

ELEC3500 TELECOMMUNICATIONS NETWORKS**Question Set – 4**

4-0. Each buffered output line of a data demultiplexer receives a block of packets every 20 μsec and keep them in buffer. A sequencer checks each block for any packet mis-ordering and corrects it, if necessary. It takes 10 μsec to check for any packet mis-ordering at each block and 30 μsec to make the right sequence if there is any mis-ordering. Suppose that a buffer is initially empty and that the numbers of mis-ordering in the first 15 blocks are 2, 4, 0, 0, 1, 4, 3, 5, 2, 4, 0, 2, 5, 2, 1.

- Illustrate a plot of queuing behavior for the number of packet blocks in a demultiplexer's output line as a function of time.
- Find the mean number of packet blocks in an output line's queue.
- Determine the percentage of the time that a buffer is not empty.

Answer [4, 0.95]

4-1. An access multiplexer (AM) installed in the roadside box of the NBN (National Broadband Network). Assume that 100 homes are connected to the AM. The average packet interarrival time at the AM is 100 μs . The average packet length is 1500 byte where the packet length is exponentially distributed.

- Calculate number of packets arriving at the AM every hour.
- Calculate the total traffic load in bits/sec at the input of the AM.
- Assume that the AM is connected by a 1 Gbps link to the NBN core network. Calculate the total normalized load ρ at the input of the AM.
- Assume that the packet arrival process is random i.e. exponentially distributed. Suggest what queuing model can be used to analyse the performance of the AM.
- Calculate the average queuing delay introduced by the AM.

Answer [36x10⁶ packets, 0.12 Gbps, 0.12, M/M/1, 13.63 μs]

4-2. A buffered router presented by an M/M/1 model receives packets in an exponential manner with a packet arrival rate of $\lambda = 40$ packets/sec where the overall network load is 0.9.

- Determine the average duration a packet remains in the queue of the router.
- Calculate the average number of packets in the queuing system.

Answer [224 ms, 8.96 packets]

4-3. Consider the problem 4-1, where 4 MB buffer is used in the AM.

- How many packets the buffer can hold before it overflows.
- Calculate the probability of packet loss.
- Calculate the average queue length.
- Calculate the average packet delay.

Answer [2797 packets, 0, 0.1363 packet, 13.63 μs]

4-4. Consider a router connecting four access multiplexers (AM) to a core network. Average number of packets arriving from each AM is 50,000 packets/sec. The system uses a fixed packet length of 8000 byte. The router is connected to the core network using a 40 Gbps transmission link.

- Calculate the normalized traffic load at the input of the router.
- Average packet delay introduced by the router.

- c. Compare the packet delay with (b) if the packet size is controlled by an exponential distribution function.

Answer [0.32, 1.976×10^{-6} sec, 2.352×10^{-6} sec]

- 4-5. Consider distributing a file of $F = 15$ Gbits to N peers. The server has an upload rate of $u_s = 30$ Mbps, and each peer has a download rate of $d_i = 2$ Mbps and an upload rate of u . For $N = 10, 100$ and 1,000 and $u = 300$ kbps, 700 kbps, and 2 Mbps, prepare a chart presenting the minimum distribution time for each of the combinations of N and u for both client server distribution and P2P distribution.

Answer [CS: $N=10$, 7500 sec, $N=100$, 50,000 sec, $N=1000$, 500,000 sec, P2P: $N=10$, $u=300$ kbps, 4545 sec, $N=100$, $u=300$ kbps, 45,455 sec]

- 4-6. Consider a content distribution network (CDN). Assume a CDN server is located in an access network as shown in figure 4. The video server transmit video using a coding rate of 12 Mbps using 25 frames per second. Server use a fixed packet size of 4000B. Calculate following:
- RTT (Round Trip Time) for each client assuming a 32B packet is used to measure the delay. Ignore the processing and queuing delays for RTT measurement packets.
 - Number of packets generated by each video frame.
 - A video frame delivery delay to client A. Ignore processing delays.

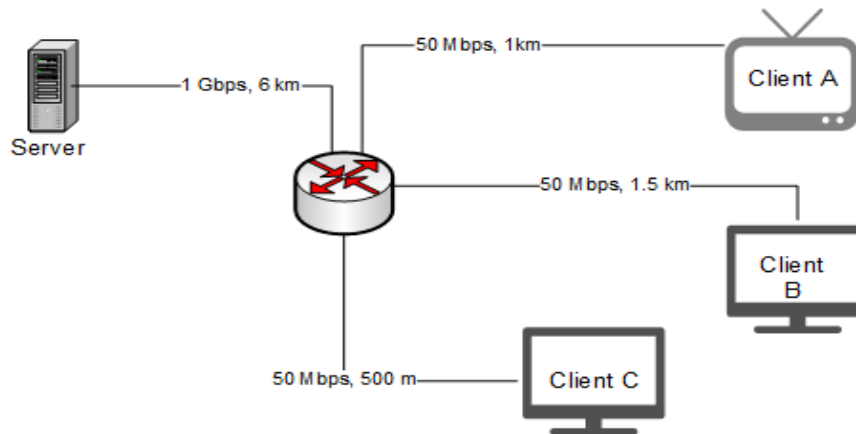


Figure 4

Answer [68.1 μ s, 71.5 μ s, 64.7 μ s, 15, 32.34 ms]

- 4-7. List three non-proprietary Internet applications and the application layer protocols that they use.
- 4-8. What is the difference between network architecture and application architecture?
- 4-9. What is the role of HTTP in a network application? What other components are needed to complete a Web application?
- 4-10. List the four broad classes of services that a transport protocol can provide. For each of the service classes, indicate if either UDP or TCP (or both) provide such a service.
