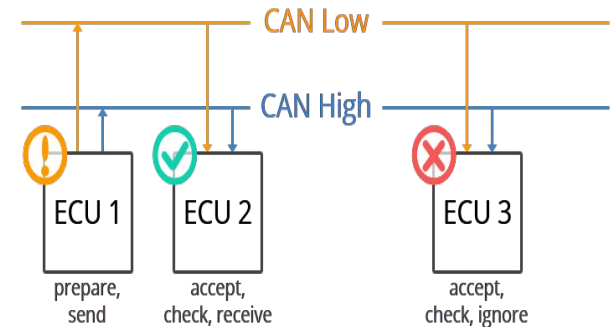
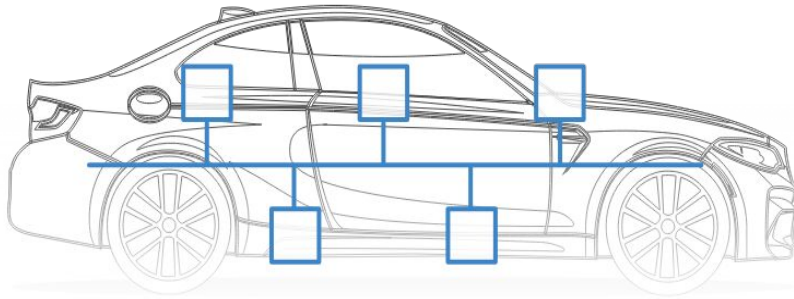
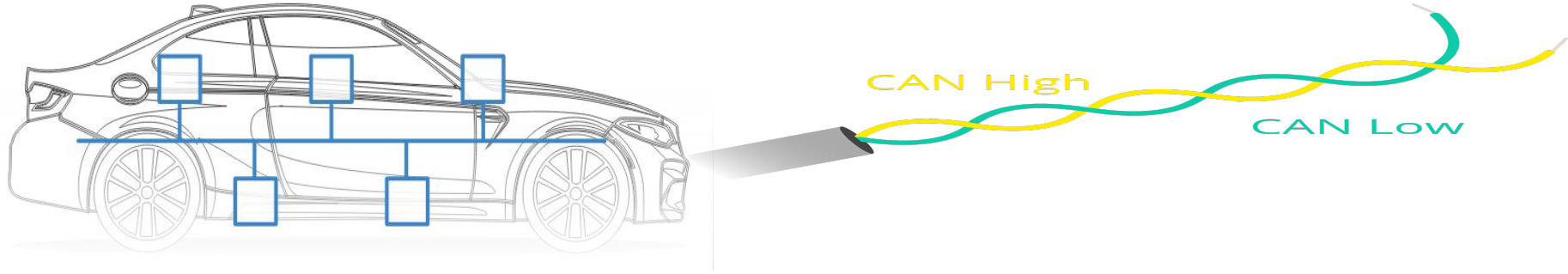


Controller Area Network Bus (CAN bus)



The Backbone of Modern Vehicle Communication



CAN bus (Controller Area Network) is a (vehicle bus standard/protocol) communication system used in vehicles/machines to enable ECUs (Electronic Control Units) to communicate with each other - without a host computer. For example, the CAN bus enables smart, quick and reliable sharing of information between your car's brakes and engine.

Originally developed to reduce the complexity and cost of electrical wiring in automobiles through multiplexing.

This innovative system promotes efficient data transfer, ensuring that critical operations function seamlessly.

Imagine your car is a human body,

The CAN bus is the nervous system, enabling communication.

In turn, ECUs are like parts of the body, interconnected via the CAN bus. Information sensed by one part can be shared with another.

In physical terms, all ECUs are connected on a two-wire bus consisting of a twisted pair: CAN high and CAN low. The wires are often color coded: CAN high is yellow (like the sun), CAN low is green (like the grass).



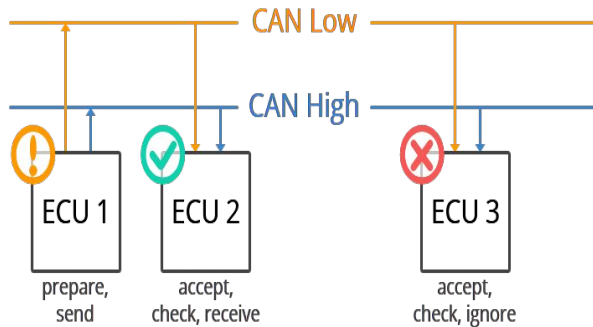
What is an ECU?

Electronic Control Units (ECUs) are components that control certain functionality - e.g. the engine control unit, transmission, brakes, steering, temperatures etc. A modern car can easily have 70+ ECUs - each sharing information with other ECUs on the bus.

