Proposal of Dynamically Configurable In-Vehicle Network as an Enabler of Software Defined Vehicle

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JASPAR Next Generation High-Speed Network WG
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Established in September, 2004, led by five board companies.
Next Generation High-Speed Network Working Group

To define standard specification of high reliability technology of in-vehicle high-speed networks with an eye focused on control system applications, and to define vehicle requirements/problem extraction and solution method of Automotive SDN (Software Defined Networking), Automotive TSN, 10Gb/s class Ethernet and SerDes.
Introduction: 3 Presentations From JASPAR

All layers are covered

**OSI REFERENCE MODEL LAYERS**

7. APPLICATION
6. PRESENTATION
5. SESSION
4. TRANSPORT
3. NETWORK
2. DATA LINK
1. PHYSICAL

Next Generation High-Speed Network Working Group

WG is composed by 4 teams and 2 sub-teams

Next Generation Technology Study Team

**SDN Sub-Team**

Next Generation Technology Study Team

**Next Gen. Physical Layer Sub-Team**

Team Composition of Next Gen. High-Speed Network WG

- **Automotive SDN**
  Proposal of Dynamically Configurable In-Vehicle Network as an Enabler of Software Defined Vehicle

- **Ethernet TSN**
  A study of Ethernet TSN profile based on JASPAR’s automotive use cases

- **Optical Physical Layer**
  Concept of test points in in-vehicle optical physical layer standardization for multi-vendorization

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Contents

• Concept of JASPAR SDV
• Automotive SDN as a SDV network
• Mechanism and Functions of Automotive SDN
• Use Cases of Automotive SDN
• Requirements of Automotive SDN
• Future Work
JASPAR has recognized the need to incorporate SDN into the automotive network early. The application of SDN to in-vehicle networks is finally becoming a reality. Furthermore, a new concept of Software Defined Vehicle is emerging and attracting attention now. We'd like to show that SDN will be even more necessary for in-vehicle networks in the SDV era. Hopefully, this presentation will accelerate broader discussion and standardization.

- We first discuss what should the network look like for SDV?
- We then propose JASPAR's vision of Automotive SDN as an enabler for SDV.
The Concept of JASPAR’s SDV

JASPAR’s SDV (as an evolution of OTA)
• Control according to the context
• Autonomous control (even if not connected to the cloud)
• Respond in a short time
• Changes in services and functions according to user requests

Functional Evolution with OTA

Dynamic Configurations according to the context

★: Feature

The concept of JASPAR’s SDV

<Example of dynamic configurations>
• Mom or Dad
• Highway or public road.
• Pay and provide service immediately
• Subscribe, PnP
To realize the JASPAR’s SDV, the Network should be as follows:

◆ The Network should have a mechanism that changes the network according to the context.

◆ The Network should be changed with sufficient immediacy to ensure the services. (Ex: in milliseconds)

◆ The Network doesn’t need the connection to the cloud every time.

We call this new network as an enabler of SDV "Automotive SDN"
802.1Qcc model ⇒ High affinity to TSN

SDN model

CUC
User/Network Interface

CNC
Network Management Protocol

Switch Switch Switch

Management Plane

Northbound Interface

Controllers
East/Westbound Interface

Southbound Interface

Switches
Data Plane

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Definition of Automotive SDN by JASPAR

**Example of SDN definition** *

SDN is a network architecture where (1) forwarding is decoupled from network control and (2) there is more freedom of choice in programming the forwarding logic.

**JASPAR’s definition**

**JASPAR’s SDN** is a network architecture where forwarding is decoupled from network control and there is more freedom of choice in programming the forwarding logic for in-vehicle networks; it can realize dynamic configuration.

Basic mechanism of Automotive SDN

Since Automotive SDN controller has to control the network autonomously according to the context and demands, we need such a dynamically configurable network.

