Chap 3.

Review Questions

- R1. What is the goal of TCP congestion control, and briefly describe the slow start, congestion avoidance, fast retransmit, and fast recovery phases.

- R2. What is the goal of TCP flow control and explain the role of the receive window in this mechanism.

- R3. Describe scenarios where TCP and UDP would be most appropriate to use and explain the reasons behind these choices.

- R5. What problems do multiplexing and demultiplexing solve in the Transport Layer, and how do these processes work

- R5. What are the units of data exchange called in the Transport Layer?

Problems

- P1(4pt). Consider the two 16-bit words (shown in binary) below. Recall that to compute the Internet checksum of a set of 16-bit words, we compute the one's complement sum [1] of the two words. That is, we add the two numbers together, making sure that any carry into the 17th bit of this initial sum is added back into the 1's place of the resulting sum); we then take the one's complement of the result. Compute the Internet checksum value for these two 16-bit words:

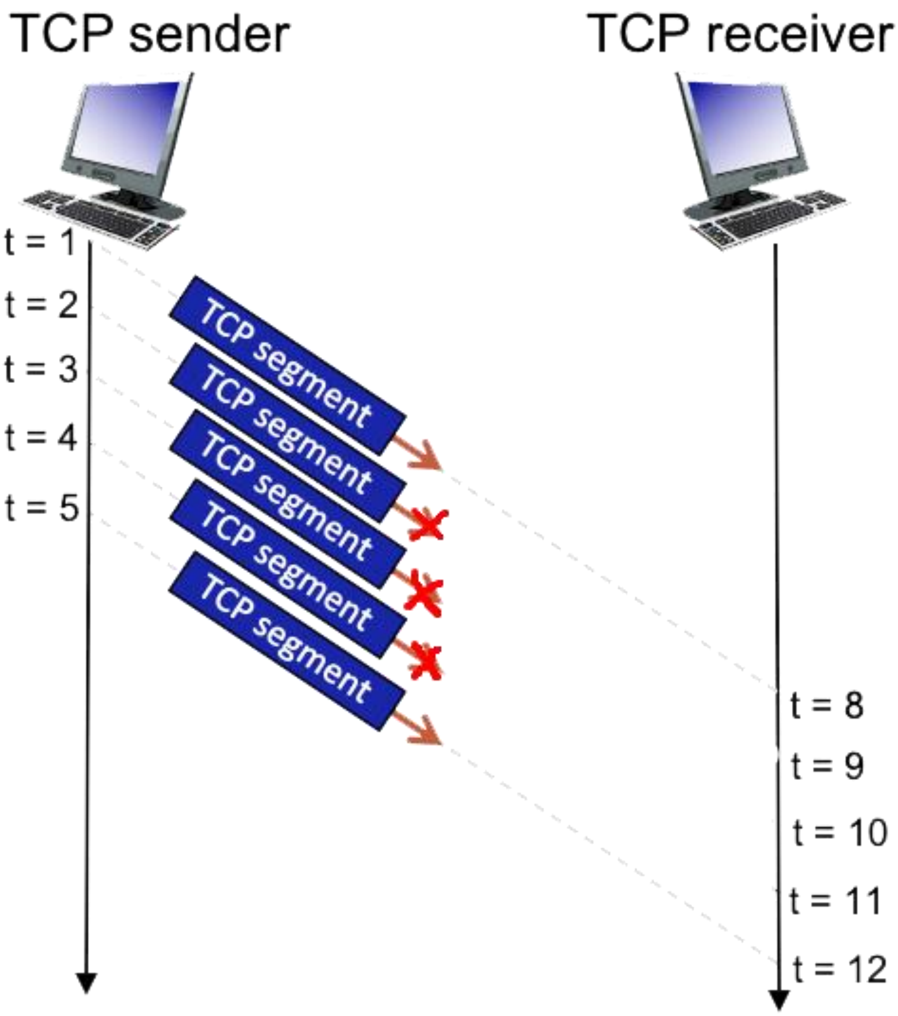
  a) 11011101 01010000 this binary number is 56656 decimal (base 10)

  b) 11000000 10110011 this binary number is 49331 decimal (base 10)

  c) 00000010 11010110 this binary number is 726 decimal (base 10)

  d) 00100110 10111000 this binary number is 9912 decimal (base 10)

