CSC 623: DCN **HW1 Solution**

Problem 1

a. **Circuit Switching**

T = $C_1 + C_2$ where

C_1 = Call Setup Time

C_2 = Message Delivery Time

C_1 = S = 0.2

C_2 = Propagation Delay + Transmission Time

= $N \times D + L/B$

= $4 \times 0.001 + 3200/9600 = 0.337$

T = 0.2 + 0.337 = 0.537 sec

Datagram Packet Switching

T = $D_1 + D_2 + D_3 + D_4$ where

D_1 = Time to Transmit and Deliver all packets through first hop

D_2 = Time to Deliver last packet across second hop

D_3 = Time to Deliver last packet across third hop

D_4 = Time to Deliver last packet across fourth hop

There are P – H = 1024 – 16 = 1008 data bits per packet. A message of 3200 bits requires four packets (3200 bits/1008 bits/packet = 3.17 packets which we round up to 4 packets).

D_1 = $4 \times t + p$ where

t = transmission time for one packet

p = propagation delay for one hop

D_1 = $4 \times (P/B) + D$

$$= 4 \times (1024/9600) + 0.001$$

$$= 0.428$$

$$D_2 = D_3 = D_4 = t + p$$

$$= (P/B) + D$$

$$= (1024/9600) + 0.001 = 0.108$$

$$T = 0.428 + 0.108 + 0.108 + 0.108$$

$$= 0.752 \text{ sec}$$

Virtual Circuit Packet Switching

$T = V_1 + V_2$ where

V_1 = Call Setup Time

V_2 = Datagram Packet Switching Time

$T = S + 0.752 = 0.2 + 0.752 = 0.952$ sec

b. Circuit Switching vs. Diagram Packet Switching

T_c = End-to-End Delay, Circuit Switching

$T_c = S + N \times D + L/B$

T_d = End-to-End Delay, Datagram Packet Switching

N_p = Number of packets = $\left\lceil \frac{L}{P-H} \right\rceil$

$T_d = D_1 + (N - 1)D_2$

D_1 = Time to Transmit and Deliver all packets through first hop

D_2 = Time to Deliver last packet through a hop

$D_1 = N_p(P/B) + D$

$D_2 = P/B + D$

$T = (N_p + N - 1)(P/B) + N \times D$

$T = T_d$

$S + L/B = (N_p + N - 1)(P/B)$

Circuit Switching vs. Virtual Circuit Packet Switching

T_V = End-to-End Delay, Virtual Circuit Packet Switching

$T_V = S + T_d$

$T_C = T_V$

$L/B = (N_p + N - 1)(P/B)$

Datagram vs. Virtual Circuit Packet Switching

$T_d = T_V - S$

Problem 2. From Problem 1, we have

$$T_d = (N_p + N - 1)(P/B) + N \times D$$

For maximum efficiency, we assume that $N_p = L/(P - H)$ is an integer. Also, it is assumed that $D = 0$. Thus

$$T_d = (L/(P - H) + N - 1)(P/B)$$

To minimize as a function of P, take the derivative:

$$0 = dT_d/(dP)$$

$$0 = (1/B)(L/(P - H) + N - 1) - (P/B)L/(P - H)^2$$

$$0 = L(P - H) + (N - 1)(P - H)^2 - LP$$

$$0 = -LH + (N - 1)(P - H)^2$$

$$(P - H)^2 = LH/(N - 1)$$

$$P = H + \sqrt{\frac{LH}{N-1}}$$

Problem 3.

- Line efficiency is greater, because a single node-to-node link can be dynamically shared by many packets over time.
- A packet-switching network can perform data-rate conversion. Two stations of different data rates can exchange packets because each connects to its node at its proper data rate.
- When traffic becomes heavy on a circuit-switching network, some calls are blocked; that is, the network refuses to accept additional connection requests until the load on the network decreases. On a packet-switching network, packets are still accepted, but delivery delay increases.
- Priorities can be used. Thus, if a node has a number of packets queued for transmission, it can transmit the higher-priority packets first. These packets will therefore experience less delay than lower-priority packets.