OSI Layers in Automotive Networks

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Outline

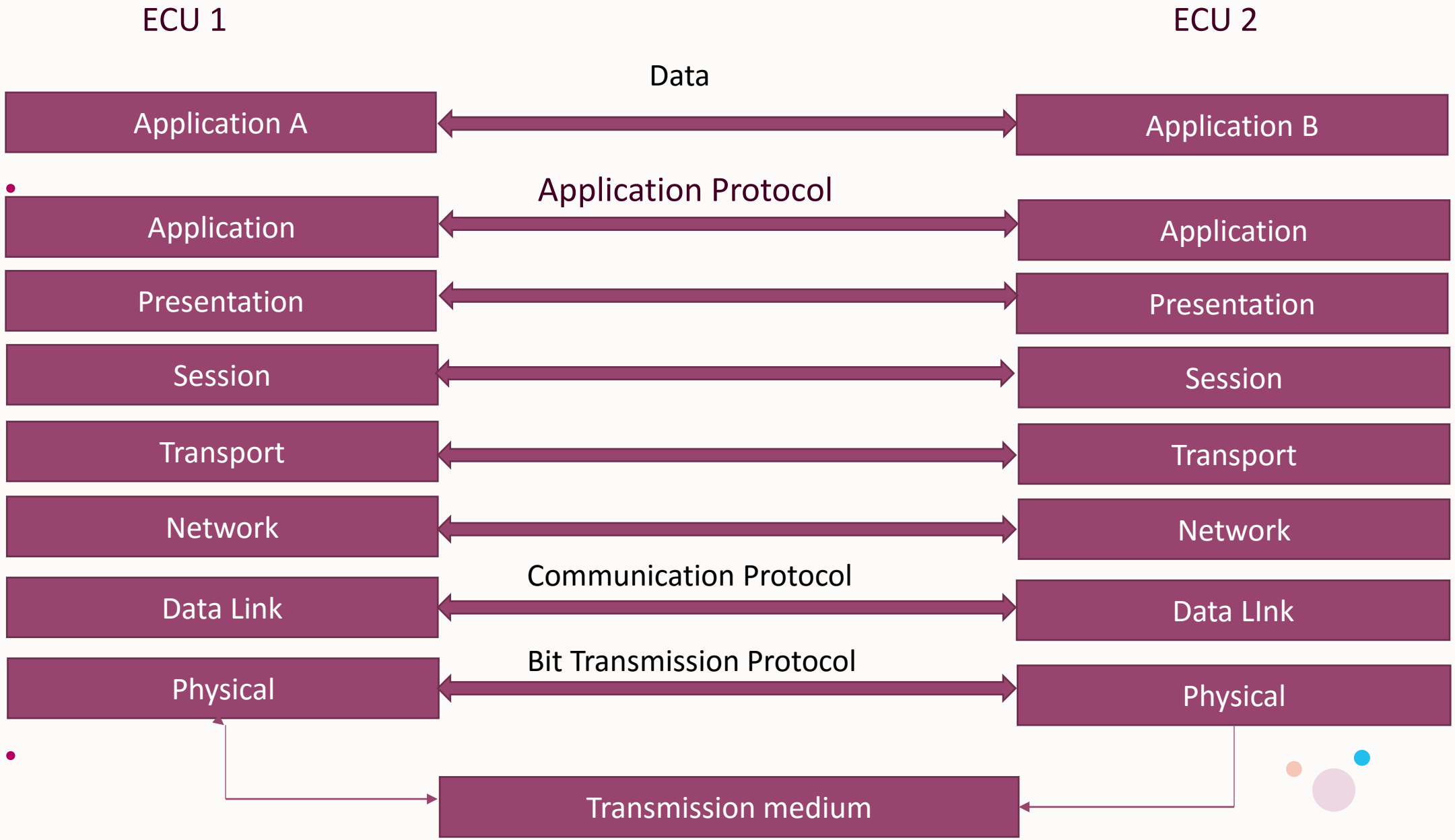
- OSI Reference Model
- Simplified generic Architecture for Automotive Serial Busses
- Automotive Bus Systems in the OSI Model
- Automotive Bus Systems in the OSI Model: Example of the CAN Bus
- Automotive Bus Systems in the OSI Model: Example of the FlexRay Bus

Why OSI Model?

