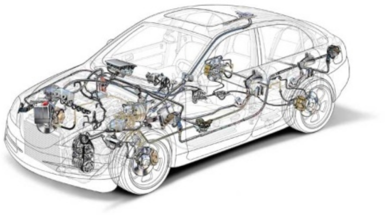

Workshop on

In Vehicle Network using CAN

By

ISM

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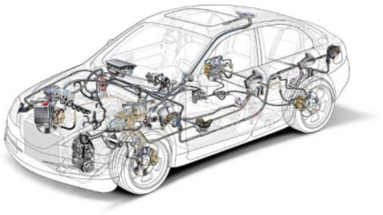
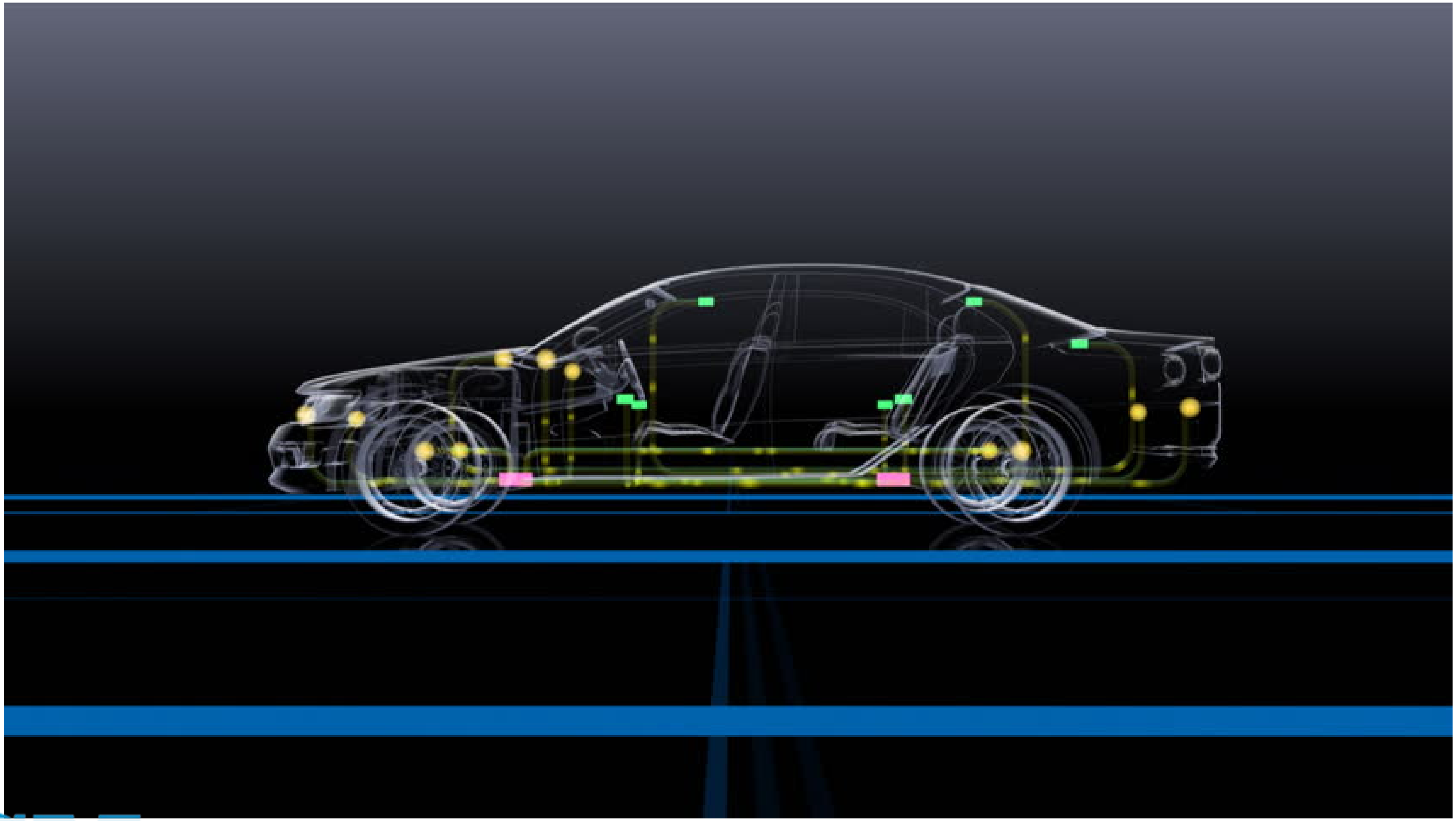
Modern CAR





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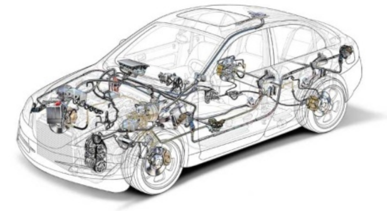
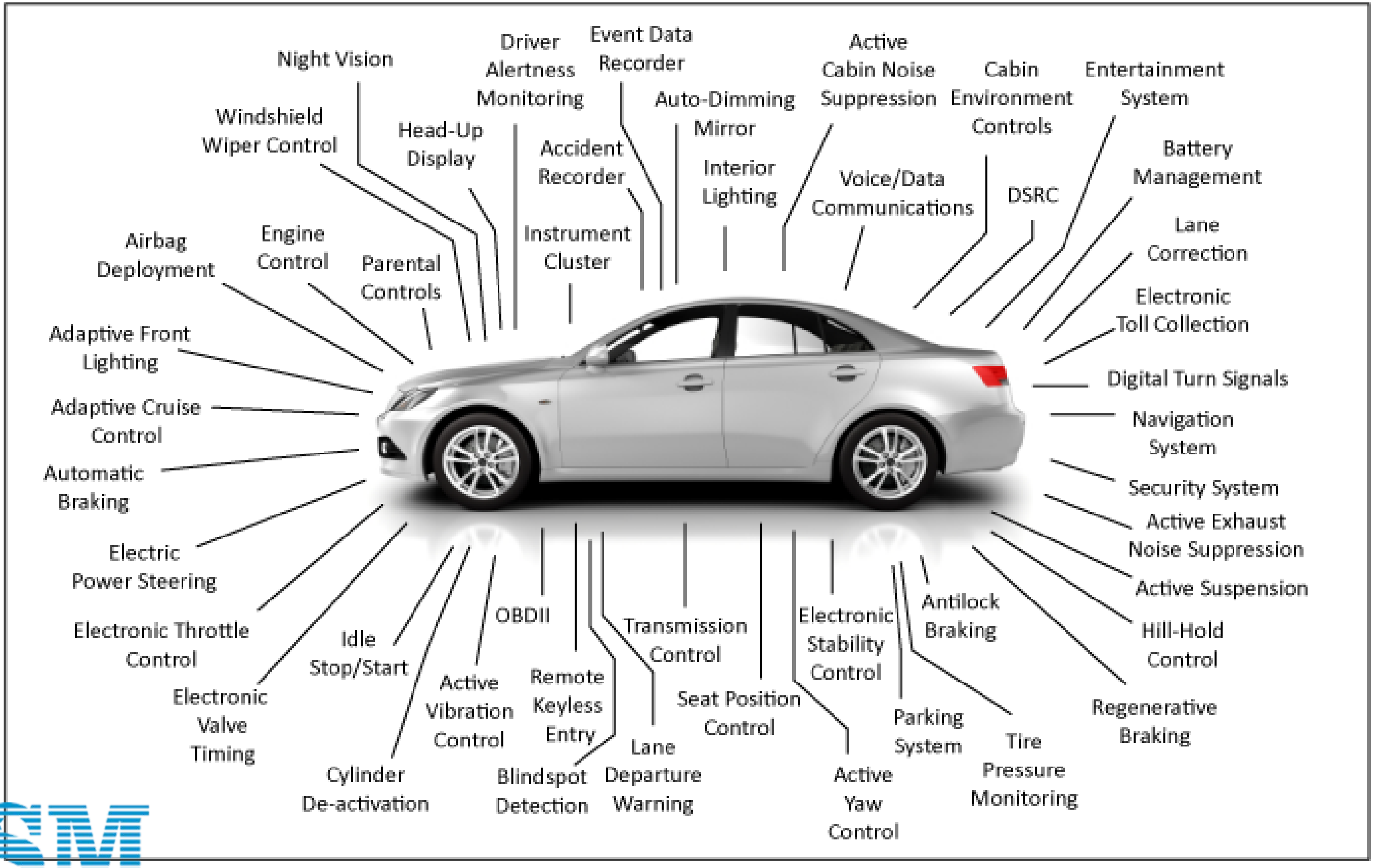
Modern CAR





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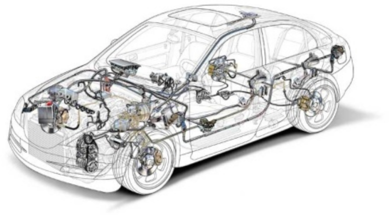
INTRODUCTION



1. Controller Area Network (CAN) was initially created by German automotive system supplier Robert Bosch in the mid-1980s .

2. The controller area network (CAN) is a serial communication protocol for connecting electronic control modules in automotive and industrial applications.

3. It is internationally standardized by the International Standardization Organization (ISO) and Society of Automotive Engineers (SAE).

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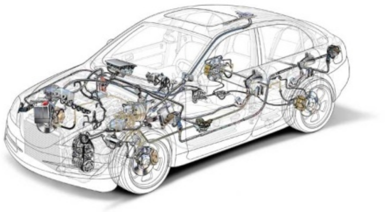

