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Homework # 6

ECE 545

Due Date: 4/23/2023

Problems to be submitted.
Review Questions: R#
Problem Questions: P#

R#4 L/R is the time taken by a node to transmit a packet of length L bits completely over a link with transmission rate R bits/sec. Propogation delay D_{prop} is the time taken by a bit to travel from source to destination. There will be collision if two nodes transmit at the same time and $D_{prop} < L/R$.

- If $D_{prop} < L/R$ then time taken by a bit to travel from source to destination is less than the time taken by a node to completely transmit a packet.
- If $D_{prop} < L/R$ then and two nodes transmit at the same time, then before a node completely transmits the packet, it will receive the bits of packet from another node. Therefore, there will be a collision.

R#5

Slotted ALOHA	Token Ring Passing
• A node to transfer continously at time full rate.	• A node to transfer at the rate of R bps.
• Throughput is R/M bps.	• Throughput is R/M bps.
• Partially decentralized.	• Decentralized
• Efficiently and easy.	• Less expensive

R#12 No, it is not possible. Each LAN has its own distinct set of adapters attached to it, with each adapter having a unique LAN address.

R#15 Almost 255 VLAN's can be configured on a switch supporting 802.1Q protocol based on IEEE standard.

R#16 Using the given data:
N switches supporting 'k' VLAN groups that are connected via a trunking protocol. It contains single input port and single output port.

- The first switch uses only output port. So, the no. of ports essential by the first switch is 1.
- The last switch uses only input port. So, the no. of ports used by last switch is 1.
- The remaining N-2 switches other than the last switches use 2 ports each. So, the no. of ports all these switches uses is $2\times(N-2)$ ports.

So, total $(2\times N)-2$ ports are needed to connect the switches.

P#5 Message (D) = 1010101010
Generator (G) = 10011
Append (n-1) 0 bits to the message; where n is no. of bits in G.
To get the remainder (R)

```
               1011011000
        ___________________
  10011 ) 10101010 10 100000
          10011
          -----
            11001
            10011
            -----
             10100
             10011
             -----
               11110
               10011
               -----
                11010
                10011
                -----
                 10010
                 10011
                 -----
R -->              100
```

Transmitted message = D (append) R = 10101010100100

Repeating the problem when $D = 1001000101$
$G = 10011$

Using same steps as up.

```
            1000100011
       ________________
10011 ) 10010001010000
        10011
        -----
            10010
            10011
            -----
                11000
                10011
                -----
                 10110
                 10011
                 -----
R  -->             101
```

Transmitted message $= D + R = 10010001010101$

P#8 a) Efficiency of slotted ALOHA is: $E(p) = Np(1-p)^{N-1}$

By derivation, we have: $E'(p) = N(1-p)^{N-1} - Np(N-1)(1-p)^{N-2}$

Let $E'(p) = 0$

Then, $p^* = 1/N$. We have the maximum efficiency.

b) When p equals to $1/N$, the efficiency of slotted ALOHA is:

$$E(p^*) = N \times \frac{1}{N}\left(1-\frac{1}{N}\right)^{N-1} = \left(1-\frac{1}{N}\right)^{N-1} = (1-1N)^{N}/1-\frac{1}{N}$$

Since, $\lim\limits_{N\to\infty}\left(1-\frac{1}{N}\right) = 1$

$$\lim_{N\to\infty}\left(1-\frac{1}{N}\right)^{N} = \frac{1}{e}$$

Thus, when n approaching infinity, the efficiency is:

$$\lim_{N\to\infty} E(p^*) = \frac{1}{e}$$

P#13 The length of polling round: $N\left(\frac{Q}{R}+d_{poll}\right)$

The maximum throughput of the broadcast channel: $\frac{NQ}{N\left(\frac{Q}{R}+d_{poll}\right)}$

$$= \frac{1}{\frac{1}{R}+\frac{d_{poll}}{Q}}$$

$$= \frac{R}{1+\frac{R \times d_{poll}}{Q}}$$

$$= \frac{RQ}{Q+R \times d_{poll}} \quad //$$

P#20 a) Assume β is probability of successive slots and $\beta = Np(1-p)^{N-1}$

Let m be an integer and X be a random variable that denotes the no. of successive slots are m.

$$P[X=m] = \beta(1-\beta)^{m-1}$$

Thus, $x = E[X]-1 = \frac{1-\beta}{\beta}$

∴ Substituting all values

$$x = \frac{1-Np(1-p)^{N-1}}{Np(1-p)^{N-1}}$$

Efficiency $(E) = \frac{k}{k+x} = \frac{k}{k+\frac{1-Np(1-p)^{N-1}}{Np(1-p)^{N-1}}} \quad //$

b) To maximize the effeciency, probability of successive slots is to be improved. At $p=\frac{1}{N}$, the efficieny is increased.

c) Consider $p=\frac{1}{N}$

$$\text{Efficiency }(E) = \frac{k}{k+x}$$

$$\therefore x = \frac{1-p}{p}$$

$$= \frac{1-\left(1-\frac{1}{N}\right)^{N-1}}{\left(1-\frac{1}{N}\right)^{N-1}}$$

$$\frac{k}{k+x} = \frac{k}{k+\left(\frac{1-\left(1-\frac{1}{N}\right)^{N-1}}{\left(1-\frac{1}{N}\right)^{N-1}}\right)}$$

$$\lim_{N\to\infty}\left(1-\frac{1}{N}\right)^{N-1} = \frac{1}{e}$$

$$\therefore \lim_{N\to\infty}\frac{k}{k+x} = \frac{k}{k+\frac{1-\frac{1}{e}}{\frac{1}{e}}}$$

$$\therefore \text{Efficiency} = \frac{k}{k+e-1} \quad //$$

d) Length of the $\lim_{k\to\infty}\frac{k}{k+e-1} = \frac{1}{1+\frac{e}{k}-\frac{1}{k}}$

As $\lim_{k\to\infty}\left(\frac{1}{k}\right) = 0$

$$\therefore \lim_{k\to\infty}\left(\frac{k}{k+e-1}\right) = \frac{1}{1+0-0} = 1$$

$\therefore$ As $k\to\infty$, efficiency becomes $\therefore$

P#32 a) Link capacity = 10Gbps = 10000 Mbps

Flow pairs count = 80

Maximum rate of a flow = $\frac{\text{Link capacity}}{\text{Flow pairs count}} = \frac{10000}{80} = 125\text{Mbps}$ //

b) Each host contains no. of paths from a tier-1 to tier-2 is 4. Path count = 4.

Maximum rate of a flow = Path count × Link capacity.
$= 4 \times 10000 = 40000$ Mbps. //

c) Take 20 hosts on each hosts and 160 pairs of flows.

- First topology: Data center network using Hierarchical topology:

  Maximum rate of flow $= \frac{10000}{160} = 62.5$ Mbps //

- Second topology: Highly interconnected network:

  Here, flow pair count = 20.

Maximum rate of flow $= 20 \times 10000 = 200000$ Mbps //