

Midterm Exam...

أحمد طه عيسى

220211170

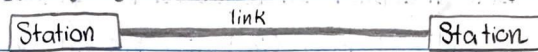
1. Identify the five components of data communications System.

1. message:- The information to be communicated (text, number, picture, video)
2. Sender :- The device that sends the message (computer)
3. Receiver :- The device that receives the message.
4. Transmission Medium :- The physical path through which the message travels (wire - wireless)

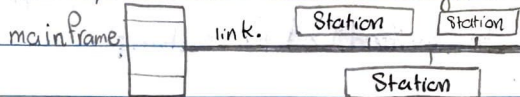
5. Protocol :- A set of rules that govern data communication between devices

2. What are the two types of line configuration?

1. point-to-point :- Dedicated link between two devices



2. Multipoint :- Shared link among multiple devices



3. When a party makes a local telephone call to another party, is this a point-to-point or multipoint connection? Explain the answer.

It is a point-to-point connection.

Explanation :- In a telephone call, the 'communication link' is dedicated between the caller and the receiver for duration of the call

- The entire capacity of the link is reserved exclusively for these two devices and no other devices share this link during the call, making it a point-to-point connection.

In contrast, a multipoint connection would involve multiple devices sharing the same link simultaneously, which is not the case in a standard two-party telephone call.

4. Which layers of the TCP/IP protocol suite are involved in a link-layer switch?

A link-layer switch is involved in the following two layers of TCP/IP

1. Data-link layer :- Responsible for framing and error detection within a single link
2. Physical layer :- Handles the transmission of raw bits over the physical medium.

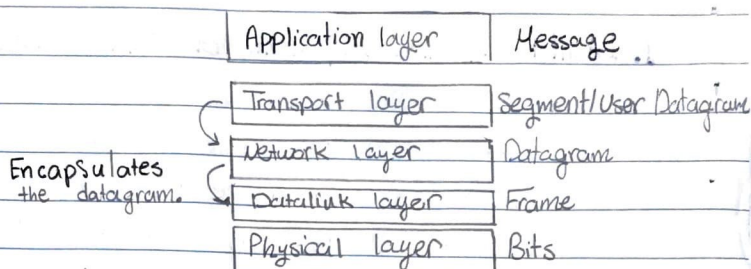
5. Which of the following data units is encapsulated in a frame?

a. a user datagram

b. a datagram ✓

c. a segment.

Data Unit Name



- A datagram (network layer packet) is encapsulated into a frame at the data-link layer.
- A user datagram and segment are encapsulated into datagrams at the network layer, not directly into frames.

6. Assume a system uses five protocol layers. If the application program creates a message of 100 bytes and each layer (including the fifth and the first) adds a header of 10 bytes to the data unit, what is the efficiency (the ratio of application-layer bytes to the number of bytes transmitted) of the system?

- Original message size : 100 bytes
- 5 protocol layers, each adding 10 byte header
- Total headers added :

$$5 \text{ layers} \times 10 \text{ bytes} = 50 \text{ bytes.}$$

- Total transmitted data :

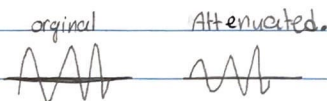
$$100 \text{ bytes (message)} + 50 \text{ bytes (headers)} = 150 \text{ bytes.}$$

- Efficiency :

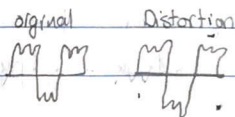
$$\text{Efficiency} = \frac{\text{Application-layer bytes}}{\text{Total transmitted bytes}} \times 100\% = \frac{100}{150} \times 100\% = 66.67\%$$

5. Name three types of transmission impairment.

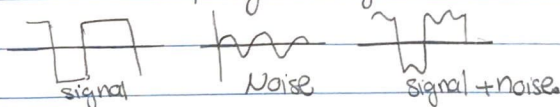
1. Attenuation : means a loss of energy



2. Distortion : means that the signal changes its form or shape



3. Noise : External interference corrupting the signal.



6. We send a digital signal from one station on a LAN to another station. Is this baseband or broadband transmission?

This is baseband transmission.

⇒ In LANs, digital signals are sent directly over the medium without converting to analog.

• This is called baseband which uses a low-pass channel starting at 0 Hz.

7. What is the bit rate for each of the following signals?

a. A signal in which 1 bit lasts 0.001 s:

$$\text{bit rate} = 1/(\text{bit duration}) = 1/0.001 = 1000 \text{ bps} = 1 \text{ kbps}$$

b. A signal in which 1 bit lasts 2 ms:

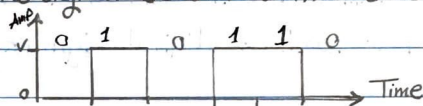
$$\text{bit rate} = 1/(\text{bit duration}) = 1/2 \text{ ms} = 500 \text{ bps}$$

c. A signal in which 10 bits last 20 μs :

$$\text{bit rate} = 1/(\text{bit duration}) = 1/(20 \mu\text{s}/10) = 1/2 \mu\text{s} = 500 \text{ kbps}$$

8. List five line coding schemes:

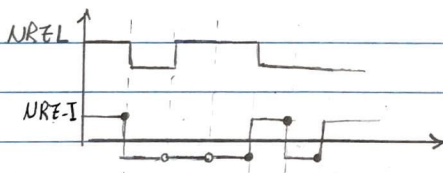
1. Unipolar NRZ scheme: The signal doesn't return to zero at the middle of the bit



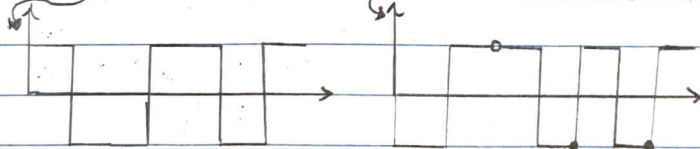
2. Polar NRZ-L and NRZ-I schemes:

