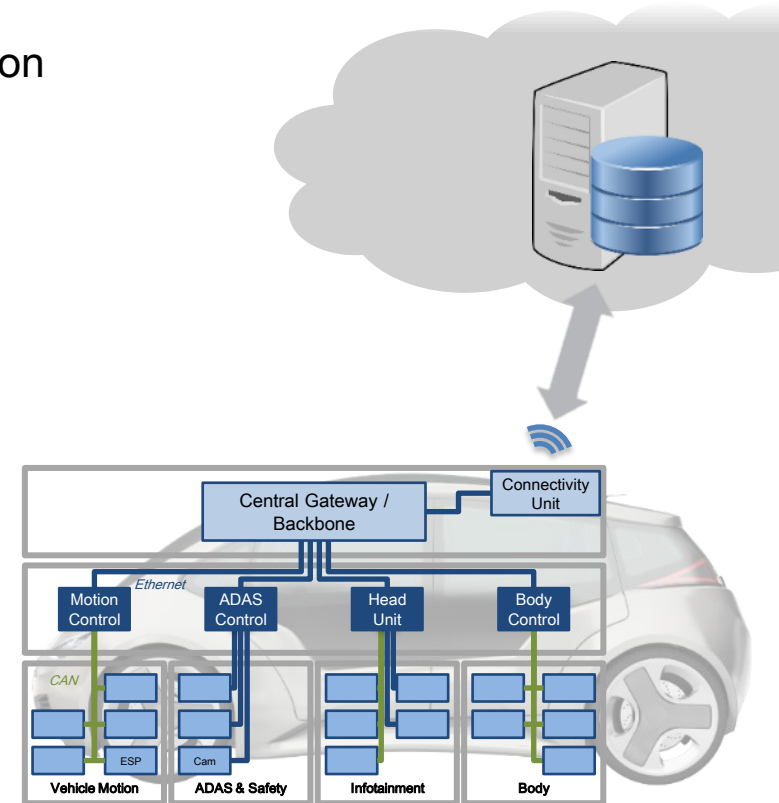


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Automotive Networks today

New challenges regarding network management

- ▶ Shift from static, development time network planning to runtime adaptation
 - Manage dynamic traffic on network and sub-network level
 - Ensure mission-critical communication can take place at any time
 - Use the resources and capabilities provided by the E/E architecture efficiently
- ▶ Manage the heterogeneity
 - Introduce network management principles that are capable on of managing the heterogeneity in
 - Network technologies (CAN, Ethernet...)
 - Protocols (SOME/IP, DDS...)
 - Establish network control mechanisms on all kinds of network technologies
- ▶ Introduce IT approved solutions to the automotive domain
 - Service-oriented communication is on its way
 - Software-defined Networking is discussed for the Ethernet domain
 - No sign of bringing SDN concepts to today's most used network system CAN



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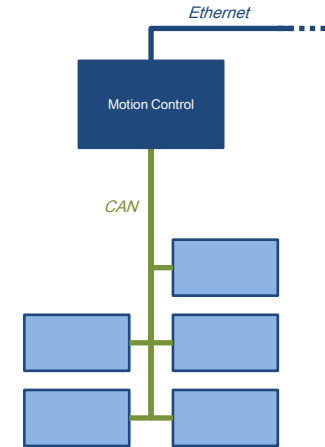
Our approach: SDN4CAN

► Overall idea:

- Bring the concepts and benefits of Software-Defined Network to the Controller Area Network

► Short introduction to CAN

- Today's most used automotive network technology
- Multi-master serial bus
- Carrier Sense Multiple Access/Collision Resolution (CSMA/CR)
- Message arbitration is based on the Identifier of a message
- Up to 1 Mbit/s data rate (realistic: 500Kbit/s)



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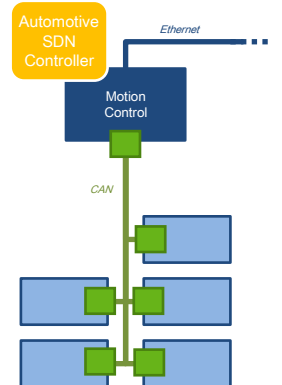
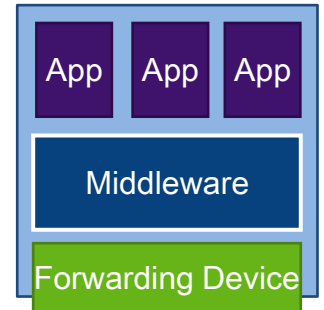
Our approach: SDN4CAN

