Quiz I
EE465/565: Computer Networks and Protocols
10/25/05
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You have 60 minutes to complete the midterm with 20 points total. Please clearly state your assumptions. You will be given partial credits for showing your work. Good luck.

Multiple choice questions: 1 point each

1) The networks on the Internet can be roughly organized into

(a) 1 tier
(b) 9 tiers
(c) 21 tiers
(d) 3 tiers

2) The network layer is

(a) Above link layer
(b) Below transport layer
(c) Both (a) and (b)
(d) None of the above

3) The protocol stacks implemented at the endhost typically consists of

(a) 5 layers
(b) 4 layers
(c) 3 layers
(d) Only application layers

4) Web caching implemented at a proxy server can provide

(a) Shorter downloading time for webpages
(b) Higher bandwidth utilization of a local network
(c) Easy support for parallel TCP connections
(d) Both (a) and (b)

5) Advantage(s) of P2P architecture are

(a) Highly scalable
(b) Efficient search for contents
(c) Both (a) and (b)
(d) None of the above

6) Which of the following is not a characteristic of a circuit switching network?

(a) Call setup
(b) Resource reservation
(c) Guaranteed performance
(d) Statistical multiplexing

7) DNS protocol is implemented at

(a) application layer
(b) network layer
(c) link layer
(d) transport layer

8) A local DNS server mostly contains records of type
(a) NS
(b) A
(c) CNAME
(d) MX

9) In general, to send a very small amount of data, e.g. only a byte from host A to host B, it is more efficient to use

(a) TDM technique
(b) FDM technique
(c) Datagram network
(d) Virtual circuit network

10) Computer A sends a 5000-bit packet to computer B through a 5 Mbps link. Suppose the propagation speed is 2.5×10^8 meter/s and the length of the link is 5×10^6 meters. When there is no network congestion, which of the following delays is largest.

(a) Propagation delay
(b) Transmission delay
(c) Queuing delay
(d) Nodal processing delay

11) Suppose you are assigned to build a "News" server to serve *n* simultaneous clients, each from a different client host. Which transport protocol would you use in order to minimize the number of sockets at the server?

(a) TCP
(b) UDP
(c) Circuit-switched
(d) Packet-switched

12) Suppose you design a web server to deliver web pages to many clients with very looooooong round trip times, e.g 0.5 seconds. Typical webpages contain 100 very small objects which reside on the same server. Assuming that the time to transmit each small object is very small, i.e. 0.01 seconds, which of the following methods should be used to implement your web server?

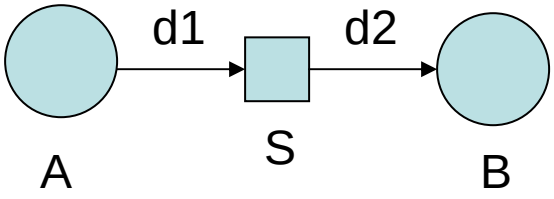
(a) Using one persistent serial TCP connection for each object
(b) Using 5 non-persistent parallel TCP connections
(c) Using UDP
(d) Using virtual circuit.

Answer (a) should have been written as "Using one persistent serial TCP connection" and would have been the correct answer. Because of that mistake, answer (a) or (b) will be accepted.

Continue on the next page.

Problem:

Suppose host A sends a file of size 100 Mbits to host B through a switch S in a store-and-forward network as shown below. The propagation delays for all the links are identical and equal to 10ms. The capacity of the link between host A and switch S is 2 Mbps while the capacity of the link between switch S and host B is 1 Mbps. Ignore the nodal processing delays and packet headers, and assume infinite buffers at the routers.



a) Assuming the packet size is 1 Kbits and the application on host A sends data at 2 Mbps, how long does it take for the entire first packet to arrive at host B? (2 pts)

