Universitatea Politehnica Timişoara

Lecture 9. Multimedia buses

Inter-IC Sound (I2S). Domestic Digital Bus (D2B). Media Oriented System Transport (MOST)

Transporting audio-video data

- A particular use case in embedded system networks is the delivery of audio-video data
- Specific requirements:
  - Higher datarates – dictated by the volume of information that has to be transported
  - Reliable transmission – required to maintain quality of the audio-video stream

Communication protocols for multimedia

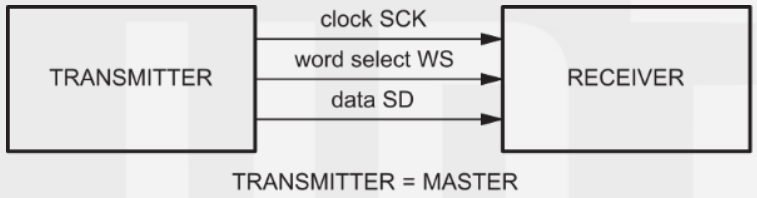
- **Inter-IC Sound (I2S)**
- **Domestic Digital Bus (D2B)**
- **Media Oriented System Transport (MOST)**
- **IEEE 1394 (FireWire)**

Inter-IC Sound (I2S)

- Serial interface designed to transfer audio data
- Developed by Philips Semiconductors (Currently NXP)
- First specification published in February 1986, revised June 1996
- Uses 3 lines:
  - Serial Data (SD): Two time-multiplexed data channels
  - Word Select (WS): 0=left channel, 1 = right channel
  - Serial Clock (SCK): Clock
- Timing requirements are specified relative to the clock period or to the minimum allowed clock period of a device T_{tr} → data rates depend circuit clocking capabilities

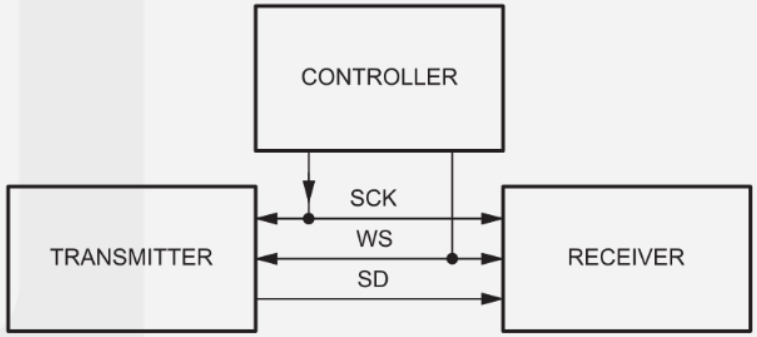
I2S system configuration

- A master controls the SCK and WS lines
- The master role can be assumed by:
  - the transmitter node
  - the receiver node
  - a system master controller node



TRANSMITTER = MASTER

RECEIVER = MASTER



CONTROLLER = MASTER

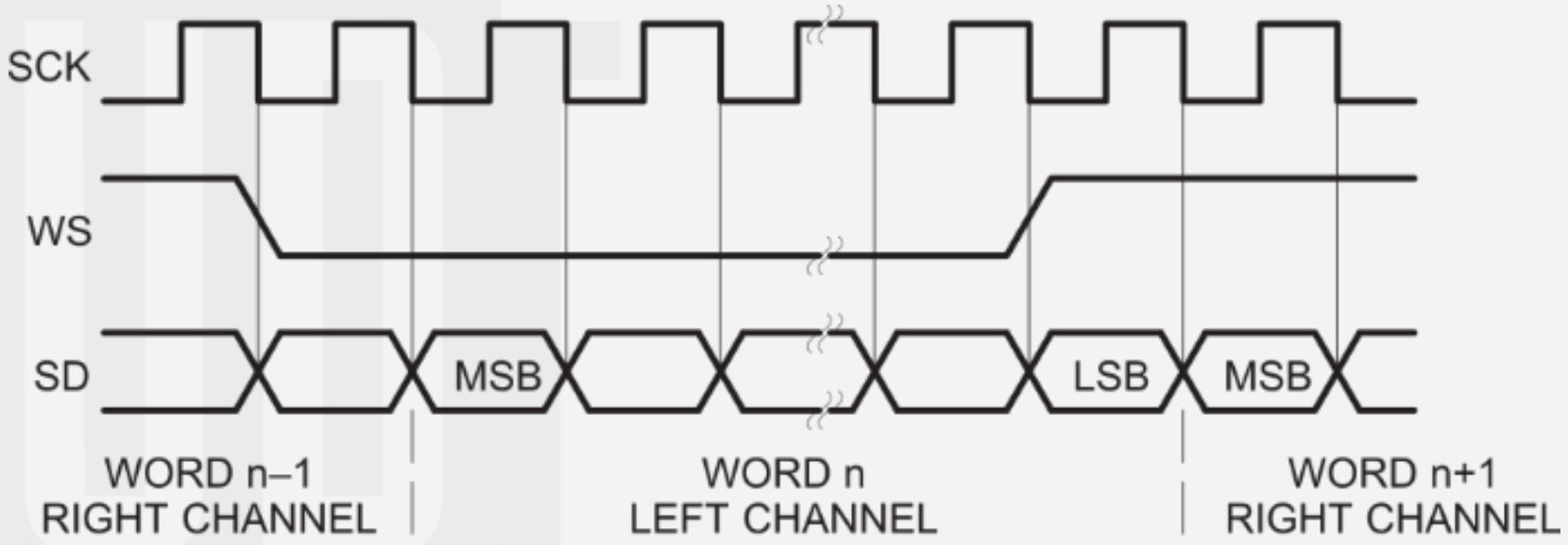
(I2S specification)

