Data Link Layer

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Review of Physical Layer

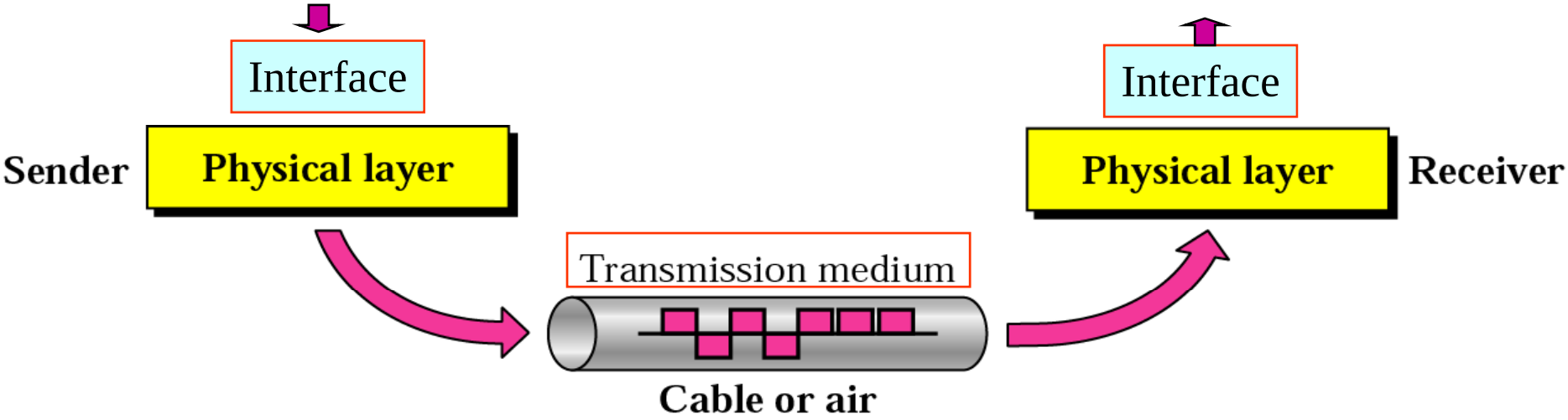
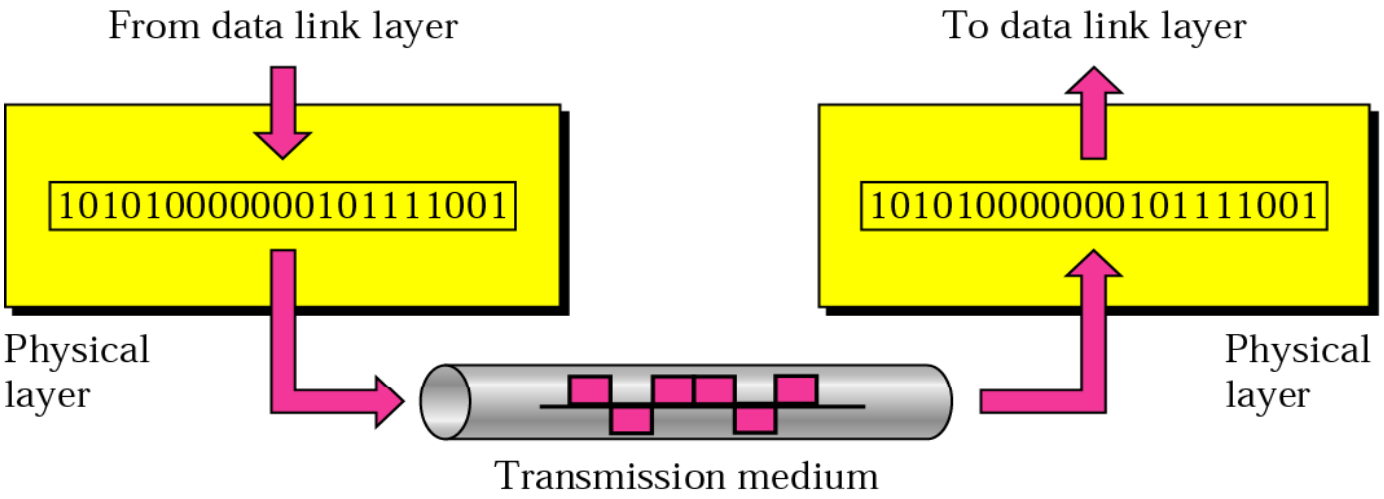