4. The CAN protocol implements layered architecture for data communication between nodes.

5. CAN chips were created by major semiconductor manufacturers such as Intel, Motorola, and Philips.

6. There are two possible bus states - called "dominant" and "recessive".

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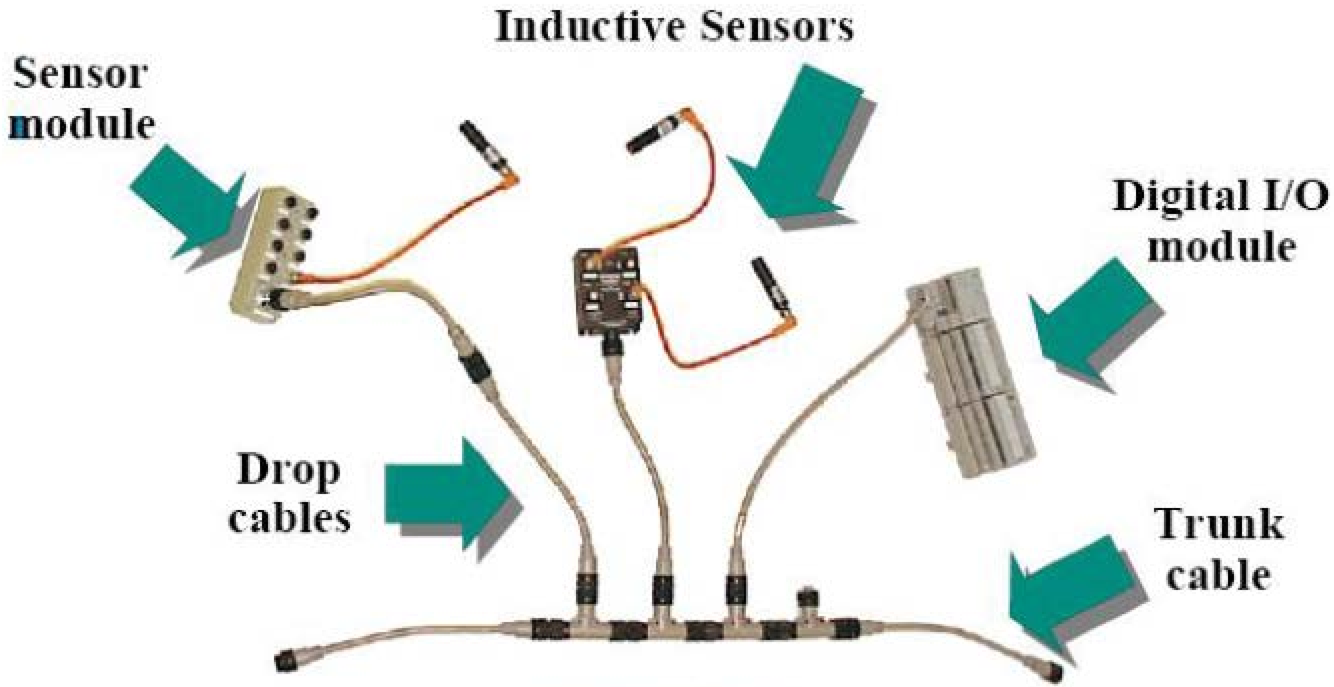
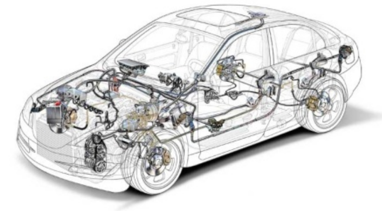
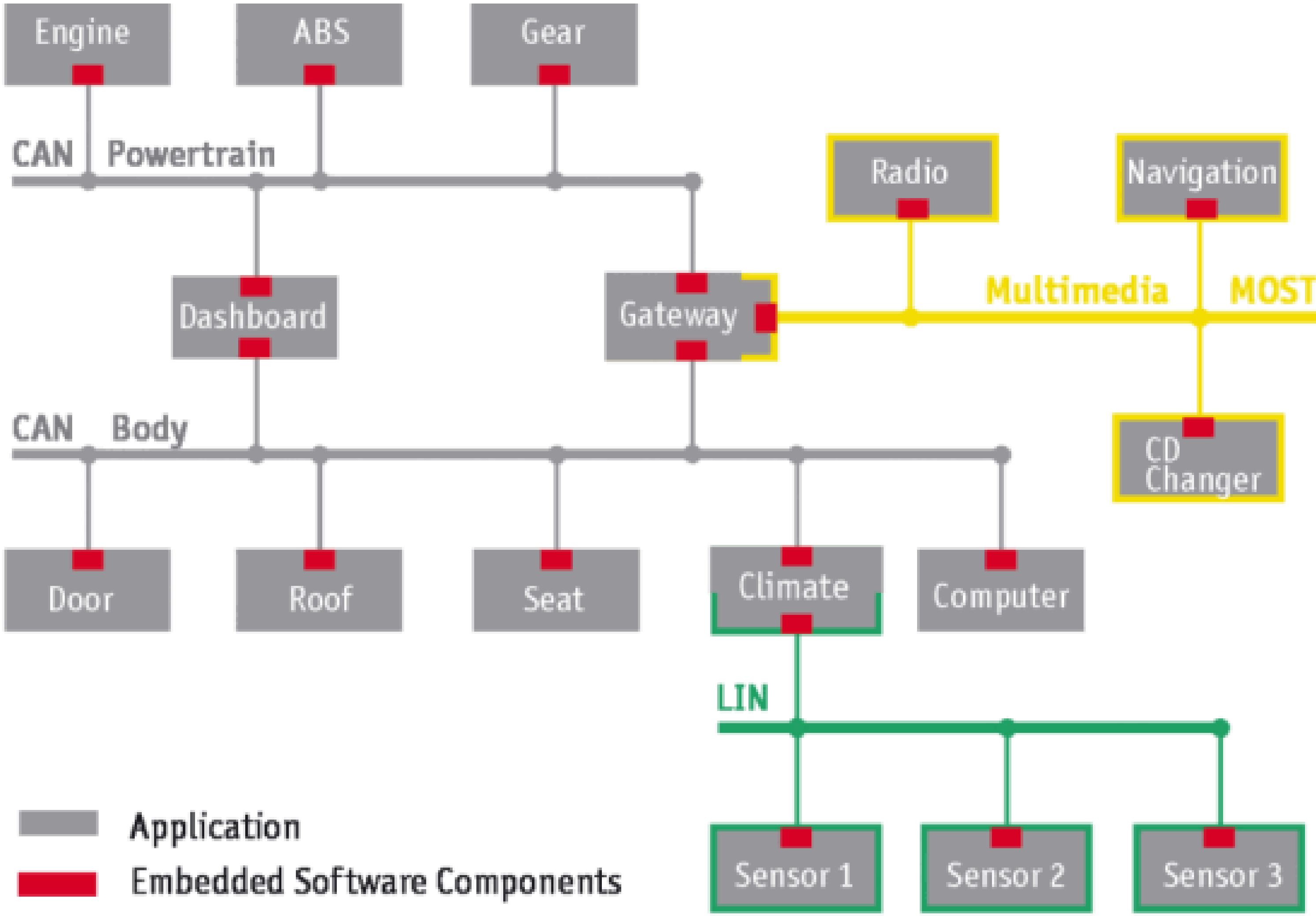
Example of a CAN system



(A segment on a DeviceNet CAN bus)

In Vehicle Network





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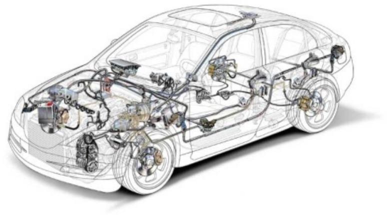
APPLICATIONS of CAN



- Automotive (modern Vehicles)
- Industrial Machinery (Packaging Machines, Sewing, Folding, Packaging machine, Industrial Freezers machine, Printing machines)

- Building Automation (Elevators)
- Medical (The Process Optimized Operating Room)
- Maritime (Maritime Research Institute)
- Restaurant Appliances (Coffee Machine)
- Laboratory Equipment & Research
- Avionics

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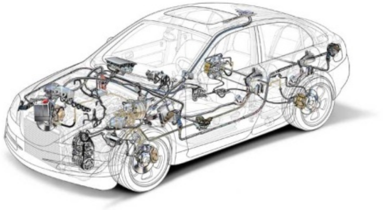
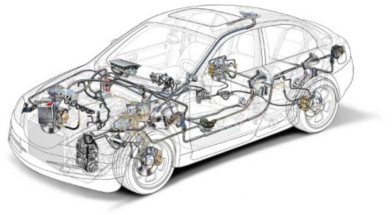


Few Terminologies



- Transmitter
- Receiver
- Master
- Slave
- Multi-master
- Arbitration
- Synchronization

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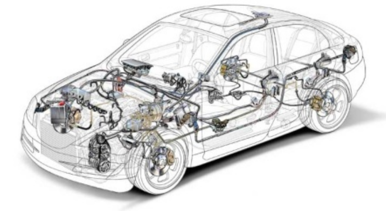
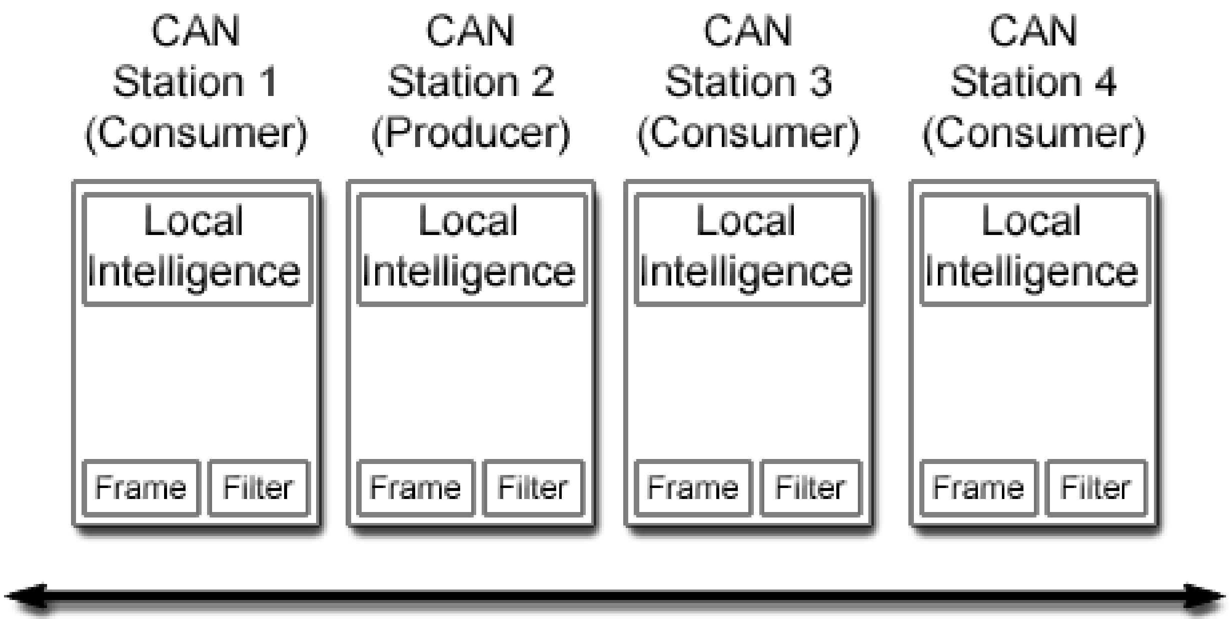
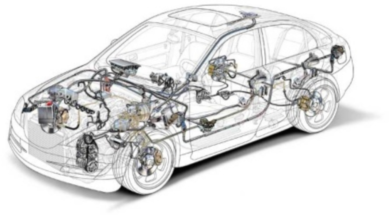
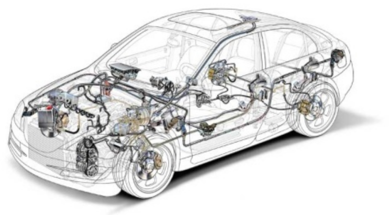



CAN
Station 1
(Consumer)
CAN
Station 2
(Producer)
CAN
Station 3
(Consumer)
CAN
Station 4
(Consumer)
Local
Intelligence
Frame
Filter

Versions of CAN

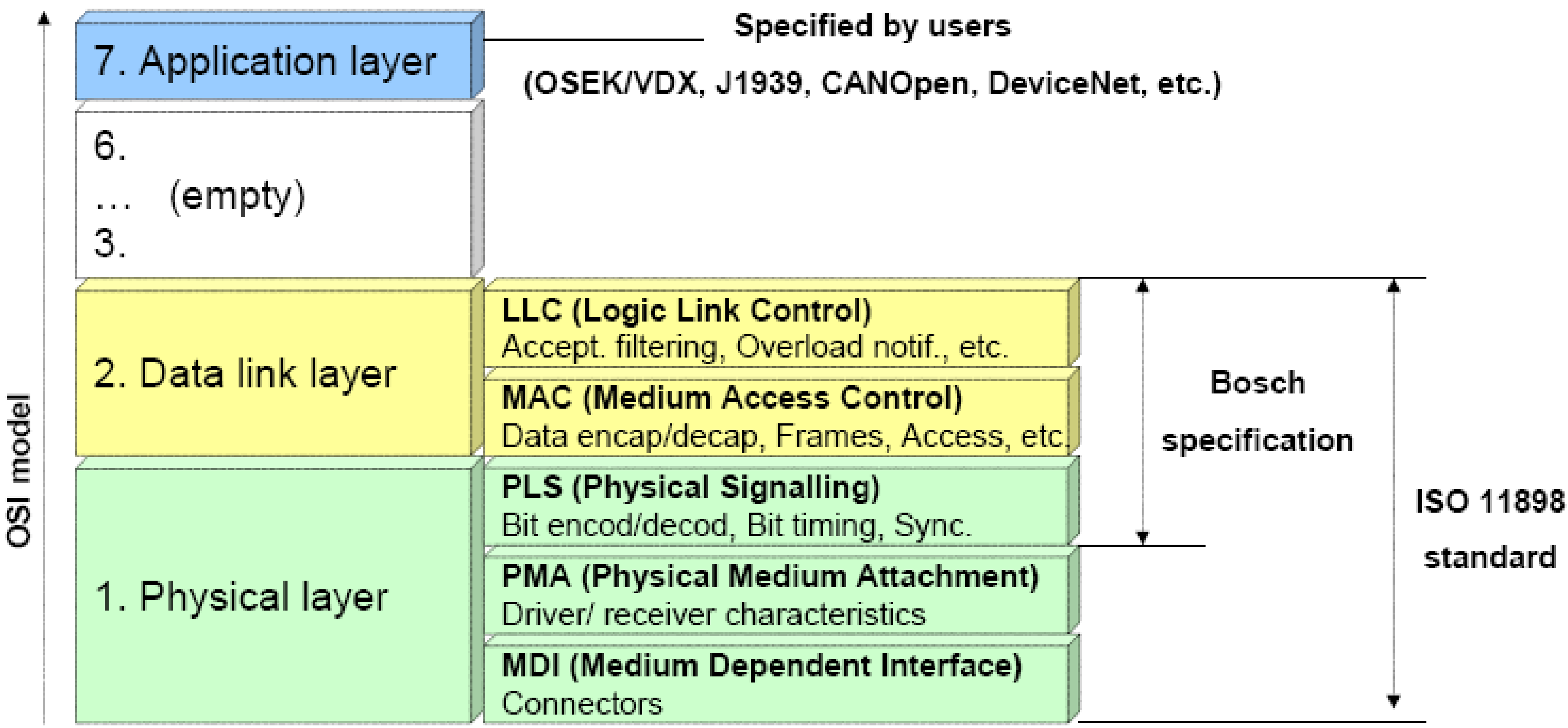


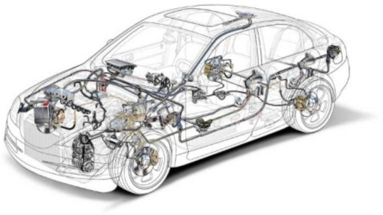
CAN 2.0A	Has an 11 bit identifier
CAN 2.0B (active)	Has an 11 bit identifier (Standard Format) .
CAN 2.0B (passive)	Has an 29 bit identifier (Extended Format) .



