CAN XL Overview

ME-IC/PRM-IP | March 14th, 2024

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CAN XL Overview
Agenda

- Motivation & Availability
- Key Features
- Transceiver & Performance
- Comparison & Use Cases

CAN XL – Next Step in CAN Evolution
Motivation & Overview

Target / Motivation

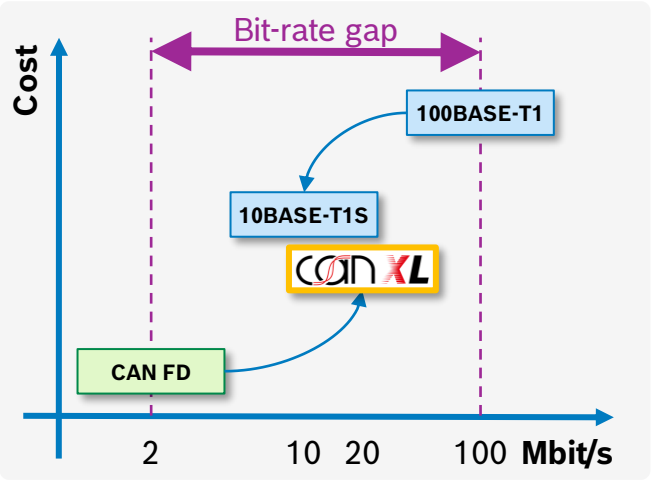
20 Mbit/s CAN technology that …

Has the well-known CAN properties

- Cost efficient (Transceiver, Cabling, …)
- Arbitration, Robustness
- Complex topologies, long stubs

Fulfills upcoming needs

- Large payload size
- Quality of Service
- Safety
- Security
- CAN FD compatibility (mixed networks)
- “IP communication to the edge”



Compatibility of CAN FD and XL

- E/E Architecture design freedom
  - “**XL only**” network: ≤ 20 Mbit/s
  - “**mixed FD/XL**” network: ≤ 8 Mbit/s
- Incrementally upgrade FD networks with XL nodes

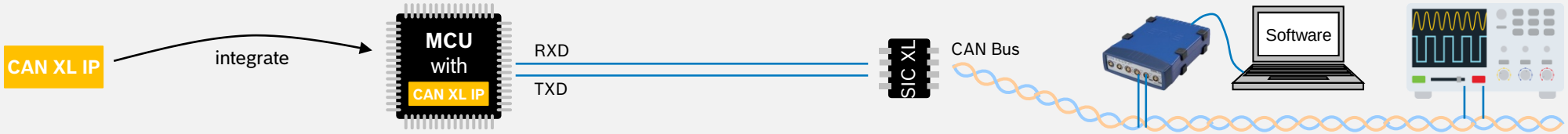
Key Success Factors

1) **Single bus for 3 types of traffic**
   CAN FD, CAN XL and Ethernet
2) **Bit rate up to 20 Mbit/s**
   All CAN Transceivers usable (HS-CAN, FD, SIC, SIC XL)
3) **Large payload size (1 .. 2048 bytes)**
   enough space for any application
4) **Ethernet Tunneling**
   brings “IP Comm. to the edge”
5) **Incremental upgrade**
   Allows CAN FD and CAN XL on the same network (up to 8 Mbit/s)
6) **Scalable**
   flexible tradeoff between cost, speed and network complexity
7) **Broad availability**
   majority of nextGen automotive µCs

IP: Internet Protocol

CAN XL – Next Step in CAN Evolution
Availability

CAN XL is ready to use!



CAN XL IPs (RTL)

- **Bosch:** X_CAN [available]
- **CAST (Fraunhofer IPMS)** [available]
- **NXP** [use in S32Z2/E2]
- **Vector** [for own tools]
- **Kvaser** [announced]
- **Peak** [announced]
- **Others** [in preparation]

CAN XL VIP (Verification IP)

- Avery, SmartDV, Cadence

MCUs with CAN XL

- **Infineon**: announced the AURIX™ TC4x Family with CAN XL [samples available]
- **NXP**: Preproduction of the S32Z2 and the S32E2 with each 2x CAN XL [samples available]
- **STM**: Stellar P Family [data sheet] [samples available]
- **Renesas**: new MCU of RH850/U2x series with CAN XL [samples since 2024]

