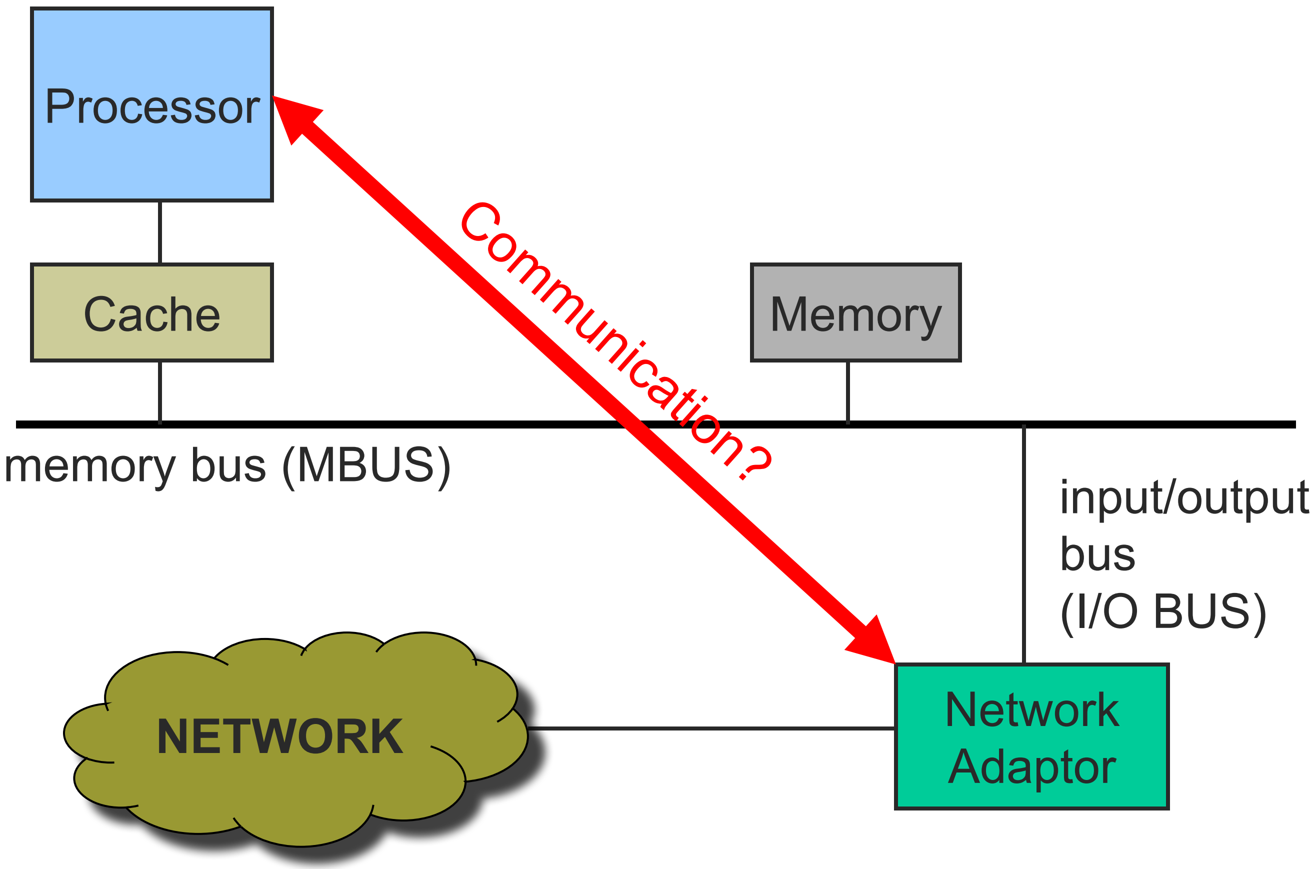
Network Adaptors

AKA Network Interface Cards (NIC)