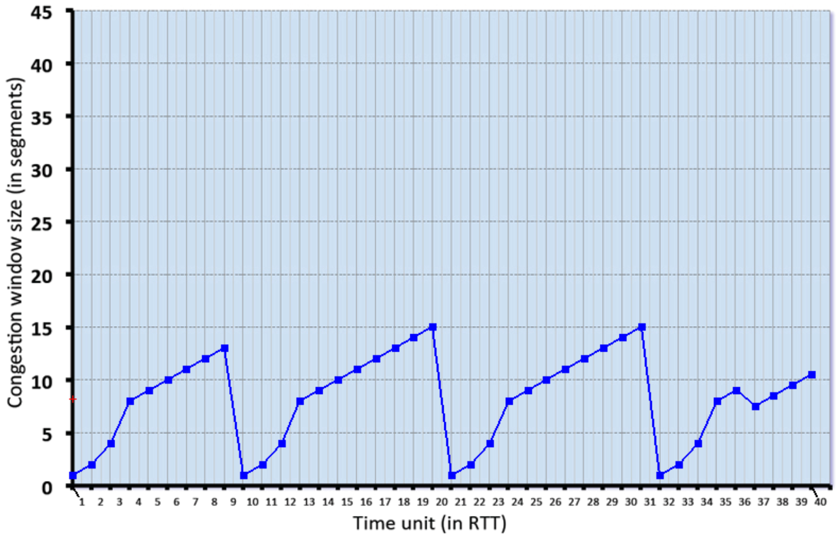
- P2(4pt). Consider the figure below in which a TCP sender and receiver communicate over a connection in which the sender->receiver segments may be lost. The TCP sender sends an initial window of 5 segments. Suppose the initial value of the sender->receiver sequence number is 421 and the first 5 segments each contain 759 bytes. The delay between the sender and receiver is 7 time units, and so the first segment arrives at the receiver at t=8. As shown in the figure below, 3 of the 5 segment(s) are lost between the segment and receiver. Format your answers like 121, 332, 224, 322, 112.



a) Give the sequence numbers associated with each of the 5 segments sent by the sender. Format your answer. (2pt)

b) Give the ACK numbers the receiver sends in response to each of the segments. If a segment never arrives use 'x' to denote it. Format your answer. (2pt)

■ P3(6pt). Consider the figure below, which plots the evolution of TCP's congestion window at the beginning of each time unit (where the unit of time is equal to the RTT); see Figure 3.53 in the text. In the abstract model for this problem, TCP sends a "flight" of packets of size cwnd at the beginning of each time unit. The result of sending that flight of packets is that either (i) all packets are ACKed at the end of the time unit, (ii) there is a timeout for the first packet, or (iii) there is a triple duplicate ACK for the first packet. In this problem, you are asked to reconstruct the sequence of events (ACKs, losses) that resulted in the evolution of TCP's cwnd shown below.



Consider the evolution of TCP's congestion window in the example above and answer the following questions. The initial value of cwnd is 1 and the initial value of ssthresh (shown as a red +) is 8. You should write the answers like 1,3,5 (If none, submit the blank)

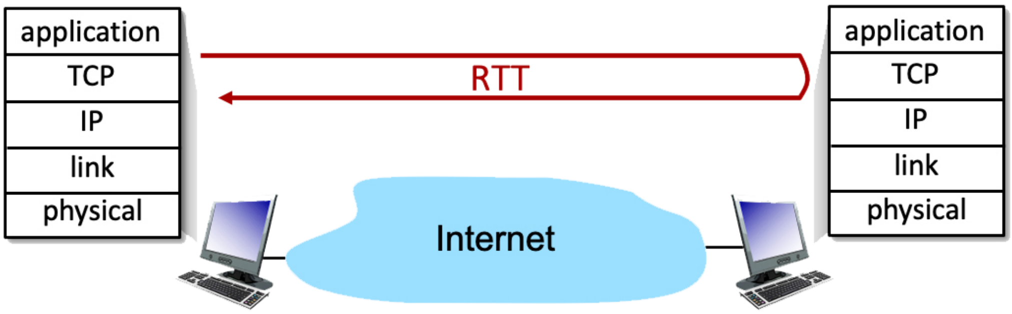
a) Give the times at which TCP is in slow start. Format your answer. (0.25 pt per time)

b) Give the times at which TCP is in fast recovery. Format your answer.

c) Give the times at which packets are lost via timeout. Format your answer.

d) Give the times at which packets are lost via triple ACK. Format your answer.