CAN SIC XL Transceiver

- **TI**: TCAN6062 (8 pin) [samples available] Additional devices to follow
- **NXP**: concept silicon (Albi) [samples available]
- **Bosch**: concept transceiver available on SBC [samples available]
- **Bosch**: PMIC SBC (CS530) with SIC XL transceiver [samples available]
- Infineon: concept transceiver [samples available]

Tooling / Software

- **Vector**: CANoe tool [available]
- **Keysight**: decoder [available]
- **LeCroy**: decoder [available]
- **Rohde & Schwarz**: decoder [available]
- **Pico Techn.:** decoder [available]
- **C&S:** FPGA Eval. Board with 2x CAN XL [available]

AUTOSAR: CAN XL support
a) CAN XL: new features
b) Ethernet Tunneling via CAN XL
[available since Nov. 2022 release]

RTL: Register Transfer Level
SBC: System Basis Chip
IP: Intellectual Property

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CAN XL – Key Features

CAN XL – Next Step in CAN Evolution
Core Properties

Bitrate

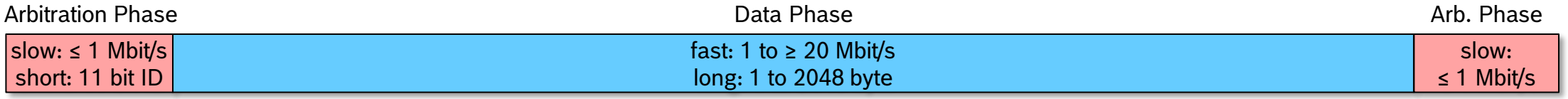
- **Arbitration** Phase: **≤ 1 Mbit/s**
- **Data** Phase: **1 … 20 Mbit/s,** user configured, tradeoff between bit rate & network topology

Data Field length

- Range: **1 … 2048 byte** (byte granularity)
- Enables: legacy CAN applications, Ethernet frame tunneling (IP to the “edge”), and more

New Features

- Virtual CAN Networks, better addressing, two powerful CRCs to protect the frame, …



CAN XL – Next Step in CAN Evolution
CAN FD & CAN XL are Compatible

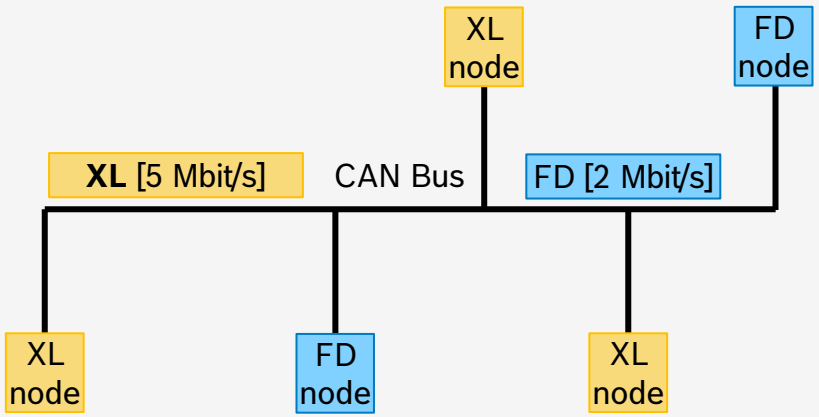
Technical solution

- CAN FD node ignores CAN XL frames
- CAN XL node understands both: FD and XL frames
- Limitation: Works up to 8 Mbit/s

