Ch # 1

— What are the basic elements of meaningful communication?

- (1) Common theme
- (2) common language
- (3) an orderly session

— What are the components of a computer network?

- (1) Intraction with the subnetwork 5
- (2) Quality of transport service 4
- (3) conversion of signals (bits ⟷ electric signal) 7
- (4) Error control 6
- (5) Authentication and login 1
- (6) common syntax 2
- (7) Establishment of an orderly exchange of message with markers for forward and backward synchronization 3

— Define the term of "computer network architecture". What is the difference between "closed system" and "open system"? give example of each type. Why do we need standarization for computer network architecture?

- computer network architecture is layered architecture it describes how the computer network has been assembled using its verious components and defines the specifications of the component and their relationship.
- "closed system" → system is vendor-specific layered architecture (Like: SNA, DNA)
  "open system" → system is vendor-independent architecture (Like: OSI)
- We need to standarization to move from (Closed system) to (open system) and standarization can solve many problems and solve alot of effort required for developing interfaces for networking different architecture.

— Explain in detail the transports-oriented function in a computer network?

- It is provided by subnetwork to transport the messages through the subnetwork without any error, these functions are assigned for :
  1. Intraction with the subnetwork 5
  2. Quality of transport service 4
  3. Conversion of signals 7
  4. Error control 6

— What are the needed functions for message transportation?

- ① Intraction with the subnetwork ② Quality of transport service
  ③ Conversion of signals ④ Error control

— What is the difference between "connection oriented transport service" and "connectionless oriented transport service" ?

- "connection oriented transport service" → In this service, the data are delivered error free, in sequence and with no loss or duplications
  "connectionless oriented transport service" → In this service, the transport messages have no guarantee about the order of delivery
  (ترتيب)

— mention two methods to achieve " high throughput transport connection"?

- ① creating multiple network connection
  ② Dividing the data among the network connections

— Why we do not need more than the lowest three layers of OSI model at any access node as well as intermediate nodes? Mention these three layer.

- ⊙ Because the network layer is overcome all problems might occure in travelling data between networks
  ⊙ These layer are → Physical layer _ Data link layer _ Network layer

– Match the following :

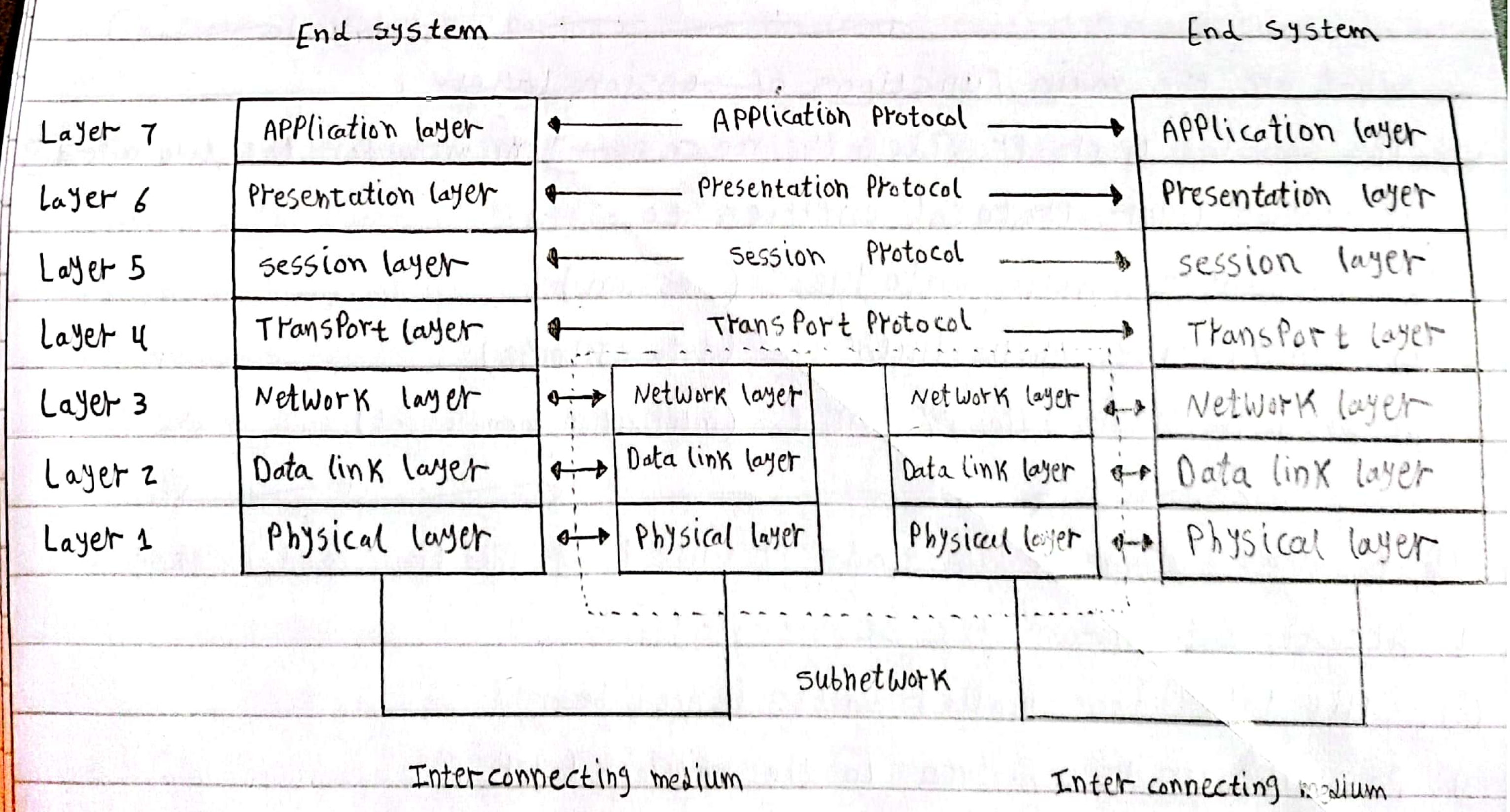
(a) End – to – End connection of required QoS — (i) Data link layer
(b) Data encryption — (ii) Session layer
(c) Synchronization of dialogue — (iii) Application layer
(d) Login — (iv) Presentation layer
(e) Media access control — (v) Transport layer

