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, one shared bus only allows one packet at a time

(b) No. Because input is connected to output via a single bus, as the same reason in (a) only one packet is allowed in one shared bus at a time.

(c) Yes, there are total 2n buses. One packet can be sent through a bus while the other packet is sent via another bus.

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

Subnet2 needsat least 7 bits
Subnet1 needsat least 6 bits
Subnet3 needsat least 4 bits

So,
Subnet2 has223.1.17.0/25 to 223.1.17.127/25
Subnet1 has223.1.17.128/26 to 223.1.17.191/26
Subnet3 has223.1.17.192/28 to 223.1.17.207/28

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

(a) payload = 700 - 20 = 680 B
So, there are 2400 / 680 = 4 fragments generated

(b) Identification number : 422
Size : 700 B
360 B (only for the last fragment)
Offset: 0, 85, 170, 255
Flags: 1
0 (only for the last fragment

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

Because both users are behind a NAT, the SYN packet will be dropped by NAT without application-specific NAT configuration.
So, it is impossible to establish a TCP connection.

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.

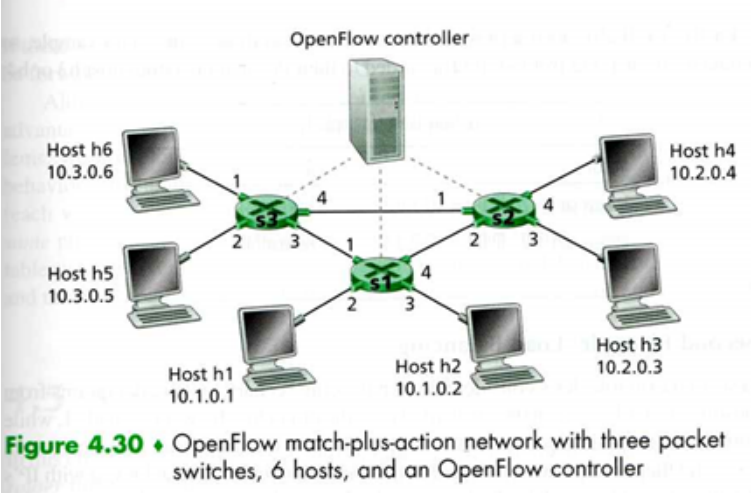

Figure 4.30 ♦ OpenFlow match-plus-action network with three packet switches, 6 hosts, and an OpenFlow controller

Problem 5 continued on next page...

Write your solution to Problem 5 in this box

Ingress Port	IP src	IP dest	Action
1	10. 3. *. *	10. 1. *. *	Forward (2)
2	10. 1. *. *	10. 3. *. *	Forward (1)
1		10. 2. 0. 3	Forward (3)
2		10. 2. 0. 3	Forward (3)
1		10. 2. 0. 4	Forward (4)
2		10. 2. 0. 4	Forward (4)
4		10. 2. 0. 3	Forward (3)
3		10. 2. 0. 4	Forward (4)