

Dynamic Service-Oriented for Software-Defined In-Vehicle Networks

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Outline

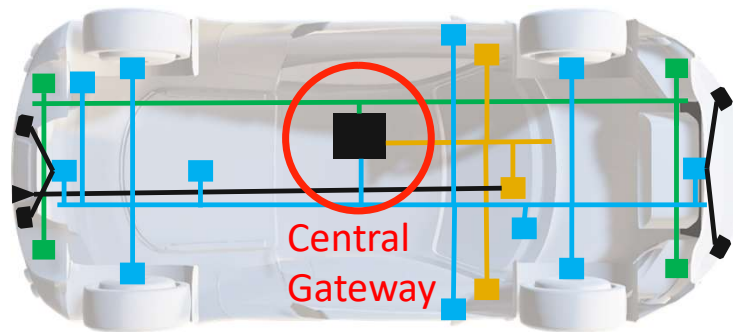
- I. Evolution of In-Vehicle Networks
- II. SDN-Supported Automotive Service-Oriented Architecture
- III. Service Discovery Performance Analysis
- IV. Conclusion and Outlook

I.

Evolution of In-Vehicle Networks

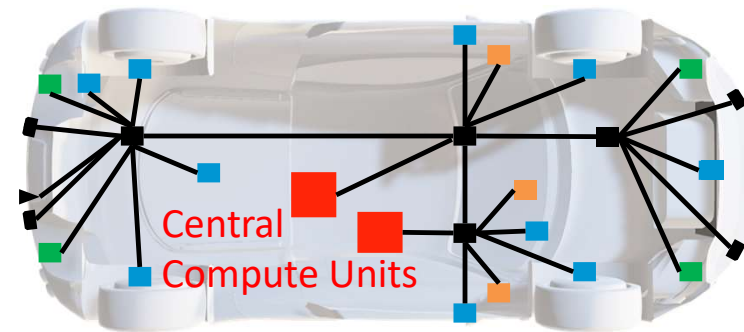
Evolution of In-Vehicle Networks

Current



- Heterogeneous bus systems
- Pre-compiled communication
- Static configuration
- No flow control capabilities

Future

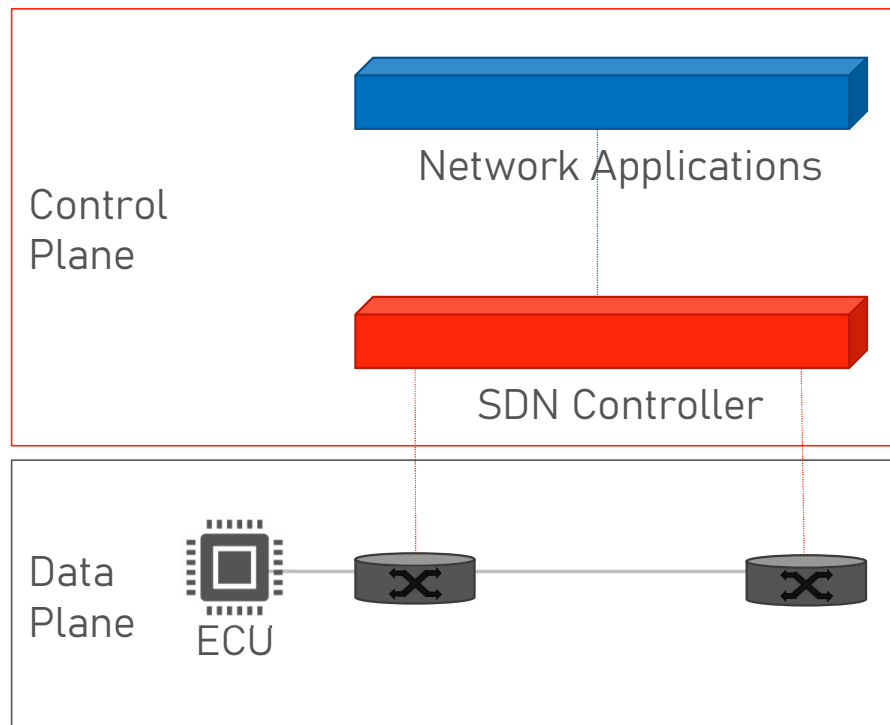


- Time-Sensitive Networking
- Service-Oriented Architecture
- Dynamic Service Discovery
- Software-Defined Networking

SOME/IP Protocol for Automotive SOA

- Distributed service discovery with multicast
 - Susceptible to spoofing, no trust mechanism
- Publish/subscribe and request/response model
 - Access control and authentication are missing
- Multiple instances of the same service can coexist
 - No mobility and failover mechanism in the network
- UDP(+multicast)/TCP-IP endpoints
 - Requires additional group management
 - Dynamic SOA does not translate to lower layer QoS

Software-Defined Networking in Cars



- Flexible and updatable network
- Flow awareness and isolation
- Central control even for real-time flows (TSSDN)
- Secure dynamic traffic steering

→ SDN elevates safety and security for in-vehicle communication

II.

