CAN BUS in Automotive systems

Raziuddin khazi

Chemnitz University of Technology

Embedded Systems

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Introduction

- CAN was dedicatedly developed for automobile in the 1980's, today CAN chips are manufactured by Motorola, Intel, Phillips etc.

- Half duplex, Message based protocol that overtook Ethernet and USB because of its price to performance ratio & simple hardware.

- ISO-11898 is the CAN standard, CAN2.0A – 11 bit identifier and CAN2.0B -29 bit identifier.

- High speed CAN - 1Mbps(suspension , engine control) and Low speed CAN – 125kbps(power window, wiper control).

Introduction
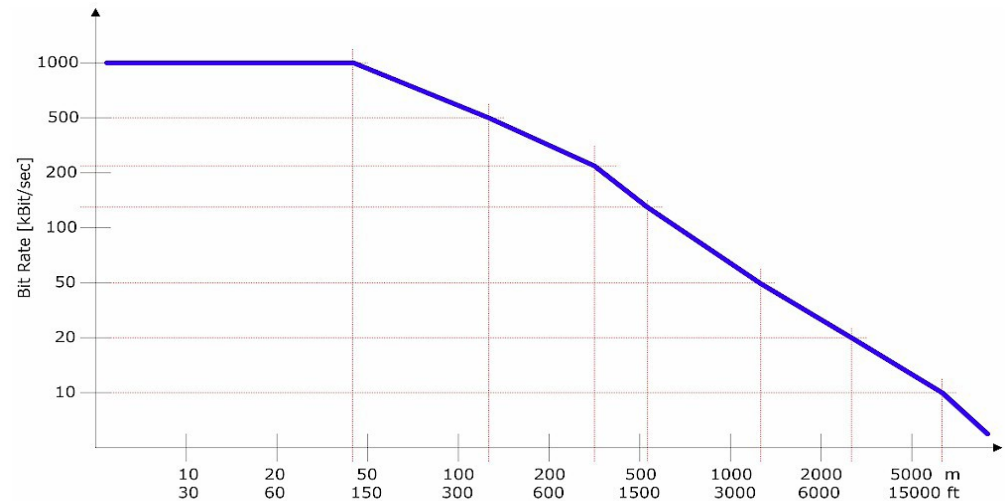
Typical CAN bus

Source: http://processors.wiki.ti.com
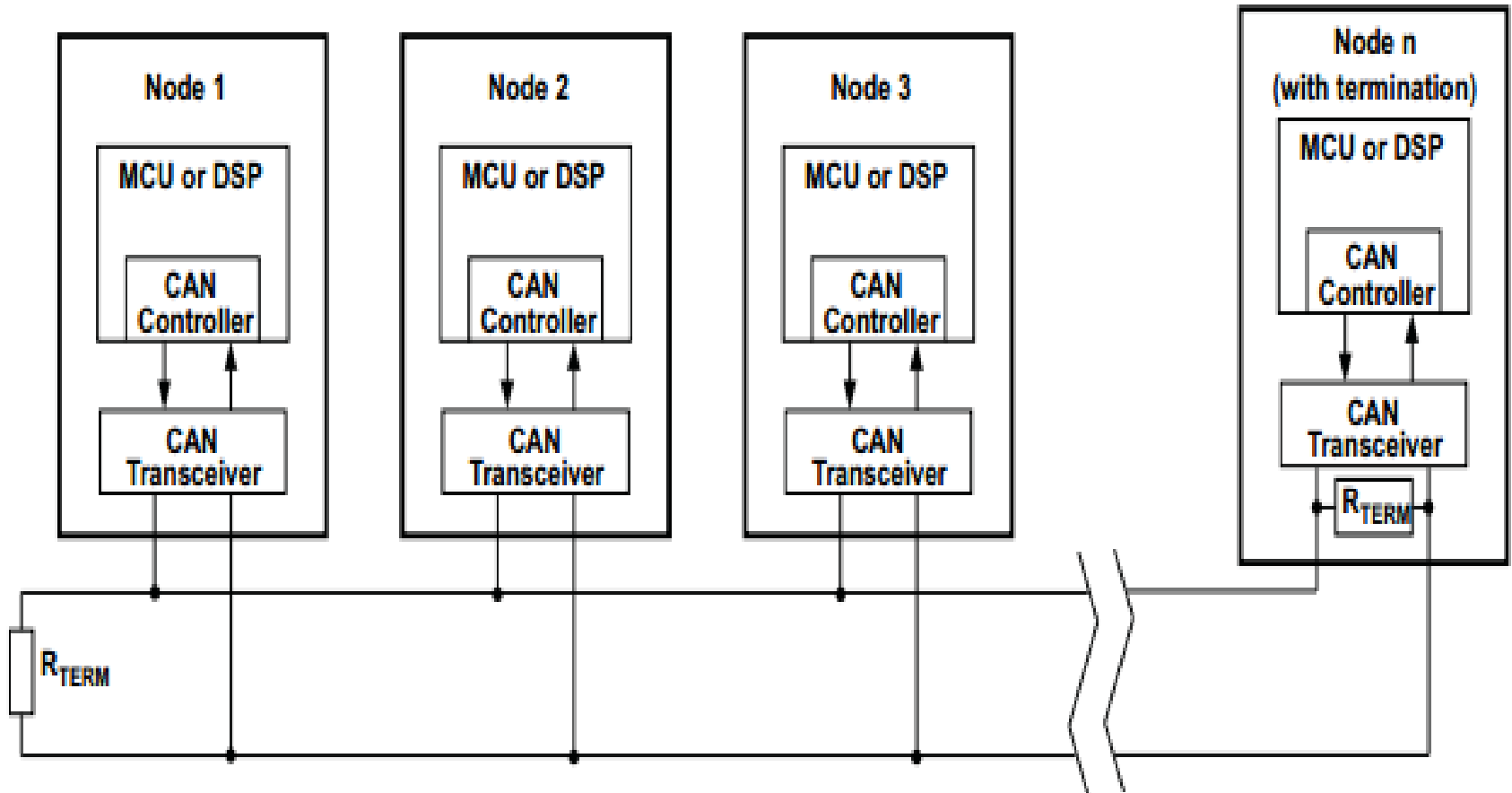
CAN requirements