CAN SPECIFICATION

- Specified by BOSCH GmbH and normalized by ISO 11898





Types of CAN Frames

- Data frame
- Remote frame
- Error frame
- Overload frame
- Interframe space

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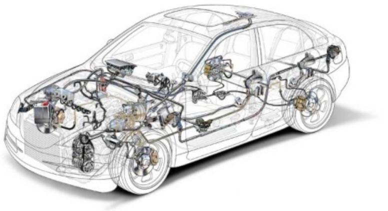
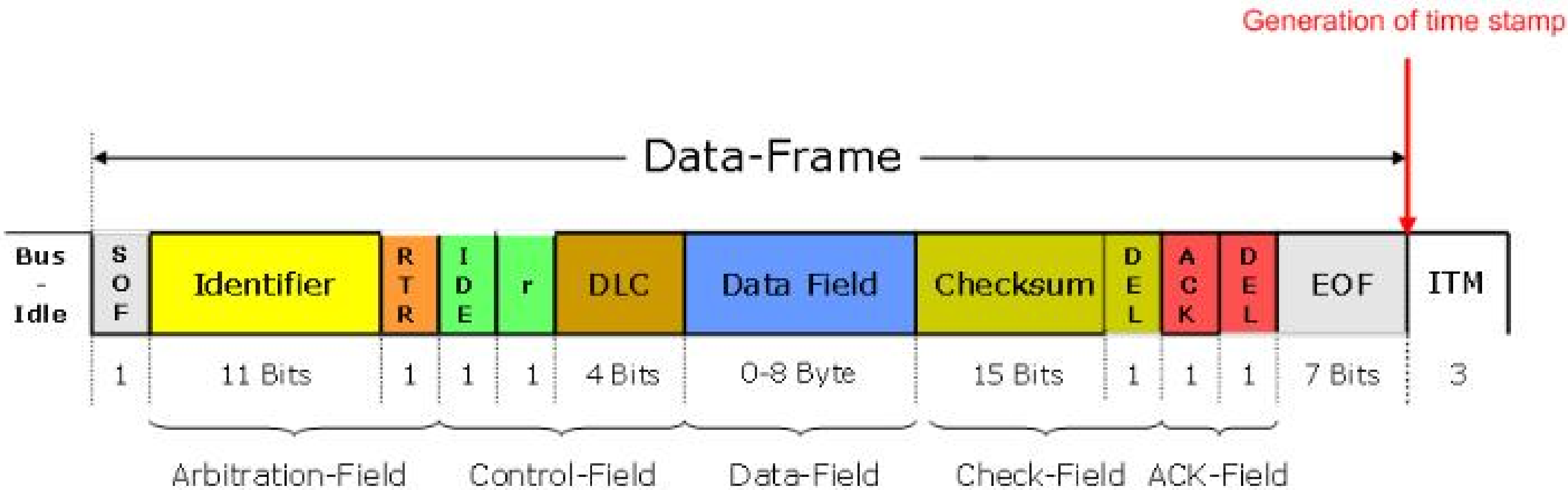
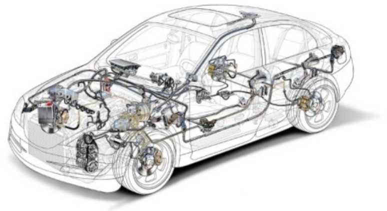
DATA Frame

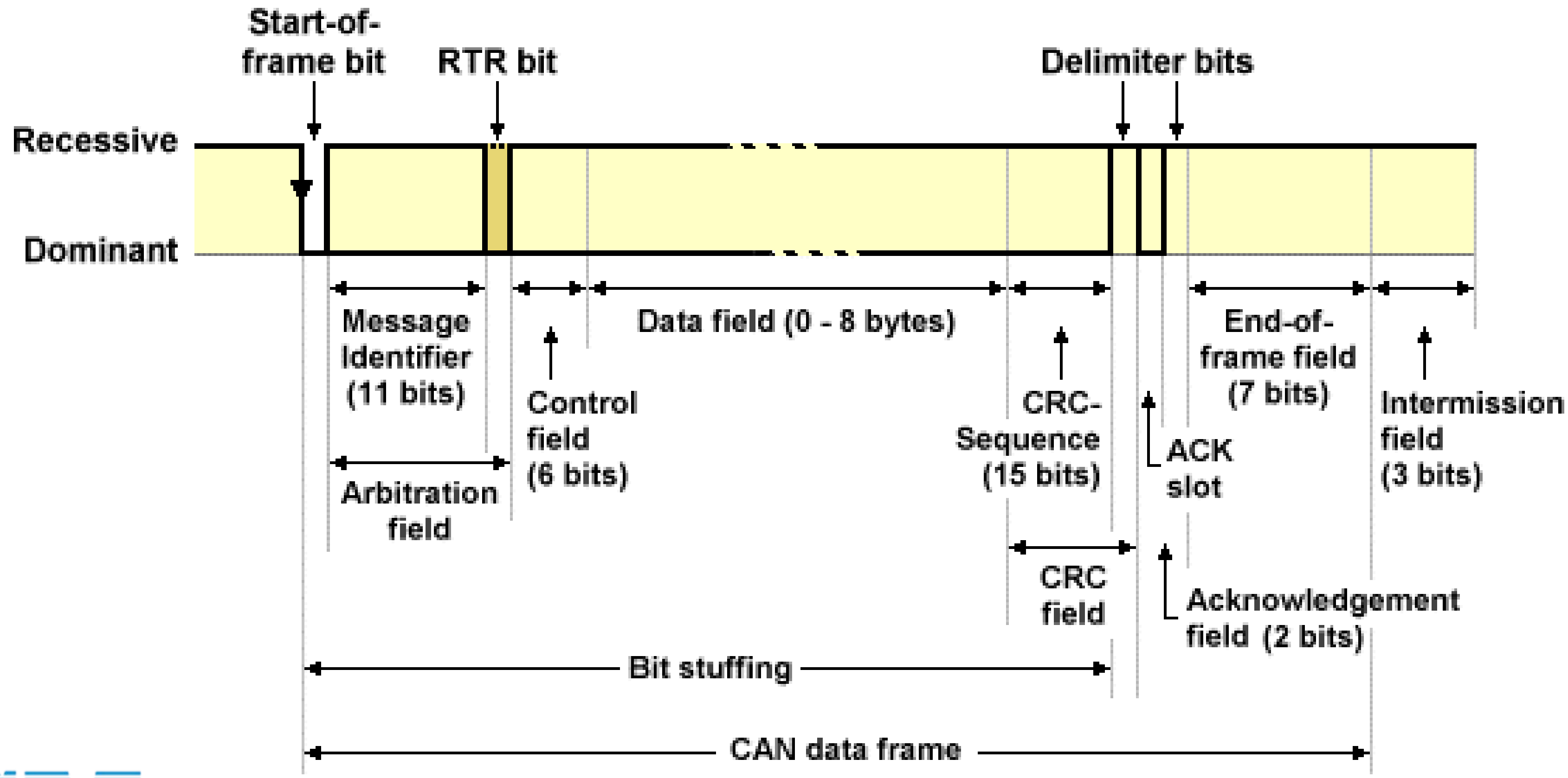




Generation of time stamp
Data-Frame
Bus - Idle
SOF
Identifier
RTR
IDE
r
DLC
Data Field
Checksum
DEL
ACK
DEL
EOF
ITM
1
11 Bits
1
1
1
4 Bits
0-8 Byte
15 Bits
1
1
1
7 Bits
3
Arbitration-Field
Control-Field
Data-Field
Check-Field
ACK-Field

DATA Frame





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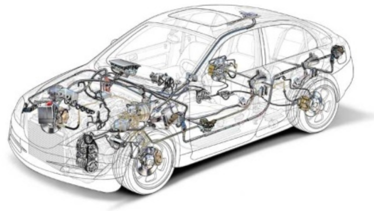
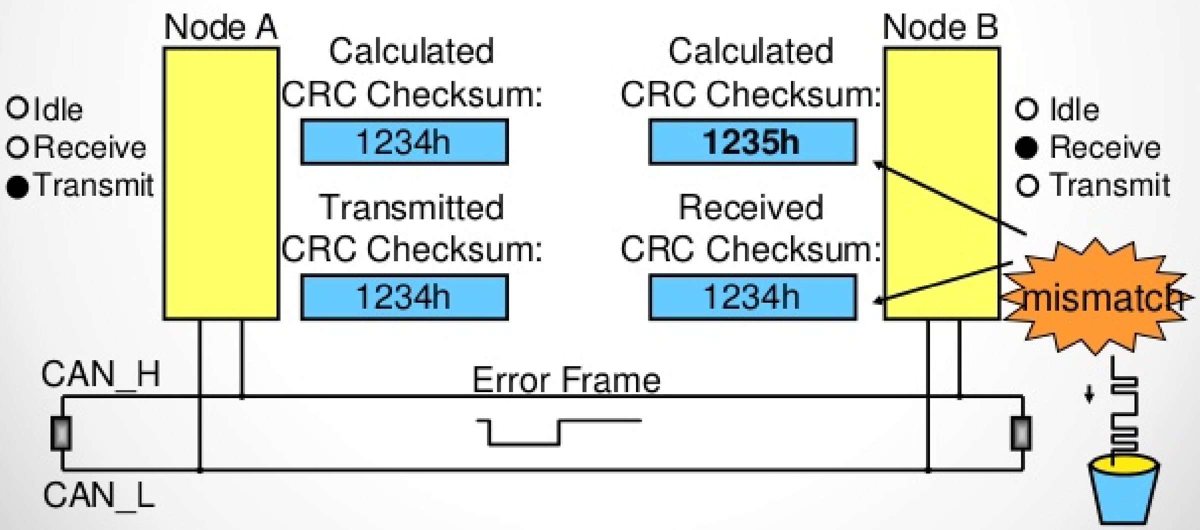


