NETWORK PROTOCOLS & SECURITY
23EC2210 R/A/E

Topic:

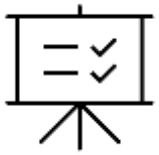
DATA LINK LAYER
DESIGN ISSUES AND FRAMING

Session - 7

AIM OF THE SESSION

To familiarize students with the design issues of Data link layer and framing methods

INSTRUCTIONAL OBJECTIVES



This Session is designed to:

1. Demonstrate the design issues of data link layer.
2. Describe different framing methods.

LEARNING OUTCOMES

At the end of this session, you should be able to:

1. Define the responsibilities of datalink layer.
2. Apply different framing methods to form the packets into frames.
3. Discuss the pros and cons of framing methods.

Design issues of Data Link Layer

- The data link layer uses the services of the physical layer to send and receive bits over communication channels.
- Provides a well-defined service interface to the network layer.
- The responsibilities of Datalink layer include:
  - Framing
  - Addressing
  - Flow Control
  - Error Control
  - Media Access Control

Design issues of Data Link Layer...

- **Framing:** The data link layer divides the stream of bits received from network layer into manageable data units called Frames.
- **Addressing:** The data link layer adds a header to the frame to define the addresses of the sender and receiver of the frame.
- **Flow Control:** Regulating the flow of data so that slow receivers are not swamped by fast senders.

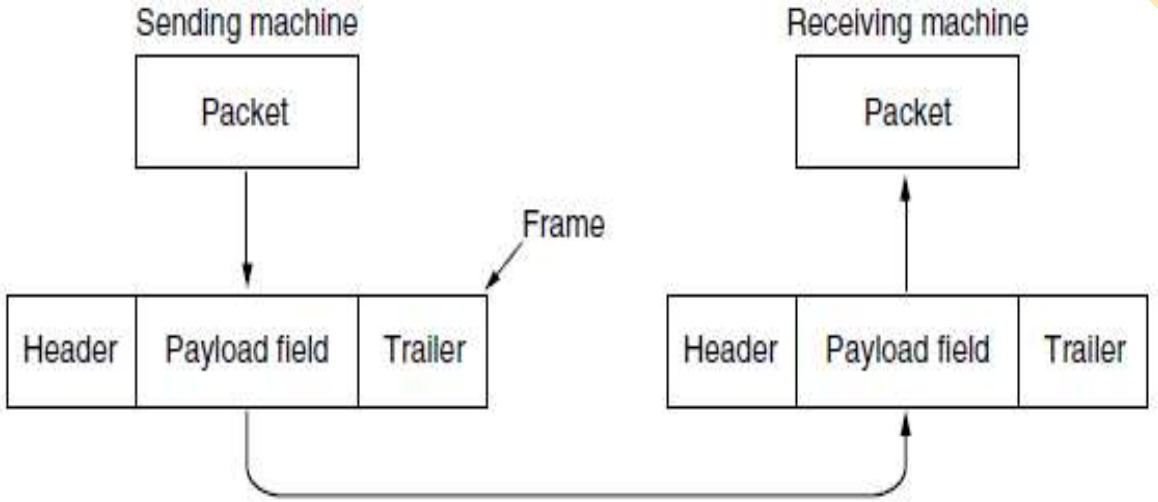


Figure: Relationship between packets and frames.

- **Error Control:** The data link layer also adds reliability to the physical layer by adding mechanisms to detect, retransmit damaged, duplicated or lost frames.
- **Media Access Control:** When two or more devices are connected to the same link, data link layer protocols are necessary to determine which device has control over the link at any given time.

Services provided to Network Layer

- The function of the data link layer is to provide services to the network layer.
- The principal service is transferring data from the network layer on the source machine to the network layer on the destination machine.