Sol

- (a) → (v) (b) → (iv) (c) → (ii) (d) → (iii) (e) → (i)

– Two end systems are interconnected using a pair of modems. A modem has the Physical layer and two Parts, one towards the end system and the other towards the second modem. Draw the layer model of the configuration.

Sol



- What are the main functions of application layer ?
  1. Information transfer
  2. Identification of the inteded comunication partner by name or by address
  3. Establishment of authority to communicate
  4. Agreement on privacy mechanism
  5. Authentication of an intended communication partner
  6. Agreement on responsibility for error recovery

- What are the main functions of presentation layer ?
  1. present the information to the communicating application entities in a way that preserves the meaning while resolving the syntax differences (Transfer syntax)
  2. Encryption of data if required

- What are the main functions of session layer ?
  - The session layer provides the necessary means for the two cooperating application layer protocol entities to :
    1. organize their dialogue (session)
    2. synchronize their dialogue (data exchange)
    3. Manage their data exchange (interaction management)

- What are the main functions provided by the transport layer ?
  1. Accept data from the session layer
  2. split data into smaller units if need be
  3. Pass the units of data to the network layer
  4. Ensure that the small units all arrive correctly at the session layer of the other end system.

— What are the main functions provided by the network layer ?

- ① The network layer provides the means to access the subnetwork for routing the message to the destination end system
- ② The network layer relives the higher layer (from transport layer to application layer) of need to know any thing about the underlying data transmission and switching technologies used to connect end systems.

— What are the main functions of data link layer ? || (Why do we need data link layer?)

- ① Data link layer take a stream of bits from the physical layer and transform it into frame then send it to the network layer
- ② Data link layer recorrect the errors which introduced by transportation of bits over the physical layer (error detection and correction)
- ③ Data link layer perform flow control mechanism
- ④ Data link layer perform media access control (MAC) function in LAN

— The data link layer performs function that is specific to local area network what is the name of these function ? and explain it in detail.

- ⊙ name → Media access control (MAC) ⊙ explain → It is a common transmission medium exists in end systems in local area network and carried out by the data link layer, MAC determines which user can use the media for its transmission

— To the end systems, what are the three functions of the physical layer ?

- ① conversion of the bits into electrical signals having characteristics suitable for transmission over the medium
- ② Signal encoding if required
- ③ Relaying of the digital signals using intermediary diveces (Like: modems)

Ch # 2

— Define the term " data link Protocol". give some examples of these Protocols :

- ⊙ Data link Protocol → Is the specified set of rules for carrying out data link control function.

⊙ The examples → ① Binary synchronous data link control (BISYNC) ② synchronous data link control (SDLC) ③ High level data link control (HDLC) ④ Advanced data comunication control Procedure (ADCCP) ⑤ Point to Point Protocol (PPP)

— What are the three Types of the frame format that may be used in the data link layer Protocol ? Draw the general frame format of HDLC Protocol.

- ⊙ ① variable Format – variable length

X	A	B	C	y

② fixed format – fixed length

X			

③ fixed format – varible Length

X		B	C	y

⊙ HDLC frame →

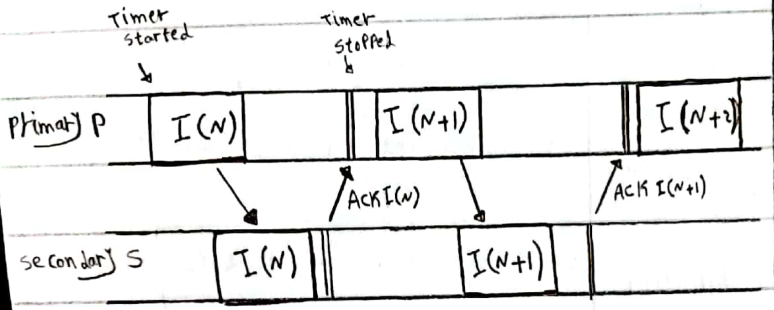
Flag	Address	control bits	Data	FCS	Flag

— What is the difference between Bit-oriented and Byte-oriented data link Protocol? give one example for each type.