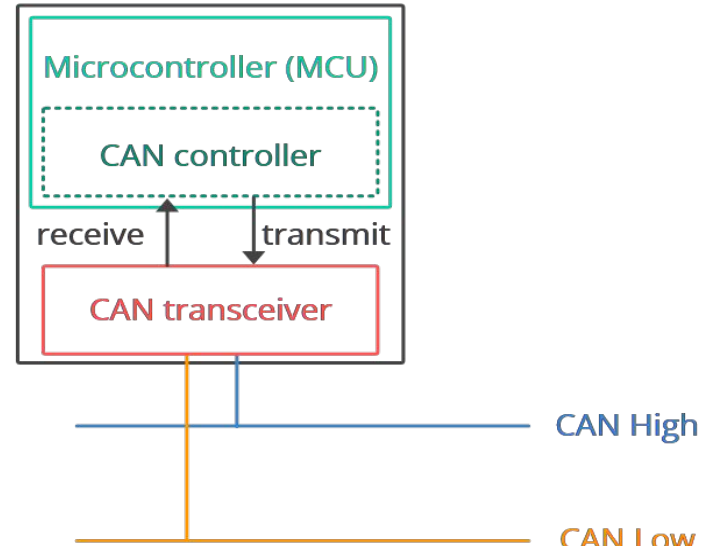
Any ECU on the CAN bus can prepare and broadcast information (e.g. sensor data). The broadcast data is accepted by all other ECUs on the network - and each ECU can then check the data and decide whether to receive or ignore it.

An ECU consists of three primary elements:

- **Microcontroller:** The MCU is the brain of the ECU - it interprets incoming CAN messages and decides what messages to transmit. For example, a sensor might be programmed to measure and broadcast oil temperature at 5 Hz
- **CAN controller:** The controller is typically integrated in the MCU and ensures all communication adheres to the CAN protocol (message encoding, error detection, arbitration etc.) - removing complexity from the MCU
- **CAN transceiver:** The CAN transceiver connects the CAN controller to the physical CAN wires, converting controller data into differential signals for the CAN bus system and vice versa. It also provides electrical protection.



ECU (Electronic Control Unit)



CAN bus variants

Before we proceed, it is useful to know that multiple variants of CAN exist:

- **Low-speed CAN:** Fault-tolerant CAN is a low cost option when fault tolerance is critical - but is increasingly replaced by LIN bus
- **High-speed CAN:** Classical CAN is the most common variant today across automotives/machinery (and the focus of this article)
- **CAN FD:** Offers longer payloads and faster speed, though adoption remains limited - learn more in our CAN FD intro
- **CAN XL:** Offers even longer payloads and faster speed to bridge the gap between CAN and Automotive Ethernet (100BASE-T1)

Benefits of CAN bus

The CAN bus standard is used in practically all vehicles and many machines due to below key benefits:

Simple & low cost

ECUs communicate via a single CAN system instead of via direct complex analogue signal lines - reducing errors, weight, wiring and costs.

Easy access

The CAN bus provides 'one point-of-entry' to communicate with all network ECUs - enabling central diagnostics, data logging and configuration

Extremely robust

The system is robust towards electric disturbances and electromagnetic interference - ideal for safety critical applications (e.g. vehicles)

Efficient

CAN frames are prioritized by ID so that top priority data gets immediate bus access, without causing interruption of other frames or CAN errors

The CAN bus history in short

- **Pre CAN:** Car ECUs relied on complex point-to-point wiring
- **1986:** Bosch developed the CAN protocol as a solution
- **1991:** Bosch published CAN 2.0 (CAN 2.0A: 11 bit, 2.0B: 29 bit)
- **1993:** CAN is adopted as international standard (ISO 11898)
- **2003:** ISO 11898 becomes a standard series
- **2012:** Bosch released the CAN FD 1.0 (flexible data rate)
- **2015:** The CAN FD protocol is standardized (ISO 11898-1)
- **2016:** The physical CAN layer for data-rates up to 5 Mbit/s standardized in ISO 11898-2 (in practice up to 8 Mbit/s)
- **2018:** CiA starts development of CAN XL
- **2024:** CAN XL standardized (ISO 11898-1:2024, 11898-2:2024)

Today, CAN is standard in automotives (cars, trucks, buses, tractors, ...), ships, planes, EV batteries, machinery and more

