Overview of TSN use cases

JasPar

Japan Automotive Software Platform and Architecture

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Objective

- Provide use case study examples to create the Automotive Profile.
  - ✓ Create use cases
  - ✓ Extract Requirements
  - ✓ Profiling

We are here

	Use cases from JASPAR
UC1	Connected-Car with 5G network
UC2	Functional Safety
UC3	Real-time communication
UC4	Security
UC5	Automotive In-Vehicle Traffic Types
UC6	Achieve FlexRay features

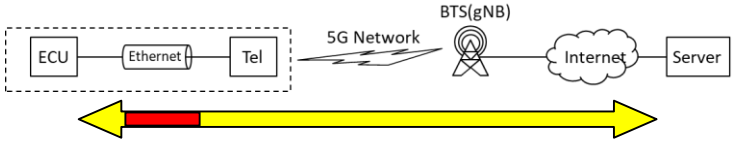
UC1. Connected-Car with 5G network

- Use case and Requirements for Connected-Car with 5G network technology (3GPP Rel15)

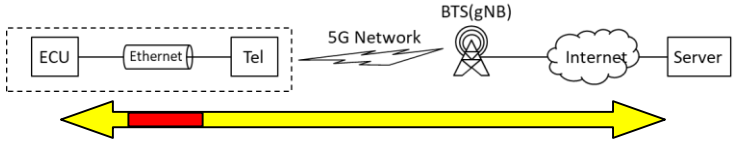
Specification of 5G Network

	Data rate (5G Network)	Latency (5G Network)	Reliability (5G Network)
5G (Sub 6GHz)	Depends on Category	< 1ms	99.999 %

Use case defined in 3GPP TS 22.261 V15.8.0 (2019-09) (Rel.15)
" 7. Performance Requirements "



Scenario	Max-allowed E2E Latency	Reliability	User experienced Data rate
ITS Infrastructure backhaul	30ms	99.999%	10Mbps



Scenario	User experienced Data rate
5 Dense Urban	DL: 300Mbps UL: 50Mbps
6 Broadcast like service	DL: 200Mbps UL: n/a
8 High Speed Vehicle	DL: 50Mbps UL: 25Mbps
(Ref) 3 Indoor hotspot (*1)	DL: 1Gbps UL: 500Mbps

*1 : Not vehicle relevant use case, but can be hotspot in vehicle

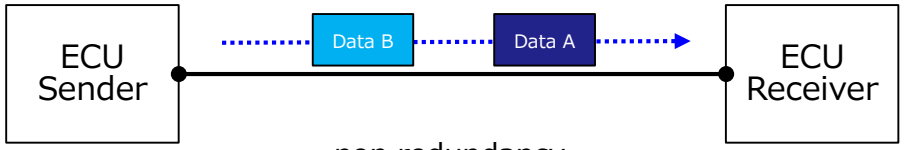
Requirements defined for In-Vehicle Network (Ethernet) (Draft)

5G Scenario for Vehicle	Latency	Reliability	User experienced Data rate
ITS Infrastructure backhaul (*2) 5 Dense Urban (*3)	?? ms (*2)	100% ? (*2) with redundant NW?	DL: 300Mbps UL: 50Mbps (*3)

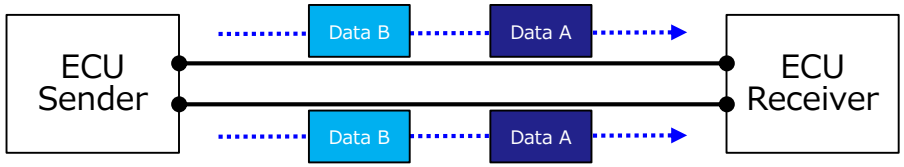
UC2. Functional Safety

- Extracts from ISO 26262-5:2018, Annex D, TableD.6－Communication Bus

Safety mechanism/ measure	Typical diagnostic coverage considered achievable	Notes
Complete hardware redundancy	High	Common mode failures can reduce diagnostic coverage
Transmission redundancy	Medium	Depends on type of redundancy. Effective only against transient faults

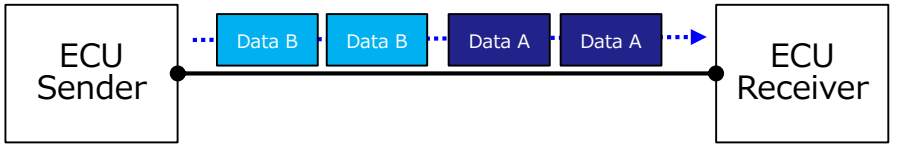


non redundancy



Complete hardware redundancy

Aim:
To detect failures during the communication by comparing the signals on two buses.
Description:
The bus is duplicated and the additional lines are used to detect failures.



