ECE/CSC 570: Computer Networks [HW 2]

Ans 1-

a) True → Packet Switching is better than circuit switching because the former can support more users.

b) True → DoS attack can be generated by a large number of legitimate TCP Connection requests to the same targeted server at the same time.

c) True → Ground station called a hub is used for communication between micro-stations which do not have sufficient power to communicate directly with one another.

d) False → Communication across the Atlantic Ocean between the USA and Europe is mostly done by physical cables laid under the ocean. Even with the coming up of new wireless and satellite technologies, cable remains the fastest, most efficient and least expensive way to send information across the ocean.

e) True → Bandwidth order

Fiber >> Coaxial Cable > Twisted Pair

Ans 2-

a) CDMA (Code Division Multiplexing) is a channel access method where several transmitters can send information simultaneously over a single communication channel. This allows several user to share a frequency band. Multiple simultaneous transmissions are seperated using coding theory. Each user in a CDMA system uses a different code to modulate their signal. At the receiving end, if the signal matches the desired users code, then the correlation function is high and the system can extract that signal. If the desired user's code has nothing in common with the signal, the correlation should be as close to zero as possible, and the signal is treated as a noise.

Reference: Wikipedia.

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Advantages of CDMA:

i) It ensures efficient practical utilization of fixed frequency spectrum.
ii) Due to codeword allocated to each user, interference is reduced.
iii) It allows more number of users to share the same bandwidth.

Disadvantages of CDMA:

i) The system is more complicated.
ii) As the number of users increases, the overall quality of service decreases.
iii) Higher cost is incurred due to greater equipment.

b) According to Shannon's formula, we have

Maximum number of bits/sec $= B \log_2(1+SNR)$

Given: ADSL has a bandwidth of approximately 1 MHz.
Assuming SNR of 40 dB for short lines of 1 to 2 km for communication via ADSL (Asymmetric Digital Subscriber Line) which provides Internet access over normal telephone lines, we have:

~~Maximum~~

$$SNR(dB) = 10 \log_{10} SNR$$
$$40 = 10 \log_{10} SNR$$
$$SNR = 10^4$$

Therefore,

Maximum number of bits/sec $= B \log_2(1+SNR)$
$= 10^6 \times \log(1+10^4)$
$= 13.287 \times 10^6$ bits/sec
≈ 13 Mbps

Therefore, in practice ADSL can give good data rates of upto 12 to 13 Mbps.

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Ans3- Given : Channel bandwidth = 3100 Hz
Maximum data rate = 35 kb/s

Calculation :

$$\text{Maximum data rate} = B \log_2(1+SNR)$$
$$35 \times 10^3 \text{ b/s} = 3100 \text{ Hz} \times \log_2(1+SNR)$$
$$\Rightarrow SNR = 2503.527$$

Now, new required data rate,
$$= \text{original data rate} + \left(\frac{60}{100} \times \text{original data rate}\right)$$
$$= 35 + \frac{\cancel{60}^{3}}{\cancel{100}_{5}} \times \cancel{35}^{7}$$
$$= (35 + 21) \text{ kbps}$$
$$= 56 \text{ kbps}$$

Hence,
$$\text{Maximum data rate} = B \log_2(1+SNR)$$
$$56 \times 10^3 = 3100 \log_2(1+SNR)$$
$$\Rightarrow SNR = 274131.9325$$

Hence, $$\frac{SNR_{new}}{SNR_{original}} = \frac{274131.9325}{2503.527} = 109.498 \approx 109 \text{ times}$$

$$\Rightarrow SNR_{new} = 109 \times SNR_{original}$$

Further, increase in SNR by 10 times
$$\Rightarrow SNR = 2741319.325$$
$$\therefore \text{Maximum data rate} = B \log_2(1+SNR)$$
$$= 3100 \log_2(1+2741319.325)$$

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Achievable Maximum data rate = 66297.96 bps

