What is the conqueror in the SOA platform for the future in-vehicle networks?

- A study based on JASPAR's automotive use cases -

Japan Automotive Software Platform and Architecture

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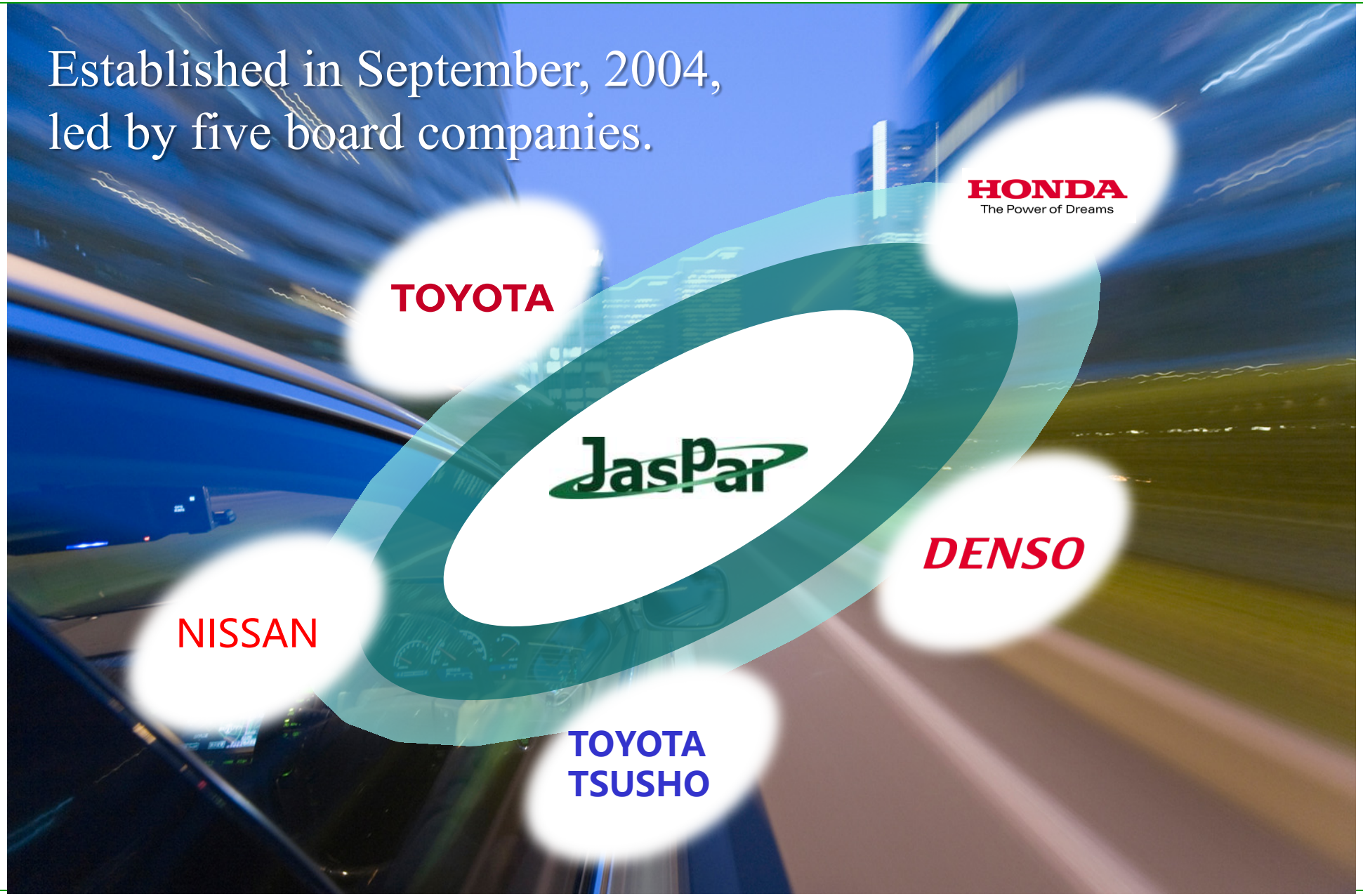
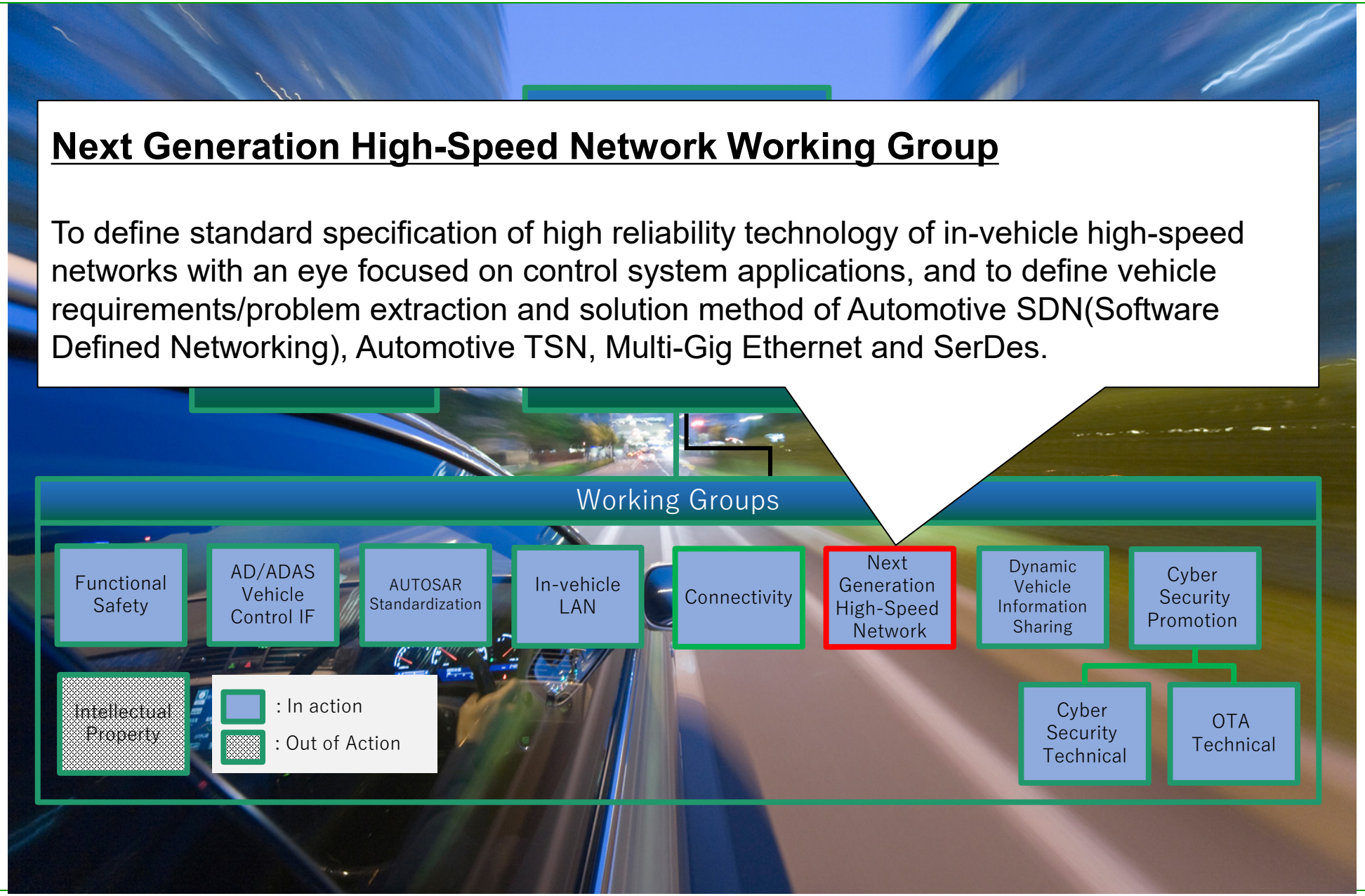
Introduction : About JASPAR



