



Networks on Wheels

An Introduction to Automotive Networks

Lara Hallaczek :: DENOG15 :: 2023-11-21



whoami

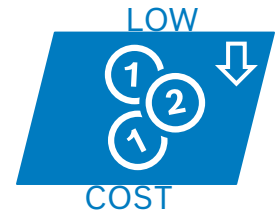
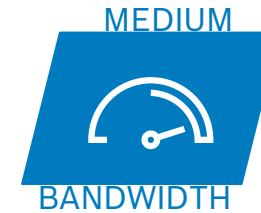
- Lara Hallaczek (Error)
she/they
- System Security Engineer
at Robert Bosch GmbH
- Practical Computer Science (M.Sc.)
Student at FernUniversität in Hagen
- Volunteer at Selfnet e.V.

Automotive Networks

Use Cases

**Control
Data
and
Safety
Relevant
Data**

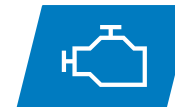
Requirements



Examples



Driver Assistance / ADAS



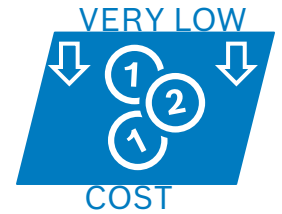
Control Data, e.g. for Powertrain ECUs

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Use Cases

**Low
Speed
Data**

Requirements



Examples



Electric Window Opener



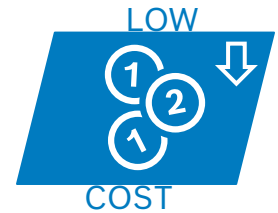
Electric Seat Control

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Use Cases

Infotainment

Requirements



Examples



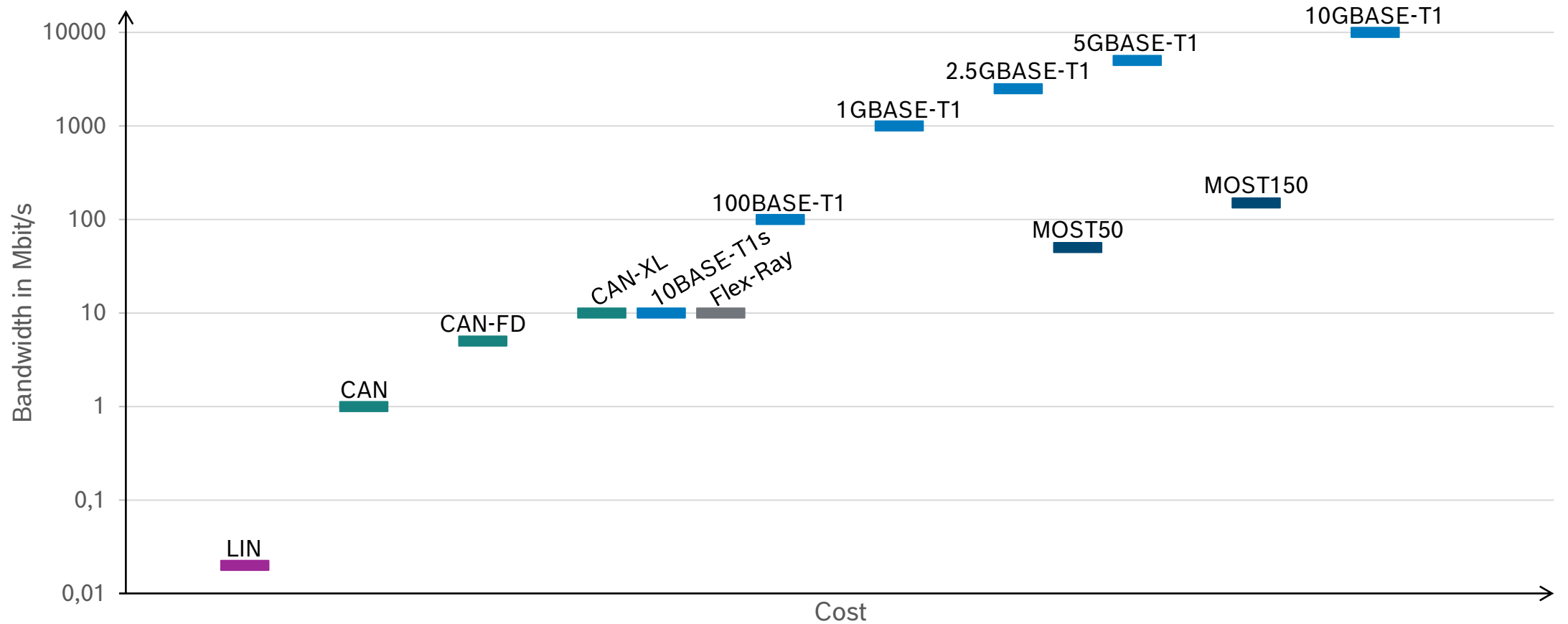
Audio/Video Streaming



Navigation System

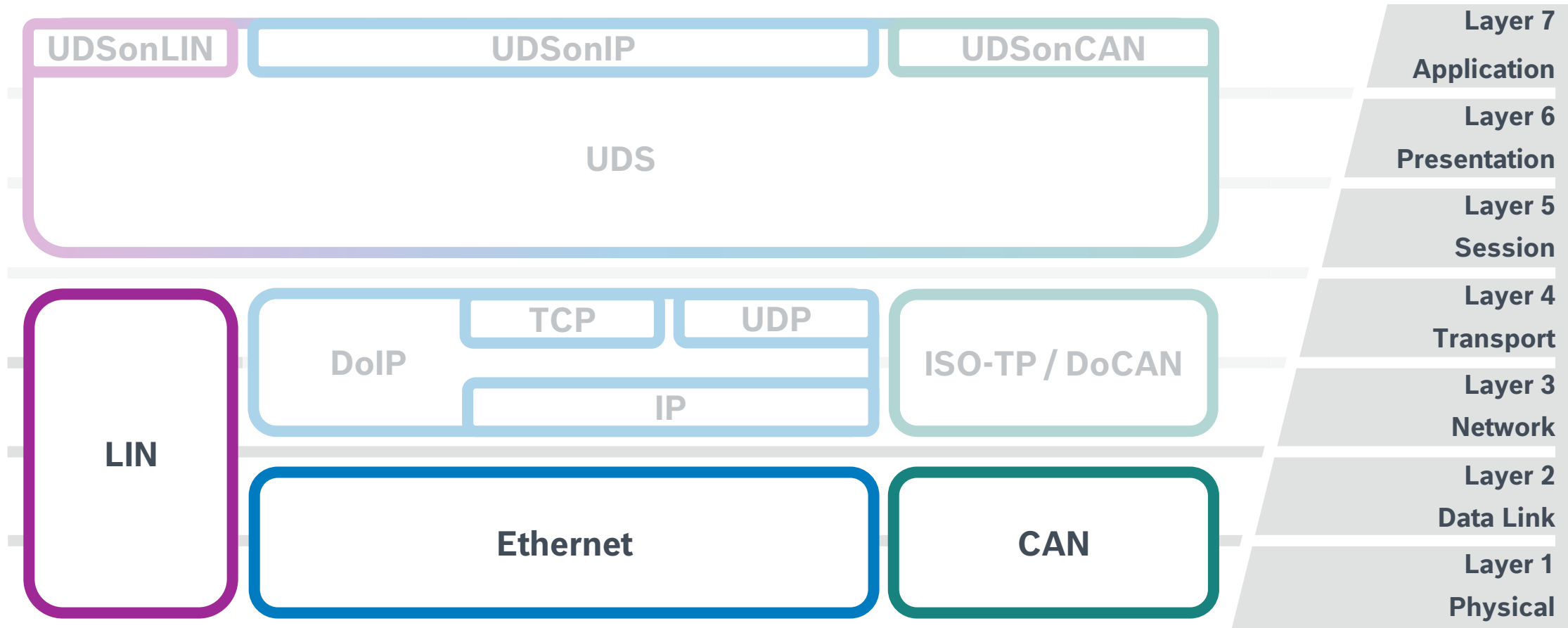
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Bus Systems



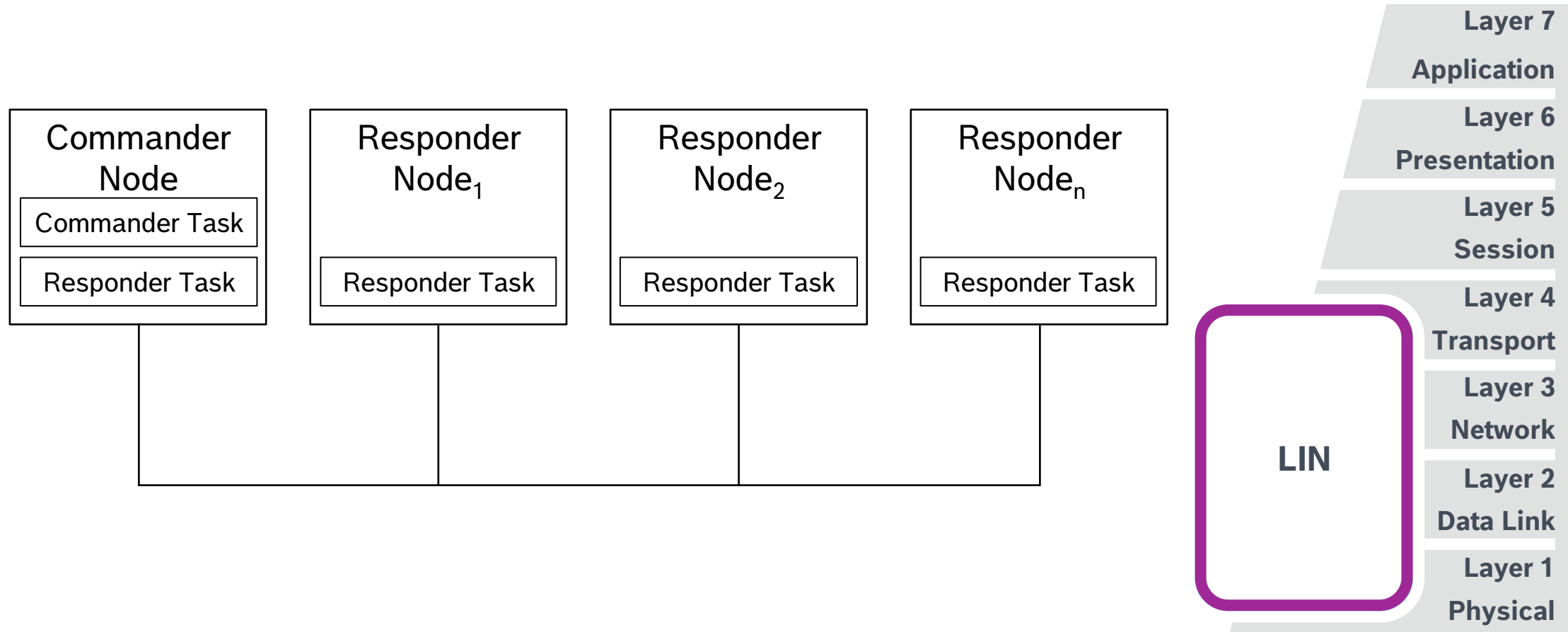
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Protocol Stack

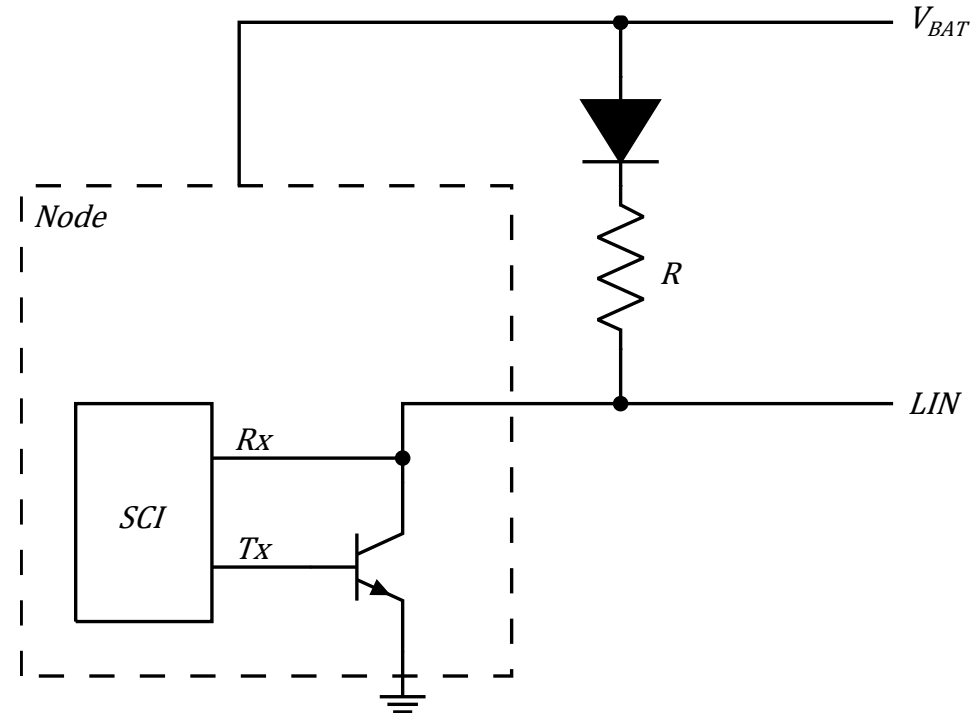


Local Interconnect Network (LIN)

