CSE 473 – Introduction to Computer Networks *Jon Turner*

Exam 1 Review Questions

10/2013

1. A user in St. Louis, connected to the internet via a 20 Mb/s (b=bits) connection retrieves a 250 KB (B=bytes) web page from a server in Seattle, where the page references 4 images of 1 MB each. Assume that the one way propagation delay is 25 ms.

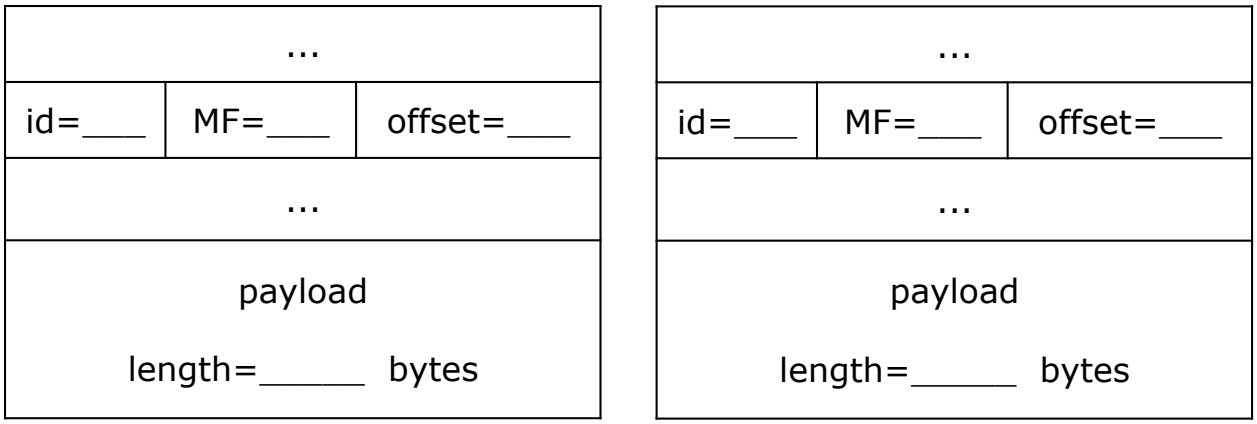
   Approximately how long does it take for the page (including images) to appear on the user's screen, assuming non-persistent HTTP using a single connection at a time (for this part, you should include transmission delay on the user's access link, but you may ignore delays at other network links)?

   How long does it take if the connection uses persistent HTTP (single connection)?

   Suppose that the path from the server to the user passes through a 1 Gb/s link at a router *R*, and that the rate at which packets arrive at router *R* that must be sent on this link is 475,000 packets per second. If the average packet length is 2,000 bits, what is the average queueing delay at this link?

2. Consider a packet with a total length of 250 bytes (including IPv4 header, with no options) and an id field equal to 17, sent from a host *A* to a host *B*, passing through routers *X* and *Y*. Assume that the subnet where host *A* is connected has an MTU of 500 bytes, the subnet where host *B* is connected has an MTU of 80 bytes and the subnet between *X* and *Y* has an MTU of 120 bytes. Assuming that the "don't fragment" flag is not set, how many fragments does router *X* divide the packet into? What is the length of each fragment?

Complete the diagram below so that it represents the first two fragments forwarded by router *Y* (not *X*). Fill in all the blanks.



Suppose host *A* sends a 100 byte packet with the "don't fragment" flag set. Explain what happens to this packet at each of the two routers.

3. The table at right represents a forwarding table for an IP router (for simplicity, we are using 8 bit addresses).

   If a packet arrives with destination address 1010 0110, what output is it sent to, and what is the IP address of the next network-level component to receive the packet?