Introduction : Next Generation High-Speed Network Working Group



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- Objectives
- Survey of the SOA protocols
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- Candidates of SOA conqueror
- Conclusions
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Background

- To realize CASE, much more software resources will be required than ever.
- **SOA** based on Ethernet/IP technology is attention–getting since software reuse and function addition/update can be achieved easily.
- While multiple candidates of SOA platform exist, we do not know ***what is the conqueror in the SOA platform?***
- Can **SOME/IP**, which is designed for local automotive networks, adapt the Connected application?
- Can **DDS** and REST, which are proven in the consumer market, be applied to the automotive network?

Objectives

For these reasons, we did the benchmark SOME/IP and DDS by comparison, to clarify the conqueror in the SOA platform for the future in-vehicle networks.

1: Desk research and analysis of the both protocols

2: Clarification of the advantage and disadvantage in terms of QoS and Security based on the given use cases?

In addition, the use cases noted above are referred from the Next-Generation E&E architectures proposed by JASPAR.

Leading the conqueror of automotive SOA platform based on the results of JASPAR's research

Survey of the SOA protocols : SOME/IP

■SOME/IP (Scalable service-Oriented MiddlewarE over IP)

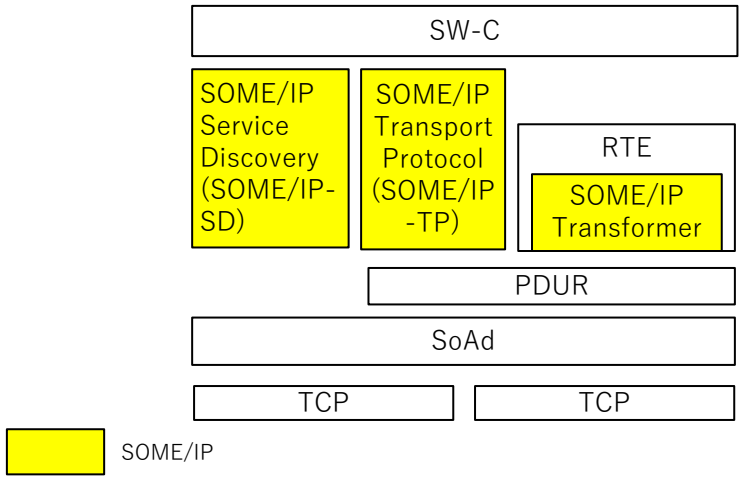
- It is an **Automotive**/embedded protocol proposed by BMW.
- It has high compatibility and features applicable for various platforms.
- It can be implemented at **Low Cost due to Light Weight.**

■Feature

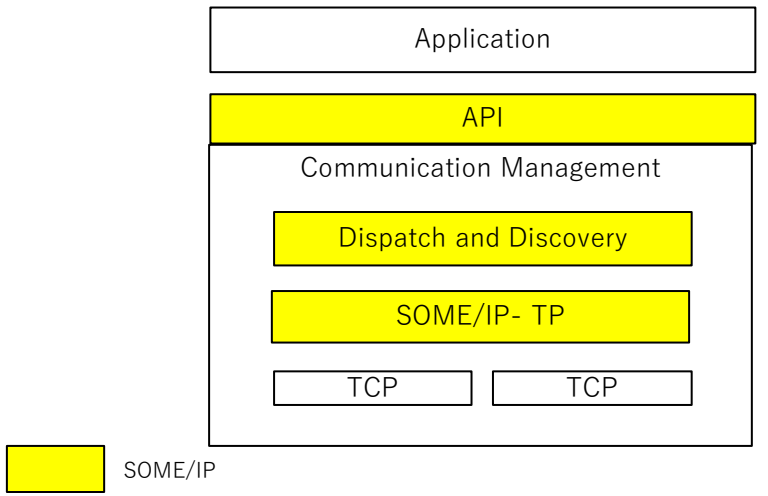
- Serialization
- Remote Procedure Call (RPC)
- Service Discovery
- Publish/Subscribe
- Segmentation of Large SOME/IP Message on UDP

■AUTOSAR

- It is defined as part of the BSW module in the AUTOSAR Classic Platform.
- It is unified into Communication Management in the AUTOSAR Adaptive Platform.



Software Architecture in AUTOSAR Classic Platform



Software Architecture in AUTOSAR Adaptive Platform

Survey of the SOA protocols : DDS

■DDS （Data Distribution Service）

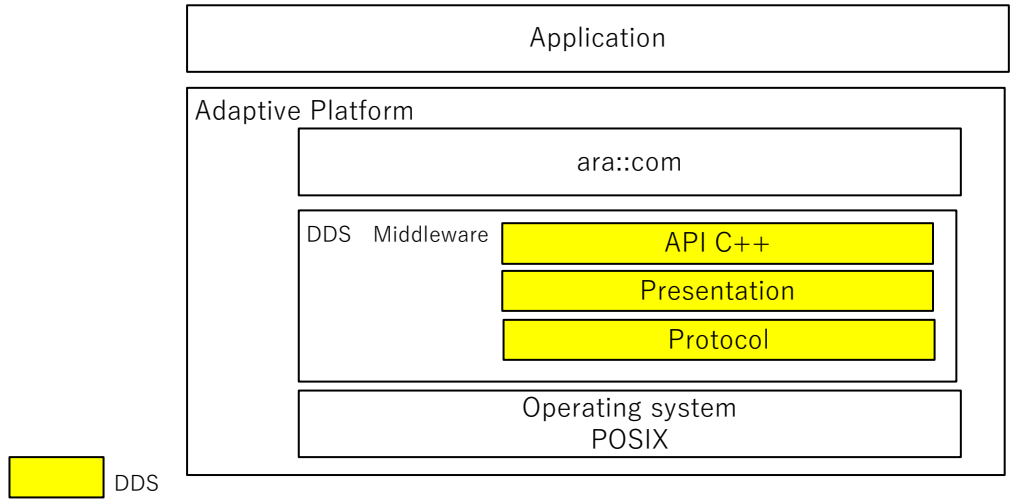
・This realizes a service-oriented architecture in distributed systems; API (Application Programming Interface), and middleware.
・It is an open standard published by the Object Management Group (OMG)
・It is optimized for large consumer Internet of Things (IoT) and is highly reliable and scalable.
・It is used in various fields such as **aviation and railway control networks**.