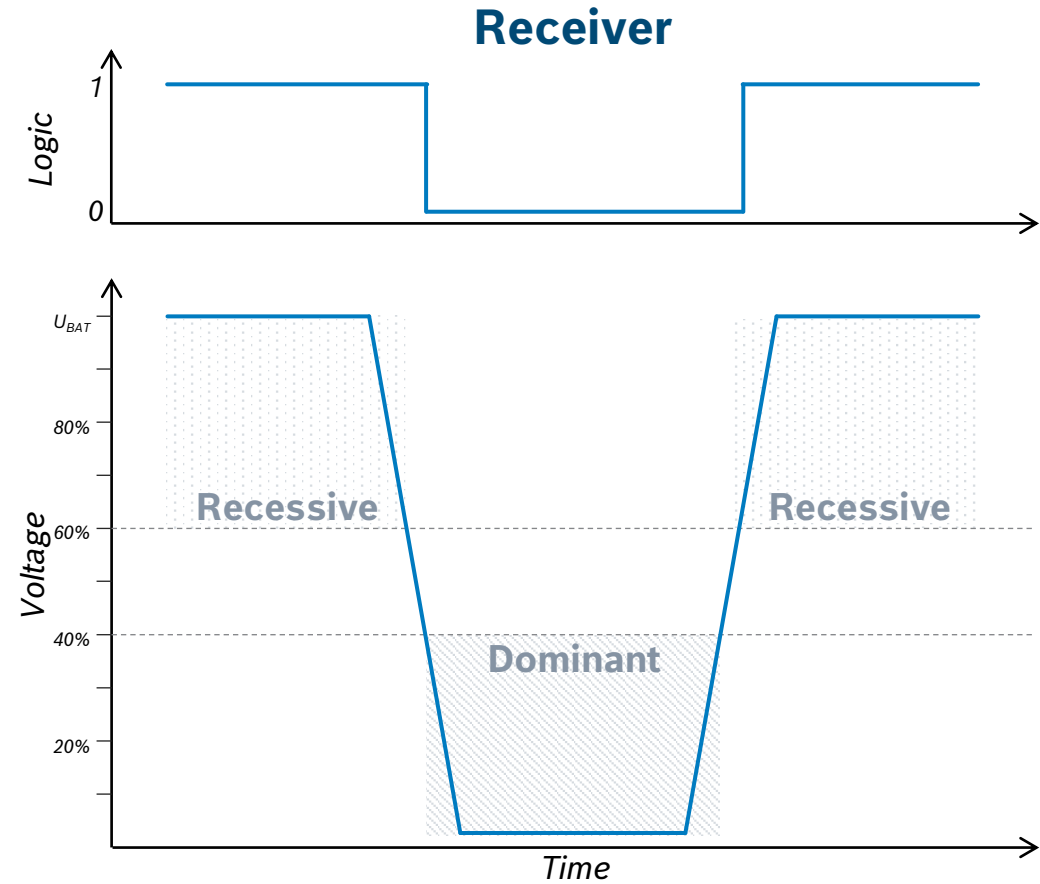
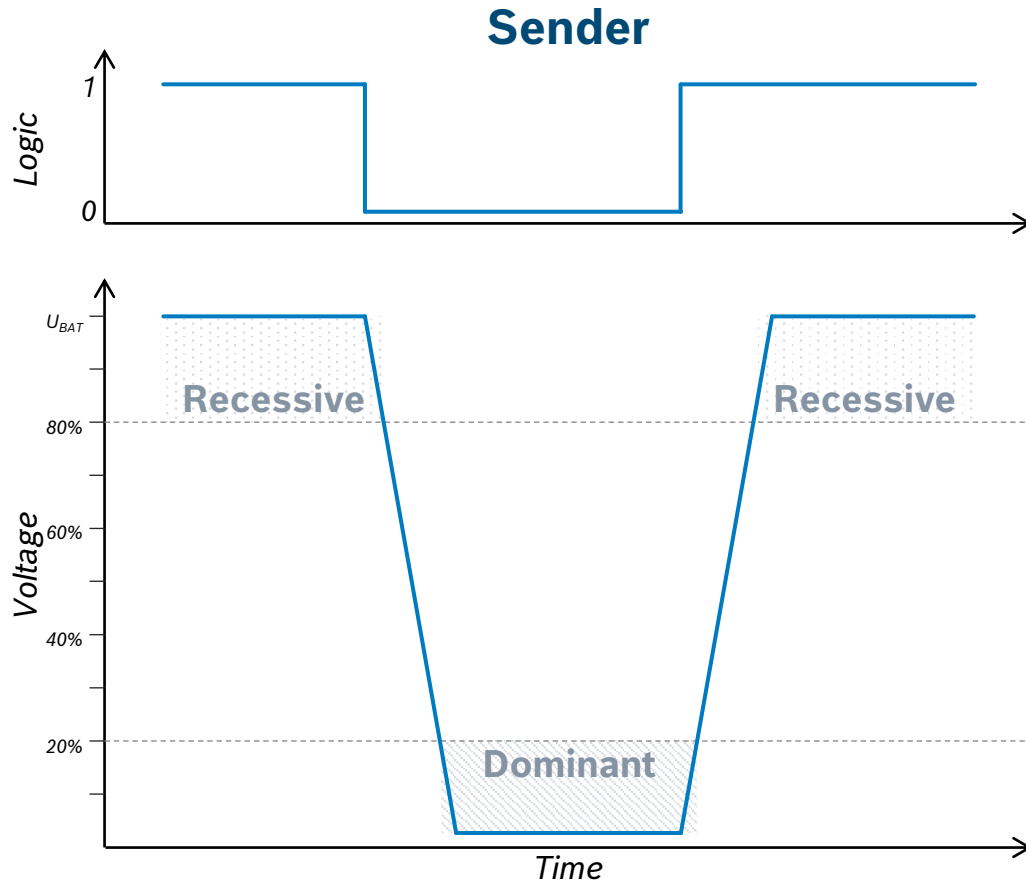
Overview



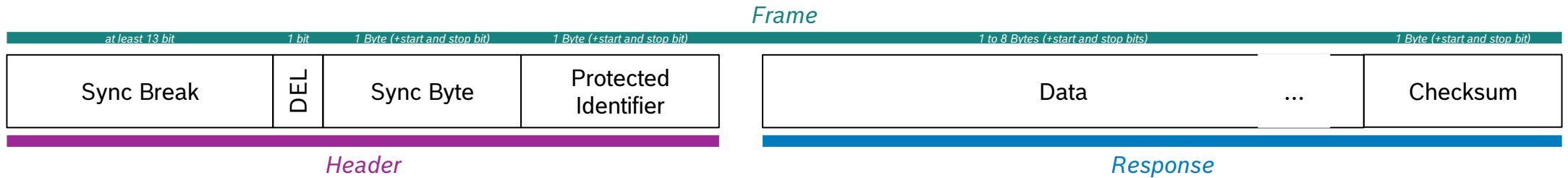
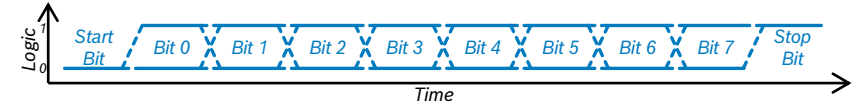
Local Interconnect Network (LIN) Driver Schematic



