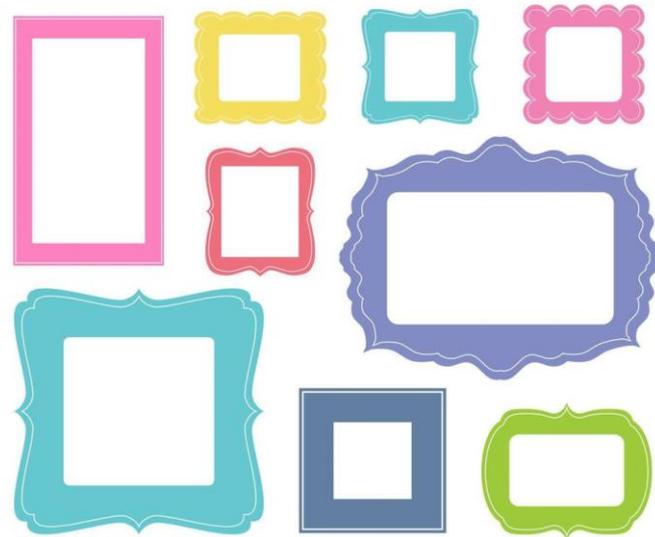
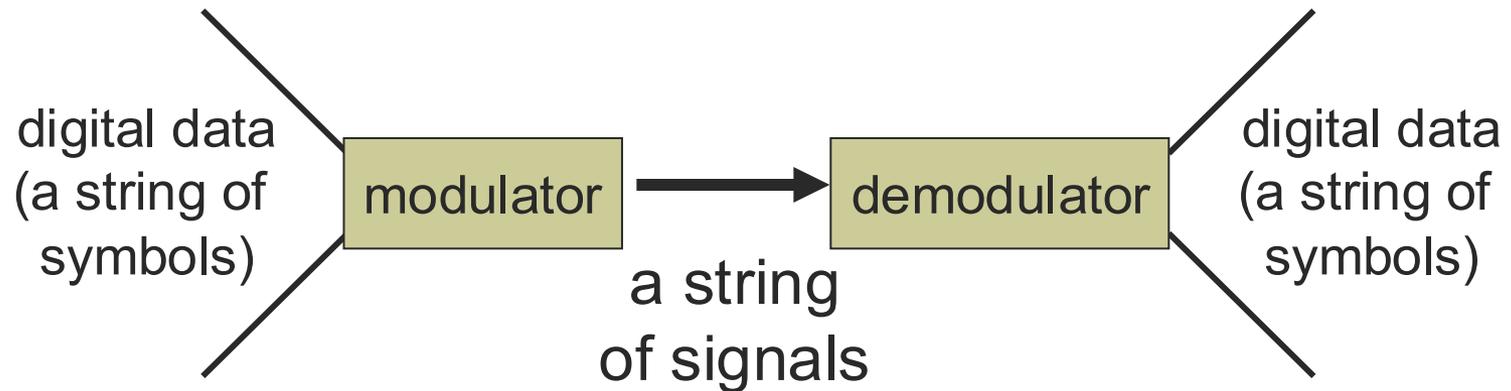


Direct Link Networks - Framing

Reading:
Peterson and
Davie, Chapter 2



[Framing]



- Encoding translates symbols to signals
- Framing demarcates units of transfer
 - Separates continuous stream of bits into frames
 - Marks start and end of each frame



[Benefits of framing]

- Synchronization recovery
 - Breaks up continuous streams of unframed bytes
 - Recall RS-232 start and stop bits
- Link multiplexing
 - Multiple hosts on shared medium
 - Simplifies multiplexing of logical channels
- Efficient error detection
 - Per-frame error checking and recovery



[Framing]

- Demarcates units of transfer
- Goal
 - Enable nodes to exchange blocks of data
- Challenge
 - How can we determine exactly what set of bits constitute a frame?
 - How do we determine the beginning and end of a frame?



[Framing]

- Approaches
 - Sentinel: delimiter at end of frame (like C strings)
 - Length-based: length field in header (like Pascal strings)
- Characteristics
 - Bit- or byte-oriented
 - Fixed or variable length
 - Data-dependent or data-independent length



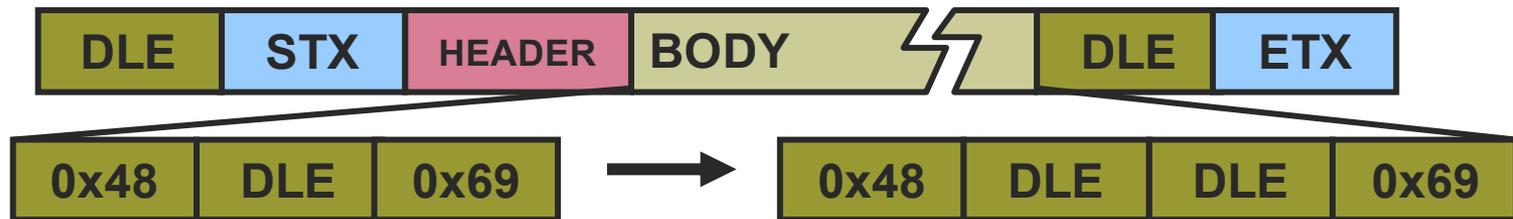
[Sentinel-Based Framing]