■Feature

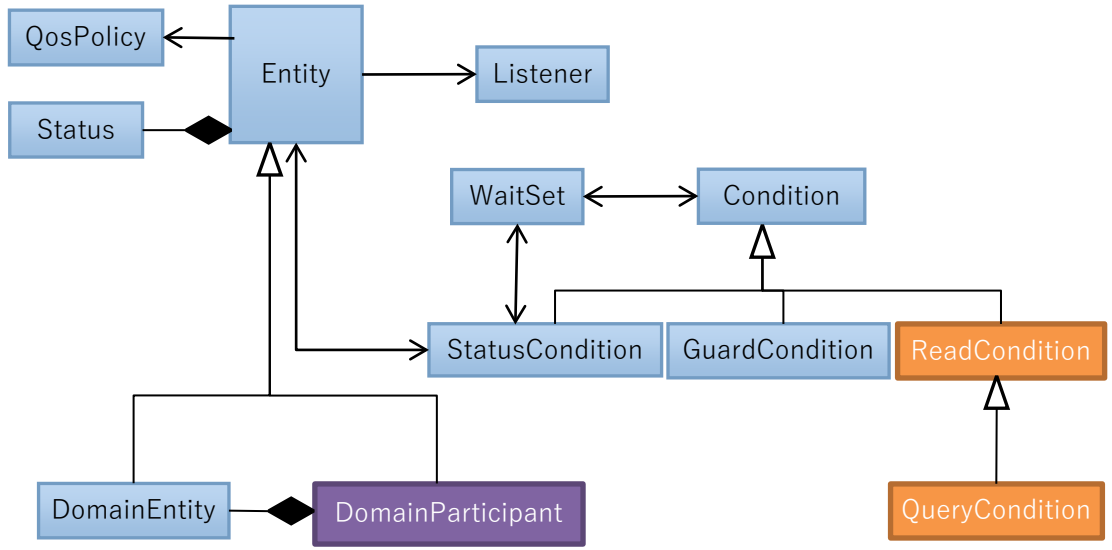
・Remote Procedure Call
・Publish/Subscribe
・**Quality of Service (QoS) for reliability and real-time performance**
・Method is defined in the lower layers of DDS

