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# Computer Networks - HW4

Ans1- Given : Transmission time of packets = 5ms
Propagation delay (one way) = 200 ms
No packet losses

Solution :-

$$\eta_{SW} = I/S$$ (Given no packet losses)

where I = packet transmission time
S = total time from start of transmission to return of acknowlegement.

$$\therefore \eta_{SW} = \frac{5\times10^{-3} \text{ sec}}{(5\times10^{-3} + 2\times200\times10^{-3}) \text{ sec}}$$

$$= \frac{5}{5+400}$$

$$= \frac{\cancel{5}^{1}}{\cancel{405}_{81}} = \frac{1}{81} = 0.0123 = 1.23\%$$

Therefore, efficiency of Stop and Wait (SAW) = 1.23%

$$\eta_{GBN} = \min\left\{1, \frac{WI}{S}\right\}$$

where I = packet transmission time
S = total time from start of transmission to return of acknowlegement.
W = window size

$$\therefore \eta_{GBN} = \min\left\{1, \frac{5\times5\times10^{-3} \text{ sec}}{(5\times10^{-3}+2\times200\times10^{-3}) \text{ sec}}\right\}$$

$$= \min\left\{1, \frac{\cancel{25}^{5}}{\cancel{405}_{81}}\right\} = 5/81 = 0.0617 = 6.17\%$$

Therefore, effeciency of Go-Back-N protocol with window size of 5 packets is 6.17%.

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Ans 2 a) Given : N stations share 56 kbps pure ALOHA channel. Each station outputs a 1000 bit frame on average every 100 sec.

To find : Maximum value of N.

Solution :- Maximum efficiency of Pure ALOHA = 18.4%

Hence, achievable rate $= 56 \times 10^3 \times 0.184$ bps
$= 56 \times 184$ bps

Now, in 100 sec, N stations transmit 1000 bit frames
Hence, $(1000N/100)$ bits are transferred per second.

$\therefore \quad 56 \times 184 = 1000N/100$

$\Rightarrow N = \frac{56 \times 184}{10} = 56 \times 18.4 = 1030.4$

$\Rightarrow N = 1030$

b) Given : Slotted ALOHA where users generate 50 requests/sec. Time is slotted in units of 40 ms.

Solution :

i) Probability of success in k attempts $= e^{-G}(1-e^{-G})^{k-1}$
For success in $1^{st}$ attempt, $k=1$
$\therefore P_1 = e^{-G}$
Now, G = number of requests in 40 ms. $= \frac{50}{1000} \times 40 = 2$
i.e. 2 requests per unit time

Hence, $P_1 = e^{-2} = 0.135$

Therefore, chance of success in $1^{st}$ attempt $= 0.135$

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ii) Probability of k collisions and then a success

$$P_{k+1} = e^{-G}(1-e^{-G})^k$$
$$= e^{-2}(1-e^{-2})^k$$
$$= 0.135 \times 0.865^k$$

iii) Expected number of transmission attempts needed when there are a large number of requests is given by

$$E = e^G = e^2 = 7.389$$

Ans3-

a) i) Signal propagation speed in twin length cable

$$= 0.82c \quad \{\text{where } c = \text{speed of light in vacuum}\}$$
$$= 0.82 \times 3 \times 10^8 \text{ m/s}$$
$$= 2.46 \times 10^8 \text{ m/s}$$

$$\text{Signal propagation time} = \frac{\text{Distance}}{\text{Signal Propagation Speed}}$$

$$= \frac{2 \times 1000 \text{ m}}{2.46 \times 10^8 \text{ m/s}}$$

$$= \frac{2000}{246 \times 10^6} \text{ sec} = \frac{1}{123} \text{ ms} = 0.00813 \text{ ms}$$
$$= 8.13 \mu s$$

Length of contention slot = 2 × signal propagation time

$$= 2 \times 8.13 \mu s$$
$$= 16.26 \mu s$$

ii) Signal propagation speed in fibre optic cable = $0.65c$

$$= 0.65 \times 3 \times 10^8 \text{ m/s}$$
$$= 1.95 \times 10^8 \text{ m/s}$$

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$$\text{Signal propagation time} = \frac{\text{Distance}}{\text{Signal Propagation Speed}}$$

$$= \frac{40 \times 10^3 \ m}{1.95 \times 10^8 \ m/s}$$

$$= \frac{4 \times 10^{-4}}{1.95} sec = \frac{40}{195} ms = 205.13 \mu s$$

$$\cancel{= \frac{40}{1.95} ms =}$$

$$\text{Length of contention slot} = 2 \times \text{signal propagation time}$$

$$= 2 \times 205.13 \mu s$$

$$= 410.26 \mu s$$

b) Given: Two stations contend for the channel using binary exponential backoff algorithm.

To find: ⇒ Probability that contention ends on round k.

⇒ Mean number of rounds per contention period.

