Data Link Layer: Framing

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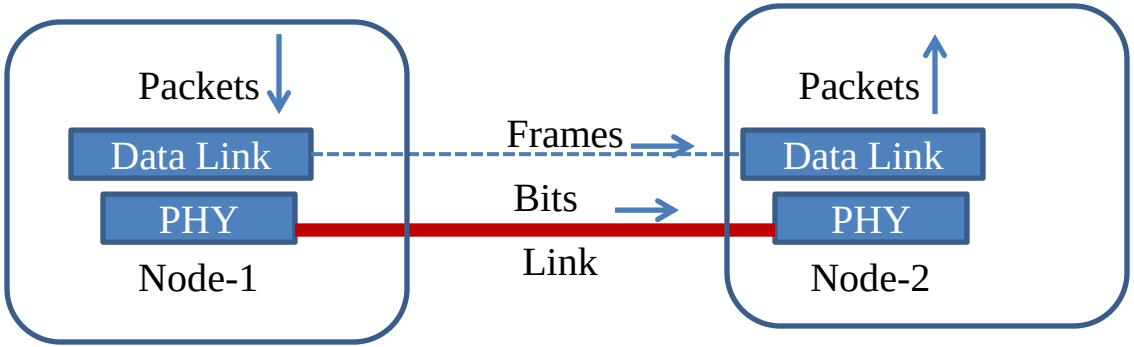
Data-Link Layer

- Frame-by-Frame next-hop delivery
  - Frame: Block of data exchanged at link layer
- Uses services of PHY layer (which delivers bits) to deliver frames



Link Layer Protocols

- Link could be point-to-point or broadcast
  - Broadcast: Many nodes connected to same communication channel (e.g. wireless)
- Protocol:
  - Define format of frames to be exchanged over the link
  - In response to frames, action to be taken by nodes
  - Examples: Ethernet, Token-Ring, WiFi, PPP etc

Services

- Logical Link Control (LLC): Interface between Network layer and MAC sub-layer
  - Multiplexing
  - Error Detection
  - Error Recovery (optional)
  - Flow Control (optional)

- Media Access Control (MAC): Controls access to physical media (Broadcast Channels)
  - Framing
- Switching (Interconnecting LANs)

Framing

- Blocks of data (termed frames at link layer) exchanged between nodes
- How do you determine which set of bits constitutes a frame?

A Possible Approach

- Keep link idle between two frames
- Not Used. Why?
- Dependency on PHY layer
  - Some Encodings may use idle time to encode data (unipolar)
  - Some PHY Layers don’t keep link idle (to maintain synchronization)

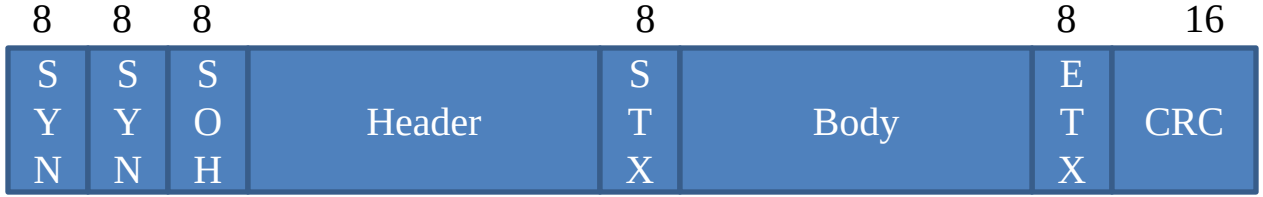
Sentinel Approach

- Use special character or bit sequence to indicate start and end of frames
- Byte Counting:
  - Used to determine end of frame (Sentinel still used at beginning of frame)

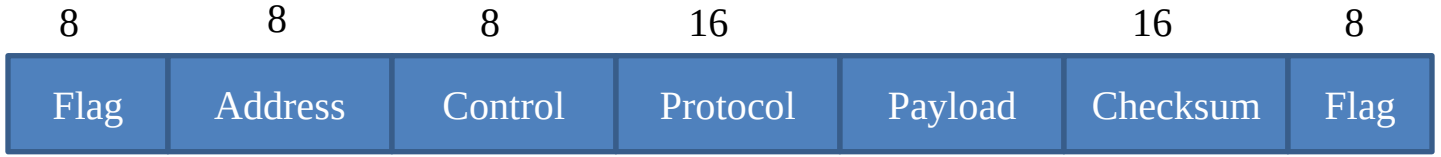
Byte Oriented Protocols

- View frame as collection of bytes (not bits)
- Special byte acts as the sentinel
- Examples:
  - BISYNC (Binary Synchronous Communication) developed by IBM
  - DDCMP (Digital Data Communication Message Protocol)
  - PPP (Point-to-Point Protocol)

Byte Oriented Protocols



BISYNC Frame Format

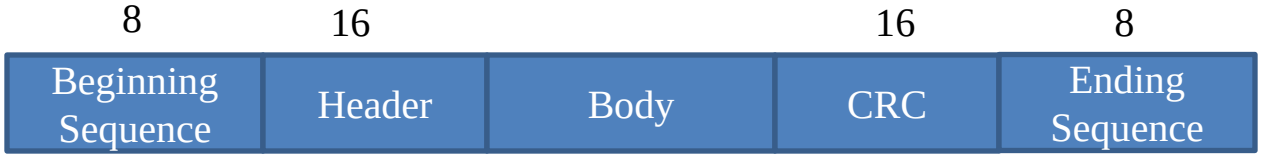


PPP Frame Format

DDCMP Frame Format

Bit Oriented Protocols

- View frame as collection of bits
  - Bits could be from ASCII characters, pixel values in an image, binary file
- HDLC (High-level Data Link Control)
  - Sequence: 01111110



HDLC Frame Format

Problem

- What if the sentinel character (e.g. ETX or ending sequence) appears in the body (payload)?
  - Frame terminated prematurely

Byte/Character Stuffing

- Used in Byte oriented protocols
- Sentinel characters escaped by “DLE” (Data Link Escape) character
  - DLE itself is escaped by another DLE
  - E.g. Send “DLE ETX” instead of “ETX” in Body

Bit Stuffing

- Flag: 01111110
- In body of message:
  - Sender inserts a 0 after 5 consecutive 1's
  - Receiver removes the 0 that follows 5 1's

Summary

- Data link layer services
- Framing: How to detect beginning and end of frames
- Byte and bit oriented protocols (Sentinel approach)
  - Byte and bit stuffing