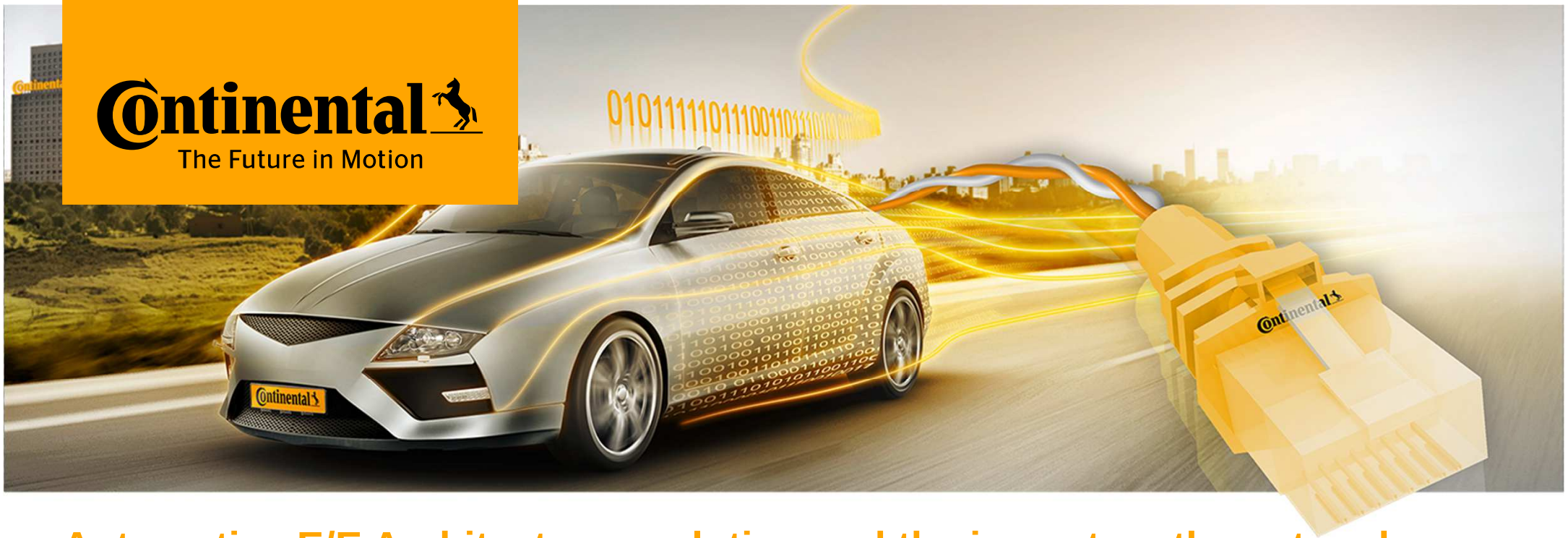


Automotive E/E Architecture evolution and the impact on the network

IEEE802 Plenary, March 2019, 802.1 TSN

Helge Zinner, Julian Brand, Daniel Hopf, Continental AG

Content of this presentation

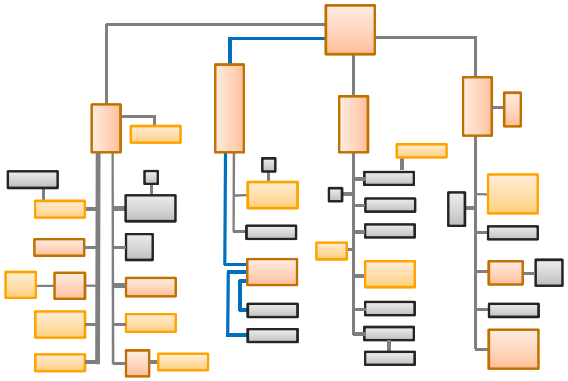
- Introduction of E/E architecture trend
- Network implication for TSN features
- Types of automotive Ethernet TSN nodes

Definitions

- 10 Mbit/s (e.g. IEEE P802.3cg 10BASE-T1) was not taken into account
- Only Ethernet was taken into account (no CAN, LIN, SerDes …)
- Arrows in drawings of communication indicate logical data flow, NOT half-duplex connections
- There is no “one common” E/E architecture among the car manufacturers
  - Every car manufacturer uses its own architecture (different number of hops & requirements)
  - But the main concept is often similar

