CAN

(Controller Area Network)

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Overview

- CAN (Controller Area Network) is a serial bus system used to communicate between several embedded 8-bit and 16-bit microcontrollers.
- It was originally designed for use in the automotive industry but is used today in many other systems (e.g. home appliances and industrial machines).

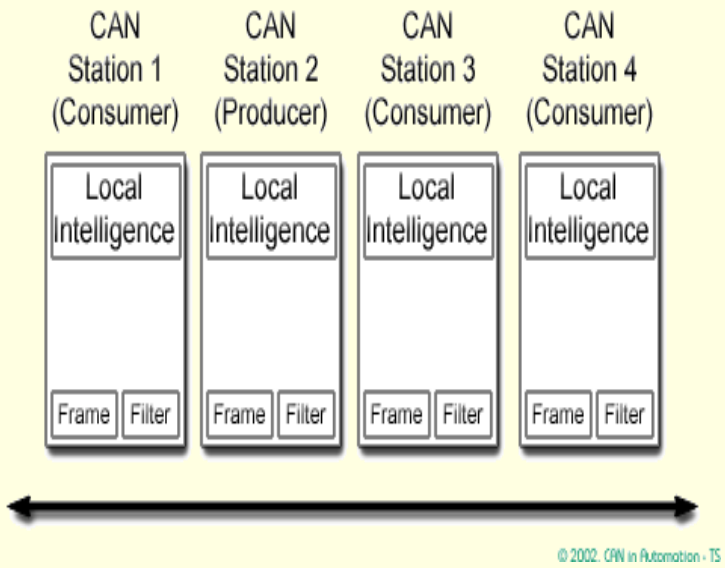
Overview (con't)

- Highest Baud Rate is 1Mbit.
- CAN uses a message oriented transmission protocol.
- There are no defined addresses, just defined messages.

Data Information – Frame Format

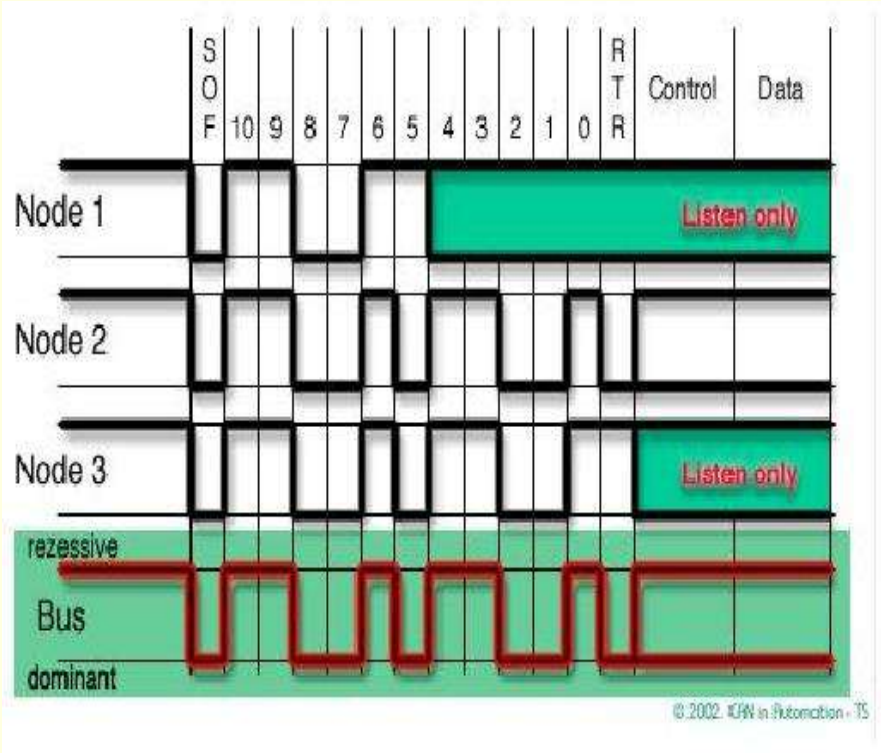
- SOF – Start of Frame
- Identifier – Tells the content of message and priority
- RTR – Remote Transmission Request
- IDE – Identifier extension (distinguishes between CAN standard,11 bit identifier, and CAN extended, 29 bit identifier.)
- DLC – Data Length Code
- Data – holds up to 8 bytes of data
- CRC – “Cyclic Redundant Check” sum
- ACK – Acknowledge
- EOF – End of Frame
- IFS – Intermission Frame Space. Minimum number of bits separating consecutive messages.

