Computer Networking Homework 5

1. (5%) What is the fundamental difference between a router and link-layer switch?

   A network-layer packet is a datagram. A router forwards a packet based on the packet's IP (layer 3) address. A link-layer switch forwards a packet based on the packet's MAC (layer 2) address.

2. (a) (5%) What are the main functions of the data plane?

   The main function of the data plane is packet forwarding, which is to forward datagrams from their input links to their output links

   (b) (5%) What are the main functions of the control plane?

   A control plane is responsible for executing routing protocols, responding to attached links that go up or down, communicating with remote controllers, and performing management functions.

3. (10%) What is an essential different between RR and WFQ packet scheduling? Is there a case where RR and WFQ will behave exactly the same? (Hint: Consider the WFQ weights)

   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 all classes have the same amount of service weight, the WFQ is identical to RR.

4. (20%) 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:

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

a. (10%) Provide a forwarding table that has five entries, uses longest prefix matching, and forwards packets to the correct link interfaces.

Prefix Match	Link Interface
11100000 00000000	0
11100000 00000001	1
1110000	2
11100011	3
otherwise	3

b. (10%) Describe how your forwarding table determines the appropriate link interface for datagrams with destination addresses:

11001000 10010001 01010001 01010101
11100001 01000000 11000011 00111100
11100001 10000000 00010001 01110111

Prefix match for first address is 5th entry: link interface 3
Prefix match for second address is 1st entry: link interface 0
Prefix match for third address is 4th entry: link interface 2

5. (10%) Consider a subnet with prefix 128.119.40.128/26.

a. (5%) Give an example of one IP address (of form xxx.xxx.xxx.xxx) that can be assigned to this network.

Any IP address in range 192.168.40.128 to 192.168.40.191.

b. (5%) Suppose an ISP owns the block of addresses of the form 128.119.40.64/26. Suppose it wants to create four subnets from this block, with each block having the same number of IP addresses. What are the prefixes (of form a.b.c.d/x) for the four subnets?

Four equal size subnets: 192.168.40.112/28, 192.168.40.96/28, 128.119.40.80/28, 192.168.40.64/28.

6. (10%) 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 values in the various fields in the IP datagram(s) generated related to fragmentation?

   The maximum size of data field in each fragment = 680, because there are 20 bytes IP header. Thus the number of required fragments = ⌈ (2400-20) / 680 ⌉ = 4

   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.

7. (10%) Suppose datagrams are limited to 1500 bytes (including header) between source Host A and destination Host B. Assuming a 20-byte IP header, how many datagrams would be required to send an MP3 consisting of 5 million bytes? Explain how you computed the answer.

   (Without TCP) Number of datagrams required 3379

   (With TCP) Number of datagrams required 3425

8. (15%) Consider the network setup in figure. Suppose that the ISP instead assigns the router the address 24.34.112.235 and that the network address of the home network is 192.168.1/24.

   (a) (5%) Assign addresses to all interfaces in the home network.

   Home addresses: 192.168.1.1, 192.168.1.2, 192.168.1.3 with the router interface being 192.168.1.4

   (b)(10%) Suppose each host has two ongoing TCP connections, all to port 80 at host 128.119.40.86. Provide the six corresponding entries in the NAT translation table.

NAT Translation Table

WAN Side	LAN Side
24.34.112.235, 4000	192.168.1.1, 3345
24.34.112.235, 4001	192.168.1.1, 3346
24.34.112.235, 4002	192.168.1.2, 3445
24.34.112.235, 4003	192.168.1.2, 3446
24.34.112.235, 4004	192.168.1.3, 3545
24.34.112.235, 4005	192.168.1.3, 3546