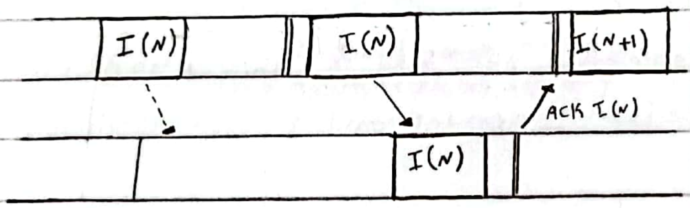
In bit-oriented data link :	In byte oriented data link :
① control information is coded at a bit level	① Control information is coded at a byte level
② The length of the data field may not be a multiple of bytes	② The length of the data field may be one or multiple of bytes
The example → High level data link Control (HDLC)	The example → Binary synchronous data link control (BISYNC)

— With the aid of frame sequence diagrams and assuming an idle RQ (stop and wait) error control procedure, describe the difference between an implicit and an explicit retransmission control scheme. which one is better? why? ||
(use diagrame to show the different between "implicit idle RQ" and "explicit idle RQ" which one is better? why?)

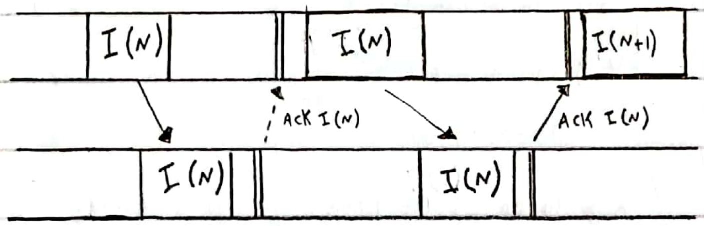
• In implicit idle RQ



(Error free)



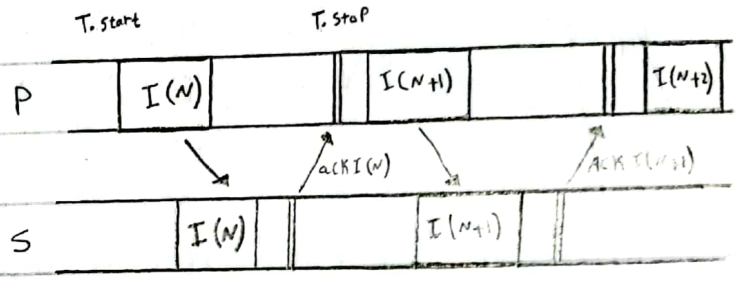
(currapted I-frame)



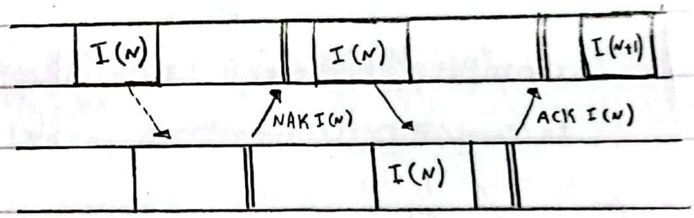
(currapted ACK)

* The secondary send acknowledgment in reciving frame correctly, else do not send any ack and so that the primary will send the fram again
in currapted ack the sendor (primary) will send the pervious frame again

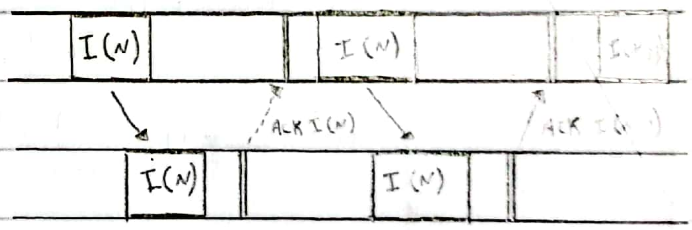
In explicit idle RQ



(Error free)



(currapted I-frame)



(currapted ACK)

* The secondary send acknowledgment in correct frame and send negative acknowledgment in currapted frame and so that the sendor will send the frame again. in currapted ACK the sendor also will send the pervious frame again.

- The better is the explicit idle RQ because when the frame have currapted the time is much shorter with explicit where a NAK frame is used.

— What are the advantages and disadvantages of : selective repeat ARQ and Go-back-N ARQ?

	advantages	disadvantages
selective repeat ARQ	Better efficient in it use of the avalilable transmission capacity	The buffer size is very large
Go-back-N ARQ	The buffer size is smaller	Less efficient in it use of the available transmission capacity

— Compare between "Idle ARQ", "selective ARQ" and "Go-back-N ARQ" with respect to : Link utilization – buffer size – sendor and reciever window size

	Idle ARQ	selective ARQ	Go-back-N ARQ
Link utilization	error free $\rightarrow U = \frac{1}{1+2a}$ implicit $\rightarrow U = \frac{1-P_f}{(1+2a)(1-P_f)+P_f\left(\frac{T_o}{T_{ix}}\right)}$ explicit $\rightarrow U = \frac{1-P_f}{1+2a}$	(error free) $K \geq 1+2a \rightarrow U = 1$ $K < 1+2a \rightarrow U = \frac{K}{1+2a}$ (with error) $K \geq 1+2a \rightarrow U = 1-P_f$ $K < 1+2a \rightarrow U = \frac{K(1-P_f)}{1+2a}$	(error free) $K \geq 1+2a \rightarrow U = 1$ $K < 1+2a \rightarrow U = \frac{K}{1+2a}$ (with error) $K \geq 1+2a \rightarrow U = \frac{1-P_f}{1+2aP_f}$ $K < 1+2a \rightarrow U = \frac{K(1-P_f)}{(1+2a)(1-P_f+KP_f)}$
Buffer size	very small	very large	medium
Window size	For sender → 1 For reciever → 1	for sendor → K for reciever → K	for sendor → K for reciever → 1