Transmission redundancy

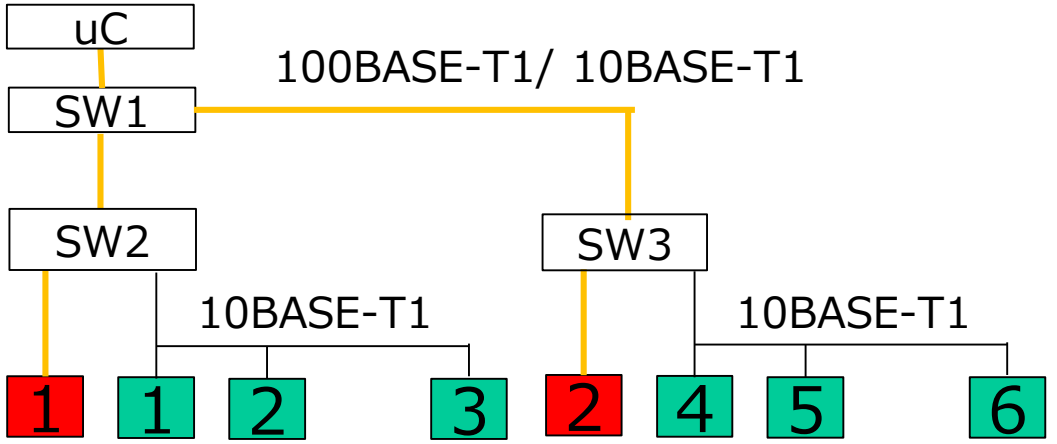
Aim:
To detect transient failures in bus communication.
Description:
The information is transferred several times in sequence.

802.1CB may be able to achieve **High/Medium diagnostic coverage**.
Considering application of TSN standards for Functional Safety.