1. **Unacknowledged connectionless service.**
2. **Acknowledged connectionless service.**
3. **Acknowledged connection-oriented service.**

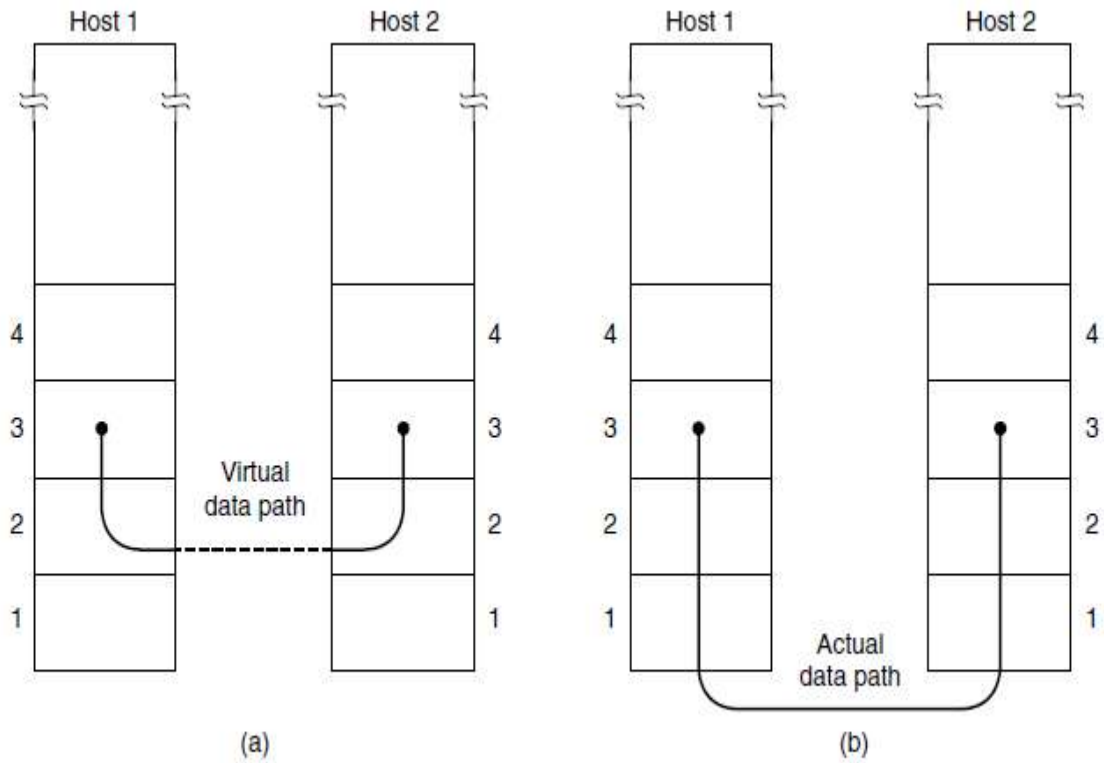
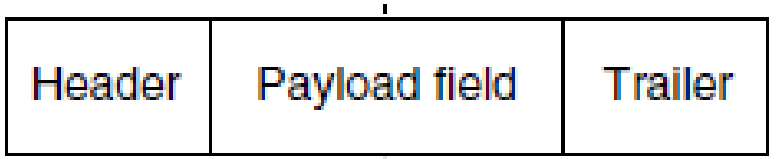


Figure 3-2. (a) Virtual communication. (b) Actual communication.

Framing Methods

Framing



- Breaking up the bit stream into portions is called Framing.
- Each frame contains HEADER and TRAILER.
- A good design must make it easy for a receiver to find the start of new frames.
- **Framing Methods:**
    1. Byte count /Character count.
    2. Flag bytes with Byte stuffing.
    3. Flag bits with Bit stuffing.

Byte count / Character count

- Uses a field in the header to specify the number of bytes in the frame.
- When the data link layer at the destination sees the byte count, it knows how many bytes follow and hence where the end of the frame is.

