Communication Protocols and Internet Architectures
Harvard CSCI E40

Solutions to Practice Exam Questions

The following are sample solutions to the practice exam. Note that many of the questions have no single "correct" answer. The correct answer can depend on the assumptions that you make about the network architecture or the protocol that is being used. This is the reason it is so important to include information on the assumptions that you make when you answer a question.

Please note that these practice questions might cover topics that are not included on the exam and that the exam will cover topics that are not included in these practice questions.

1.) Token ring networks (an older form of LAN) and ethernet networks have different maximum frame sizes (approximately 1,500 versus 4,500 bytes.) Given that layer 2 switches could be used to interconnect these two different types of networks, should these switches be designed so that they implement fragmentation and reassembly? Why or why not. (Note that even though you don't know much about token ring, you should still be able to answer this question.)

Sample Solution

Layer 2 switches should not implement fragmentation since they operate at the link layer (layer two) and the link layer protocols 802.3 and 802.5 do not include protocol support for fragmentation. Therefore, if a switch was used to connect together a token ring LAN and an Ethernet LAN, any frames from the token ring that were destined for the Ethernet that were larger than 1500 bytes would be dropped by the switch. (Remember that fragmentation and reassembly is part of the functionality provided by IP at layer three.)

2.) Study the TCP state diagram (which is shown in the chapter on TCP.) Describe two ways to get into the SYN RCVD state. (Note that if we asked this question on the exam we would provide a copy of the state diagram.)

Sample Solution

One way to get to this state is to start out in the LISTEN state, and then when a SYN is received, the protocol moves to the SYN RCVD state. A second way to reach this state is the result of a simultaneous open. In this situation, one side of the connection does an active open, sends a SYN and moves to the SYN SENT state. Once in the SYN SENT state, the protocol receives a SYN from the far side and as a result, it moves to the SYN RCVD state.

3.) Explain the use of both upward multiplexing and downward multiplexing in relation to the transport layer. Do comparable approaches apply to other layers?

Sample Solution

When we talk about multiplexing in class we typically mean the sharing of a single communication channel by multiple users or, how port numbers in a protocol (such as TCP port #s) allow multiple higher-layer protocols to share a single instance of a lower layer protocol. These are examples of upward multiplexing and this functionality is used in all layers of the model.

Downward multiplexing in relation to the transport layer means that the transport layer opens and uses multiple network layer connections to send traffic. Traffic would typically be distributed in a round robin fashion to these multiple connections (or via other means) and as a result, overall performance would be improved. This technique is less common but it can also be applied to different layers of the model.

4.) Explain how a link level protocol that uses a window size of 127 could be more efficient than a protocol that uses a window size of 7. Include in your answer how the link's end-to-end delay and the link's bandwidth influence the link's performance.

Sample Solution

A sliding window of 127 can be more efficient than a window size of 7 because with a larger window, more frames can be sent without having to wait for an acknowledgment from the far end. Additionally with a large window size, there is a better chance that an ack could be "piggybacked" on a data frame thus precluding the need to send a separate ack. This ensures an almost continuous flow of frames. The issues related to bandwidth and link delay are more complex. Links that have high latency (such as satellite links) require the sender to wait long periods to receive an ack and the smaller the window size, the more this happens. On a high bandwidth circuit, many frames can be sent quickly and if there is a significant end-to-end delay, the window can be closed before the first frame ever reaches the destination. It is therefore critical to have large window sizes on circuits that have both high bandwidth and high delay.

Note that this question related to layer two; a more interesting question would be one that asked how the window size in TCP influenced end-to-end performance. You should review both flow control and congestion control in TCP as you prepare for the exams.

5.) In the Internet today the only layer 3 protocol that is used and processed by the routers is IP. Yet people are still able to send and use other network layer vendor-specific protocols and proprietary protocols across the Internet. (By this we mean that the proprietary protocol header is still present in the packet that is sent across the Internet.) How is this accomplished? Explain the technical issues in detail.

Sample Solution

Since proprietary or other packets are not changed into IP packets (as we describe in the question), the Internet must somehow be able to carry the complete packet from end to end. This is down by setting up a tunnel, comparable in some ways to a physical tunnel, at each end of the network and encapsulating the Apple or other proprietary packet in an IP packet and sending it undisturbed through the tunnel to the far end. Only the hosts (or possibly the first and last router or firewall in the path) at both ends handle the encapsulation process. The encapsulated protocol will be identified by the Protocol field in the IP header. You can review this table at www.iana.org. Note that this approach is also being used to encapsulate an IPv6 packet within an IPv4 packet.

6a.) Describe what happens to a TCP/IP packet that is encapsulated in an ethernet frame when it traverses a old-style wiring hub, an ethernet switch and a router? In each case, describe what protocol fields (if any) change at both layer 2 and layer 3.

6b.) Which of these devices inherently adds the most delay to the arrival of a single packet? Why?

Sample Solution

a. When an Ethernet frame traverses a hub, no changes occur since the hub is basically a dumb repeater that simply regenerates the bits of either good or bad packets. An ethernet switch on the other hand will typically drop a packet with a bad FCS/CRC but other than that, it doesn't alter the frame itself and does not look at or alter the layer 3 information. A router strips off and then creates a new layer 2 frame since it is responsible for moving the frame from one physical network to another. In addition, the router would of course change some layer 3 information such as the IP checksum and the TTL.

b. The router adds the most delay for the reasons described in A above.

7. The intent of this question is to have you use the SP3 framework we described in class to compare and contrast two different protocols. In the answer below we use the framework to compare the ethernet 802.3 protocol and the PPP protocol.

Solution
Remember that SP3 (as introduced in lecture) stands for:
- Service – describes what the protocol accomplishes in fairly general terms:
- Purpose – describes what specific functionality (such as flow control) is provided by the protocol;
- Packets – describes the various packet formats used by the protocol;
- Procedures – defines how the protocol functions. This would explain for example, whether an end-to-end connection was established, or how error handling was done.

Your answer should describe the two protocols you want to compare using this framework.