**Assignment 1**

1. What is the difference between a flat network architecture and a hierarchical network architecture? Discuss pointing out the advantages and disadvantages of each.

2. What is the Internet's architecture? Discuss from: I- an administrative point of view and II- a routing point of view, pointing out concrete examples of the advantages of such architecture for the Internet.

3. Define bandwidth-delay product in the context of network performance. What is the importance of the bandwidth-delay product for networks? Give an example of a system that has large bandwidth-delay product.

4. Discuss the following statement, pointing out to what extent is it true or false: We can never guarantee services over computer networks, even in circuit switching or the packet switched Internet, when the demand exceeds the available capacity the network goes into congestion and quality guarantees are lost.

5. What were some of the main design requirements/principles during the design of the original Internet? (Mention at least four). If you are to re-design the Internet today, which new design requirements would you include as very high priority (excluding the original requirements) and why. [Include at least two].

6. Suppose a 100-Mbps point-to-point link is being set up between Earth and a new lunar colony.

The distance from the moon to Earth is 385,000 km and data travels over the link at the speed of

light, 3 x 108 m/s.

1. Calculate the minimum RTT for the link.
2. Calculate the bandwidth-delay product for the link.
3. A camera on the lunar base takes pictures of Earth and saves them in digital format to disk. Suppose Mission Control on Earth wishes to download the most current image (25MB). What is the minimum amount of time that will elapse between when the request for the data goes out and the transfer is finished?

7. DNS attacks: Discuss four different attacks on the DNS system. For each describe the characteristics or measures of DNS to thwart or ameliorate the severity of the attacks.

8. Discuss the adequacy of existing transport layer protocols (TCP and UDP) to support today's Internet applications and services, noting how application developers deal with these two options as transport layer. [Support your answer with example applications and their use of the transport layer].

9. Compare and contrast the client-server model and the peer-to-peer model as paradigms for connection in the Internet, pointing advantages and disadvantages of each.

10. Suppose within your web browser you click on a link to obtain a Web page. The IP address of the associated URL is not cached in your local host, so a DNS lookup is necessary to obtain the IP address. Suppose N DNS servers are visited before your host receives the IP address from DNS: the successive visits incur an RTT of RTT1, ... , RTTn. Further suppose that the webpage associated with the link contains exactly one object consisting of a small amount of HTML text. Let RTT0 denote the RTT between the local host and the server containing the object. Assuming zero transmission time of the object, how much time elapses from when the client clicks on the link until the client receives the object?

11. Referring to problem 10, suppose the HTML file references 8 very small objects on the same server. Neglecting transmission times, how time elapses with

1. Non-persistent HTTP with no parallel TCP connections?
2. Non-persistent HTTP with the browser configures for 5 parallel connections?
3. Persistent HTTP?

13. Read RFC 5321 for SMTP. What does MTA stand for? Consider the spam email included in your book below this problem. Assuming the originator of this spam email is malicious and all other hosts are honest, identify the malicious host that has generated this email.

14. A telephone modem is used to connect a personal computer to a host computer. The speed of the modem is 56 kbps, the one-way propagation delay is 100 ms, the packet size is 256 bytes, and the probability of an error in a packet is 10−4 .

1. Find the efficiency of stop-and-wait ARQ.
2. What window size N is needed to keep the channel busy when there are no transmission errors. For this window size find the efficiency of the go-back-N and selective repeat protocols.

15. True or False?

1. Host A is sending a large file to host B over a TCP connection. Assume host B has no data to send to host A. Host B will not send acknowledgments to host A because host B cannot piggyback the acknowledgments on data.
2. The size of the TCP RcvWindow never changes throughout the duration of the connection.
3. Suppose host A is sending a large file to host B over a TCP connection. The number of unacknowledged bytes that A sends cannot exceed the size of the advertised receiver buffer.
4. Suppose that the last SampleRTT in a TCP connection is equal to 1sec. Then the current value of TimeoutInterval for the connection will necessarily be ≥ 1sec.

16. Suppose host A is sending a large file to host B over a TCP connection. The two end hosts are 10msec apart (20msec RTT) connected by a 1Gbps link. Assume that they are using a packet size of 1000 bytes to transmit the file. Also assume for simplicity that ACK packets are extremely small and can be ignored.

1. At least how big would the window size (in packets) have to be for the channel utilization to be greater than 80%.
2. Assuming infinite initial threshold, no losses and competing traffic, approximately how long (in seconds) would it take for the normal slow start mechanism to achieve 80% utilization?

17. In modern packet-switched networks, including the Internet, the source host segments long, application layer messages (for example an image or a music file) into smaller packets and sends the packets into the network. The receiver then resembles the packets back into the original message. We refer to this process as message segmentation. Consider a message that is 8\*10^6 bits long that is to be sent from a source to a destination which are separated by two routers in between. Suppose each of the three link in this path is 2 Mbps. Ignore propagation, queueing and processing delays.

* 1. Consider sending the message without message segmentation. How long does it take to move the message from the source host to the first router ? Keeping in mind that each router uses a store-and-forward packet switching, what is the total time to move the message from source to destination?
  2. Now suppose the packet is segmented into 800 packets with each packet being 10000 bits long. How long does it take to move the first packet to the first router ? When the first packet is being sent from the first router to the second one, the second packet is on its way to the first router. At what time will the second packet be fully received by the second router ?
  3. What is the total to move the message to destination host ? Compare this result with your answer in part a.
  4. In addition to reducing delay, what are the reasons to use message segmentation?
  5. Discuss the drawbacks of message segmentation.

18. Consider DNS protocol.

1. Sketch the main architecture of domain name servers currently used for the internet. You should include a client, a server and different types of DNSs.
2. Explain four different types of record which are kept in a DNS list. According to your sketch in part a, in what point is each of these types used ?
3. Name two different types of a DNS query. Complete your sketch with some arrows to explain how these two approaches work.
4. What is the necessity of having Root Domain Name Servers ?

19. True or False ? Justify

1. A user requests a Web page that consists of some text and three images. For this page, the client will send one request message and receive four response messages.
2. Two distinct web pages (for example, www.mit.edu/research.html and www.mit.edu/students.html) can be sent over the same persistent connection.
3. with nonpersistent connections between browser and origin server, it is possible for a single TCP segment to carry two distinct HTTP request messages.
4. The *Data:* header in HTTP response message indicates when the object in the response was last modified.
5. HTTP response messages never have an empty message body.