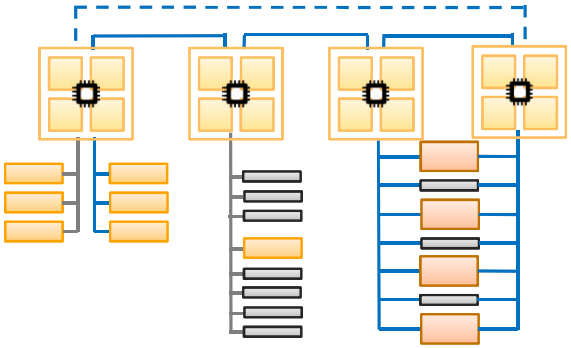
Automotive E/E architecture
Current state and outlook

Today: Traditional architecture



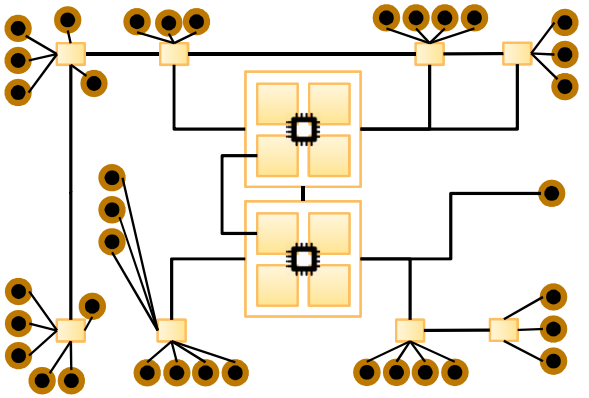
- application-specific ECUs
- application-specific bus systems
- 1-to-1 communication

In development: Domain architecture



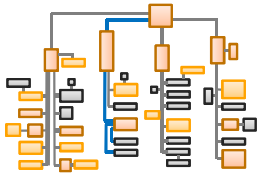
- application-specific ECUs
- functional consolidation in domain controllers
- 1-to-1, “many-to-one” communication

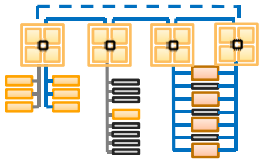
Tomorrow: Centralized architecture

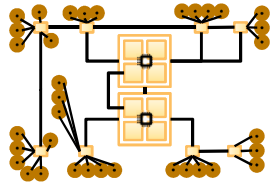


- software-driven architecture
- centralized processing
- “all-to-some” communication

Automotive E/E architecture
Characteristics



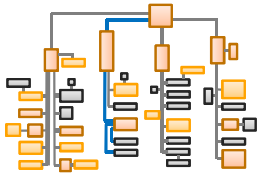


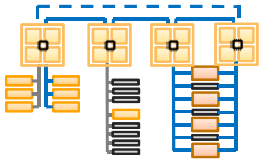


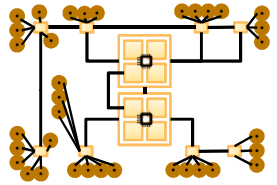
Network topology			
topology	point-to-point, star	point-to-point, star, ring	point-to-point, star, multiple rings
no. of hops for a stream	1-2	2-4	3-6
link speed	100 Mbit/s	10 Mbit/s – 10 Gigabit/s	10 Mbit/s – 50 Gigabit/s
no. of Ethernet links	< 10	10 - 50	> 50
no. of congestion points for a stream	0-1	1-3	2-5
no. of segments (VLANs, IP-networks)	< 8	< 8	> 8

Information here is based on educated guess, no full centralized architectures are in development today yet