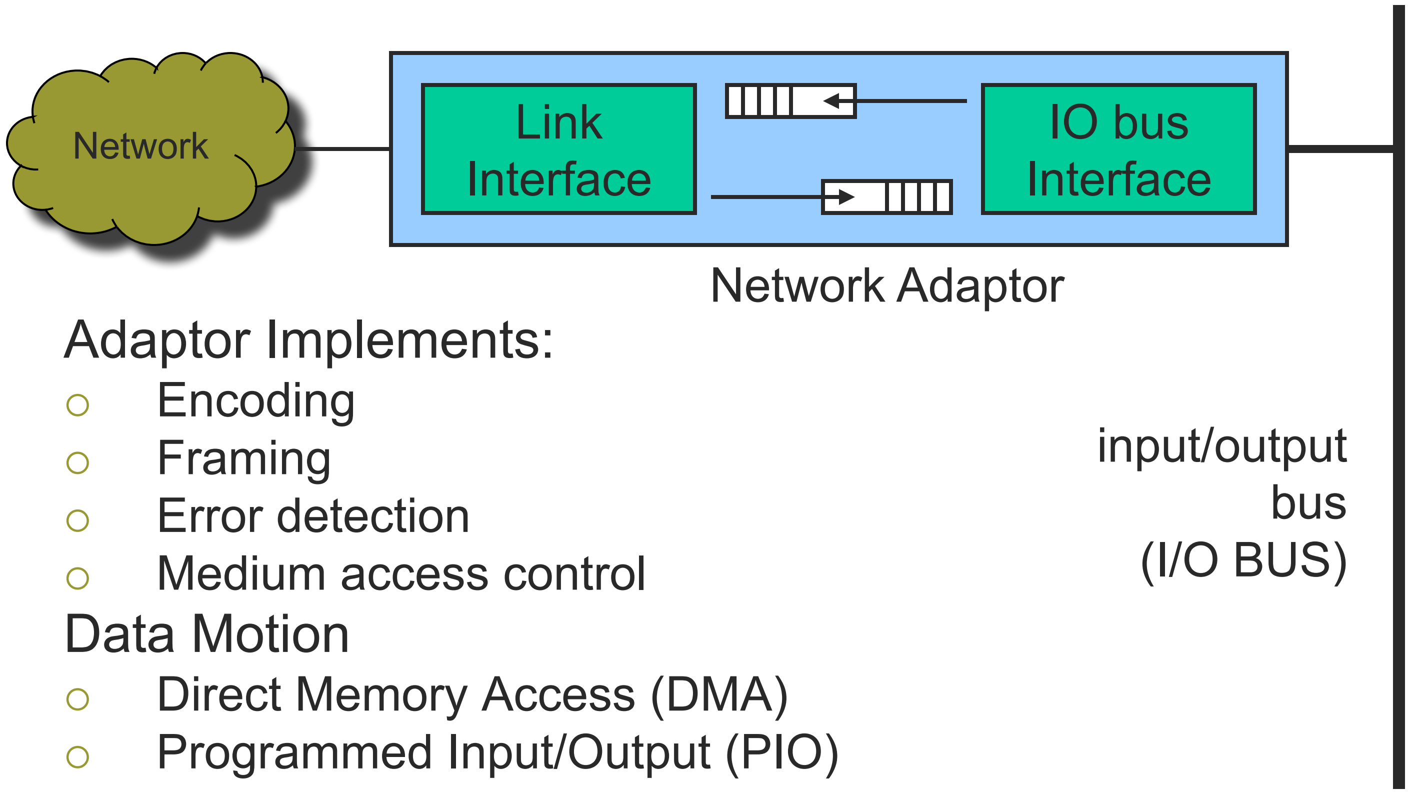
Network Adaptors

- Components
- Options for Use
  - Data Motion
  - Event Notification
- Potential performance bottlenecks
- Programming device drivers

