Homework Assignment Solutions

1. The advantages and disadvantages are listed in the table

	Advantage	Disadvantage
Circuit-switched	1.bandwidth guarantee 2.highly reliable	1. low bandwidth utilization 2. requires proprietary multiplexer
Packet-switched	1. high bandwidth utilization 2. easy to implement	1. less reliable 2. no bandwidth guarantee

The answers should at least mention bandwidth guarantee and resource utilizations or user accommodations.

2.

1) the delays are composed of processing delay, queueing delay, transition delay and propagation delay. (1pt)

2) only queueing delay is variable. The other three are fixed (1pt)

3.

1) transmission delay is the amount of time it takes to push a packet into a link while the propagation delay is the amount of time it takes for a packet to travel over a link. (1pt)

2) No. Cause the propagation delay is determined by the length of physical link and the propagation speed. (1pt)

4.

a. $traffic\ intensity = \frac{La}{R}$, L is packet length, a is the average packet arrival rate and R is the link bandwidth. So, $traffic\ intensity = \frac{100{,}000 \times 15}{1.5 \times 10^6} = 1$. As the traffic intensity approaches 1, the queueing delay becomes very large and grows without bound. Thus, there is no guarantee the packets will be delivered. (2pt. 1pt for calculating the traffic intensity correctly and 1pt for mentioning the queueing delay will grow without bound)

b. In this case, $traffic\ intensity = \frac{100{,}000 \times 15}{100 \times 10^6} = 0.015$. Then, $access\ delay = \frac{D_{Trans}}{(1 - traffic\ intensity)} = \frac{100{,}000/100 \times 10^6}{(1 - 0.015)} = 0.1015$ secs. So, $total\ delay = 2 + 0.102 \approx\ 2.1$ secs. Therefore, the total delay is significantly shortened by increasing the access link bandwidth. (3pt, 2pt for the calculations of the traffic intensity and the final result. 1pt for comparing with the previous result)

c. (Optional) Assume the capacity of local LAN is 100 Mbps, then $total\ delay = 0.6\ \times (\sim msec) + 0.4\ \times\ 2.01 \approx 0.8$ secs (3pt if the calculation is correct. The result does not have to be accurate. Any value approximating 0.8 is correct.)

5.

a. $total\ time = D_{transmission} + D_{propagation} = \frac{20{,}000}{10^6} + \frac{10 \times 10^6}{2.5 \times 10^8} = 0.06$ secs (1pt)

b. $total\ time = 5\ \times (D_{transmission} + 2\ \times D_{propagation}) = 5\ \times (\frac{4{,}000}{10^6} + 2\ \times \frac{10 \times 10^6}{2.5 \times 10^8}) = 0.42$ secs (2pt, 1pt for the correct equation and 1pt for the correct result)

c. The bottleneck link in this case is R_1. Thus, the total end-to-end delay is $\frac{20{,}000}{5 \times 10^5} = 0.04$ secs roughly. (2pt, both 0.04 and 0.042 are correct when calculating the delay.)