Do we need Data Distribution Service (DDS) and service-oriented architecture for automotive applications?

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General Motors

Flow of presentation…

- Future needs of architecture platforms
  - Computation and performance demands on processor
  - Bandwidth demands on communication
- AUTOSAR Adaptive
  - Service Oriented Architecture
- Network bindings for ara::com
  - SOME/IP
  - DDS
  - IPC
- Conclusion

Future of automotive…

Feature Requirements

- Highly automated driving
- Back-end connectivity
- V2X
- Electric vehicles

Growing demand on

- Computation
- Bandwidth requirements
- Software quality
- Remote software updates

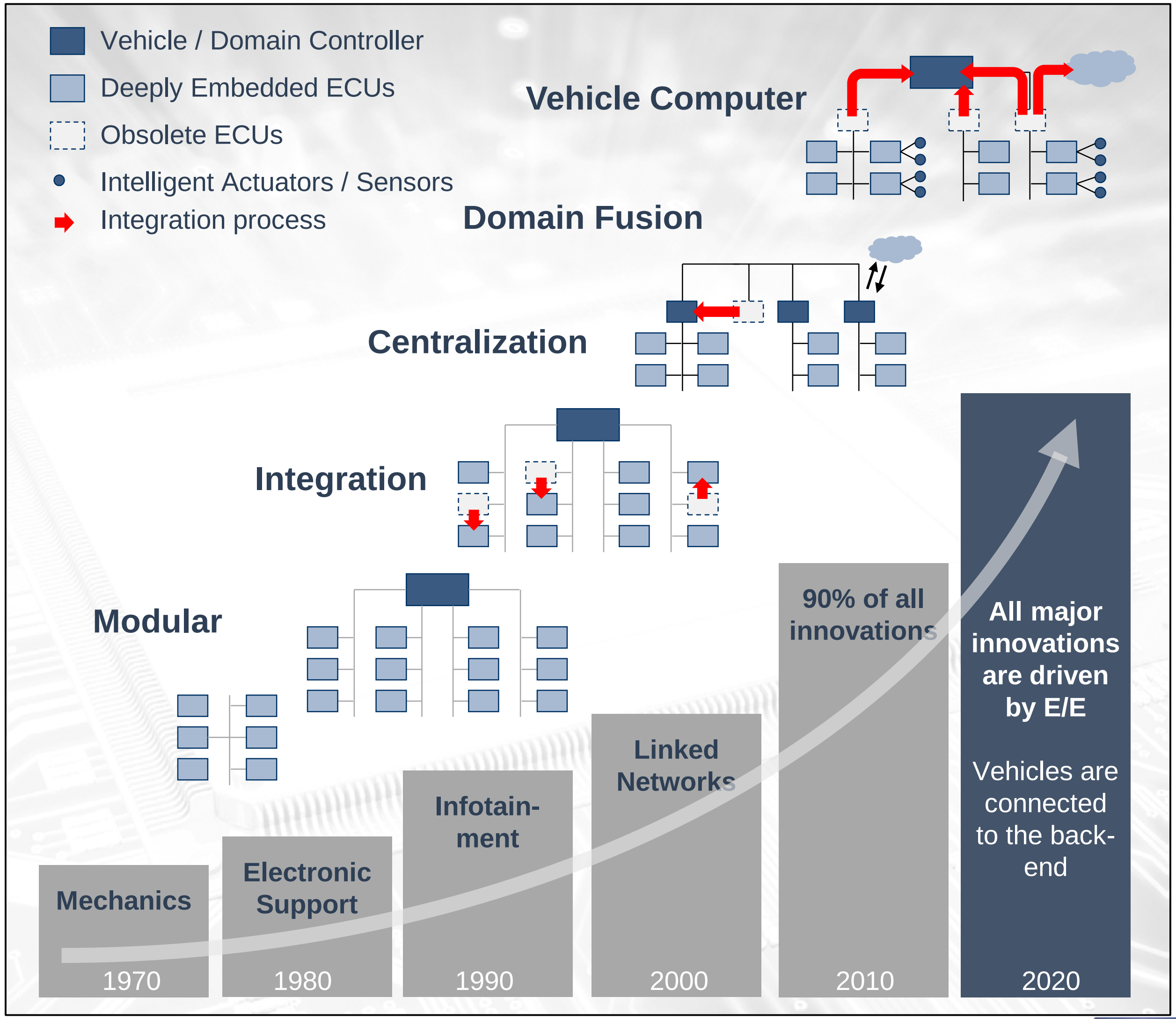
Standard architecture

- Enabling integration of different manufacturers’ software, in-house software development

Trends in E/E Architectures

- New types of in vehicle computers are required to fulfill the needs of
  - **Performance**,
  - **Flexibility** and
  - **Connectivity**

- But
  - **Backwards compatibility** with existing solutions,
  - Fulfillment of increasing requirements for **safety** and **security** is **a must** as well.