■ P4(9pt). Suppose that TCP's current estimated values for the round trip time (estimatedRTT) and deviation in the RTT (DevRTT) are 380 msec and 34 msec, respectively (see Section 3.5.3 for a discussion of these variables). Suppose that the next three measured values of the RTT are 350 msec, 330 msec, and 310 msec respectively.



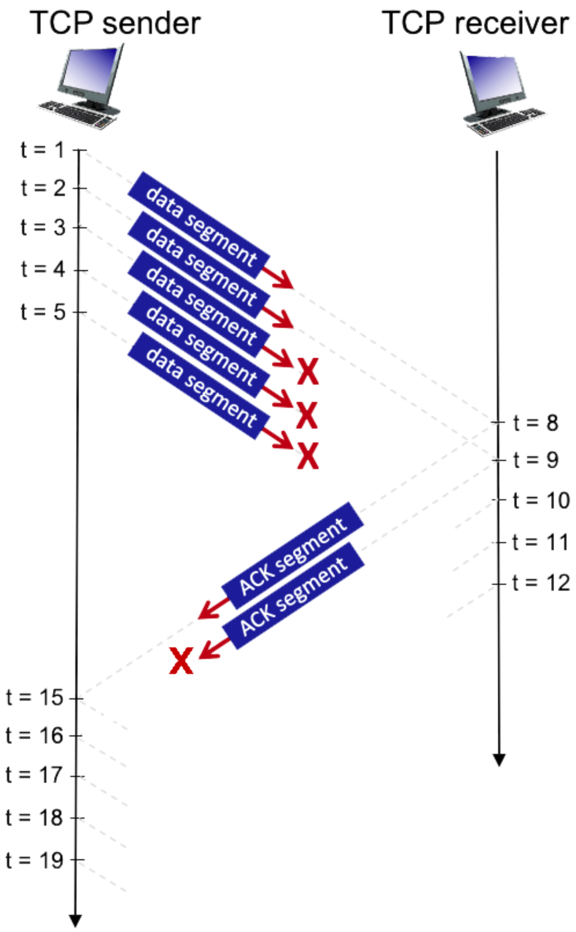
Compute TCP's new value of DevRTT, estimatedRTT, and the TCP timeout value after each of these three measured RTT values is obtained. Use the values of $\alpha = 0.125$, and $\beta = 0.25$. Round your answers to two decimal places after leading zeros.

a) What is the estimatedRTT, RTT Deviation, and TCP timeout after the first RTT? (1 pt per component)

b) What is the estimatedRTT, RTT Deviation, and TCP timeout after the second RTT? (1 pt per answer)

c) What is the estimatedRTT, RTT Deviation, and TCP timeout after the third RTT? (1 pt per answer)

- P5(6pt). Consider the figure below in which a TCP sender and receiver communicate over a connection in which the segments can be lost. The TCP sender wants to send a total of 10 segments to the receiver and sends an initial window of 5 segments at t = 1, 2, 3, 4, and 5, respectively. Suppose the initial value of the sequence number is 156 and every segment sent to the receiver each contains 618 bytes. The delay between the sender and receiver is 7 time units, and so the first segment arrives at the receiver at t = 8, and an ACK for this segment arrives at t = 15. As shown in the figure, 3 of the 5 segments is lost between the sender and the receiver, but one of the ACKs is lost. Assume there are no timeouts and any out of order segments received are thrown out.



a) What is the sequence number of the segment sent at t=1, 2, 3, 4, 5? (2pt)

b) What is the value of the ACK sent at t=8, 9, 10, 11, 12? (If segment lost, write 'x', 2pt)

c) What is the sequence number of the segment sent at t = 15, 16, 17, 18, 19? (If ACK never arrives, write 'x', 2pt)

Chap 4.

Review Questions

- R6. Suppose the network layer provides the following service. The network layer in the source host accepts a segment of maximum size 1,200 bytes and a destination host address from the transport layer. The network layer then guarantees to deliver the segment to the transport layer at the destination host. Suppose many network application processes can be running at the destination host.
  a. Design the simplest possible transport-layer protocol that will get application data to the desired process at the destination host. Assume the operating system in the destination host has assigned a 4-byte port number to each running application process.
  b. What is the difference between routing and forwarding?
  c. What is the concept of Software-Defined Networks?

