MPCS 54001, Winter 2021

Homework 4 - Solutions

Due: February 11 at 5:30 pm

Submit your assignment to Gradescope. This work must be entirely your own. If you need help, post questions to Ed Discussion and/or visit the staff during office hours. As a reminder, if you make a public post on Ed Discussion, please don't give away the answer!

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1. Describe the following packet scheduling disciplines: first-in first-out (FIFO), priority, round robin (RR), and weighted fair queueing (WFQ). Which algorithm is susceptible to starvation (i.e., a class of packets is perpetually denied service)? What is the difference between RR and WFQ packet scheduling? Is there a case where RR and WFQ will behave in exactly the same way? (25 points)

   FIFO selects packets in the same order in which they arrived. Priority selects packets from the highest priority class with at least one packet available for transmission (FIFO is used within each class). RR alternates among the various service classes by sending one packet from each class (if a packet is available). WFQ is a generalization of RR where each service class is allowed to transmit a number of packets at once proportional to its weight.

   Priority scheduling is the scheduling discipline susceptible to starvation.

   With RR, all service classes are treated equally, i.e., no service class has priority over any other service class. With WFQ, service classes are treated differently, i.e., each class may receive a differential amount of service in any interval of time. When a WFQ's classes all have the same amount of service weight, the WFQ is identical to RR.

2. 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	0

01	1
100	1
101	2
11	3

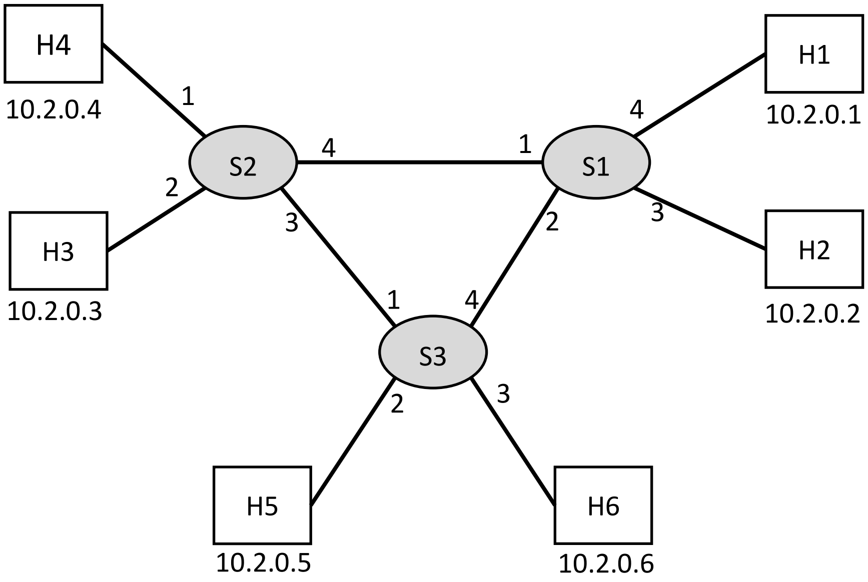
For each of the four interfaces, give the associated range of destination host addresses and the number of addresses in the range. (25 points)

Destination Address Range	Interface	Number of Addresses
00000000 through 00111111	0	2^6=64
01000000 through 01111111	1	2^6=64
10000000 through 10011111	1	2^5=32
10100000 through 10111111	2	2^5=32
11000000 through 11111111	3	2^6=64

3. Consider sending a 2400-byte datagram into a link that has an MTU of 700 bytes. Suppose the original datagram is stamped with the identification number 422. How many fragments are generated? What are the fragmentation-related IP datagram header fields? What are their values for this example? (25 points)

The maximum size of data field in each fragment = 680 (because there are 20 bytes of IP header). Thus the number of required fragments is 4. The fragmentation-related IP datagram header fields are the following: identifier, flags, and fragmentation offset. Each fragment will have identification number 422. Each fragment except the last one will be of size 700 bytes (including IP header). The last datagram will be of size 360 bytes (including IP header). The offsets of the 4 fragments will be 0, 85, 170, 255. Each of the first 3 fragments will have flag=1; the last fragment will have flag=0.

4. Consider the OpenFlow network shown in the following figure. (25 points)



Specify the flow table entries in router S1 assuming the following forwarding behavior.

a. Any packets arriving on input port 1 from hosts H3 or H4 that are destined to hosts H5 or H6 should be forwarded over output port 2.
b. Any packets arriving on input port 2 from hosts H5 or H6 that are destined to hosts H3 or H4 should be forwarded over output port 1.
c. Any arriving packets on input ports 1 or 2 and destined to hosts H1 or H2 should be delivered to the host specified.
d. Hosts H1 and H2 should be able to send packets to each other.

S1 Flow Table	
Match	Action
Ingress Port = 1 IP Src = 10.2.*.* IP Dst = 10.3.*.*	Forward(2)
Ingress Port = 2 IP Src = 10.3.*.* IP Dst = 10.2.*.*	Forward (1)

Ingress Port = 1 IP Dst = 10.1.0.2
Ingress Port = 2 IP Dst = 10.1.0.2
Ingress Port = 1 IP Dst = 10.1.0.1
Ingress Port = 2 IP Dst = 10.1.0.1
	Forward(3)
	Forward(3)
	Forward(4)
	Forward(4)

Ingress Port = 4
Ingress Port = 3
	Forward(3)
	Forward(4)