➔ **Customer benefit**

- Mixed FD/XL networks ➔ save cabling
- Incremental upgrade ➔ re-use FD ECUs

Mixed CAN FD / CAN XL Network



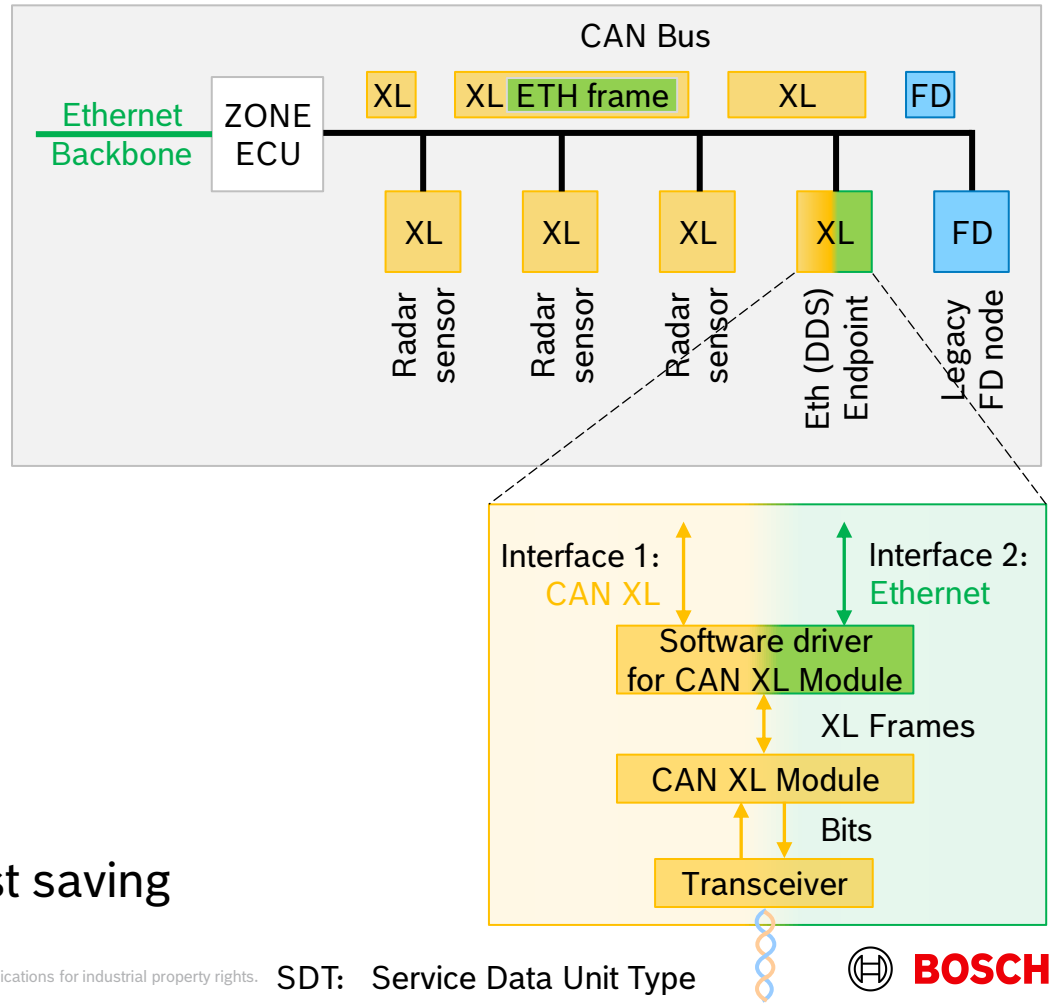
Bit-Rates: may be different in FD and XL frames
Arbitration-Phase: 500 kbit/s
FD Data-Phase: **2 Mbit/s**
XL Data-Phase: **5 Mbit/s**

ECU: Electronic Control Unit

CAN XL – Next Step in CAN Evolution
Ethernet Tunneling – brings “IP to the edge”

How does this work?

- SDT field indicates content of CAN XL frame
- SDT values are specified in CiA611-1
- **SDT=0x05 is Ethernet Frame**
- AUTOSAR supports CiA611-1 Ethernet tunneling
  ➔ e.g. used for **Service Oriented Communication**



➔ **Customer benefit**

3 types of protocols on one cable (FD, XL, ETH) ➔ cost saving

SDT: Service Data Unit Type

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CAN XL

Layer 1: Physical Layer / Transceiver

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CAN XL – Next Step in CAN Evolution
Transceiver Types usable with CAN XL

All CAN Transceivers usable

- High Speed CAN Transceiver
  up to **1 Mbit/s** in Data-Phase
- FD Transceiver
  up to **2 Mbit/s** in Data-Phase
- SIC Transceiver (Signal Improvement)
  up to **8 Mbit/s** in Data-Phase
- SIC XL Transceiver
  up to **20 Mbit/s** in Date-Phase