Solution:

The probability of collision in the $i^{th}$ round for 2 stations contending for the channel using exponential backoff algorithm is given by $1/2^{i-1}$

Therefore, probability that the contention ends in round k

= probability that first (k-1) attempts fail, followed by success in the $k^{th}$ round.

$$P_k = \underbrace{\left( \prod_{i=1}^{k-1} \frac{1}{2^{i-1}} \right)}_{\substack{\text{Probability of} \\ \text{failure in (k-1)} \\ \text{rounds}}} \times \underbrace{\left( 1 - \frac{1}{2^{k-1}} \right)}_{\substack{\text{Probability of} \\ \text{success in } k^{th} \\ \text{round.}}}$$

Kreator

$$P_k = \left(1 \times 2^{-1} \times 2^{-2} \times \cdots \times 2^{-(k-2)}\right)\left(1 - 2^{-(k-1)}\right)$$

$$P_k = \left[2^{(-1)+(-2)+\cdots+(-(k-2))}\right]\left(1 - 2^{-(k-1)}\right)$$

$$P_k = \left[2^{-(k-2)(k-1)/2}\right]\left(1 - 2^{-(k-1)}\right)$$

Therefore, probability that the contention ends in round k is

$$P_k = \left[2^{-(k-2)(k-1)/2}\right]\left(1 - 2^{-(k-1)}\right) = \left[2^{(k-1)} - 1\right] \times 2^{-\left[\frac{(k-2)(k-1)}{2} + (k-1)\right]}$$

$$\therefore \; P_k = \left(2^{(k-1)} - 1\right) / 2^{k(k-1)/2}$$

Mean number of rounds per contention period $= \sum_{k=1}^{\infty} k p_k$

Where $k$ = round number

$p_k$ = probability that contention ends in $k^{th}$ round.

Therefore, maximum number of rounds/contention slot $= \sum_{k=1}^{\infty} k \left[2^{(k-1)} - 1\right] / 2^{\frac{k(k-1)}{2}}$

Ans 4- Difference between LAN Switches and Routers.

| LAN switches | Router |
|---|---|
| i) It is a layer 2 device | i) It is a layer 3 device |
| ii) Works on MAC addresses | ii) Works on IP addresses |
| iii) Used for connecting various hosts inside a LAN network. | iii) Used for connecting various LAN networks together. |
| iv) Layer 2 switching is hardware based and switches use ASIC's to maintain MAC address tables. | iv) Layer 3 routing is both software and hardware based and uses protocols for routing packets. |
| v) Switches operating on Layer 2 are faster since they are hardware based | v) Routers operating on Layer 3 are slower since they are software based |

Ans 5-

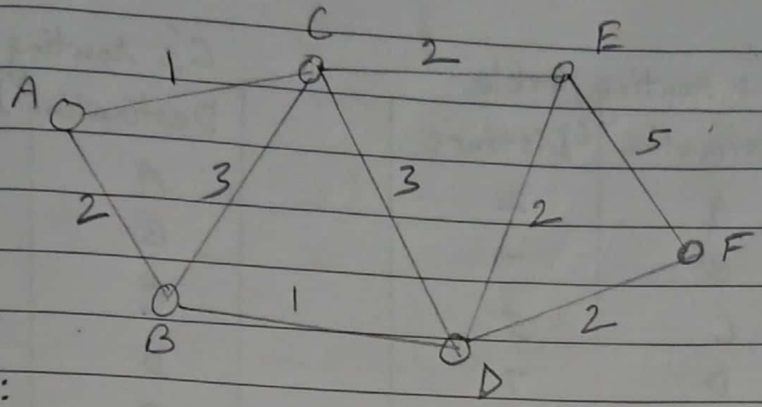


Table 1:

| Step | Black nodes | D(A), nh(A) | D(B), nh(B) | D(C), nh(C) | D(D), nh(D) | D(E), nh(E) |
|---|---|---|---|---|---|---|
| 0 | {F} | ∞, – | ∞, – | ∞, – | 2, F | 5, F |
| 1 | {F, D} | ∞, – | 3, D | 5, D | 2, F | 4, D |
| 2 | {F, D, B} | 5, B | 3, D | 5, D | 2, F | 4, D |
| 3 | {F, D, B, E} | 5, B | 3, D | 5, D | 2, F | 4, D |
| 4 | {F, D, B, E, C} | 5, B | 3, D | 5, D | 2, F | 4, D |
| 5 | {F, D, B, E, C, A} | 5, B | 3, D | 5, D | 2, F | 4, D |

Table 2 (Routing Table):

| Destination | Next Hop | Cost |
|---|---|---|
| A | D | 5 |
| B | D | 3 |
| C | D | 5 |
| D | D | 2 |
| E | D | 4 |

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Ans6-

B's routing table

| Destination | Distance |
|---|---|
| A | 2 |
| B | - |
| C | 5 |
| D | 7 |
| F | 1 |
| G | 4 |

C's routing table

| Destination | Distance |
|---|---|
| A | 4 |
| B | 5 |
| C | - |
| D | 2 |
| F | 2 |
| G | 3 |

A's Routing Table:

| Destination | Distance | Next Hop |
|---|---|---|
| B | 2 | B |
| C | 4 | C |
| D | 6 | C |
| F | 3 | B |
| G | 6 | B |