- Twisted pair cable eliminate the electromagnetic interference.

- Recommended to have maximum 30 nodes with 120 ohm termination .

- According to the 'rule of thumb', signal rate * length <= 50

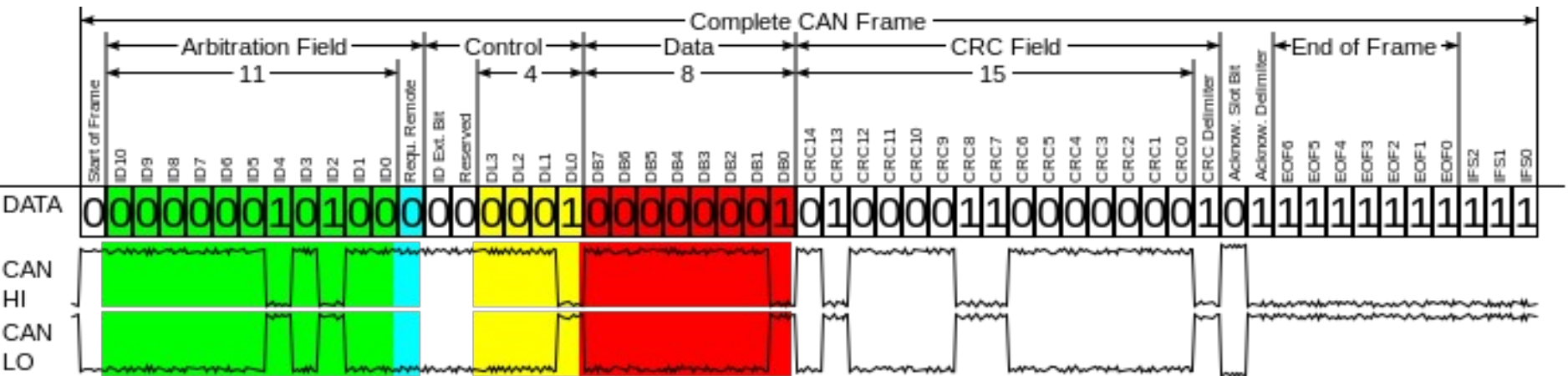| Bus length in meters	Signal rate in Mbps
40	1
100	0.5
500	0.10
1000	0.05