Figure 7.1 **Transmission medium and physical Interface**

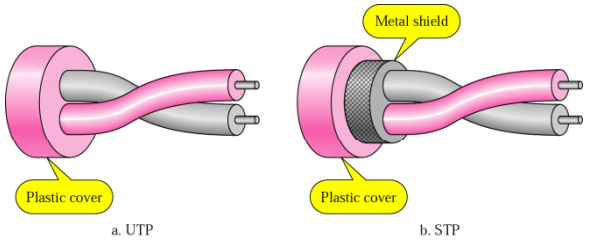
Review of Signals



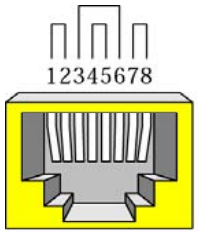
	Analog signal	Digital signal
Analog Data	**AM, FM**	**PCM & Video using codecs**
Digital Data	**ASK, FSK, PSK, QAM**	**LAN Cable Standards (bi-phase, Manchester)**

Review of Ethernet Interface

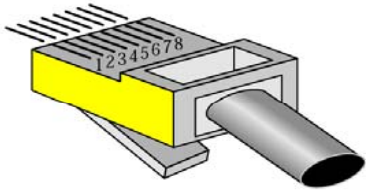
- **Cable: UTP**



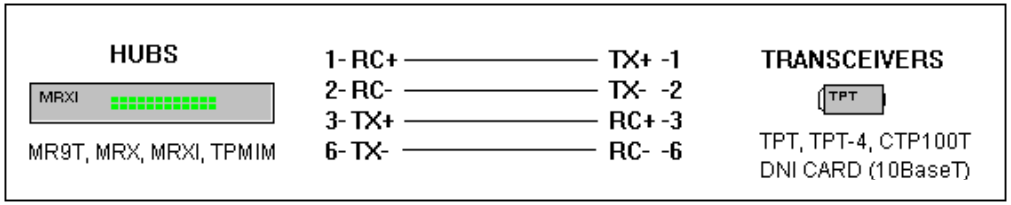
- **Connector: RJ-45**
- **NIC (Network interface card)**