- End of Frame
 - Marked with a special byte or bit pattern
 - Frame length is data-dependent
 - Challenge
 - Frame marker may exist in data
 - Requires stuffing
- Examples
 - BISYNC, HDLC, PPP, IEEE 802.4 (token bus)



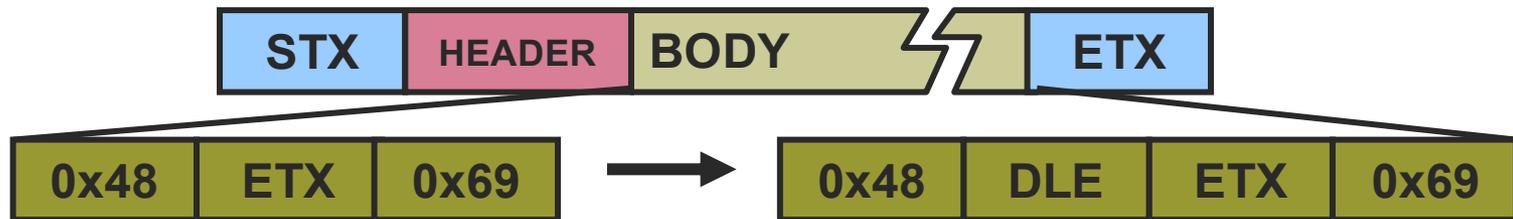
ARPANET IMP-IMP

- Interface Message processors (IMPs)
 - Packet switching nodes in the original ARPANET
 - Byte oriented, Variable length, Data dependent
 - Frame marker bytes
 - STX/ETX start of text/end of text
 - DLE data link escape
 - Byte Stuffing
 - DLE byte in data sent as two DLE bytes back-to-back



BISYNC

- Binary SYNchronous Communication
 - Developed by IBM in late 1960' s
 - Byte oriented, Variable length, Data dependent
 - Frame marker bytes:
 - STX/ETX start of text/end of text
 - DLE data link escape
 - Byte Stuffing
 - ETX/DLE bytes in data prefixed with DLE' s



[Byte Stuffing: BISYNC]

0000 0011 1110 0111 1111
1110 0001 0000 0001 1111

- ETX/DLE bytes in data prefixed with DLE's
 - DLE = 16; STX = 2; ETX = 3

■ Ans: **0000 0010 0001 0000** 0000 0011
 1110 0111 1111 1110 **0001 0000**
 0001 0000 0001 1111 **0000 0011**



[Byte Stuffing: Efficiency]

0000 0011 1110 0111 1111

1110 0001 0000 0001 1111

■ Frame: **0000** **0010** **0001** **0000** 0000 0011
 1110 0111 1111 1110 **0001** **0000**
 0001 0000 0001 1111 **0000** **0011**

■ Efficiency:

- 72 bits were sent for 40 bits of data
- Efficiency is $40/72 = 55.6\%$



High-Level Data Link Control Protocol (HDLC)

- Bit oriented, Variable length, Data-dependent
- Frame Marker
 - 01111110
- Bit Stuffing
 - Insert 0 after pattern 011111 in data
 - Example
 - 01111110 end of frame
 - 01111111 error! lose one or two frames



[Bit Stuffing: HDLC]

0000 0011 1110 0111 1111

1110 0001 0000 0001 1111

- Insert 0 after pattern 011111 in data

- Ans: **0111 1110** 0000 0011 111**0** 0111
 11**0**11 1110 0001 0000 0001 1111**0**
 (**0111 1110** next frame)



[Bit Stuffing: Efficiency]

0000 0011 1110 0111 1111

1110 0001 0000 0001 1111

- Frame: **0111 1110** 0000 0011 111**0** 0111
11**0**11 1110 0001 0000 0001 1111**0**
(**0111 1110** next frame)

- Efficiency
 - 51 bits were sent for 40 bits of data
 - Efficiency = 78.4%



[Length-Based Framing]

- End of frame
 - Calculated from length sent at start of frame
 - Challenge
 - Corrupt length markers
- Examples
 - DECNET's DDCMP
 - Byte-oriented, variable-length
 - RS-232 framing
 - Bit-oriented, implicit fixed-length



[Framing Summary]

- Technique

- Demarcate units of transfer

- Benefits

- Synchronization recovery
- Link multiplexing
- Efficient error detection

- Approaches

- Sentinel
- Length-based

- Characteristics

- Bit- or byte-oriented
- Fixed or variable length
- Data-dependent or data-independent length

