

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?

- (a) No, you can only transmit one packet at a time over a shared bus.
- (b) Yes, as discussed in the text, as long as the two packets use different input busses and different output busses, they can be forwarded in parallel.
- (c) No, in this case the two packets would have to be sent over the same output bus at the same time, which is not possible.

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>.

- 223.1.17.0/26
- 223.1.17.128/25
- 223.1.17.192/28

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?

The maximum size of data field in each fragment = 680 (because there are 20 bytes IP header). Thus the number of required fragments. 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 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.

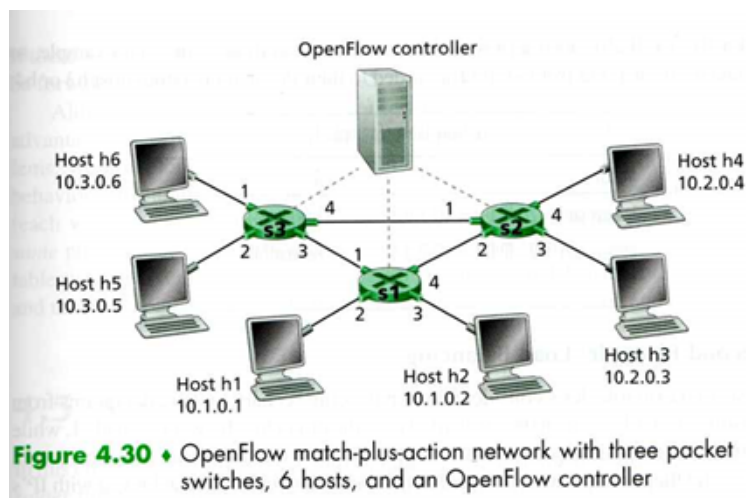
It is not possible to devise such a technique. In order to establish a direct TCP connection between Arnold and Bernard, either Arnold or Bob must initiate a connection to the other. But the NATs covering Arnold and Bob drop SYN packets arriving from the WAN side. Thus neither Arnold nor Bob can initiate a TCP connection to the other if they are both behind NATs.

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.



S2 Flow Table	
Match	Action
Ingress Port = 1; IP Src = 10.3.*.*; IP Dst = 10.1.*.*	Forward (2)
Ingress Port = 2; IP Src = 10.1.*.*; IP Dst = 10.3.*.*	Forward (1)
Ingress Port = 1; IP Dst = 10.2.0.3	Forward (3)
Ingress Port = 2; IP Dst = 10.2.0.3	Forward (3)
Ingress Port = 1; IP Dst = 10.2.0.4	Forward (4)
Ingress Port = 2; IP Dst = 10.2.0.4	Forward (4)
Ingress Port = 4	Forward (3)
Ingress Port = 3	Forward (4)