Network Adaptors

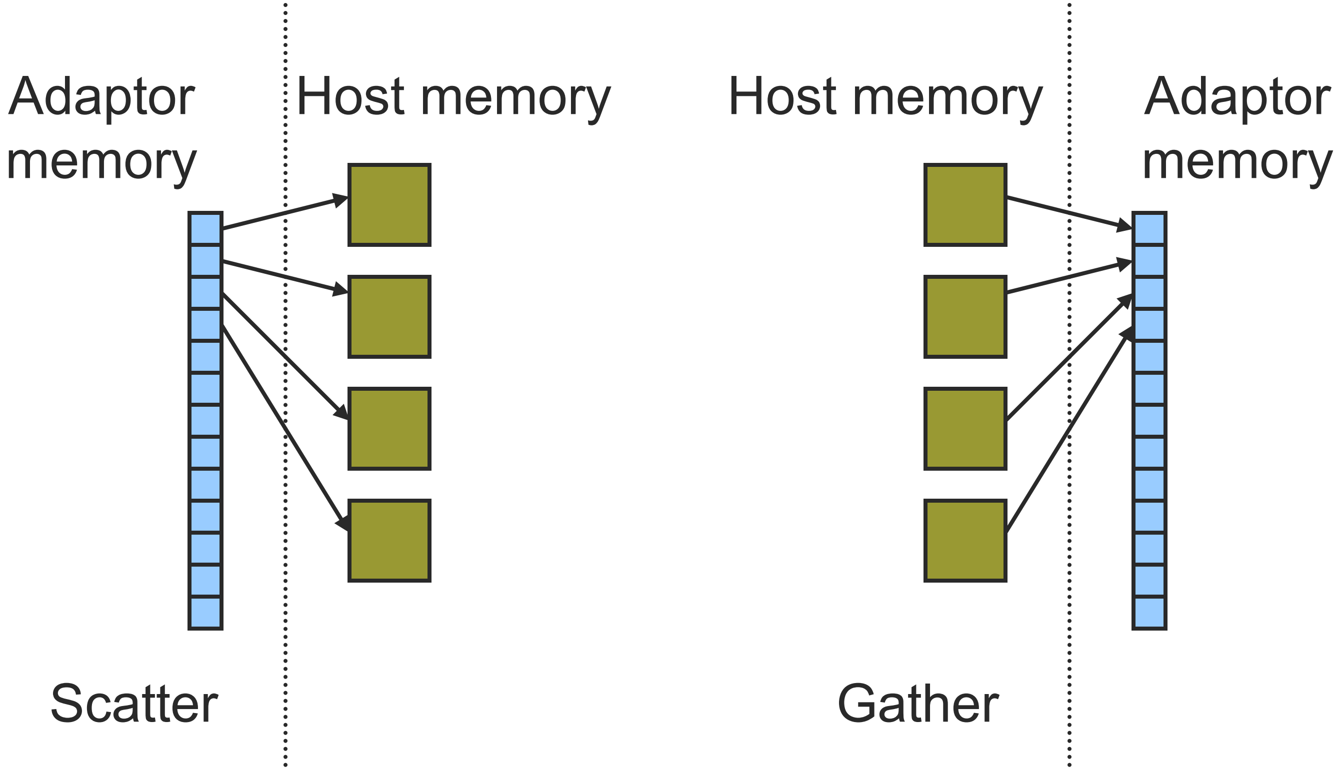


Network Adaptors

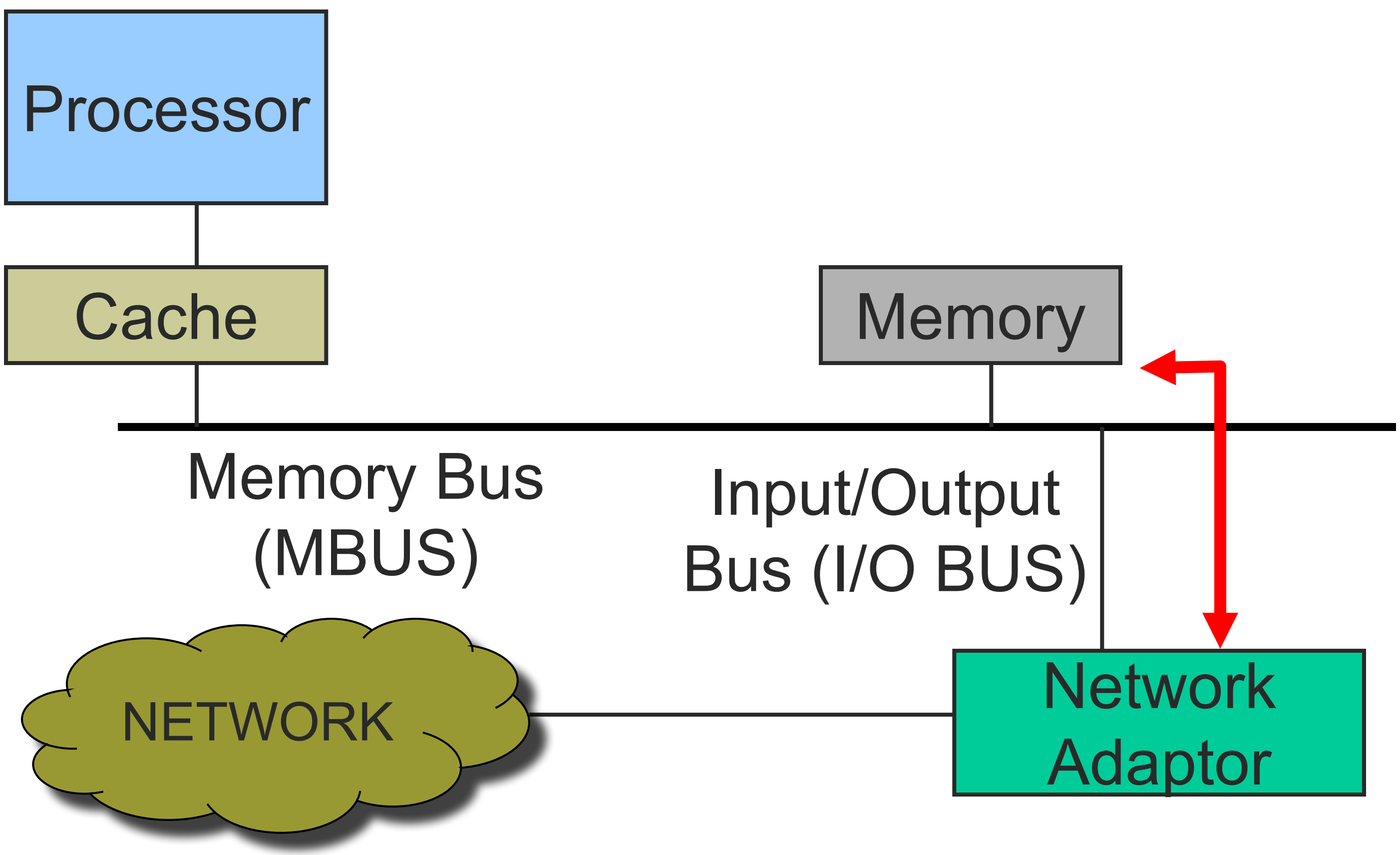


- Adaptor Implements:
  - Encoding
  - Framing
  - Error detection
  - Medium access control
- Data Motion
  - Direct Memory Access (DMA)
  - Programmed Input/Output (PIO)