Serial data transmission

- Serial data is transmitted in two's complement
- MSB is transmitted first
- Transmitter and receiver may have different word lengths
  - System word length > receiver word length -> truncate received word
  - System word length < receiver word length -> append 0s for missing bits
  - System word length > transmitter word length -> missing bits set to 0
- Word length depend on implementation: 16-, 24-, 32-, 48- and 64-bit available in various I2S chips

I2S timing

- Transmitter always sends the MSB of the next word one clock period after WS changes
- Serial data sent by the transmitter may be synchronized with either the trailing (HIGH-to-LOW) or the leading (LOW-to-HIGH) edge of the SCK signal
- However, the serial data must be latched into the receiver on the leading edge of the SCK



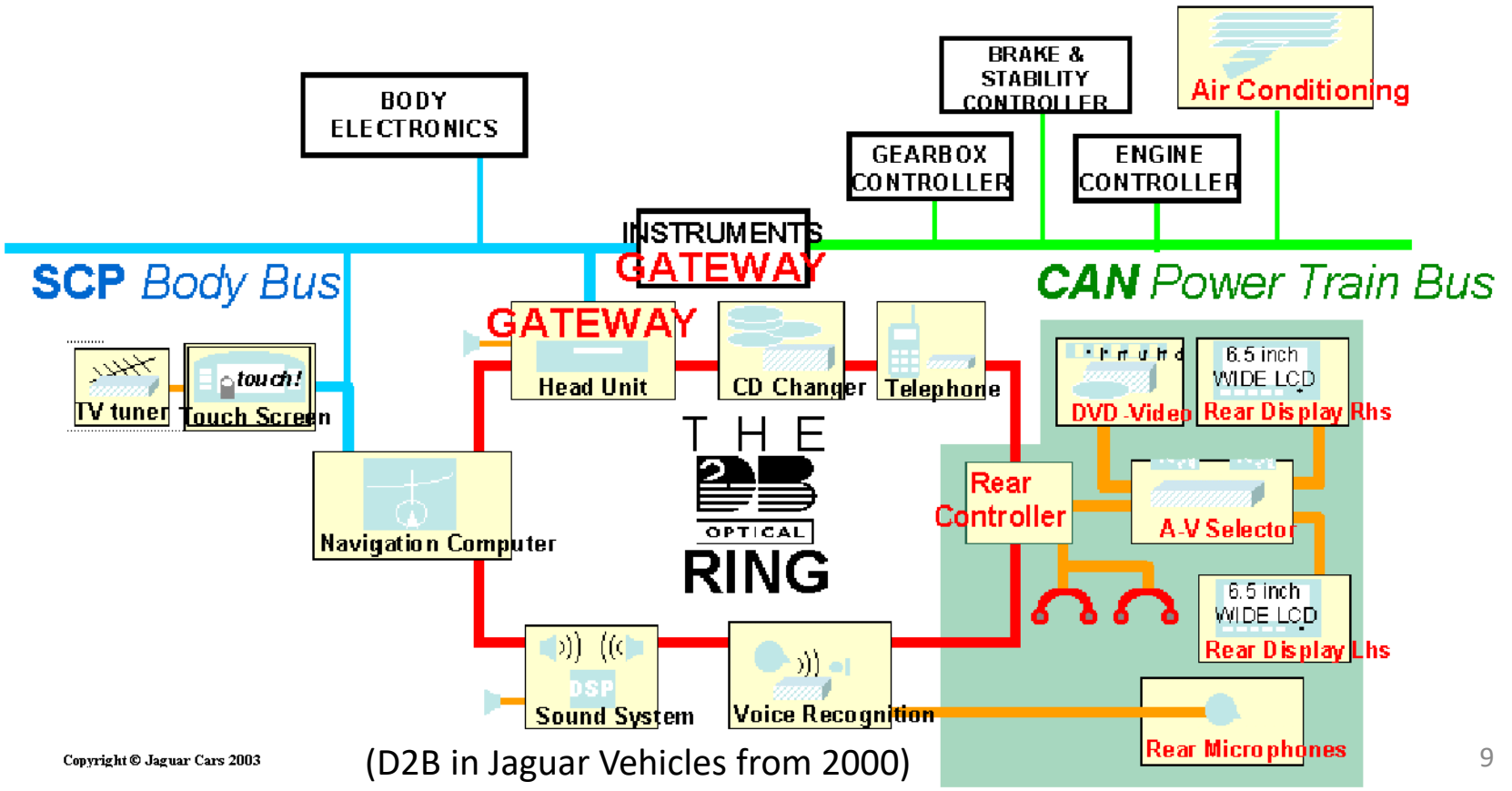
(I2S specification)

