

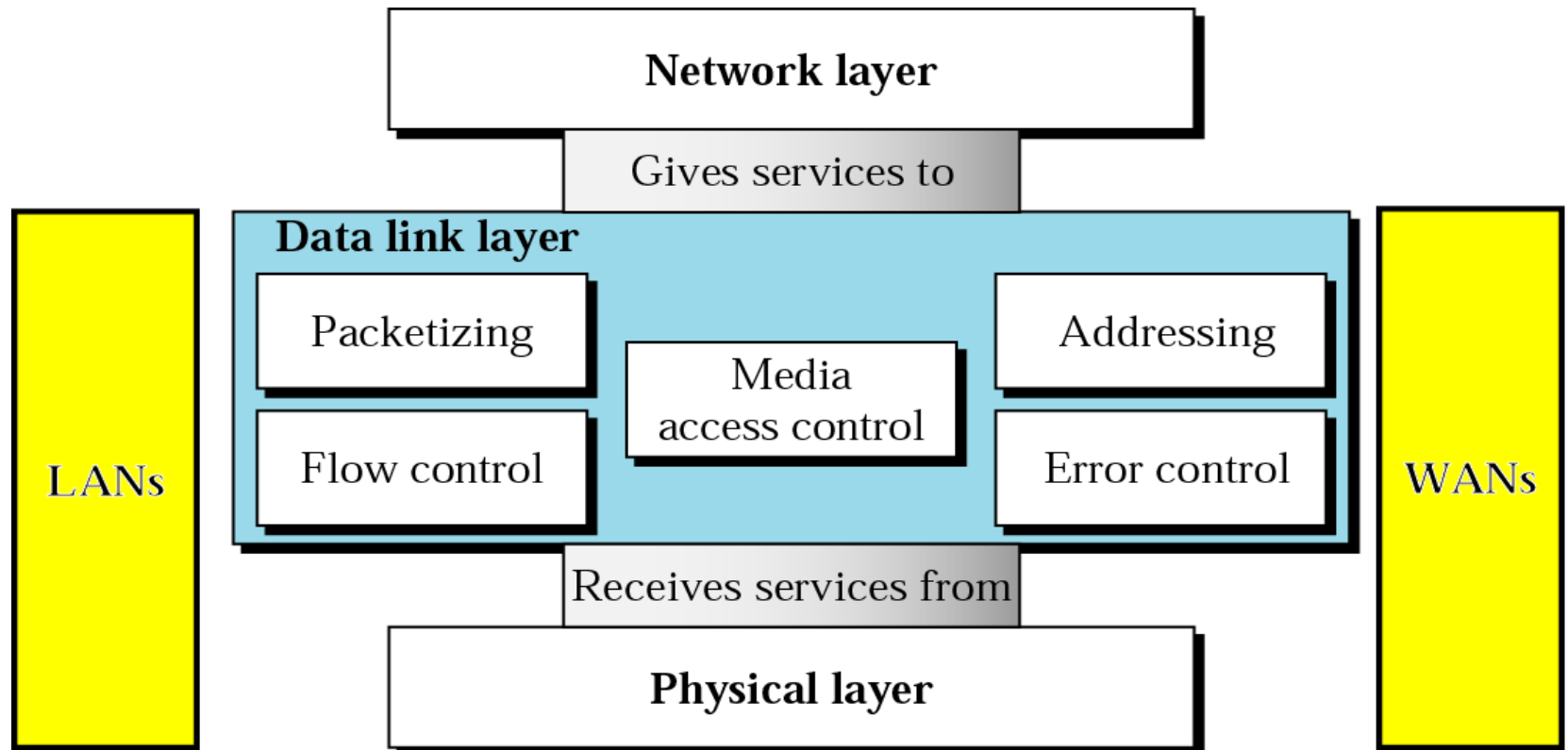
CAP276: Data Communication and Networking