SDN-Supported Automotive Service-Oriented Architecture

Idea

- Adapt the network to running services, locations and paths
- Central controller can unlock future potentials
 - Optimize service discovery
 - Enforce quality-of-service
 - Enable seamless service mobility
 - Respond to incidents (failover)
 - Protect service discovery

→ **SOME/IP protocol remains unaltered**

SOME/IP – SDN Interaction

SDN Vanilla

- Intercept all unknown flows
- Learn MAC and IP addresses
- Flood multicast requests and announcements on every hop
- Set up path when first data frame arrives
- Requires additional group management, e.g., IGMP

SOME/IP aware

- Intercept discovery packets
- Learn about services
- Cache announcements and respond to requests
- Set up path when subscription established
- Adapt paths as subscribers join or leave

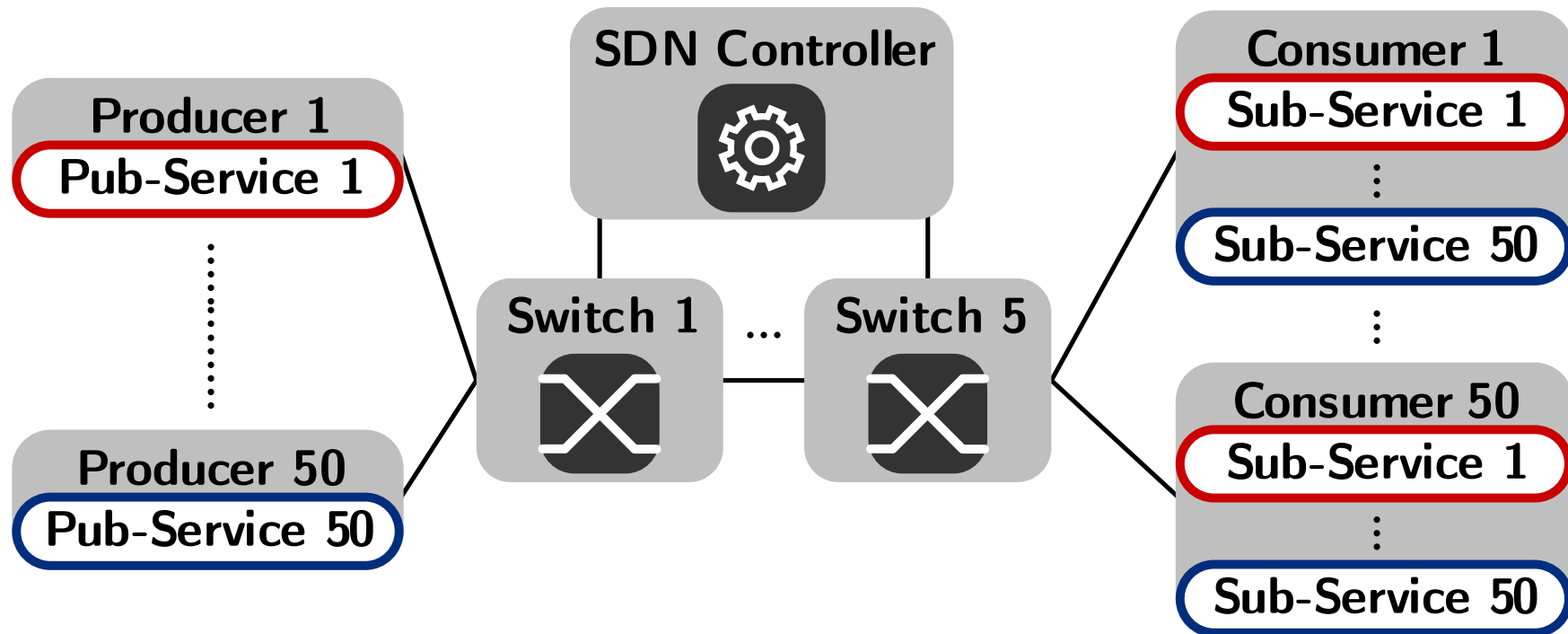
Controller as rendezvous point

→ constant distance for nodes

III.