Maximum data rate required = Max. data rate + 20% of max. data rate

$$= 56\times10^3 + \left(\frac{20}{100}\times 56\times10^3\right)$$

$$= 67200 \text{ bps}$$

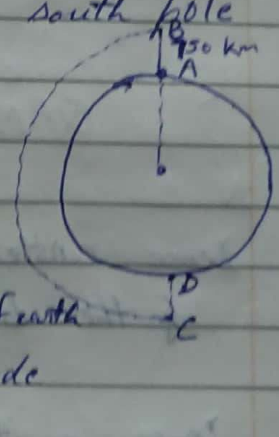
Since, achievable maximum data rate is less than the maximum data rate required, it is not possible to further increase the maximum data rate by 20%.

Ans 4- Latency of the call = Time taken to travel from North to South Pole + Total Switching Time

To reach from North to South Pole, we have 6 iridium satellites and each satellite has a switching time of 10 microseconds.

Therefore, total switching time = $6\times10 = 60\ \mu s = 0.06$ ms

Total distance travelled from north to the south pole
= Distance from A to B + Distance from B to C + Distance from C to D.



Now, AB = CD = 750 km = d (assume)

$$BC = \frac{2\pi(r_e + A)}{2}$$ where r_e = radius of earth and A = Altitude

$$= \pi(r_e + A)$$

Hence, Total distance $= 2d + \pi(r_e + A)$

$$= (2\times750) + \pi(6371 + 750)$$

$$= 23860 \text{ km}$$

Time ~~taken~~ to travel $= \dfrac{\text{Total distance}}{\text{Speed of light}}$

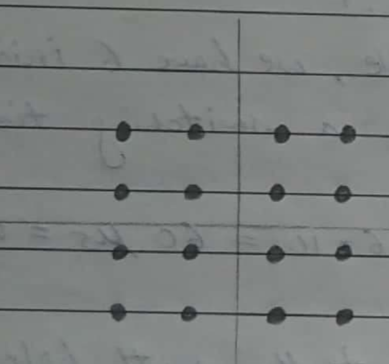
$= \dfrac{23860 \times 10^3}{3 \times 10^8} = 0.0795$ sec.

$= 79.5$ ms

Hence, the total time = Switching time + travel time
$= (0.06 + 79.5)$ ms
$= 79.56$ ms

Therefore, total latency $= 79.56$ ms.

Ans 5-



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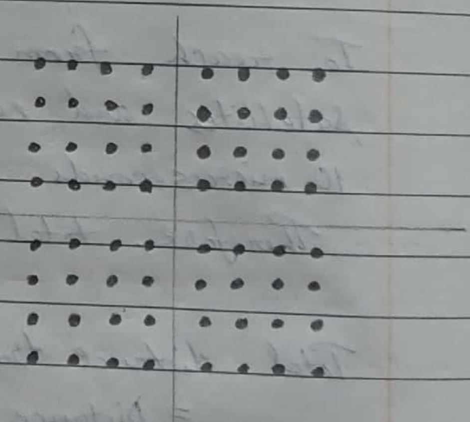

