Spring 2024, CS 3611 : Computer Networks

Homework 4

Problem 1 Suppose two packets arrive to two different input ports of a router at exactly the same time. Also suppose there are no other packets anywhere in the router. (15 points)

1. Suppose the two packets are to be forwarded to two different output ports. Is it possible to forward the two packets through the switch fabric at the same time when the fabric uses a shared bus? (5 points)
2. Suppose the two packets are to be forwarded to two different output ports. Is it possible to forward the two packets through the switch fabric at the same time when the fabric uses switching via memory? (5 points)
3. Suppose the two packets are to be forwarded to the same output port. Is it possible to forward the two packets through the switch fabric at the same time when the fabric uses a crossbar? (5 points)

Problem 2 Consider a datagram network using 32-bit host addresses. Suppose a router has four links, numbered 0 through 3, and packets are to be forwarded to the link interfaces as follows: (15 points)

Destination Address Range	Link Interface
11100000 00000000 00000000 00000000 through 11100000 00111111 11111111 11111111	0
11100000 01000000 00000000 00000000 through 11100000 01000000 11111111 11111111	1
11100000 01000001 00000000 00000000 through 11100001 01111111 11111111 11111111	2
otherwise	3

1. Provide a forwarding table that has four entries, uses longest prefix matching, and forwards packets to the correct link interfaces. (5 points)

2. Rewrite this forwarding table using the a.b.c.d/x notation instead of the binary string notation. (5 points)

3. Describe how your forwarding table determines the appropriate link interface for datagrams with destination addresses: (5 points)

11000000 00010001 01010001 01010101

11100000 01000000 11000011 00111100

11100001 10000000 00010001 01110111

11001000 10010001 01010001 01010101

Problem 3 Consider the topology shown below. (10 points)

1. Assign network addresses to each of these six subnets, with the following constraints: 214.20.254/23; Subnet A should have enough addresses to support 250 interfaces; Subnet B should have enough addresses to support 120 interfaces; and Subnet C should have enough addresses to support 120 interfaces. Of course, subnets D, E and F should each be able to support two interfaces. For each subnet, the assignment should take the form a.b .c.d/x or a. b. c .d/x – e. f. g. h/y. (5 points)

2. Using your answer to part 1, provide the forwarding tables (using longest prefix matching) for each of the three routers. (5 points)

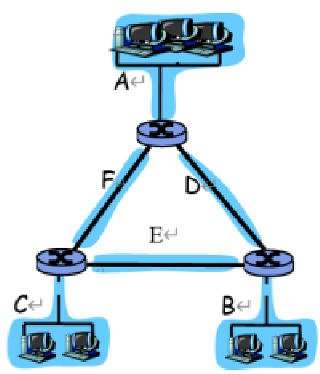

Figure 1: The topology in P3

Problem 4 Please explain why we need IPv6 to replace IPv4. (10 points)

Problem 5 Describe how packet loss can occur at input ports. Describe how packet loss at input ports can be eliminated (without using infinite buffers). (5 points)

Problem 6 Describe how packet loss can occur at output ports. Can this loss be prevented by increasing the switch fabric speed? (5 points)

Problem 7 Consider sending a 2000-byte datagram into a link that has an MTU of 788 bytes. Suppose the original datagram is stamped with the identification number 432. How many fragments are generated? What are the values in the various fields in the IP datagram(s) generated related to fragmentation? (10 points)

Problem 8 Company A needs 1024 IP addresses from an ISP who owns network prefix 206.0.64.0/18. (20 points)

Company A has 4 departments: Department1 requires 510 addresses which is further divided into 4 LANs(LAN1 LAN4); Department2 requires 256 addresses which is further divided into 4 LANs(LAN5 LAN8); Department3 requires 128 addresses which is further divided into 2 LANs(LAN9 LAN10); Department4 requires 128 addresses which is further divided into 2 LANs(LAN11 LAN12) . Another subnet LAN0 only needs 1 public IP address which uses NAT. please assign IP prefix to these 13 subnets with CIDR (Classless Inter-Domain Routing) technology.

network	network prefix	network mask	network	network prefix	network mask
LAN0			LAN7		
LAN1			LAN8		
LAN2			LAN9		
LAN3			LAN10		
LAN4			LAN11		
LAN5			LAN12		
LAN6					

Problem 9 (10 points) Assuming TCP Reno is the protocol experiencing the behavior shown in Figure 2, answer the following questions. In all cases, you should provide a short discussion justifying your answer.

1. Identify the intervals of time when TCP slow start is operating.
2. After the 16^{th} transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?
3. After the 22^{nd} transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?
4. What is the initial value of ssthresh at the first transmission round?
5. What is the value of ssthresh at the 19^{th} transmission round?
6. What is the value of ssthresh at the 23^{th} transmission round?

7. During what transmission round is the 90^{th} segment sent?

8. Assuming a packet loss is detected after the 26^{th} round by the receipt of a triple duplicate ACK, what will be the values of the congestion window size and of ssthresh?

9. Suppose TCP Tahoe is used (instead of TCP Reno), and assume that triple duplicate ACKs are received at the 16^{th} round. What are the ssthresh and the congestion window size at the 20^{th} round?

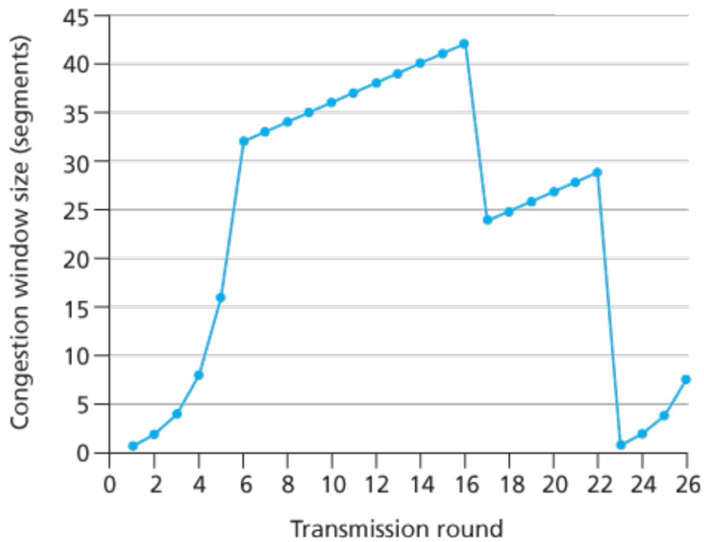

Figure 2: TCP window size as a function of time