Data Information - Protocol



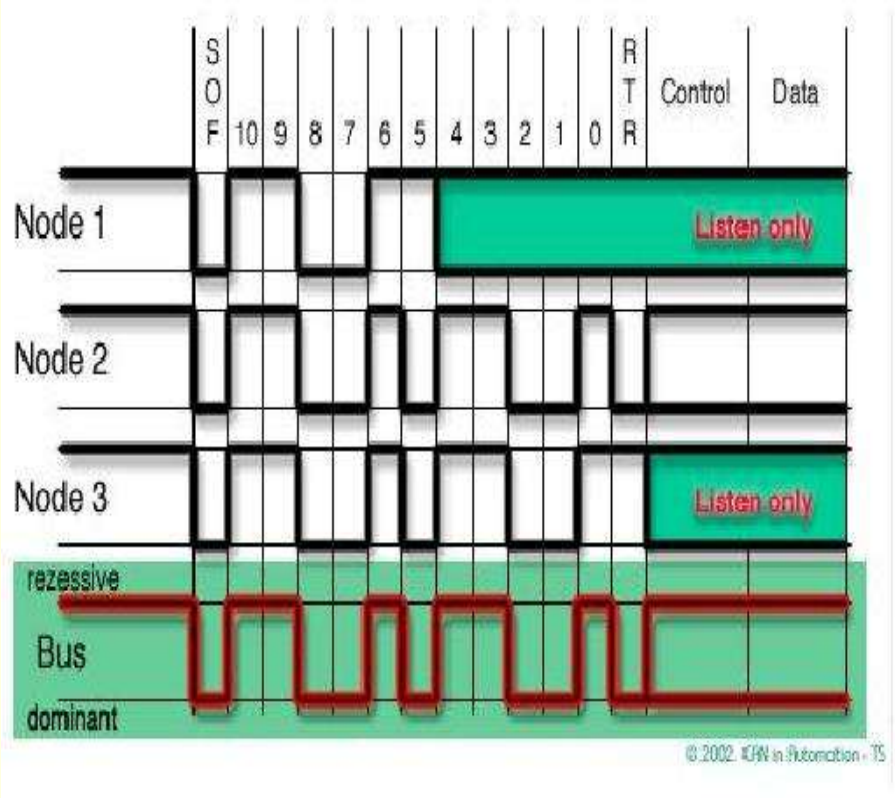
- Messages are distinguished by message identifiers.
- The identifier is unique to the network and defines the content & priority of the message.

Data Information – Protocol (con't)



- When several messages access the bus at the same time, the one with the higher priority "wins".
- The identifier with the lowest binary number has the highest priority.
- The priority are specified during system design and cannot be changed dynamically.

Data Information – Protocol (con't)



- Access conflicts on the bus are resolved by a "wired and" mechanism, where the dominate state overwrites the recessive state.
- All "losers" automatically become receivers and they won't try to send another message until the bus becomes available again.

