Question 1 (packet switching):

a 4 Mbps link
each user requires 200 Kbps only 50 percent of the time
assume $2^{10} \cong 1000$

a) Yes, 50 users can simultaneously use the packet switching network. It just needs congestion control.

b) Probability of having minimum 8 users (out of 10) active at the same time.

$$\binom{10}{8}\left(\frac{1}{2}\right)^{10} + \binom{10}{9}\left(\frac{1}{2}\right)^{10} + \binom{10}{10}\left(\frac{1}{2}\right)^{10} = \left(\frac{10 \times 9}{2} + \frac{10}{1} + 1\right)\left(\frac{1}{2}\right)^{10} = 56\left(\frac{1}{2}\right)^{10} \cong 0.056$$

Question 2 (cache):

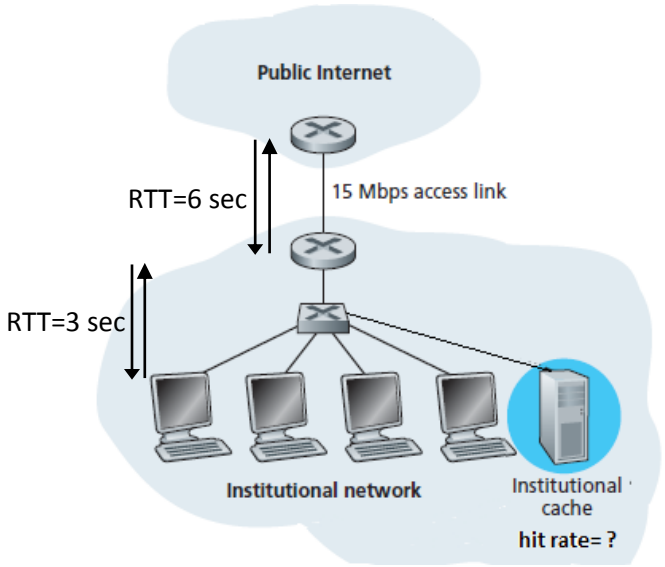

Figure 1a

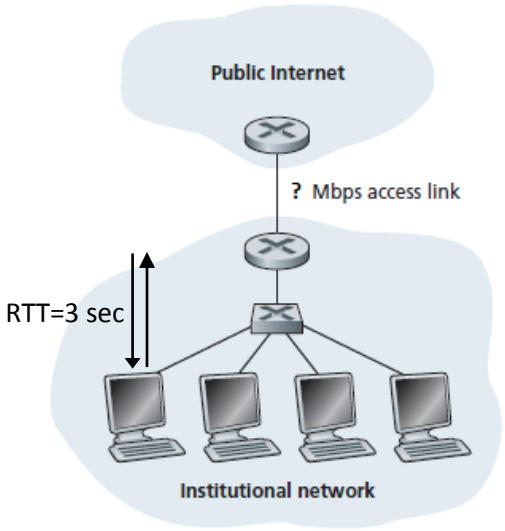

Figure 1b

a) Let x denote the cache hit rate, RTT_0 denote the local round trip time, and RTT_1 the round trip time between the routers. $RTT_0=3$, $RTT_1=6$.

$$x.RTT_0 + (1-x)(RTT_0+RTT_1) < 6$$
$$3x + 9(1-x) < 6$$
$$\Rightarrow \quad x > 0.5$$

b) Objective: $RTT_0 + RTT_1 = 6$ sec.
Assumptions: $RTT_0=3$ sec, and $RTT_1= 6$ sec when $R= 15$Mbps.
Hence, in order to have $RTT_1=3$ sec, R should be 30 Mbps.

Question 3 (steady state):

Assumptions: Assume that the system is in state S_0, S_1, S_2 with probability P_0, P_1, P_2 respectively. Also, $\frac{P_{a1}}{P_{d1}} = \frac{1}{2}$ and $\frac{P_{a2}}{P_{d2}} = \frac{1}{3}$ and $P_a = P_{a1} + P_{a2}$.

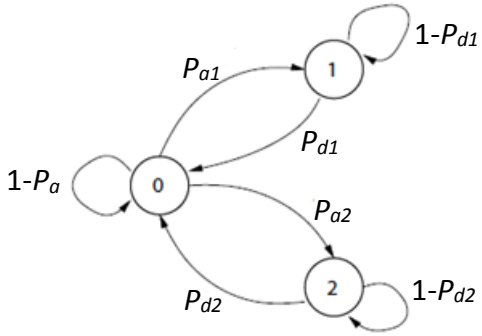

Figure 2

Based on Figure 2 and since $\frac{P_{a1}}{P_{d1}} = \frac{1}{2}$ and $\frac{P_{a2}}{P_{d2}} = \frac{1}{3}$:

$P_0 = 2P_1$ $P_0 = 3P_2$ (1)

Also, $P_0 + P_1 + P_2 = 1$ (2)

(1) and (2) ==> $P_0 + P_0/2 + P_0/3 = 1$

==> $11P_0/6 = 1$ ==> $P_0 = 6/11$ $P_1 = 3/11$ $P_2 = 2/11$

In other words: $P_0 \cong 0.55$ $P_1 \cong 0.27$ $P_2 \cong 0.18$

Part 1: true:

- ⇨ HTTP is stateless.
- ⇨ DNS, the domain name system, is an example of a client-server architecture.
- ⇨ DHT, the distributed hash table, can be designed so that the number of messages per query is O(log *N*), where *N* is the number of peers.
- ⇨ After a packet arrives to a switch, its first bits can be propagated while remaining bits are being processed.

Part 1: false:

- ⇨ µTP is a transport layer protocol.
- ⇨ In order to join a BitTorrent torrent, a peer must have at least one chunk.
- ⇨ TCP provides minimum data transmission rate between processes.
- ⇨ It takes 1 msec for a packet of length 1 Kbits to propagate over a link of distance 5 Km, propagation speed of 10^6 mps, and transmission rate of 10^6 bps, neglecting any other delays.
- ⇨ Suppose that a file size is 1000 Kbits and the path from Host A to Host B has two links of rates *R*1 = 1 Mbps and *R*2 = 500 Kbps. The throughput for the file transfer is 2 seconds.
- ⇨ A circuit-switched network is well suited for applications in which the transmission rate is unknown and bursty.