Source : http://digital.ni.com

Source : www.esp elecrtonics.com

CAN frame format

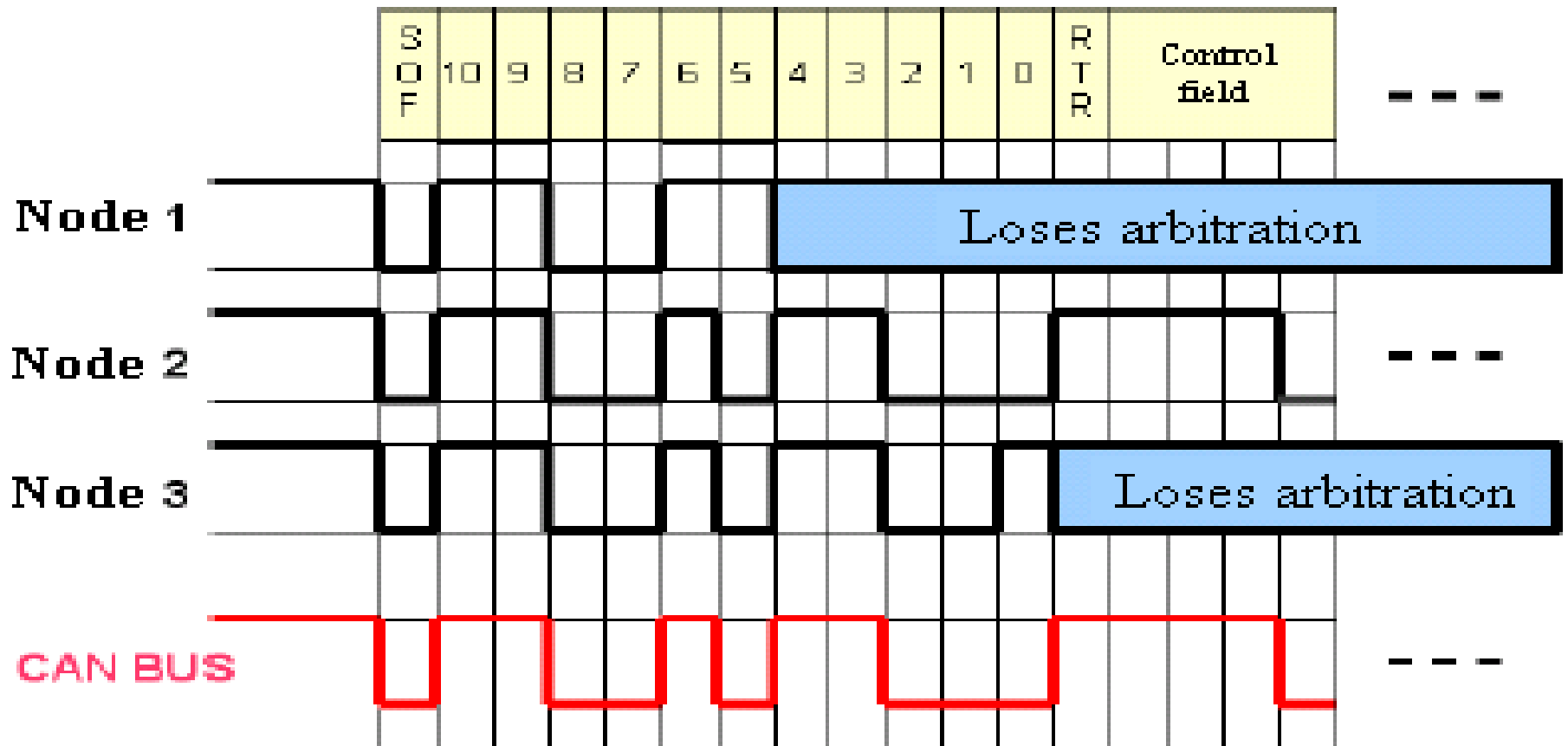
Source: https://en.wikipedia.org

Arbitration : When multiple nodes access the bus same time, the node with least arbitration wins.

RTR : When RTR = '1' then it is remote frame, otherwise data frame.

IDE : Select standard CAN when '0' and extended CAN when '1'

CAN frame format

Source: http://canbus.pl

Continued..

CAN frame format

- **DLC:** Data length code(4 bits) contains number of bytes of data being transmitted**.**

- **DATA:** up to 64 bits (8 bytes) of data can be transmitted.

- **CRC:** 16 bit cyclic redundancy check detects the transmission error.

- **ACK:** Dominant bit(0) after receiving correct data, otherwise writes recessive bit(1).

- **EOF:** Marks the end of frame and disable the bit stuffing .

- **IFS:** Inter frame space is the time required to move correctly received frame to message buffer area.

CAN bit stuffing

Stuff error:

Active error:

• It has six '0's & eight '1's, For every active error count increments by 8 and rest all receiving nodes increments by 1.

Passive error:

• Do not block bus traffic but keeps counting, if count is beyond 256 it results into bus off error.

Bus off error:

• Internally disconnects the node and only re-initialization can solve the issue.

Bit stuffing :

• Transmitter adds the opposite level bit on detecting 5 consecutive same level bits, and receiver discard the stuffed bit when receiving.

CAN OSI : Physical layer

- Physical layer can only be implemented on hardware.

- When transmitting it converts 1's and 0's into electrical signal and back again to bits when receiving.

