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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.

(a) 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?

(b) 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?

(c) 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 crossbar?

Write your solution to Problem 1 in this box

1.

a. No, It is not possible to forward 2 packets through the switch fabric at the same time when the fabric uses a shared bus because a shared bus only allows 1 packets to transfer at a single time.

b. No, It is not possible to forward 2 packets through the switch fabric at the same time when the fabric uses switching via memory because from input to output, it is connected via a single bus. Thus, then again only 1 packet can be forwarded via single bus at the particular time. Thus, it is impossible to forward 2 packets at the same time.

c. Yes, It is possible to forward 2 packets through the switch fabric at the same time when the fabric uses a crossbar because a crossbar design to have 2n buses that connect one input to another output. Thus, if we send 2 packets, 1 will send via first bus, and the other will send via another bus, which go to the different output port.

Problem 2

Consider a router that interconnects three subnets: Subnet 1, Subnet 2, and Subnet 3. Suppose all of the interfaces in each of these three subnets are required to have the prefix 223.1.17/24. Also suppose that Subnet 1 is required to support at least 60 interfaces, Subnet 2 is to support at least 90 interfaces, and Subnet 3 is to support at least 12 interfaces. Provide three subnet addresses (of the form `a.b.c.d/x`) that satisfy the constraints. You may use the following link to help verify your result: `http://jodies.de/ipcalc`.

Write your solution to Problem 2 in this box

2. 223.1.17/24, subnet 1 support 60 interfaces, subnet 2 support 90 interfaces, and subnet 3 support 12 interfaces. Thus,
Subnet 2 need 90 interfaces -> at least needs $2^7 = 128$, 7 bits
Subnet 1 need 60 interfaces -> at least needs $2^6 = 64$, 6 bits
Subnet 3 need 12 interfaces -> at least needs $2^4 = 16$, 4 bits
Thus,
Subnet 2 = 223.1.17.0/25 to 223.1.17.127/25
Subnet 1 = 223.1.17.128/26 to 223.1.17.191/26
Subnet 3 = 223.1.17.192/28 to 223.1.17.207/28

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.

Problem 3

Consider sending a 2400 B datagram into a link that has an MTU (maximum transmission unit) of 700 B. Suppose the original datagram is stamped with the identification number 422.

(a) How many fragments are generated?

(b) What are the values in the various fields in the IP datagram(s) generated related to fragmentation?

Write your solution to Problem 3 in this box

3.

a. Since MTU is 700 B -> 700 - 20 (header) = 680 B,

Fragments generated are 2400 B / 680 B = 4 fragments

b. Each fragment has identification number of 422

Each fragment will of size 700 B (except for the last one)

Last datagram will be the size of 360 B

Offset of 4 fragments are 0, 85, 170, 255.

Each of first 3 fragments will have flag 1, last fragment will have flag 0

Problem 4

In this problem we will explore the impact of NATs on P2P applications. Suppose a peer with username Arnold discovers through querying that a peer with username Bernard has a file it wants to download. Also suppose that Bernard and Arnold are both behind a NAT. Try to devise a technique that will allow Arnold to establish a TCP connection with Bernard without application-specific NAT configuration. If you have difficulty devising such a technique, discuss why.

Write your solution to Problem 4 in this box

4. There will be a problem or difficulty since it is impossible to establish a TCP connection between Arnold and Bernard without application-specific NAT configuration because both of them are behind NAT. As a result, NAT will drop the handshake between TCP and SYN packet from WAN side.

Problem 5

Consider the SDN OpenFlow network shown as follows. Suppose that the desired forwarding behavior for datagrams arriving at s2 is as follows:

- Any datagrams arriving on input port 1 from hosts h5 or h6 that are destined to hosts h1 or h2 should be forwarded over output port 2;
- Any datagrams arriving on input port 2 from hosts h1 or h2 that are destined to hosts h5 or h6 should be forwarded over output port 1;
- Any arriving datagrams on input ports 1 or 2 and destined to hosts h3 or h4 should be delivered to the host specified;
- Host h3 and h4 should be able to send datagram to each other.

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

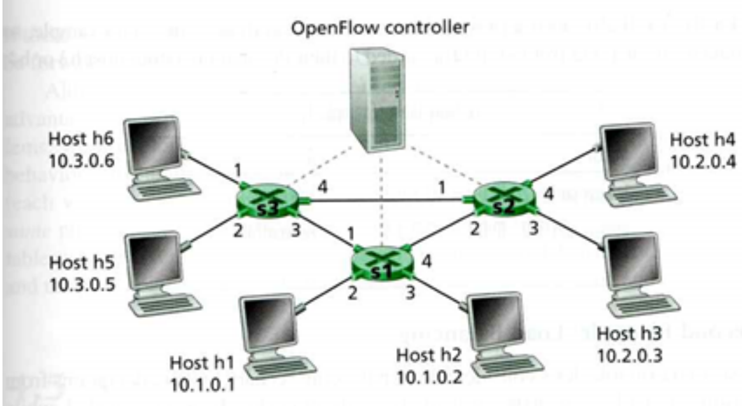

Figure 4.30 ♦ OpenFlow match-plus-action network with three packet switches, 6 hosts, and an OpenFlow controller

Write your solution to Problem 5 in this box

5. S2 Flow Table

Match	Action
Ingress port=1, IP src=10.3.*.*, IP dest=10.1.*.*	Forward(2)
Ingress port=2, IP src=10.1.*.*, IP dest=10.3.*.*	Forward(1)
Ingress port=1, IP dest=10.2.0.3	Forward(3)
Ingress port=2, IP dest=10.2.0.3	Forward(3)
Ingress port=1, IP dest=10.2.0.4	Forward(4)
Ingress port=2, IP dest=10.2.0.4	Forward(4)
Ingress port = 4, IP dest=10.2.0.3	Forward(3)
Ingress port = 3, IP dest=10.2.0.4	Forward(4)