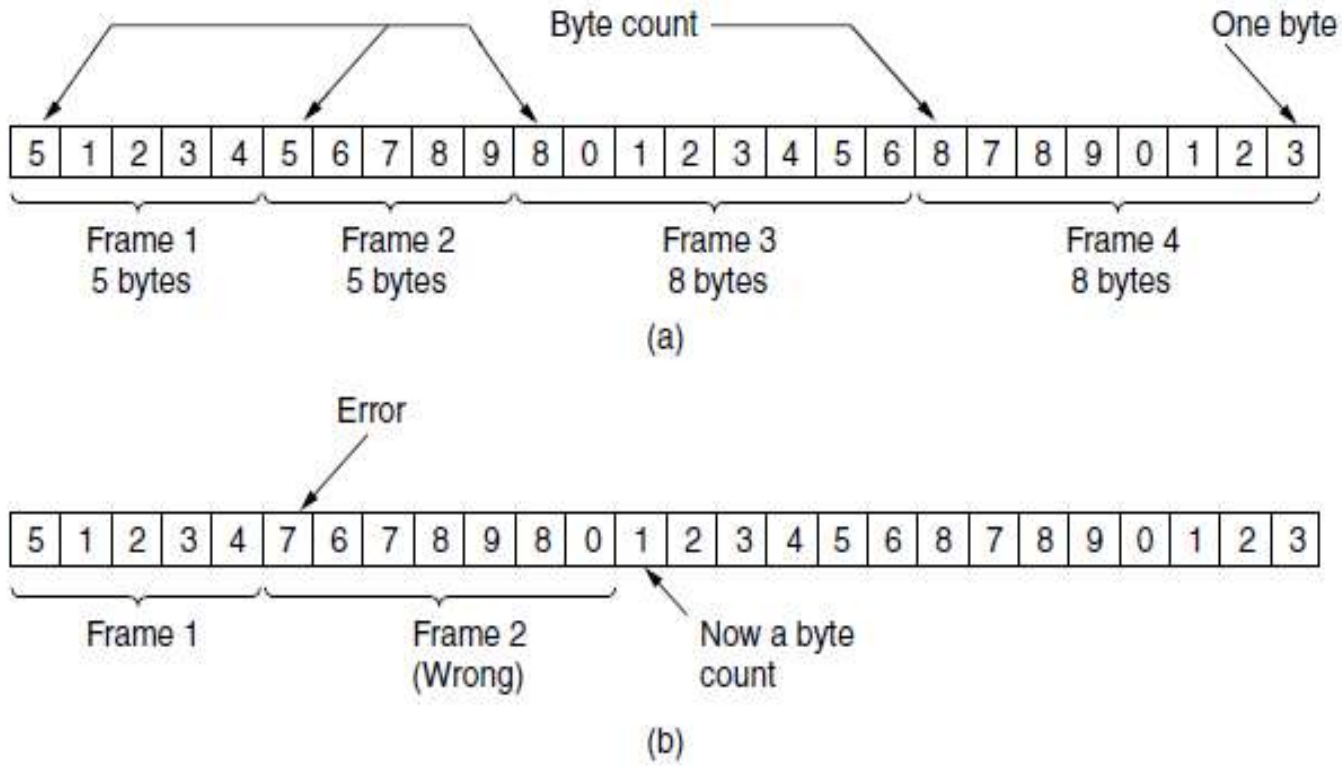


Figure 3-3. A byte stream. (a) Without errors. (b) With one error.

Example-1

Given Message P = 1 2 3 4 5 6 7 8 9

Payload size of frames: F1 =3, F2 = 2, F3 = 4

Perform byte count method and write the final byte sequence.

F1 = ?

F2 = ?

F3 = ?

Final Byte Sequence = ?

Solution-1

Given Message P = 1 2 3 4 5 6 7 8 9

Payload size of frames: F1 =3, F2 = 2, F3 = 4

Sol:

F1 =

4	1	2	3

F2 =

3	4	5

F3 =

5	6	7	8	9

Final Byte Sequence =

4	1	2	3	3	4	5	5	6	7	8	9

Byte Stuffing / Character Stuffing

- Same byte, called a **flag byte**, is used as both the starting and ending delimiter.
- Two consecutive flag bytes indicate the end of one frame and the start of the next.
- Thus, if the receiver ever loses synchronization it can just search for two flag bytes to find the end of the current frame and the start of the next frame.