The future of CAN bus

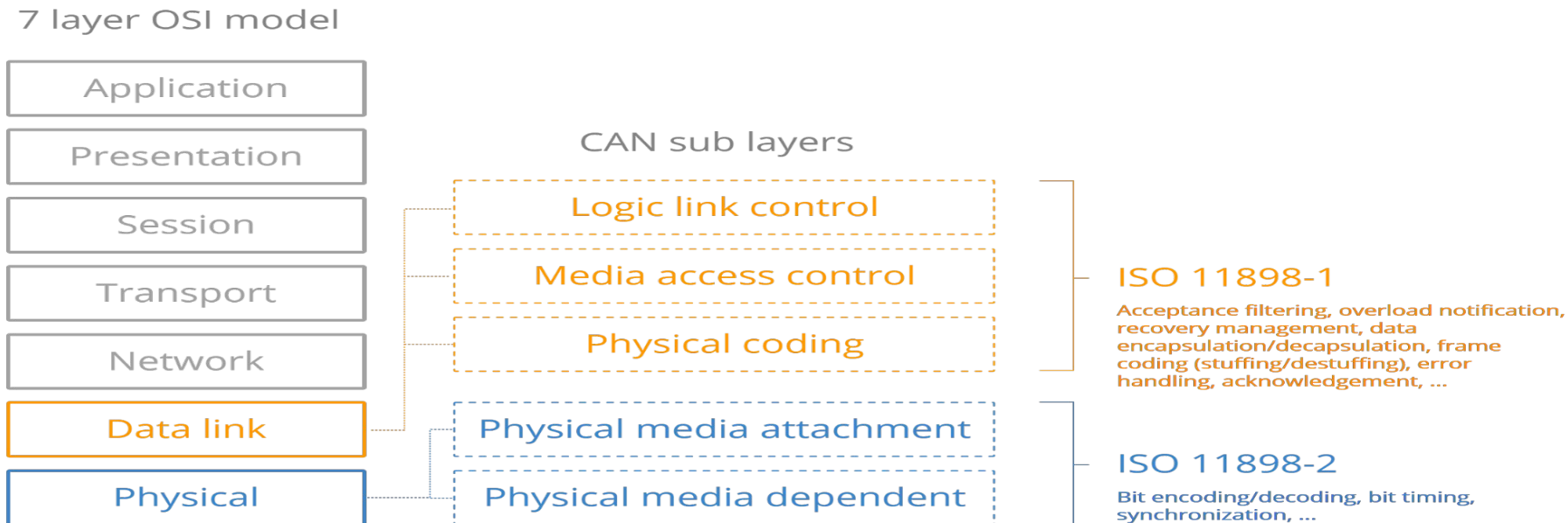
Looking ahead, the CAN bus protocol will stay relevant - though it will be impacted by **major trends**:

- **Need for speed:** Demand for higher data rates may drive transition towards CAN FD, CAN XL or Automotive Ethernet
- **Connected vehicles:** Rise of cloud computing and vehicle telematics may enable e.g. predictive maintenance and remote troubleshooting/updates - but also cybersecurity risks
- **Open vs. closed:** A push towards 'Open Source' and Right to Repair may face off vs. an OEM-driven demand for keeping data proprietary to e.g. offer subscription-based microservices

CAN physical & data link layer

In more technical terms, the controller area network is described by a data link layer and physical layer. For high-speed CAN, ISO 11898-1 describes the data link layer, while ISO 11898-2 describes the physical layer.

In the context of a 7 layer OSI model, CAN thus represents the two lowest layers as illustrated.



Physical layer (ISO 11898-2)

The CAN bus **physical layer** defines cable types, electrical signal levels, node requirements, cable impedance etc. For example, the physical layer specifies below:

- **Baud rate:** Nodes must be connected via a two-wire bus with baud rates up to 1 Mbit/s (Classical CAN) or 8 Mbit/s (CAN FD)
- **Cable length:** Maximal CAN cable lengths should be between 500 meters (125 kbit/s) and 40 meters (1 Mbit/s)
- **Termination:** The CAN bus must be terminated using a 120 Ohm termination resistor at each end of the bus

Data link layer (ISO 11898-1)

The CAN bus **data link layer** defines e.g. CAN frame formats, error handling, data transmission and helps ensure data integrity. For example, the data link layer specifies:

- **Frame formats:** Four types (data frames, remote frames, error frames, overload frames) and 11-bit/29-bit identifiers
- **Error handling:** Methods for detecting/handling CAN errors incl. CRC, acknowledgement slots, error counters and more
- **Arbitration:** Non-destructive bitwise arbitration helps manage CAN bus access and avoid collisions via ID-based priority

References

- 1 [Comprehensive Overview of CAN Bus Architecture in Automotive Design - Vehicle Empire](#)
- 2 [CAN Bus Explained - A Simple Intro \[2025\] – CSS Electronics](#)