• NRZ-L: The level of the voltage determines the value of the bit

• NRZ-I: The inversion or the lack of inversion determines the value of the bit

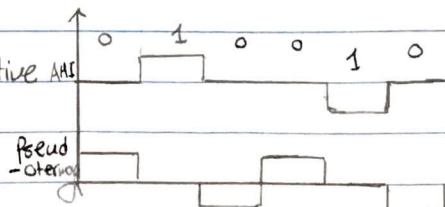


• Polar biphase: Manchester and differential Manchester schemes



3. Bipolar schemes: AMI and pseudoternary

↳ we use three levels positive, zero, negative



4. Multilevel: 2B/1Q, 8B/6T and 4D-PAM5

2B/1Q (Two binary, one quaternary)

8B/6T (8 binary, 6 ternary)

4D-PAM5: 4 wires at the same time and 5 voltage levels

5. Multitransition: MLT-3.

9. Distinguish between data rate and signal rate.

	Data rate (N)	Signal rate (S)
Define	The number of data elements (bit) sent in 1s	The number of signal elements sent in 1s
unit	Bits per second bps	baud
called	Bit rate	pulse rate, modulation rate - baud rate

$$S = N/r$$

Signal rate Data rate Factor

10. What is the maximum data rate of a channel with a bandwidth of 200 kHz if we use four levels of digital signaling?

$$\begin{aligned} N_{\max} &= 2B \times \log_2 L \\ &= 2 \times 200,000 \times \log_2 4 \\ &= 2 \times 200,000 \times 2 \\ &= 800,000 \text{ bps} \\ &= 800 \text{ Kbps} \end{aligned}$$

$N_{\max}$: Maximum data rate bps

B : Bandwidth = 200 kHz

L : Number of signal levels = 4

11. Which of the four digital-to-analog conversion techniques (ASK, FSK, PSK or QAM) is the most susceptible to noise? Defend your answer:

ASK is the most susceptible to noise among the four techniques.

ASK implemented by changing the amplitude of a carrier signal. Noise directly affects amplitude, making it highly vulnerable to distortion.

In contrast:

FSK: Changes the frequency of carrier signal which are less affected by noise.

PSK: phase shift of the carrier signal which are more robust against noise.

QAM: Combines amplitude and phase but its noise resistance is better

12. The telephone line has 4KHz bandwidth. what is the maximum number of bits we can send using each of the following techniques? let $d=0$. $B=4\text{KHz}$

a. ASK

$$B = (1+d) \times \frac{N}{r}$$

$$N = \lceil 1/(1+d) \rceil \times r \times B$$

$$r = \log_2 2 = 1 \Rightarrow N = \lceil 1/(1+0) \rceil \times 1 \times 4000 = 4\text{Kbps}$$

b. QPSK.

$$r = \log_2 4 = 2 \Rightarrow N = \lceil 1/(1+d) \rceil \times r \times B$$

$$= \lceil 1/1 \rceil \times 2 \times 4\text{K} = 8\text{Kbps}$$

c. 16-QAM.

$$N = \lceil 1/(1+d) \rceil \times r \times B$$

$$r = \log_2 16 = 4 \quad N = \lceil 1/(1+0) \rceil \times 4 \times 4\text{K} = 16\text{Kbps}$$

d. 64-QAM.

$$N = \lceil 1/(1+d) \rceil \times r \times B$$

$$r = \log_2 64 = 6 \rightarrow N = 1 \times 6 \times 4\text{K} = 24\text{Kbps}$$

13. Assume that a voice channel occupies a bandwidth of 4KHz. we need to multiplex 10 voice channels with guard bands of 500Hz using FDM.

Calculate the required bandwidth.

Given: Bandwidth = 4KHz

Number of voice channels = 10

Guard band between channels = 500Hz

Channels can be separated by strips of unused bandwidth - guard bands - to prevent signals from overlapping.

10 channels $\Rightarrow$ 9 guard bands.

$$B_{\text{FDM}} = \overset{\text{Total channel}}{10 \times 4\text{K}} + \overset{\text{total guard}}{500 \times 9} = 40\text{K} + 4.5\text{K}$$

$$= 44.5\text{KHz}$$

#

14. we have a digital medium with a data rate of 10 Mbps. How many 64 kbps voice channels can be carried by this medium if we use DSSS with the Barker sequence?

Given :

medium data rate = 10 Mbps

voice channel data rate = 64 kbps

Barker Chips are 11 bits $\Rightarrow$ increase bit rate 11 times

$$64 \text{ kbps} \times 11 = 704 \text{ kbps}$$

$$\therefore \text{number of voice channel} = \frac{10 \text{ Mbps}}{704 \text{ kbps}} = 14.2$$

$\therefore$ 14 voice channel can be carried by the medium.

15. what is the function of the twisting in twisted-pair cable?

The two are twisted around each other

One carries the signal, the other is used as a ground reference.

The signal used is the difference between the two

- The two are subject to noise and/or cross talk from another pair
- if the noise source is closer to one side, twisting make the effect even

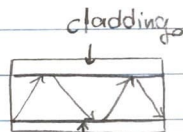
- When the signal difference is used the noise cancels out.

$\therefore$ 1. Reduction of cross talk.

2. Reduction of electromagnetic interference.

what is the purpose of cladding in an optical fiber?

$\Rightarrow$ The cladding is a layer that surrounds the core of an optical fiber



- It has a lower refractive index than the core. This difference in refractive index causes total internal reflection, keeping the light inside the core
- It prevents light from escaping so the signal can travel long distances with less loss

It also helps protect the core and maintain the quality of the signal