1.

89/100

Packet Length = 1000 bytes (L)

Distance = 2500 km (D)

Speed = 2.5×10^8 m/s (s)

transmission rate = 2 Mbps (R)

Time taken (t) = $\frac{L}{R} + \frac{D}{s}$

(transmission delay + propagation delay)

propagation delay = $\frac{D}{s} \Rightarrow \frac{2500 \text{ km}}{2.5 \times 10^8 \text{ m/s}}$

$\Rightarrow \frac{2500 \times 10^3}{2.5 \times 10^8}$ m/s (1 km = 1000 m)

$\Rightarrow \frac{2.5 \times 10^6}{2.5 \times 10^8} \Rightarrow \frac{1}{100} = 0.01 \text{ s} \Rightarrow \boxed{10\text{ms}}$

transmission delay = $\frac{1000 \text{ bytes}}{2 \text{Mbps}} \Rightarrow \frac{\cancel{8} 4 * \cancel{1000} \text{ bits}}{\cancel{2} * 1000 * \cancel{1000} \text{ bits/sec}}$ (1Mb = 1,000,000 bytes)

$\Rightarrow 0.004 \Rightarrow 4$ ms

B) part just general form of p

9/10(2.5+1.5+2.5+

total delay = 4 + 10 ms $\Rightarrow$ 14 ms.

this delay doesn't depend on both packet length and transmission rate as we don't consider there in propagation delay

2.

Data trasfer rate,

$R_1 \Rightarrow 500$ Kbps

$R_2 \Rightarrow 2$ Mbps

$R_3 \Rightarrow 1$Mbps

(a) if there is no traffic, we can say that minimum bottle neck value as an throughput for the file transefer, so, among all the data Rates "(R_1)" can be considered as minimum throughput.

(b) filesize ⇒ 4 million bytes.

throughput ⇒ 500 kbps

time (t) ⇒ $\frac{\text{file size}}{\text{throughput}} \Rightarrow \frac{4,000,000 * 8}{500 \text{ Kbps}}$

(converting bytes to bits ⇒ 1 byte = 8 bits)

$\Rightarrow \frac{\cancel{4000}^{8} \text{ Kbp} * 8}{\cancel{500}} \Rightarrow 8 * 8 \Rightarrow \boxed{64 \text{ sec.}}$

(c) If throughput ⇒ 100 kbps

$\Rightarrow \frac{4000 \text{ kbps} * 8}{100} \Rightarrow \boxed{320 \text{ sec}}$

(3) Yes. It can be done through by putting reliable - data transfer. It can be Implumeted by the Application programmer by Keeping acknowledgement and re-transmission of data using RDUP, QUIC prtocols with UDP reliable data transfer.

10/10

(4) - Circuit - switching (N_{cs}) $\Rightarrow$ bandwidth - 20Mbps

share link cap - 100Mbps

- packet switching $\Rightarrow$ share link = 100 Mbps

min. transmission = 20Mbps

min. trans time = 20%

(a)

maximum users = $\frac{\text{total cap}}{\text{min band for user}}$

$\Rightarrow \frac{100}{20} \Rightarrow \boxed{5 \text{ users}}$

(b) Probability for fraction of time(P) = 0.2

· probability when specific user is not busy = (1 - P)

therefore, prob of all users not transmitting

$\Rightarrow (1-p)^{N_p - 1}$

$\boxed{\therefore \text{ Probability} = N * p * (1-P)^{N-1}}$

N is not necessary

Consider for specific user

$= \boxed{N * (0.2) * (0.8)^{N-1}}$

(c) If 9 users are in total:

probability $\Rightarrow 9 * 0.2 * (0.8)^{9-1}$

$\Rightarrow 9 * 0.2 * 0.1\cancel{67} \Rightarrow \cancel{0.8} \Rightarrow \boxed{0.3006}$

(d) In packet switching, probability of more than 5 users transmitting. and the rest users are idle then probability can be taken as $(P)^5 (1-P)^{9-5}$.

25/35(5+6+1

lets assume six(6) members are using the channel at same time probability

$\Rightarrow 6 \cdot (P)^6 (1-P)^{9-6}$

$\Rightarrow$ ~~6~~ p $6 \cdot (0.2)^6 (0.8)^3$

$\Rightarrow 0.0001$

It is the summation from 6 to

$P(7) \Rightarrow 7 \cdot P^7 (1-P)^{9-7}$

$\Rightarrow 7 \cdot (0.2)^7 (0.8)^2$

$= 0.00005$

$P(5) = 0.006$

So, I ~~t~~ varies based on the number of users using the packet switching at the same time.

(5) $F = 4$ Gb, 7 peers, upload rate $= 94$ Mbps

Upload rate: $U_1 = 28$, $U_2 = 14$, $U_3 = 29$, $U_4 = 22$

$U_5 = 16$, $U_6 = 15$, $U_7 = 11$ Mbps.

download rate: $d_1 = 15$ Mbps, $d_2 = 36$, $d_3 = 21$, $d_4 = 25$

$d_5 = 31$, $d_6 = 20$, $d_7 = 38$.

(a) Minimum time Needed =

$$\text{Max}\left(\text{No. of peers} * \frac{\text{file size}}{\text{Upload rate}}, \frac{\text{file size}}{\text{Minimum download Speed}}\right)$$

$$\Rightarrow \text{Max}\left(7 * \frac{4\text{Gb}}{94\text{Mbps}}, \frac{4\text{gb}}{15\text{Mb}}\right)$$

$$\Rightarrow \text{Max}\left(\frac{7 * 4 * 1000}{94}, \frac{4 * 1000}{15}\right) \Rightarrow$$

$$\Rightarrow \text{Max}(297.87, 266.66)$$

Minimum time needed $= \boxed{297.87 \text{ sec}}$

(b) the root cause of this specific minimum time is due to server distributing file to every client.

(c)

minimum time needed to distribute =>

$$\Rightarrow Max\left(\frac{filesize}{upload\ speed}, \frac{filesize}{Min\ download\ Speed}, N * \frac{filesize}{\sum_i^N upload\ speed}\right)$$

$$\Rightarrow Max\left(\frac{4*1000}{94}, \frac{4*1000}{15}, 7*\frac{4*1000}{28+14+29+22+16+15+11}\right)$$

$$\Rightarrow Max\left(\overset{42.55}{\cancel{229}}, 266.66, 207.40\right)$$

$\Rightarrow$ 266.66.

30/30

minimum time needed to distribute in peer-to-peer model => $\boxed{266.66}$

(d) the root cause of this specific minimum time is due slower download speed of the client d1 (15 mbps).