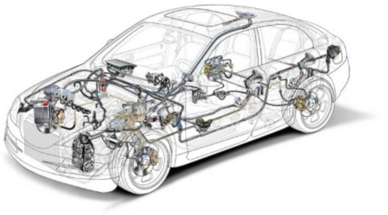
CAN

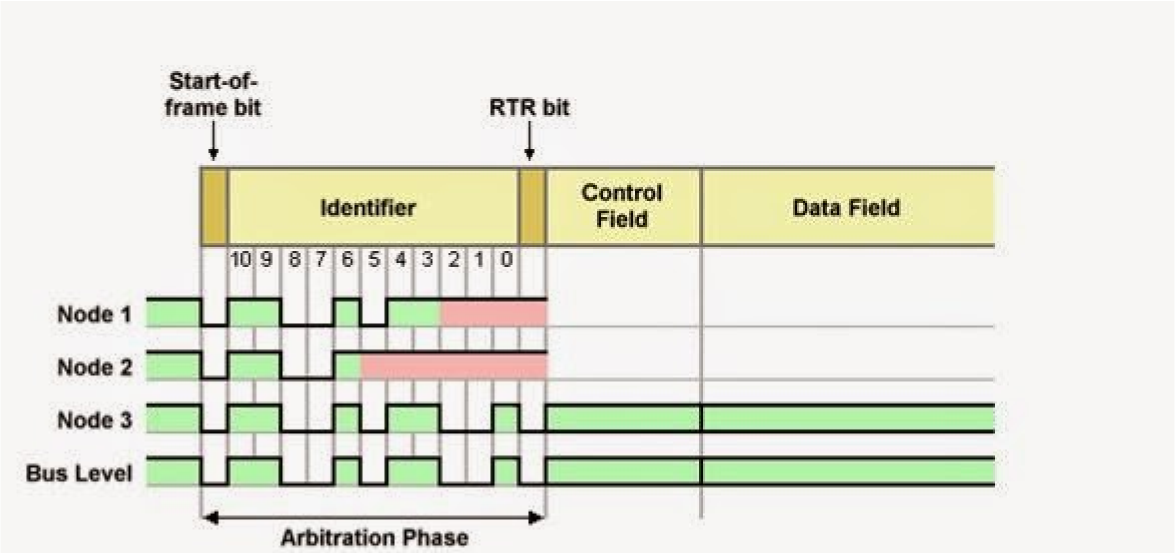
CAN Error Detection:

CRC

- Otherwise Frame was not received correctly (CRC Error)







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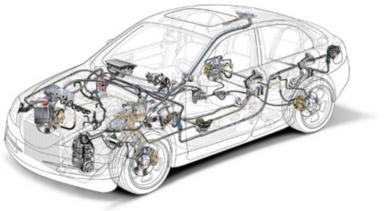
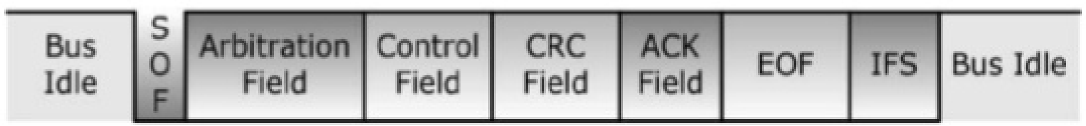


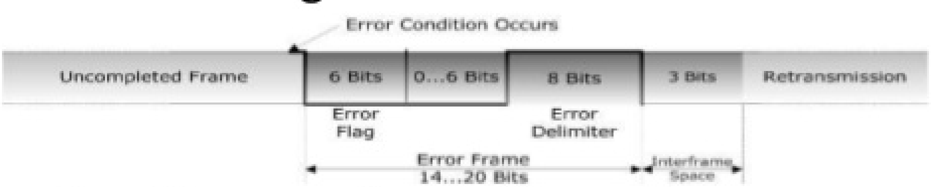
Message Frames

- **Data Frame** – Broadcasts a message to the CAN bus

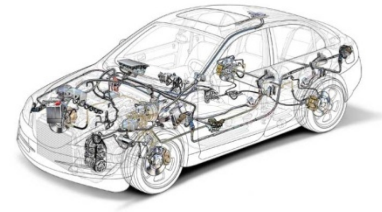
- **Remote Frame** – Requests transmission of message

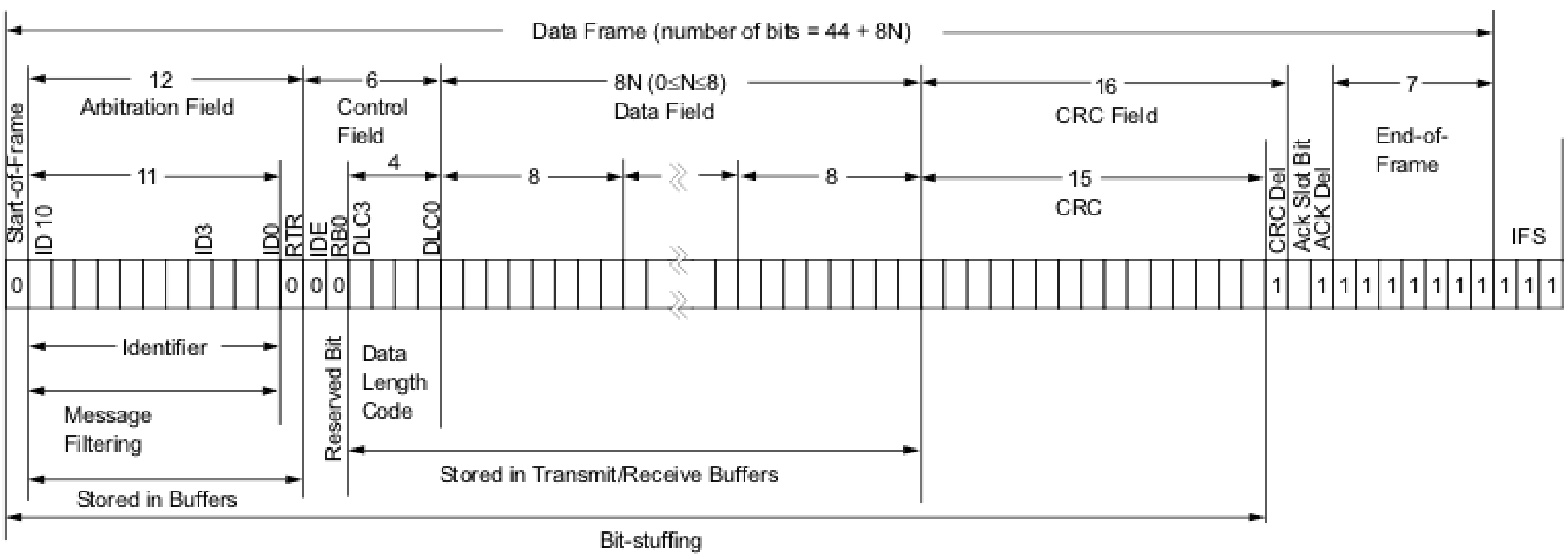


- **Error Frame** – Signals error condition



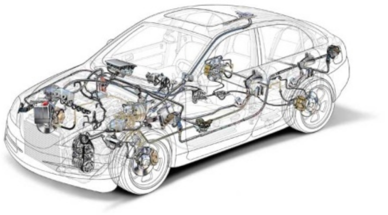
- **Overload Frame** – Special Error Frame

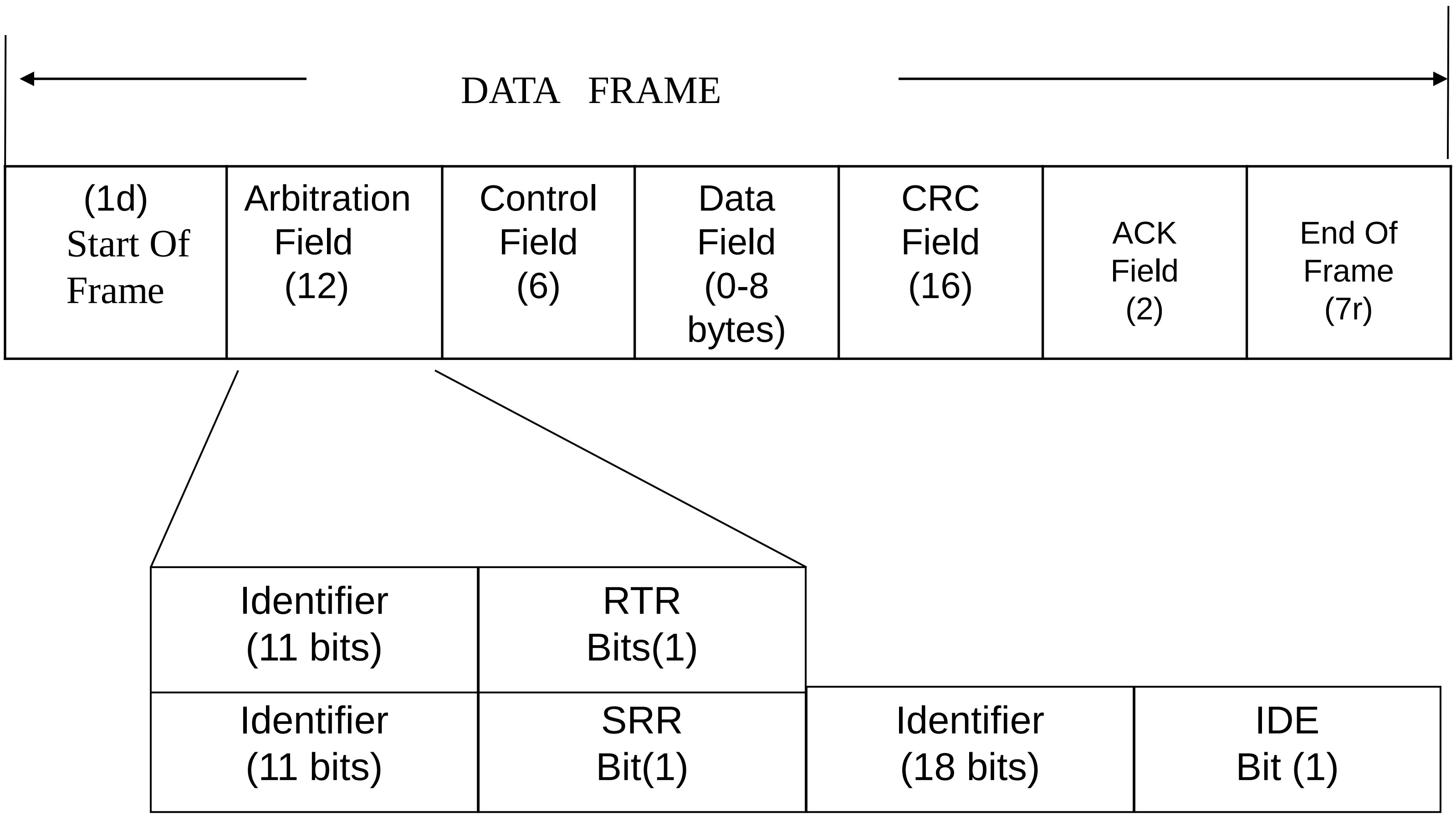




Data Frame (number of bits = 44 + 8N)
12
Arbitration Field
6
Control Field
8N (0≤N≤8)
Data Field
16
CRC Field
7
End-of-Frame
Start-of-Frame
11
4
8
8
15
CRC
ID 10
ID3
ID0
RTR
IDE
RB0
DLC3
DLC0
CRC Del
Ack Slot Bit
ACK Del
IFS
0
0 0 0
1
1 1 1 1 1 1 1 1 1 1 1
Identifier
Message Filtering
Reserved Bit
Data Length Code
Stored in Transmit/Receive Buffers
Stored in Buffers
Bit-stuffing

DATA Frame





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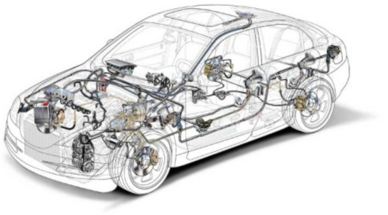
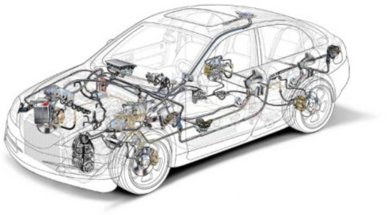
DATA Frame



DATA FRAME

Start Of Frame (1)	Arbitration Field (12)	Control Field (6)	Data Field (0-8 bytes)	CRC Field (16)	ACK Field (2)	End Of Frame (7)

IDE	R0	DLC3	DLC2	DLC1	DLC0
R1	R0	DLC3	DLC2	DLC1	DLC0



DATA Frame

d →'dominant'
r →'recessive'

No.of data bytes	DLC3	DLC2	DLC1	DLC0
0	d	d	d	d
1	d	d	d	r
2	d	d	r	d
3	d	d	r	r
4	d	r	d	d
5	d	r	d	r
6	d	r	r	d
7	d	r	r	r
8	r	d	d	d