Local Interconnect Network (LIN) Encoding

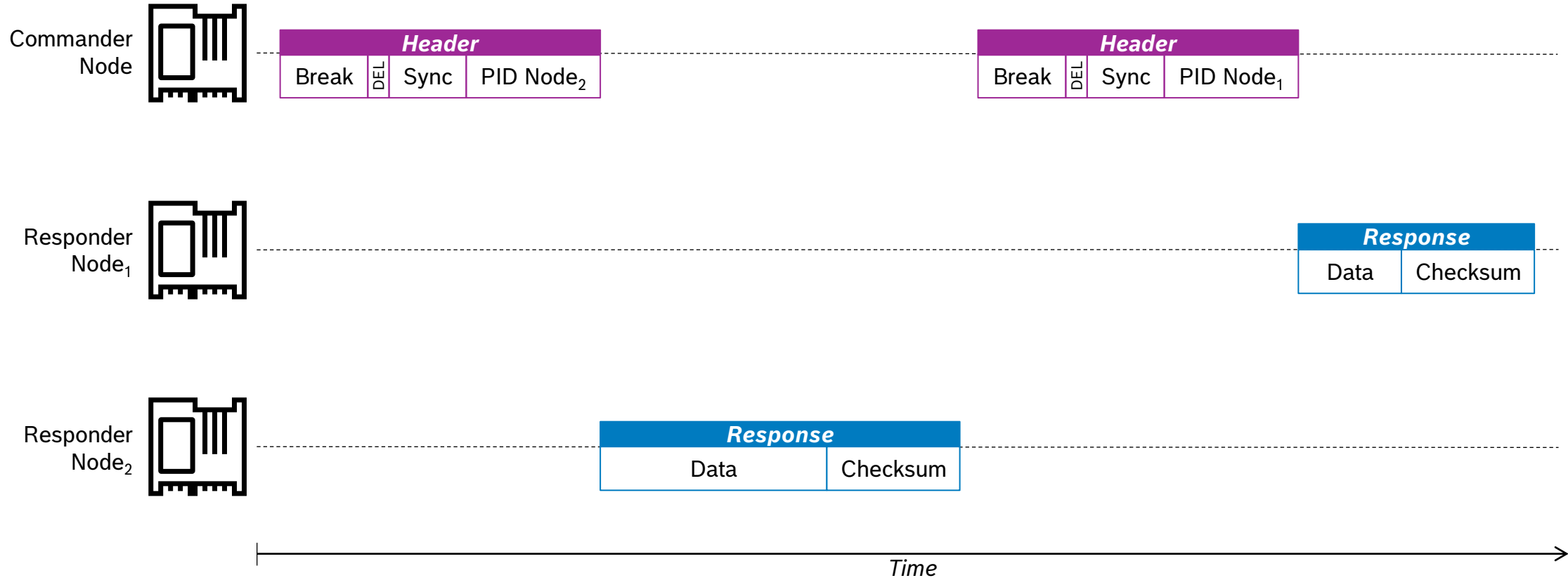


Local Interconnect Network (LIN) Frame Format



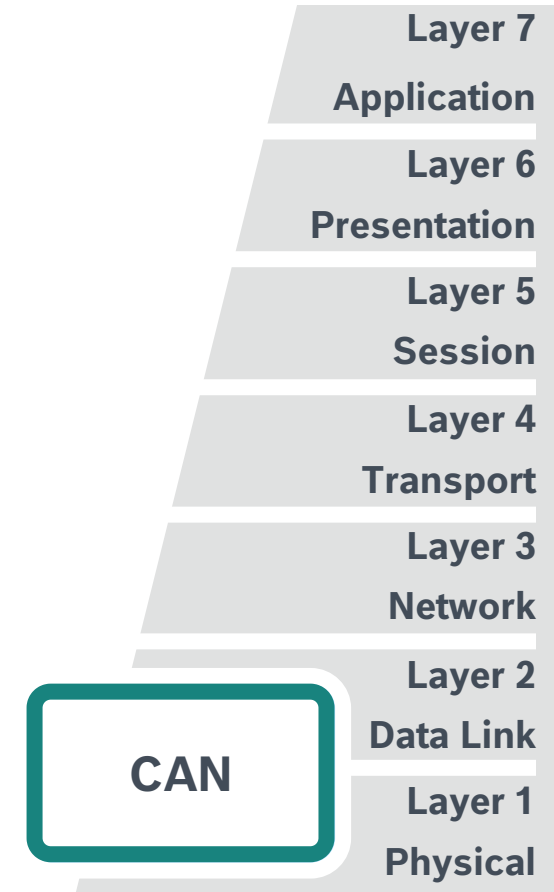
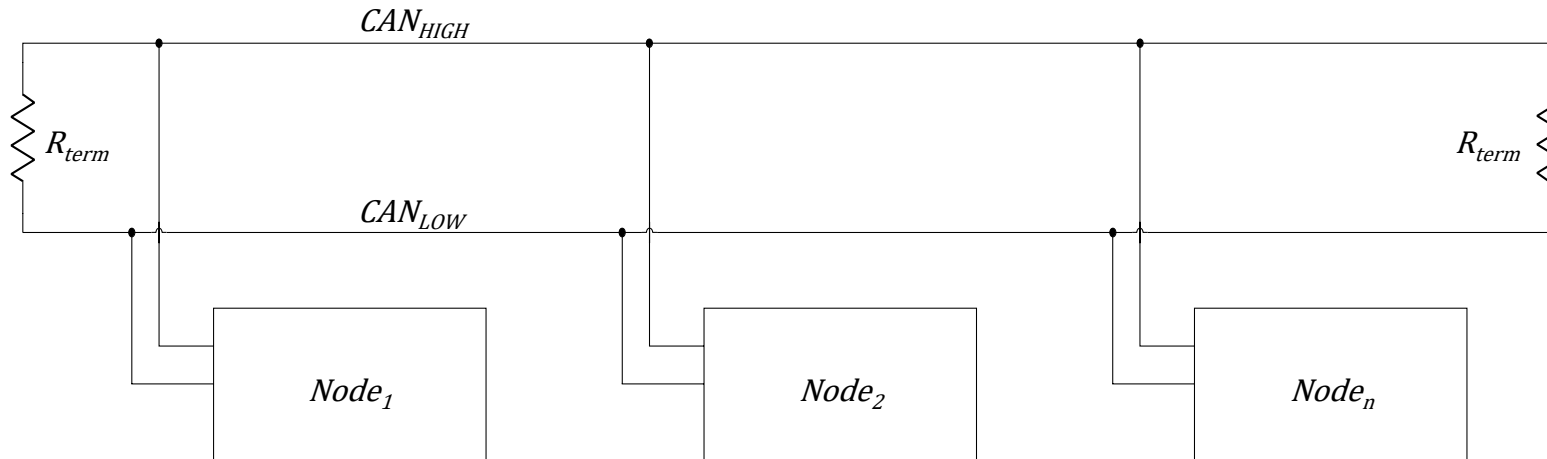
Local Interconnect Network (LIN)

Commander – Responder Communication



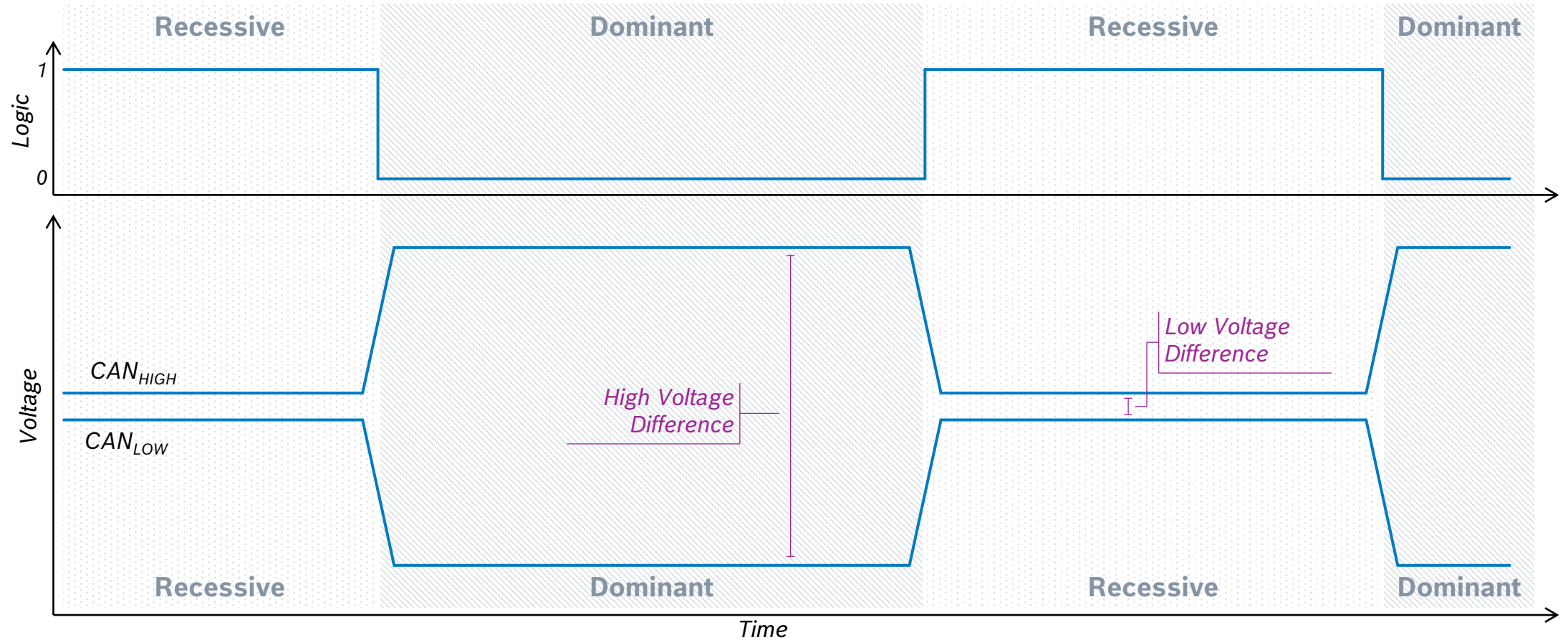
Controller Area Network (CAN)

Overview



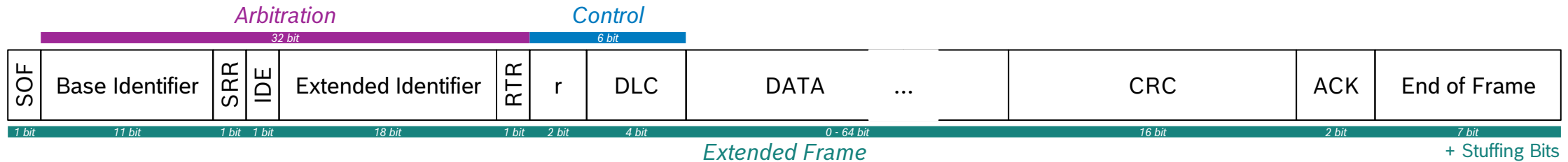
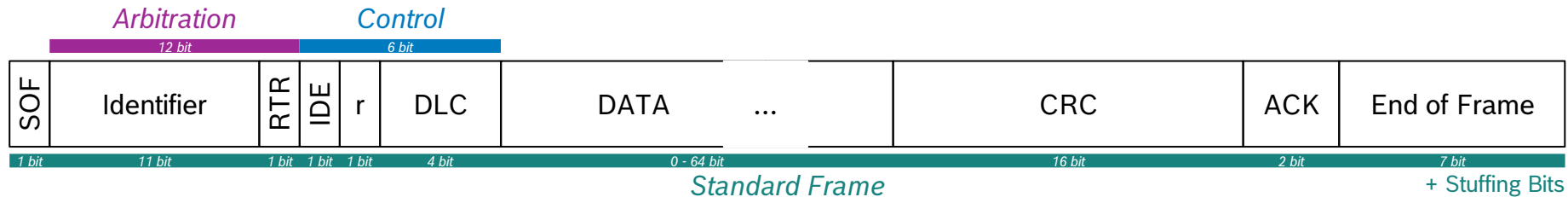
Controller Area Network (CAN)

Encoding



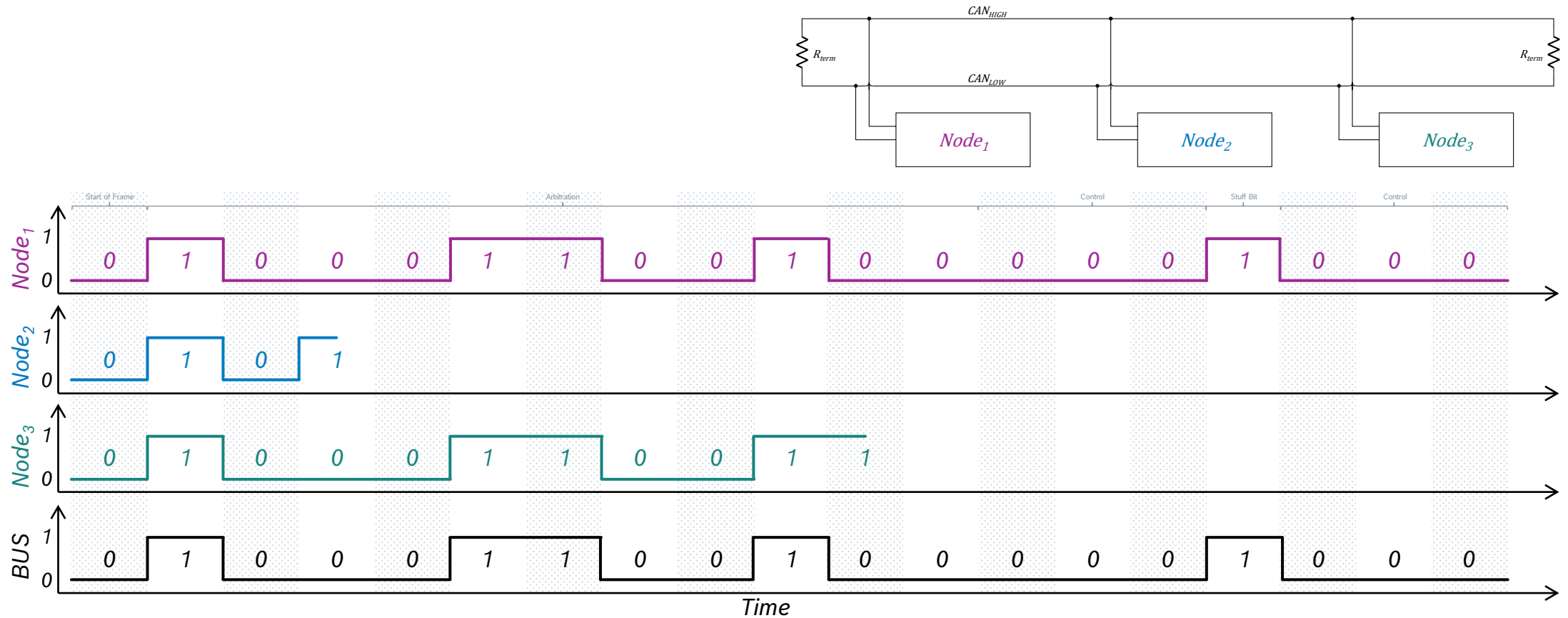
Controller Area Network (CAN)