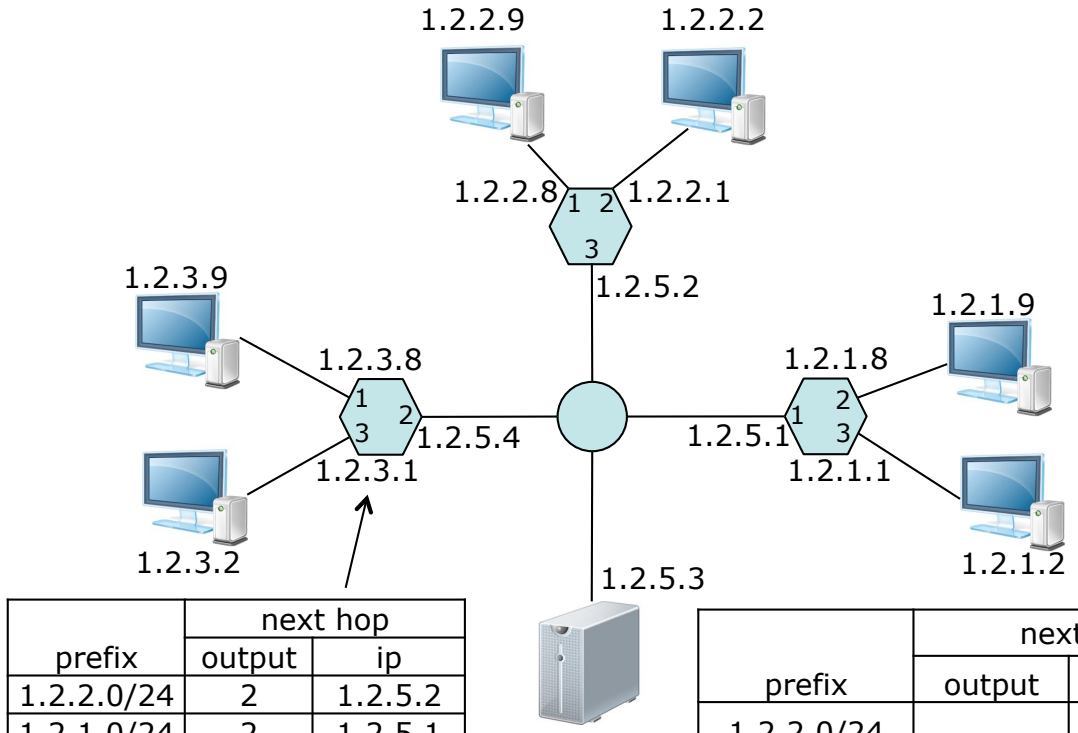
prefix	next hop	
	output	address
101*	2	1010 1111
0100*	4	0100 0110
0010 0*	6	-
1010 1*	7	-
0101 0*	5	0101 0011
1011 00*	3	1011 0000
0101 11*	1	0101 1100
0010 01*	9	-

   If a packet arrives with destination address 0010 0110, what output is it sent to, and what is the IP address of the next network-level component to receive the packet?

   If a packet arrives with destination address 1011 0010, what output is it sent to, and what is the IP address of the next network-level component to receive the packet?

   Draw a diagram of a binary trie that could be used as a lookup data structure for the prefixes in the table. Mark each node that corresponds to a prefix in the table with an X. Be sure to label all edges with '0' or '1'.

4. The diagram below shows a network with 3 routers (shown as hexagons) connected by an Ethernet switch. The routing table for the left-hand router is shown. Complete the routing table for the right-hand router, so that packets will be delivered appropriately (use no more than 5 route table entries).



prefix	next hop	
	output	ip
1.2.2.0/24	2	1.2.5.2
1.2.1.0/24	2	1.2.5.1
1.2.5.0/24	2	-
1.2.3.0/29	3	-
1.2.3.8/29	1	-