- R7. Describe how packet loss can occur at output ports. Can this loss be prevented by increasing the switch fabric speed?

- R8. Compare and contrast the IPv4 and the IPv6 header fields. Do they have any fields in common?

- R9. Explain the concept and purpose of subnetting in the IP addressing scheme. Describe the role of the subnet mask with a specific example

- R10. What are the units of data exchange called in the Network Layer?

- P6(2pt). What is the length (in bits) of an a) IPv4 address, and b) IPv6 address?

- P7(3pt). Consider a datagram network using 8-bit host addresses.
  Suppose a router uses longest-prefix matching, and has the following forwarding table:

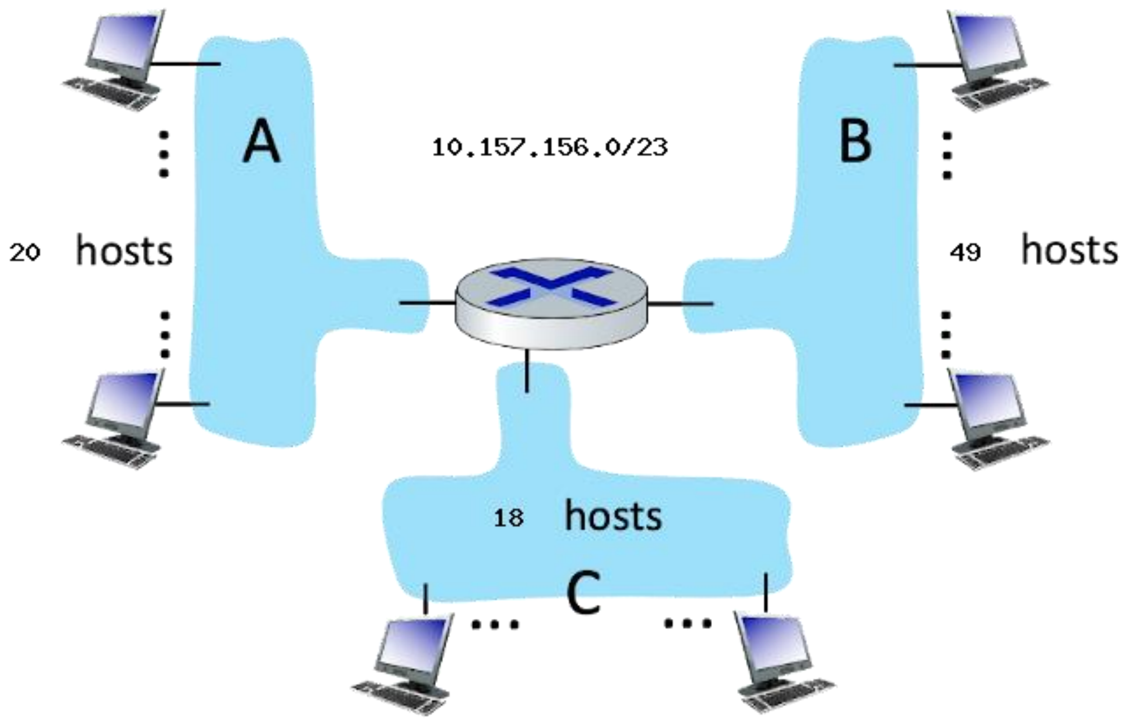
Prefix Match	Interface
00	1
01	2
001	3
011	4
100	5
otherwise	6

a) Suppose a datagram arrives at the router, with destination address 00011101. To which interface will this datagram be forwarded using the longest-prefix matching?

b) Suppose a datagram arrives at the router, with destination address 10011001. To which interface will this datagram be forwarded using the longest-prefix matching?

c) Suppose a datagram arrives at the router, with destination address 01111001. To which interface will this datagram be forwarded using the longest-prefix matching?

- P8(8pt). Consider the router and the three attached subnets below (A, B, and C). The number of hosts is also shown below. The subnets share the 23 high-order bits of the address space: 10.157.156.0/23



Assign subnet addresses to each of the subnets (A, B, and C) so that the amount of address space assigned is minimal, and at the same time leaving the largest possible contiguous address space available for assignment if a new subnet were to be added. Then answer the questions below.

a) Is the address space public or private?

b) How many hosts can there be in this address space?