■AUTOSAR

・ara::com's API is mapped to an API defined as DDS middleware

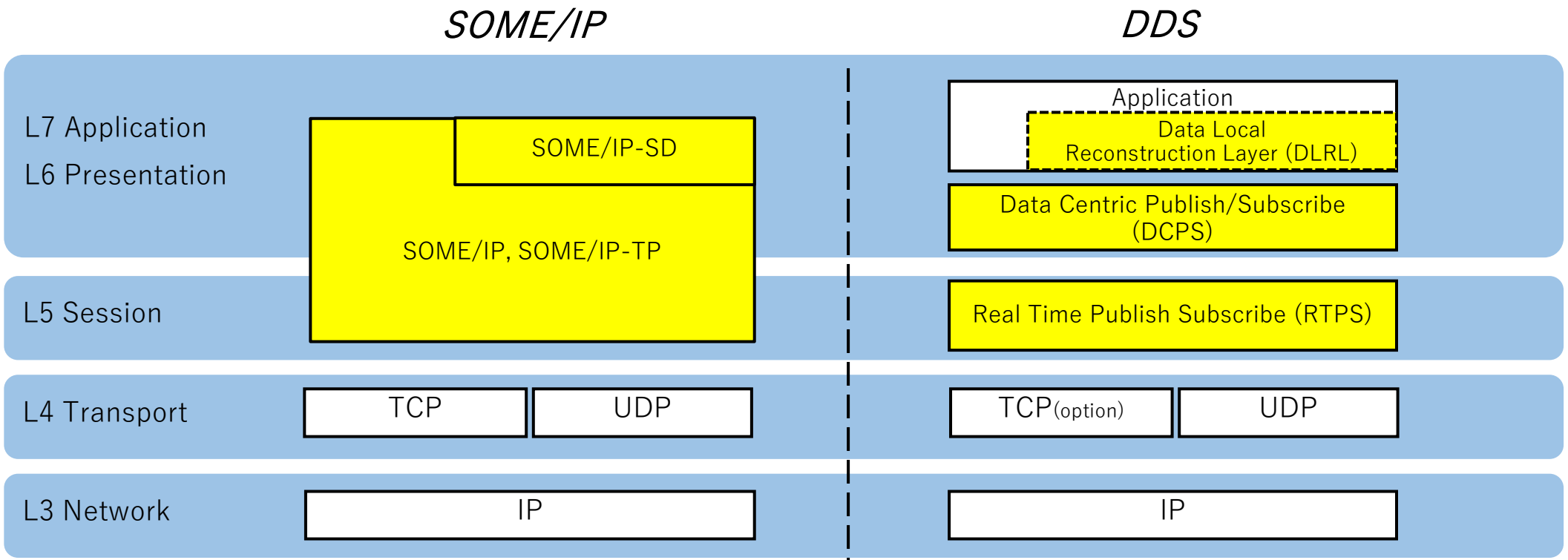


Software Architecture in AUTOSAR Adaptive Platform



Infrastructure module

Survey of the SOA protocols : Protocol stack



- L5-L7
- Lower layer is TCP/UDP

- L5-L7
- DCPS realizes Public/Subscribe communication and provides it to applications as middleware
- Lower layers of RTPS use UDP, but TCP is also available as an option

DDS's abstraction layer has the functionalities for the application layer. SOME/IP also does.

Survey of the SOA protocols : AUTOSAR Release

SOME/IP and DDS related AUTOSAR documents

ID	Document Title	Classification	SOME/IP	DDS
616	Specification of Service Discovery	CP	✓	
660	Specification of SOME/IP Transformer	CP	✓	
696	SOME/IP Protocol Specification	FO	✓	
716	Requirements on Communication Management	AP	✓	
717	Specification of Communication Management	AP	✓	✓
800	Requirements on SOME/IP Protocol	FO	✓	
801	Requirements on SOME/IP Service Discovery Protocol	FO	✓	
802	SOME/IP Service Discovery Protocol Specification	FO	✓	
809	Specification on SOME/IP Transformer Protocol	CP	✓	
846	Explanation of ara::com API	AP	✓	✓

FO : AUTOSAR Foundation
CP : AUTOSAR Classic Platform
AP : AUTOSAR Adaptive Platform

SOME/IP is ahead of AUTOSAR support, and DDS is also catching up

SOA Protocol : security

	SOME/IP	DDS	Remark
User Authentication	-	DDS Security	This feature is out of scope as automotive applications.
Digital signature	-	DDS Security	This feature is out of scope as automotive applications.
Access control	ara::com	DDS Security	Provided
Encryption	IPSec, TLS	DDS Security	provided
Message Authentication	SecOC, IPSec, TLS	DDS Security	provided
logging	AUTOSAR R20-11 IDSM	DDS Security	provided

■SOME/IP

Security function is not included in SOME/IP. Need to be used in combination **with other general technologies**, e.g., Standard Ethernet and TCP/IP, AUTOSAR modules.

■DDS

DDS Security includes a set of security functions.

Survey of the SOA protocols : Protocol summary

	SOME/IP	DDS
Application	- Automotive	- IoT, aviation, railway control network, etc.
AUTOSAR	- AUTOSAR CP - AUTOSAR AP	- AUTOSAR AP
OSI Layer	- Layer5-7	- Layer5-7
Communication model	- RPC - Publish / Subscribe	- RPC - Publish / Subscribe
Reliability	- Detect delays, losses, iterations, and replacements	- QoS policy “RELIABILITY”
Redundancy	- Multiple Providers. - Distributed method of SOME/IP Service Discovery	- Implementation requirements
Real time	- To meet real-time requirements	- QoS Policy.
Security	- Not contain security - Use other general technologies	- Authentication, access control, encryption, digital signatures, etc.