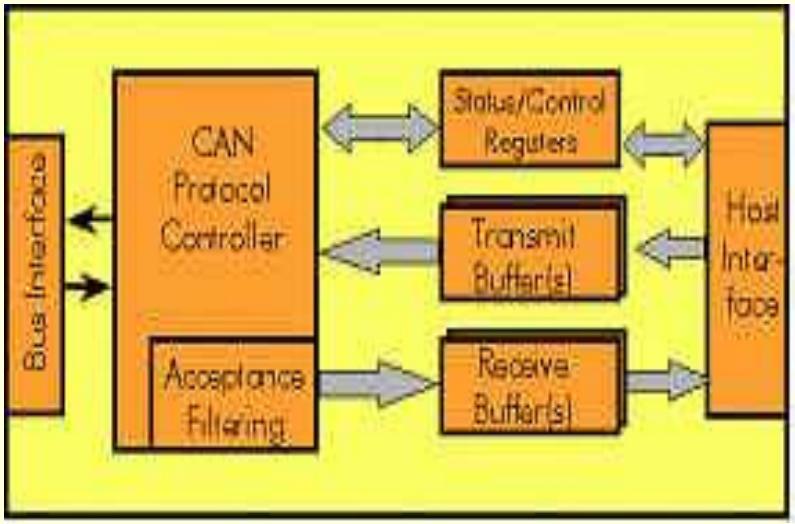
Data Information – Error detection

- If one or more errors are detected, the transmission is aborted. This prevents all other stations or nodes from accepting the message.
- Re-transmission is automatic. If errors continue, then the station or node may switch itself off to prevent the bus from being tied up.
- Error detection is done on two levels:
  - Message level
  - Bit level

Data Information – Error detection (con't)

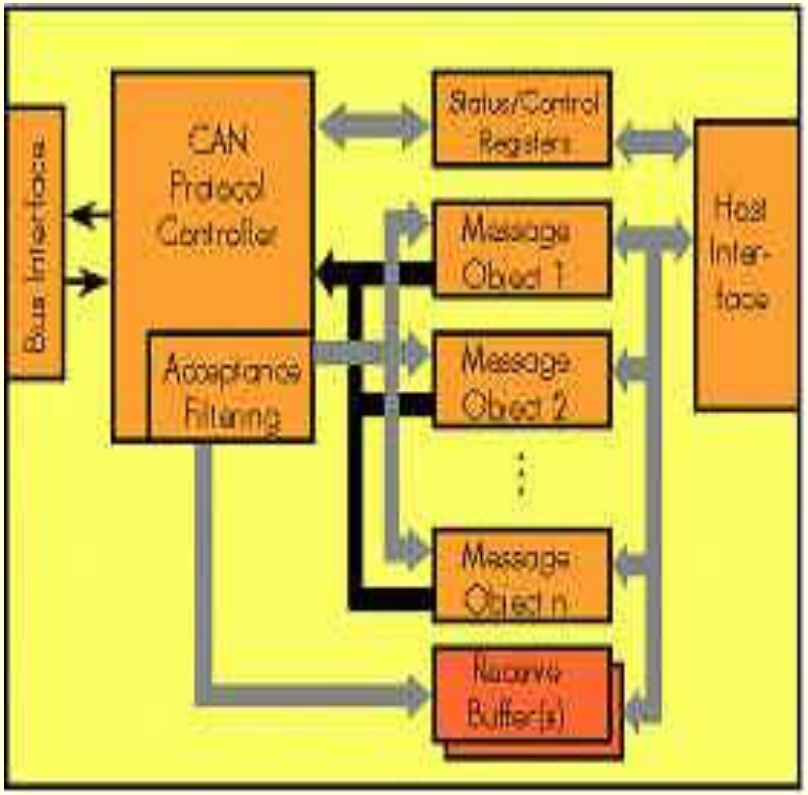
- Message Level
  - CRC = Cyclic Redundant Check sum
  - Frame Check = compares message to fixed format and frame size
  - ACK errors = if transmitter does not receive an ACK signal from the receivers
- Bit level
  - Monitoring = The transmitter monitors the bus signal as it sends the message and compares the bit sent to the bit received.
  - Bit Stuffing = After five consecutive equal bits, the transmitter inserts a stuff bit with a compliment value into the bit stream. The receivers remove this stuff bit.

