CS 655: Computer Networks
Fall 2020

Midterm Review Questions

1. What is a layered communication model? Draw the two (layered) models of the ISO OSI and the TCP/IP protocol suites. Compare the two models. For each model, indicate the main functions provided by each layer.

2. What are two reasons for using layered protocols?

3. In the context of layered network architecture, what is a connection-oriented service and what is a connection-less service? Why do we need both services? Identify the various functions and interfaces needed to provide each service?

4. Explain the difference between FDM (Frequency Division Multiplexing), STDM (Synchronous Time Division Multiplexing), and statistical multiplexing.

5. A cable TV system has 100 commercial channels; each of them is alternating between programs and advertising. Is this more like TDM (Time Division Multiplexing) or like FDM (Frequency Division Multiplexing)?

6. Define the terms *client* and *server* application programs. Which one of the two is usually more difficult to build? Why? With the help of a diagram, describe the different components and the operation of an electronic mail application.

7. We have seen a number of application-layer protocols. Give examples and explain the difference between (i) stateless and stateful protocols, (ii) push and pull protocols, and (iii) persistent and non-persistent protocols.

8. Mention at least three techniques to scale client-server application architectures (i.e. reduce their load on the server and/or network for a large number of clients)?

9. With the help of a diagram, explain the steps involved in mapping an Internet name into its IP address. Be precise about how each step is accomplished.

10. The primary model of network interaction among application programs is known as the *client-server* model. (a) Define the terms *client* and *server*. (b) A client sends a 128-byte request to a server located 100 km away over a 1-Gbps optical fiber, and then waits for a reply to get back. What is the utilization of the link (i.e. percentage of time the link is busy transmitting) during this transaction? Take the speed of light in fiber optics to be 200 km/msec. (c) Consider the situation of part (b) again. Compute the minimum possible response time both for the 1-Gbps link and for a 1-Mbps link. What conclusion can you draw?

11. Suppose a 100-Mbps point-to-point link is being set up between the earth and a new lunar colony. The distance from the moon to the earth is approximately 240,000 miles, and data travels over the link at the speed of light---186,000 miles per second. (a) Calculate the minimum round-trip time (RTT) for the link. (b) Using the RTT as the delay, calculate the delay-bandwidth product for the link. (c) A camera on the lunar base takes pictures of the earth and saves them in digital format to disk. Suppose Mission Control on earth wishes to download the most current image, which is 25 MB. What is the minimum amount of time that will elapse between the request for the data goes out and the transfer is finished? (d) Suppose each image is transferred as a sequence of packets using the sliding window selective-repeat protocol. Assuming each packet carries 1 KB of data, how many bits do you need for the sequence number? Explain your answer.

12. Go-back-n and selective-repeat are two basic approaches to deal with transmission errors. (a) Compare the two approaches in terms of storage and capacity requirements. (b) With the aid of a packet sequence (timing) diagram, show the operation of go-back-n when a data-packet/ACK-packet/NAK-packet is lost.

13. Consider an ARQ algorithm running over a 20,000-meter point-to-point fiber link. (a) Compute the propagation delay for this link, assuming that the speed of light is $2*10^8$ meters per second in the fiber. (b) Suggest a suitable timeout value for the ARQ algorithm to use. What is the reason behind your suggestion? (c) Why might it still be possible for the ARQ algorithm to timeout and retransmit a packet, given this timeout value?

14. Consider a satellite link with a one-way propagation time of 0.27 second and a transmission rate of 1 Mbps (10^6 bps) with packets of 1000 bits each. What is the minimum window size of go-back-n that results in efficiency (utilization) of 100%?

15. Assume a sliding window protocol using selective repeat. With the aid of a packet sequence (timing) diagram, show why the range of sequence numbers {0, 1, … , 2K-1}, where K denotes the size of the sender's window and the receiver's window, is enough for the protocol to work correctly.

16. Suppose you are designing a sliding window protocol for a 1 Mbps point-to-point link to Venus, which has a round-trip propagation delay of 4 seconds. Assuming the size of each packet is 1,000 bytes, how many bits do you need for the sequence number? Explain your answer.

17. Explain how two application programs interact with TCP in order to communicate in a client/server fashion. Make sure to define the terms *client* and *server*, and identify the various operations performed by the client and server. Explain what TCP does as a result of each operation.

18. How does TCP identify a connection? Is the information needed for this identification readily available to the TCP software in the received TCP segment? Explain.

19. Why does UDP exist? Would it not have been enough to just let user processes send raw IP packets?

20. A reliable transport protocol with window size of 65,535 bytes is used over a 1-Gbps link (10^9 bps) link that has a 10-msec one-way propagation delay. What is the maximum throughput (data rate) achievable? What is the link utilization (percentage of time the link is busy)?