– In idle ARQ error control mechanism (explicit transmission) prove that the link utilization in the presence of error is given by

$$U = \frac{1 - P_f}{1 + 2a}$$

Sol

$U = \frac{T_{ix}}{T_t}$. $T_t = N_r(T_{ix} + 2T_p)$. $N_r = \frac{1}{1 - P_f}$. $a = \frac{T_p}{T_{ix}}$

$\because U = \frac{T_{ix}}{T_t}$ $\therefore U = \frac{T_{ix}}{N_r(T_{ix} + 2T_p)} = \frac{T_{ix}}{\frac{1}{1-P_f}(T_{ix} + 2T_p)} = \frac{(1-P_f)T_{ix}}{T_{ix} + 2T_p}$

$\therefore U = \frac{1 - P_f}{1 + (2T_p/T_{ix})}$ $\therefore U = \frac{1 - P_f}{1 + 2a}$ //

* قوانين مهمة في حل المسائل (بجانب قوانين U) :

$$T_{ix} = \frac{N \text{ (or } L) \longrightarrow \text{(in bits)}}{\text{Transmission rate } (R) \to \text{(in bps)}}$$

$T_p = \frac{\text{distance} \longrightarrow \text{(in m)}}{\text{Propagation speed } (v) \to \text{(in m/s)}}$ $a = \frac{T_p}{T_{ix}}$. $P_f = 1 - (1 - P)^L$

* أفكار المسائل :

① Idle ARQ (error free) $\xrightarrow{\text{we use}}$ $U = \frac{1}{1 + 2a}$

② Idle ARQ (explicit) $\xrightarrow{\text{we use}}$ $U = \frac{1 - P_f}{1 + 2a}$

" The required here may be U or L or distance "

③ Continuous ARQ (error free || Bit error rate is negligible) $\xrightarrow{\text{we use}}$ $U = 1$ " $K \geq 1 + 2a$ "

$U = \frac{K}{1 + 2a}$ " $K < 1 + 2a$ "

④ Continuous ARQ (with error || with Bit error rate [BER]) we use

– selective repeat : $U = 1 - P_f$ " $K \geq 1 + 2a$ " / $U = \frac{K(1 - P_f)}{1 + 2a}$ " $K < 1 + 2a$ "

– Go back N : $U = \frac{1 - P_f}{1 + 2a P_f}$ " $K \geq 1 + 2a$ " / $U = \frac{K(1 - P_f)}{(1 + 2a)(1 - P_f + KP_f)}$ " $K < 1 + 2a$ "

- A series of 1000-bit frames is to be transmitted using an idle RQ protocol. Determine the link utilization for the following types of data link assuming a data transmission rate of : (i) 1 KbPs and (ii) 1 MbPs. The velocity of Propagation of the link is 2×10^8 m/s and the bit error rate is negligible. (a) A twisted Pair cable 1 Km in length (b) A leased line 200 Km in length (c) A Satalite link of 50000 Km

Sol

Number of bits $(N) = 1000$, Transmission rate $(R) \Rightarrow$ (i) 10^3 , (ii) 10^6 ,

Propagation speed $(V) = 2 \times 10^8$, Distance $\Rightarrow$ (a) 10^3 , (b) 200×10^3 , (c) 50000×10^3 ,

ARQ $\longrightarrow$ idle , Bit error rate $(P) \longrightarrow$ negligible

$$\left(T_{ix} = \frac{N}{R} \;,\; T_p = \frac{\text{Distance}}{V} \;,\; a = \frac{T_p}{T_{ix}} \;,\; U = \frac{1}{1+2a} \right)$$

at 1 KbPs $\longrightarrow T_{ix} = \frac{1000}{1000} = 1$ (i) , at 1 MbPs $\longrightarrow T_{ix} = \frac{1000}{10^6} = 10^{-3}$ (ii)

(a) $T_p = \frac{1000}{2 \times 10^8} = 5 \times 10^{-6}$

(i) $a = \frac{T_p}{T_{ix}} = \frac{5 \times 10^{-6}}{1} = 5 \times 10^{-6}$ $\therefore 1 + 2a \simeq 1$

$\therefore U = 1$ (100 %)

(ii) $a = \frac{5 \times 10^{-6}}{10^{-3}} = 5 \times 10^{-3}$ $\therefore 1 + 2a \simeq 1$

$\therefore U = 1$ (100 %)

(b) $T_p = \frac{200 \times 10^3}{2 \times 10^8} = 10^{-3}$

(i) $a = \frac{10^{-3}}{1} = 10^{-3}$ $\therefore 1 + 2a \simeq 1$

$\therefore U = 1$ (100 %)

(ii) $a = \frac{10^{-3}}{10^{-3}} = 1$ $\therefore U = \frac{1}{1+2a} = \frac{1}{1+2} = \frac{1}{3}$

$\therefore U = 0.33$ (33%)

(c) $T_p = \frac{50000 \times 10^3}{2 \times 10^8} = 0.25$

(i) $a = \frac{0.25}{1} = 0.25$ $\therefore U = \frac{1}{1+2(0.25)} = \frac{1}{1.5}$

