Computer Networks

Solutions to Homework #4

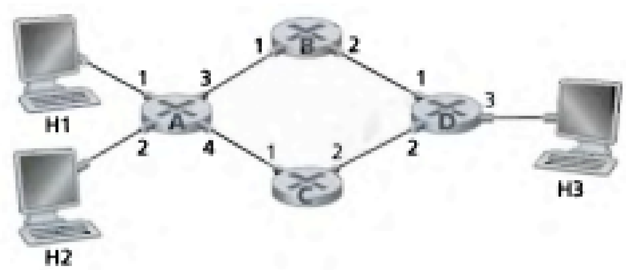
Chapter 4 - The Network Layer

P 4. Consider the network below.

a.Suppose that this network is a datagram network. Show the forwarding table in router A, such that all traffic destined to host H3 is forwarded through interface 3. b. Suppose that this network is a datagram network. Can you write down a forwarding table in router A, such that all traffic from HI destined to host H3 is forwarded through interface 3, while all traffic from H2 destined to host H3 is forwarded through interface 4? (Hint: this is a trick question.)

c.Now suppose that this network is a virtual circuit network and that there is one ongoing call between HI and H3, and another ongoing call between H2 and H3. Write down a forwarding table in router A, such that all traffic from HI destined to host H3 is forwarded through interface 3, while all traffic from H2 destined to host H3 is forwarded through interface 4.

d. Assuming the same scenario as (c), write down the forwarding tables in nodes B, C, and D.



Solution:

a) For Router A, data destined to host H3 is forwarded through interface 3.

Distention address	Link interface
H3	#3

b) No, because, for datagram networks, forwarding rule is only based only on destination address (not the source address).

c) One possible configuration for Router A is:

Incoming interface	Incoming VC#	Outgoing Interface	Outgoing VC#

1	12	3	22
2	63	4	18

Note, that the two flows could actually have the same VC numbers.

d) One possible configuration is: for Router B

Incoming interface	Incoming VC#	Outgoing Interface	Outgoing VC#
1	22	2	24

For Router C

Incoming interface	Incoming VC#	Outgoing Interface	Outgoing VC#
1	18	2	50

For Router D

Incoming interface	Incoming VC#	Outgoing Interface	Outgoing VC#
1	24	3	70
2	50	3	76

P 7. Suppose two packets arrive at different input ports of a router at exactly the same time. Also suppose there are no other packets 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 a *crossbar*?

c. Suppose the two packets are to be forwarded to the same output port. Is it possible to forward the two packets through the switch fabric at the same time when the fabric uses a *crossbar*?

Solution:

a) No, you can only transmit one packet at a time over a shared bus.

1 3

2 4

b) Yes, as long as the two packets use different input busses and different output busses, they can be forwarded in parallel.

1

2

3 4

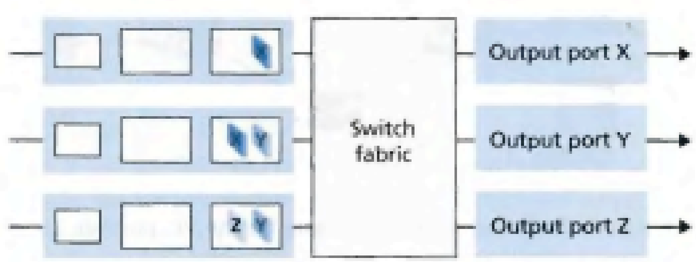
c) No, in this case the two packets would have to be sent over the same output bus at the same time, which is not possible.

1

2

3 4

P 9. Consider the switch shown below. Suppose that all datagrams have the same fixed length, that the switch operates in a slotted, synchronous manner, and that in one time slot a datagram can be transferred from an input port to an output port. The switch fabric is a crossbar so that at most one datagram can be transferred to a given output port in a time slot, but different output ports can receive datagrams from different input ports in a single time slot. What is the minimal number of time slots needed to transfer the packets shown from input ports to their output ports, assuming any input queue scheduling order you want? What is the largest number of slots needed, assuming the worst-case scheduling order you can devise, assuming that a non-empty input queue is never idle?