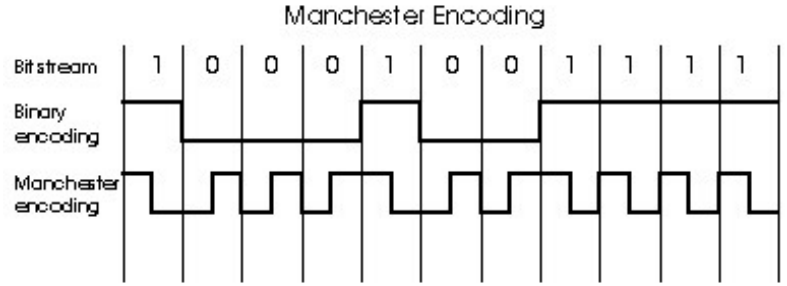
RJ-45 Female



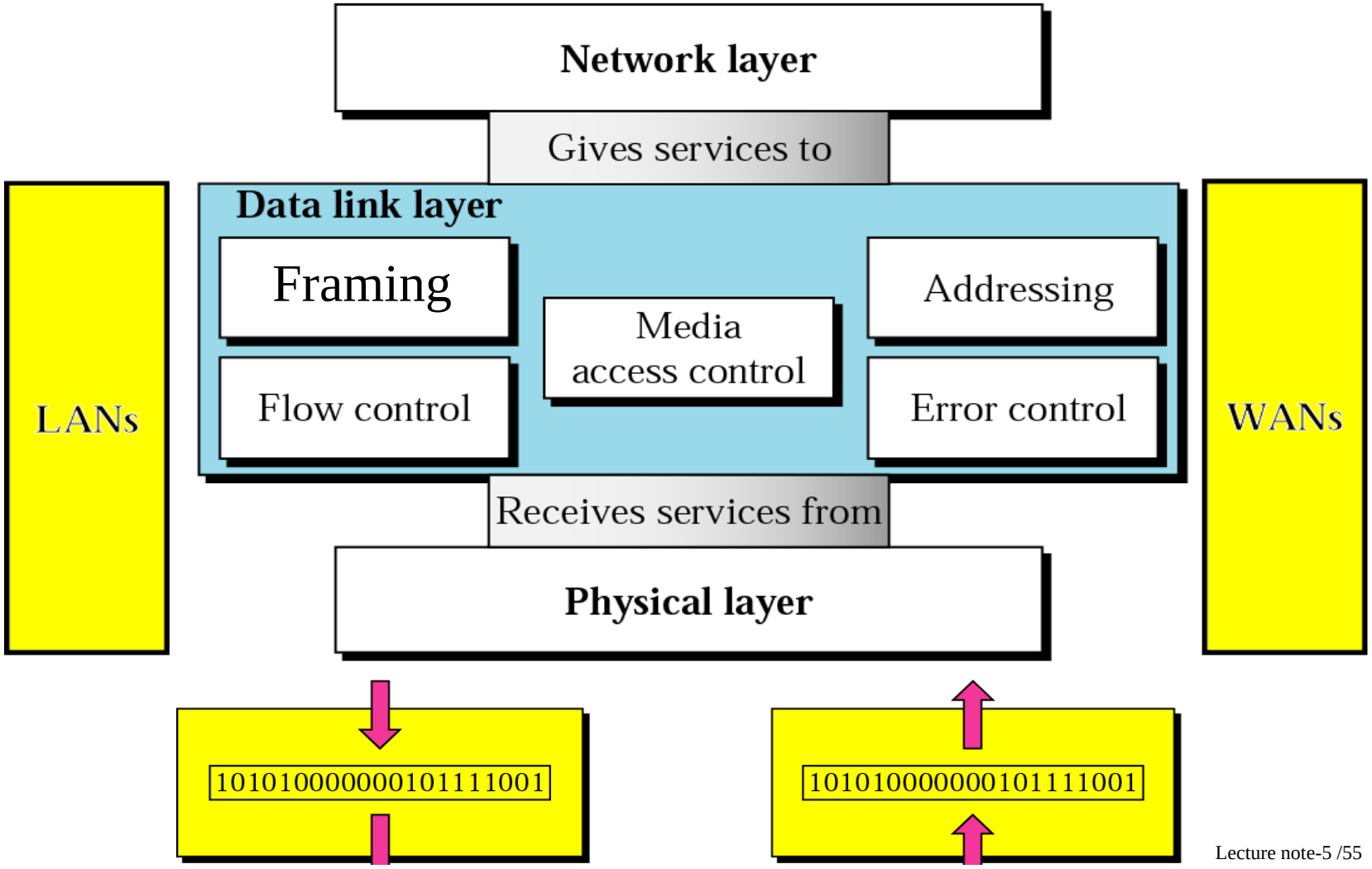
RJ-45 Male



- **LAN encoding is Manchester**

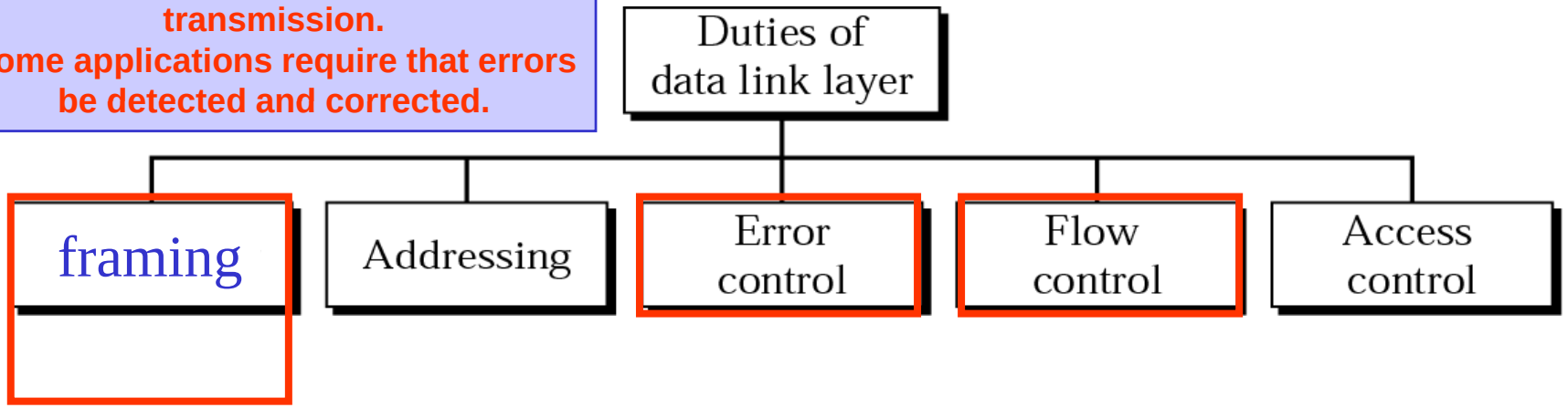


Position of the data-link layer



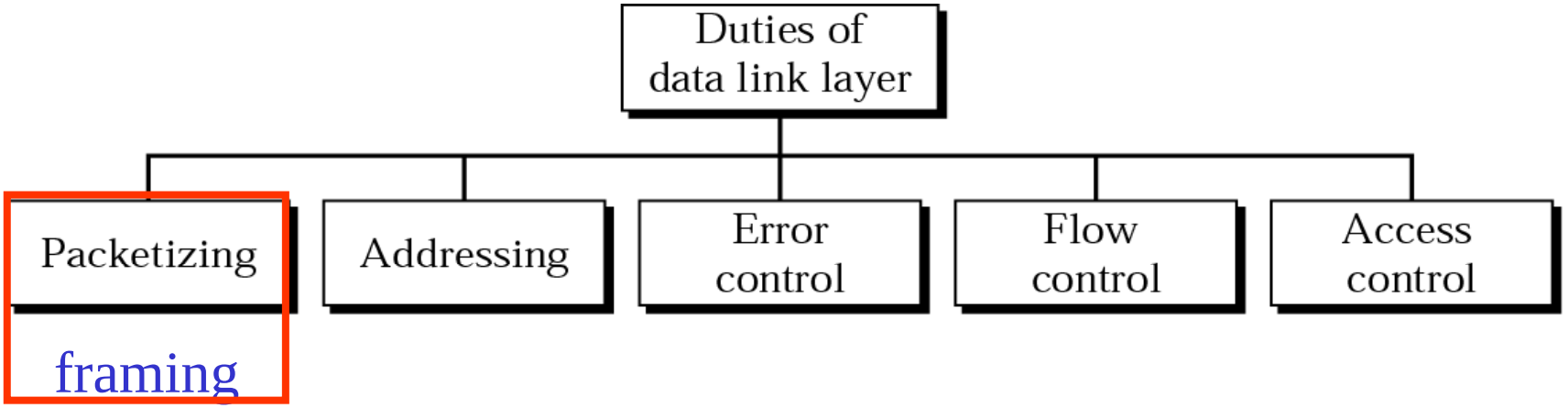
Data link layer duties

Data can be corrupted during transmission.
Some applications require that errors be detected and corrected.



- **Data link protocols have three functions:**
  - Error Control**: Detecting and correcting transmission errors. (Error & flow)**
  - Media Access Control**: Controlling when computers transmit. Who should send now(Access control)**
  - Message Delineation**: Identifying the beginning and end of a message. (Framing & Addressing)**