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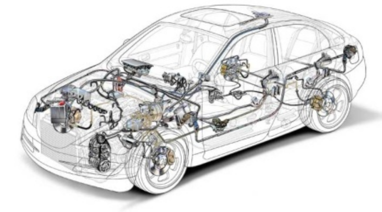
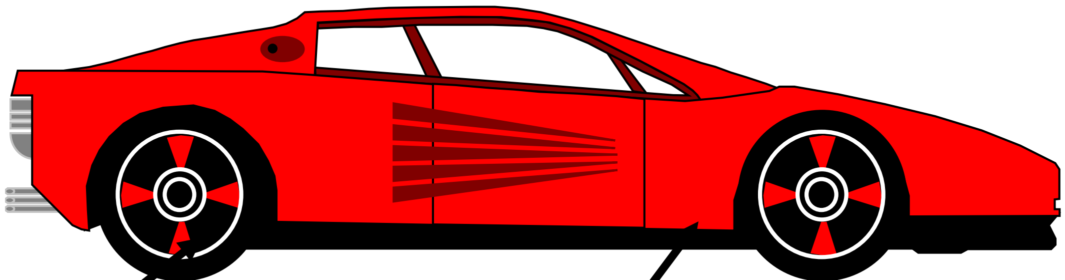
CAN Data Frame – Example





Gearbox CAN Data Frame

0x5	….	Temperature	Pressure	Torque	….
		4 bytes	2 bytes	2 bytes	

Data – 8 bytes

ABS CAN Data Frame

0x10	….	Temperature	Torque		….
ID		4 bytes	2 bytes		

Data – 8 byte (2 bytes not used)

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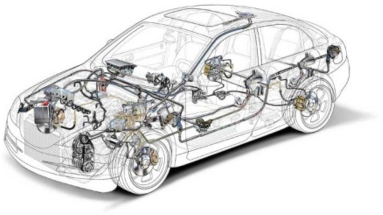
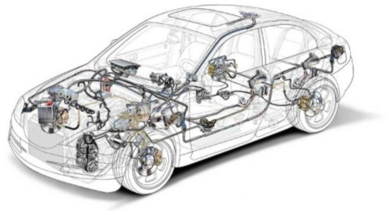
DATA Frame



Start Of Frame (1)	Arbitration Field (12)	Control Field (6)	Data Field (0-8 bytes)	CRC Field (16)	ACK Field (2)	End Of Frame (7)

CRC Sequence (15)	CRC Delimiter (1)

DATA Frame



DATA FRAME

Start Of Frame (1)	Arbitration Field (12)	Control Field (6)	Data Field (0-8 bytes)	CRC Field (16)	ACK Field (2)	End Of Frame (7)

ACK Field:

ACK Slot (1)	ACK Delimiter (1)

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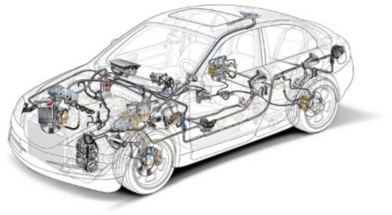
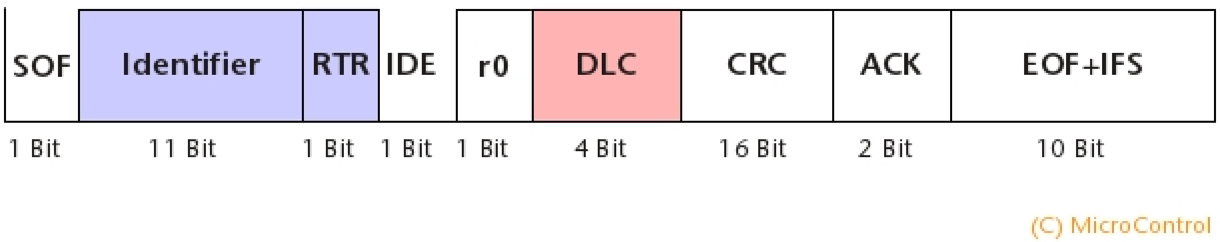
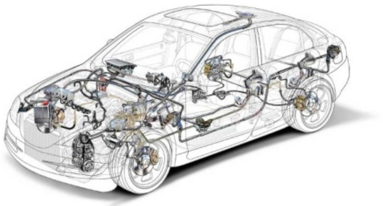
REMOTE Frame



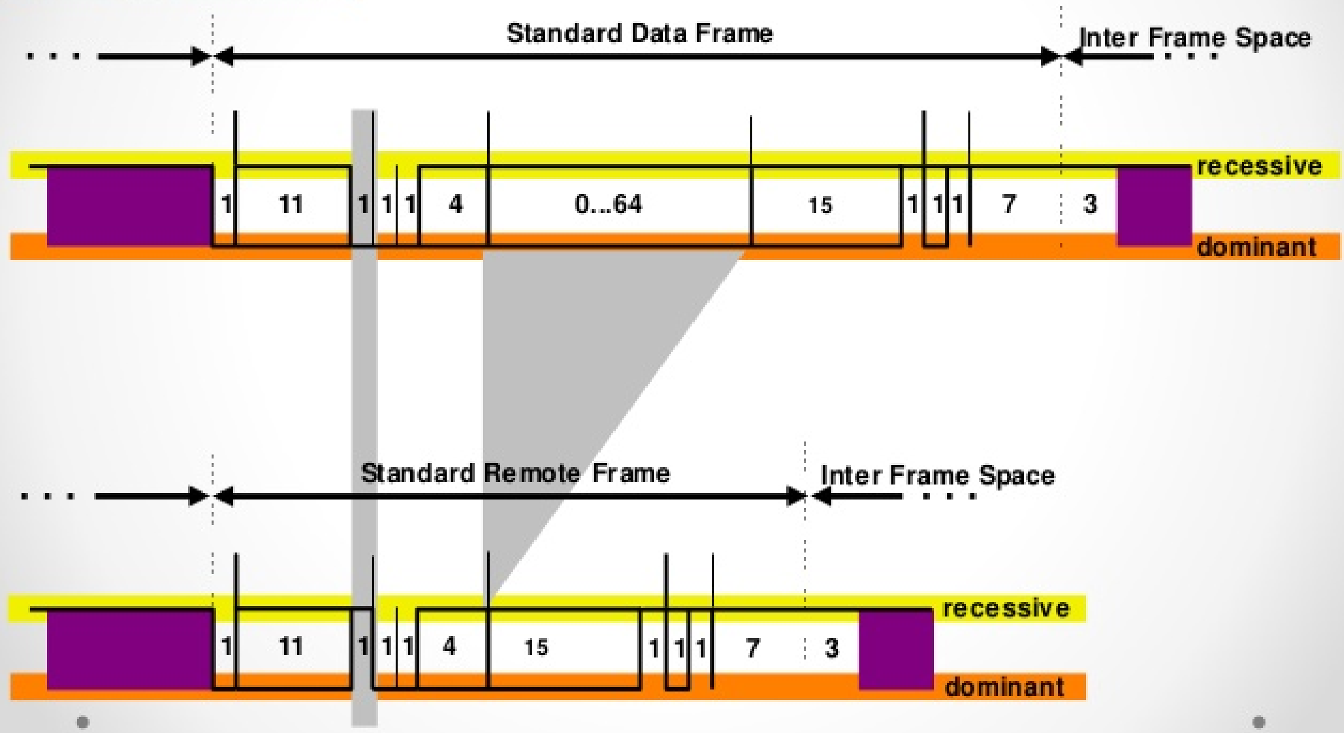




CAN

CAN Frames

Remote Frame



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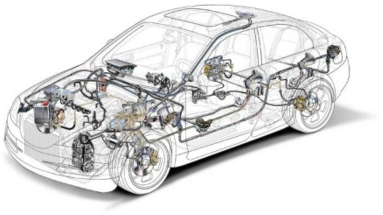
REMOTE Frame



REMOTE FRAME

Start of Frame (1)	Arbitration Field (12)	Control Field (16)	ACK Field (2)	End OF Frame (7)

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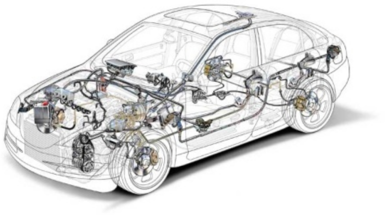
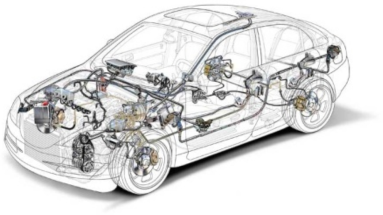
ERROR Frame

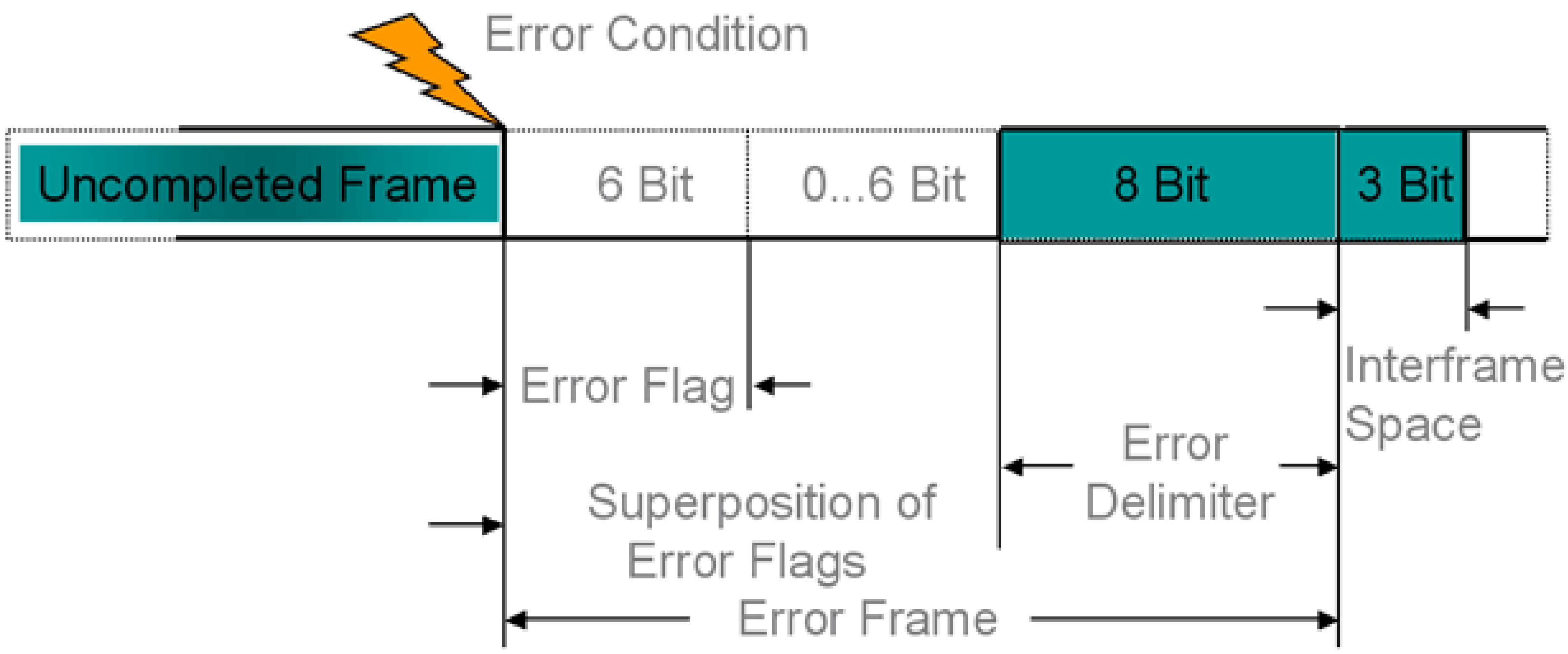


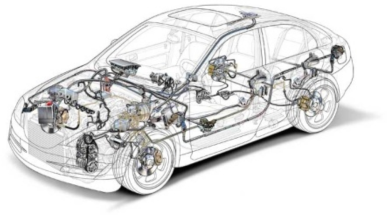
ERROR FRAME

Error Flag (6d/r)	Super position of Over Load Flags	Error Delimiter (8r)