Implementations



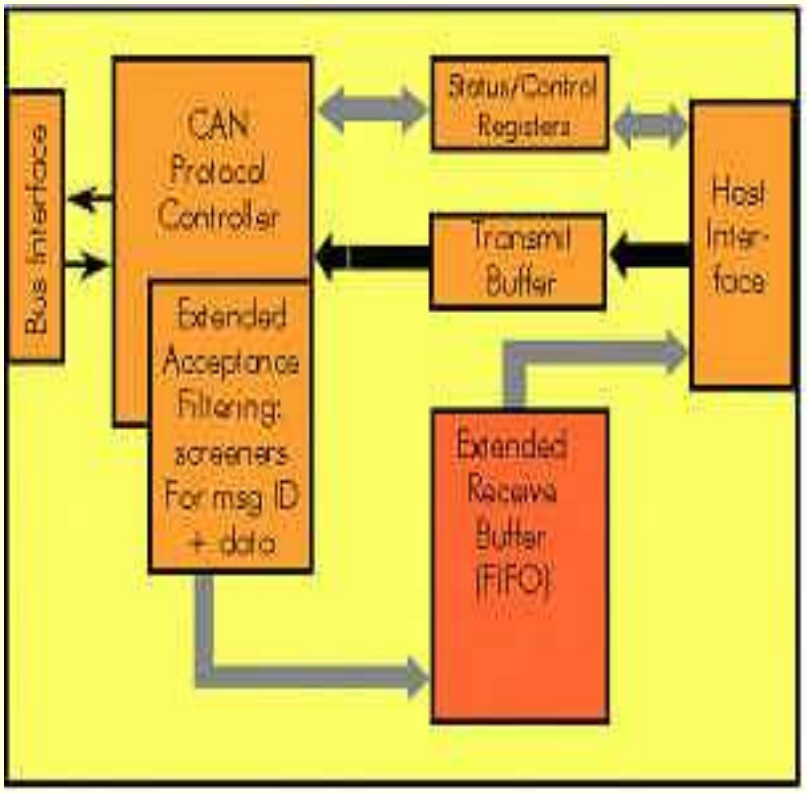
- Basic CAN
  - Limited number of receive buffers and filters
  - Can get bogged down quickly with multiple consecutive messages.

Implementation (con't)



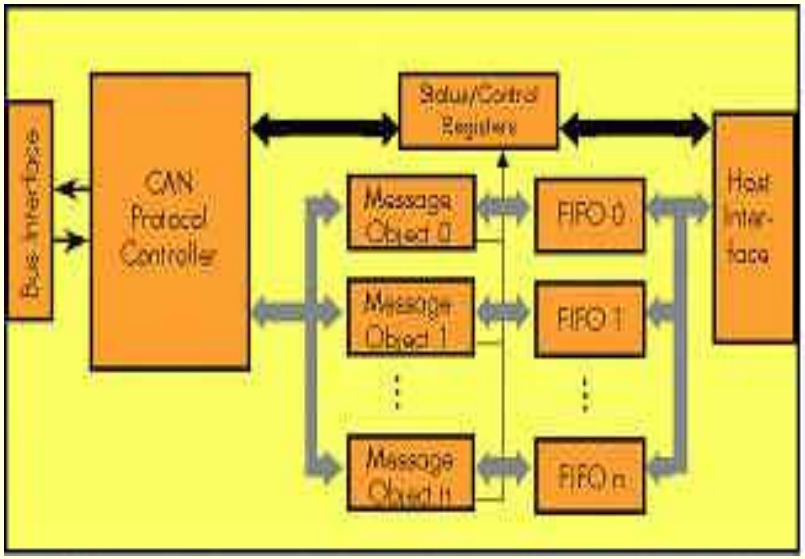
- Full CAN
  - Has several message objects (usually 15)
  - Can loose data if message objects are setup for multiple filters
  - Can still get bogged down if too many messages are sent consecutively

Implementation (con't)



- FIFO
  - "First In First Out" receive buffer
  - Fixes problem with multiple consecutive messages
  - Cannot allow a high priority message to move to front. It has to wait its turn

Implementation (con't)