$\therefore U = 0.67$ (67%)

(ii) $a = \frac{0.25}{10^{-3}} = 250$ $\therefore U = \frac{1}{1+2(250)} = \frac{1}{501}$

$\therefore U = 0.002$ (0.2%)

Calculate the link utilization for stop and wait protocol (explicit transmission) for the following two transmission rates: (i) 1 Kbps (ii) 1 Mbps where the bit error rate $= 10^{-4}$, end to end distance $= 8000$ Km, frame length $= 1000$ bytes and the propagation speed $= 2\times10^{8}$ m/s. Give your comments

Sol

Length of frame $(L) = 8000$, Transmission rate $(R) \Rightarrow$ (i) 10^3 (ii) 10^6

Propagation speed $(v) = 2\times10^8$, Distance $= 8000\times10^3$, Bit error rate $(P) = 10^{-4}$

ARQ $\longrightarrow$ Stop and wait (idle) $\longrightarrow$ explicit transmission

$$\left(T_{ix} = \frac{L}{R} ,\ T_p = \frac{\text{Distance}}{v} ,\ a = \frac{T_p}{T_{ix}} ,\ P_f = 1-(1-P)^L ,\ U = \frac{1-P_f}{1+2a} \right)$$

$$T_p = \frac{\text{Distance}}{v} = \frac{8000\times10^3}{2\times10^8} = 0.04 ,\quad P_f = 1-(1-P)^L = 1-(1-10^{-4})^{8000} = 0.55$$

(i) $$T_{ix} = \frac{L}{R} = \frac{8000}{10^3} = 8 \qquad a = \frac{T_p}{T_{ix}} = \frac{0.04}{8} = 5\times10^{-3}$$

$$U = \frac{1-P_f}{1+2a} = \frac{1-0.55}{1+2(5\times10^{-3})} = 0.45 \qquad \therefore U = 0.45\ (45\%)$$

(ii) $$T_{ix} = \frac{L}{R} = \frac{8000}{10^6} = 8\times10^{-3} \qquad a = \frac{T_p}{T_{ix}} = \frac{0.04}{8\times10^{-3}} = 5$$

$$U = \frac{1-P_f}{1+2a} = \frac{1-0.55}{1+2(5)} = 0.04 \qquad \therefore U = 0.04\ (4\%)$$

* Comment $\longrightarrow$ We note that the link utilization (U) decrease when the transmission rate (R) have increased

- Calculate minimum frame length (L) for idle ARQ (explicit transmission) if: Probability (P_f) that a frame is received with error = 0.550689, Propagation delay (T_p) = 40 ms, Transmission rate (R) = 1 Mbps and U = 4%

Sol

$L = ??$, $P_f = 0.550689$, $T_p = 0.04$, $R = 10^6$, $U = 0.04$

ARQ → idle → explicit

$$\therefore U = \frac{1-P_f}{1+2a} = \frac{1-P_f}{1+2(T_p/T_{ix})} = \frac{1-P_f}{1+2(T_p/\frac{L}{R})} = \frac{1-P_f}{1+(2RT_p/L)}$$

$$\therefore 1+\frac{2RT_p}{L} = \frac{1-P_f}{U} \qquad \therefore \frac{2RT_p}{L} = \frac{1-P_f}{U} - 1$$

$$\therefore L = \frac{2RT_p}{\frac{1-P_f}{U}-1} = \frac{2\times10^6\times0.04}{\frac{1-0.550689}{0.04}-1} = 7818 \text{ bits} \quad \therefore L \simeq 1000 \text{ bytes}$$

- Calculate the distance between the transmitter and the reciever for explicit transmission idle ARQ if: Link utilization (U) = 0.04, Bit error rate (BER) = 10^{-4}, Frame length (L) = 10^3 bytes, R = 1 Mbps, $V = 2\times10^8$ m/s

Sol

Distance (x) = ?? , $U = 0.04$, $P = 10^{-4}$, $L = 8000$, $R = 10^6$, $V = 2\times10^8$

ARQ → idle → explicit

$$\therefore U = \frac{1-P_f}{1+2a} = \frac{1-P_f}{1+2(T_p/T_{ix})} = \frac{T_{ix}(1-P_f)}{T_{ix}+2T_p} = \frac{T_{ix}(1-P_f)}{T_{ix}+(2X/V)}$$

$$\therefore T_{ix}+(2X/V) = \frac{T_{ix}(1-P_f)}{U} \qquad \therefore \frac{2X}{V} = \frac{T_{ix}(1-P_f)}{U} - T_{ix} = T_{ix}\left(\frac{1-P_f}{U}-1\right)$$

$$\therefore X = \left(\frac{T_{ix}V}{2}\right)\left(\frac{1-P_f}{U}-1\right)$$

$\left(\because T_{ix} = \frac{L}{R} = \frac{8000}{10^6} = 8\times10^{-3}\right.$, $\left. P_f = 1-(1-P)^L = 1-(1-10^{-4})^{8000} = 0.550689\right)$

$$\therefore X = \left(\frac{8\times10^{-3}\times2\times10^8}{2}\right)\left(\frac{1-0.550689}{0.04}-1\right) = 8186220 \quad \therefore \text{Distance} \simeq 8000 \text{ Km}$$

A series of 1000 bit I-frames is to be transmitted using a continuous RQ Protocol. Determine the link efficiency for the following types of data link if the velocity of Propagation is 2×10^8 m/s and the bit error rates of the links are all negligible.