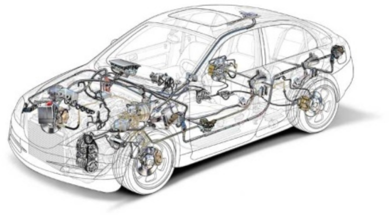
ERROR Frame




Error Condition
Uncompleted Frame
6 Bit
0...6 Bit
8 Bit
3 Bit
Error Flag
Interframe Space
Error Delimiter
Superposition of Error Flags
Error Frame

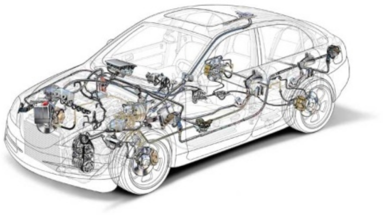


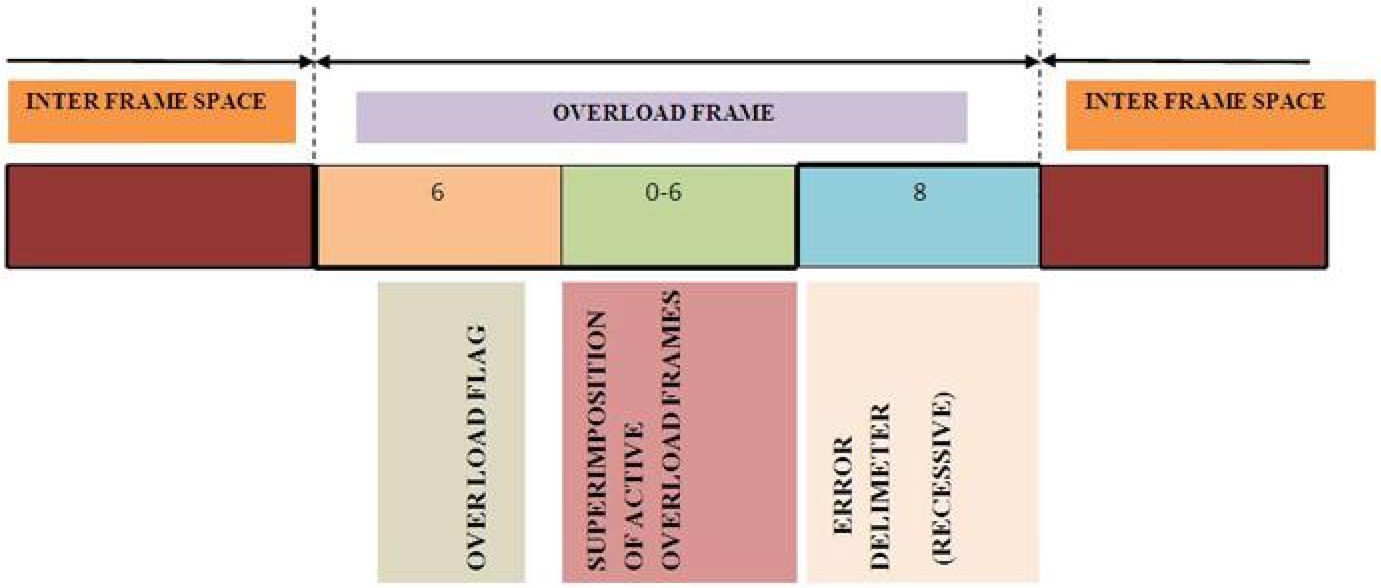
OVERLOAD Frame



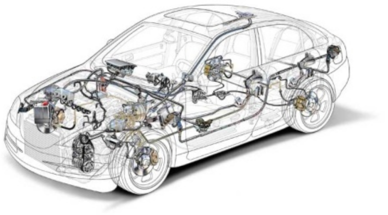
OVER LOAD FRAME		
Over Load Flag (6d)	Super position of Over Load Flags	Over Load Delimiter (8r)

OVERLOAD Frame





INTER-FRAME SPACE



INTERFRAME SPACE

Intermission(3)	**Suspend Transmission(8)**	Bus Idle (…….)

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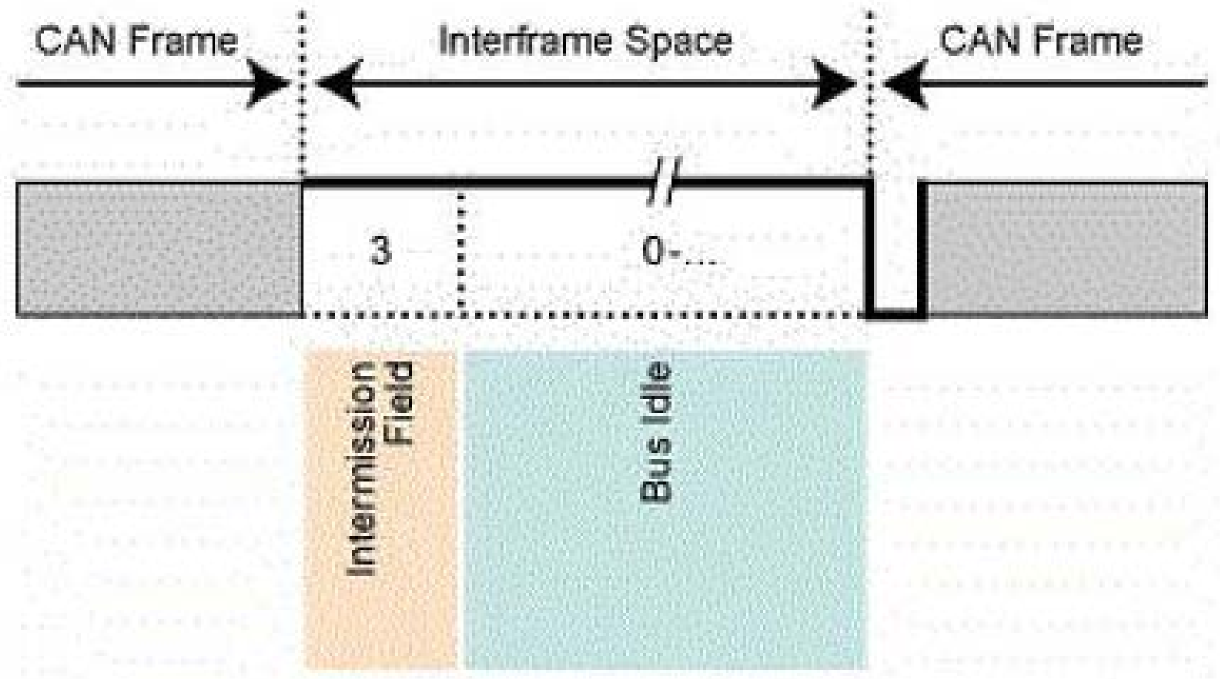
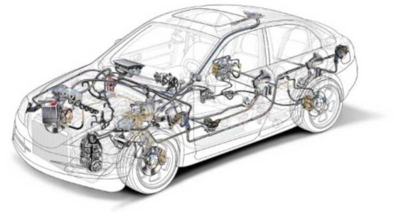
INTER-FRAME SPACE





Layered Structure of a CAN Node

Application Layer

Object Layer

- Message Filtering
- Message and Status Handling

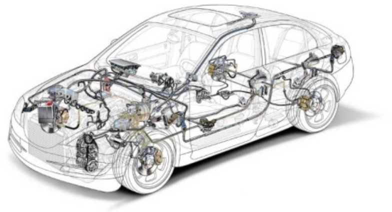
Transfer Layer

- Fault Confinement
- Error Detection and Signalling
- Message Validation
- Acknowledgment
- Arbitration
- Message Framing
- Transfer Rate and Timing

Physical Layer

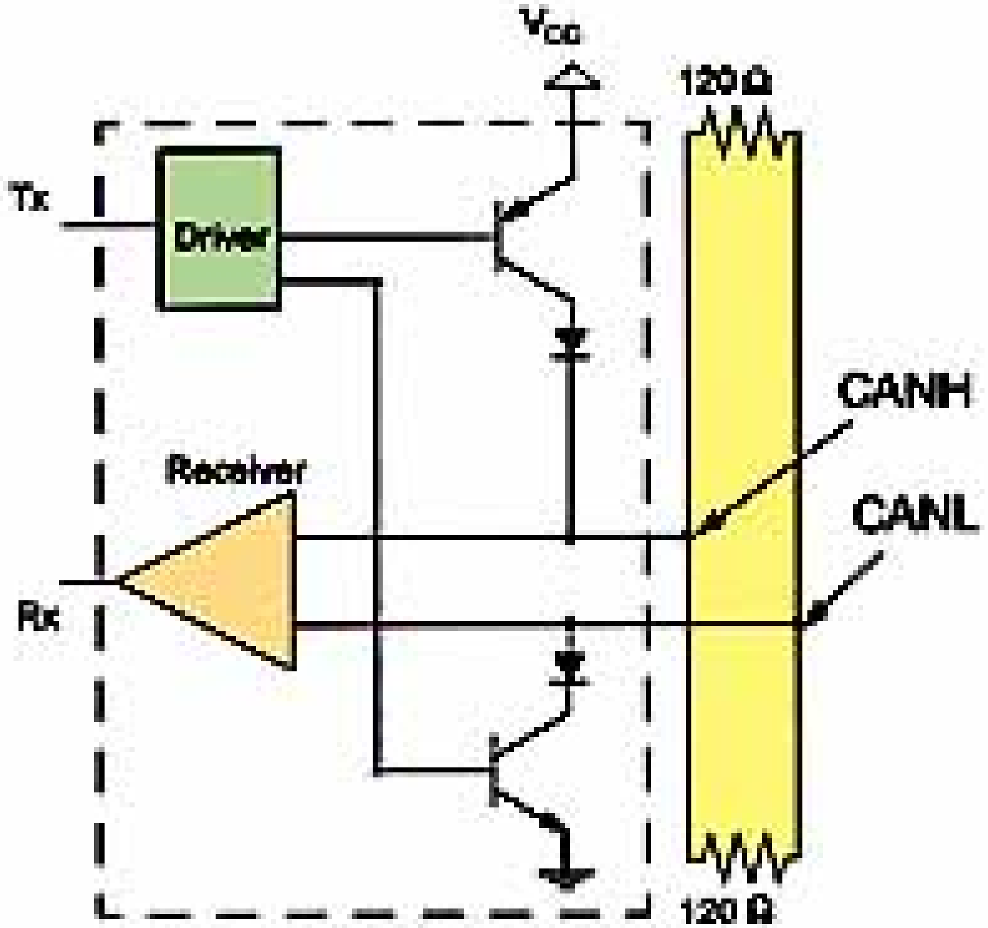
- Signal Level and Bit Representation
- Transmission Medium

History of CAN



- **1983 :** Start of the Bosch internal project to develop an in-vehicle network
- **1986 :** Official introduction of CAN protocol
- **1987 :** First CAN controller chips from Intel and Philips Semiconductors
- **1991 :** Bosch's CAN specification 2.0 published
- **1991 :**CAN Kingdom CAN-based higher-layer protocol introduced by Kvaser
- **1992 :** CAN in Automation (CiA) international users and manufacturers group established
- **1992 :** CAN Application Layer (CAL) protocol published by CiA
- **1992 :** First cars from Mercedes-Benz used CAN network
- **1993 :** ISO 11898 standard published
- **1994 :** 1st international CAN Conference (iCC) organized by CiA
- **1994 :** DeviceNet protocol introduction by Allen-Bradley
- **1995 :** ISO 11898 amendment (extended frame format) published
- **1995 :** CANopen protocol published by CiA
- **2000 :** Development of the time-triggered communication protocol for CAN (TTCAN)

