MAKERERE UNIVERSITY

COLLEGE OF ENGINEERING, DESIGN, ART AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

BACHELOR OF SCIENCE IN COMPUTER ENGINEERING

COURSE UNIT: CMP 2205: COMPUTER NETWORKS AND SIGNALS
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NAME: KIMEZE SAMUEL

REG. NUMBER: 17/U/5169/PS

STUDENTS NUMBER: 217004128

LECTURER: Mr. Amitu David

QUESTION 1

a)

From the given data, there are t- layers and each has H-headers and message generated is M byte long

The total number of header bytes = tH since each layer adds a header that contains ccontrol information, such as addresses.

Therefore, the total message size = m+ tH

Fraction of the network bandwidth is filled with message

$$= \frac{message\ size}{message\ size + header\ size}$$

$$= \frac{M}{M + tH}$$

- Assuming that the physical layer generates a no header then;

The header size is (t-1)H thus the fraction filled with the message will be

$$= \frac{M}{M + (t-1)H}$$

b)

Fraction of the network bandwidth is filled with headers

$$= \frac{header\ size}{message\ size + header\ size}$$

$$= \frac{tH}{M + tH}$$

- Assuming that the physical layer generates a no header then;

The header size is (t-1)H thus the fraction filled with the header will be

$$= \frac{(t-1)H}{M + (t-1)H}$$

QUESTION TWO

Given;

Bandwidth = $3MHz = 3{,}000{,}000Hz$

Capacity= $20Mbps = 20{,}000{,}000bps$

Using Shannon's Theorem;

$C = Bw\, log_2(1 + SNR)$

Where:

C =Capacity

Bw = Bandwidth

SNR = Signal to Noise Ratio

$$\frac{C}{Bw} = log_2(1 + SNR)$$

But $log_B A = D \; is\; equivalent\; to\; B^D = A$

Therefore

$$2^{\left(\frac{C}{Bw}\right)} = (1 + SNR)$$

$$2^{\left(\frac{20{,}000{,}000}{3{,}000{,}000}\right)} = (1 + SNR)$$

$$\therefore SNR = 2^{\left(\frac{20{,}000{,}000}{3{,}000{,}000}\right)} - 1$$

$$= 100.593637$$

$$\approx 100.6$$

$$SNR_{dB} = 10\, log_{10} SNR$$

$$= 10 log_{10} 101.5$$

$$= 20.0432dB$$

$$= 20dB$$

QUESTION THREE

a)

Reasons for using layered protocol designs,

- Protocols in a given layer can be changed without affecting the higher or lower layers.
- Reduces complexity i.e. breaks up the design problem into smaller and manageable units.

Disadvantages

- There is a lower performance due to extra overhead i.e. data packets have to go through a number of layers and each layer adds a header.
- Poorly conceived layers can lead to awkward and complex interfaces.

b) Components of network latency

- Processing overhead :

  This involves transfer of data from one layer to another and it can dominate for high data rate links over short distances with short messages.
- Transmission time :

  This is the amount of time from the beginning until the end of a message transmission and it depends on the band width and the length of the message.
- Propagation delay :

  This is the time it takes a bit to propagate from one end of a link to the to another.
- Queuing delay :

  This is the sum of the delays encountered by a packet between the time of insertion into the network and the time of delivery to the address.

➢ Network latency is not constant because it is caused by various reasons which include: - bandwidth, distance.

Latency increases with increase in distance and increases with decrease in bandwidth.

QUESTION FOUR

Network	Best case	Average case	Worst case
A	2	2	2
B	1	$\frac{p}{2}$	$\frac{p}{2}$
C	1	1	1

Explanation:

Network A; - Star topology with a central switch.

It would always take two hops to travel from one node to the other through the central switch i.e. one hop is from the sender to the central switch and the other hop is from the central switch to the receiver to the destination.

Network B; - Bi-directional ring network.

Transmission path from one node to other node is 1 if nodes are adjacent and $\frac{p}{2}$ if nodes are far away. Where p is the number of node in the network.

Hence best case is 1 and worst case is $\frac{p}{2}$.

Network C; - Fully interconnected.

The best case, average case and worst case are all 1 because the nodes are directly linked to each other and so only a single hop is involved during transmission of the signal.

QUESTION FIVE

a)

For the 4bit word

Given: Maximum bit rate/capacity $= 9.6\text{Mbps} = 9600000\text{bps}$

Signal Level(L) $= 2^4$

Using Nyquist Theorem

C= 2 Bw$\log_2 L$

Where:

C - Capacity of the system

Bw- Bandwidth

L-Signaling data

$$\text{Maximum bit rate} = 2\ \text{Bw}\ \log_2 \text{L}$$

$$9600000 = 2\ \text{Bw} \log_2 2^4$$

$$9600000 = 8\ \text{Bw}$$

$$\text{Bw} = \frac{9600000}{8} = 1.2\text{MHz}$$

b)

For the 8bit word

$$\text{Signal Level (L)} = 2^8$$

$$\text{Maximum bit rate/capacity} = 2\ \text{Bw}\ \log_2 \text{L}$$

$$9600000 = 2\ \text{Bw} \log_2 2^8$$

$$9600000 = 16\text{Bw}$$

$$\text{Bw} = \frac{9600000}{16} = 600000\text{Hz}$$

$=0.6$MHz

References:

1.Computer networks 5th edition by Andrew S. Tanembuam

2.Lecture Notes.