All CAN transceivers are
(1) usable for XL &
(2) pin compatible

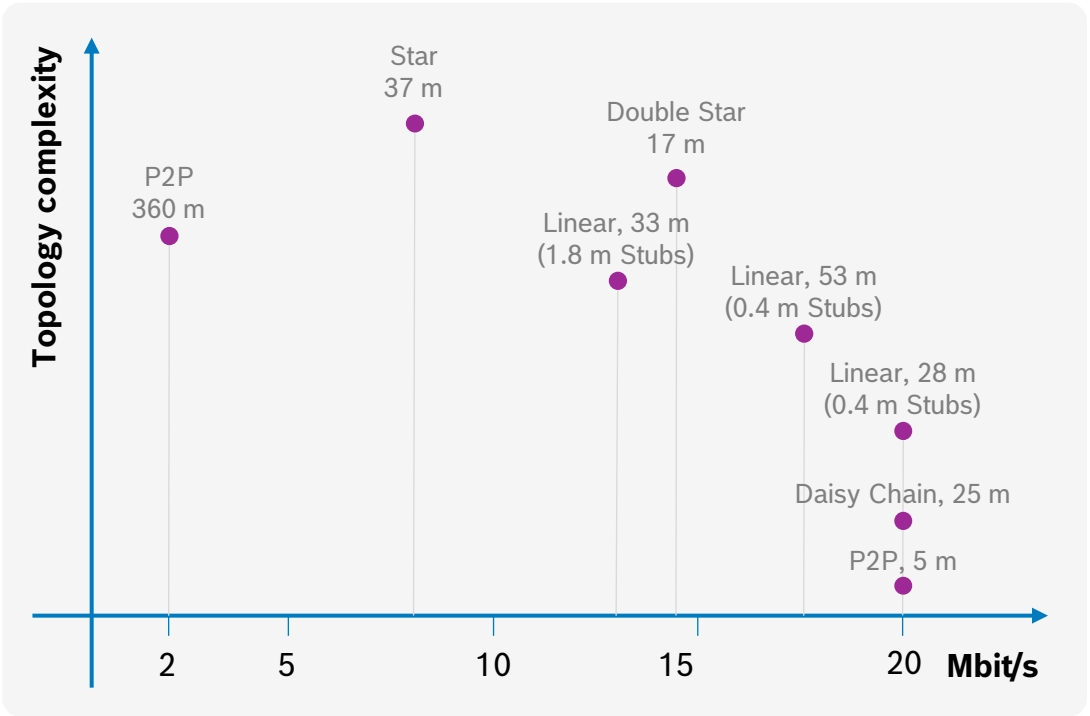
Transceiver defines node cost.
With same transceiver,
XL and FD cost the same!