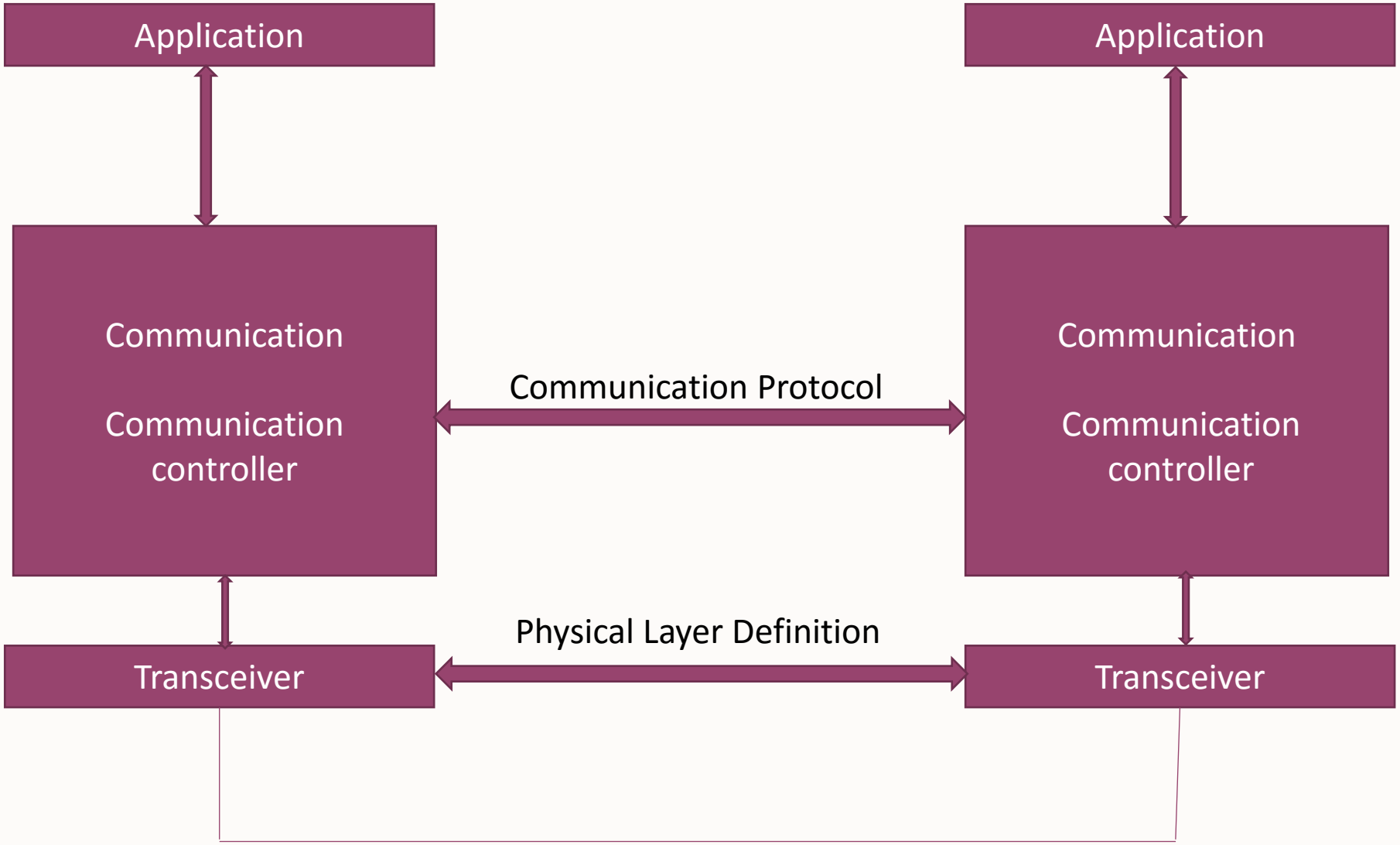
- OSI Model has two layers – upper layers and lower layers.
- The upper layer deals with application issues using the software.
- Application layers are nearest to the users.
- The layer above another one refers to the upper layer.
- The lower layer deals with data transport using hardware and software.
- Lowest layer is the physical layer as it deals with information placed on the physical medium.

- Allows users to understand network communication.
- Different network layers allow easier troubleshooting.
- The development of new technology is easier to understand through this model.
- Comparison of primary functional relationships is possible on various layers.