Frame Format

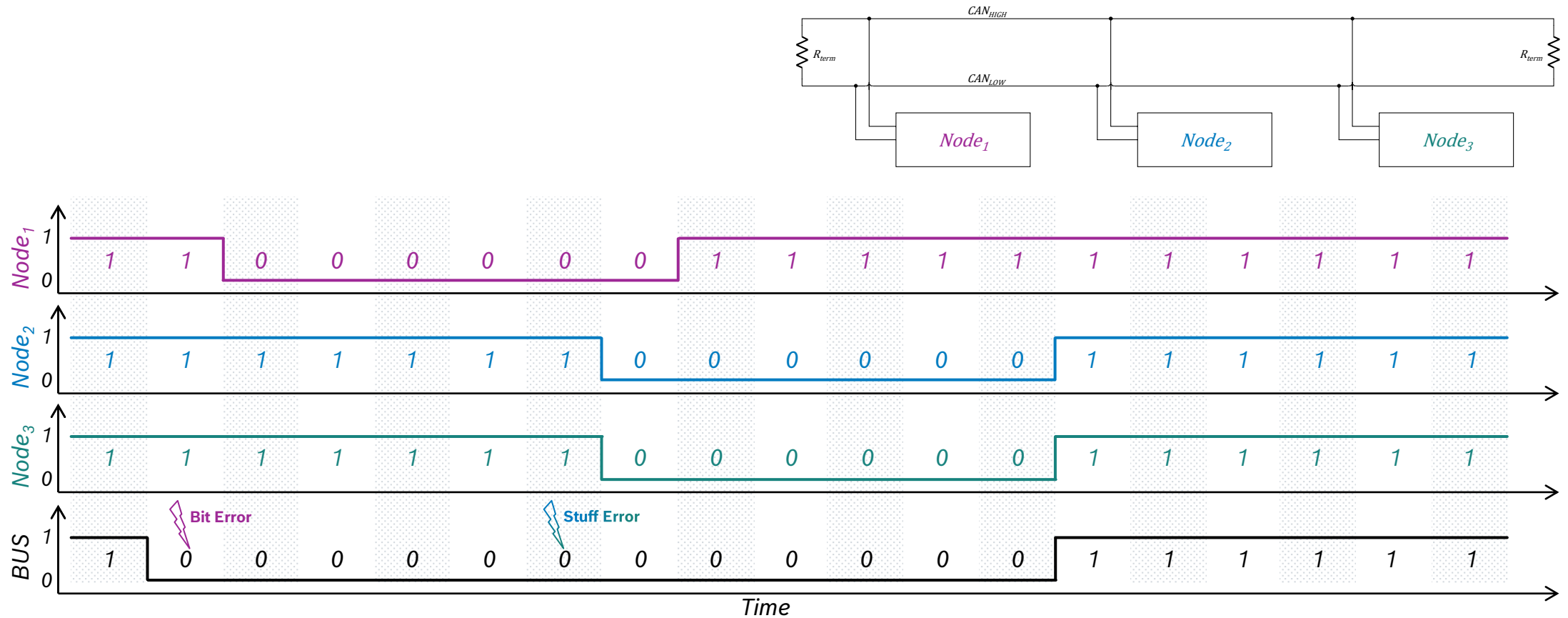


Controller Area Network (CAN)

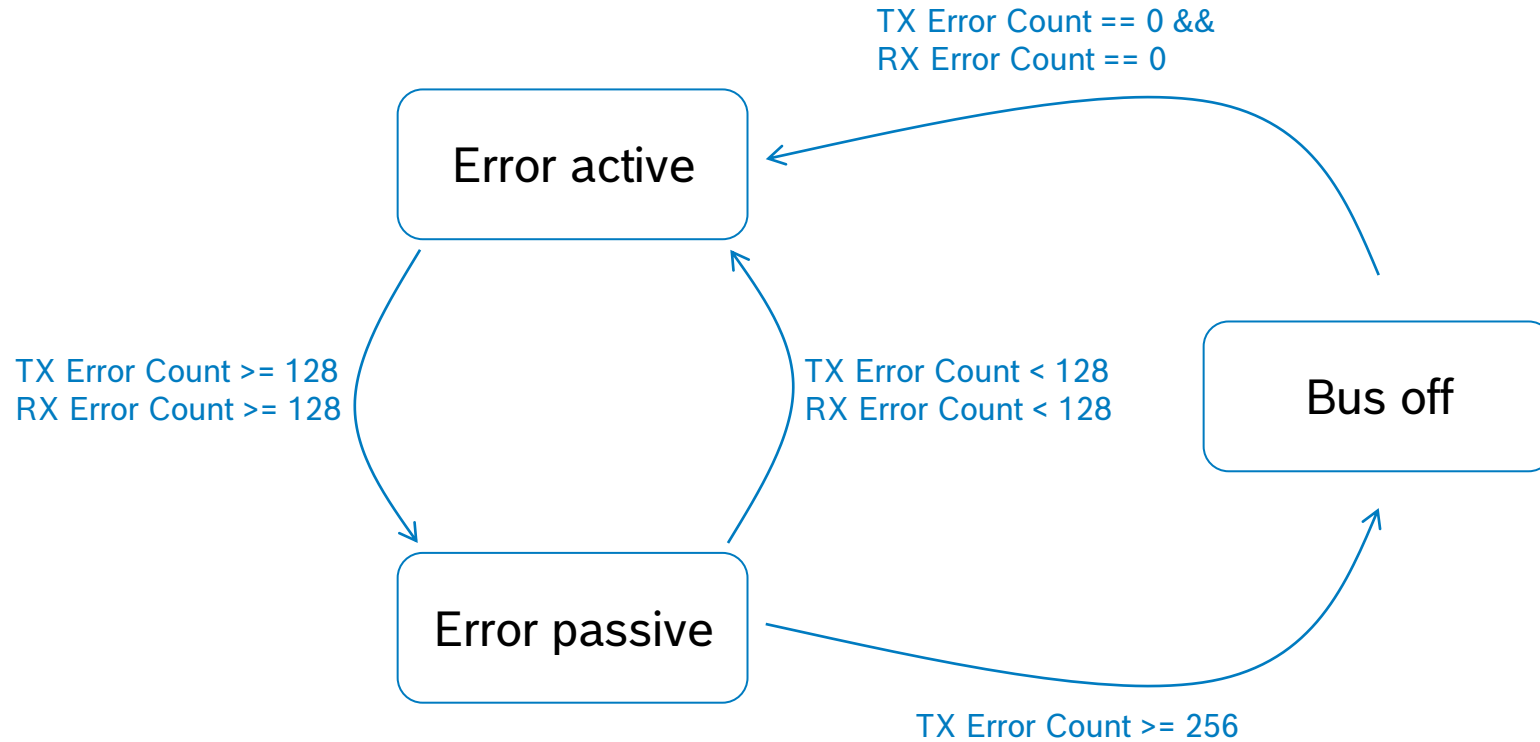
Arbitration



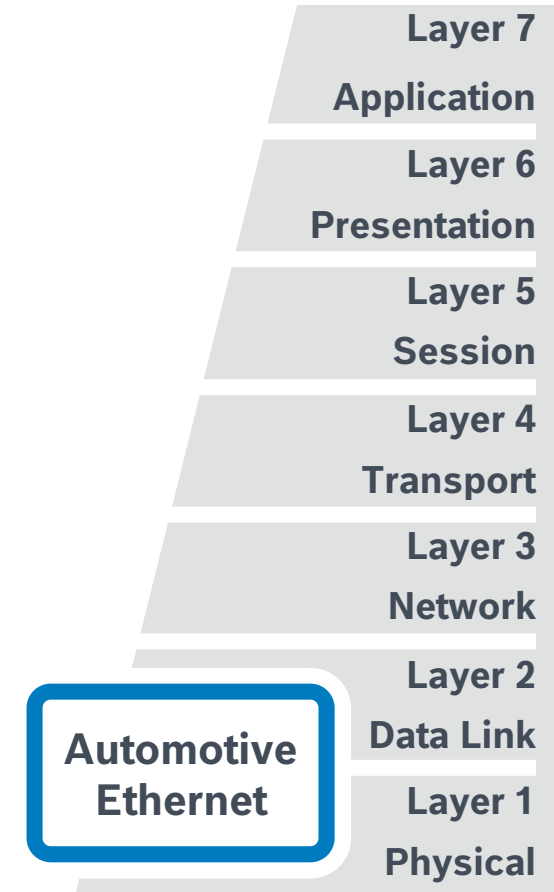
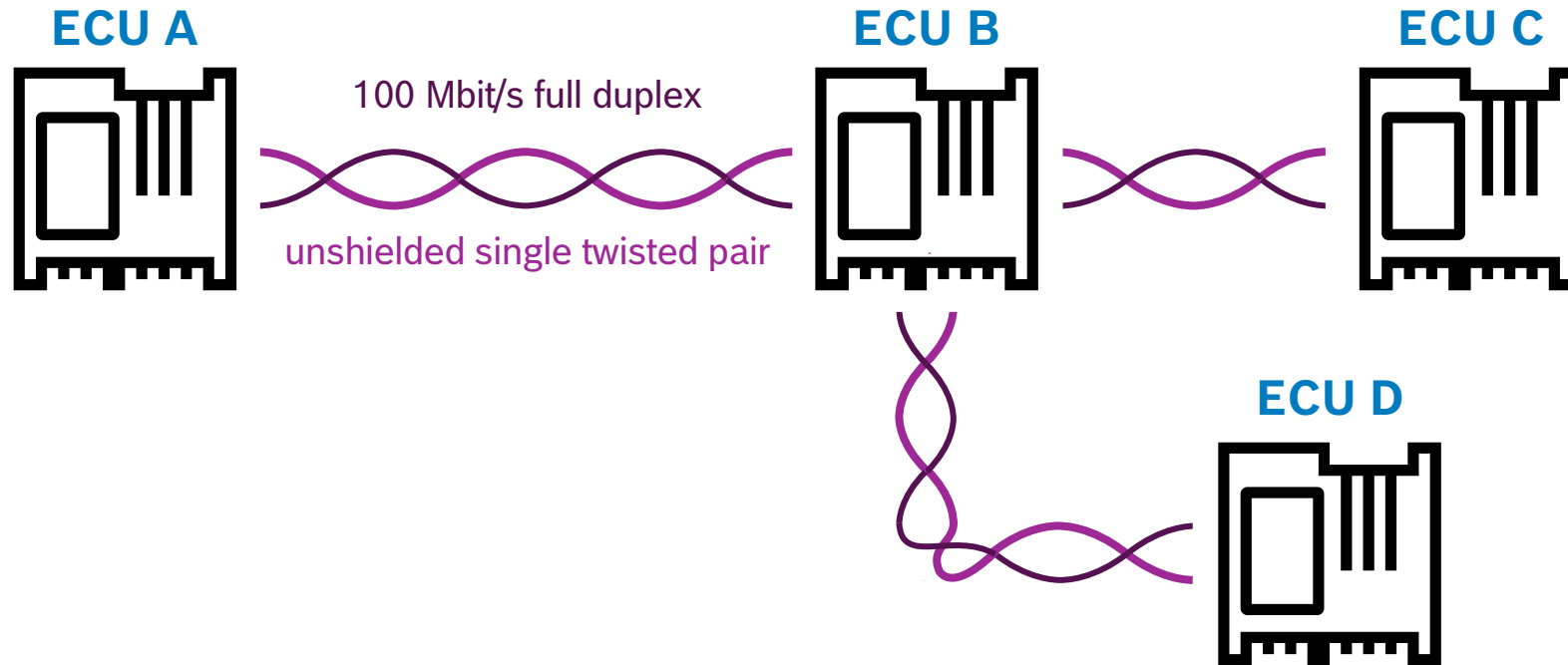
Controller Area Network (CAN) Error Handling



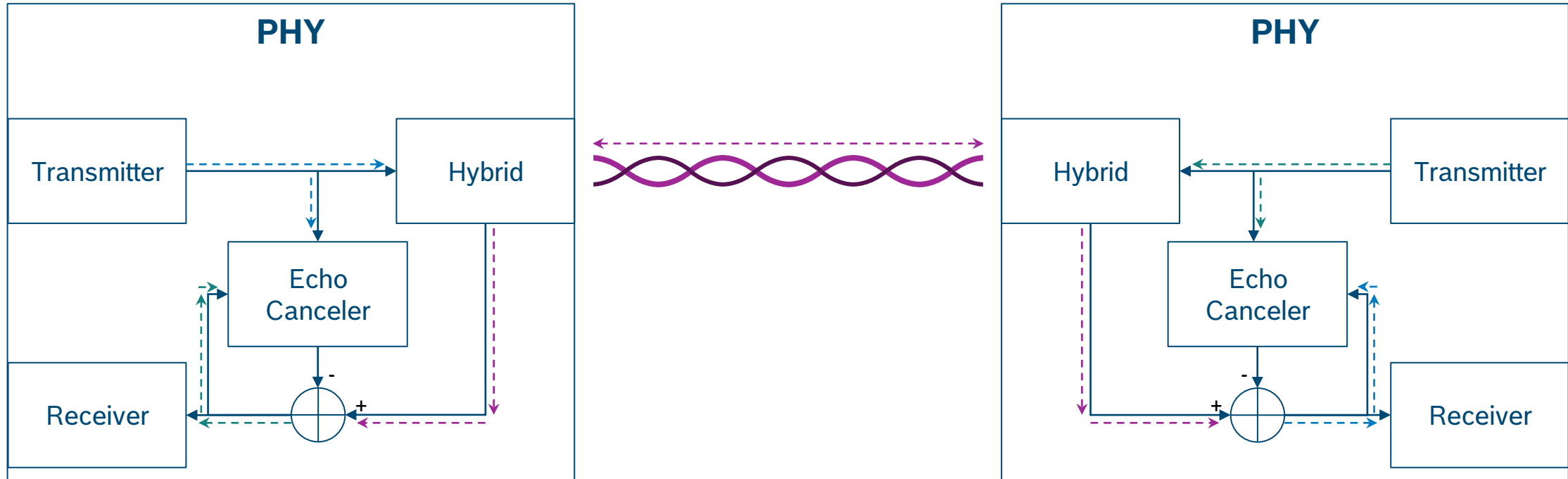
Controller Area Network (CAN) Error State