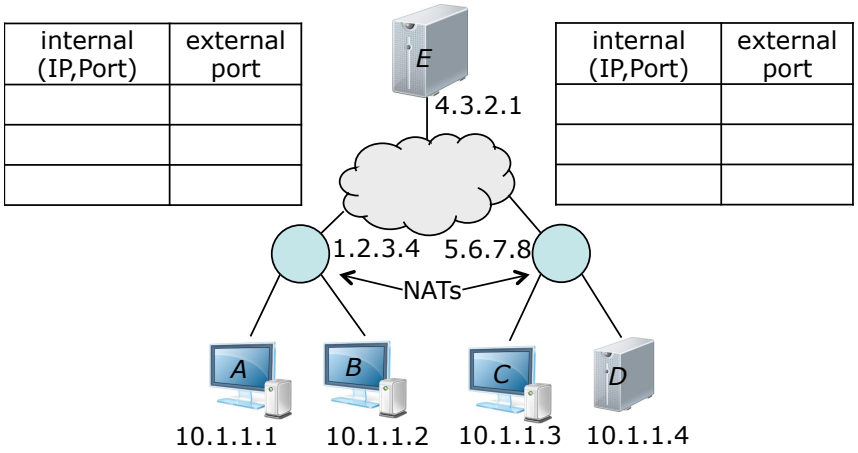
prefix	next hop	
	output	ip
1.2.2.0/24		
1.2.3.0/24		
1.2.5.0/24		
1.2.1.0/29		
1.2.1.8/29		

If a switch was inserted between the host with IP address 1.2.3.2 and its router, how many hosts could be *added* to that switch, without having to change the routing table entries? What IP addresses would those hosts use?

5. In the figure in problem 4, suppose that the server, with IP address 1.2 5.3 is configured to use the right-hand router for its non-local traffic. Assume that the ARP tables for all hosts and routers are empty initially. List all packets that must be sent from one network-level component to another, in order to deliver a packet from the server to the host with IP address 1.2.2.9. For each packet, specify which component sends it and which receives it and give a brief description (for example – "left router to top router: ARP request for address xyz", or "server to top router: data packet").

   What packets must be sent when the server sends a second packet to the same host?

6. The figure at right shows two residential networks with routers that implement NAT. Suppose host *A* is connected to the web server at host *E*.



In the left-hand NAT table, add an entry that would allow *A* to communicate with *E*. You may choose any port numbers you like.

Show the values of the address and port fields in the diagram below, for a typical packet sent by host *A*.

src adr	dest adr	src port	dest port

Show the fields in the packet as it might appear when it reaches *E*.

src adr	dest adr	src port	dest port

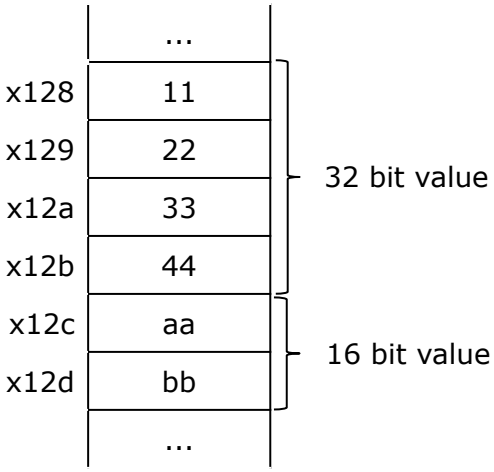
Suppose the user in the right-hand network wants to run a web server on host *D*. Add an entry to the right-hand table that would allow remote connections to the web server. Assume host *B* connects to the web server at *D*. Add an entry to the left-hand NAT table for this connection. Show the address and port field for a typical packet leaving host *B*, the fields in the same packet as it passes through the public internet, and the packet that is delivered to *D*.

src adr	dest adr	src port	dest port

src adr	dest adr	src port	dest port

src adr	dest adr	src port	dest port

7. (5 points). The diagram below shows the bytes that define a 32 bit integer and a 16 bit integer as they are stored in a computer's memory.