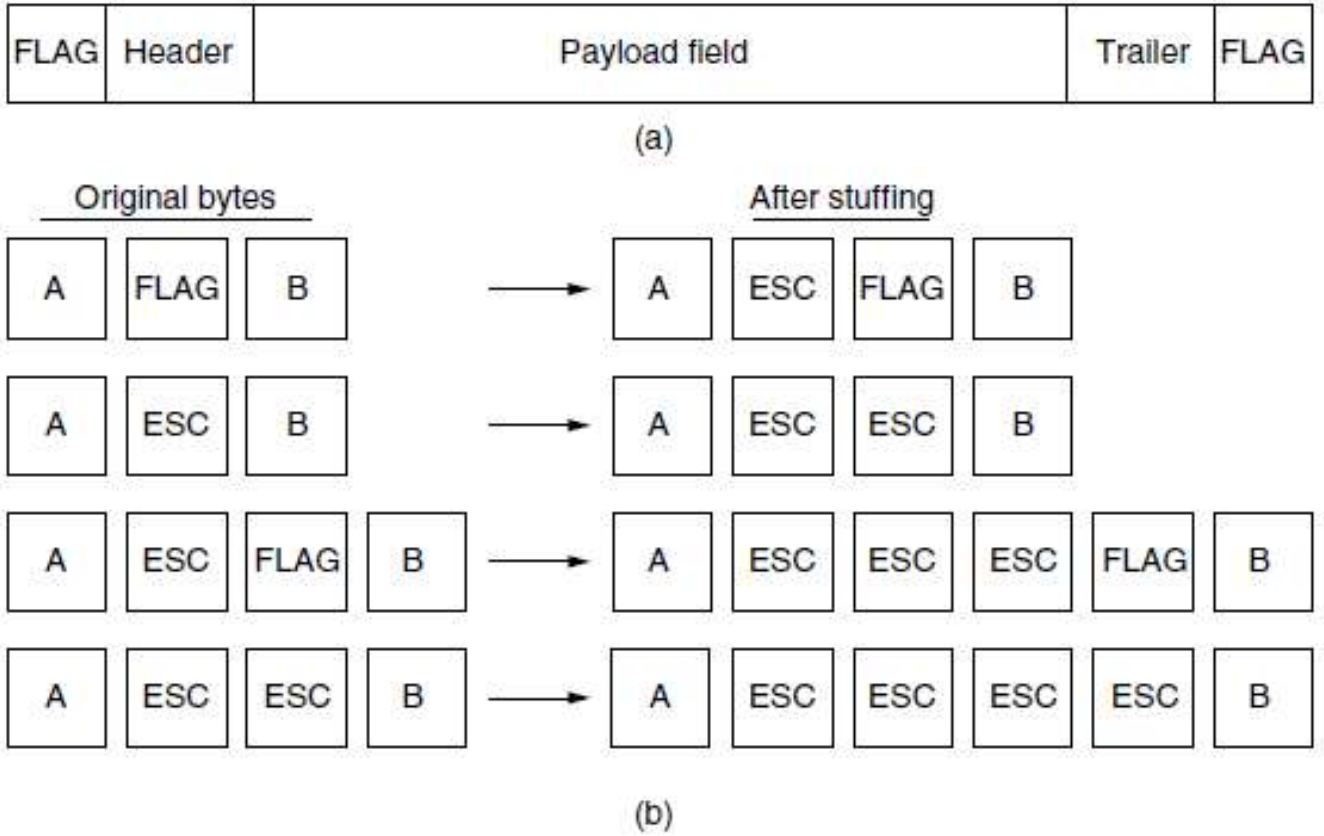


Figure 3-4. (a) A frame delimited by flag bytes. (b) Four examples of byte sequences before and after byte stuffing.

Example-2

Given FLAG = @, ESC = $, Frame format= FLAG DATA FLAG

Original Data	Stuffed Data	Destuffed Data
D1 = ABC	F1 = @ABC@	R1 = ABC
D2 = P@QR	F2 = ?	R2 = ?
D3 = P@QR$	F3 = ?	R3 = ?

Solution-2

Given FLAG = @, ESC = $, Frame format= FLAG DATA FLAG

Original Data	Stuffed Data	Destuffed Data
D1 = ABC	F1 = @ABC@	R1 = ABC
D2 = P@QR	F2 = @P$@QR@	R2 = P@QR
D3 = P@QR$	F3 = @P$@QR$$@	R3 = P@QR$

Bit Stuffing

- Framing can be also be done at the bit level, so frames can contain an arbitrary number of bits made up of units of any size.
- Flag byte: 01111110 or 0x7E in hexadecimal
- Whenever the sender's data link layer encounters five consecutive 1s in the data, it automatically stuffs a 0 bit into the outgoing bit stream.