OSI Reference Model



Simplified generic Architecture for Automotive Serial Busses



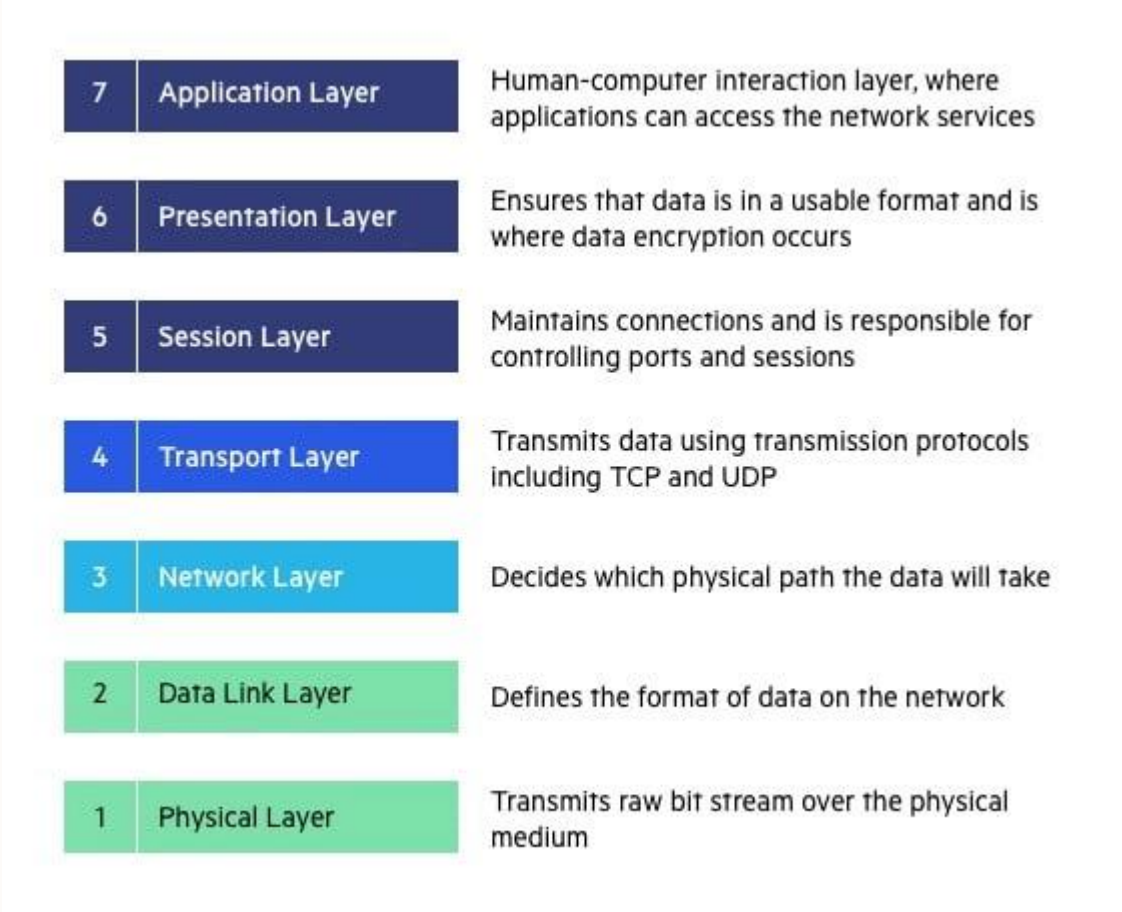
Automotive Bus Systems in the OSI Model: Example of the CAN Bus

- 7 Application
- 6 Presentation
- 5 Session
- 4 Transport
- 3 Network
- 2 Data Link
- 1 Physical

 Logical Link Control (LLC) Acceptance Filtering Overload Notification Recovery Management Medium Access control(MAC) Data Encapsulation/Decapsulation Frame Coding Error Detection/Signaling/Handling

 Physical Signaling (PLS) Bit Encoding/Decoding Bit Time Synchronization Physical Medium attachment(PMA) Driver/Receiver Characteristics Media Dependant Interface(MDI) Connectors

Layers……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Application Layer
Human-computer interaction layer, where applications can access the network services
6
Presentation Layer
Ensures that data is in a usable format and is where data encryption occurs
5
Session Layer
Maintains connections and is responsible for controlling ports and sessions
4
Transport Layer
Transmits data using transmission protocols including TCP and UDP
3
Network Layer
Decides which physical path the data will take
2
Data Link Layer
Defines the format of data on the network
1
Physical Layer
Transmits raw bit stream over the physical medium