CAN XL – Next Step in CAN Evolution

Physical Layer Performance – Results from Plugfests

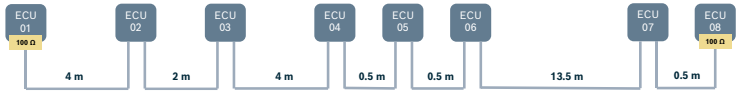
CAN XL Data Bit-Rate

with SIC XL Transceivers @ typical conditions

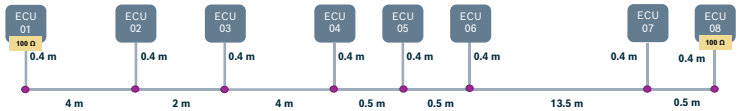


P2P
5 m & 360 m

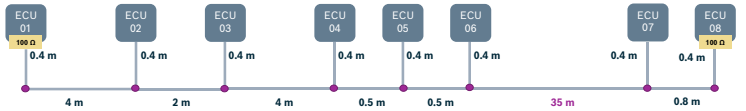
Daisy Chain
25 m



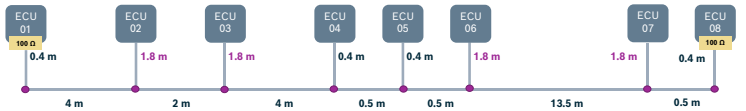
Linear
28 m, 0.4 m stubs



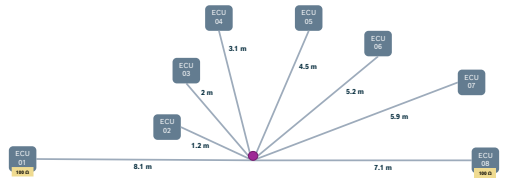