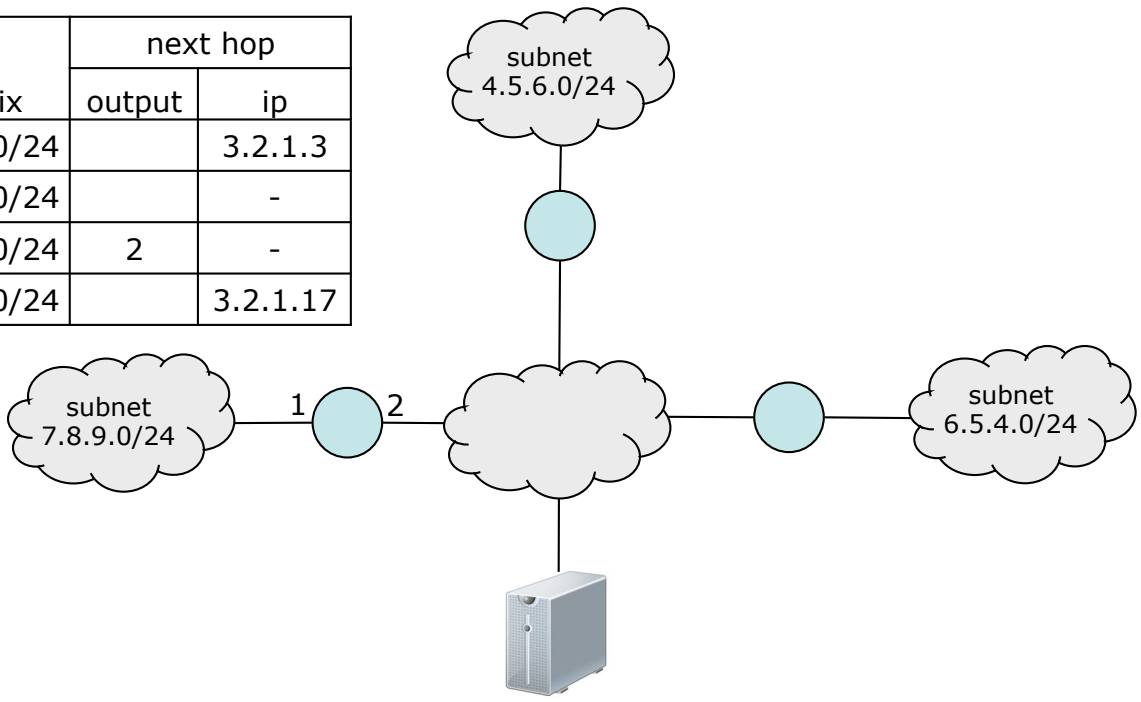
Assuming that the computer is "little-endian", what is the actual value of these two integer variables? You may write the values in hex.

What are the values if the computer is big-endian?

In what order should these 6 bytes be transmitted over the Internet in each of the two cases?

8. The diagram below shows three routers and four layer 2 networks. The table is the routing table for the left-hand router.

prefix	next hop	
	output	ip
4.5.6.0/24		3.2.1.3
7.8.9.0/24		-
3.2.1.0/24	2	-
6.5.4.0/24		3.2.1.17



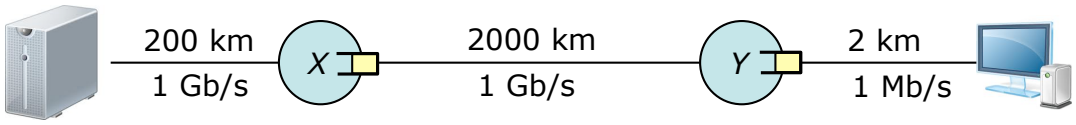
In three of the entries in the routing table, the output has been left blank. Fill in the missing values.

Based on the information in the table, what is the IP address of the interface that connects the top router to the central subnet?

What is the IP address of the interface that connects the right-hand router to the central subnet?

What is the subnet prefix for the central subnet?

9. The figure below shows a network path connecting a server to a client.



What is the propagation delay for a packet going from the server to the client (you may assume that the speed of light is 200,000 km/s)?

What is the total transmission delay of a 10,000 bit packet on all of the links?

What is the average queueing delay at router *X*, assuming that the traffic intensity is 1.3, and the buffer can hold 10,000 packets and that the average packet size is 5,000 bits?

What is the average queueing delay at router *Y*, assuming that the traffic intensity is 0.8, and the buffer can hold 100 packets and the average packet size is 5,000 bits?