Benchmark of QoS

SOME/IP and DDS application examples are shown for traffic types

Traffic Type	Periodic /Sporadic	Criticality	Frame size	L7-L5 (example)	L4	L3	Required against L2			SOME/IP	DDS
							Bandwidth	Latency	Loss		
Safety-relevant Control	Periodic	Urgent	64	Driving command application to vehicle systems	TCP/UDP	IP	Low	Low	Low		✓
Safety-relevant Media	Sporadic	Urgent	MTU	Communication between ADAS ECUs and View cameras, radars, and sensors	UDP	IP	High-Middle	Low	Low		✓
Network Control	Periodic	Minimal	64	Topology discovery, network redundancy, MAC address acquisition	-	-	Low	Large	High	✓	✓
	Sporadic	Critical	64	Time synchronization (802.1AS)	UDP	IP	Low	Low	Low		✓
Event	Sporadic	Medium	64	Alarms for less critical L2 switches, etc.	N/A	nonIP	Low	Middle	Low	✓	✓
		Urgent	64	Emergency earthquake bulletins, etc.	UDP	IP	Low	Low	Low		✓
		Minimal	64~MTU	Nearby facility information, etc.	TCP		Low	Large	High	✓	✓
Safety-irrelevant Control	Periodic	Medium	64~MTU	L2 Switch logs, etc.	N/A	nonIP	Middle	Middle	Middle	✓	✓
		Serious	64	Control signals for doors, air conditioners, lights, etc.	UDP	IP	Low	Middle	Middle	✓	✓
		Serious	64~MTU	Various sensor information such as fuel gauge and interior temperature	TCP		Low	Large	High	✓	✓
Safety irrelevant Media	Periodic	Critical	64~MTU	Video and audio to assist driving	UDP	IP	Middle	Low	Middle		✓
		Medium	64~MTU	Infotainment	UDP	IP	High- Middle	Middle	Middle	✓	✓
Best Effort	Sporadic	Serious	64~MTU	Software Updates Over The Air (SOTA), Firmware update Over The (FOTA)	TCP	IP	Middle	Middle -Large	High	✓	✓
	Periodic	Medium	64	Periodic logging	TCP/UDP	IP	Low	Middle	Middle	✓	✓
	Sporadic	Medium	64~MTU	A periodical logging / diagnostics	TCP/UDP	IP	Low	Middle -Large	High	✓	✓
	Sporadic	Minimal	64~MTU	Internet access	TCP	IP	Middle	Middle -Large	High	✓	✓

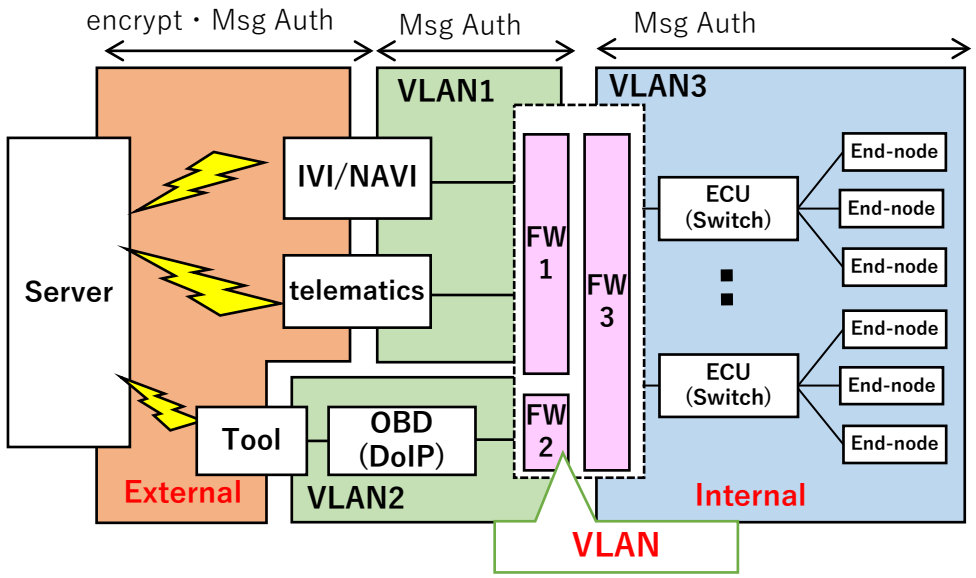
DDS with QoS Profile is a candidate when real-time is required

Benchmark of Security

Consideration for security capability of SOME/IP and DDS for defense in depth.

JASPAR has defined security requirements for in-vehicle Ethernet.
→Need to be applied security protocols or technology according to the requirements, for each layer.

■Security Architecture



Layer class :External, VLAN, Internal

■ Security requirements and capability of SOA protocols

Layer	Requirements	SOME/IP	DDS
External	・server and device authentication ・data encryption	・Use TLS for encryption and authentication. ・There are some problems for authentication of Service Discovery.	DDS have user authentication and encryption.
VLAN	・network inspection ・ACL ・Message Authentication ・VLAN filters	・There are some problems for Service Discovery between another VLAN. ・AUTOSAR has access control , and logging. ・VLAN filters are Standard Ethernet. ・Message Authentication Code(MAC) is enabled by IPSec or SecOC.	・DDS has logging, filtering ,access control, and message authentication. ・VLAN filters are Ethernet Standard specification.
Internal	Message Authentication	・Message Authentication Code(MAC) is enabled by IPSec or SecOC.	DDS has ,massage authentication.

