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

a. No, in a shared bus system, you can only transmit one packet at a time.

b. No only one memory read or write can be done.

c. No, can only send one packet at a time in crossbar.

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 8 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

For subnet one, need 6 bits (2^6). Thus, we can have a total of 26 bits used.
meaning, 223.1.17.0/26 to 223.1.17.63/26.

For subnet two, need 7 bits meaning 223.1.17.64/25 to 223.1.17.191/25

For subnet three, need 3 bits meaning 223.1.17.192/29 to 223.1.17.199/29.

Problem 3

Consider sending a datagram with total length 2400 B into a link that has an MTU (maximum transmission unit) of 800 B. Suppose the original datagram is stamped with the identification number 421.

(a) How many fragments are generated?

(b) What are the values in the various fields (header length, total length, identification, MF flag, fragment offset, and IP payload size) in the IP datagram(s) generated related to fragmentation?

Write your solution to Problem 3 in this box

a. ip header is 20B
MTU is 800B.

Need to generate 2400-20 = 2380/800 = 3 fragments.

b. identification is 421. the fragment bit of the 1 and 2 frags need to be set to 1, but the last fragment header bit needs to be set to 0 to mark the end of fragments.

the offset of the first is offset is 2400/8 = 300 total offset spaces.

the first datagram is offset 0 to 100
the second datagram is offset 101 to 201
the final third one is offset 202 to 300

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

It is not possible to design such a technique.

To establish a TCP connection, either Arnold or Bernard needs to initiate the connection. The problem is that the NAT since both P2P user are behind NAT, they cannot establish a direct TCP connection as the NAT will drop the handshake of TCP.

Problem 5

Consider the SDN OpenFlow network shown as follows. Suppose that the desired forwarding behavior for datagrams arriving at `s3` is as follows:

- Any datagrams arriving on input port 4 from hosts `h3` or `h4` that are destined to hosts `h1` or `h2` should be forwarded over output port 3;
- Any datagrams arriving on input port 3 from hosts `h1` or `h2` that are destined to hosts `h3` or `h4` should be forwarded over output port 4;
- Any arriving datagrams on input ports 3 or 4 and destined to hosts `h5` or `h6` should be delivered to the host specified;
- Host `h5` and `h6` should be able to send datagram to each other.

Specify the flow table entries in `s3` that implement this forwarding behavior.

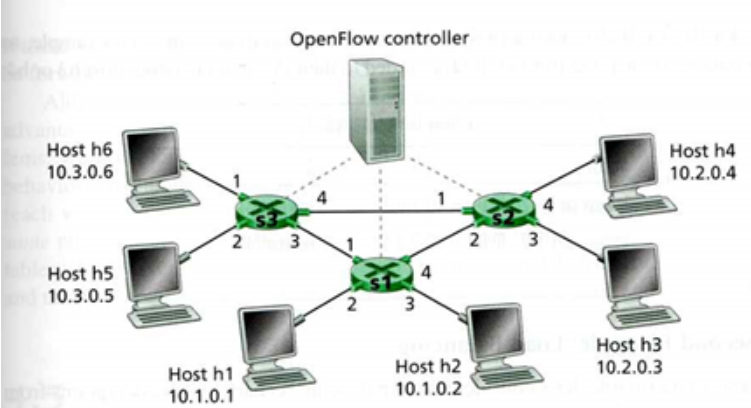

Figure 4.30 ♦ OpenFlow match-plus-action network with three packet switches, 6 hosts, and an OpenFlow controller

Problem 5 continued on next page...

Write your solution to Problem 5 in this box

Match	Action
dst: 10.3.0.6	forward(1)
dst: 10.3.0.5	forward(2)
ingress port: 4 src: 10.2.0.* dst: 10.1.0.*	forward(3)
ingress port: 3 src: 10.1.0.* dst: 10.2.0.*	forward(4)