<u>Solution:</u>

The minimal number of time slots needed is 3. The scheduling is as follows. Slot 1: send X in top input queue, send Y in middle input queue.
Slot 2: send X in middle input queue, send Y in bottom input queue
Slot 3: send Z in bottom input queue.

Largest number of slots is still 3. Actually, based on the assumption that a non-empty input queue is never idle, we see that the first time slot always consists of sending X in the top input queue and Y in either middle or bottom input queue, and in the second time slot, we can always send two more datagram, and the last datagram can be sent in third time slot.

NOTE: Actually, if the first datagram in the bottom input queue is X, then the worst case would require 4 time slots.

P 10. 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. Provide a forwarding table that has four entries, uses longest prefix matching, and forwards packets to the correct link interfaces.

b. 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

Solition:

a)

Prefix Match Link Interface

11100000 00 0
11100000 01000000 1
1110000 2
11100001 1 3
otherwise 3

b) Prefix match for first address is 5th entry: link interface 3
Prefix match for second address is 3nd entry: link interface 2
Prefix match for third address is 4th entry: link interface 3

P 13. 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 up to 60 interfaces, Subnet 2 is to support up to 90 interfaces, and Subnet 3 is to support up to 12 interfaces. Provide three network addresses (of the form a.b.c.d/x) that satisfy these constraints.

Solution:

The parent network address is 223.1.17/24.
24 bits are prefix for the network. 8 bits can be used for subnet portions & host portions. Start with the largest required subnet (Subnet 2)

- Subnet #2 (90 interfaces)

Subnet
portion Host portion
128 64 32 16 8 4 2 1

With 7 bits, we can get 128 addresses (126 usable host addresses + 1 subnet address + 1 subnet broadcast address), which is > 90.
1 bit is left for the subnet portion (we can have 2 subnets, each with 128 addresses) 223.1.17.0/25 (range 223.1.17.0 to 223.1.17. 127)
223.1.17.128/25 (range 223.1.17.128 to 223.1.17. 255)
We assign one of those subnets to our Subnet #2 and further subnet the other range for out Subnet #1 & Subnet #3.

Subnet #2 223.1.17.128/25 , Mask 255.255.255.128

Subnet ID 223.1.17.128 , Subnet broadcast address

223.1.17.255 Hosts 223.1.17.129 to 223.1.17.254

- Subnet #1 (60 interfaces)

  The parent network 223.1.17.0/25 (32-25= 7 bits can be used for subnet portions & and host portions)

  portion Host portion

  Prefix to 0

  Subnet

  128 64 32 16 8 4 2 1 We can have 2 subnets, each with 64 addresses: 223.1.17.0/26 (range 223.1.17.0 to 223.1.17. 63) 223.1.17.64/26 (range 223.1.17.64 to 223.1.17. 127)

Subnet #1 223.1.17.0/26 , Mask 255.255.255.0
Subnet ID 223.1.17.0 , Subnet broadcast address
223.1.17.63 Hosts 223.1.17.1 to 223.1.17.62

- Subnet #3 (12 interfaces)

  The parent network is 223.1.17.64/26

  Prefix to 0 Subnet portion

  Prefix to 1 portion Host

  128 64 32 16 8 4 2 1

  We can have 4 subnets, each with 16 addresses:

  223.1.17.64/28 (range 223.1.17.64 to 223.1.17. 79)

  223.1.17.80/28 (range 223.1.17.80 to 223.1.17. 95)

  223.1.17.96/28 (range 223.1.17.96 to 223.1.17. 111)

  223.1.17.112/28 (range 223.1.17.112 to 223.1.17. 127)

  We assign one of these to our Subnet #3

Subnet #3 223.1.17.96/28 , Mask 255.255.255.96
Subnet ID 223.1.17.96 , Subnet broadcast address
223.1.17.111 Hosts 223.1.17.97 to 223.1.17.110

P 16. Consider a subnet with prefix 128.119.40.128/26. Give an example of one IP address (of form xxx.xxx.xxx.xxx) that can be assigned to this network. 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?

Solution:

Any IP address in range 128.119.40.128 to 128.119.40.191 can be an example.

Four equal size subnets:
128.119.40.64/28,
128.119.40.80/28,
128.119.40.96/28,
128.119.40.112/28