Automotive Ethernet (100Base-T1) Overview

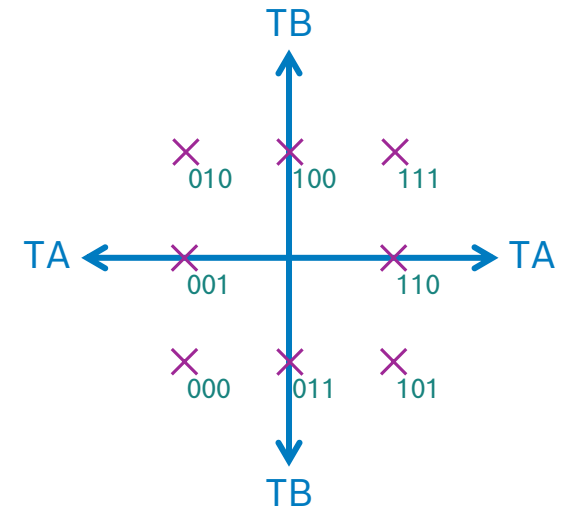
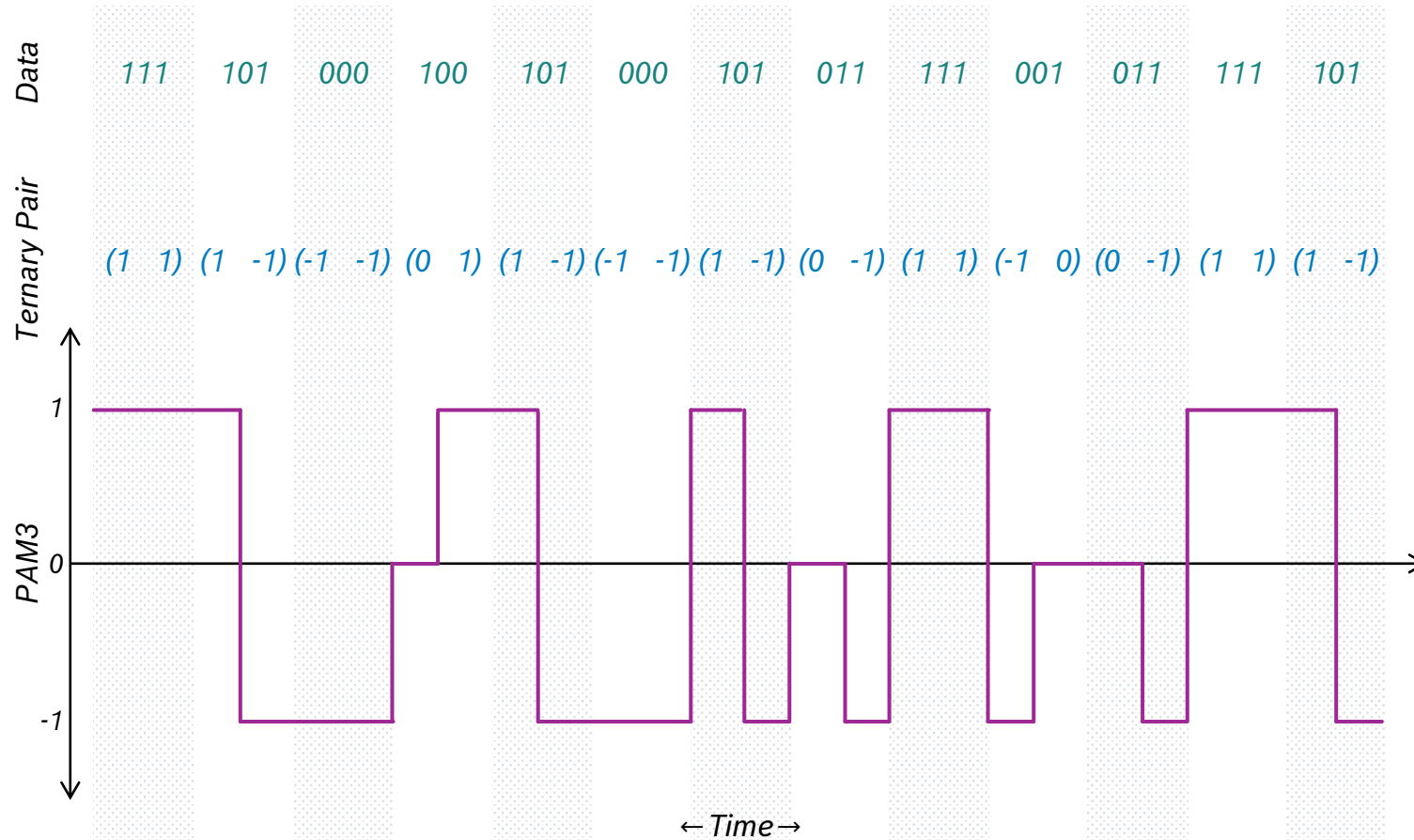


Automotive Ethernet (100Base-T1) PHY Schematic



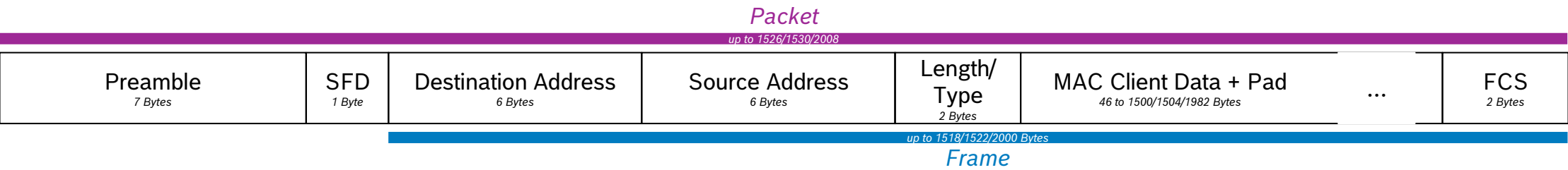
Automotive Ethernet (100Base-T1)

PAM3 Encoding



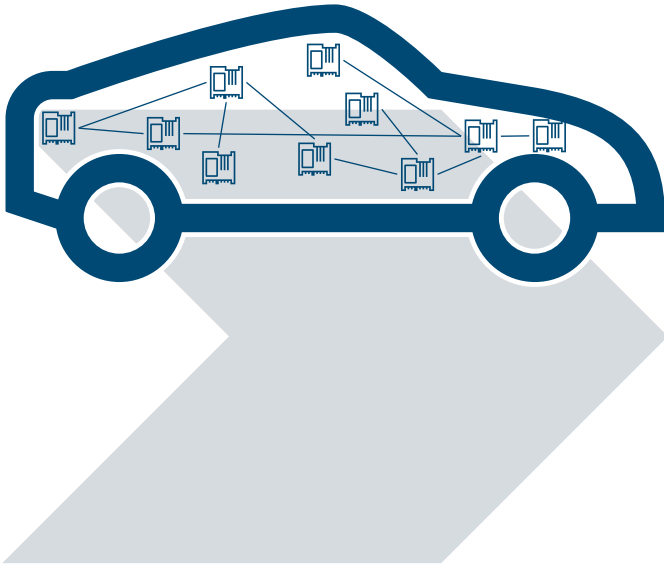
Automotive Ethernet (100Base-T1)

Frame Format

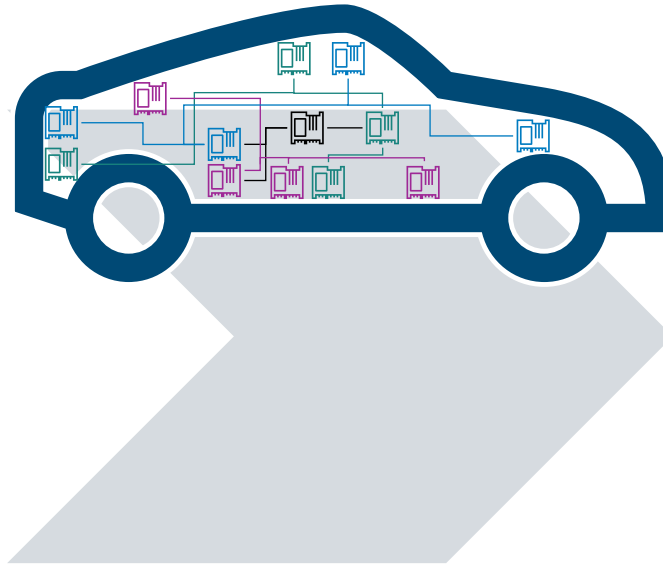


E/E Architectures Overview

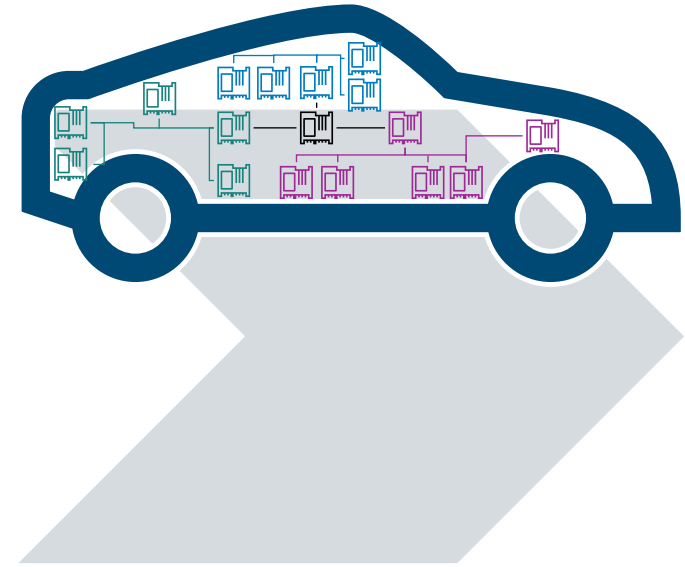
Distributed Architecture



Domain Architecture

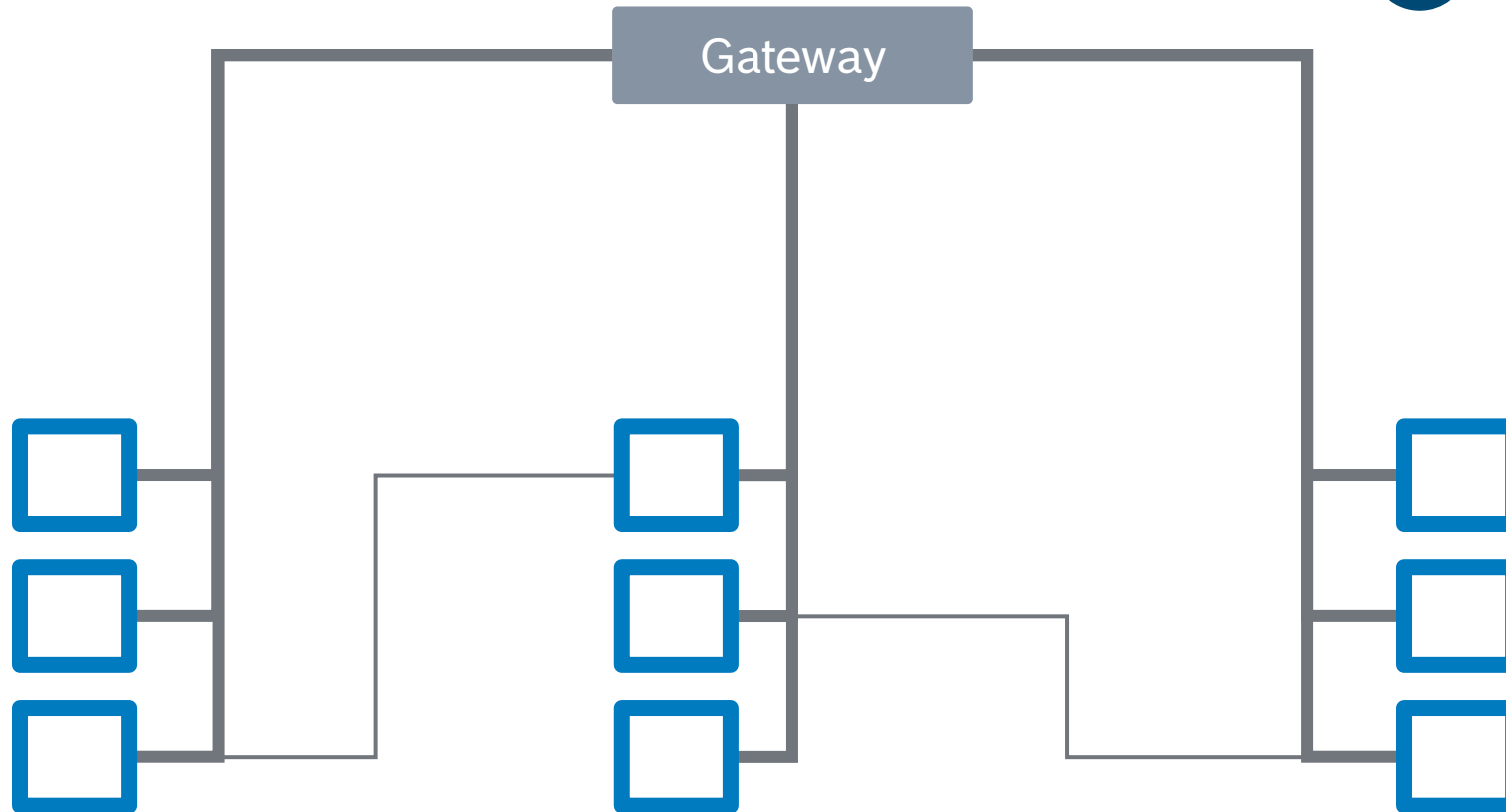
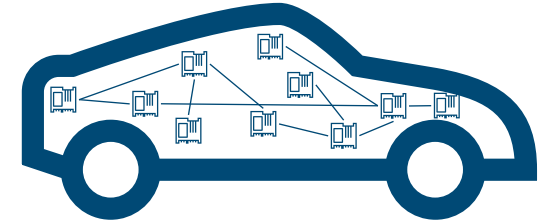