Source: http://www.ti.com/product/SN65HVD231/datasheet
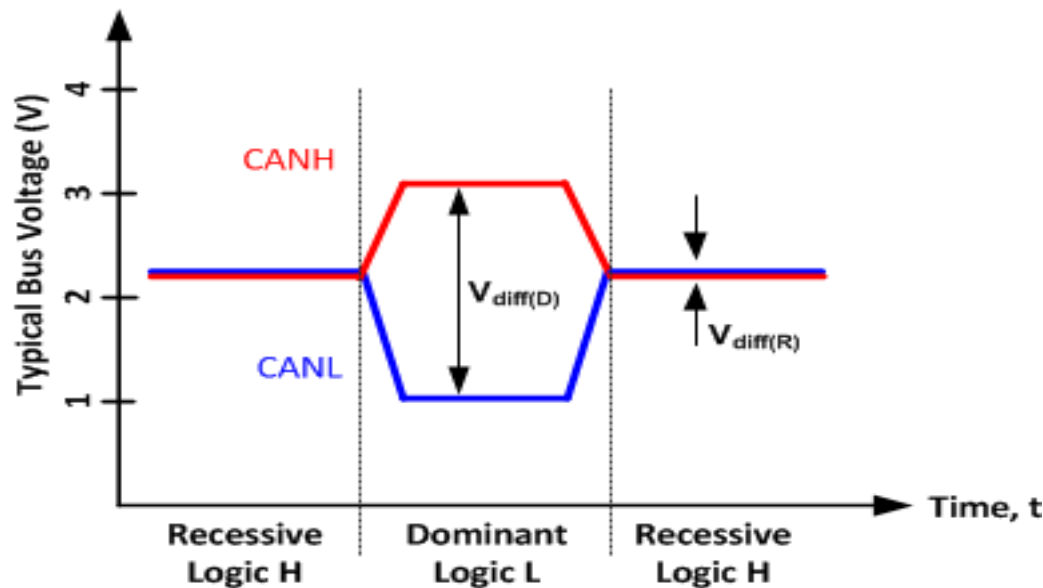
Continued..

CAN OSI : Datalink layer

• It can be implemented both on hardware and software.

• Carrier Sense: Nodes checks the bus status, if the bus is idle then accesses it otherwise wait.

• Multiple Access/CD+ AMP: Avoid collision when multiple nodes access the bus same time.
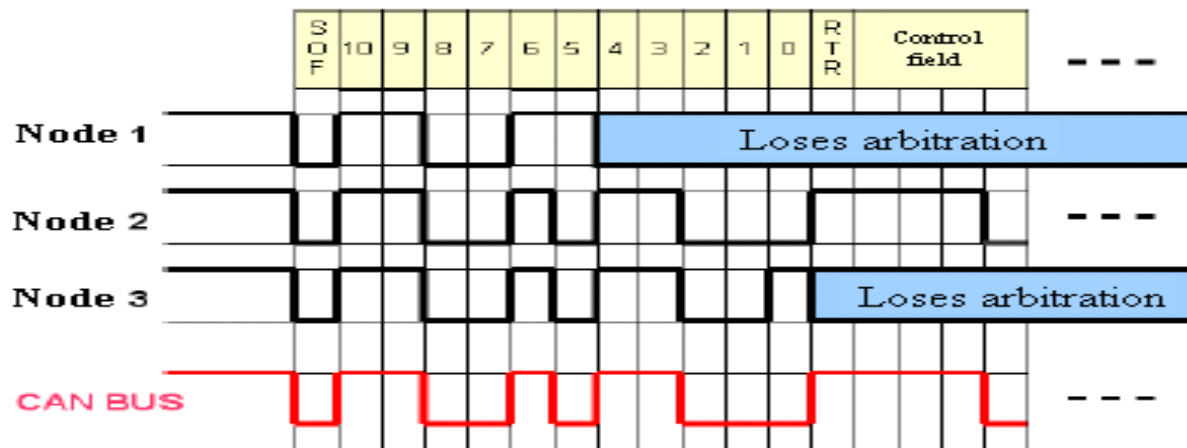
CSMA/CD+AMP explained

Source: http://canbus.pl

Advantages

- CAN is multi master capable communication.

- Reduce the wiring complexity between nodes.
.
- Error detection and correction capability.

- Easy interface with other protocol.

- High speed up to 1Mbps .

Source: www.ixxat.com

CAN vs Flex ray

Properties	CAN bus	Flex ray
Standard	ISO-11898	ISO-17458
Max speed	1 Mbps	10 Mbps
Topology	Bus	Bus and Star
Cost	Low	High

Source : https://en.wikipedia.org/

References

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[2] A novel bit stuffing technique for controller area network(CAN) protocol, Tapas ranjan, Ayas kant and kamala kant , 978-1-4799-2206-2/14, 2014

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THANK YOU