(a) A 1 km link of 1 Mbps and a send window $K = 2$

(b) A 10 km link of 200 Mbps and a send window $K = 7$

(c) A 50000 km satallite link of 2 Mbps and a send window $K = 127$

sol

(a) $N = 1000$, $V = 2 \times 10^8$, distance $(x) = 10^3$, $R = 10^6$, $K = 2$

$$T_{ix} = \frac{N}{R} = \frac{1000}{10^6} = 10^{-3} \quad , \quad T_p = \frac{x}{V} = \frac{10^3}{2 \times 10^8} = 5 \times 10^{-6}$$

$$\therefore a = \frac{T_p}{T_{ix}} = \frac{5 \times 10^{-6}}{10^{-3}} = 5 \times 10^{-3} \qquad \therefore 1 + 2a = 1.01 \qquad \therefore K > 1 + 2a$$

$$\therefore U = 1 \; (100\%)$$

(b) $N = 1000$, $V = 2 \times 10^8$, distance $(x) = 10 \times 10^3$, $R = 200 \times 10^6$, $K = 7$

$$T_{ix} = \frac{N}{R} = \frac{1000}{200 \times 10^6} = 5 \times 10^{-6} \quad , \quad T_p = \frac{x}{V} = \frac{10 \times 10^3}{2 \times 10^8} = 5 \times 10^{-5}$$

$$\therefore a = \frac{T_p}{T_{ix}} = \frac{5 \times 10^{-5}}{5 \times 10^{-6}} = 10 \qquad \therefore 1 + 2a = 21 \qquad \therefore K < 1 + 2a$$

$$\therefore U = \frac{K}{1 + 2a} = \frac{7}{21} = 0.33 \qquad \therefore U = 0.33 \; (33\%)$$

(c) $N = 1000$, $V = 2 \times 10^8$, distance $(x) = 50000 \times 10^3$, $R = 2 \times 10^6$, $K = 127$

$$T_{ix} = \frac{N}{R} = \frac{1000}{2 \times 10^6} = 5 \times 10^{-4} \quad , \quad T_p = \frac{x}{V} = \frac{50000 \times 10^3}{2 \times 10^8} = 0.25$$

$$\therefore a = \frac{T_p}{T_{ix}} = \frac{0.25}{5 \times 10^{-4}} = 500 \qquad \therefore 1 + 2a = 1001 \qquad \therefore K < 1 + 2a$$

$$\therefore U = \frac{K}{1 + 2a} = \frac{127}{1001} = 0.127$$

$$\therefore U = 0.127 \; (12.7\%)$$

- Calculate link utilization for the following link parameters: I-frame size is 1000 byte , $T_p = 40$ ms , BER $= 10^{-5}$, Transmission rate $= 2$ Mbps

bit error rate = p (not error free)

using the following link protocols:

i) selective repeat with $K = 7$, $K = 127$

ii) Go back N with $K = 7$, $K = 127$

Sol

$L = 8000$, $T_p = 40 \times 10^{-3}$, $P = 10^{-5}$, $R = 2 \times 10^6$

$T_{ix} = \frac{L}{R} = \frac{8000}{2 \times 10^6} = 4 \times 10^{-3}$ $\therefore a = \frac{T_p}{T_{ix}} = \frac{40 \times 10^{-3}}{4 \times 10^{-3}} = 10$

$\therefore 1 + 2a = 21$. $P_f = 1 - (1-P)^L = 1 - (1 - 10^{-5})^{8000} = 0.077$

$\therefore 1 - P_f = 0.923$

i) selective repeat :

(a) $K = 7$ $\therefore K < 1 + 2a$ $\therefore U = \frac{K(1-P_f)}{1+2a} = \frac{7(0.923)}{21} \simeq 0.3$

$\therefore U = 0.3$ (30 %)

(b) $K = 127$ $\therefore K > 1 + 2a$ $\therefore U = 1 - P_f \simeq 0.92$

$\therefore U = 0.92$ (92 %)

ii) Go back N :

(a) $K = 7$ $\therefore K < 1 + 2a$ $\therefore U = \frac{K(1-P_f)}{(1+2a)(1-P_f + KP_f)}$

$\therefore U = \frac{7(0.923)}{21(0.923 + 7(0.077))} = 0.21$

$\therefore U = 0.21$ (21 %)

(b) $K = 127$ $\therefore K > 1 + 2a$

$\therefore U = \frac{1-P_f}{1 + 2aP_f} = \frac{0.923}{1 + 2(10)(0.077)} = 0.36$ $\therefore U = 0.36$ (36 %)

- In CSMA medium access protocol, "P-Persistent protocol is used to compromise between non-persistent protocol". explain in detail this statement.

• Because P-persistent attempts to reduce collisions like non-persistent and reduce idle time (wasted capacity) like 1-persistent where: The station wishing to transmit Listen to the medium and

1. if the medium is idle, transmit with probability P and delay one time unit with probability 1-P
2. if the medium is busy, continue to listen untill the channel is sensed idle and repeat step 1
3. if transmission is delayed one time unit, repeat step 1

- Compare between "non-persistent CSMA", "1-Persisten CSMA" and "P-persistent CSMA" with respect to: Probability of collision - Link Utilization

	non-persistent	1-persistent	P-persistent
Probability of collision	not high and not low	High	Low
Link utilization	Low	not high and not low	High

- Although P-persistent protocol has better utilization. the IEEE 802.3 standard does not use it. explain the reason.

