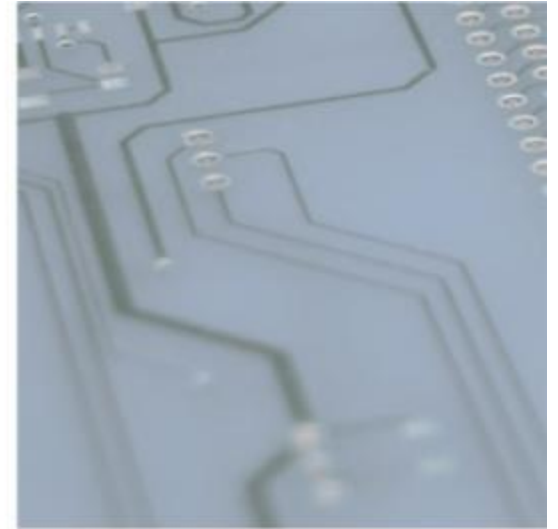
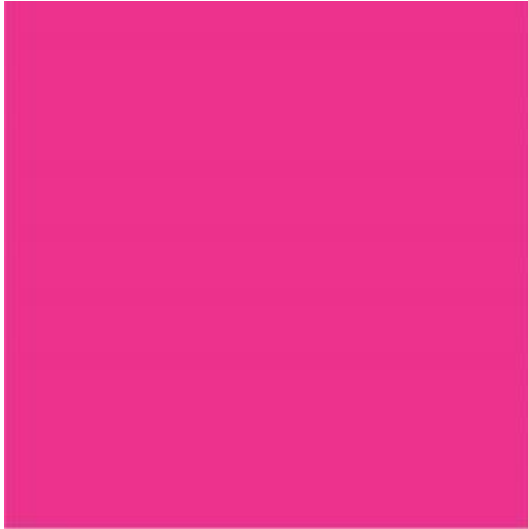


CAN Basics



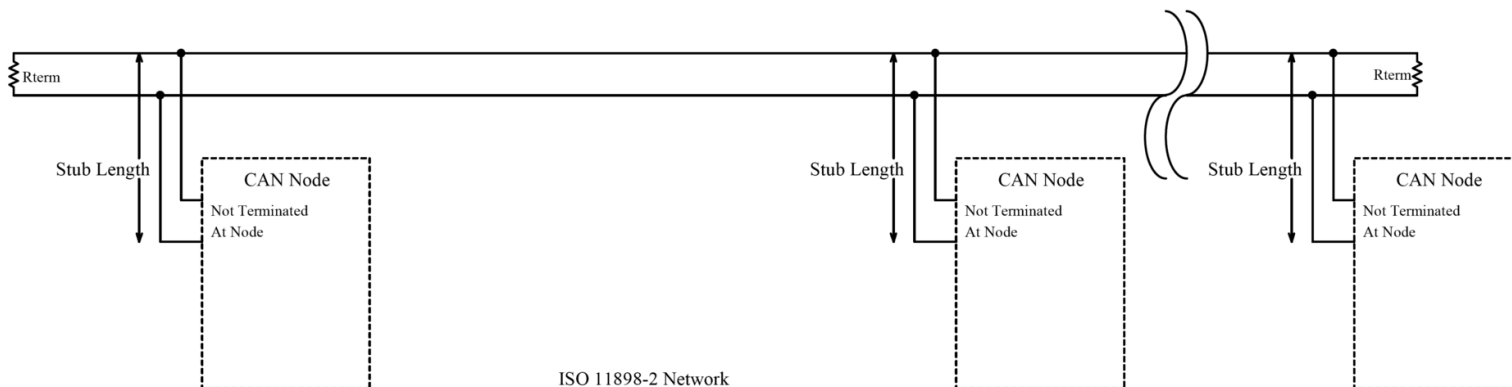
CAN Basics

- What is CAN
 - Topology
 - Objects of Communication Matrix
 - Communication Matrix
 - Message structure
 - Identifier
-

What is CAN?