CAN Output Section



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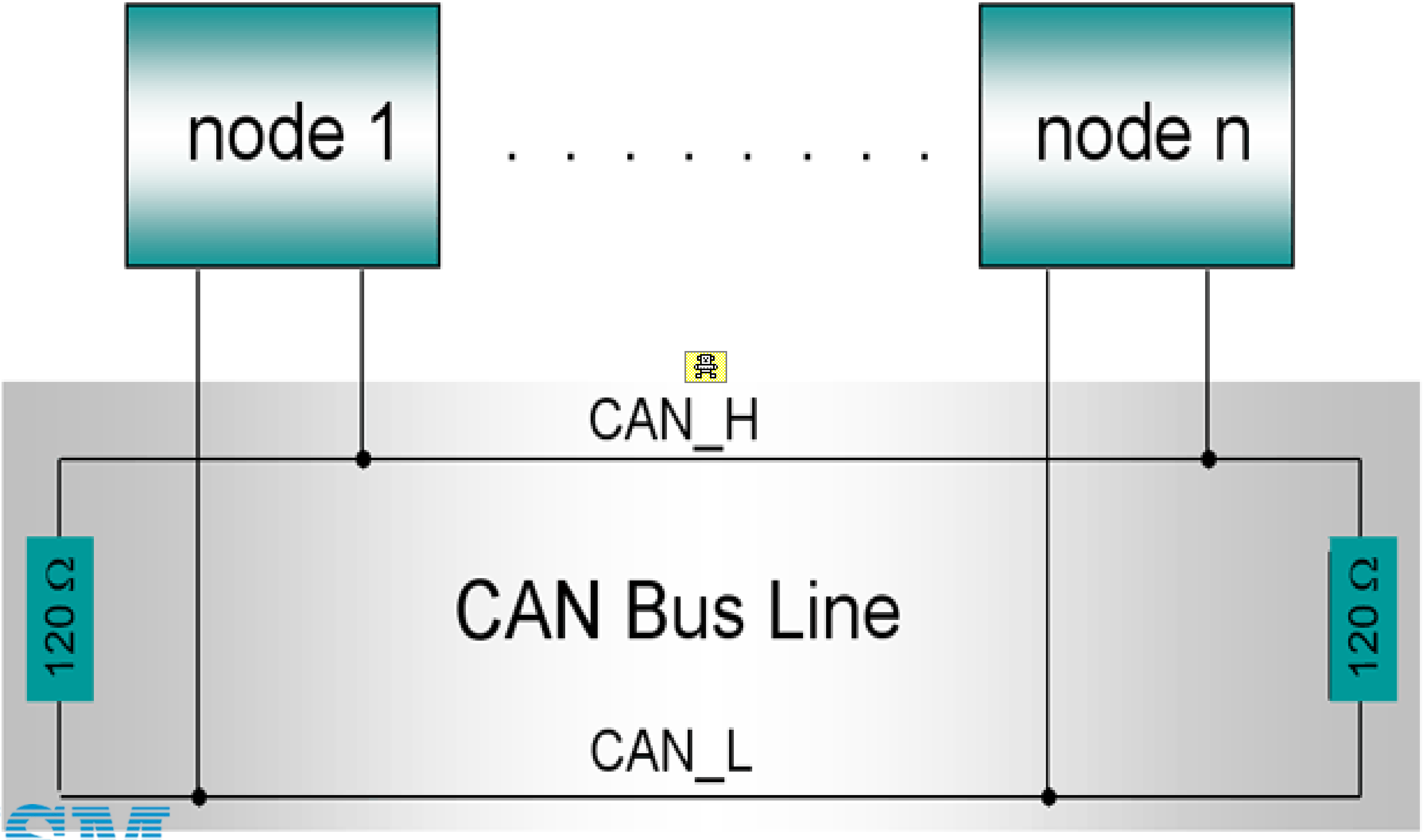
CAN Bus Lines



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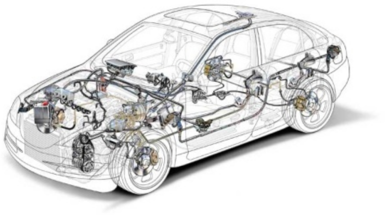
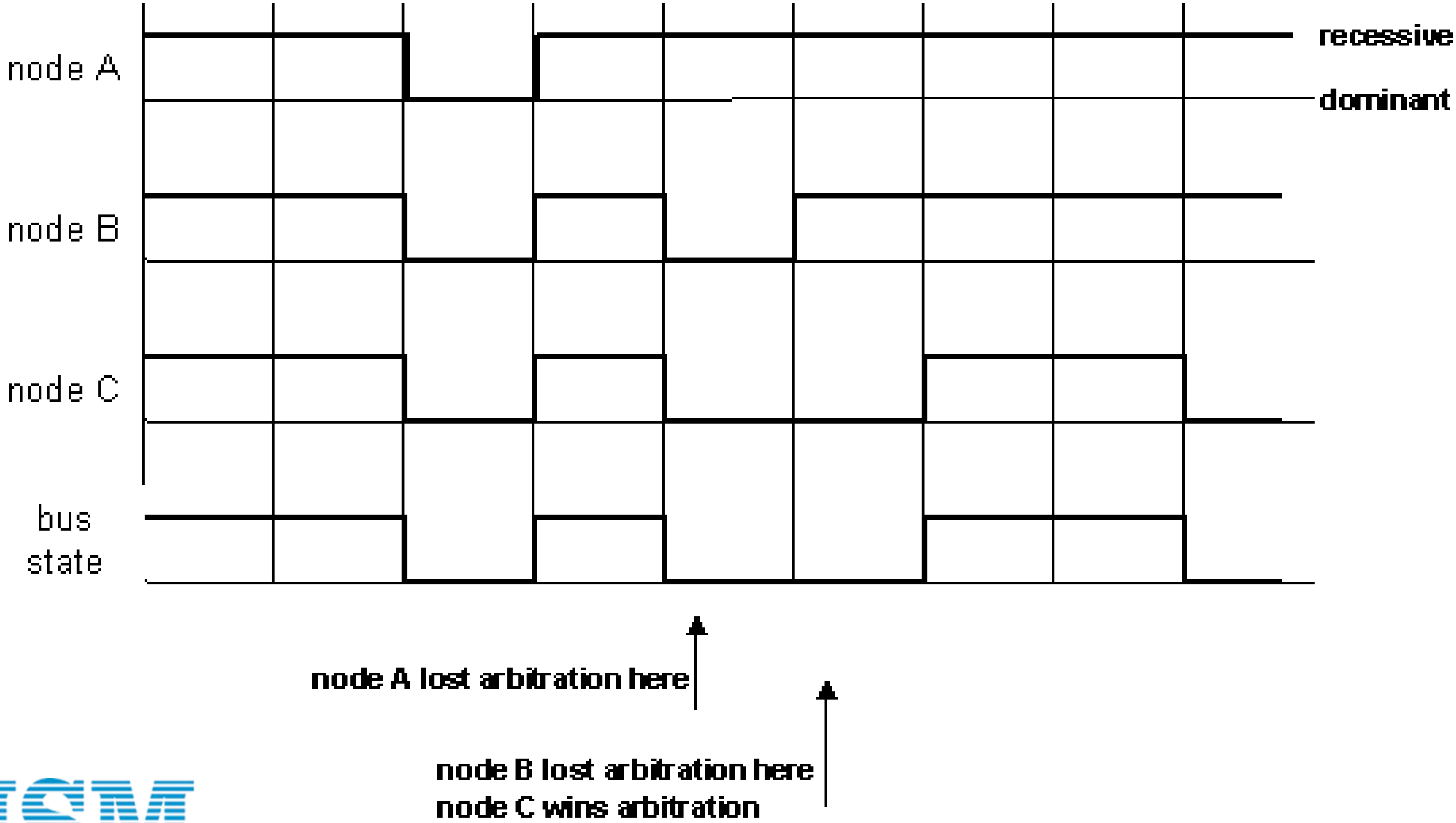
Arbitration





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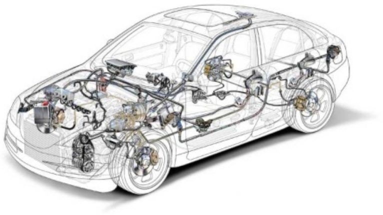
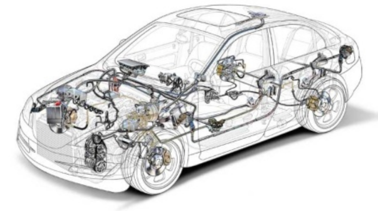
Error Handling



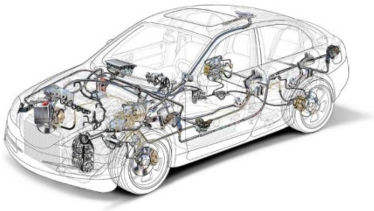
1) CRC ERROR
2) STUFFING ERROR
3) ACK ERROR
4) BIT ERROR
5) FORM ERROR

Classification of CAN Protocols



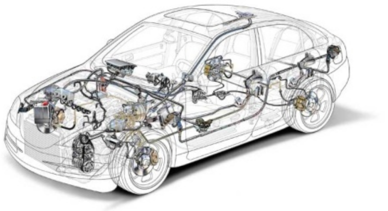
Class[4]	Communication speed	Purpose of use	Application range	
			CAN	Other protocols
Class A	Up to 10 kbps (body system)	Lamp and light Power window Door lock Power sheet Keyless entry, etc.	Low-speed	●Each carmaker's original protocol ●LIN
Class B	10 kbps to 125 kbps (status information system)	Electronic meter Drive information Auto air-conditioner Failure diagnosis, etc.		●J1850 ●VAN
Class C	125 kbps to 1 Mbps (realtime control system)	Engine control Transmission control Brake control Suspension control, etc.	High-speed	●Safe-by-Wire
Class D	5 Mbps and over (multimedia)	Car navi, Audio by-Wire, etc.		●D2B optical ●MOST ●IEEE 1394 ●FlexRay

CAN Standard Specifications



Standard	Common Name	Baud Rate	Max nodes	Max Length
ISO 11783	ISOBUS	250 KBit/s	30	40m
ISO 11898-2	High speed-CAN	max. 1 MBit/s	110	6500 m
ISO 11898-3	Fault Tolerant CAN	max. 125 KBit/s	32	500 m
ISO 11992	Truck/Trailer CAN	max. 125 KBit/s	2 (Point to Point)	40 m
ISO 15765	Diagnostics On CAN	max 1 MBit/s	110	
SAE J1939		250 KBit/s	30	40m
SAE J2284		max. 1 MBit/s	110	
SAE J2411	Single Wire CAN	33,3 KBit/s 83,3KBit/s in HSMode	32	

CAN Standard Specifications



Name	Baud rate	Specification	Application field
SAE J1939-11	250 k	Two-wire shielded twisted pair	Truck, bus
SAE J1939-12	250 k	Two-wire shielded twisted pair 12 V supply	Agricultural machine
SAE J2284	500 k	Two-wire twisted pair (non-shielded)	Automobile (high-speed: power train system)
SAE J2411	33.3 k, 83.3 k	One-wire	Automobile (low-speed: body system)
NMEA-2000[*2]	62.5 k, 125 k, 250 k, 500 k, 1 M	Two-wire shielded twisted pair Power supply	Ship
DeviceNet	125 k, 250 k, 500 k	Two-wire shielded twisted pair 24 V supply	Industrial equipment
CANopen	10 k, 20 k, 25 k, 50 k, 125 k 250 k, 500 k, 800 k, 1 M	Two-wire twisted pair Optional (shielded, power supply)	Industrial equipment
SDS[*3]	125 k, 250 k, 500 k, 1 M	Two-wire shielded twisted pair Optional (power supply)	Industrial equipment