Data Link Layer – Framing

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Data Link Layer

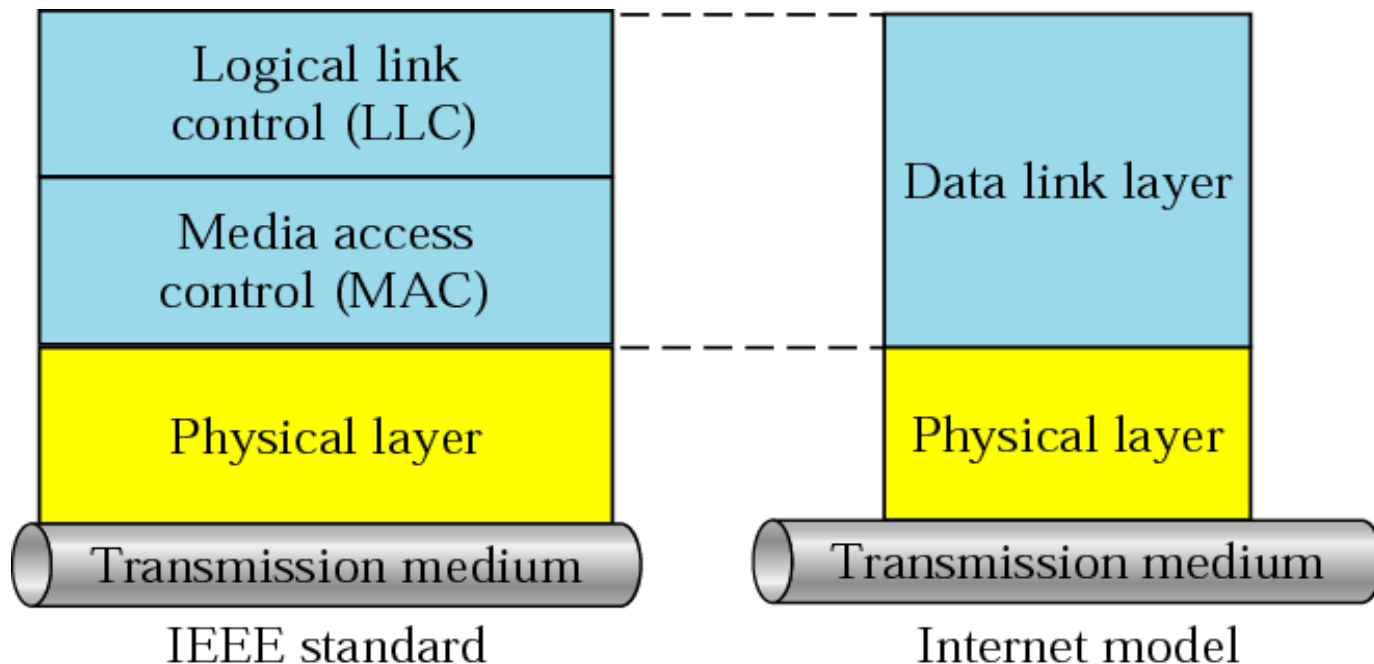
- The Data Link Layer is the second layer in the OSI model, above the Physical Layer, which ensures that the error free data is transferred between the adjacent nodes in the network.



- Data Link Layer provides two main functionalities:
 - Reliable data transfer service between two peer network layers
 - Providing a well-defined service interface to the network layer.
 - Dealing with transmission errors.
 - Flow Control mechanism which regulates the flow of frames such that data congestion should not occur at slow receivers due to fast senders.
- **Functions of Data Link Layer**
 - **Framing:** Data-link layer takes packets from Network Layer and encapsulates them into Frames. Then, it sends each frame bit-by-bit on the hardware. At receiver' end, data link layer picks up signals from hardware and assembles them into frames.
 - **Physical Addressing:** Data-link layer provides layer-2 hardware addressing mechanism. Hardware address is assumed to be unique on the link. It is encoded into hardware at the time of manufacturing.
 - **Synchronization:** When data frames are sent on the link, both machines must be synchronized in order to transfer to take place.