Example network of real-time communication

1 Time-triggered ECUs
periodically transmits frames to uC.

1 Event-triggered ECUs
transmits frames to uC on demand.



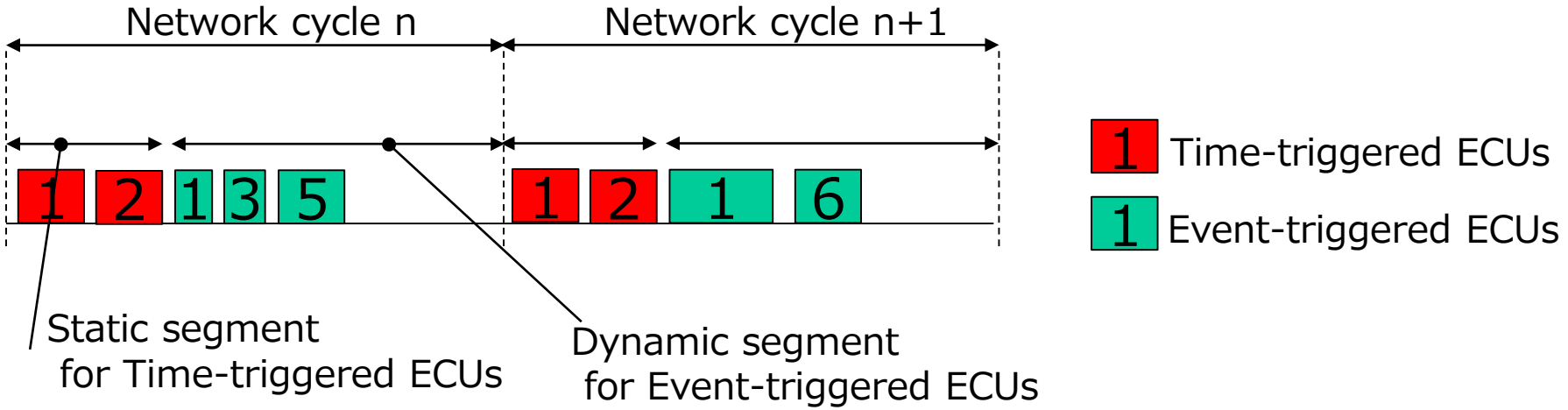
Requirements

Characteristics	Requirement
Network cycle	1 ms to 100ms
Bounded latency	100μs to 1ms
Network diameter	2 to 3
Link speed	10Mbps to 1Gbps
Number of devices	8 Time-triggered ECUs 16 Event-triggered ECUs

Useful aspects of TSN

Requirement	Function	Standard
Periodic traffic Bounded low latency	Clock synchronization	802.1AS
	Scheduled traffic	802.1Q 8.6.8.4 : Qbv
Traffic classification	TCP/IP-based stream identification	802.1 CBdb
	Ingress Policing	802.1Q 8.6.5.1 : Qci
Configuration		802.1Qcc, 802.1ABcu etc.

Example of traffic scheduling

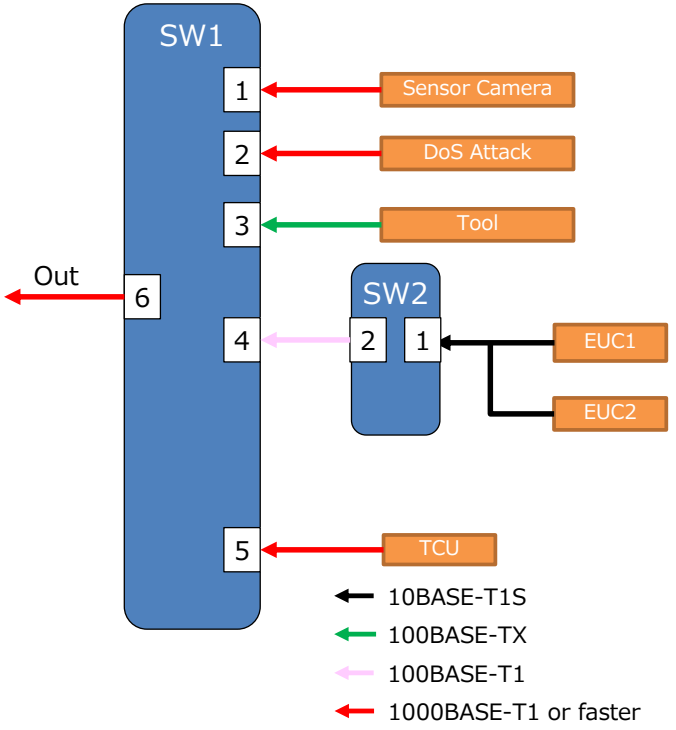


UC4. Security

- Goal
  1. Define an IVN profile which can provide protection of high priority traffic
  2. Ensure low latency with this IVN profile for ECUs communication(Scheduled Traffic) against DDoS attacks
  3. Detect DDoS attacks immediately and protect the IVN and ECUs from them

- Potential Security Issues
  1. DDoS attacks bring bandwidth exhaustion and disturbances to traffic prioritization on switch
  2. IVN is exposed to unauthorized access due to Brute-force attack

- Example approach of using Qci to Security Issues
  1. Block misbehaving streams by Per-Stream Filtering and Policing
  2. Detect unknown nodes or streams by Per-Stream Filtering and Policing
  3. Protect high-priority traffic from DDoS attacks and keep low latency



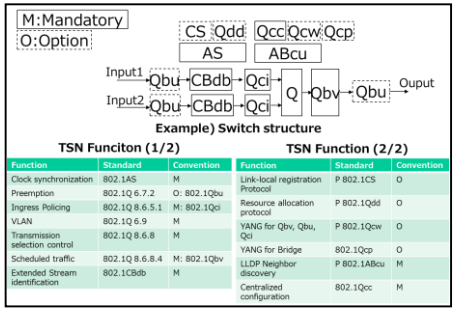
Example IVN in this use case

UC5. Automotive In-Vehicle Traffic Types

- Add a supplement to Auto Use Case 04 of「dg-pannell-automotive-use-cases-0719-v04.pdf」

