Automotive In-Vehicle Traffic Type

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Background & Purpose

- Background
  - The traffic type summarization can be used as a reference when drafting the profile.
  - There are discussions on Industrial Automation traffic types in IEC/IEEE P60802.
    http://www.ieee802.org/1/files/public/docs2018/60802-industrial-use-cases-0918-v13.pdf Use case draft P17-20.
    http://www.ieee802.org/1/files/public/docs2019/60802-ademaj-traffic-type-introduction-0319-v03.pdf
  - P802.1DG uses a 'use case – requirement – profile' approach similar to P60802.

- Purpose
  - Summarizing the automotive in-vehicle traffic types to make it an input to the .1DG use case document.

Types	Periodicity	Period	Synchronized to network	Data delivery requirements	Tolerance to interference	Tolerance to loss	Application data size	Criticality
Isochronous	Periodic	< 2ms	Yes	Deadline	0	None	Fixed: 30 - 100 Bytes	High
Cyclic	Periodic	2 - 20ms	No	Latency	<= latency	1 - 4 Frames	Fixed: 50 - 1000 Bytes	High
Events	Sporadic	n.a.	No	Latency	n.a.	Yes	Variable: 100 - 1500 Bytes	High
Network Control	Periodic	50ms - 1s	No	Bandwidth	Yes	Yes	Variable: 50 - 500 Bytes	High
Config & Diagnostics	Sporadic	n.a.	No	Bandwidth	n.a.	Yes	Variable: 500 - 1500 bytes	Medium
Best Effort	Sporadic	n.a.	No	None	n.a.	Yes	Variable: 30 - 1500 Bytes	Low
Video	Periodic	Frame Rate	No	Latency	n.a.	Yes	Variable: 1000 - 1500 Bytes	Low
Audio/Voice	Periodic	Sampling Rate	No	Latency	n.a.	Yes	Variable: 1000 - 1500 Bytes	Low

A definition of Industrial Automation traffic types

Traffic characteristics

Characteristic	Description
Data transmission periodicity	Traffic types consist of data streams that can either be transmitted in a cyclic/periodic or acyclic/sporadic manner.
Period	For traffic types that transmit cyclic/periodic data streams, period denotes the planned data transmission interval (often also called “cycle”) at the application layer. The interval is provided as a typical range in orders of magnitude of time, i.e. 80% of the automotive applications in scope of the given traffic type are within the provided range. This characteristics only apply to cyclic/periodic traffic types.
Data delivery guarantee	Data delivery of each packet in a stream is guaranteed to occur at all registered receivers 1. Latency: within a predictable timespan, starting when the packet is transmitted by the sender, and ending when the packet is received. 2. Deadline: before a predictable time. (From the network perspective, Deadline can be expressed as Latency if the sending time is known.) 3. Bandwidth: if the bandwidth utilization is within the resources reserved by the sender. For each option, a typical quantification shall be provided with the data delivery guarantee, i.e. 80% of the automotive applications in scope of the given traffic type are within the provided quantification. In the case that a packet cannot be delivered within the given latency or deadline requirement, that packet may be considered as lost or discarded by the application. Any non-application-related requirements and any impact from the application itself and the sending and receiving device’s communication stack are out of scope.
Tolerance to loss	Denotes the application’s tolerance to a certain amount of consecutive packet loss in network transmission. In this case, a quantifiable number of tolerable lost packets shall be provided. Alternatively, the option “yes” can be provided for applications that tolerate packet loss to the extent that basic redundancy protocols such as Spanning Tree suffice to recover from potential network interruptions.
Application data size	Denotes the size of application data (payload) to be transmitted in the Ethernet frames. The size can be fixed or variable (i.e. 80% of the automotive applications in scope of the given traffic type are within the provided range).
Criticality	1. High: Unmet QoS guarantees may cause critical system malfunction. 2. Medium: Unmet QoS guarantees may cause degraded operation but not a system malfunction. 3. Low: Typically no QoS guarantee is needed, and data loss can be compensated by repeating/retransmitting the same data.

Traffic types

Traffic Types	Periodicity	Period	Data delivery guarantee	Tolerance to loss	Application data size	Criticality
Safety-relevant Control	Periodic (+Sporadic)	<=20ms	Deadline / Latency<1ms	No	<=64 Bytes	High
Safety-relevant Media	Periodic	<=10ms	Latency<1ms; Bandwidth	No	Up to 1500 Bytes	High
Network Control	Periodic	50ms-1s	Bandwidth	Yes	50-500 Bytes	High
Event	Sporadic	/	Latency<10ms	Yes	Up to 1500 Bytes	Medium
Safety-irrelevant Control	Periodic / Sporadic	<200ms	Latency<50ms	Yes	<=64 Bytes	Medium
Safety-irrelevant Media	Periodic	Sampling rate / Frame rate	Latency<300ms; Bandwidth	Yes	Up to 1500 Bytes	Medium
Best Effort	Sporadic	/	None	Yes	Up to 1500 Bytes	Low

The basic idea of classifying these traffic types is: One traffic type might possibly need to use a **different QoS** (provided by the network) than any other traffic type, because of their differences in traffic characteristics and requirements.