SDN activation scenario

1) Determination of the context
2) Comparison of the context with the current situation
3) Selection the optimal configuration
4) Create the change schedule
5) Synchronization of in-vehicle systems
6) change the network configuration

1. Dynamic Routing
2. Blocking
3. Flexible Redundancy
4. On-demand Bandwidth allocation
Examples of SDN Functions

1. Dynamic Routing

2. Blocking

3. Flexible Redundancy

4. On-Demand BW Allocation
Use Case (OTA only)

Parking

- Stops
- Program Update
- PnP
Use Case (OTA & SDN)

Parking
- Stops
- Program Update
- PnP

Manual driving
- Driving on public roads

Automatic driving
- Switch to automatic driving on highways.

Goal (Eco-driving)
- Arrive at eco-driving depending on battery level

Failure
- Failure detection and Functional restriction

Security
- Detection of unauthorized access

Detection of unauthorized access

- Network table change
- CB setting enabled

Failure
- Network table update
- Hardware failure

Security
- Network table update or Configuration by Qci

Goal (Eco-driving)
- Network table update or Configuration by Qci

Manual driving
- Driving assist

Automatic driving
- Qav, Qbv configuration change

Parking
- - Qav, Qbv configuration change
Use Case (OTA & SDN) Architecture

MoM: Manager of Managers
Use Case (OTA & SDN) Architecture

OTA master (Communication Module)

MoM: Manager of Managers
Use Case (OTA & SDN) Parking

< Context >
Stop
OTA
Battery driven

< Network configuration >
Efficiency & Power Saving
OTA Support Mode

SDN Requirement
1) The mechanism to change the networks according to the context is required
Use Case (OTA & SDN)  Manual driving

< Context >
Normal state
(vehicle speed ≥ 0)

< Network configuration >
Default mode

SDN Requirement
-
Use Case (OTA & SDN) Automatic driving

< Context >
Automatic Startup on highways

< Network configuration >
Automatic driving Mode

SDN Requirement
1) The mechanism to change the networks according to the context is required
2) To realize sufficient immediacy, the SDN controller should be mounted in the car.
Use Case (OTA & SDN) Security

< Context >
Security Attack Detection

< Network configuration >
Defense Mode

SDN Requirement
1) The mechanism to change the networks according to the context is required
3) Based on the current context, the SDN controller should perform autonomously.
Use Case (OTA & SDN)  Failure

< Context >
Fault Retraction

< Network configuration >
Fault Retraction Mode

SDN Requirement
1) The mechanism to change the networks according to the context is required
2) To realize sufficient immediacy, the SDN controller should be mounted in the car.
Use Case (OTA & SDN) Goal (Eco-driving)

< Context > Eco-driving

< Network configuration > Energy Saving Mode

SDN Requirement
1) The mechanism to change the networks according to the context is required.
SDN requirements based on use cases

Based on our investigation of the use cases, we clarified some requirements as follows,

1) The mechanism to change the networks according to the context is required.
   ✓ Re-Configure the TSN parameters will be an effective method.

2) To realize sufficient immediacy, the SDN controller should be mounted in the car.
   ✓ Synchronization and Simultaneity will be required further.

3) Based on the current context, the SDN controller should perform autonomously.
   ✓ External vehicle communication is not always possible.

We propose some requirements of "Automotive SDN". Further investigation is needed to clarify all the details.
Harmonize with TSN

Two types of SDN to be considered

• **TSN by SDN** (Control TSN parameters by SDN)
  • Bandwidth allocation (Qav, Qbv, Qcr, ?)
  • Block (Qci, ?)
  • Redundancy (CB, ?)
  • Dynamic Routing (Qci, ?)

• **TSN for SDN** (TSN’s requirements for SDN)
  • Synchronization and Simultaneity (AS, Qav, Qbv, ?)
  • Platform (Qcc, ?)

We will propose TSN by/for SDN to IEEE 802.1DG
Conclusion

SDV needs Automotive SDN.

It would be fine if there was SDN instead of just OTA.

Future Works:
• Security
• Architecture
• Protocols
• Evaluation

We would like to call for positive and wide-ranging discussions and wholesome standardization.
If you want to create Automotive SDN, discuss with JASPAR!

Thank you for your kind listening.