► Base element: Forwarding Device

- Plays the role of a gatekeeper between a CAN node and the network
 - Control functionality (e.g. whitelisting, blacklisting, bandwidth budgeting)
 - Message prioritization (e.g. prioritized message queues, identifier manipulation)
- Includes the interface to the Automotive SDN Controller
 - Forwarding of path requests
 - Accept and realize forwarding rules sent by the SDN Controller

► Topological approach

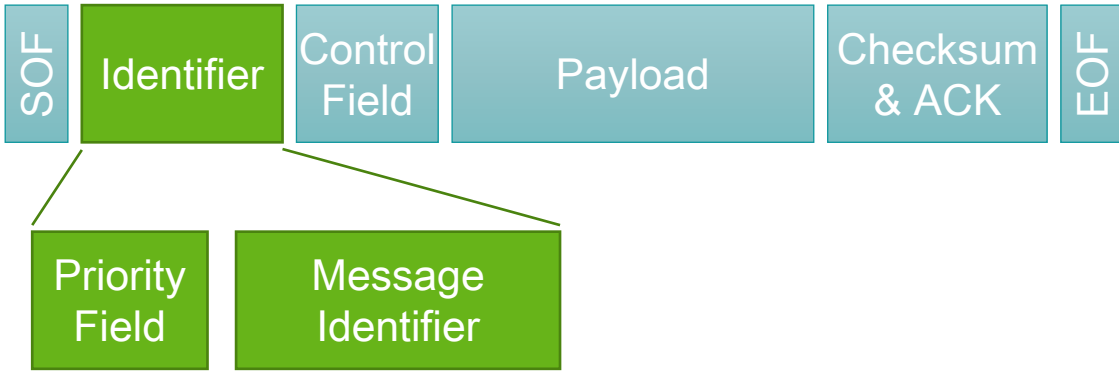
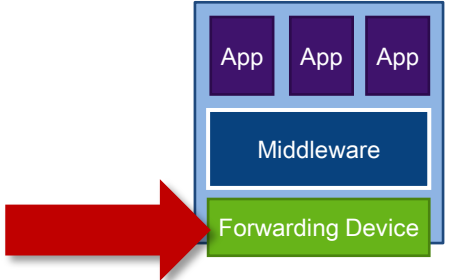
- A forwarding device is added to every CAN node
- One or more Automotive SDN Controllers monitor and govern the network