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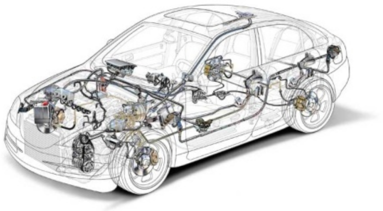
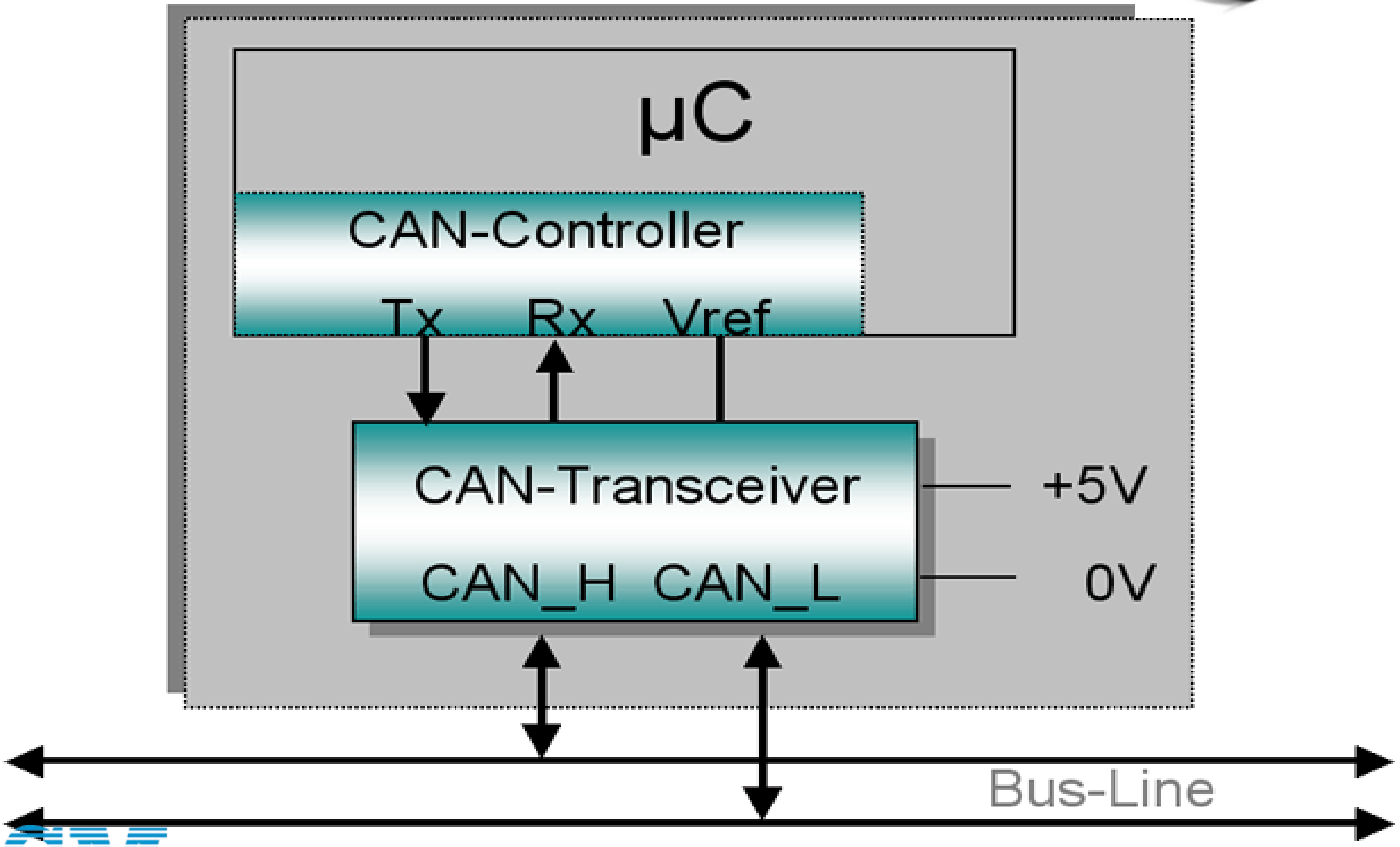
CAN Hardware Implementation





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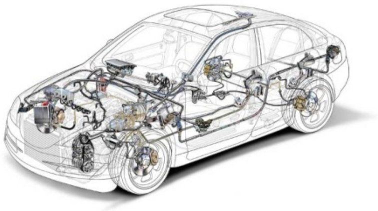
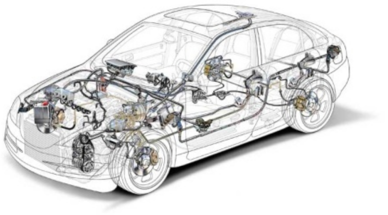


ISO11898 and ISO11519-2 Compliant Driver ICs

Transceiver IC	ISO11898	ISO11519-2
	HA13721RPJE(RENESAS)	
	TJA1050T(Philips)	TJA1054T(Philips)
	TLE6250G(Infineon)	TLE6254-3G(Infineon)
	CF150C(BOSCH)	

- 1992: CiA 201 series (CAN Application Layer)
- 1994: IEC 62026-3 (DeviceNet)
- 1994: SAE J1939 series
- 1994: EN 50325-4 (CANopen)
- 1999: ISO 11992 series
- 2000: IEC 61162-3 (NMEA 2000)
- 2002: ISO 11783 series (Isobus)
- 2004: ISO 15765 series (OBDII/ISO-TP)
- 2007: Arinc 825/826

CAN Development Tools



- CANALYSER
- CAN OE
- LAB VIEW

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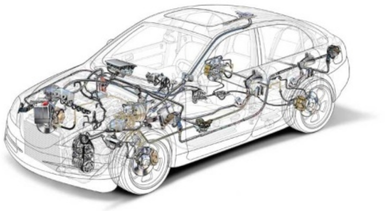
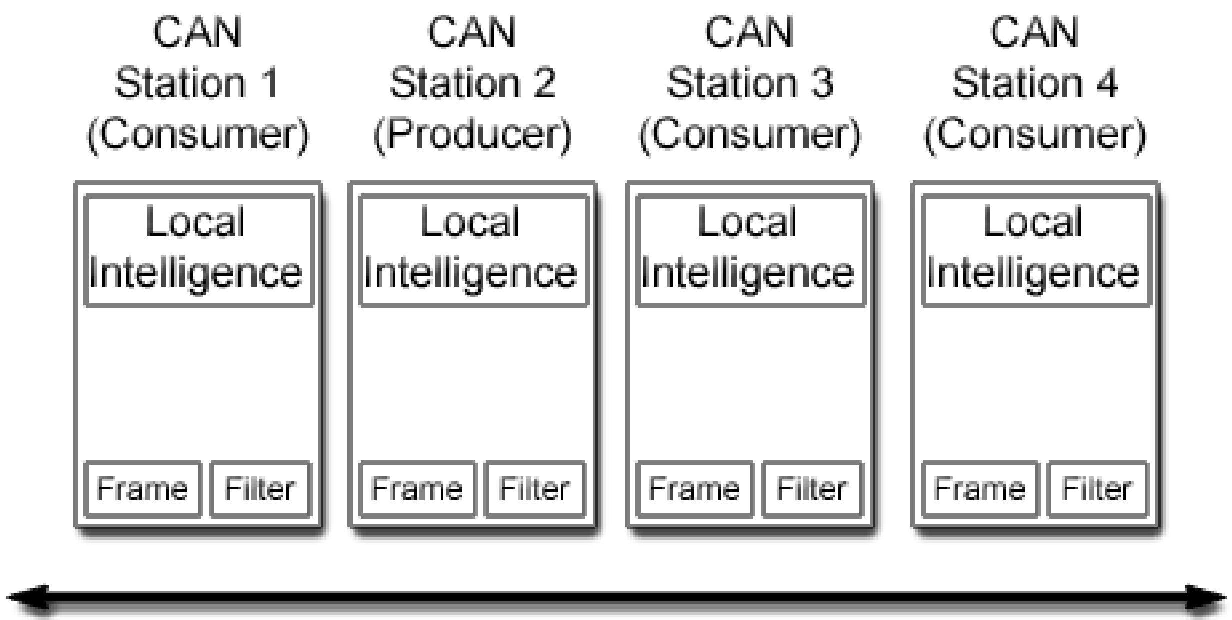


Designing CAN Messaging System

A Thorough planning of the system on Messaging Architecture

1. List of messages that a node need to transmit
2. Events for Message Generation & Transmit
3. List of Messages to be accepted
4. How to Act-upon a message.



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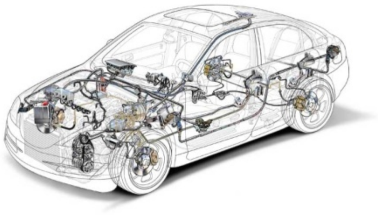
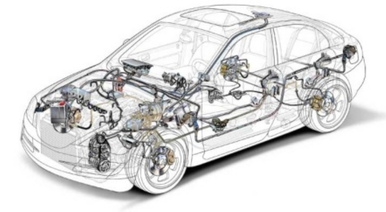


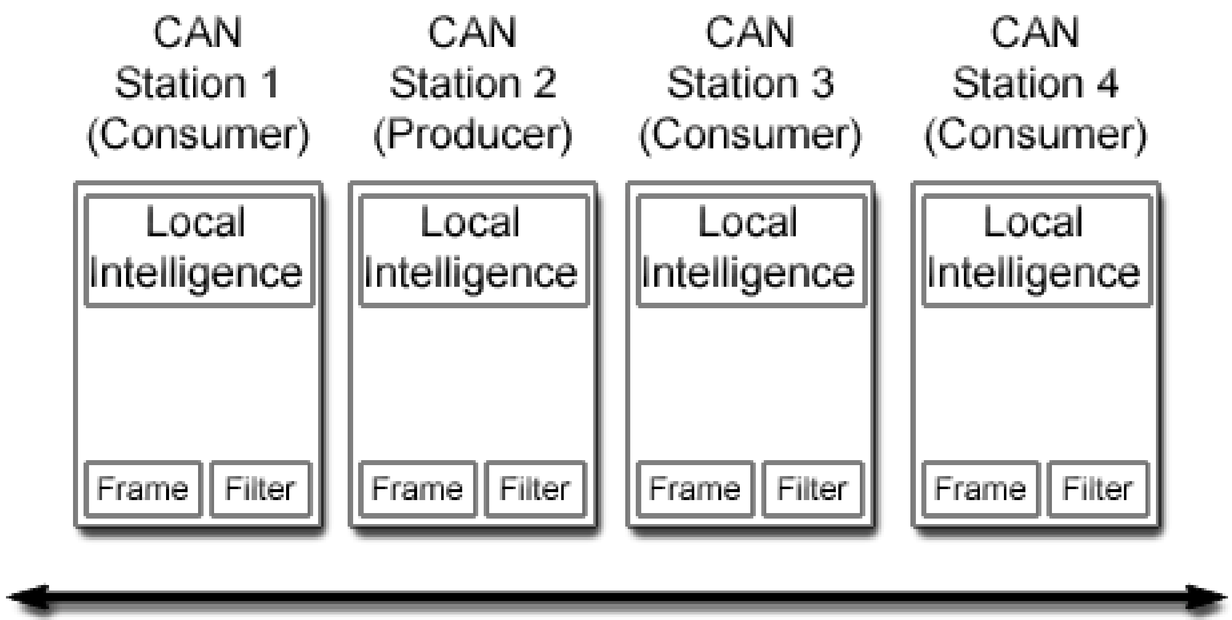
Q/A



Now A Practical Demonstration of

CAN Messaging System

will follow…



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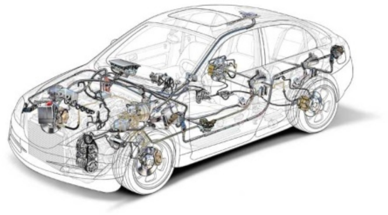
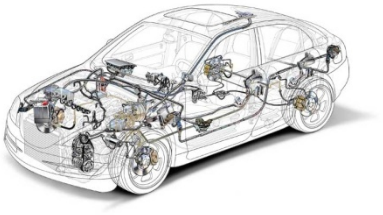


THANK YOU



Promotion

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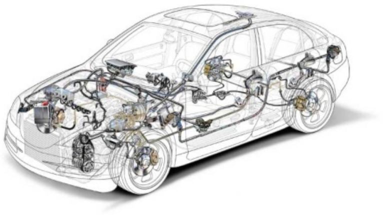

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- Specialized in Embedded System
- Provides Authentic Training with Experienced Faculty Team
- Have Placed 15000+ Engineers in core domain
- Rated one of the best Embedded Training Institute in India

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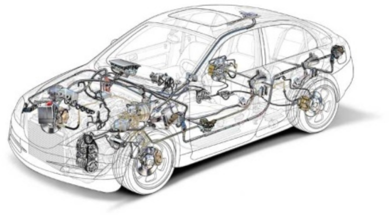
Few of our popular Training cou



- Embedded System Development
- IoT System Development
- Cloud Computing
- Python Programming
- C,C++ Programming
- Android App Development
- Linux Kernel Programming
- Java Programming

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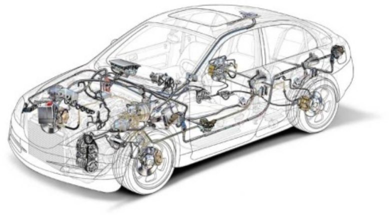

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