Data link layer duties



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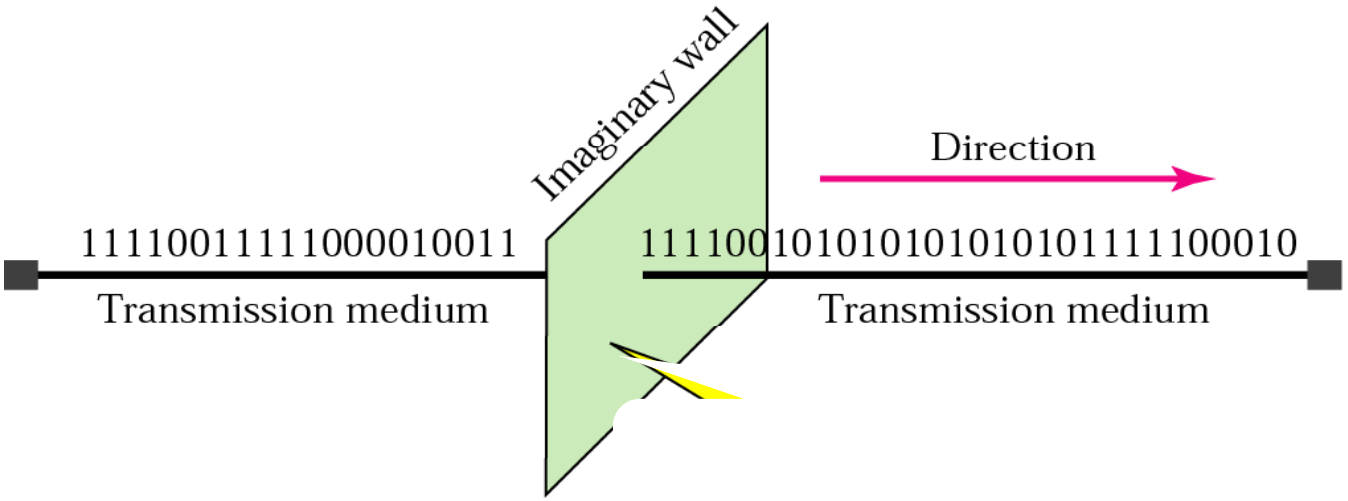
  - Error Control**: Detecting and correcting transmission errors. (Error & flow)**
  - Media Access Control**: Controlling when computers transmit. Who should send now(Access control)**
  - Message Delineation**: Identifying the beginning and end of a message. (Packetizing & Addressing)**

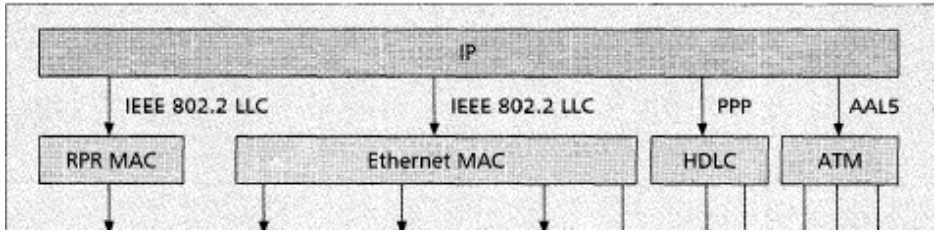
11.1 Framing - Overview

- **Problem: Breaking sequence of bits into a frame**
- **Must determine first and last bit of the frame (frame delineation)**
- **Typically implemented by network adapter (interface card)**
- **Adapter fetches (deposits) frames out of (into) host memory**



Four Approaches

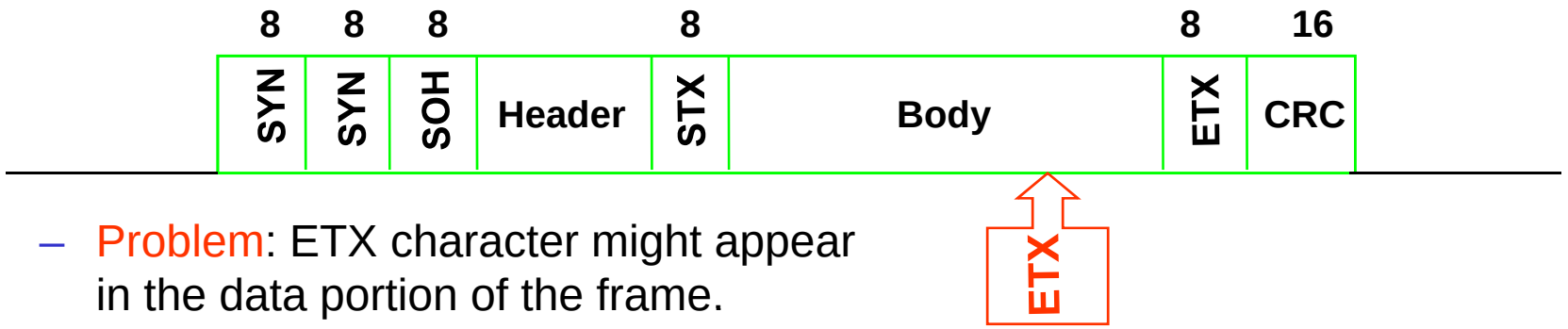
- Clock Based Synchronous: ex) SONET
  - Time synchronized fixed length frames, high reliability required
- Asynchronous [Sentinels=보초, 감시]
  - Special character to delineate frames, replace character in data stream
    - ❖ Byte oriented protocol
    - ❖ Bit oriented protocol