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Our approach: SDN4CAN

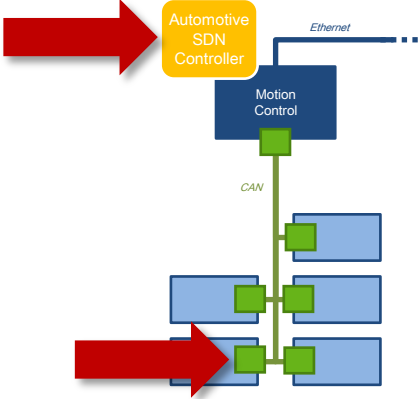
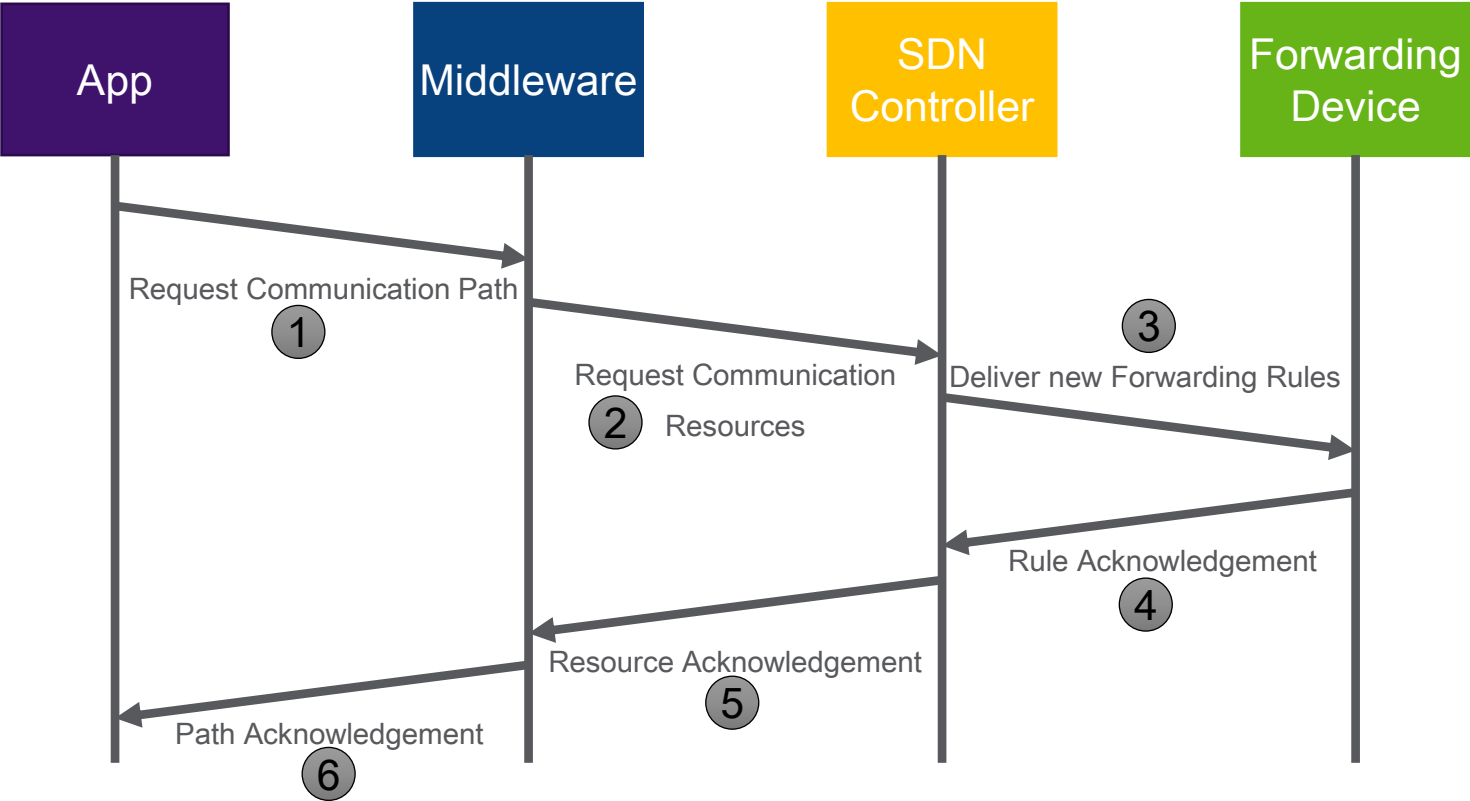
- ▶ Forwarding Rule example
 - ▶ Message prioritization through identifier manipulation



Retrofitting SDN to classical in-vehicle networks

Our approach: SDN4CAN

► Provisioning of new communication paths



Retrofitting SDN to classical in-vehicle networks

Status, Future Work and Remaining Challenges

► Current state

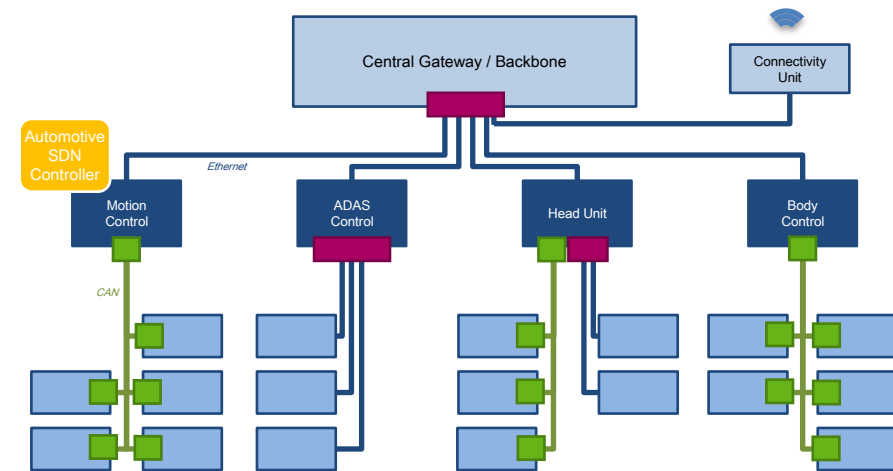
- Concept has been developed
- Partial implementation on Linux and SocketCAN has been done

► Next steps

- Integration into an overall automotive E/E architecture
 - Combination von TSN
 - Definition of end-to-end paths

► Remaining Challenges

- Availability guarantees (e.g. robustness, offline operation)
- Network heterogeneity (topological styles, additional network technologies, limited network capabilities)
- Introduction of dependable planning processes for network traffic (vs. usage of thumb rules)
- Controller redundancy strategies



THANK YOU



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