Zone Architecture



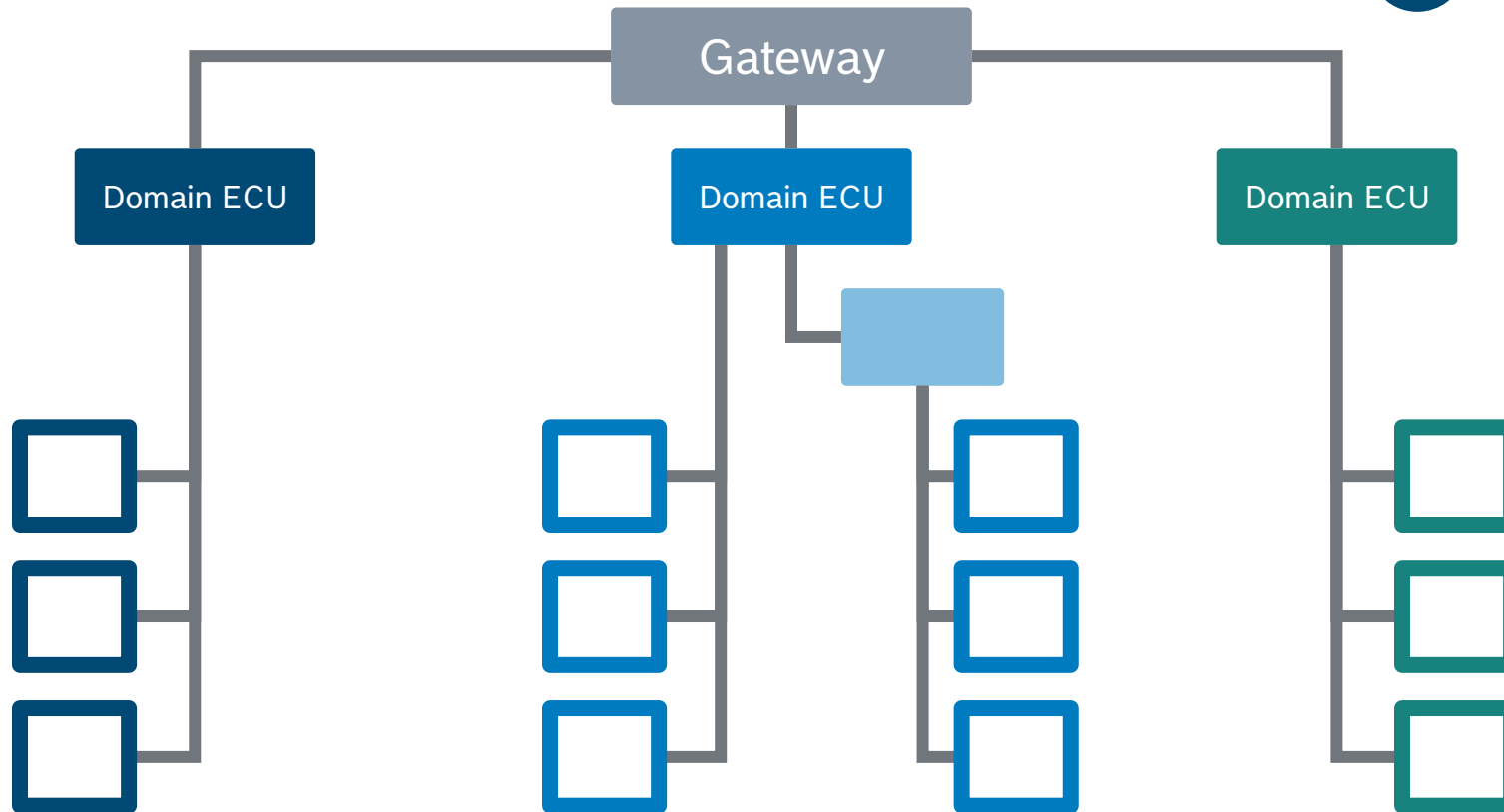
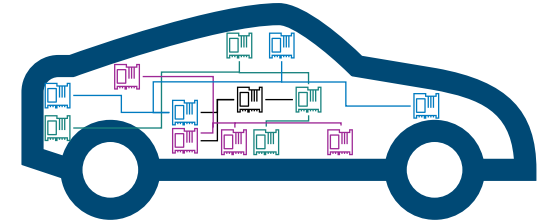
E/E Architectures

Distributed Architecture



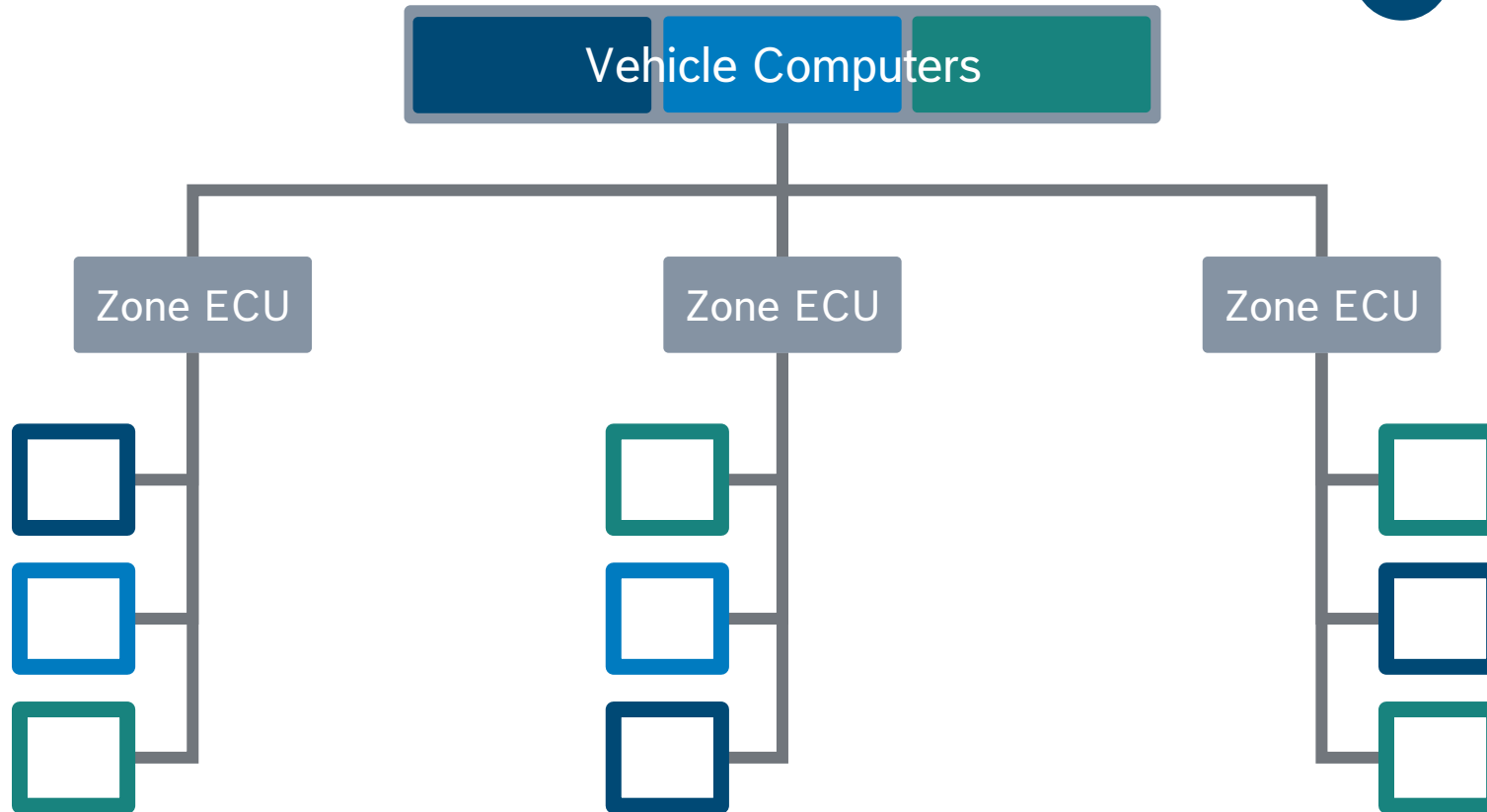
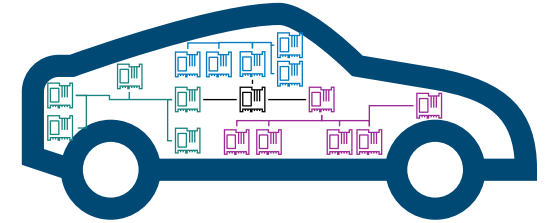
E/E Architectures