Automotive E/E architecture
Characteristics





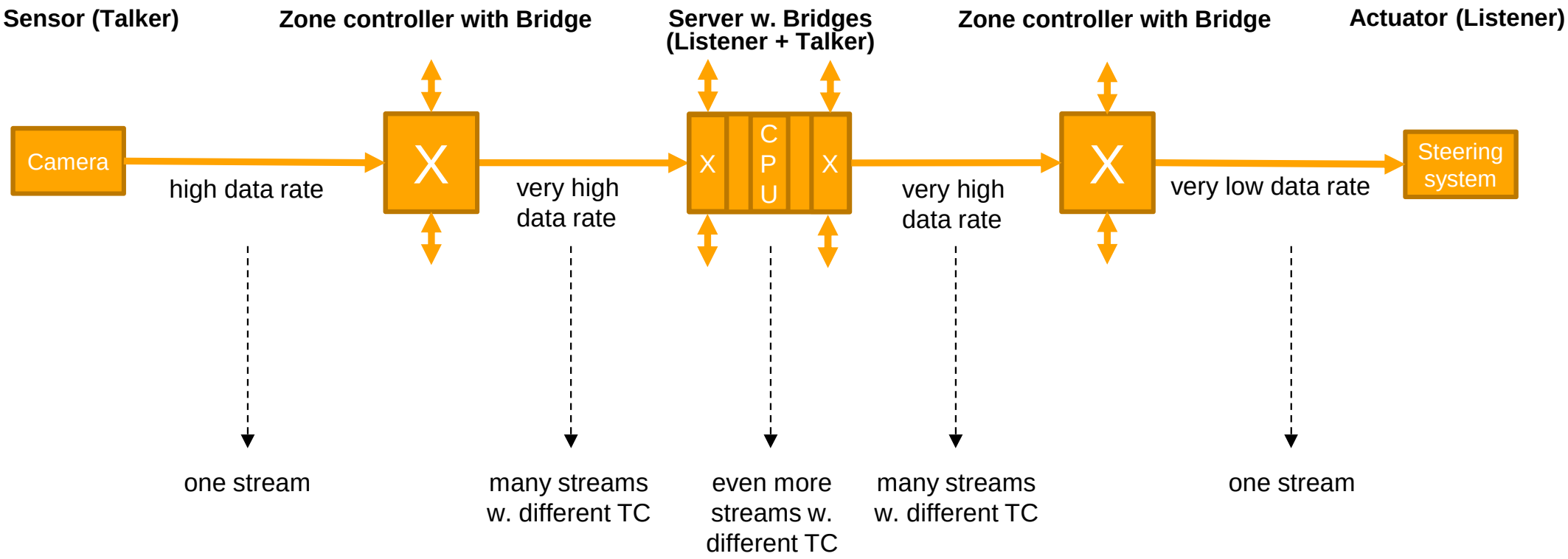


Data characteristics			
no. of different traffic classes at congestion points	< 8	< 8	> 8
no. of streams at congestion points	< 10	< 50 at domain controller	> 200 (at Server)
typical latency requirements	milliseconds (2 digits)	milliseconds (1-2 digits)	microseconds (2-3 digits)
typical target of traffic load per link	mid to high	mid	low (at vehicle SOP)
typical L2 frame size	64 Byte, 1500 Byte	64 Byte, 1500 Byte	> 64 Byte (no encapsulation)
periodicity of data	various types	various types	various types
time synchronization requirements	milliseconds (1 digit)	milliseconds (1 digit)	microseconds (2-3 digits)
dynamic network configuration	very little	little	partially

Information here is based on educated guess, no full centralized architectures are in development today yet

Classes of Ethernet devices

Example use case: Object detection camera in system context (simplified illus.)



TC = Traffic Class

Classes of Ethernet devices

Types of different TSN automotive implementation: Profiles?

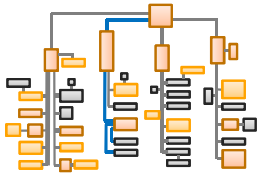
- TSN Endpoints
  - Single port Talker/Listener
    - focus: safety relevant data processing e.g. server, antenna module
    - other:
  - Single port Talker only (back channel data is not time critical)
    - focus: safety relevant sensors for ADAS (Cameras, Radars, Lidars,…)
    - other: microphone
  - Single port Listener only (back channel data is not time critical)
    - focus: safety relevant actuators (steering, braking, display)
    - other: speaker

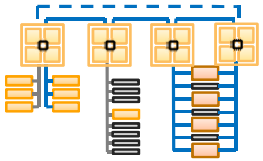
Classes of Ethernet devices

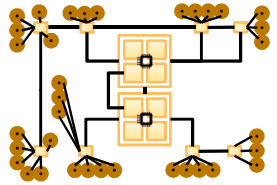
Types of different TSN automotive implementation: Profiles?

- TSN Bridges
  - 3-port bridge (supports ring topology)
  - access bridge (interface to outside vehicle networks)
    - focus: security
  - aggregation bridge (low port count)
  - aggregation bridge (high port count)

Classes of Ethernet devices







Class			
Talker endpoints only	< 10	< 20	> 25
Listener endpoints only	< 5	< 10	< 20
Talker/Listener endpoints	< 5	< 10	< 10
3-port bridge	0	< 5	< 5
Aggregation bridge mid	1-2	< 5	< 10
Aggregation bridge high	0	< 3	< 5

Information here is based on educated guess, no full centralized architectures are in development today yet