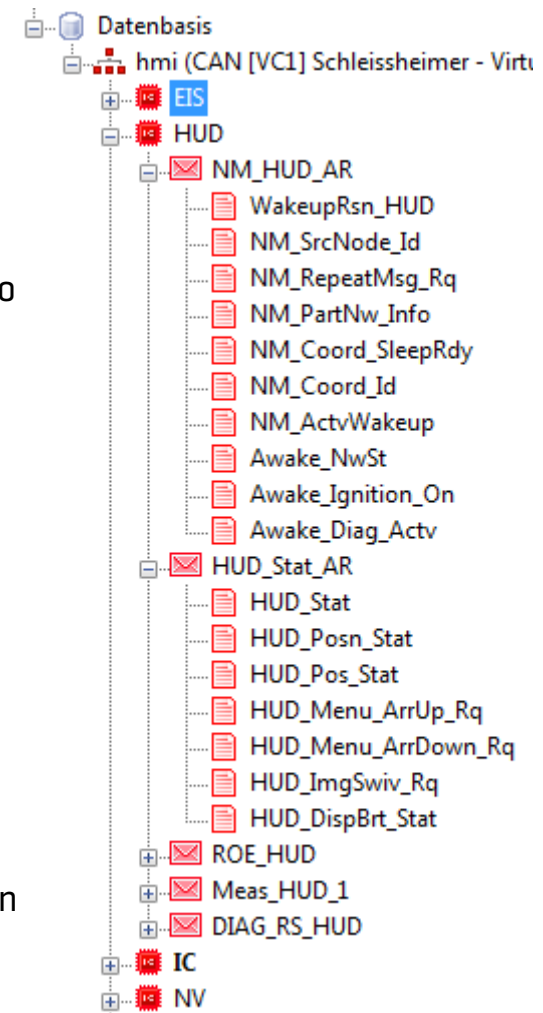
- CAN means „Controller Area Network“
- Defined in ISO-Standard 11898
- For networking electronic control units
- Often used in automotive environments
- CAN can work in difficult electrical environments
- Has real-time capabilities
- Asynchronous communication[connected control units work independent from each other]

- Linear topology [reduces the number and length of cables in vehicles]
- Multi-Master communication
- Carrier Sense Multiple Access/Collision Resolution [CSMA/CR]
- CAN bus systems are built using two parallel data cables [differential signal]
- Logical „1“ is recessive and logical „0“ is dominate [Wired-AND]
- For higher baud rates termination resistors are necessary at the ends (e.g. 120 Ω) to avoid reflections



Objects of CAN communication

- **Control units (ECUs, Nodes)**
ECUs are **E**lectronic **C**ontrol **U**nits, which independently accept, process and forward information.
- **Message (Telegram, Frame)**
A message is a bundle of information units, which is sent from one control unit on the CAN bus. All messages have a unique identifier.
- **Multiplex message**
A multiplex message contains different signals depending on the mode signal. The value of the mode signal refers to one or more included signals. This way, the limited amount of message IDs on the CAN data line can be used several times.
- **Signal**
A signal is a specific information unit within a message.
- **Attribute**
Attributes define additional information of an object in the communication matrix, describing it in detail or determining its dimensioning (e.g. cycle time).



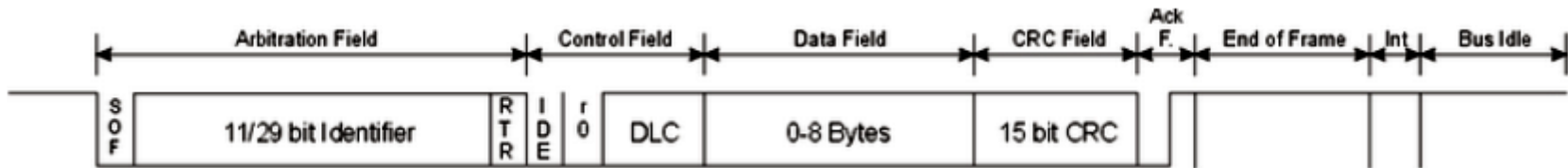
Communication Matrix

The communication matrix (or CAN matrix, K-Matrix) is a table structure, essentially defining the following:

- Which ECU sends which message with which cycle time
- Which ECU receives a certain message/signal
- Which signals are included in a message as well as their interpretation, i.e. how hexadecimal values are converted into physical or logical values
- Which identifier messages have