A **different QoS** means a different class/priority assignment, or a different shaping mechanism.

http://www.ieee802.org/1/files/public/docs2019/60802-ademaj-contribution-traffic-type-definitions-0319-v03.pdf

Traffic type: Safety-relevant Control

- Example:
  - Control loops of engine, braking, steering, etc.
  - ADAS command.

Safety-relevant Controls		
Characteristics		Notes
Periodicity	Periodic (+Sporadic)	Periodic+Sporadic mode may exist: Though the data is transmitted cyclically, an event can trigger a data transfer to occur between cycles.
Period	<=20ms	
Data delivery guarantee	Deadline / Latency<1ms	Latency usually within one data transmission period
Tolerance to loss	No	Seamless redundancy is required
Application data size	<=64 Bytes	
Criticality	High	

ADAS: Advanced driver-assistance systems

Traffic type: Safety-relevant Media

- Example:
  - Environment perception sensors: Radar, Lidar, Ultrasonic, Camera, etc.
  - Fusion data for ADAS.
  - Real-time map-downloading and positioning.

} Vision based systems

Safety-relevant Media		
Characteristics		Notes
Periodicity	Periodic	
Period	<=10ms	
Data delivery guarantee	Latency<1ms, Bandwidth	The bandwidth requirements may vary widely, e.g., RAW versus compressed. A further separation of this traffic type might be needed.
Tolerance to loss	No	Fast redundancy is required.
Application data size	Up to 1500 Bytes	
Criticality	High	

ADAS: Advanced driver-assistance systems

Traffic type: Network Control

- Example:
  - Clock synchronization (e.g. PTP).
  - Network redundancy (e.g. RSTP).
  - Topology detection (e.g. LLDP).

Network Control		
Characteristics		Notes
Periodicity	Periodic	
Period	50ms-1s	
Data delivery guarantee	Bandwidth	Typically, 1-2Mbits.
Tolerance to loss	Yes	Excessive loss of network control frames can lead to loss of network functions (e.g. link-down state or grand master fail-over).
Application data size	50-500 Bytes	
Criticality	High	

Traffic type: Events

- Example:
  - V2I, V2V, V2N events/warnings/alarms.
  - Dynamic network configuration (if needed).

Events		
Characteristics		Notes
Periodicity	Sporadic	
Period	/	
Data delivery guarantee	Latency<10ms	
Tolerance to loss	Yes	
Application data size	Up to 1500 Bytes	
Criticality	Medium	

V2I: vehicle-to-infrastructure. V2V: vehicle-to-vehicle. V2N: vehicle-to-network.

Traffic type: Safety-irrelevant Control (& Sensing)

- Example:
  - Control of lights, air conditioning, doors and windows, infotainment system, etc.
  - Sensing and signal display of vehicle status, e.g., fuel/battery consumption, battery/water temperature, tire pressure, etc.

Safety-irrelevant Controls		
Characteristics		Notes
Periodicity	Periodic / Sporadic	Periodic+Sporadic mode may exist.
Period	<=200ms	
Data delivery guarantee	Latency<50ms	
Tolerance to loss	Yes	Loss of packets may lead to decreased quality.
Application data size	<=64 Bytes	
Criticality	Medium	

Traffic type: Safety-irrelevant Media

- Example:
  - Infotainment audio and video.
  - Camera for driver at low speed (e.g., reversing camera, 360-degree camera)
  - Head-up Display (HUD), eCall, …

Safety-irrelevant Media		
Characteristics		Notes
Periodicity	Periodic	
Period	Sampling rate / Frame rate	
Data delivery guarantee	Latency<300ms, Bandwidth	Application performance may degrade if latency increases. Need to further divide this traffic type into audio and video?
Tolerance to loss	Yes	Loss of packets may lead to decreased quality
Application data size	Up to 1500 Bytes	
Criticality	Medium	

Traffic type: Best Effort

- Example:
  - Firmware OTA and software OTA (including offline map downloading).
  - Logging and log uploading, diagnostics, configurations
  - All other Internet data access.

Best Effort		
Characteristics		Notes
Periodicity	Sporadic	
Period	/	
Data delivery guarantee	None	
Tolerance to loss	Yes	Data loss can be compensated by repeating/retransmitting the same data.
Application data size	Up to 1500 Bytes	
Criticality	Low	

OTA: Over-the-air (updates)

Next steps

- Modifications of the current traffic type summarization may be needed.
  - The current traffic type summarization in this presentation is based on the author's personal thoughts and judgments based on limited information.
  - Discussion and more input will definitely help to make this traffic type summarization better.
- Use this traffic type summarization as a reference when
  - Discussing related issues, e.g., traffic type mapping to QoS mechanism selections.
  - Drafting the profile.

Thank you