Traffic Type	Period	Guarantee[4]	Tolerance to Loss[5]	Frame Size	Criticality
Safety-relevant Control: see 3.4.1.2	<= 20ms	Deadline based Reserved w/Latency < 1ms	No	64 bytes	High
Safety-relevant Media: see 3.4.1.3	<= 10ms	Bandwidth based Reserved w/Latency < 1ms	No	64 to max frame size[6] (w/1500 data bytes)	High
Network Control: see 3.4.1.4	50ms to 1s	Sporadic Highest priority Non-Reserved	Yes	64 to 512[7] bytes	High
Event: see 3.4.1.5	N/A	Sporadic 2nd Highest priority Non-Reserved	Yes	64 to max frame size (w/1500 data bytes)	Medium
Safety-irrelevant Control see 3.4.1.6	< 200ms	Bandwidth based Reserved w/Latency < 50ms	Yes	64 bytes	Medium
Safety irrelevant Media: see 3.4.1.7	Defined by the media type	Bandwidth based Reserved w/Latency < 300ms	Yes	64 to max frame size (w/1500 data bytes)	Medium
Best Effort: see 3.4.1.8	N/A	None	Yes	64 to max frame size (w/1500 data by	

L2	L3	L4	L5~L7
	IP	TCP	
	IP	UDP	
	IP ARP ICMP	TCP	
	IP	TCP, UDP	
	IP	TCP	MQTT SOME/IP
	IP	UDP	HTTP
	IP	TCP, UDP	HTTP FTP



Function	Standard	Convention
Clock synchronization	802.1AS	M
Preemption	802.1Q 6.7.2	O: 802.1Qbu
Ingress Policing	802.1Q 8.6.5.1	M: 802.1Qci
VLAN	802.1Q 6.9	M
Transmission selection control	802.1Q 8.6.8	M
Scheduled traffic	802.1Q 8.6.8.4	M: 802.1Qbv
Extended Stream identification	802.1CBdb	M

Function	Standard	Convention
Link-local registration Protocol	P 802.1CS	O
Resource allocation protocol	P 802.1Qdd	O
YANG for Qbv, Qbu, Qci	P 802.1Qcw	O
YANG for Bridge	802.1Qcp	O
LLDP Neighbor discovery	P 802.1ABcu	M
Centralized configuration	802.1Qcc	M

L2 Colum shows in diagram of TSN functions.

ADD

UC6. TSN Profiling to achieve FlexRay features

Use Case: Example use cases like FlexRay and the features

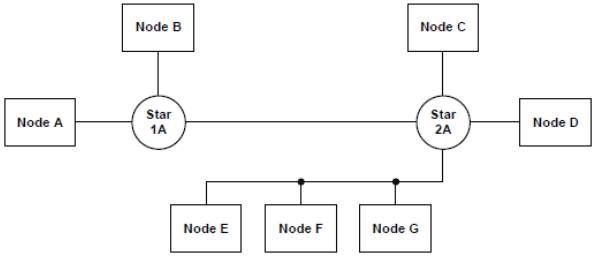


Figure 10 — Single channel hybrid example

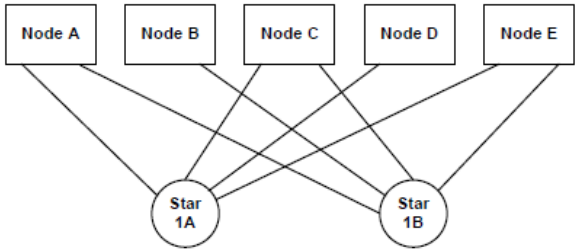


Figure 7 — Dual channel single star configuration

Referenced from ISO 174580-2:2013

Requirement:

R x.1	Requirements to enable FlexRay like functionality
R x.2	
R x.3	
R x.4	
R x.5	

Useful 802.1 mechanisms:

- 802.1...

TSN protocols/subset proposals to realize above requirements