- Character Count : ex) DDCMP, SDL
  - Frame length at certain position in frame
- Physical layer invalid codes -
  - requires physical layer redundancy

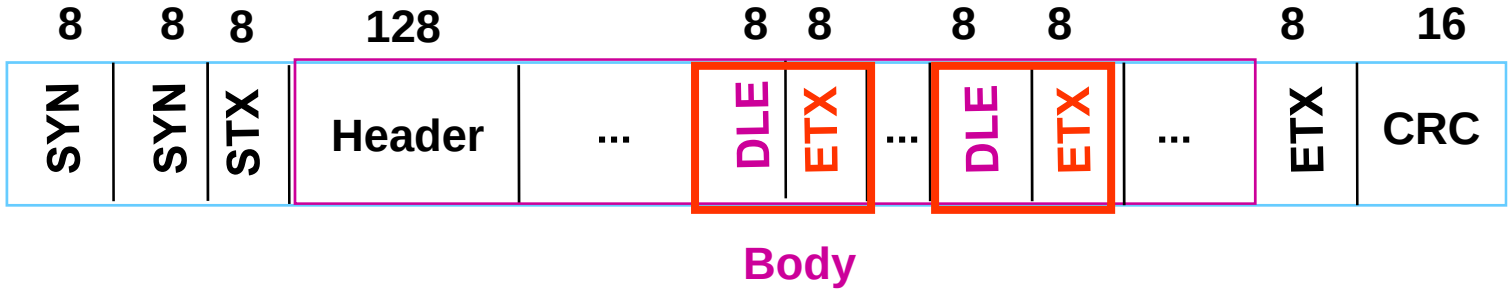
Byte-Oriented Protocols

- **delineate Approach**
  - **BISYNC (Binary Synchronous Communication)**



  - Problem: ETX character might appear in the data portion of the frame.

  - Solution: Escape the ETX character with a DLE character in BISYNC; escape the DLE character with a DLE character in IMP-IMP.