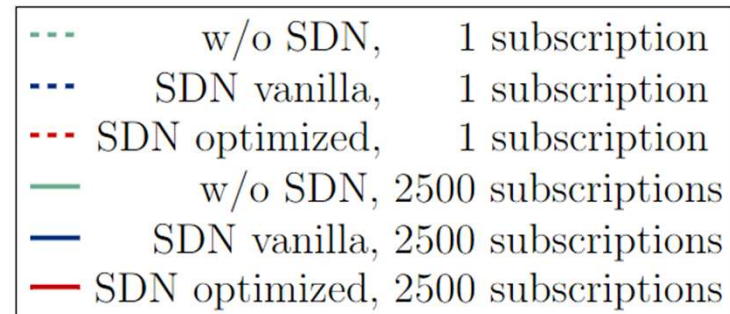
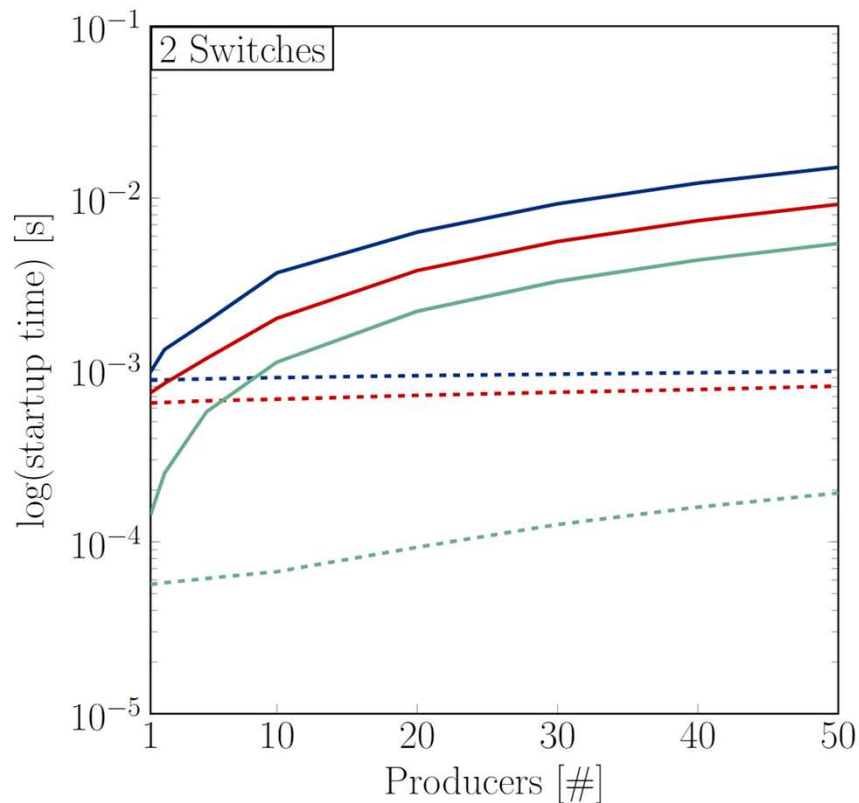
Service Discovery Performance Analysis

Simulation Study in OMNeT++



Three scenarios: w/o SDN, SDN vanilla, optimized SDN

Scalability Comparison



- Data transfer not impacted
- Our approach improved SDN performance by up to 50%
- 10 ms for 2500 subscriptions meets automotive requirements

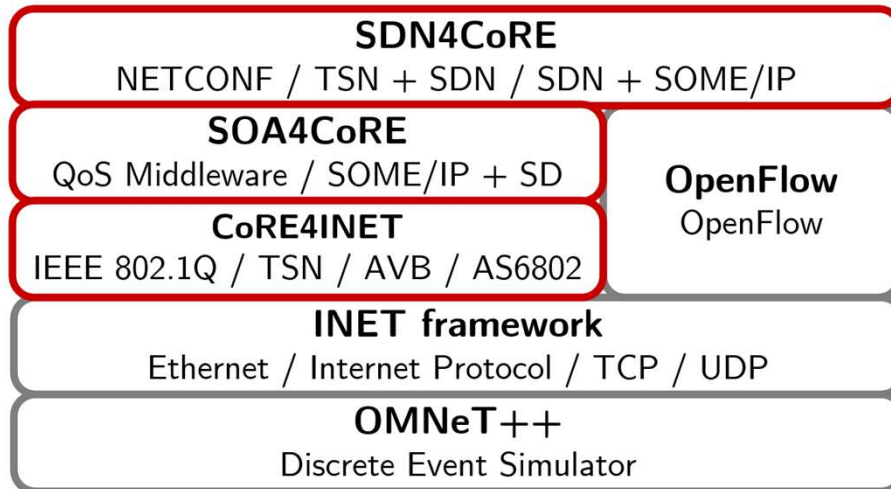
IV.

Conclusion and Outlook

Conclusion and Outlook

- Dynamic in-vehicle services require network support
- SDN can elevate safety and security for in-vehicle communication
- SOME/IP-aware controller
 - Acts as rendezvous point, constant distance for nodes
 - Transparent for services, data transfer is not impacted
 - Improves service discovery performance with SDN by up to 50%
 - 10ms start up for 2500 subscriptions meets automotive requirements
- Future work: Optimize service discovery, mobility, and reconfiguration for improved robustness, QoS support, and security enhancements

Dynamic Service-Orientation for Software-Defined In-Vehicle Networks



Simulation Frameworks
available Open Source at



<https://github.com/CoRE-RG>

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