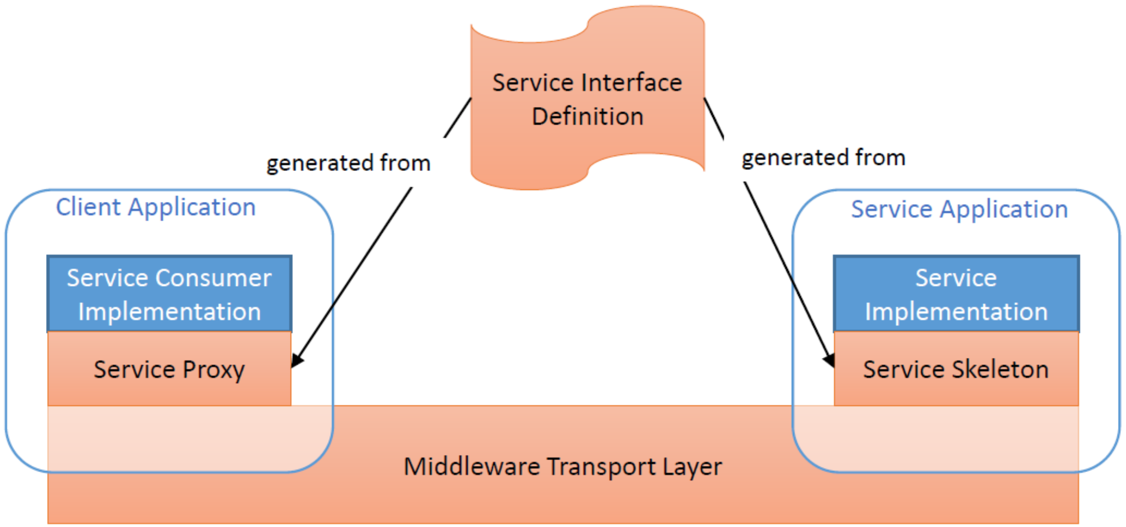


Future of mobility… Software driven

New Requirements
Integration with off-Board Software Systems
Secure Software Upgrades, Updates
Central control centers to process customer/ environment inputs and conditions
Integration of in-Vehicle Software Systems: Central Control, Smart Actuators and localized Sensor/Actuator Control with Security & Safety
Scalable power/ thermal technologies to efficiently run central computing centers

Capabilities and Technologies
Service-based communication
Connectivity to Industrial Internet with security framework
In-Vehicle Large Scale Software Integrations making use of new ECU HW technologies using modern SW languages
ECU Classifications: Central Compute, Integrated Control Units, I/O control Units
In-Vehicle High Speed Communication
ECU Hardware, Compute technologies, heterogeneous systems (Many-core, GPU, FPGA, Accelerators, etc.)
Evolutionary/ Revolutionary E/E Architecture to enable all of the above

What is SOA?



AUTOSAR standard 19-03

- Service oriented architecture defines a 'server' which is the provider for a service/data and a 'client' that subscribes to the desired service/data