・For external communication: DDS with authentication at service layer is a potential candidate.
・For internal communication： SOME/IP with MAC authentication is necessary and sufficient condition.

Candidates of SOA conqueror

SOME/IP

- Advantages
  - Many achievements in automotive
    - SOME/IP supports AUTOSAR and has been defined from a (current) automotive viewpoint.
  - Light-weight protocol
    - SOME/IP can be implemented at low cost.
    - Many devices will utilize SOME/IP.

- Requirements
  - QoS and security guarantee
    - To support QoS or Security, SOME/IP must be combined with the other frameworks.
    - By combining SOME/IP with the other frameworks, the cost of in-vehicle design will increase.

Candidates of SOA conqueror

DDS

- Advantages
  - Support of QoS and Security
    - DDS includes a framework to guarantee QoS and security.
      (However, actual QoS guarantee requires QoS controls, such as IEEE 802.1TSN)
  - Many achievements in industry automation and so on.
    - Good knowledge can be benefited by other fields.

- Requirements
  - Achievement in automotive field
    - We have no knowledge of DDS in automotive field.
  - Correspondence to AUTOSAR
    - We must consider adapting DDS to the existing automotive protocols.
  - Application Programming Interface for automotive design
    - It is necessary to sophisticate the API more.

Conclusions

- According to the JASPAR's use cases, DDS is a strong candidate of SOA platform from a viewpoint on QoS requirements.

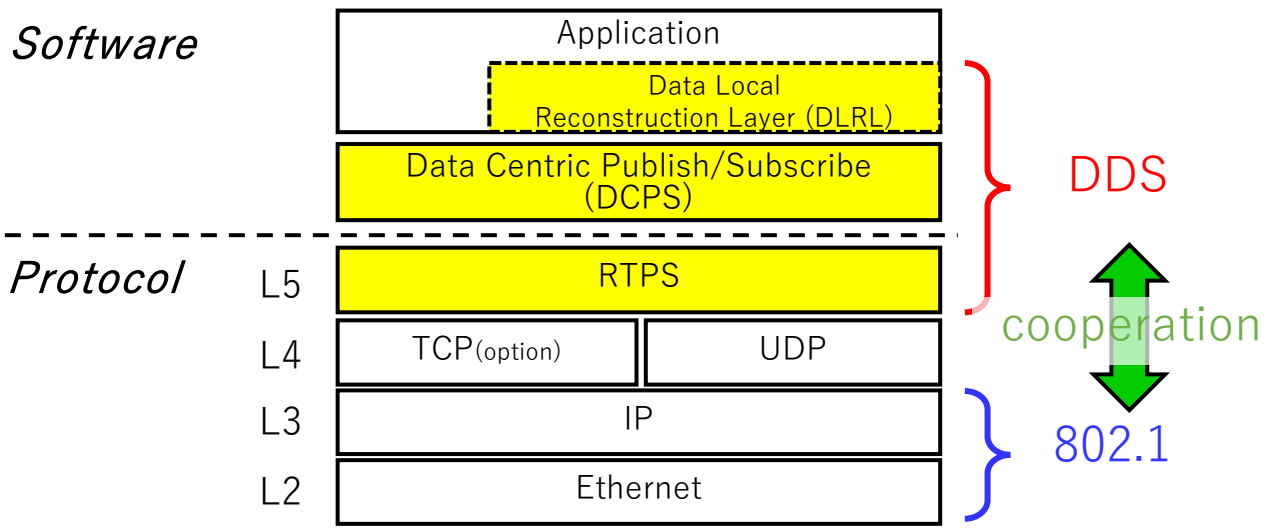
- According to the JASPAR's benchmark, from a viewpoint of security requirements, DDS is suitable for connected because of the easiness of implementation, but SOME/IP is adequate for in-vehicle communications because of the achievements.

- **Requirements to be a conquer of SOA protocol:**

  SOME/IP: **Support to both of QoS and security**

  DDS: **Many achievements in automotive field,**
  Correspondence to AUTOSAR,
  API for in-vehicle Ethernet

Future work 1



DDS provides the framework of QoS, but doesn't show how to implement it. SOME/IP doesn't even have a framework to support QoS.

To meet QoS policy required by DDS, we need to **cooperate with lower layers defined in IEEE 802.1** and implement each protocol appropriately. This is a common issue for SOA protocols, not just for DDS.