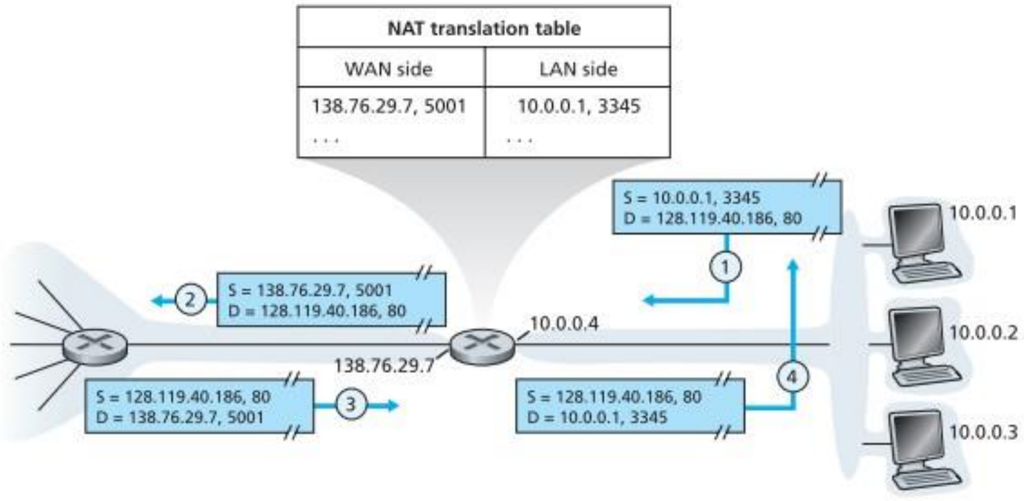

Figure 4.22 ♦ Network address translation

9. (10%) Consider the SDN OpenFlow network shown in Figure. Suppose that the desired forwarding behavior for datagrams arriving from host h3 or h4 as s2 is as follows:

- any datagrams arriving from host h3 and destined for h1, h2, h5 or h6 should be forwarded in a clockwise direction in the network;
- any datagrams arriving from host h4 and destined for h1, h2, h5 or h6 should be forwarded in a counter-clockwise direction in the network.

Specify the flow table entries in s2 that implement this forwarding behavior.

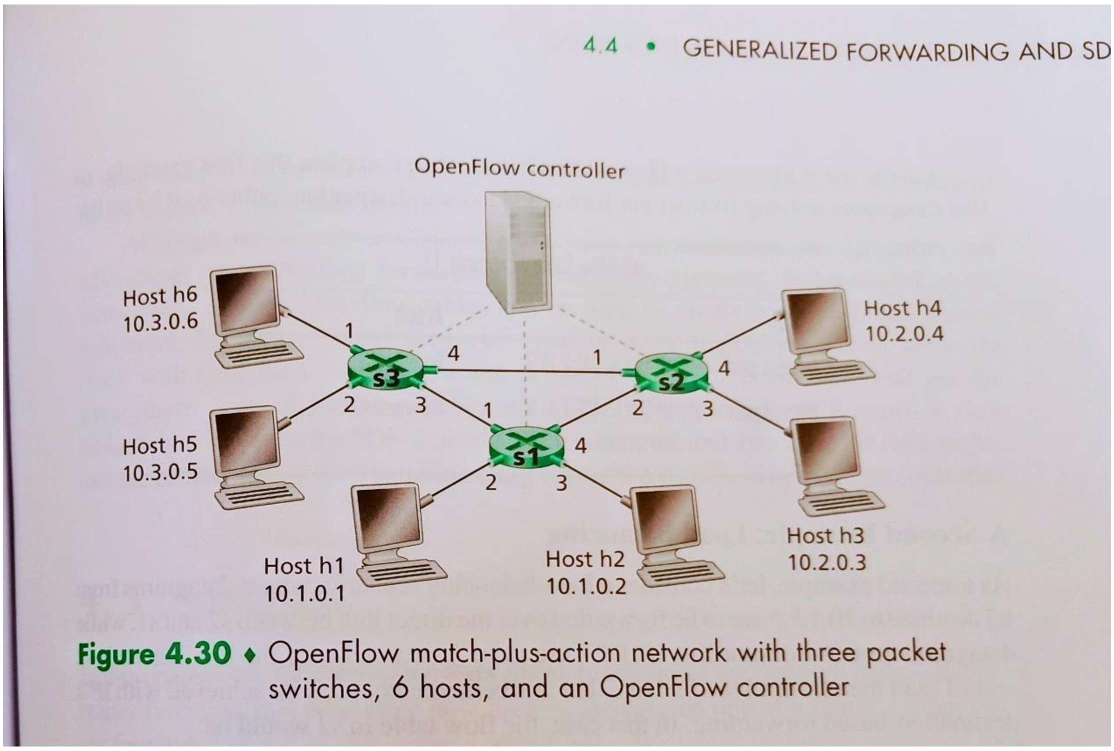

Figure 4.30 ♦ OpenFlow match-plus-action network with three packet switches, 6 hosts, and an OpenFlow controller

S2 Flow Table	
Match	**Action**
Ingress Port = 3; IP Dst = 10.1.*.*	Forward (2)
Ingress Port = 3; IP Dst = 10.3.*.*	Forward (2)
Ingress Port = 4; IP Dst = 10.1.*.*	Forward (1)
Ingress Port = 4; IP Dst = 10.3.*.*	Forward (1)