Domestic Digital Bus (D2B)

- Developed by Philips in the 1980s
- Standardised as IEC 61030 in 1991 but currently withdrawn and replaced with newer technology
- Multimaster communication
- Differential Twisted pair electrical conductor or optical fiber as transmission media

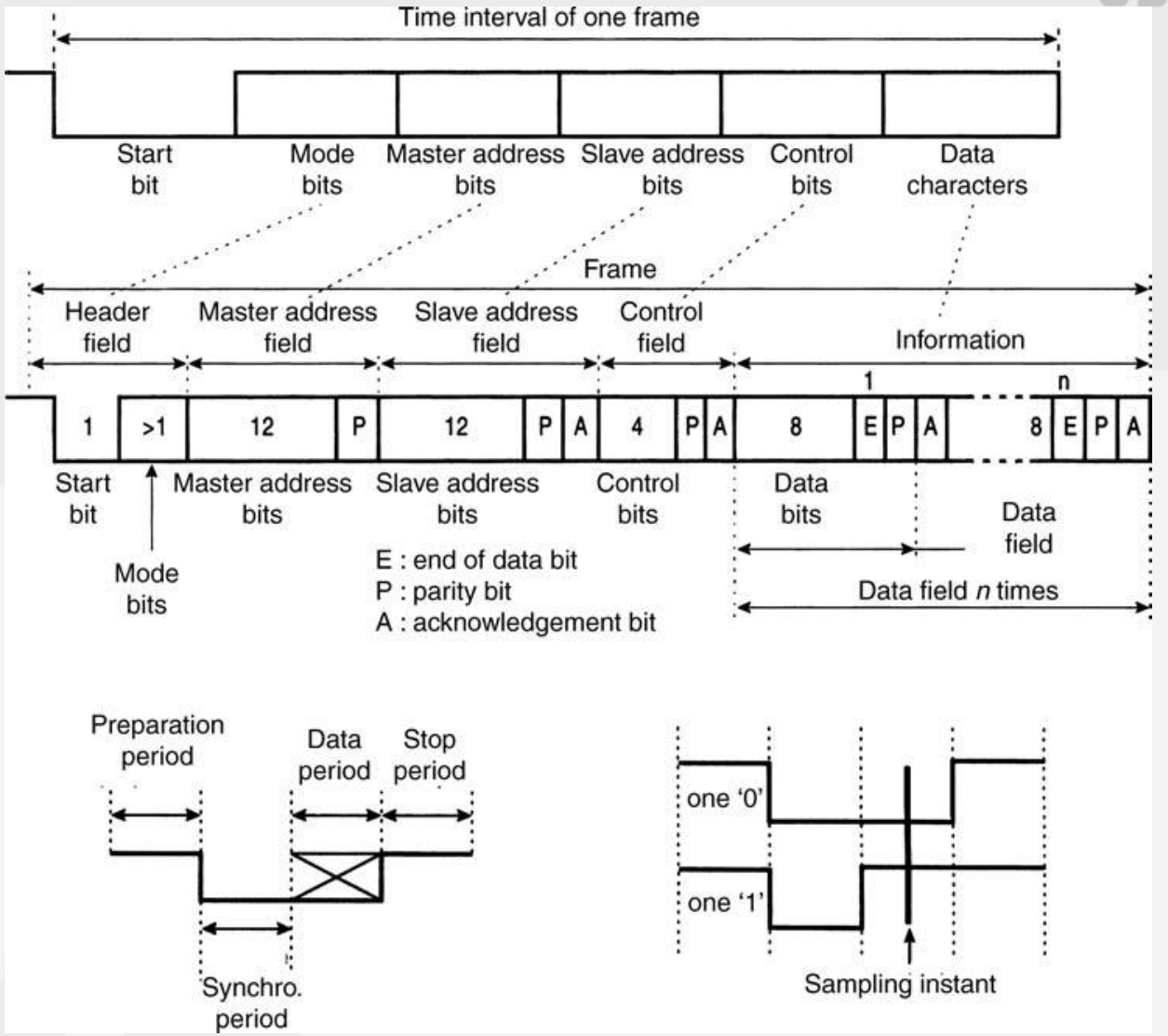
D2B Topology

- Daisy chain
- Optical ring



(D2B in Jaguar Vehicles from 2000)

D2B frame