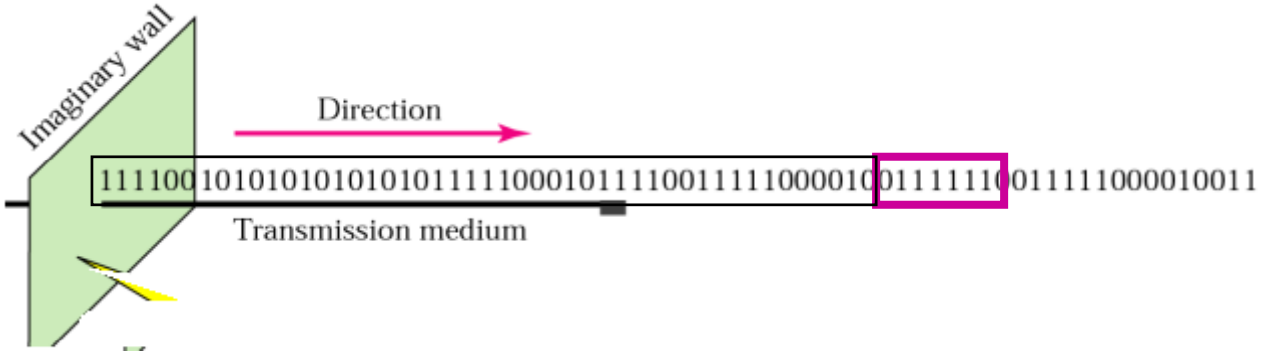


DLE=Data-link-escape

Bit-Oriented Protocols

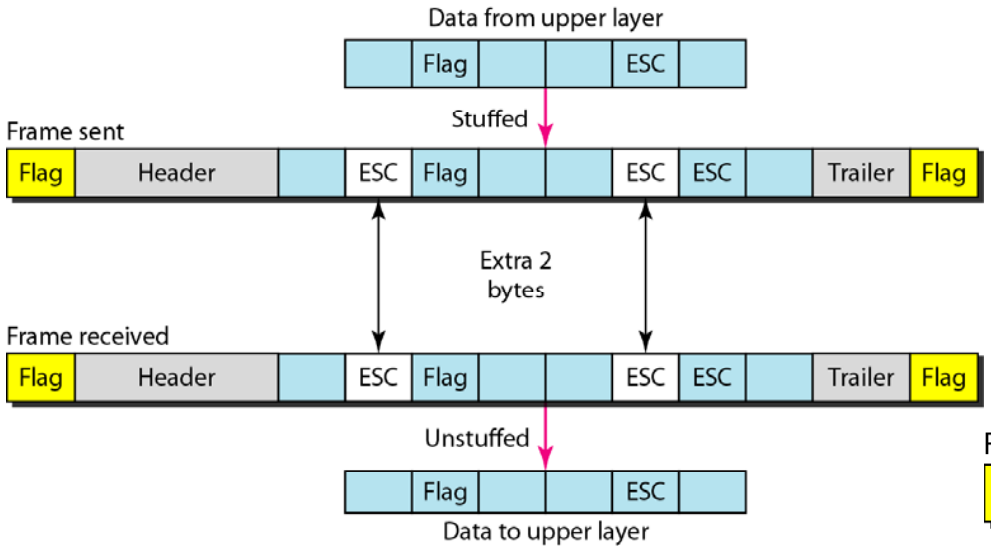
- **HDLC: High-Level Data Link Control (also SDLC and PPP)**

- **Delineate frame with a special bit-sequence: 01111110**



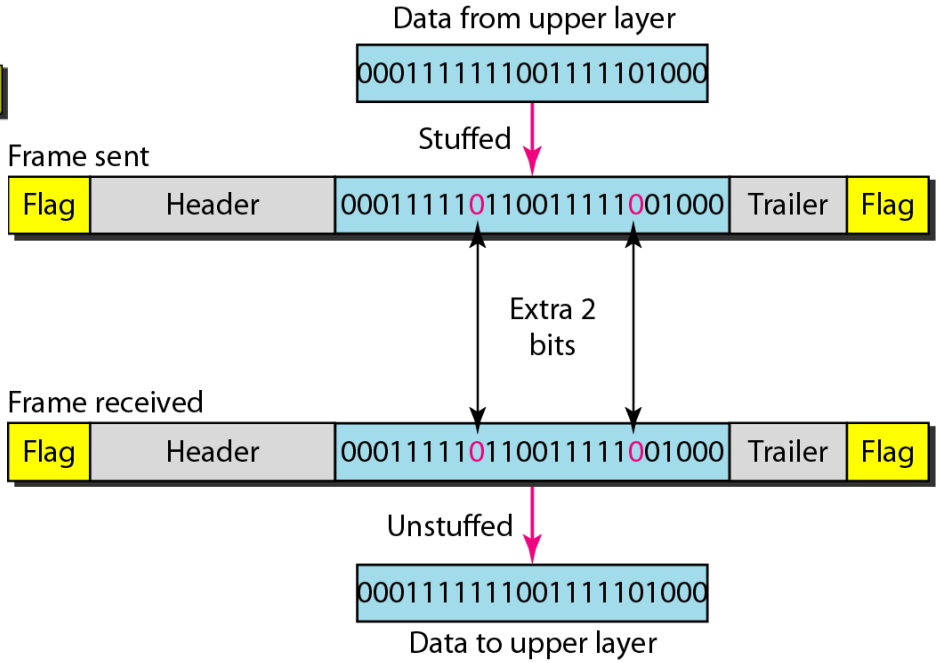
Problem & Solutions

- **Problem: Flag might appear in the data portion of the frame**
- **Solution: Bit Stuffing & Bit stuffing Example**