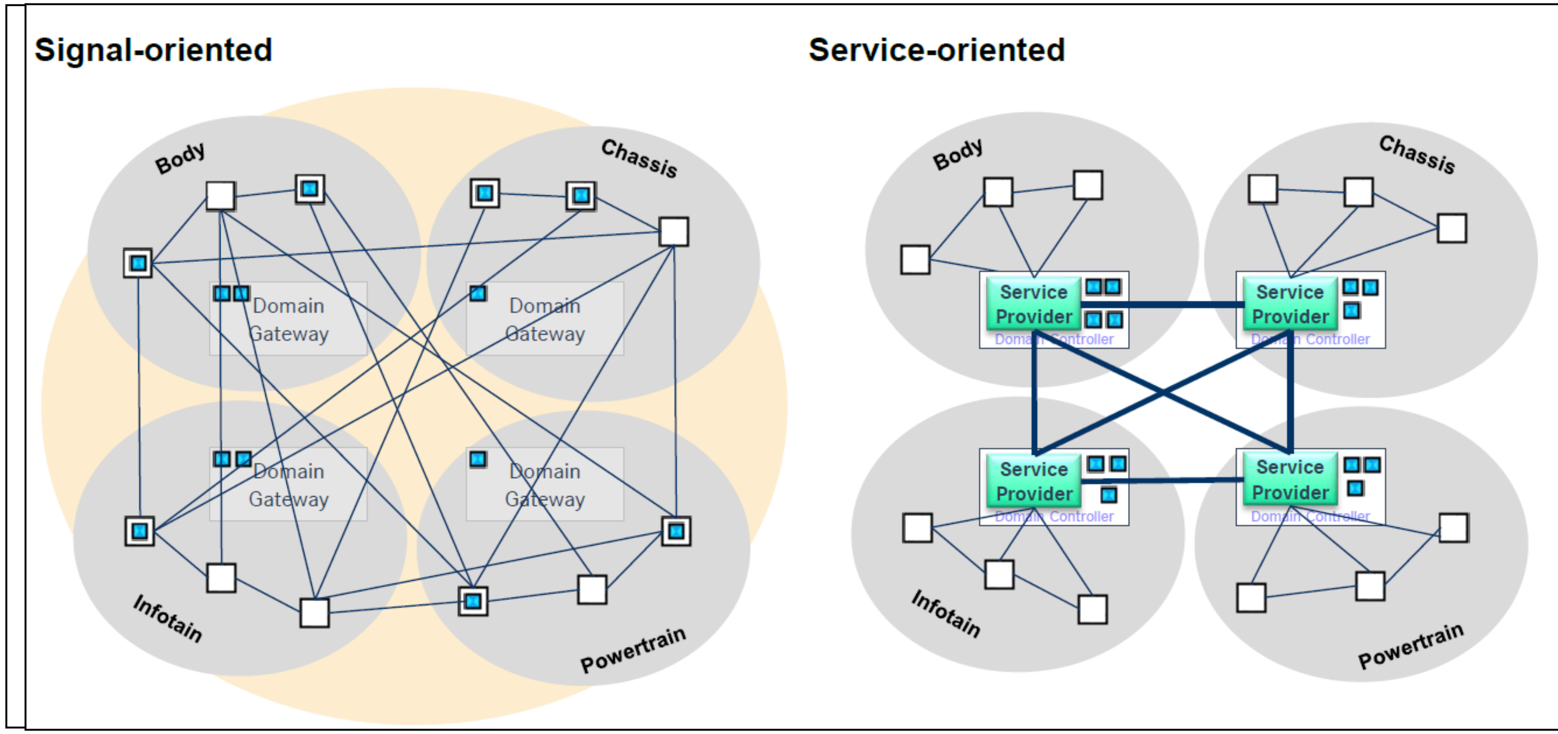
- SOA has been used for years in the IT industry for distributed systems
  - Players from IoT world such as Google, Amazon, pave the path to digitalization

- Applications are loosely coupled and communicate over a service bus as middleware

Signal vs SOA

Main reasons of adoption:

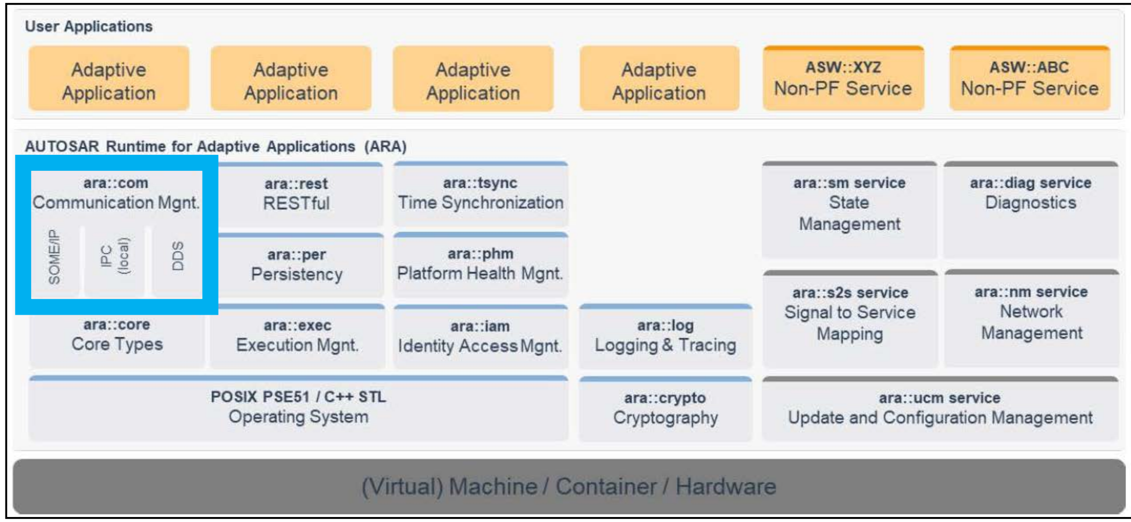
- Flexibility, scalability and reusability of code
- Partial updates of the system can be performed
- “Soft” migration scenarios are also possible