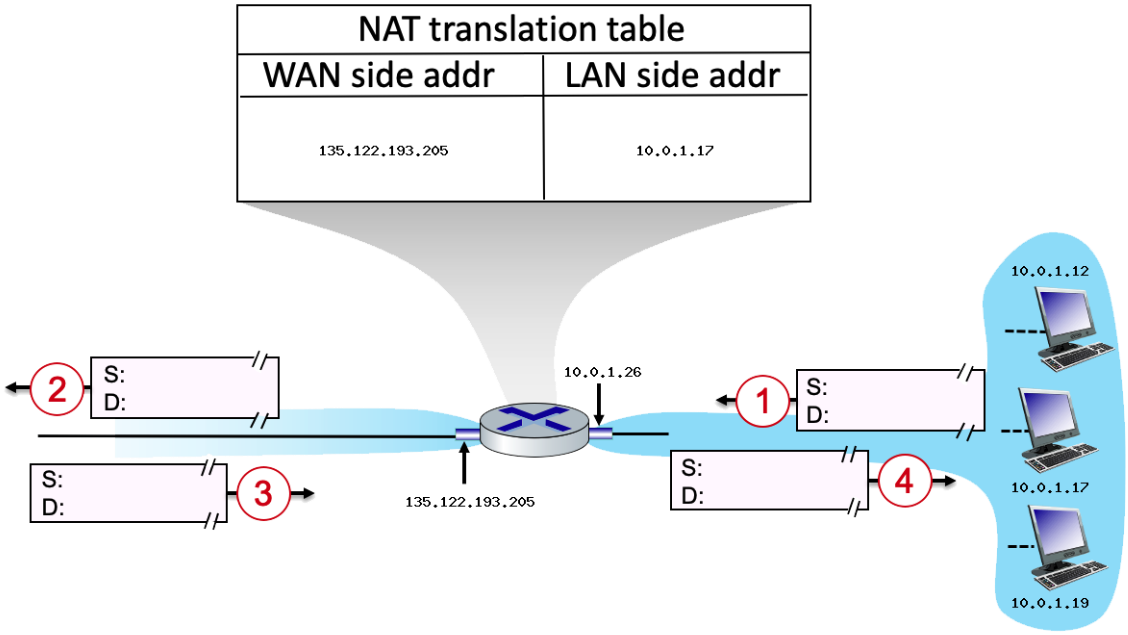
c) For subnet A, identify the subnet address, broadcast address, starting address, and ending address (CIDR notation, 0.5pt per address)

d) For subnet B, identify the subnet address, broadcast address, starting address, and ending address (CIDR notation, 0.5pt per address)

e) For subnet C, identify the subnet address, broadcast address, starting address, and ending address (CIDR notation, 0.5pt per address)

- P9(10pt). Consider the scenario below in which three hosts, with private IP addresses 10.0.1.12, 10.0.1.17, 10.0.1.19 are in a local network behind a NAT'd router that sits between these three hosts and the larger Internet. IP datagrams being sent from, or destined to, these three hosts must pass through this NAT router. The router's interface on the LAN side has IP address 10.0.1.26, while the router's address on the Internet side has IP address 135.122.193.205

  Before doing this problem, you might want to reread the section on the NAT protocol in section 4.3.4 in the text.



  Suppose that the host with IP address 10.0.1.17 sends an IP datagram destined to host 128.119.160.183. The source port is 3337, and the destination port is 80.

  a) Consider the datagram at step 1, after it has been sent by the host but before it has reached the router. What is the source IP address for this datagram?

  b) At step 1, what is the destination IP address?

  c) Now consider the datagram at step 2, after it has been transmitted by the router. What is the source IP address for this datagram?

  d) At step 2, what is the destination IP address for this datagram?

  e) Will the source port have changed? Yes or No.

f) Now consider the datagram at step 3, just before it is received by the router. What is the source IP address for this datagram?

