ECE 462 **Data and Computer Communications**
Solutions to Homework 8

Question 10.1

It is advantageous to have more than one possible path through a network for each pair of stations to enhance reliability in case a particular path fails.

Question 10.2

Subscribers: The devices that attach to the network, such as telephones and modems.
Subscriber line: the link between the subscriber and the network.
Exchanges: the switching centers in the network.
Trunks: the branches between exchanges. Trunks carry multiple voice-frequency circuits using either FDM or synchronous TDM.

Question 10.3 Telephone communications.

Question 10.4

(1) Line efficiency is greater, because a single node-to-node link can be dynamically shared by many packets over time.
(2) 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.
(3) 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.
(4) 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.

Question 10.5

In the **datagram** approach, each packet is treated independently, with no reference to packets that have gone before. In the **virtual circuit** approach, a preplanned route is established before any packets are sent. Once the route is established, all the packets between a pair of communicating parties follow this same route through the network.

Question 10.6

There is a significant relationship between packet size and transmission time. As a smaller packet size is used, there is a more efficient "pipelining" effect. However, if the packet size becomes too small, then the transmission is less efficient.

Problem 10.5

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

$$= N \times D + \frac{L}{B}$$

$$= 4 \times (0.001) + \frac{3200}{9600} = 0.337$$

$T = 0.2 + 0.337 = 0.537$ 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 forth hop

There are $P - H = 1024 - 16 = 1008$ data bits per packet. A message of 3200 bits requires four packets ($\frac{3200 bits}{1008 bits / packet}$ = 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

$$D_1 = 4 \times \frac{P}{B} + D$$

$= 4 \times \frac{1024}{9600} + 0.001$
$= 0.428$ sec

$D_2 = D_3 = D_4 = t + p$
$= \frac{P}{B} + D$
$= \frac{1024}{9600} + 0.001 = 0.108$

$T = 0.428 + 0.108 + 0.108 + 0.108$
$= 0.752$ 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
$T_c = S + N \times D + \frac{L}{B}$
T_d = End-to-End Delay, Datagram Packet Switching
N_p = Number of packets = $\frac{L}{P-H}$
$T_d = D_1 + (N - 1) \times D_2$

D_1 = Time to Transmit and Deliver all packets through first hop
D_2 = Time to Deliver last packet through a hop
$D_1 = N_p \times \frac{P}{B} + D$
$D_2 = \frac{P}{B} + D$
$T = (N_p + N - 1) \times \frac{P}{B} + N \times D$
$T = T_d$

$$S + \frac{L}{B} = (N_p + N - 1) \times \frac{P}{B}$$

Circuit Switching vs. Virtual Circuit Packet Switching

T_V = End-to-End Delay, Virtual Circuit Packet Switching
$T_V = S + T_d$
$T_c = T_V$

$$\frac{L}{B} = (N_p + N - 1) \times \frac{P}{B}$$

Datagram vs. Virtual Circuit Packet Switching

$T_d = T_V - S$