Computer Networks
Fall 2009
Homework 1 Solutions

Question 1-2:
There is no difference. Throughout the text, the words "host" and "end system" are used interchangeably. End systems include PCs, workstations, Web servers, mail servers, Internet-connected PDAs, WebTVs, etc.

Question 1-3:

No	Technology	Residential	Company	Mobile
1	Dial-up modem over telephone line	X		
2	DSL over telephone line	X	X	
3	Cable to HFC	X		
4	100 Mbps Switched Ethernet		X	
5	Wireless LAN			X
6	Cellular mobile access			X

Question 1-11:
At time t_0 the sending host begins to transmit. At time $t_1 = L/R_1$, the sending host completes transmission and the entire packet is received at the router (no propagation delay). Because the router has the entire packet at time *t1*, it can begin to transmit the packet to the receiving host at time t_1. At time $t_2 = t_1 + L/R_2$, the router completes transmission and the entire packet is received at the receiving host (again, no propagation delay). Thus, the end-to-end delay is $L/R_1 + L/R_2$.

Question 1-18:
a. The throughput equals the smallest rate = 500 kbps
b. Time = 4 MB / 500 kbps = 4*8 * 1024 / 500 = 66 seconds
c. The throughput = 100 kbps
   Time = 4 MB / 100 kbps = 4*8 * 1024 / 100 = 328 seconds

Question 1-20:
Transmission delay = L/R = 8 bits/byte * 1,000 bytes / 2,000,000 bps = 4 ms
Propagation delay = d/s = 2,500 / 2.5×10^5 = 10 ms
Total Time = 4 + 10 = 14 ms

Generally, the total time = L/R + d/s

The propagation delay does not depend on the packet length or the transmission rate; but the total time does.

Question 1-22:
Routers process layers 1 through 3. (This is a little bit of a white lie, as modern routers sometimes act as firewalls or caching components, and process layer four as well.) Link layer switches process layers 1 through 2. Hosts process all five layers.

Question 1-25:
The five layers in the Internet protocol stack are – from top to bottom – the application layer, the transport layer, the network layer, the link layer, and the physical layer. The principal responsibilities are outlined in Section 1.5.1.

Question 1-26:

a) Virus

Requires some form of human interaction to spread. Classic example: E-mail viruses.

b)Worms

No user replication needed. Worm in infected host scans IP addresses and port numbers, looking for vulnerable processes to infect.

a) Trojan horse

Hidden, devious part of some otherwise useful software.

Question 1-28:
Creation of a botnet requires an attacker to find vulnerability in some application or system (e.g. exploiting the buffer overflow vulnerability that might exist in an application). After finding the vulnerability, the attacker needs to scan for hosts that are vulnerable. The target is basically to compromise a series of systems by exploiting that particular vulnerability. Any system that is part of the botnet can automatically scan its environment and propagate by exploiting the vulnerability. An important property of such botnets is that the originator of the botnet can remotely control and issue commands to all the nodes in the botnet. Hence, it becomes possible for the attacker to issue a command to all the nodes, that target a single node (for example, all nodes in the botnet might be commanded by the attacker to send a TCP SYN message to the target, which might result in a TCP SYN flood attack at the target).

Question 2-2:
The Web: HTTP; file transfer: FTP; remote login: Telnet; Network News: NNTP; e-mail: SMTP.

Question 2-3:
The IP address of the destination host and the port number of the destination socket.

Question 2-6:
You would use UDP. With UDP, the transaction can be completed in one roundtrip time (RTT) - the client sends the transaction request into a UDP socket, and the server sends the reply back to the client's UDP socket. With TCP, a minimum of two RTTs are needed - one to set-up the TCP connection, and another for the client to send the request, and for the server to send back the reply.

Question 2-10:
Web caching can bring the desired content “closer” to the user, perhaps to the same LAN to which the user’s host is connected. Web caching can reduce the delay for all objects, even objects that are not cached, since caching reduces the traffic on links.

Question 2-14:
FTP uses two parallel TCP connections, one connection for sending control information (such as a request to transfer a file) and another connection for actually transferring the file. Because the control information is not sent over the same connection that the file is sent over, FTP sends control information out of band.

Question 2-19:
With download and delete, after a user retrieves its messages from a POP server, the messages are deleted. This poses a problem for the nomadic user, who may want to access the messages from many different machines (office PC, home PC, etc.). In the download and keep configuration, messages are not deleted after the user retrieves the messages. This can also be inconvenient, as each time the user retrieves the stored messages from a new machine, all of non-deleted messages will be transferred to the new machine (including very old messages).

Question 2-21:
It is a hybrid of client server and P2P architectures:

a) There is a centralized component (the index) like in the case of a client server system.
b) Other functions (except the indexing) do not use any kind of central server. This is similar to what exists in a P2P system.

Question 2-23:

a) User location
b) NAT traversal