1. Physical Layer

- It is the last layer of the model responsible for preparing physical devices in the network for data acceptance. It can also terminate the connection between two nodes of a network.
- This layer takes in raw data which goes to higher layers later. It also converts digital bits into other signals.
- Functions of Physical Layer of OSI Model
- It enables bit synchronization using a clock that controls both sender and receiver.
- It also controls the transmission rate or several bits sent per second.
- This layer decides the ideal topology type for node arrangement in a network.
- It decides the transmission mode between the devices.
- The physical consist of – Hub, Repeater, Modem, and Cables.
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2. Data Link Layer

- This layer allows access to get the data by breaking it into frames for easier analysis. This ensures that data is error-free and reaches the next layer in time. It sends data in the form of packets. It has two sub-layers –
- Logical Link Control is for transferring the packets to the next layer by identifying the protocol address from the header. Media Access Control Layer creates a link to the network's physical layer. This by obtaining the receiver's address using Address Resolution Protocol.
- Functions of Data Link Layer of OSI Model:
- It frames the data in a way that is meaningful to the receiver using special bit patterns.
- It adds physical addresses of both sender and receiver in every frame.
- This layer controls error by detecting and retransmitting frames.
- It controls the flow by calculating the amount of data before receiving it.
- It determines the extent of control devices have in a given time.
- Network Interface Card handles this layer using devices like switch & bridge

7. Application Layer

- This is the layer where users interact with the data. The layer identifies communication partners that will allow data transmission for an application. Some of the applications are – Browsers, Messengers, etc. Desktop Layer is another word for this layer.
- Functions of the Application layer of OSI Model:
- File management by allowing users to access, retrieve and manage the files on a remote computer.
- Allows users to go ahead with email forwarding and storage.
- Provides distributed database sources and global information about several objects.
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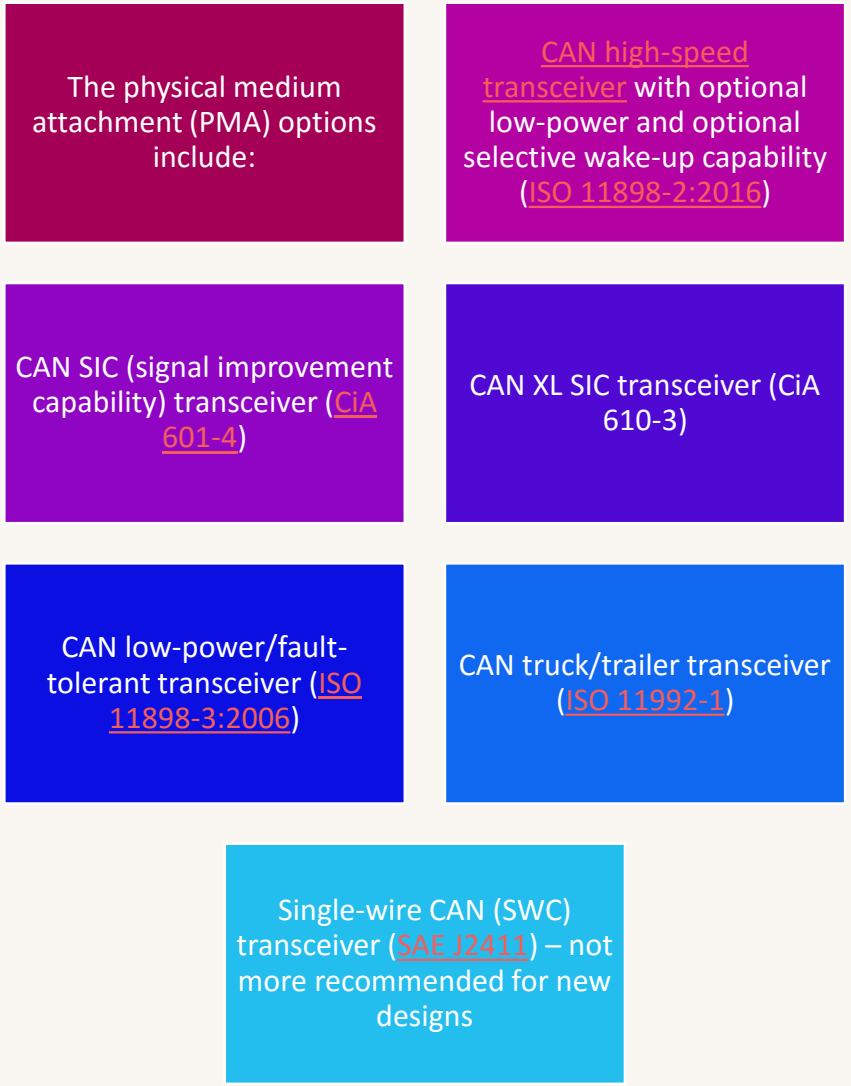
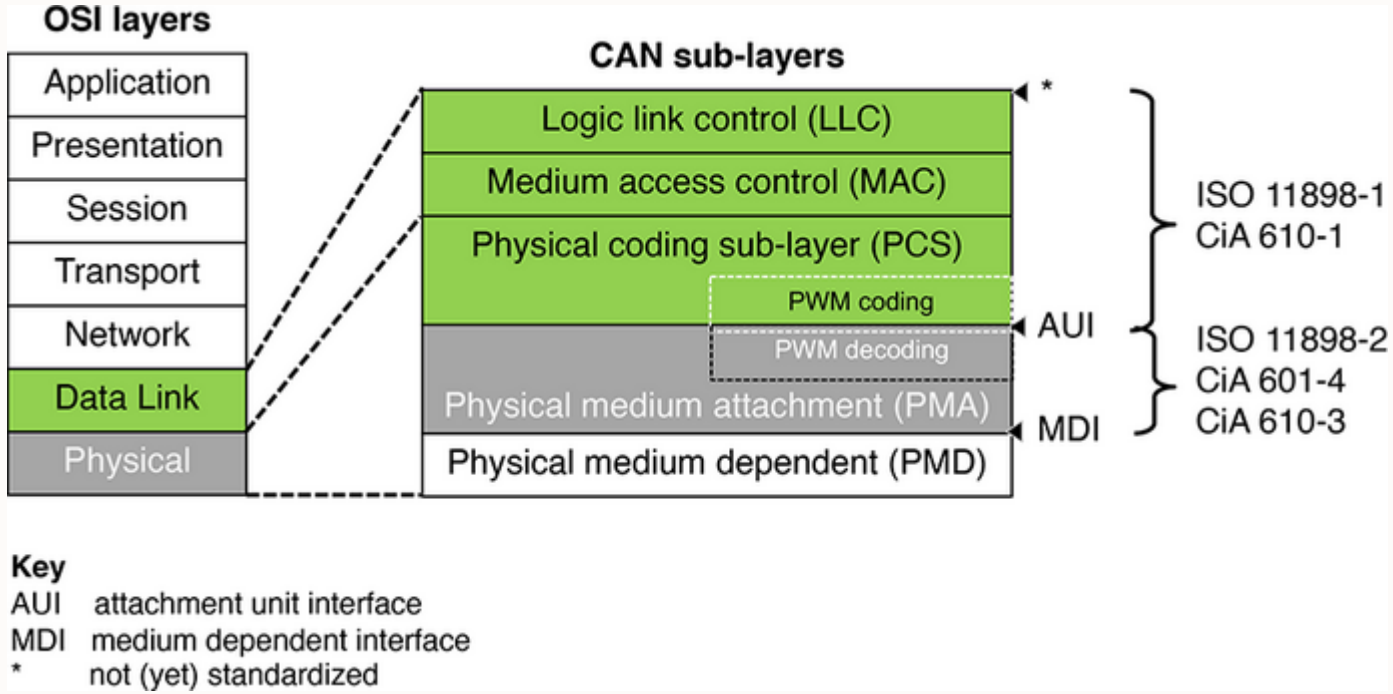
There are several CAN physical media attachment (PMA) sub-layers standardized