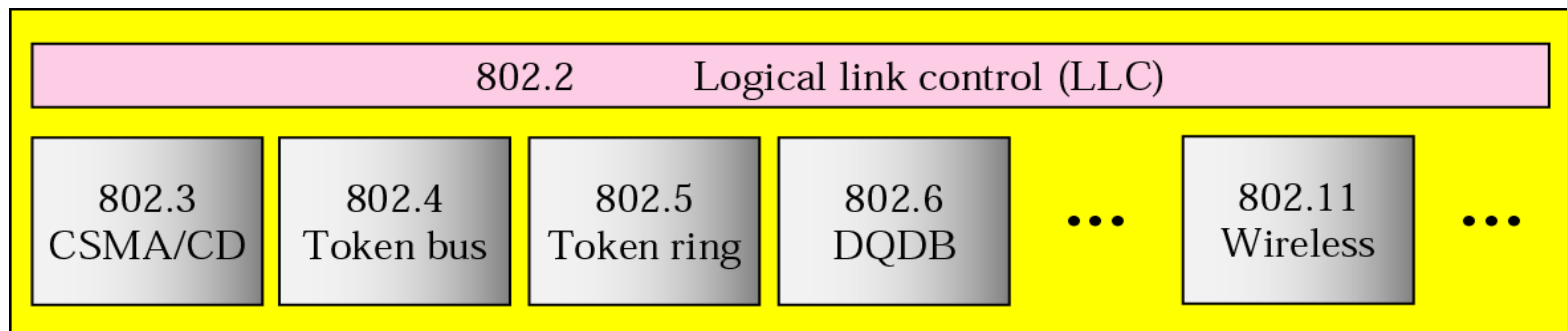
- **Error Control:** Sometimes signals may have encountered problem in transition and the bits are flipped. These errors are detected and attempted to recover actual data bits. It also provides error reporting mechanism to the sender.
- **Flow Control:** Stations on same link may have different speed or capacity. Data-link layer ensures flow control that enables both machine to exchange data on same speed.
- **Multiple-Access:** When host on the shared link tries to transfer the data, it has a high probability of collision. Data-link layer provides mechanism such as CSMA/CD to equip capability of accessing a shared media among multiple Systems.

- Therefore the two main functions of the data link layer are:
 - **Logical Link Control (LLC):** It deals with the design and procedures for communication b/w nodes: node-to-node communication.
 - **Media Access Control (MAC):** It explains how to share the link.



Logical Link Control

- **Logical link control functions include** framing, flow and error control, and software implemented protocols that provide smooth and reliable transmission of frames between nodes.
- To implement logical link control, we need protocols.
 - Protocol is a set of rules that need to be implemented in software and run by the two nodes involved in data exchange at the data link layer.