AUTOSAR Methodology- Robert Sakretz Nov. 2018

AUTOSAR Adaptive

AUTOSAR standard



- The standard contains interfaces required for developing auto- -motive ECUs running on state-of-the-art multicore microprocessors.
- With the Adaptive Platform, communication between software functionalities is no longer conducted in cyclic bursts, but is service-oriented.
- Lower-level communication is no longer based on CAN or other classic automotive bus systems, which use dedicated protocols, but on Ethernet.

Middleware: SOME/IP

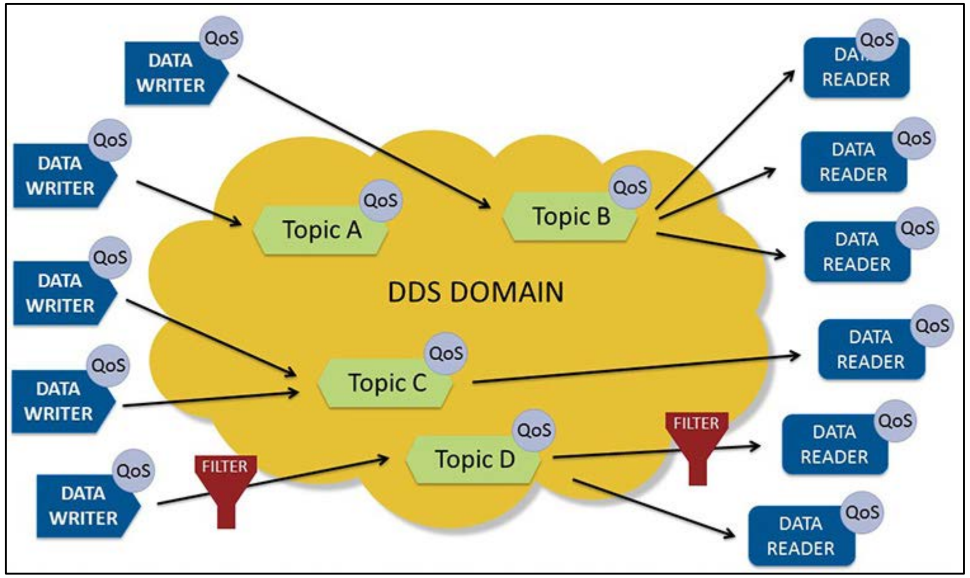
Middleware dynamically creates the connection between the service provider and service consumer at runtime – and not at system design time.

SOME/IP

- Serialization
- RPC
- Service Discovery
- Publish/Subscribe
- Segmentation of UDP messages

Designed to fit devices of different size, and different OS

Middleware: DDS



Reference: https://omg.org

- DDS (Data Distribution Service) targets the broader Industrial IoT domain.
- It is a family of open standards published by the Object Management Group (OMG).
- Was specifically designed for distributed real-time systems, and is used in many industries including transportation, energy, medical systems, industrial automation, aerospace and defense, etc.
- Uses Real Time Publish Subscribe (RTPS)
- Offers Quality of Service (QoS) mechanisms
- DDS was introduced as the network binding for ara::com

How to evaluate SOME/IP vs DDS as network binding for ara::com ?

Performance based evaluation

- End-to-end latency, throughput, jitter, CPU & memory usage

Functional evaluation

- Based on Quality of services(QoS) such as reliability, deadline, priority, ownership, content filters, etc., from DDS

Other factors:

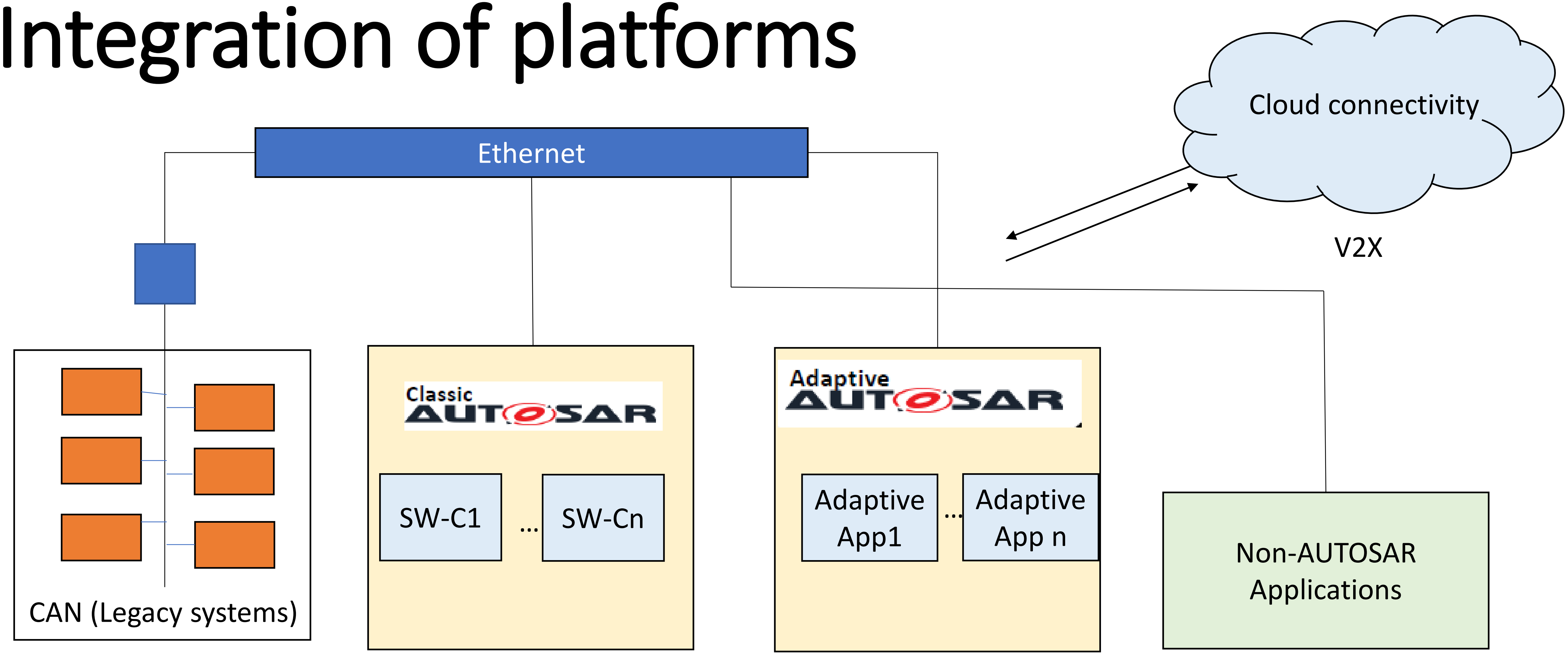
- Cloud connectivity
- Compatibility with legacy systems
- System design capability (toolchain and processes)

Sample use cases for performance based evaluation

Use case	Size	Sampling rate	Latency req.
Lidar	250B	10ms	10ms
Ultrasonic	100B	20ms	20ms
ADAS sensors	10KB	10ms	10ms
30fps Video- ADAS(100Mbps)	43KB	33ms	33ms
30fps Video- ADAS(1Gbps)	43KB	10ms	16ms
Raw 30fps Video- Automated driving (10Gbps)	6.9MB	33ms	33ms

Ref: Giancarlo Vasta, Lucia Lo Bello, TechDay 2018

Integration of platforms



SOME/IP Use cases include:
Communication between Classic and Adaptive
Signal to Service translation
Legacy systems

DDS Use cases include:
Cloud connectivity
Non-AUTOSAR applications
More robust Quality of Service mechanisms

Conclusion

Applications for automated driving, V2X demand **high computation** and **bandwidth**

Moving towards **Ethernet** and **SOA**-> Adaptive AUTOSAR

- Suitable for ADAS applications

SOME/IP and **DDS** as middleware for Adaptive AUTOSAR

Evaluation of SOME/IP and DDS can be based on performance, quality of service requirements, applicability.

DDS seems promising but we need experimental data to evaluate

- Also need to measure overhead of CPU and memory usage

Future Work

Quantitative and qualitative analyses with SOME/IP and DDS over ara::com

Network layer must be integrated with DDS QoS policies to enforce and synchronize time-based guarantees

Analyze the integration of DDS Ethernet-TSN to enable traffic shaping, priority scheduling, etc., based on application's QoS requirements

Questions?

IEEE Ethernet & IP @ Automotive
Technology Day 2019

Acknowledgments

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