(D. Paret, Multiplexed Networks for Embedded Systems, Wiley, 2007)

Media Oriented Systems Transport (MOST)

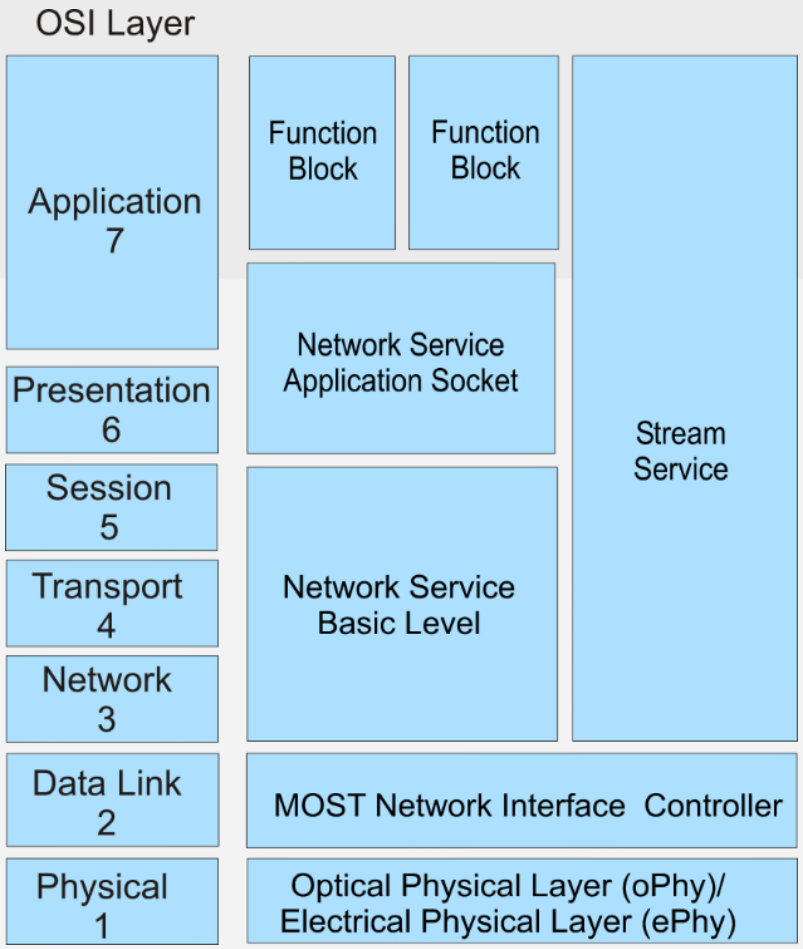
- High-speed multimedia protocol
- Based on the D2B protocol
- Used by most of the major car manufacturers
- The MOST specification is developed and maintained by the MOST Cooperation organization

Main reference:

[MOST] Andreas Grzemba, *MOST, the automotive multimedia network*, Franzis Verlag, 2011