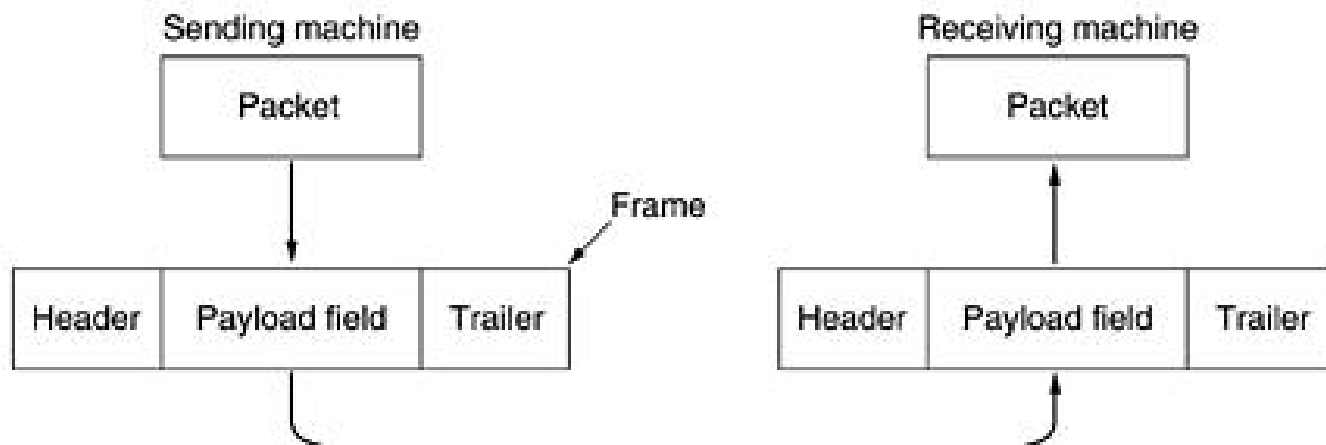
Project 802

Logical Link Layer Services

- **Framing**
- **Error Control**
- **Flow Control**

Framing

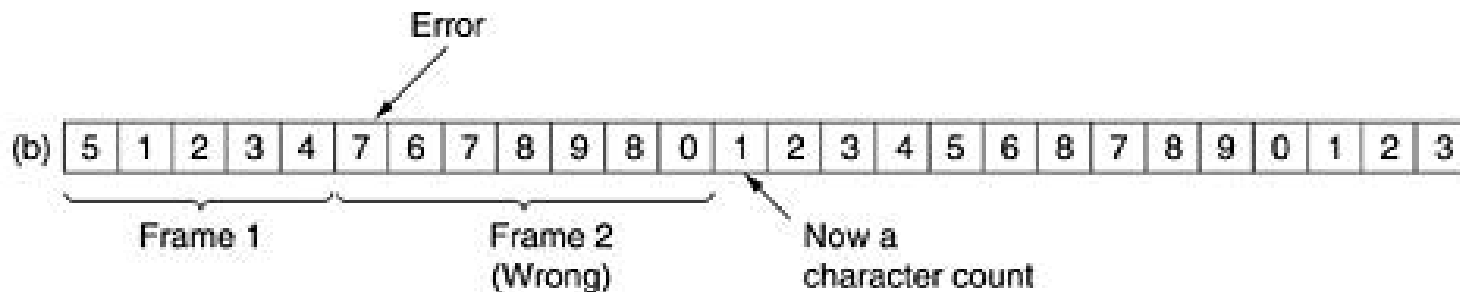
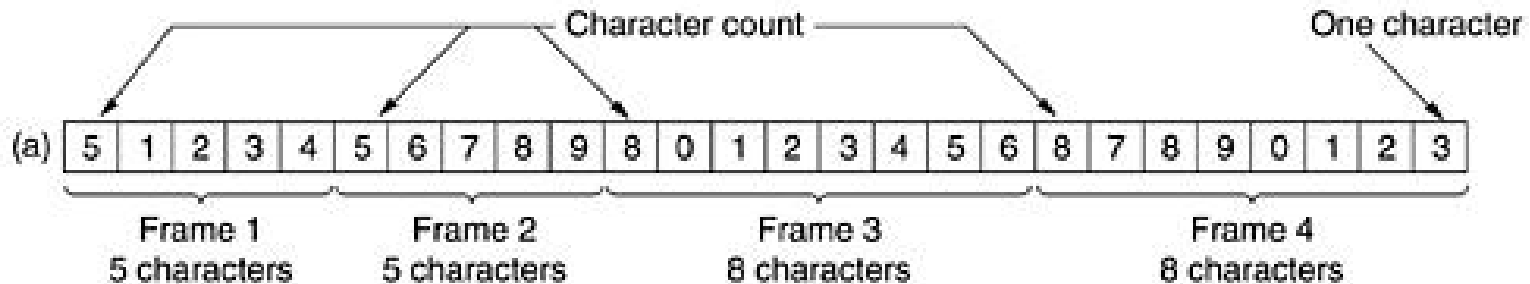
- The data link layer needs to pack bits into frames, so that each frame is distinguishable from another.
 - Our postal system practices a type of framing. The simple act of inserting a letter into an envelope separates one piece of information from another; the envelope serves as the delimiter.
- The frame contains
 - Frame header
 - Payload field for holding packet
 - Frame trailer



- Breaking the bit stream up into frames is more difficult than it at first appears. One way to achieve this framing is to insert time gaps between frames, much like the spaces between words in ordinary text. However, networks rarely make any guarantees about timing, so it is possible these gaps might be squeezed out or other gaps might be inserted during transmission.
- There are four methods:
 1. Character count
 2. Flag bytes with byte stuffing
 3. Starting and ending flags, with bit stuffing
 4. Physical layer coding violations

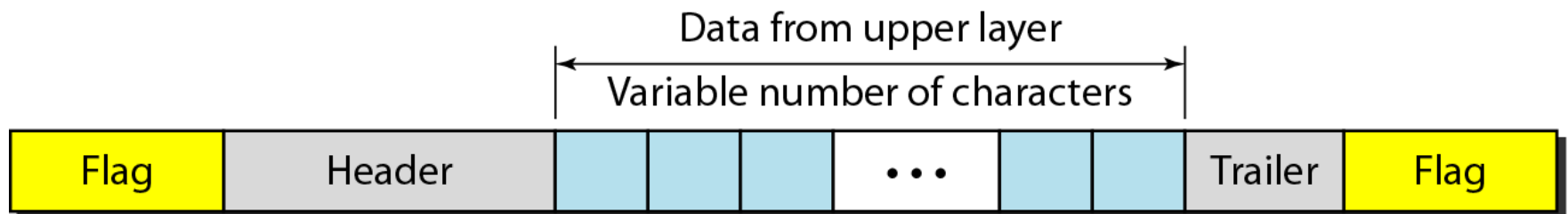
Character count

- The first framing method uses a field in the header to specify the number of characters in the frame.
- When the data link layer at the destination sees the character count, it knows how many characters follow and hence where the end of the frame is.