There are three CAN data link layer generations:
Classical CAN data link layer (1st generation)
CAN FD data link layer (2nd generation)
CAN XL data link layer (3rd generation)



All three generations use the same non-destructive bus-arbitration method. They support standardized data frame formats as well as error and overload frames. Remote frames are only featured by Classical CAN.

Automotive Bus Systems in the OSI Model: Example of the FlexRay Bus

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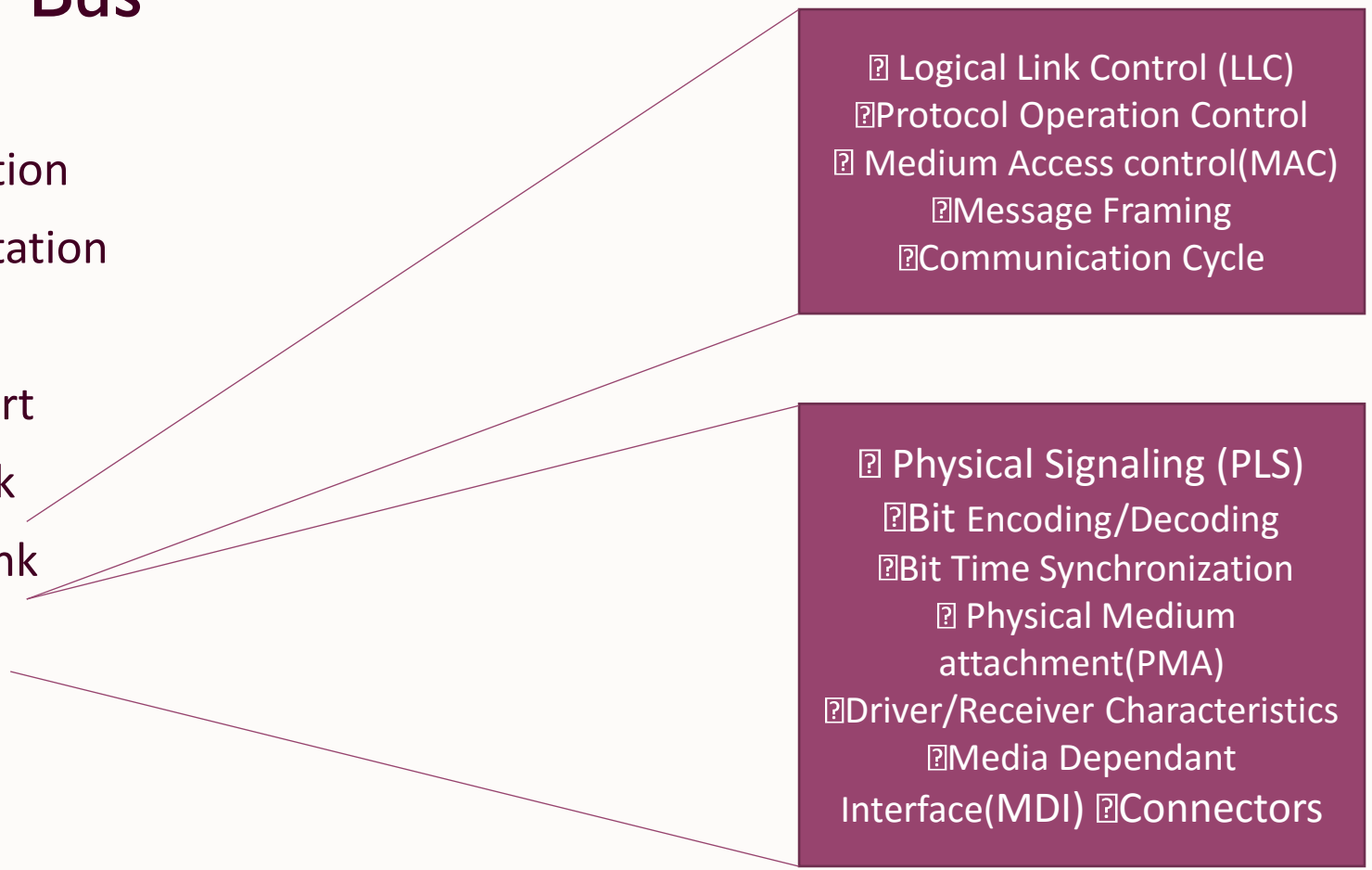

FlexRay?

- What is FlexRay used for?
- FlexRay is a communication bus designed **to ensure high data rates, fault tolerance, operating on a time cycle, split into static and dynamic segments for event-triggered and time-triggered communications**.
- Where is FlexRay protocol used?
- FlexRay is a serial communication technology that is used in particular for **data communication in very safety-critical use areas in the automobile**. Differential signaling on each pair of wires reduces the effects of external noise on the network without expensive shielding.
- What is difference between can and FlexRay?
- CAN is used in soft real-time systems. For example: In engines, power trains, chassis, battery management systems, etc. FlexRay is used in a hard real-time system

CONCLUSION

In reference to the OSI Data Communication Model, the Serial Interface of CAN, FlexRay and LIN Busses typically needs 3 OSI Layers for On-Board Communication excepted OBD: the **Physical Layer**, the **Data Link Layer** and the **Application Layer**

The most Bus covers all the 7 OSI Layers for On-Board Communication

The **Transport Layer** is used for Off-Board Communication like Diagnosis and also for OBD on these typical Automotive Area Networks. The Layers 3 and 4 can be used for Vehicle On-Board Communication in Car2X Communication Applications

Therefore, for a Control Data Communication that occurs in an In-vehicle closed Network, the need of the Layer 2 is justified.

Thank You for your Attention

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Transmitting data in CAN