If $d_{Trans} = \frac{L}{R} = \frac{500}{R}$

$R = \frac{5 \times 500}{0.4}$ b

$\therefore d_{Trans} = \frac{500}{500 \times 5} \times 0.4 = \frac{4}{50} = 0.08s$

2) Time taken using dedicated link →

$\frac{10\ TB}{100\ Mbps} = \frac{10 \times 10^{6} \times 8}{100}$

$8 \times 10^{5} = s$

Courier = 1 day = 86400 s = 8.6×10^{4} s

∴ Courier is faster.

3) $d_{Trans} = 1000 \times d_{Prop}$

$d_T + d_p = 3 \times 10^{-6}$

$d_T + \frac{1}{1000} d_T = 3 \times 10^{-6}$

$1.0001\, d_T = 3 \times 10^{-6}$

$d_T = 2.997\ \mu s$

4) $d_{Trans} = \frac{L}{R} = \frac{8 \times 10^{14}}{10^9} = 8 \times 10^5$

$d_{prop} = \frac{d}{s} = \frac{35 \times 10^4}{2 \times 10^8} = 17.5 \times 10^{-4} s.$

Total delay = 800000.00175 seconds

Driving = 14 hrs = ~50000 seconds.

∴ Driving is faster.

5) $d_{Trans} = \frac{100 \times 10^3 \times 8}{10 \times 10^6} = 8 \times 10^{-2} = 0.08 s.$

$d_{prop} = \frac{10000 \times 10^3}{2.5 \times 10^8} = 0.04 s$

Total delay = 0.08 + 0.04 = 0.12 s

= 120 ms

∴ In the worst case scenario, the minimum delay is 120 ms, Hence the ISP cannot keep a promise of 5 ms.

6) circuit switched

500ms - setup.

$$\text{Delay} = 500 \times 10^{-3} + \frac{8 \times 16 \times 10^{3}}{100 \times 10^{6}} \times n$$

$$500 + n(1.28) \text{ ms}$$

packet-switched

$$\text{Delay} = 10n + \frac{16 \times 10^{3}}{10 \times 10^{6}}$$

$$= 10n + 12.8$$

$$\therefore 10n + 12.8 > 500 + 11.28n$$

$$8.72n > 487.2$$

$$n > \frac{487.2}{8.72}$$

$$\therefore n > 55.8$$

When number of packets is more than 56, circuit-switched is better.

7) $L = 1000$ bits

$R = 20 \times 10^{6}$

$$d_{Trans} = \frac{10^{3}}{20 \times 10^{6}} = 5 \times 10^{-5}$$

$$= 50 \mu s.$$

8 3a) $R = \frac{200}{4} = 50$ Mbps (per server)

$R_s = 70$ Mbps

$R_c = 90$ Mbps.

∴ Throughput = 50 Mbps.

Link utilization = $\frac{\text{Bottleneck}}{R} = \frac{50}{50} = 1$

b) link utilization = $\frac{50}{50} = 1 \Rightarrow$ Implies the link is being fully used.