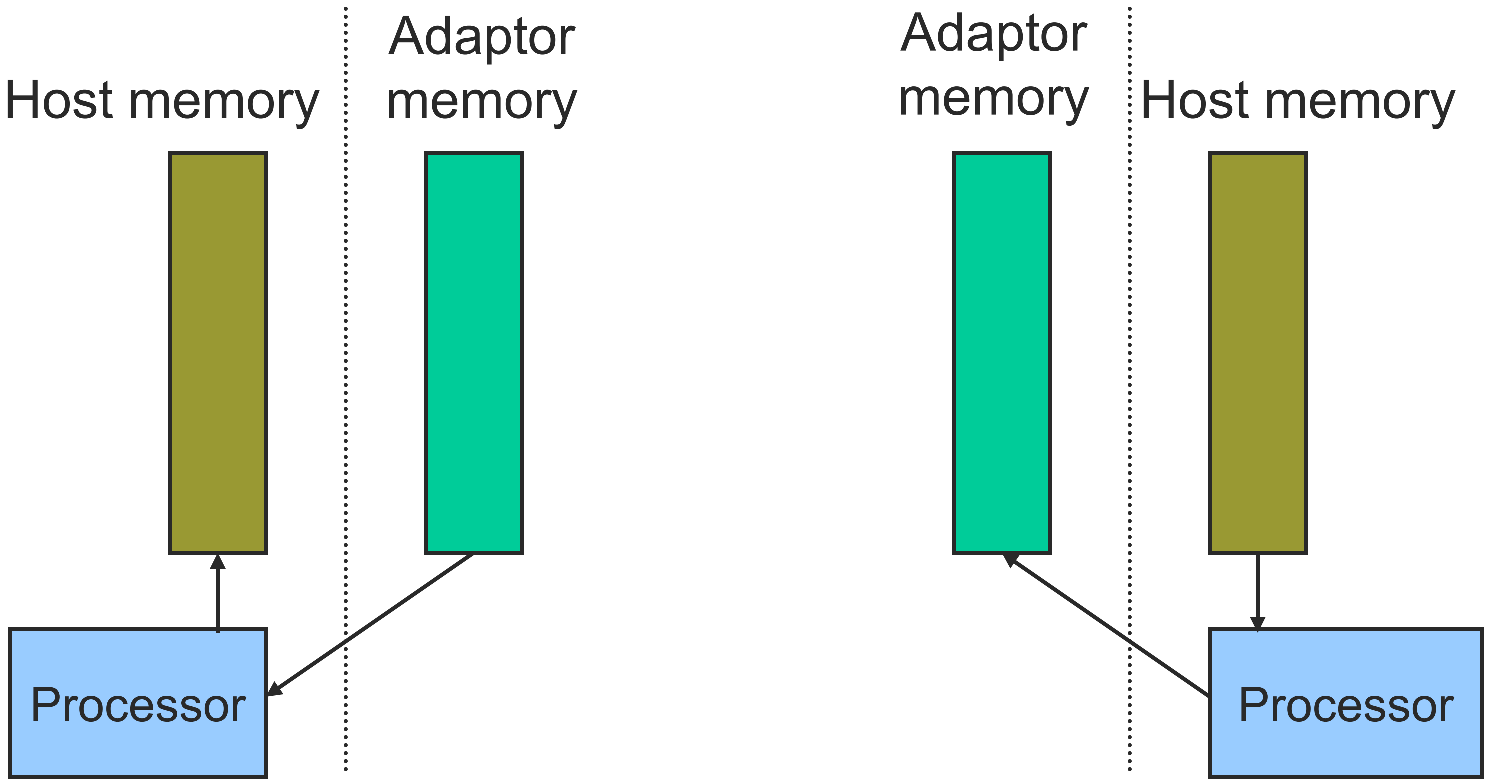
Network Adaptor: DMA



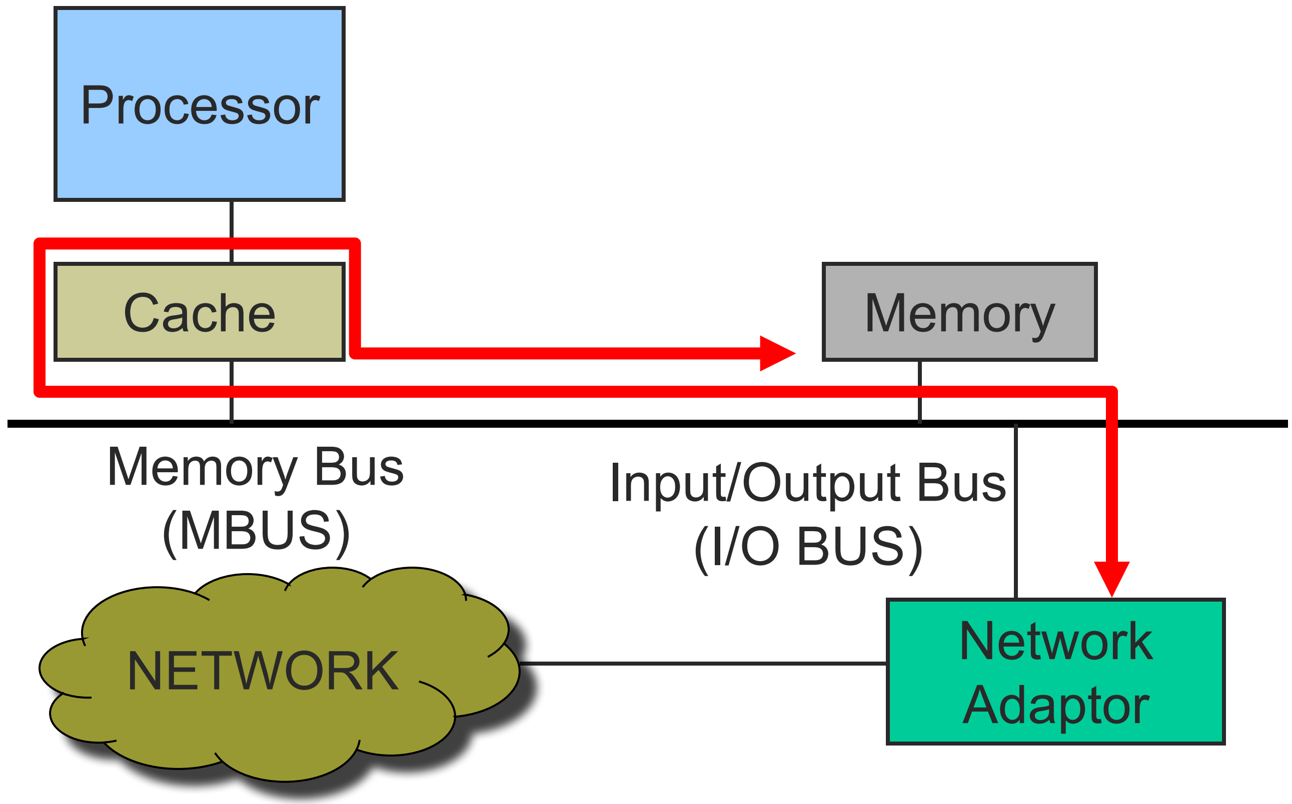
Network Adaptor: DMA



Network Adaptor: PIO



Network Adaptor: PIO



Network Adaptor Use

- Data Motion
  - Direct Memory Access (DMA)
    - Processor free to do other things
    - Can be faster than memory copy through CPU
    - Start up cost
  - Programmed Input/Output (PIO)
    - Processor manages each access (loads/stores)
    - Faster than DMA for small amounts of data

Network Adaptor Use

- Event Notification
  - Hardware interrupts
    - Processor free to do other things
    - Events delivered immediately
    - State (register) save/restore expensive
    - Context switches more expensive
  - Event polling
    - Processor must periodically check
    - Events wait until next check
    - No extra state changes

Network Adaptor Performance

- Potential bottlenecks
  - Link capacity
  - I/O bus bandwidth
  - Memory bus bandwidth
  - Processor computing power

Programming Device Drivers

- Sample device driver in P&D
- Better examples in Linux
- Key Features
  - Memory-mapped control registers
  - Interrupt driven
  - Handler code must execute quickly
  - Logically concurrent with other processors

Direct Link Examples

- Goal
  - Explain real systems in terms of direct link topics
- TCP transport layer
- IP network layer
- Two examples of data link/physical layers
  - Ethernet
  - FDDI
- merely case studies—no need to memorize details