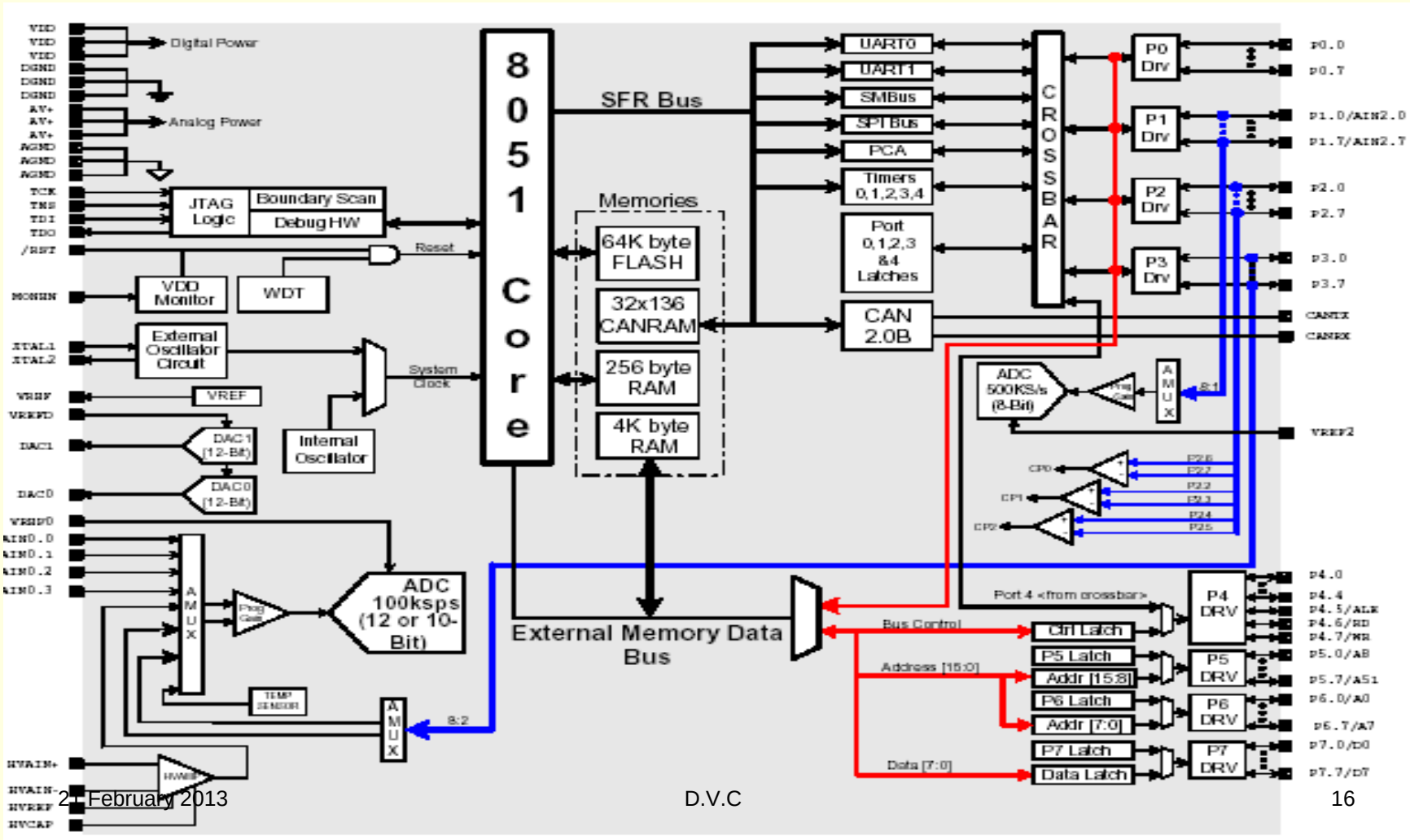


- Enhanced Full Can
  - Dedicated FIFO for each individual message object
  - Very complicated to use
  - Less common