Linear
53 m, 0.4 m stubs



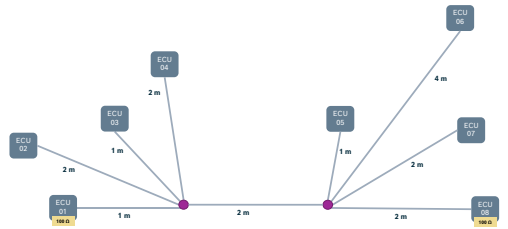
Linear
33 m, 1.8 m stubs



Star
37 m, long stubs



Double Star
17 m, long stubs



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Comparison & Use Cases

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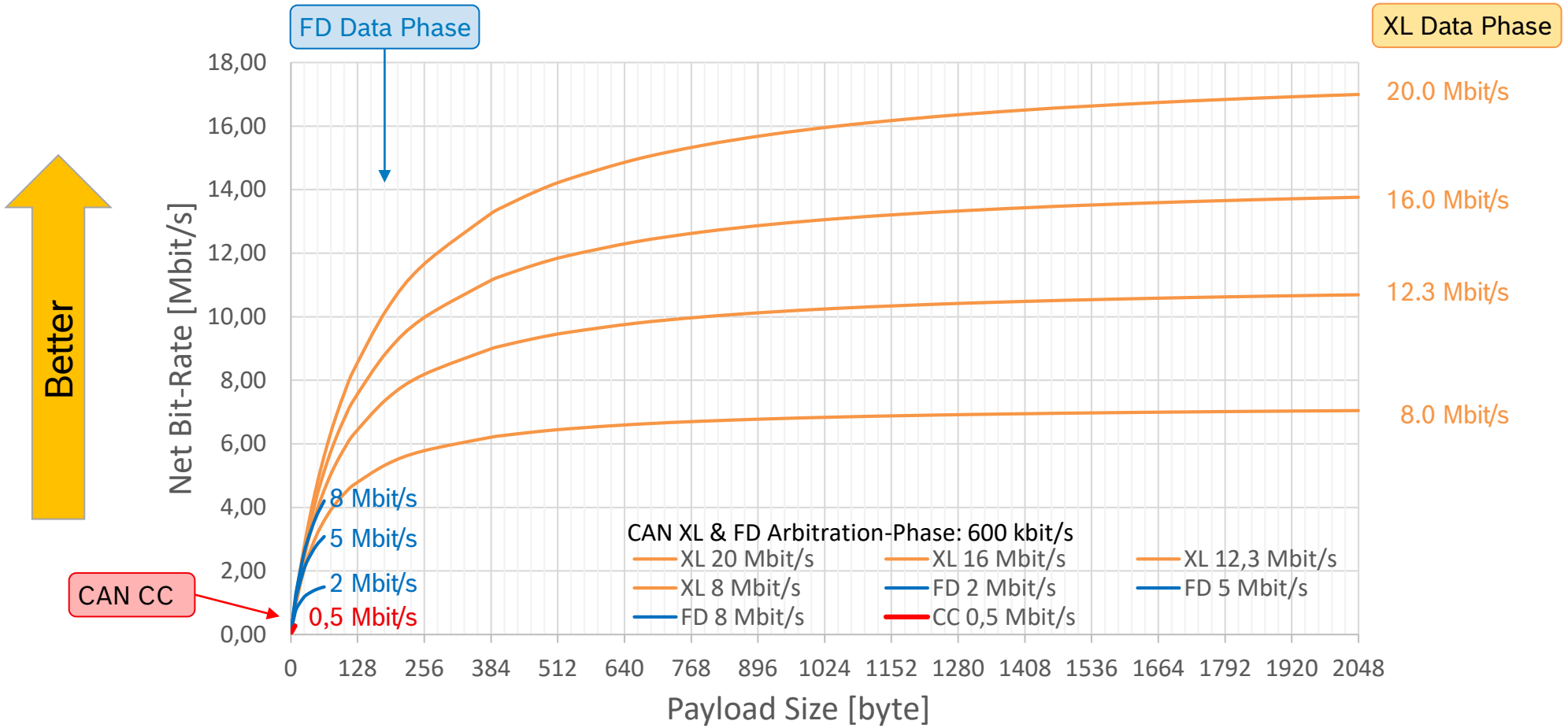
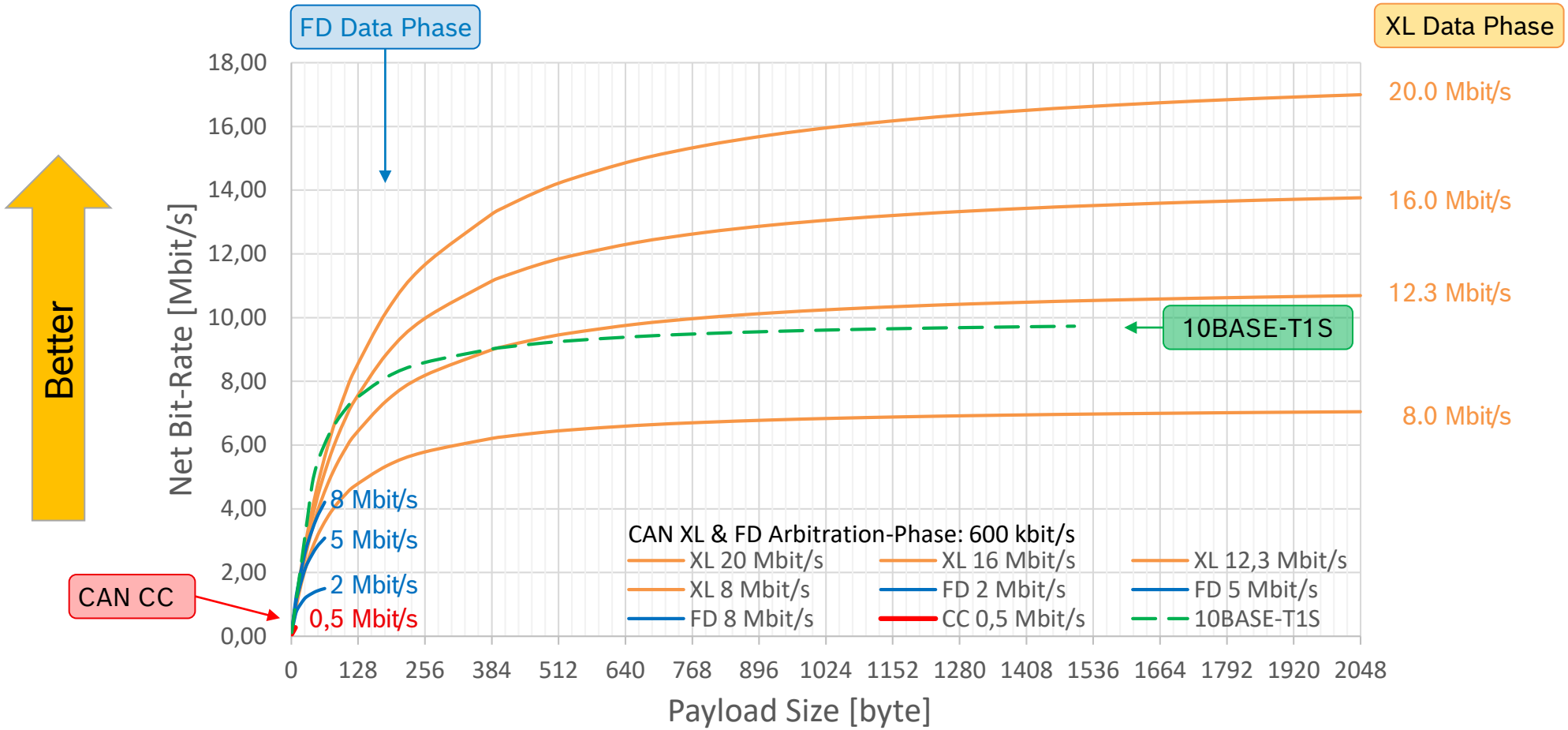
CAN XL – Next Step in CAN Evolution

