CSE 473 – Introduction to Computer Networks

Review Questions for Lecture 2 - Solution

***Your Name**:*

Please print out this form (two-sided, if you can) and write your answers legibly in the spaces provided. If you can't write legibly, type.

1) Consider a 100 Mb/s link, preceded by a queue that can hold 100 packets. Packets are on average 125 bytes long (you can assume approximately random packet sizes around that average value).

   a) How long does it take to transmit an average size packet over the link?

   Average packet size is 1,000 bits, so that average transmission time is $10^3/10^8=10\mu sec$

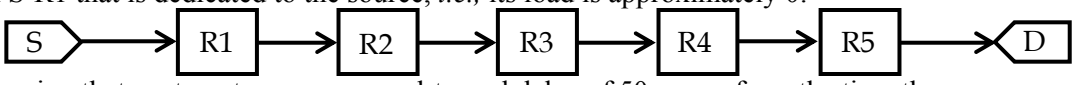
   b) Assume that packet arrive at the queue, at the rate of 85 thousand packets per second. What is the average number of packets in the queue? What is the average amount of time that a packet waits in the queue? What is the probability that a packet is dropped?

   Traffic load is $85{,}000*10^3/10^8=0.85$, so that the average number of packets in the queue can be approximated by $0/85/(1-0.85)=5.67$ packets. As a result, the average queueing time is 56.7μsec.

   The packet loss can be computed using the expression on slide 18 of the first lecture and is equal to $1.12*10^{-8}$. Note that for numerical stability, it may be easier to compute the packet loss using the following expression:

   $P_B=\rho^{B+1}/(1+\rho+\rho^2+\rho^3+...+\rho^B)$

2) Consider a voice codec producing audio samples at a rate of 16 kilobits/sec. Voice samples are sent on a packet network with packet headers of size 20 bytes. Packets leave the source S and traverse five routers, R1 to R5, before reaching their destination D, as shown below. The links S-R1 and R5-D have a propagation delay of 100 μsecs, while all links between routers have a propagation delay of 5 msecs. Links are all of the same speed *R* bits/sec and are loaded at a level of 85%, except for the link S-R1 that is dedicated to the source, *i.e.,* its load is approximately 0.



Assuming that we target an average end-to-end delay of 50 msecs from the time the source generates a given *bit* until it is delivered to the destination. What is the maximum packet size that the source can use for a link speed of *R*=100 kbits/sec? How does the answer change if the link speed is *R*=100 Mbits/sec.

The packetization delay at the source is P/16,000, where P is the packet payload size.

The end-to-end propagation delay is 20.2 msec.

*The average queue size at all routers (R1 to R5) is 0.85/(1-0.85)=5.67 packets, so that the queueing times at all the routers are of the form 5.67*L/R, where L is the average packet size.*

Assuming all packets have the same average size of L=P+H, where P is the payload size and H=160 bits the header size, the end-to-end delay is

$D_{e2e} = P/16{,}000+(P+160)/R+5*(5.67+1)(P+160)/R+20.2\text{msec}$

If we want D_{e2e} *to be less than 50 msec, we need based on the above expression*

$P \leq (29.8*10^{-3}-5496/R)/(1/16000+34.35/R)$

This inequality cannot be satisfied when R=100 kbits/sec, as simply transmitting packets with empty payloads and only headers yields an end-to-end delay that exceeds 50msec.

When R is 100 Mbits/sec, then we find from the above expression that as long as P≤473 bits, then the end-to-end average delay bound of 50 msec can be met.

3) For a communication session between a pair of processes, which process is the client and which one is the server?

The process that initiates the communication is labeled as the client, while the process that waits to be contacted is the server.

4) In the internet, what two pieces of information does a program need to know in order to connect to an application running on a remote server?

In order to connect to an application in a remote server, a process needs the IP address of the remote server, and the port number of the socket on which the server is listening for incoming communication requests.

5) Who benefits from web proxies, users, the users' institutions, web content providers, all of them? Provide specific justifications for your choice(s).

All three benefit web proxies. Users see faster response times to their queries, institutions lower the traffic load on their access links, and web content providers see lower query loads on their origin servers.