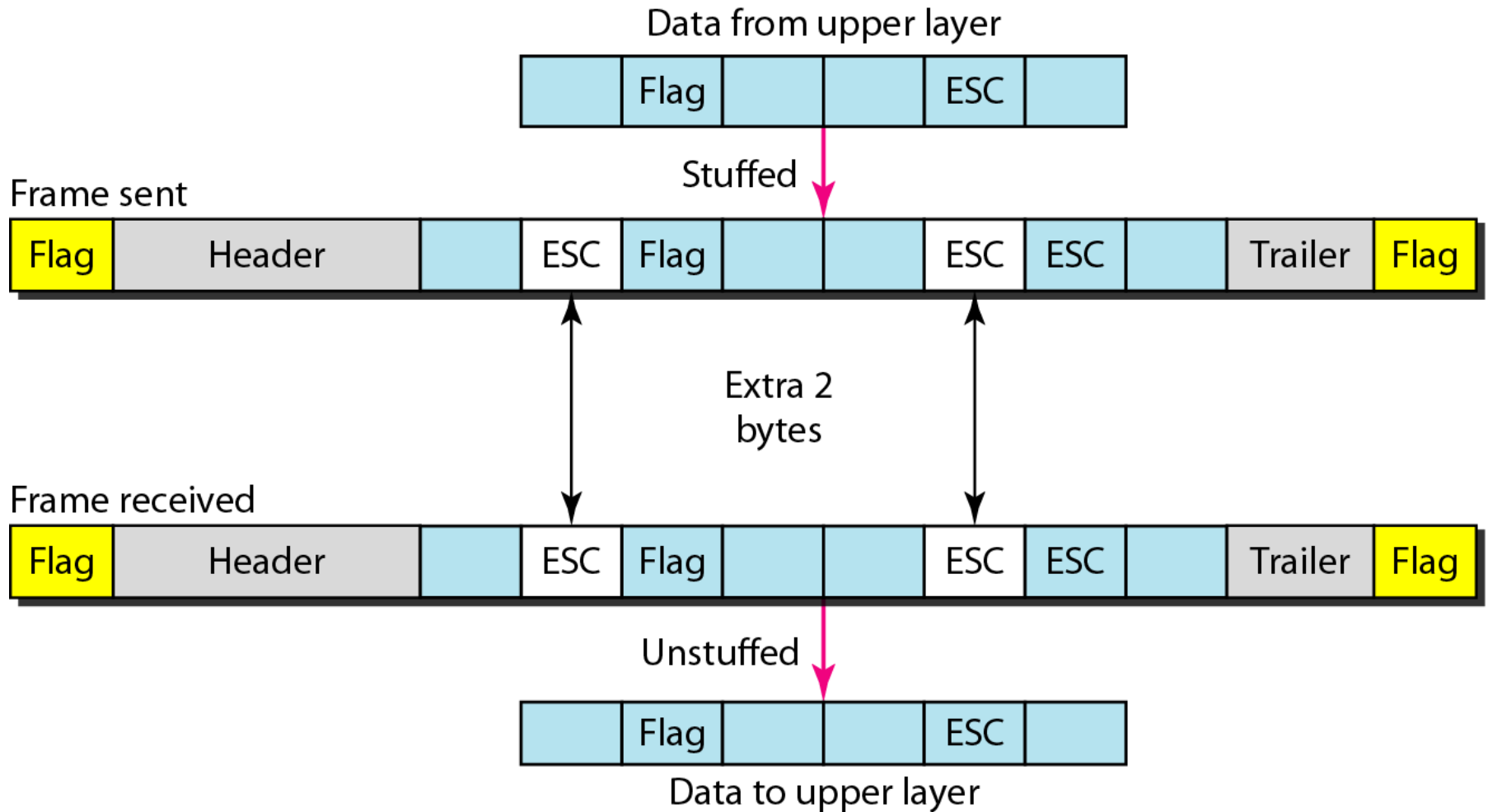


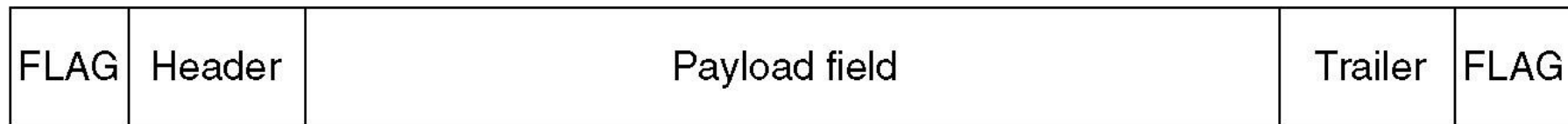
Flag bytes with byte stuffing

- This type of approach is also known as character-oriented approach, data to be carried are 8-bit characters.
- The header, which normally carries the source and destination addresses and other control information.
- Trailer carries error detection or error correction redundant bits, are also multiples of 8 bits.
- To separate one frame from the next, an 8-bit (1-byte) flag is added at the beginning and the end of a frame.
- The flag, composed of protocol-dependent special characters, signals the start or end of a frame.