MOST mapped on the OSI model

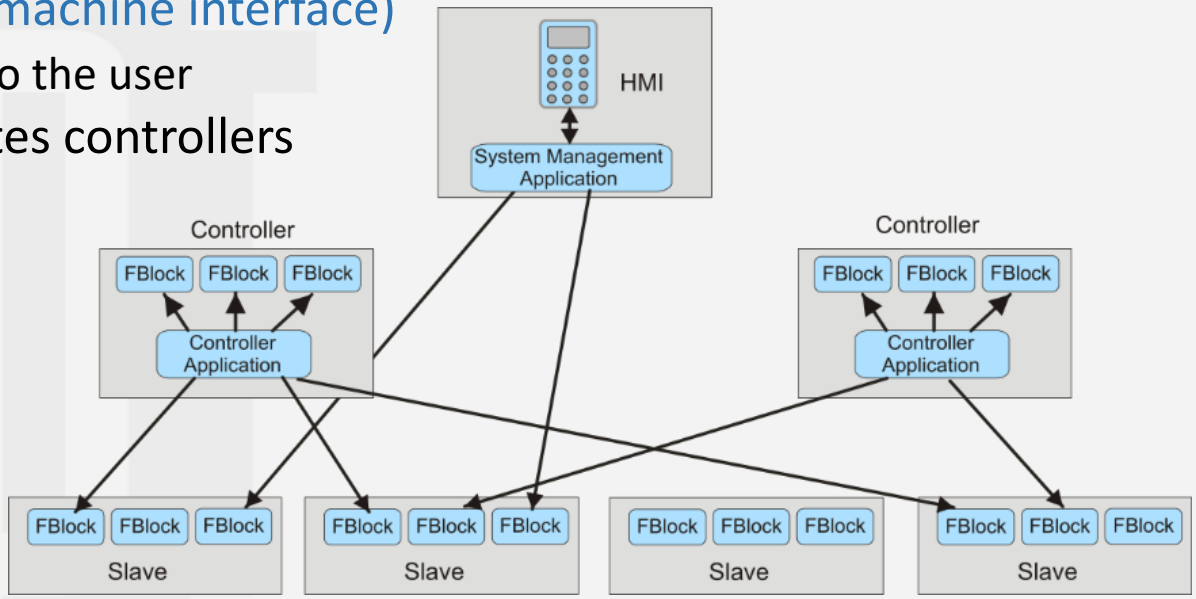
- MOST protocol stack is mapped across all 7 OSI layers
- A high abstraction level enables fast system design
- Application is interfaced with the MOST stack through function blocks
- A function block provides the interface for controlling a particular functionality within a MOST node



(after [MOST])

Interactions in the MOST hierarchy

- Slave
  - device controlled by a controller but has no knowledge about the system
  - provides functionalities through its function blocks
- Controller
  - administrates functionalities within a MOST system
  - requires knowledge about the subsystem it controls
- HMI (human-machine interface)
  - interface to the user
  - coordinates controllers



(after [MOST])

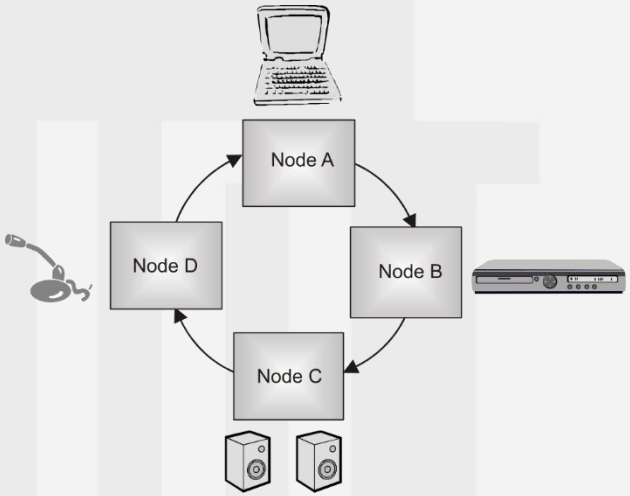
MOST physical layer

- Optical
  - uses Plastic Optic Fiber (POF)
  - Very good electromagnetic compatibility
- Electrical
  - Specified only for MOST50 and MOST 150

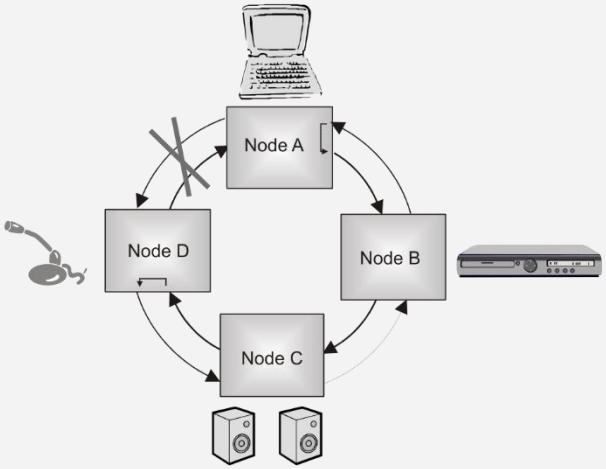
	MOST25	MOST50	MOST150
Bit rate	~25Mbit/s	~50Mbit/s	~150Mbit/s
Physical layer	Optical	Optical / Electrical	Optical/Electrical (based on coax line drivers)