Comparison – Net Bit Rate over Payload Size



CAN XL – Next Step in CAN Evolution

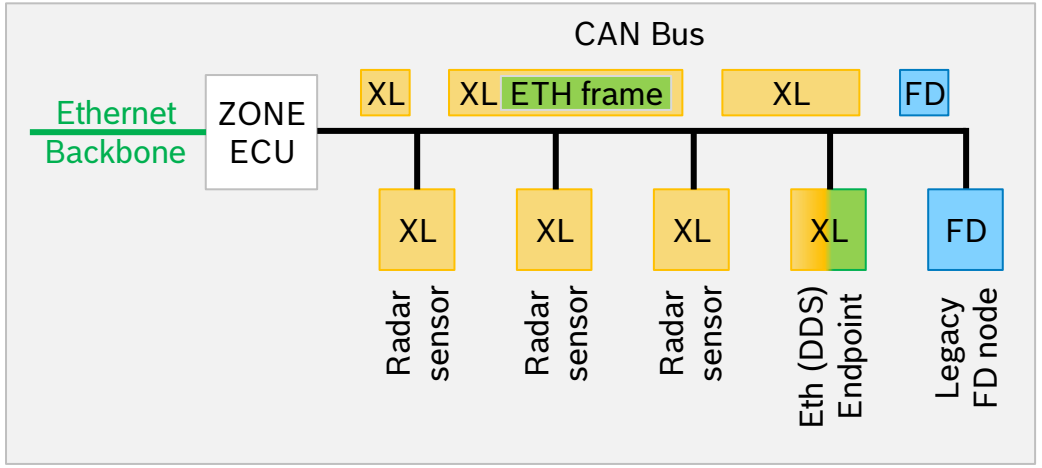
Comparison – Net Bit Rate over Payload Size



CAN XL – Next Step in CAN Evolution
Cost Optimal E/E Architectures with CAN XL

Single bus for 3 types of traffic

- XL, FD, and Ethernet frames share same cable
  (Ethernet tunneling brings “IP to the edge”)
- Ethernet tunneling standardized (CiA, AUTOSAR)
- Incremental upgrade of existing CAN FD networks



Topology freedom

- Any topology possible: from P2P to Double-Star
- Trade off: Bit-Rate vs. topology complexity

Transceiver choice: cost optimal

- CAN XL usable with any CAN transceiver
  SIC XL (20 Mbit/s), SIC (8 Mbit/s), FD (2 Mbit/s), HS-CAN (1 Mbit/s)
- Chose CAN transceiver based on required bit-rate

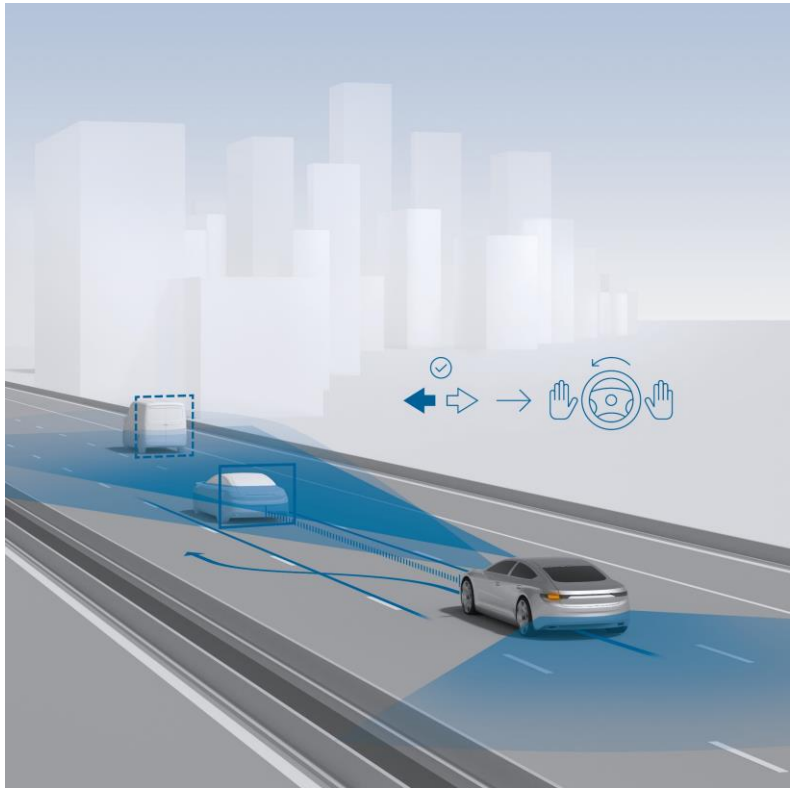
CAN XL – Next Step in CAN Evolution
Use Cases – Overview