• Because if $nP > 1$ on average multiple stations will attempt to transmit and there will be a collision, when these stations realize that they will transmit again. is generating more collision and so on .... that causing continious collisions with throughput dropping to zero. In addition if we want to void these collisions we will reduce P and so that the station must wait longer to send transmission. this can result in very large delays

— " The CSMA Protocol has one glaring inefficiency when two frames collide" discuss in detail this statement and how can one overcome this inefficiency ?

- ⊙ Because the medium remains unstable for the duration of transmission of both damaged frames. For long frames transmission time, compared to propagation time, the amount of wasted capacity can be considerable.
  ⊙ To overcome this inefficiency we use CSMA/CD MAC Protocol.

— Draw and explain MAC frame formate of IEEE 802.3 LAN.

-

7	1	6	6	2	← 46 – 1500 bytes →		4
Preamble	SFD	DA	SA	Length	Data	Pad	FCS

1- Preamble → is of 7 bytes. it enables bit synchronization
2- SFD (start frame delimiter) → is of one byte. it marks the start of the frame
3- DA (destination address) → is of 6 bytes. it identifies the station which should recieve the frame
4- SA (source address) → is of 6 bytes. it identifies the sending station
5- Length → is of 2 bytes. it indicates the number of bytes in the data field
6- Data → can have 46 to 1500 bytes
7- Pad → if size of the data field is less than 46, the pad field makes up the difference to ensure minimum frame size. this is for proper CD operation
8- FCS (frame check sequence) → is of 4 bytes. it based on all fields except preamble

— In the ethernet LAN. if the transmitted frame is intended to group and local destination addresses. What are the values of I/G bit and U/L bit ?

- I/G = 1 "group address" & U/L = 1 "local address"

- In CSMA/CD what are three factors that having strong effect on the maximum segment length ?

1. Transmission rate
2. Transmission characteristics of the cable
3. Minimum frame size

- Compare between "10 base 2" LAN and "10 base 5" LAN with respect: Bit rate (Transmission rate) – segment Length – Transmission medium type – maximum number stations per segment – MAC protocol.

	10 base 2	10 base 5
Bit rate	10 MbPS	10 MbPS
segment length	Less than 200 m	Less than 500 m
Transmission medium type	thin coaxial	thick coaxial
Maximum number of stations per segment	30	100
MAC protocol	CSMA/CD	CSMA/CD

* قوانين حل المسائل :

$$T_{ix} = \frac{L}{R} = 2T_p \quad , \quad T_p = \frac{X}{V} = \frac{T_{ix}}{2}$$

where : T_{ix} → Transmission time , T_p → Propagation delay

L → minimum frame length , X → maximum segment length

R → Transmission rate , V → Propagation speed

- Calculate maximum end-to-end cable segment length for an ethernet LAN operating at 10 MbPs having minimum frame size of 64 bytes. assume propagation velocity of the medium is 2×10^5 Km/s

Sol

Transmission rate (R) = 10 MbPs $\therefore R = 10^7$ bPs

minimum frame length (L) = 64 bytes $\therefore L = 512$ bits

Propagation velocity (v) = 2×10^5 Km/s $\therefore v = 2 \times 10^8$ m/s

$$\therefore T_{ix} = \frac{L}{R} = \frac{512}{10^7} = 5.12 \times 10^{-5} \text{ s}$$

$$\because T_{ix} = 2T_p \qquad \therefore T_p = \frac{T_{ix}}{2} = \frac{5.12 \times 10^{-5}}{2} = 2.56 \times 10^{-5} \text{ s}$$

$$\because T_p = \frac{\text{maximum segment length } (x)}{v} \qquad \therefore x = T_p v = 2.56 \times 10^{-5} \times 2 \times 10^8$$

$\therefore$ maximum segment length = 5120 m = 5.12 Km

- If we have one segment LAN of 10 base 5 CSMA/CD. What is the minimum frame length for proper operation. assume that the propagation speed is 2×10^8 m/s

Sol

in 10 base 5 CSMA/CD $\longrightarrow$ R = 10 MbPs = 10^7 bPs & X = 200m

$$\because T_{ix} = 2T_p \qquad \therefore \frac{L}{R} = 2T_p \qquad \therefore L = 2 T_p R$$

$$\because T_p = \frac{X}{V} = \frac{200}{2 \times 10^8} = 10^{-6} \text{ s} \qquad \therefore N = 2 \times 10^{-6} \times 10^7 = 20$$

$\therefore$ minimum frame length = 20 bits

An ethernet LAN consists of three stations A & B and C. the distance AB = 3 Km. the Propagation speed is 2×10^8 m/s, the minimum frame size = 64 bytes, and the transmission rate is 10 MbPs.

i) calculate the maximum distance BC

ii) If the transmission rate is increased to 100 MbPs, What will be the maximum end-to-end cable segment length?
if X is a new distance AB, What is the range of X will be?