MOST network topology

- Simple ring topology is the most commonly employed
- Double ring is used for increased availability in case of broken connections



Simple ring



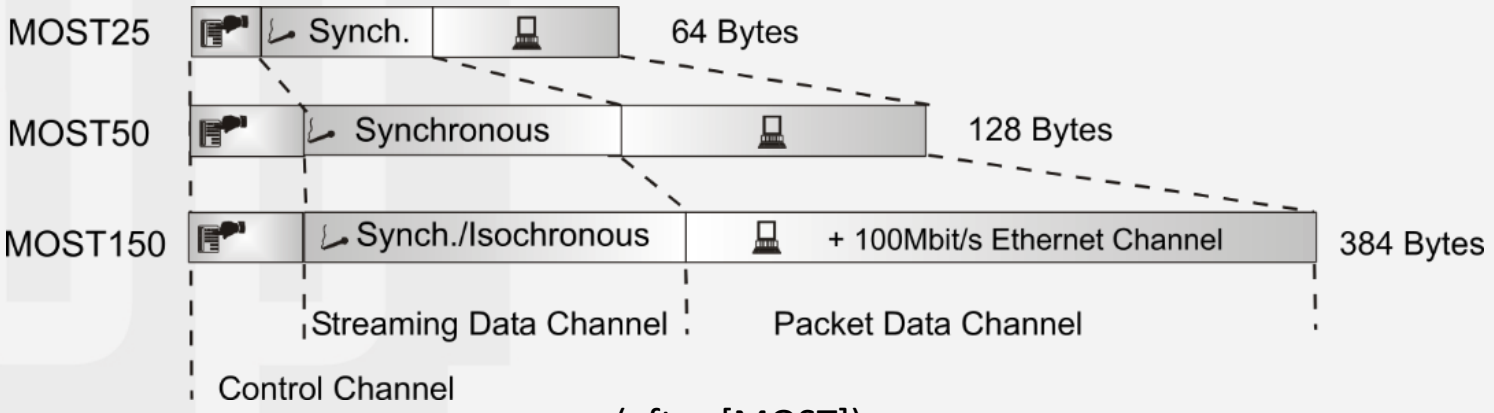
Double ring

(after [MOST])

MOST frames

- A MOST frame contains
  - one channel for the synchronous transmission of streaming data
  - one channel for the asynchronous transmission of packet data
  - one channel for the transmission of control data

- Streaming channel – accommodates static connections between streaming sources and sinks
- Control channel – general control messages for function blocks
- Packet data channel – packet data such as configuration information



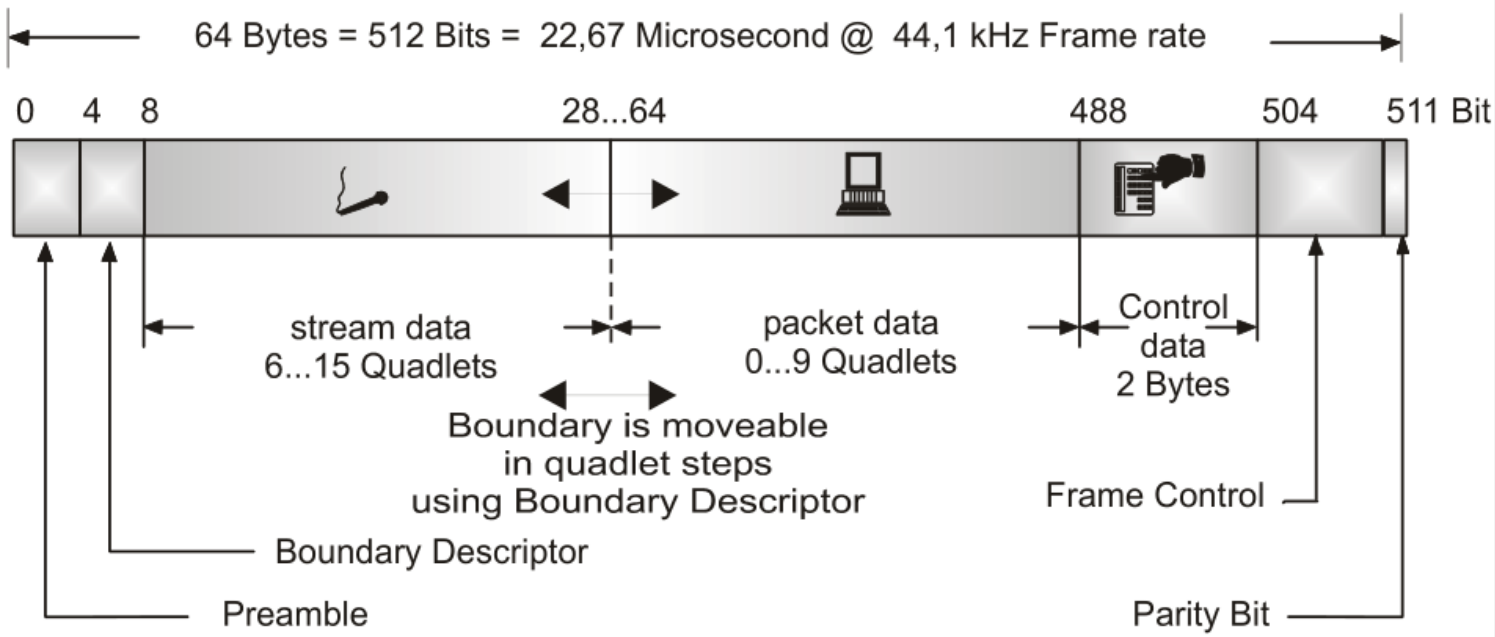
(after [MOST])