- **Faster CAN FD** (Signal based communication)
  - Use XL like FD: Real time bus system with low latency for high priority traffic
  - But get more features, >64 byte payload, etc. ➔ same price as CAN FD up to 8 Mbit/s!
  - Incremental upgrade possible
- Speed up **Software Updates** (Flashing)
  - New MCUs will support XL / FD / CC
  - Even if FD is used during driving ➔ use XL to reduce Software Updates times by factor 8
- Better & cheaper **physical layer for Ethernet**
  - Bring “IP to the edge” and enable Service Oriented Communication
- **Share the bus** between different applications ➔ cost efficient solution for the Zone
  - XL enables (via SDT field, and VCID field) to share the same cable (bus) between applications
  - Essential feature for Zone architectures

DoIP: Diagnostic over internet protocol

CAN XL – Next Step in CAN Evolution
Use Case – Radar

1. **Radar Data needs higher bit-rates than CAN FD**
   - Send (Processed) Radar data (Object, Target, and Functions) with up to 20 Mbit/s: e.g. send more objects compared to CAN FD
   - Future proof for next generation of automotives
2. **Lower Cost compared to CAN FD daisy chain topology**
   - Many radar solution are connected via CAN FD
   - Save cost (Cabling, connector) compared to daisy chain CAN FD
3. **Tunneling Ethernet frames for DoIP**
   - Tunneling of ethernet frames for Diagnostics over IP (DoIP)
4. **CAN XL is a low-cost technology with up to 20 Mbit/s**
   - Scalable in cost (selection of transceivers)



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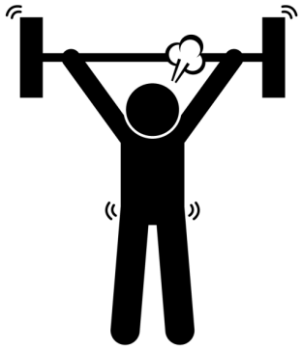
Summary

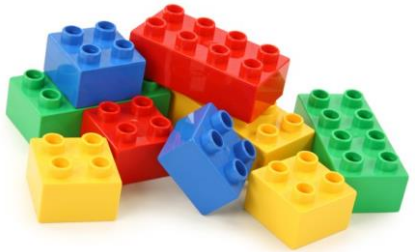
CAN XL – Next Step in CAN Evolution

Summary

CAN XL is the cost-efficient enabler for Zones (“last mile”):

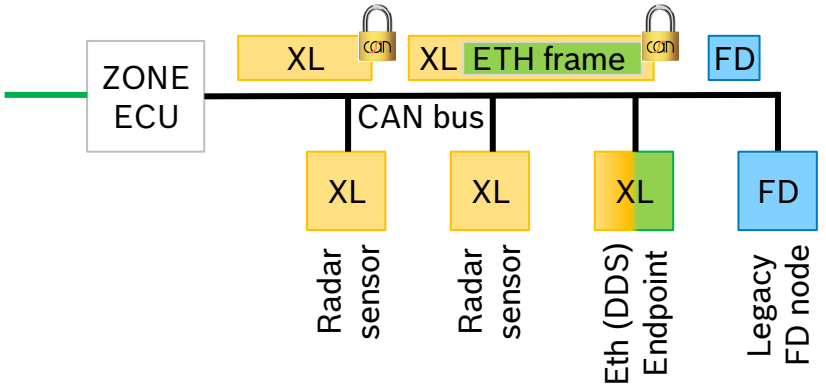


provides high
Throughput
up to 20 Mbit/s
up to 2048 byte



is
Flexible
cabling, bit-rate
transceiver

supports 3 protocols on the same bus
a) **XL & FD**
b) **Ethernet over CAN XL**



provides
L2-Security
via CANsec
(CiA613-2)