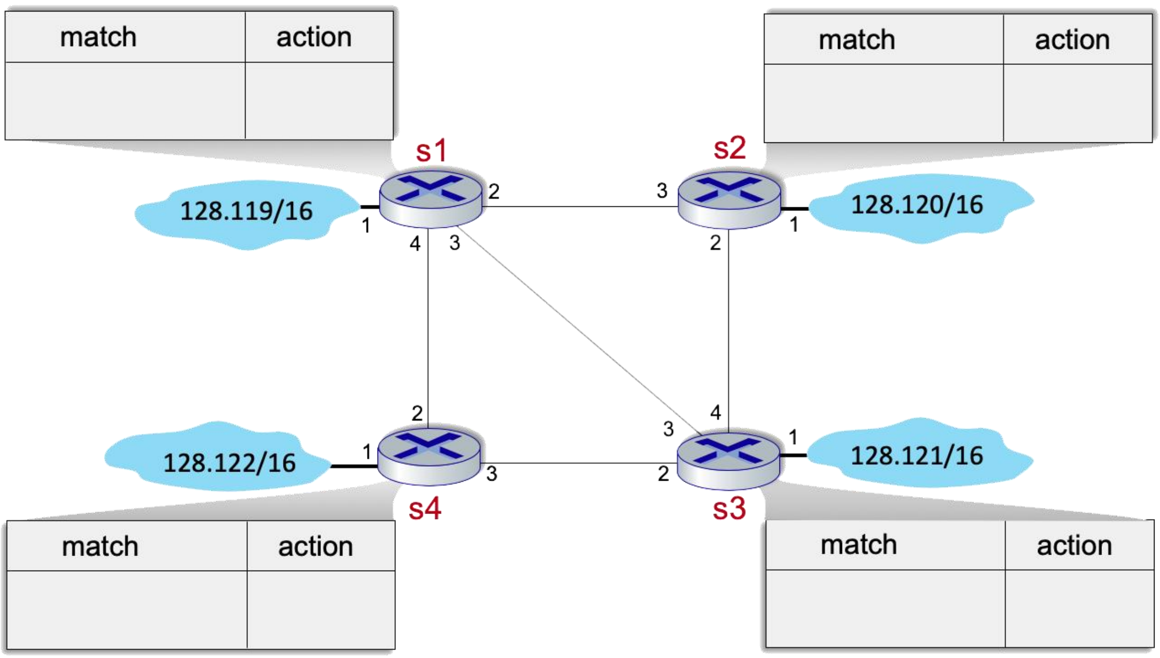
g) At step 3, what is the destination IP address for this datagram?

h) Last, consider the datagram at step 4, after it has been transmitted by the router but before it has been received by the host. What is the source IP address for this datagram?

i) At step 4, what is the destination IP address for this datagram

j) Has a new entry been made in the router's NAT table? Yes or No.

- P10(15pt). Consider the 4-router network shown below, where packet forwarding is controlled by flow tables (e.g., configured via OpenFlow in an SDN controller), rather than by a forwarding table computed by a routing algorithm. The addresses of networks attached to each of the routers are also shown. The interfaces at each of the routers are also as indicated.



Suppose we want the following forwarding behavior of packets to be implemented:

- Packets coming from the source network attached to s1 and destined to the network attached to s4 should be forwarded along the path: s1 -> s3 -> s4. Assume that at s4 that only TCP traffic is allowed to enter the network.

Complete the match-plus-action tables in each of the routers, s1, s2, s3, and s4, that implement these forwarding behaviors. Your rules should be as strict as possible (should only allow these behaviors, and no other forwarding behaviors). You can assume that any packet arriving at a router that does not match a rule in that table will be dropped.

a) For router s1, specify the values that should be used for each of the following fields: IP Src, IP Dst, Src Port, Dst Port. (specific address with CIDR notation, any, or none, 0.5 pt per value)

b) For router s3, specify the values that should be used for each of the following fields: IP Src, IP Dst, Src Port, Dst Port. (specific address with CIDR notation, any, or none, 0.5 pt per value)

c) For router s4, specify the values that should be used for each of the following fields: IP Src, IP Dst, Src Port, Dst Port. (specific address with CIDR notation, any, or none, 0.5 pt per value)

d) Identify which IP Protocol (TCP, UDP, or any) should be specified in the 'IP Proto' field for each of the following routers: s1, s3, and s4 (1pt per protocol)

e) Specify the appropriate rule action (such as forward, allow, deny, etc.) that should be implemented for each of the following routers: s1, s3, and s4. (1pt per action)

f) Identify the specific interface that should be used for packet forwarding on each of the following routers: s1, s3, and s4 (1pt per interface)