Timing masters/Timing slaves

- Synchronization is achieved by a common system clock derived from the data stream
- System clock is generated by the Timing Master (usually implemented in the head unit of the infotainment system)
- All Timing Slaves are synchronized with the system clock pulse through a PLL connection
- The Timing Master receives the frame again after it travelled through the ring and generates the next frame
- Lock/Unlock state
  - a Timing Slave is in the lock state if it receives the input signal used to synchronize with the PLL
  - a Timing Master is in the lock state if it can regenerate the frame from the signal that travelled around the ring

MOST25 frame

- Preamble – used to synchronize TimingSlaves and initial frame identification
- Boundary descriptor – used to adapt the bandwidth of the streaming and packet data channels
- Frame control – holds frame control data and status bits
- Parity bit – used for bit error detection

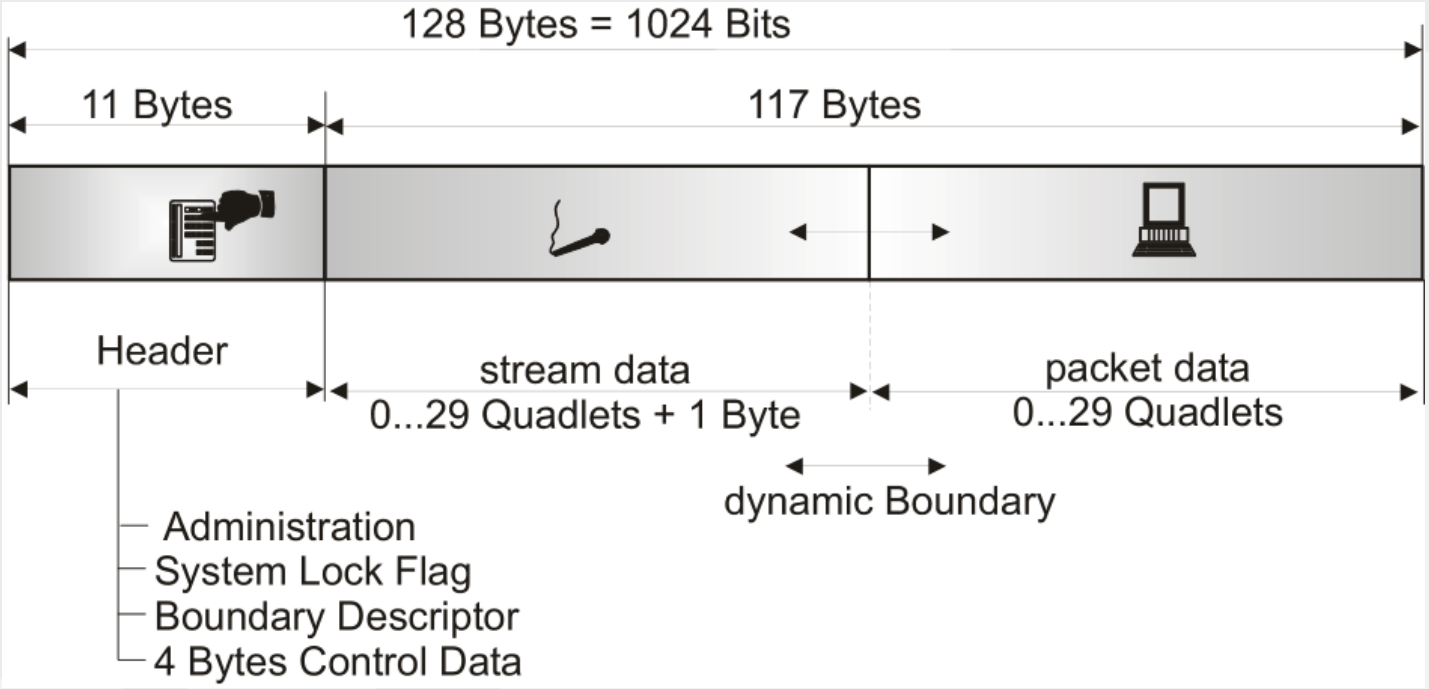


1 quadlet = 4 Bytes

([MOST])

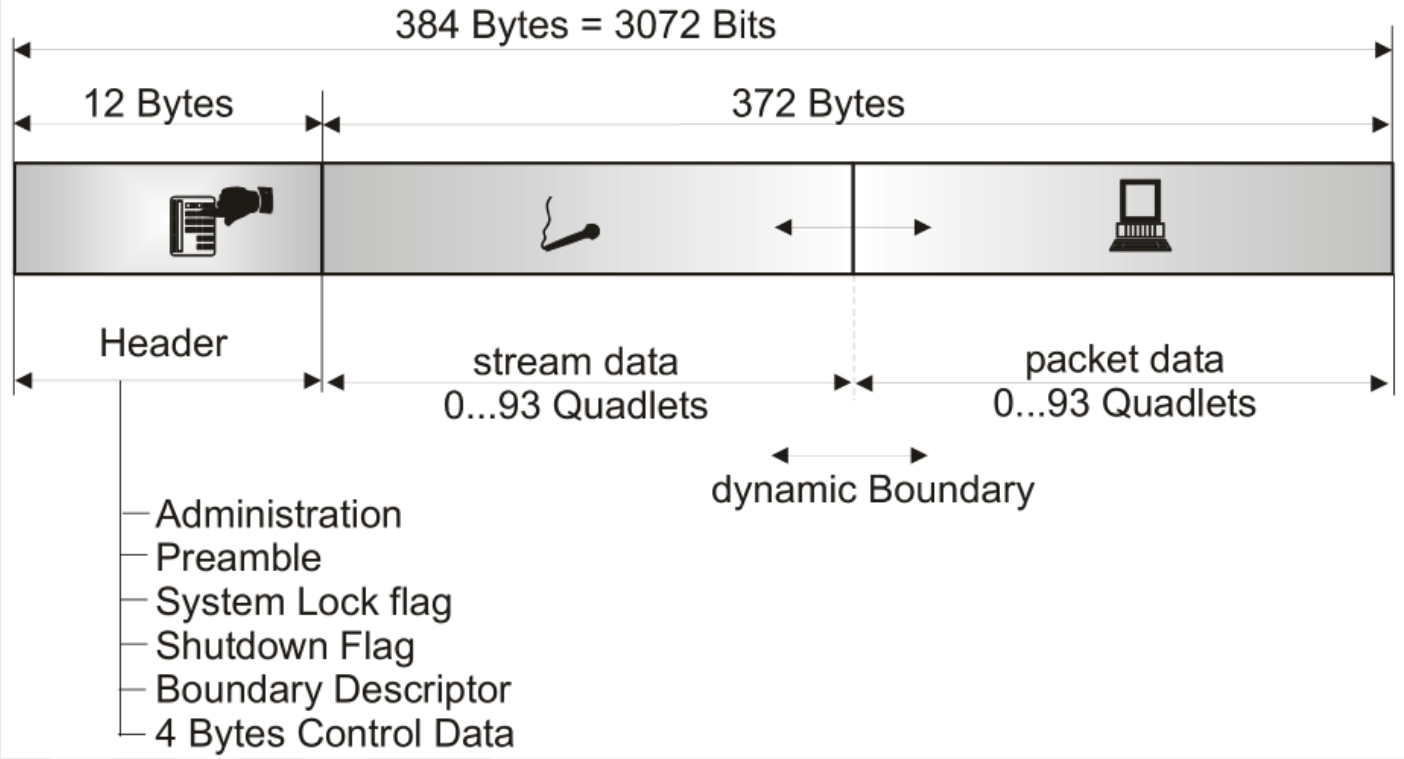
MOST50 frame

- Administration – used for administrative data
- System Lock Flag – indicated the system lock state



([MOST])

MOST150 frame



([MOST])