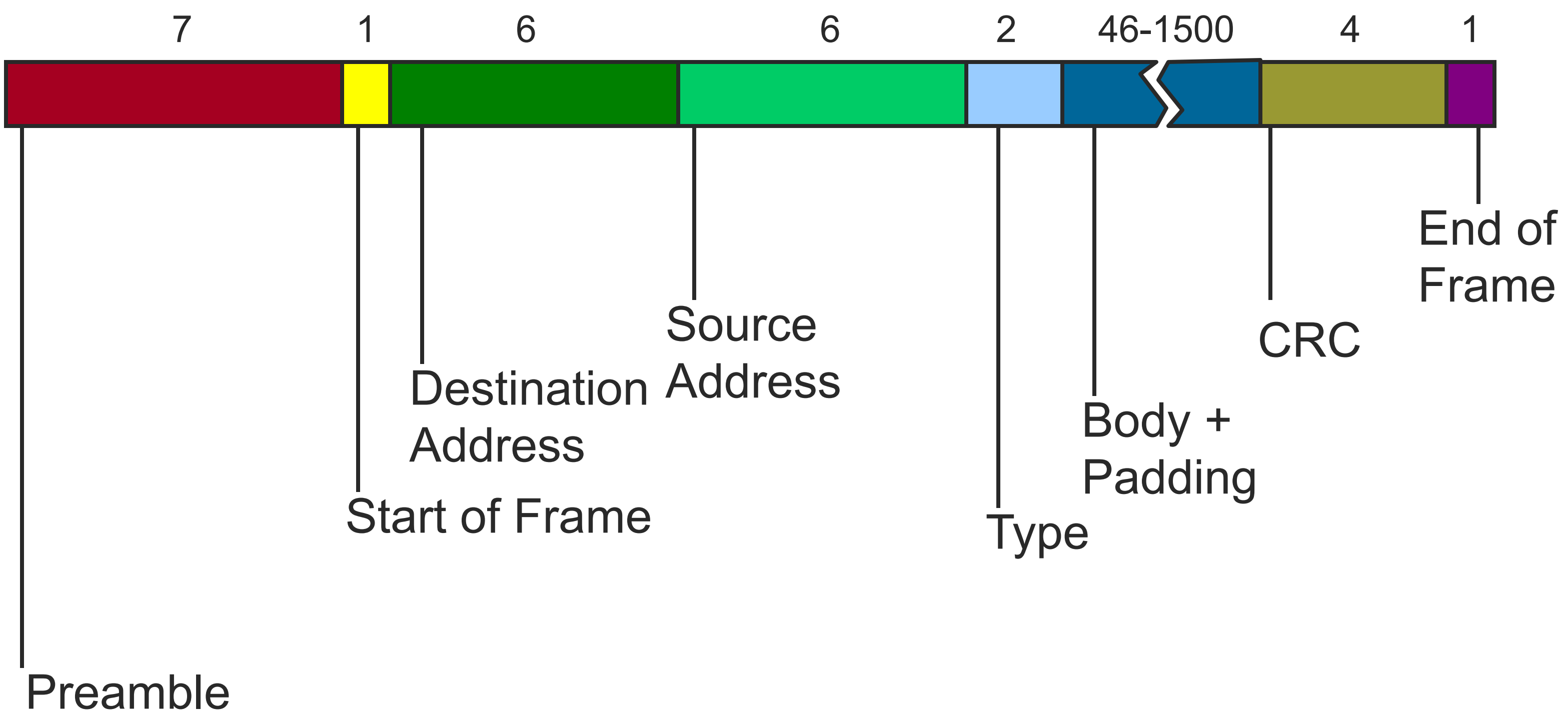
Example

- TCP transport layer (reliable transmission)
  - sliding window algorithm
  - adaptive window sizes
    - heuristics to address contention
    - aim at global optimum
    - see P&D 6.3 for details or wait until April
- IP network layer (error detection)
  - IP checksum
  - backs up stronger data link barriers (usually CRC)

Example

- 10 Mbps Ethernet (Xerox)
  - Encoding
    - Manchester
    - 10 Mbps, so transitions at 20 MHz
  - Error detection
    - Cyclic redundancy check (probably CRC-32)
  - Framing
    - Sentinel marks end-of-frame
    - Bit-oriented (similar to HDLC)
    - Variable length
    - Data-dependent length
  - Medium access control
    - CSMA/CD

10Mb Ethernet Frame Format



Ethernet Frame Components

- Preamble + Start of Frame
  - 7 bytes of 10101010, 1 byte of 10101011
  - Encoded as 10Mhz square wave
  - Synchronize receiver’s clock
- Source and Destination Address
  - Unique unicast Ethernet addresses
    - 20 bit manufacturer prefix + 28 bit ID
  - Broadcast address: FF:FF:FF:FF:FF:FF
  - Multicast address: MSB set (80:00:…)

Ethernet Frame Components

- Type
  - 2 – bytes
  - Used to demultiplex higher layers
- Body + Padding
  - Minimum data size = 46 (minimum frame size = 64)
  - Data padded to minimum value
  - Maximum data size = 1500

Ethernet Frame Components

- CRC
  - 4 byte
- End of frame marker
  - 1 byte
- Total of 27 bytes header and trailer
- Xerox vs. 802.3
  - 802.3 replaces type with length
  - 802.3 drops EOF

IEEE 802.11 Frame Format

- Types
  - control frames, management frames, data frames
- Sequence numbers
  - important against duplicated frames due to lost ACKs
- Addresses
  - receiver, transmitter (physical), BSS identifier, sender (logical)
- Miscellaneous
  - sending time, checksum, frame control, data

IEEE 802.11 Data Frame Format

bytes	2	2	6	6	6	2	6	0-2312	4
	Frame Control	Duration/ ID	Address 1	Address 2	Address 3	Sequence Control	Address 4	Data	CRC

bits	2	2	4	1	1	1	1	1	1	1	1
	Protocol version	Type	Subtype	To DS	From DS	More Frag	Retry	Power Mgmt	More Data	WEP	Order

IEEE 802.11 Control Frame Format

- Acknowledgement

ACK

bytes	2	2	6	4
	Frame Control	Duration	Receiver Address	CRC

- Request To Send

RTS

bytes	2	2	6	6	4
	Frame Control	Duration	Receiver Address	Transmitter Address	CRC

- Clear To Send

CTS

bytes	2	2	6	4
	Frame Control	Duration	Receiver Address	CRC