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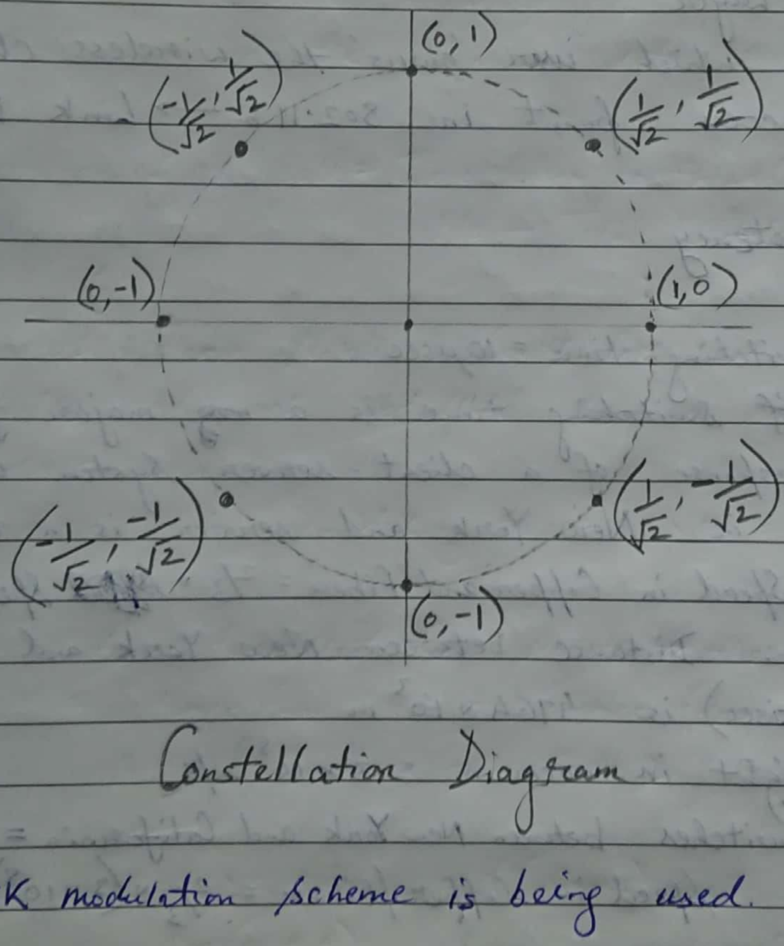
Dense constellation diagrams have drawbacks. Below are some of the drawbacks:

i) Dense constellations are prone to more noise. It is easier for a symbol to be wrongly represented as a different symbol if there is a slight change in amplitude and/or phase in a dense constellation as opposed to a light constellation. In space, symbols are ~~further~~ more far apart from each other in a light constellation than in a dense constellation. Hence, higher amount of noise is required to cause significant distortion so as to misinterpret a symbol as another symbol in light constellations.

ii) Dense constellations require a complex receiver and more power to receive the signal at the receiver end.

Ans6-



Constellation Diagram

8-PSK modulation scheme is being used.

Baud rate = Number of symbols carried per second
Since, above constellation uses 3 bits/symbol $\{\log_2 8 = 3\}$
Therefore; Bit rate $= 2000 \times 3$ bps
$= 6000$ bps

Ans 7- $A(+1\ -1\ +1\ -1\ +1\ -1)$ and $B(+1\ +1\ +1\ -1\ -1\ +1)$

a) For the two CDMA codes to be orthogonal, we need to show $A \cdot B = 0$

$$A \cdot B = (1\ -1\ 1\ -1\ 1\ -1)\cdot(1\ 1\ 1\ -1\ -1\ 1)$$
$$= 1+(-1)+1+1+(-1)+(-1)$$
$$= 0$$

Hence, the two CDMA codes are orthogonal.

b) If A sends a bit of 0 and B sends a bit of 1, we have,

$$\bar{A}+B = (-1\ +1\ -1\ +1\ -1\ +1) + (+1\ +1\ +1\ -1\ -1\ +1)$$
$$= (0\ 2\ 0\ 0\ -2\ 2)$$

Hence, $(0\ 2\ 0\ 0\ -2\ 2)$ is transmitted.

c) If A transmits a 0 and B transmits a 0,

we have, $\bar{A}+\bar{B} = (-1\ 1\ -1\ 1\ -1\ 1)+(-1\ -1\ -1\ 1\ 1\ -1)$
$$=(-2\ 0\ -2\ 2\ 0\ 0)/8 = -2/8 = -1/4 \approx 0$$

Since, the received signal is $(-1\ -1\ -1\ 1\ 1\ 1) = 0/8 = 0$, ~~transmit~~ both A and B must have transmitted a 0.
i.e. $\bar{A}(-1\ 1\ -1\ 1\ -1\ 1)$ and $\bar{B}(-1\ -1\ -1\ 1\ 1\ -1)$