Example of QoS policy supported by DDS

QoS Policy	Overview
DEADLINE	QoS attribute for DataWriter. DataReader expects a new sample updating the value of each instance at least once every DEADLINE period.
LATENCY_BUDGET	Tips on the maximum acceptable latency between writing by DataWriter and receiving by the application. Usage is not defined.
LIFESPAN	DataWriter indicates the maximum duration of validity of the data. DataReader decides whether pass the data to application based on LIFESPAN.
DESTINATION_ORDER	Controls the criteria used to determine the logical order among changes made by Publisher entities to the same instance of data. BY_RECEPTION_TIMESTAMP or BY_SOURCE_TIMESTAMP

Future work of JASPAR

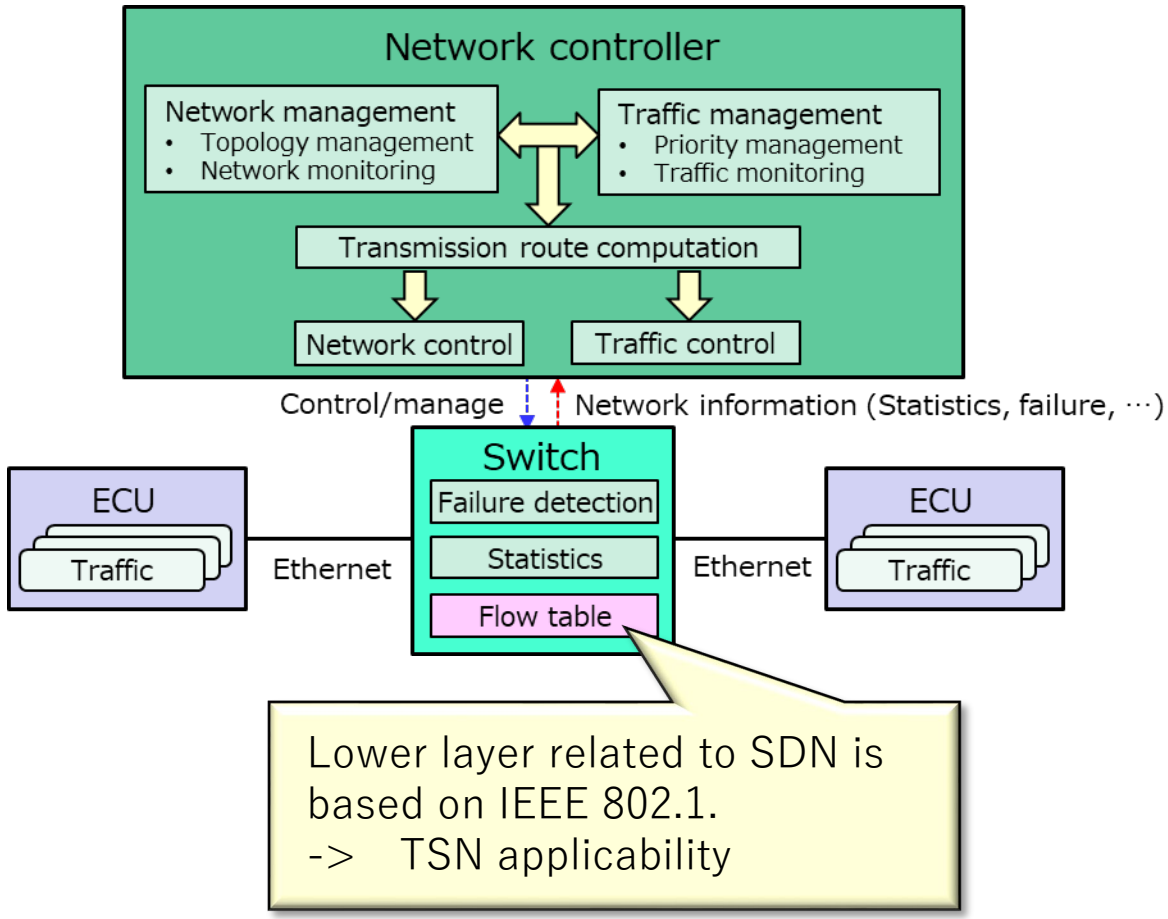
To complement the advantage of SOA protocols, we study how to apply **TSN automotive profile of IEEE P802.1DG**.

(Example) Use the shaper defined by Qav/Qbv to meet the QoS policy.

Future work 2

The introduction of SOA platform makes in-vehicle services frequent updates with ease (including additions and deletions). With the service update, it is necessary to flexibly change the related network settings (QoS, bandwidth, routing, etc.).

In-vehicle SDN (Software Defined Networking) that enables dynamic network changes is expected.



Future work of JASPAR

We study requirements, architecture and realization method for **in-vehicle SDN** (effective use of TSN, coexistence with SOA protocols, etc.).

(Example)
- Feasibility study of applying TSN
- Which TSN protocol can be subject to SDN configuration changes

Future work will contribute to TSN automotive profile of IEEE P802.1DG.

Thank you for your kind listening.