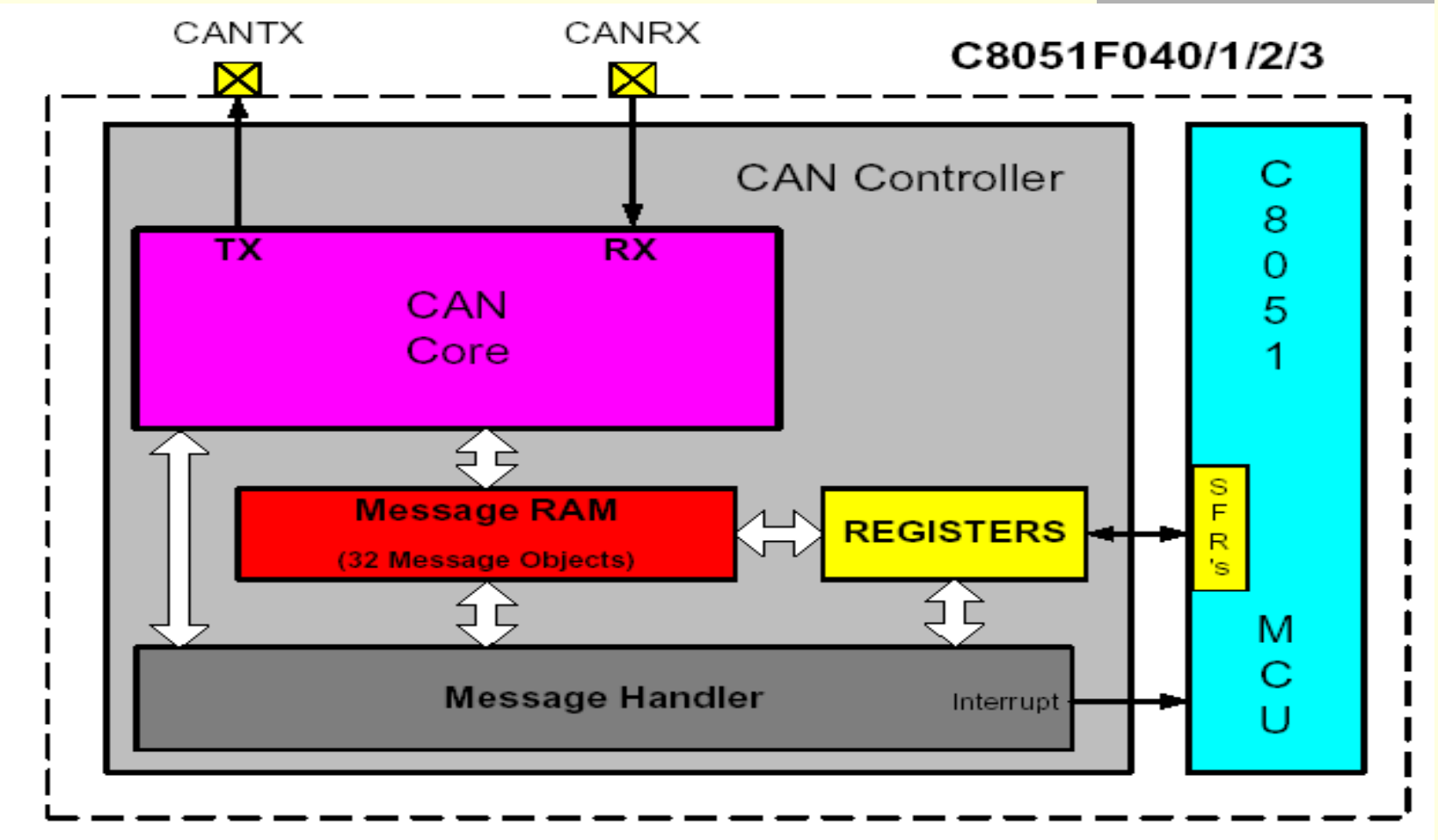
Manufacturers

- Over 20 different chip manufacturers produce microcontrollers with on-chip CAN interfaces.
- Some more notable ones are:
  - Cygnal
  - Intel
  - Motorola
  - NEC
  - Phillips
  - Toshiba

Cygnal C8051F040/042 Block Diagram



CAN Controller Diagram



Summary

- CAN (Controller Area Network) is a serial bus system used to communicate between several embedded 8-bit and 16-bit microcontrollers
- Data Information
  - Frame Format
  - Protocol – message oriented
  - Error Detection
    - Message level (CRC, frame check, ACK errors)
    - Bit level (monitoring, bit stuffing)
- Implementations
  - Basic CAN
  - Full CAN
  - FIFO
  - Enhanced Full CAN
- Over 20 different chip manufacturers produce microcontrollers with on-chip CAN interfaces including Cygnal, Intel, and Motorala.