Domain Architecture



E/E Architectures

Zone Architecture

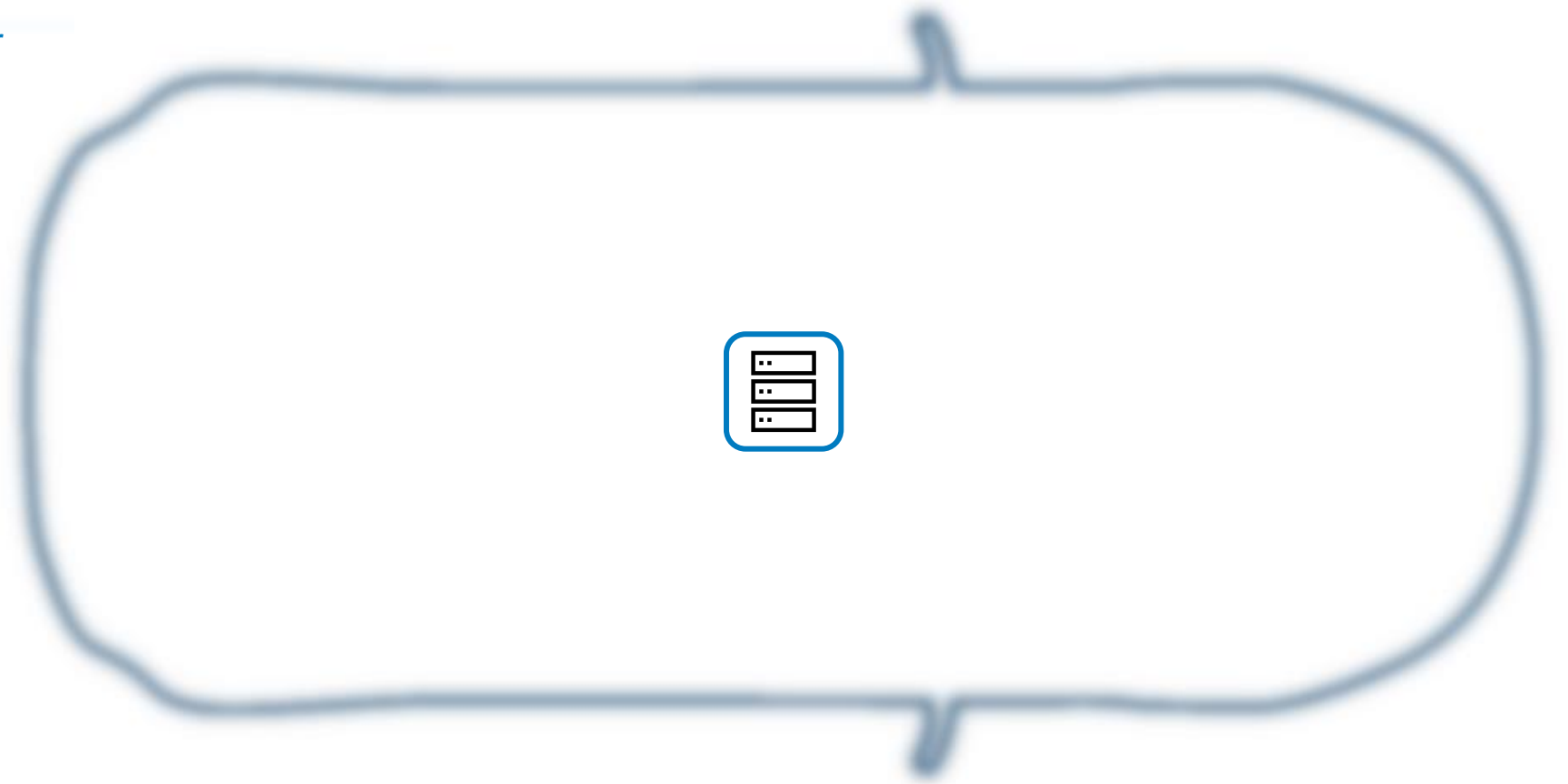


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Example Architecture



Vehicle Computer

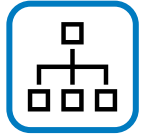


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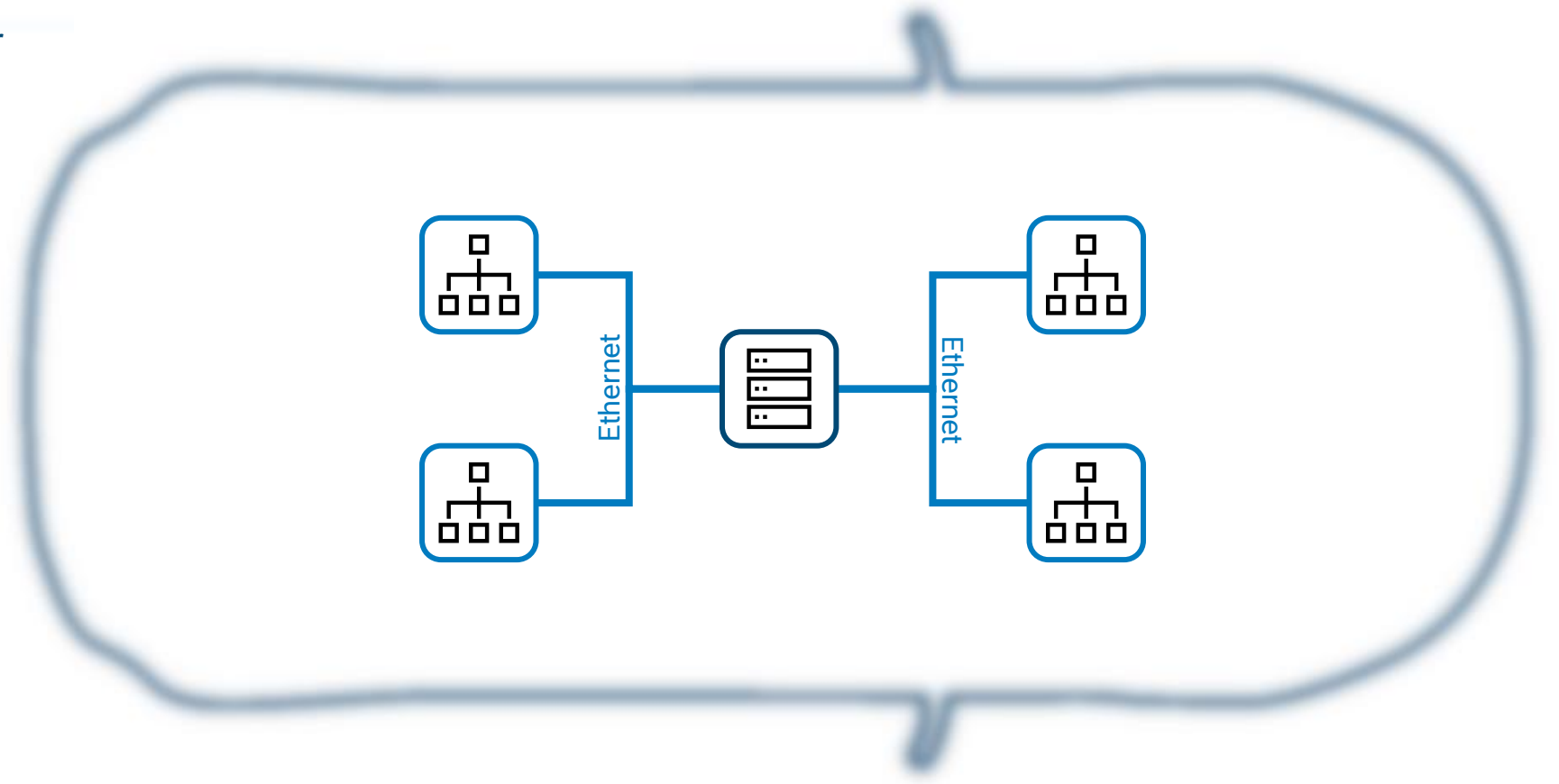
Example Architecture



Vehicle Computer

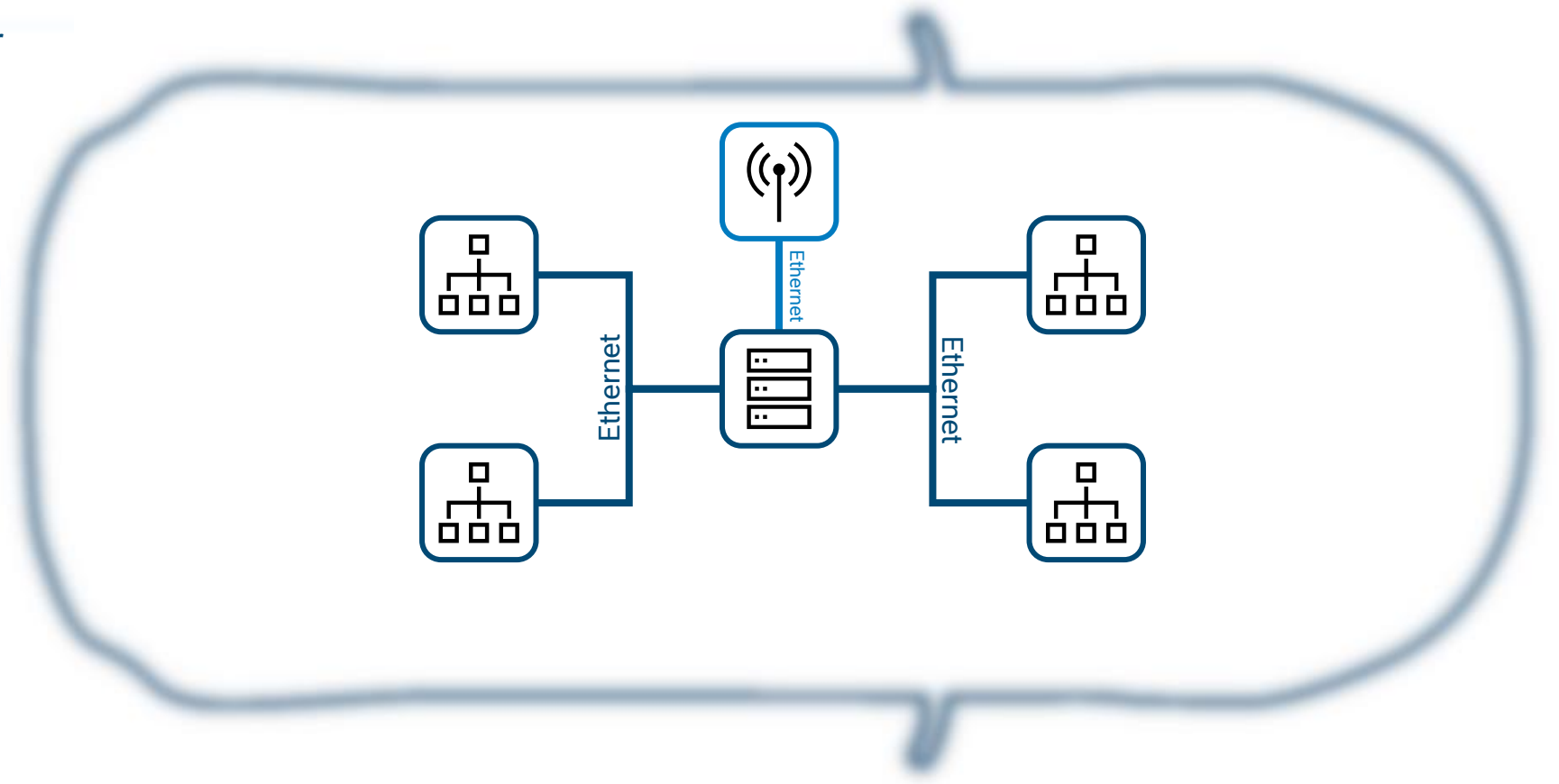
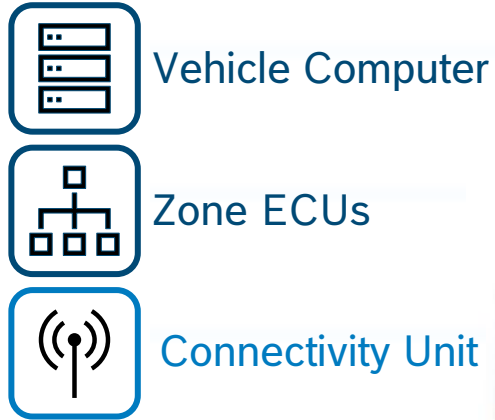