Message	Data Element Function	Type	Length [Bit]	Head Unit	HUD	ABS	Door Module	IC	Value	Description
IC_Base [0x247] (100 ms)	Steering wheel switch "-" pressed	Boolean	1	R	R			T		
	Steering wheel switch "Ok"	Boolean	1	R	R			T		
	Steering wheel switch "+" pressed	Boolean	1	R	R			T		
	Pressure unit	Enum	2	R				T	0	Bar
									1	Psi
									2	not defined
	Temperature unit	Enum	2	R				T	0	Celsius
									1	Fahrenheit
									2	not defined
	Vehicle speed unit	Enum	1	R	R	R	R	T	0	Vehicle speed unit "km/h"
									1	Vehicle speed unit "mph"
	Displayed vehicle speed	Scaled	12	R	R	R	R	T	0..4094	0.1 km/h

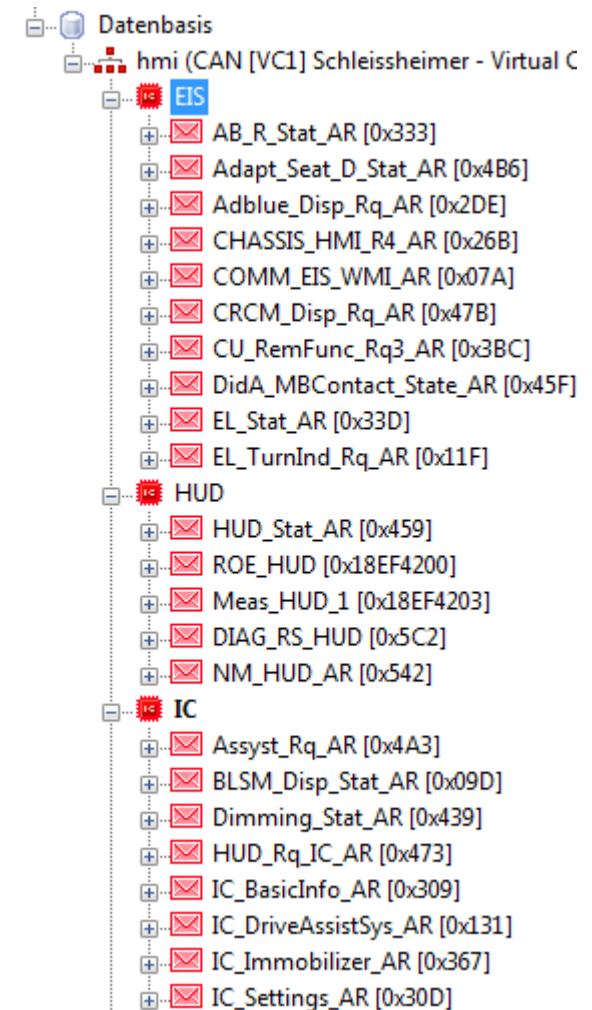
Structure of CAN Messages



- **SOF (start of frame):** Identifies start of frame.
- **Arbitration field:** Contains the identifier and the **RTR** bit (Remote Transmission Request). The RTR bit identifies whether the frame is a data frame or a request frame (remote frame).
- **Control field:** To distinguish standard and extended frame formats, the **IDE**-bit (identifier extension bit) is used. A reserved bit intended for future extensions follows. The last 4 bits (**DLC**) identify the number of bytes included in the data field.
- **Data field:** Contains the actual message data of message. Its length can range from 0 to 8 byte.
- **CRC field:** Contains a check sum that is used to identify bit errors.
- **ACK field:** Contains the **ACK** slot. This bit indicates that at least one receiver has received the data correctly.
- **End of frame:** Identifies the end of message.
- **Intermission:** Minimum bit time separating consecutive messages. If no station accesses the bus after this time, the bus remains idle (**bus idle**)

Message Identifier

- In contrast to most other network systems, ECUs on a CAN bus do not have unique addresses.
- Communication control is therefore regulated via the message' unique identification numbers (IDs):
- Based on the identifier, a receiver decides whether a message is relevant or not
- The IDs are used to prioritize messages (Because of, the Wired-AND design, lower IDs are dominant on the bus)
- If an ECU cannot send its ID onto the bus a collision has been detected and the ECU has to stop sending any data for this message (Bus Arbitration)
- Standard CAN IDs (11 bit), up to 2.048 unique IDs
Extended CAN IDs (29 bit), up to 536.870.912 unique IDs



Pros

- More reliable, e.g. less connectors
- Wiring less complex, more cost-effective
- Installation easier, changes easier
- Additional elements can be integrated
- Location changeable without electrical problems
- Communication system becomes diagnosable

Cons

- Discussion...

Thank you for your attention!