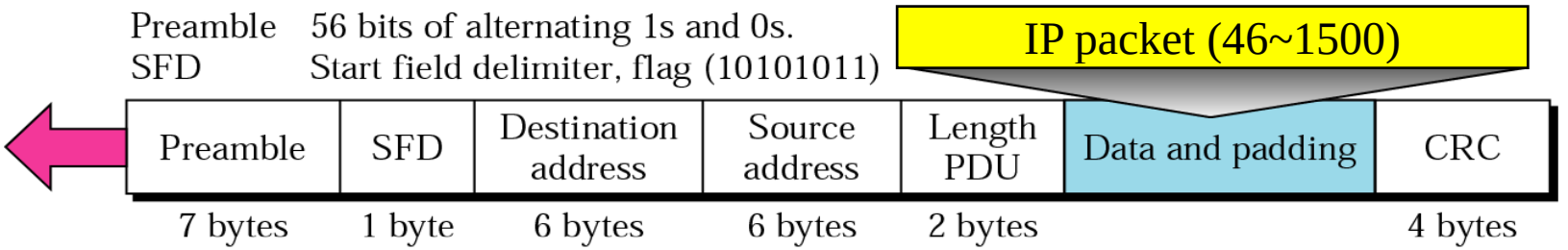
Byte stuffing is the process of adding 1 extra byte whenever there is a flag or escape character in the text.

Bit stuffing is the process of adding one extra 0 whenever five consecutive 1s follow a 0 in the data, so that the receiver does not mistake the pattern 0111110 for a flag.



Framing Example: Ethernet Framing

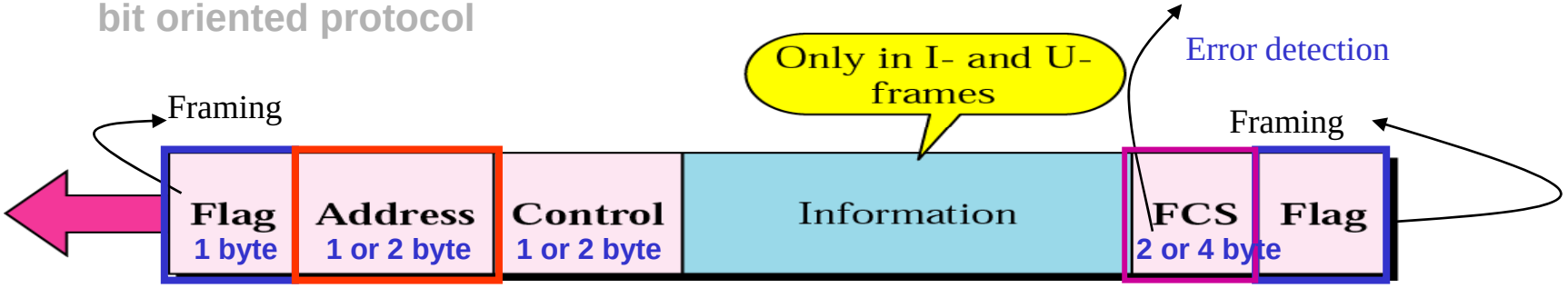
- **Frame format**
  - **Similar to HDLC**



1. Preamble: (7bytes) trains clock-recovery circuits **10101010**
2. Start of Frame Delimiter: indicates start of frame **10101011**
3. Destination Address: 48-bit globally unique address assigned by manufacturer.
   - 1b=0: unicast/multicast
   - 1b=1: local/global address
4. Type: Indicates protocol of encapsulated data (e.g. IP = 0x0800)
5. Pad: Zeroes used to ensure minimum frame length (=46bytes)
6. Cyclic Redundancy Check(4byte): check sequence to detect bit errors.

Framing Example: HDLC Frame Format

bit oriented protocol



- **Flag: 8-bit sequence with a special bit pattern 01111110**
  - Identify both the beginning and end of a frame as a synchronization
  - Bit-stuffing needed within the information field
- **Address field: 1 byte (identifying 128 stations)**
  - If primary station to secondary: to destination
  - If secondary station to primary: from address
  - 7bits + 1 bit for extension

x x x x x x x 1 or x x x x x x x 0 x x x x x x x 1

- **FCS: Either a 2- or 4-byte ITU-T CRC**