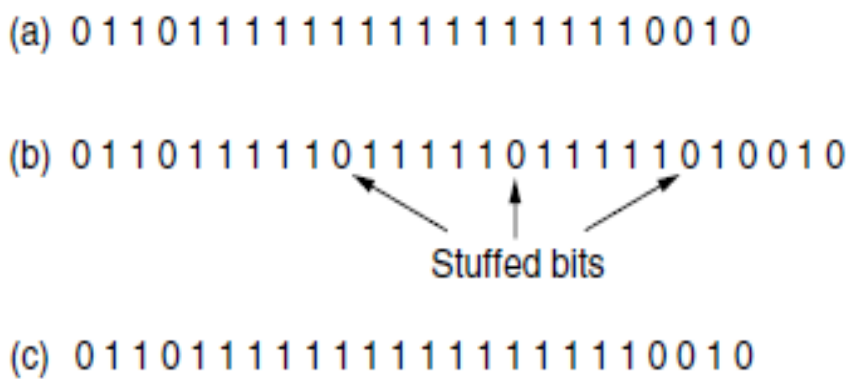


Figure 3-5. Bit stuffing. (a) The original data. (b) The data as they appear on the line. (c) The data as they are stored in the receiver's memory after destuffing.

Example-3

FLAG = 01111110

M1 = 10101000011100101111101

F1= ?

Flag = 01111110

M2 = 10101111110110111111100000110

F2 = ?

FLAG = 011110

M3 = 1100101111010101110

F3 = ?

Solution-3

FLAG = 01111110

M1 = 101010000111001011101

F1= 01111110 101010000111001011101 01111110

Flag = 01111110

M2 = 10101111110110111111100000110

F2 = 01111110 10101111101011011111**0**100000110 01111110

FLAG = 011110

M3 = 1100101111010101110**0** 011110

Example-4

The following character encoding is used in a data link protocol:

A: 01000111; B: 11100011; FLAG: 01111110; ESC: 11100000; Show the bit sequence transmitted (in binary) for the four-character frame

"A FLAG B ESC"

when each of the following framing methods is used:

(a) Byte count.

(b) Flag bytes with byte stuffing.

(c) Starting and ending flag bytes with bit stuffing.

Solution-4

Given Data: A= 01000111; B= 11100011; FLAG= 01111110; ESC= 11100000;

Byte Seq: A FLAG B ESC

a) Byte count:

Byte Seq:	5	A	FLAG	B	ESC
Bit Seq:	00000101	01000111	01111110	11100011	11100000

b) Byte stuffing:

Byte Seq:	FLAG	A	ESC	FLAG	B	ESC	ESC	FLAG
Bit Seq:	01111110	01000111	11100000	01111110	11100011	11100000	11100000	01111110

c) Bit stuffing: F A F B E F

Bit Seq. before Stuffing:		01000111 01111110 11100011 11100000	
Bit Seq after Stuffing:	01111110	01000111 011111010 11100011 111000000	01111110

SELF-ASSESSMENT QUESTIONS

1. Which among the following represents the objectives/requirements of Data Link Layer??

(a) Frame Synchronization
(b) Error & Flow Control
(c) Both a & b
(d) Neither a or b

2. The data link layer takes the packets from _____ and encapsulates them into frames for transmission.

(a) application layer
(b) transport layer
(c) network layer
(d) physical layer

3. In bit stuffing framing method if the flag is 0111110, then after how many 1's the 0 must be stuffed in data?

(a) After every six 1's
(b) After every five 1's
(c) After every four 1's
(d) After every three 1's

SELF-ASSESSMENT QUESTIONS

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- Responsibilities of Datalink layer
- Framing
- Framing Methods
  - Byte Count
  - Byte Stuffing
  - Bit Stuffing

TERMINAL QUESTIONS

1. Describe the design issues of data link layer.

2. Illustrate different framing methods with examples.

3. Analyze the pros and cons of each of the framing methods.

REFERENCES FOR FURTHER LEARNING OF THE SESSION

Reference Books:

1. A.S. Tanenbaum, David J. Wetheral “Computer Networks” Pearson, 5th Edition.
2. Kurose, J and Ross, K Computer Networking: A Top-Down Approach Addison-Wesley- 6th edition.

Sites and Web links:

1. https://www.geeksforgeeks.org/various-kind-of-framing-in-data-link-layer/


THANK YOU

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