Sol:

i) $L = 64$ bytes $= 512$ bits & $R = 10$ MbPs $= 10^7$ bPs
$V = 2 \times 10^8$ m/S
suppose: maximum segment length → y

$$T_{ix} = \frac{L}{R} = \frac{512}{10^7} = 5.12 \times 10^{-5} \text{ s} \quad \& \quad T_p = \frac{T_{ix}}{2} = \frac{5.12 \times 10^{-5}}{2} = 2.56 \times 10^{-5} \text{ s}$$

$$\because T_p = \frac{y}{V} \quad \therefore y = T_p V = 2.56 \times 10^{-5} \times 2 \times 10^8 = 5120 \text{ m} = 5.12 \text{ Km}$$

$$\because y = AB + BC \quad \therefore BC = y - AB = 5.12 - 3 = 2.12 \text{ Km}$$

$\therefore$ maximum distance $BC = 2.12$ Km

ii) after increased R: $R = 10^8$ & $L = 512$ & $V = 2 \times 10^8$

$$T_{ix} = \frac{L}{R} = \frac{512}{10^8} = 5.12 \times 10^{-6} \text{ s} \quad \& \quad T_p = \frac{T_{ix}}{2} = \frac{5.12 \times 10^{-6}}{2} = 2.56 \times 10^{-6} \text{ s}$$

$$\because T_p = \frac{y}{V} \quad \therefore y = T_p V = 2.56 \times 10^{-6} \times 2 \times 10^8 = 512 \text{ m} = 0.512 \text{ Km}$$

AB → y
3 Km → 5.12 Km
X → 0.512 Km

$$\therefore X = \frac{3 \times 0.512}{5.12} = 0.3 \text{ Km} = 300 \text{ m}$$

$\therefore$ maximum distance of $AB = 300$ m

- An ethernet LAN consists of three stations A, B and C. the distance AB = 3 Km, the propagation speed is 2×10^8 m/s, the end-to-end propagation delay = 0.0256 ms, the transmission rate is 10 Mbps
  (i) calculate the maximum distance BC.
  (ii) calculate the minimum frame size.

SoL

$T_p = 0.0256 \text{ ms} = 0.0256 \times 10^{-3}$ s و $V = 2 \times 10^8$ m/s و $R = 10^7$ bps

(i) $\because T_p = \frac{X}{V}$ $\therefore X = T_p V = 0.0256 \times 10^{-3} \times 2 \times 10^8 = 5120 \text{ m} = 5.12 \text{ Km}$

$\because X = AB + BC$ $\therefore BC = X - AB = 5.12 - 3 = 2.12$ Km

$\therefore$ maximum distance BC = 2.12 Km

(ii) $T_{ix} = 2T_p = 2 \times 0.0256 \times 10^{-3} = 5.12 \times 10^{-5}$ s

$\because T_{ix} = \frac{L}{R}$ $\therefore L = T_{ix} R = 5.12 \times 10^{-5} \times 10^7 = 512 \text{ bits} = 64 \text{ bytes}$

$\therefore$ minimum frame size = 64 bytes

(notes)

In MAC frame Format "In destination address (DA) and source address (SA)":
- I/G → is the first bit frame left و U/L → is the second bit frame left
- I/G → is used only in DA و U/L → is used on DA and SA
- I/G = 0 "at individual address" و I/G = 1 "at group address" و
  U/L = 0 "at global address" و U/L = 1 "at local address"

(notes)

1 non-persistent CSMA :-

- Rules :

station wishing to transmit listen to the medium and

1. if the medium is idle, transmit ; otherwise, go to step 2
2. if the medium is busy, wait an amount of time drawn from a probability destribution (retransmission delay) and repeat step 1

- properties :

1. Probability of collision compartively low
2. wasted capacity is very high (link utilization is very low.)

2 1-persistent CSMA :-

- Rules :

station wishing to transmit listen to the medium [illegible]

1. if the medium is idle, transmit ; otherwise, go to step 2
2. if the medium is busy, continue to listen until the channel is sensed idle then transmit immediately

- properties :

1. Probability of collision is very high
2. wasted capacity compartively low (link utilization com[illegible]

3 P-persistent CSMA :-

- Rules :

station wishing to transmit listen to the medium and

1. if the medium is idle, transmit with probability P and delay one time unit with probability 1-P (the time unit = max propagation delay)
2. if the medium is busy, continue to listen until the channel is sensed idle and repeat step 1
3. if transmission is delayed one time unit, repeat step 1

⊙ Properties :

1. In normal, Probability of collision is low
2. In normal, Wasted capacity is low (Link utilization is high)
3. If $np > 1$ on average multiple station will attempt to transmit and there will be a collision, then these stations realize that their transmission suffered a collision, they will back again almost generateeing more collision and so on...... that causing continious collisions with throughput dropping at zero.

If we want to void these collisions we will reduce P and so that the station must wait longer to send transmission. this can result in very long delays

4] CSMA/CD :-

⊙ Rules :

1. if the medium is idle, transmit ; otherwise, go to step 2
2. if the medium is busy, continue to listen until the channel is sensed idle than transmit immediately
3. if a collision is detected during transmission, the station stops for transmission of the frame and transmit a brief jamming signal to ensure that all stations know that there has been a collision
4. after transmitting the jamming signal, wait a random amount of time (back of time) then repeat step 1

⊙ Properties :

1. Probability of collision is very low
2. Wasted capacity is very low (Link utilization is very high)

⊙ note :

In order to high benefit of CSMA/CD ⟶ frame should be long enough

(frame transmission time must be $\geq 2T_p$)