20 ms + 1 Kbits/2 Mbps + 1 Kbits/1 Mbps = 0.02 + .0005 + .0010 = 0.0215 seconds

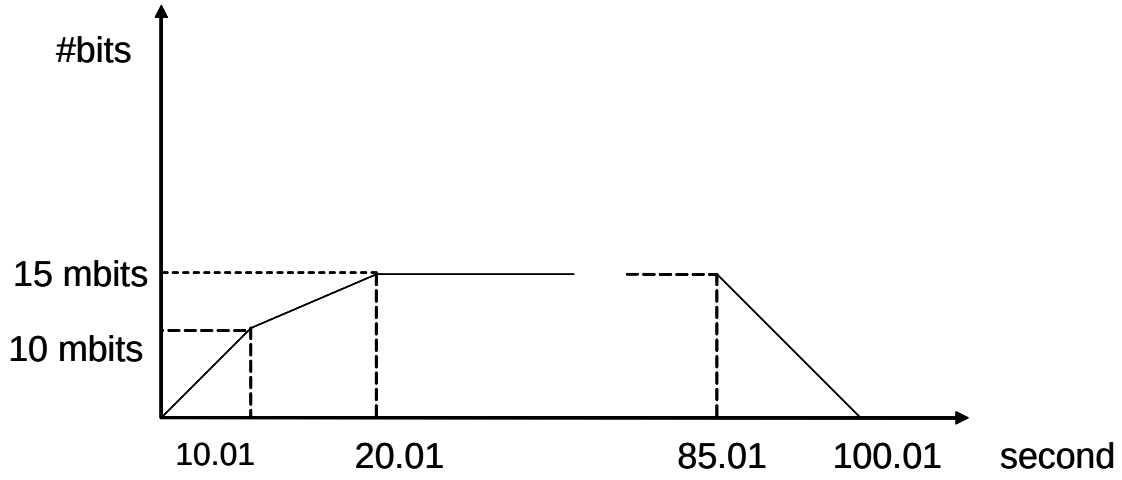
b) Using assumptions in (a), what is the queuing delay of the first bit in the third packet at the switch S? (2 pts)

By the time the first bit of the second packet arrives at the switch, the first bit of the first packet is leaving the switch. Once the first bit of the third packet arrives at the switch, half of the first packet has been transmitted and the whole second packet is waiting in the queue. This means the first bit will wait 0.5 Kbit/1 Mbps + 1 Kbit/ 1 Mbps = 1.5 Kbit/ 1 Mbps = 0.0015 seconds

c) Assuming packet size is 1 bit, and the application on host A sends data at 1.5 Mbps, how long does it take for the host B to receive the entire file? (2 pts)

Note that since packet size is 1 bit, the switch will forward the packet immediately upon receiving a bit. Hence the queuing delay introduced by store and forward network is zero here. Therefore, the time it takes to transfer the file is simply the propagation delay + the transmission time of the link with lowest rate which equals to 20 ms + 100 Mbps/1 Mbps = 100.02 seconds.

d) Assuming packet size is 1 bit, and the application on host A sends data at 2 Mbps for the first 10 seconds, and then 1.5 Mbps for the next 10 seconds, and finally 1 Mbps for the remaining time. Plot the number of bits in the queue at the switch S as a function of time. (2 pts)



Bonus (2pts)
Suppose that host A segments the file into segments of S bits each and adds 4 bytes of header to each segment, forming packets of length L = 32 + S bits. Find the value of S that minimizes the delay of moving the file from host A to host B.

Denote F = file length = 100Mbits,
Denote R = the rate of the second link = 1Mbps
H = 32 bits (header)

Hence, the number of packets to be sent is F/S

The time it takes for the entire first packet to arrive at the host B is

$$20 \text{ ms} + (H + S)/2R + (H + S)/R$$

After this, host B receives 1 packet every (H+S)/R second. Since there are F/S -1 packets left, the total time to transfer the file is

$$T = 20\text{ms} + 3(H + S)/2R + (F/S - 1)(H + S)/R = 20\text{ms} + (H+S)/2R + F(H+S)/SR$$

Using basic calculus to find the minimum or maximum, we take the derivative of T with respect to S, and set the result to 0. This gives us:

$T' = 1/(2R) + (FSR - RF(H+S))/S^2R^2 = 0; \rightarrow S^2R - 2RFH = 0 \rightarrow S = \sqrt{2FH} = 80Kbits$

One can easily verify that the above value of S is a minimum by showing that the second derivative of T is greater than zero for $S=\sqrt{2FH}$.