Zone ECUs



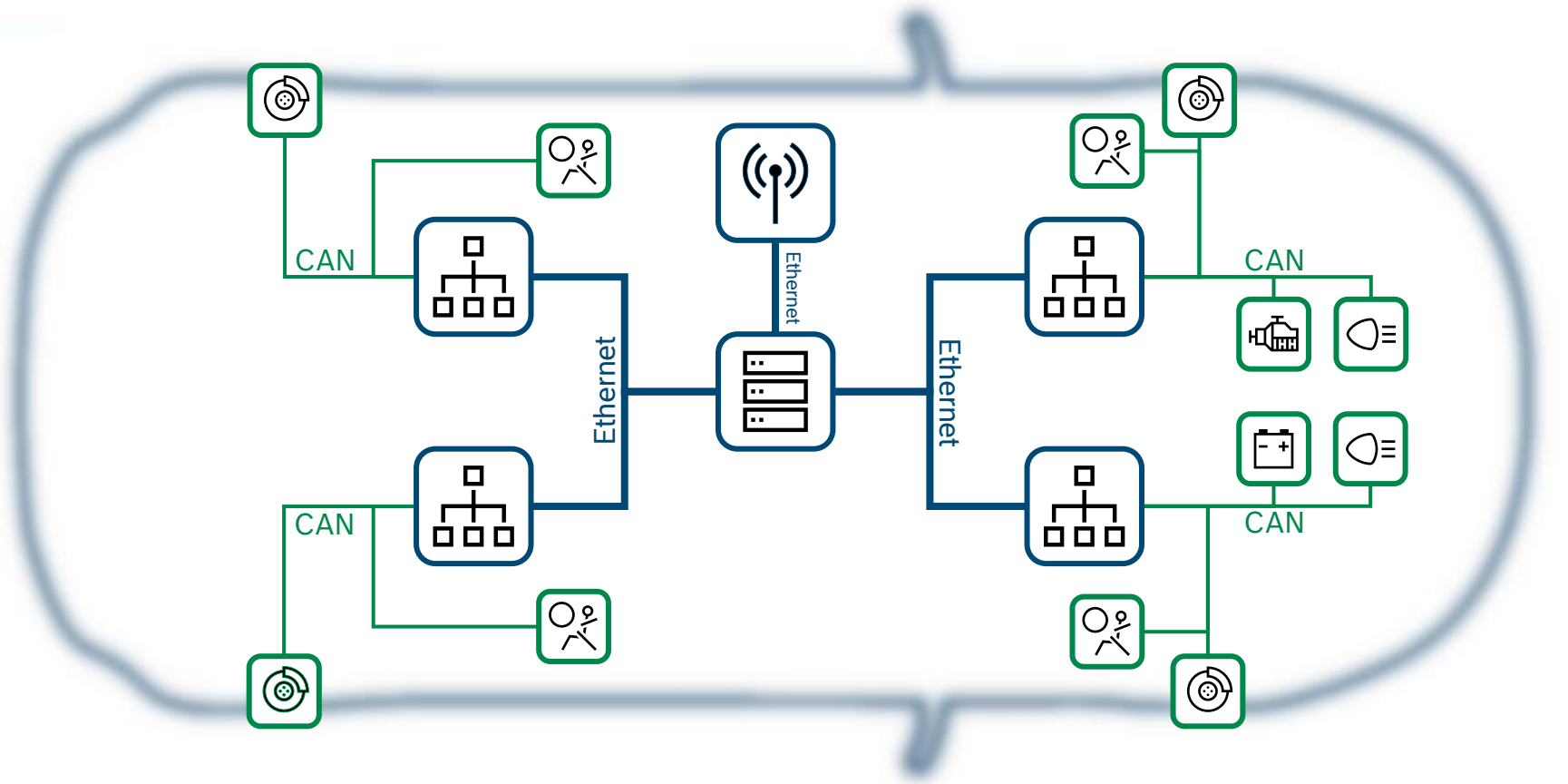
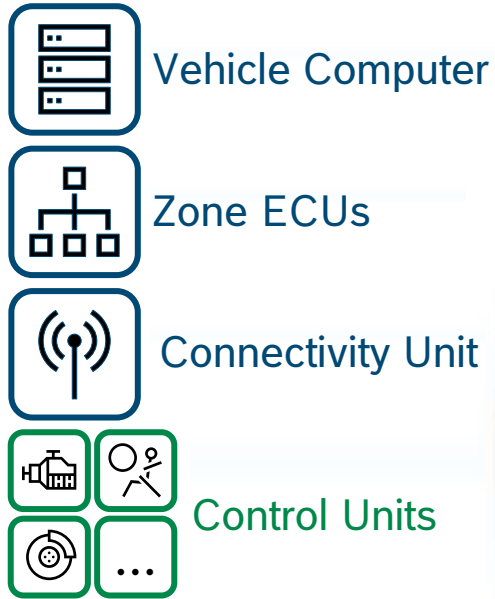
Automotive Networks

Example Architecture



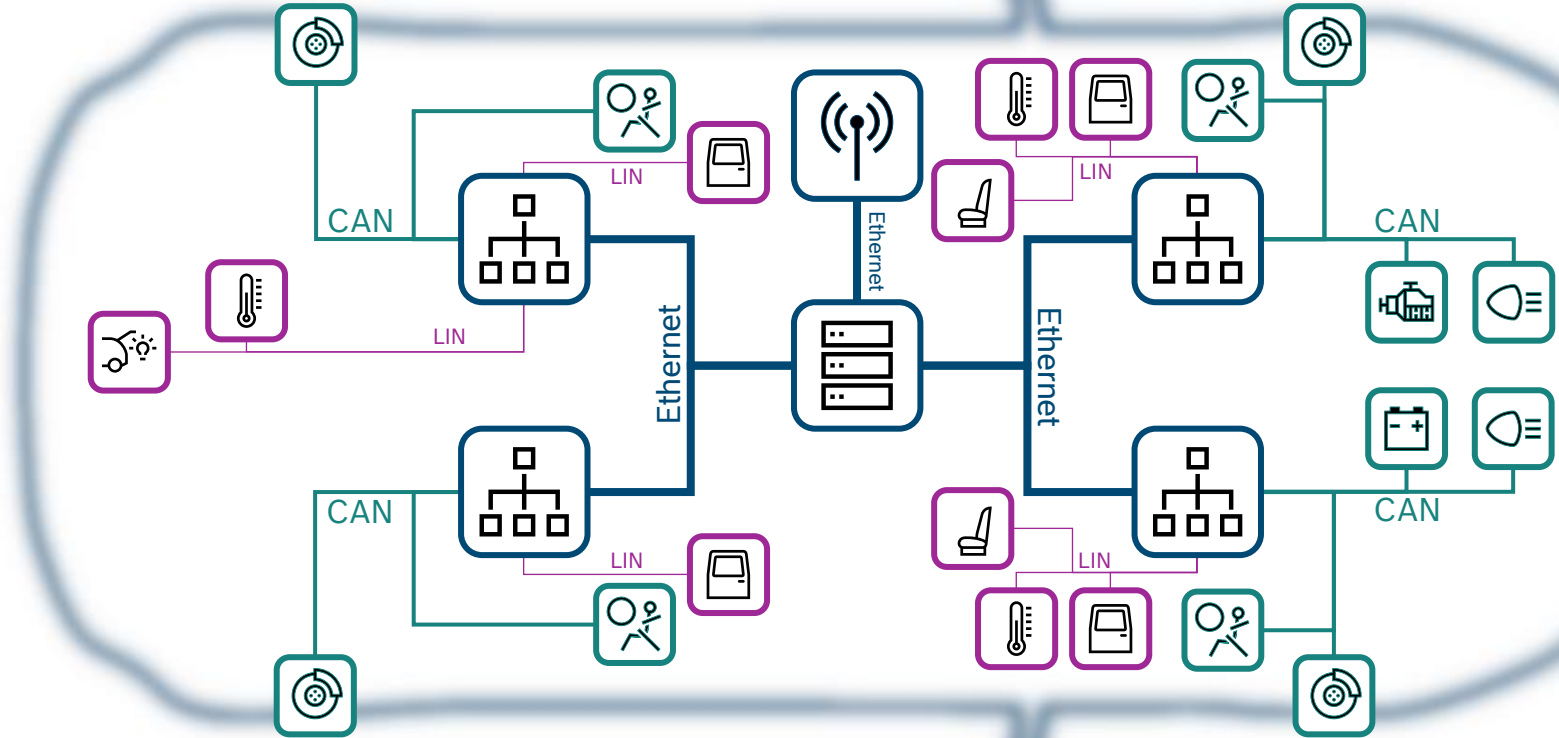
Automotive Networks

Example Architecture



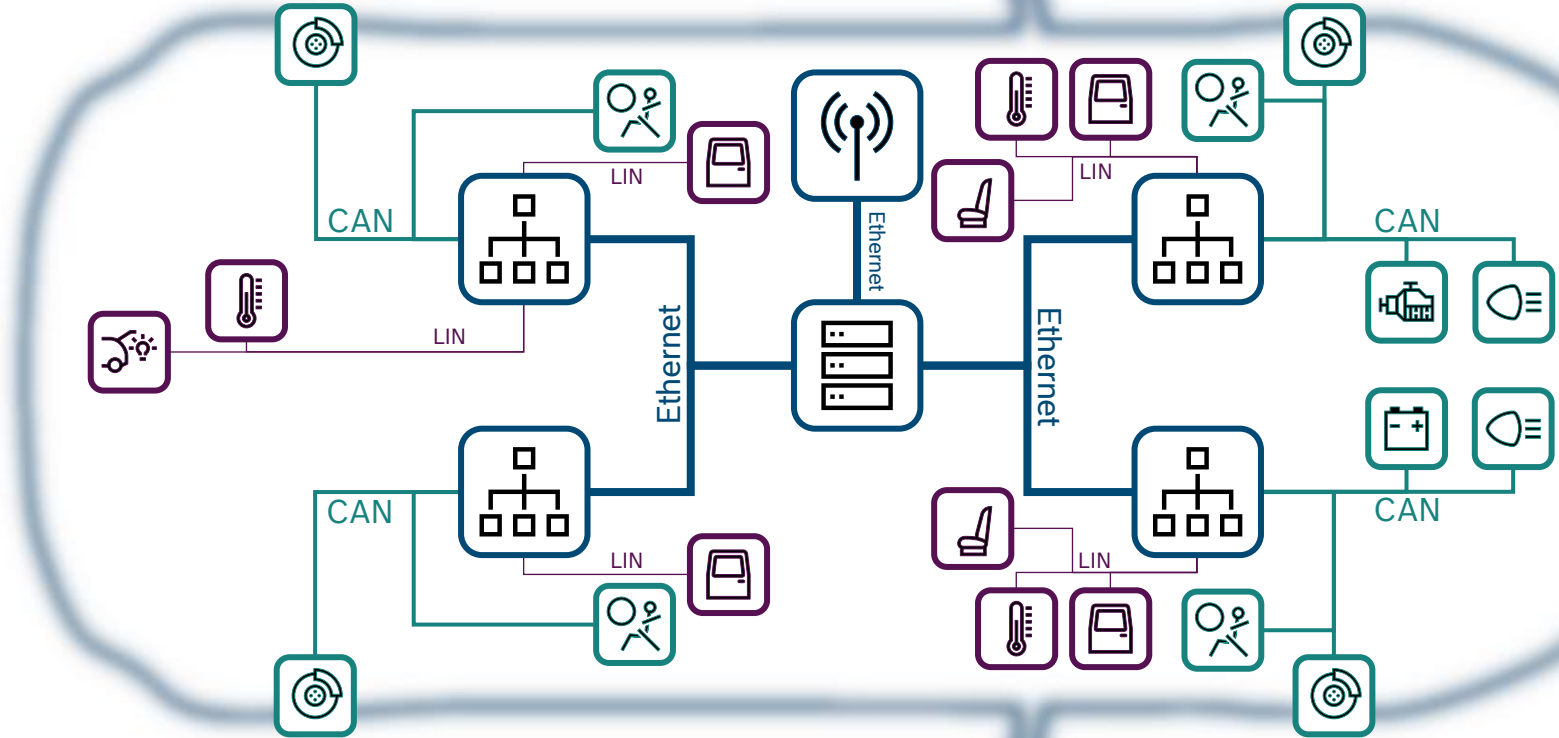
Automotive Networks

Example Architecture



Automotive Networks

Example Architecture





Thank You For Your Attention

✉ @error@chaos.social

✉ lara.hallaczek@bosch.com

Appendix A

Abbreviations

ACK	Acknowledge	MSB	Most Significant Bit
ADAS	Advanced Driver Assistance System	PAM	Pulse-amplitude modulation
CAN	Controller Area Network	PID	Protected Identifier
CAN-FD	Controller Area Network Flexible Data-Rate	r	Reserved
CRC	Cyclic Redundancy Check	RTR	Remote Transmission Request
DEL	Sync Break Delimiter	Rx	Receive
DLC	Data Length Content	SCI	Serial Communication Interface
DoCAN	Diagnostic communication over CAN	SFD	Start Frame Delimiter
DoIP	Diagnostics over IP	SOF	Start of Frame
ECU	Electronic Control Unit	SRR	Substitute Remote Request
E/E Architecture	Electrical/Electronic Architecture	TCP	Transmission Control Protocol
FCS	Frame Check Sequence	Tx	Transmit
IDE	Identifier Extension	UDP	User Datagram Protocol
IP	Internet Protocol	UDS	Unified Diagnostic Services
LIN	Local Interconnect Network	UDSonCAN	Unified Diagnostic Services on CAN
LSB	Least Significant Bit	UDSonIP	Unified Diagnostic Services on IP
MAC	Media Access Control	UDSonLIN	Unified Diagnostic Services on LIN
MOST	Media Oriented Systems Transport		

Appendix B

Relevant Standards

- [1] Institute of Electrical and Electronics Engineers, “IEEE Std 802.3bw: IEEE Standard for Ethernet Amendment 1: Physical Layer Specifications and Management Parameters for 100 Mb/s Operation over a Single Balanced Twisted Pair Cable (100BASE-T1)”.
- [2] International Organization for Standardization, “ISO 11898: Road vehicles — Controller area network (CAN)”.
- [3] International Organization for Standardization, “ISO 17987: Road vehicles — Local Interconnect Network (LIN)”.