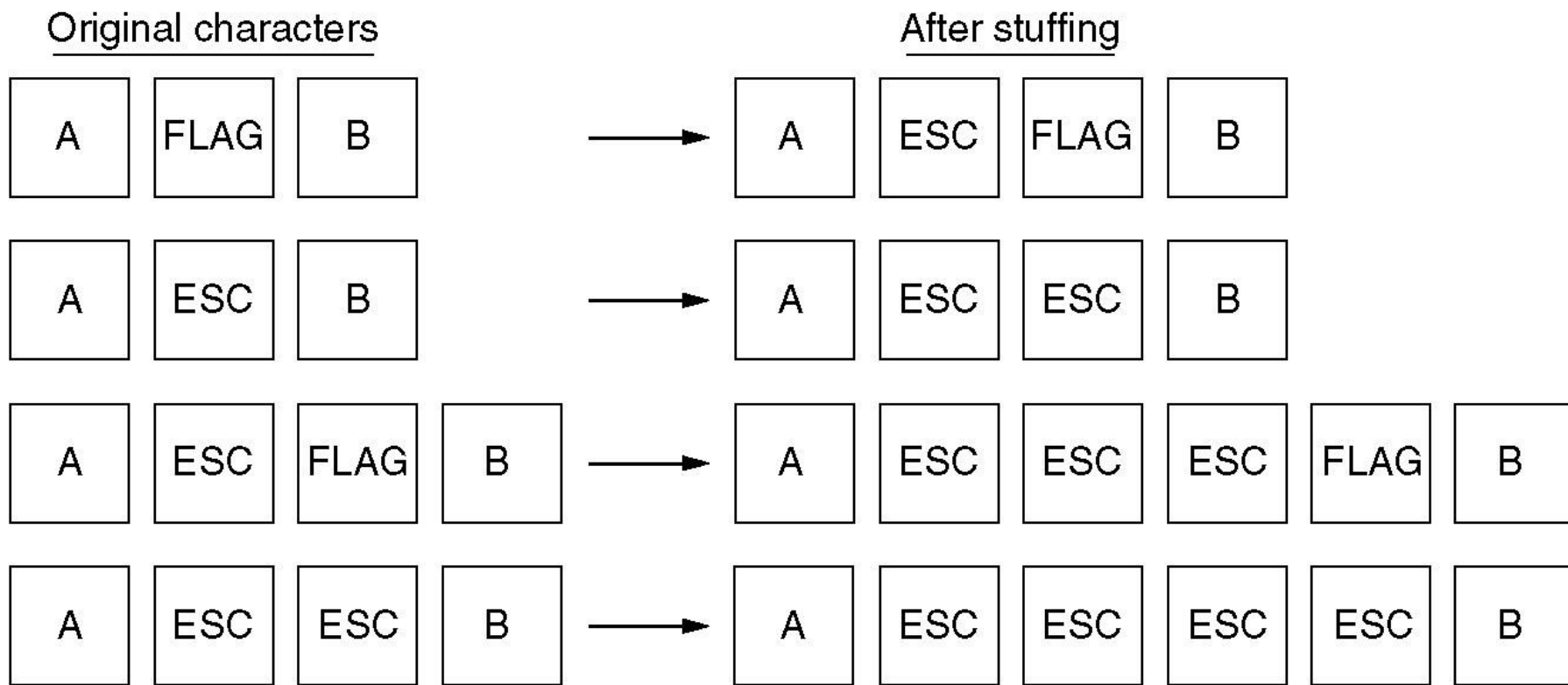


Byte Stuffing and Unstuffing





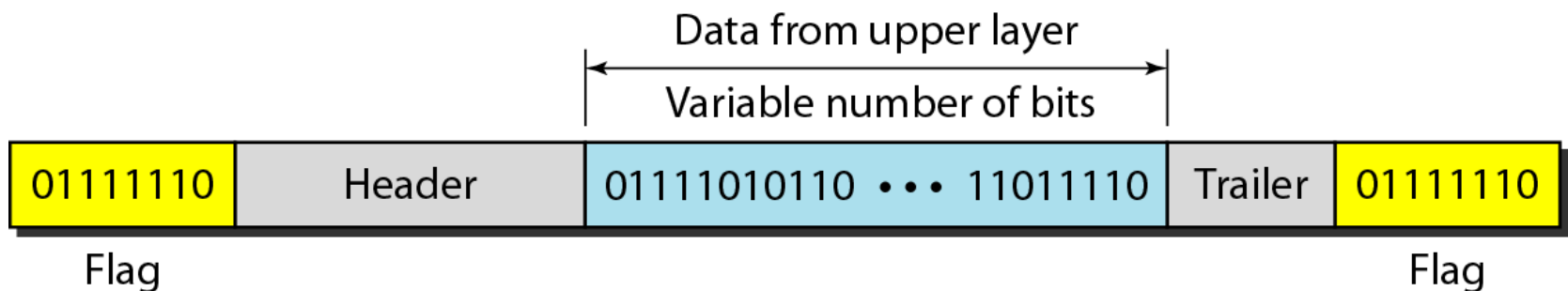
(a)



(b)

Starting and ending flags, with bit stuffing

- This process is also known as bit oriented framing approach.
- Bit stuffing is the process of adding one extra 0 whenever five consecutive 1's follow a 0 in the data, so that the receiver does not mistake the pattern 0111110 for a flag.
- Most protocols use a special 8-bit pattern flag 01111110 as the delimiter to define the beginning and the end of the frame, as shown in Figure below
- This flag can create the same type of problem. That is, if the flag pattern appears in the data, we need to somehow inform the receiver that this is not the end of the frame.
- We do this by stuffing 1 single bit (instead of 1 byte) to prevent the pattern from looking like a flag. The strategy is called bit stuffing.



Bit Stuffing

Data from upper layer

0001111111001111101000

Stuffed

Frame sent



Extra 2
bits

Frame received




Unstuffed

0001111111001111101000

Data to upper layer

(a) 0 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 1 0

(b) 0 1 1 0 1 1 1 1 1 0 1 1 1 1 1 0 1 1 1 1 1 0 1 0 0 1 0



Stuffed bits

The diagram shows three arrows pointing from the text 'Stuffed bits' to the stuffed zeros in the sequence. The first arrow points to the 9th bit (0), the second arrow points to the 14th bit (0), and the third arrow points to the 21st bit (0).

(c) 0 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 1 0

(a) The original data.

(b) The data as they appear on the line.

(c) The data as they are stored in receiver's memory after destuffing.

Physical Layer Coding Violation

- The last method of framing is only applicable to networks in which the encoding on the physical medium contains some redundancy
 - For example, some LANs encode 1 bit of data by using 2 physical bits. Normally, a 1 bit is a high-low pair and a 0 bit is a low-high pair.
 - The scheme means that every data bit has a transition in the middle, making it easy for the receiver to locate the bit boundaries.
 - The combinations high-high and low-low are not used for data but are used for delimiting frames in some protocols.
- As a final note on framing, many data link protocols use a combination of a character count with one of the other methods for extra safety.
- When a frame arrives, the count field is used to locate the end of the frame.
 - Only if the appropriate delimiter is present at that position and the checksum is correct is the frame accepted as valid.
 - Otherwise, the input stream is scanned for the next delimiter.