

## CS 536 Fall 2009 - Homework 2

Due 10/6/2009 in class

Total Points : 100

**Instructions.** Submit your homework electronically in a text or PDF file. Please use the blackboard to submit your homework by Oct 6th of 2009 before class. Late submission will not be accepted, nor will we allow group submissions. You can discuss with other students, but please write your own answers. Please also indicate the set of students you have discussed the problems with in case you collaborate.

To receive credit, all submissions should contain this statement at the beginning: “By turning in this homework submission, I certify that this work was done solely by me.”

### Problem 1 (10 pts)

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:

- 11100000 00000000 00000000 00000000 through 11100000 01111111 11111111 11111111 to interface 0
- 11100000 10000000 00000000 00000000 through 11100000 10000001 11111111 11111111 to interface 1
- 11100000 10000010 00000000 00000000 through 11100000 11111111 11111111 11111111 to interface 2
- otherwise to interface 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:

```
11101000 10010001 01010001 01010101
11100000 10000001 01000011 00111100
11100000 11000000 00010001 01110111
```

### Problem 2 (15 pts)

**Virtual Circuit Network.** Consider a virtual-circuit VC number is a 16-bit field.

1. What is the maximum number of virtual circuits that can be carried over a link ?

- Suppose a central node determines paths and VC numbers at connection setup. Suppose the same VC number is used on each link along with the VC's path. Describe how the central node might determine the VC number at connection setup. Is it possible that there are fewer VCs in progress than the maximum determined in part (a) yet there is no common free VC number ?
- Suppose that different VC numbers are permitted in each link along a VC's path. During connection setup, after an end-to-end path is determined, describe how the links can choose their VC numbers and configure their forwarding tables in a decentralized manner, without reliance on a central node.

### Problem 3 (15 pts)

#### Switch fabrics.

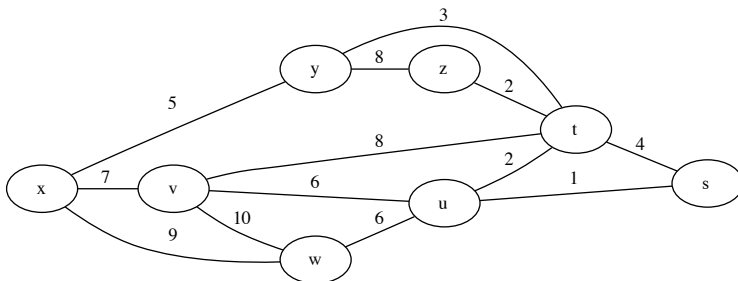
- Why would there be no input queueing if the switch fabric is  $n$  times faster than the input line rates, assuming  $n$  input lines all have the same line rate.
- Consider a router with a switch fabric with 2 input ports A and B, and 2 output ports C and D. Suppose the switch fabric operates at 1.5 times the line speed.
  - If, for some reason, all packets from A are destined to D, and all packets from B are destined to C, can a switch fabric be designed so that there is no input port queueing ? Explain why or why not in one sentence.
  - Suppose now packets from A and B are randomly destined to both C and D. Can a switch fabric be designed so that there is no input port queueing ? Explain why or why not in one sentence.

### Problem 4 (10 pts)

Consider a subnet with prefix 123.123.123.64/26. 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 123.123.128/17. 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?

### Problem 5 (20 pts)

Consider the network below:

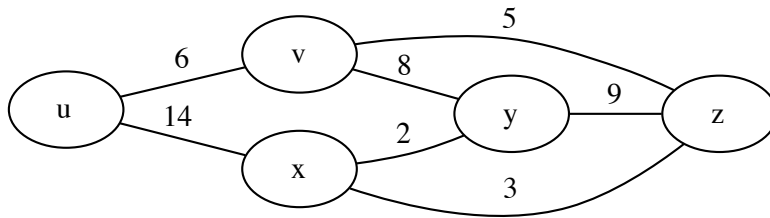


Using Dijkstra's algorithm, and showing your work using a table similar to the one shown in class slides, do the following:

- a. Compute the shortest path from  $s$  to all network nodes.
- b. Compute the shortest path from  $u$  to all network nodes.
- c. Compute the shortest path from  $x$  to all network nodes.
- d. Compute the shortest path from  $z$  to all network nodes.

### Problem 6 (10 pts)

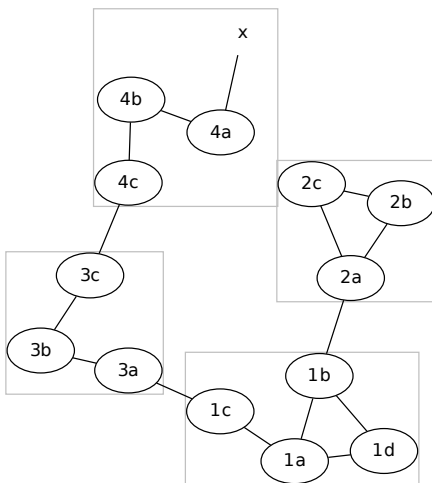
Consider the network below:



Assume each node initially knows the costs to each of its neighbors. Consider the distance-vector algorithm and show the distance entries at node  $z$ .

### Problem 7 (10 pts)

Consider the network below, which shows a network with 4 ASes (each enclosed in a box). Node identifiers begin with their AS number.



Suppose AS3 and AS2 are running OSPF for their intra-AS routing protocol. Suppose AS1 and AS4 are running RIP for their intra-AS routing protocol. Suppose eBGP and iBGP are used for the inter-AS routing protocol.

- a. Router 3c learns about prefix  $x$  from which routing protocol: OSPF, RIP, eBGP, or iBGP?
- b. Router 3a learns about  $x$  from which routing protocol?
- c. Router 1c learns about  $x$  from which routing protocol?
- d. Router 1d learns about  $x$  from which routing protocol?

### **Problem 8 (10 pts)**

What is the size of the multicast address space? Suppose now that two multicast groups randomly choose a multicast address. What is the probability that they choose the same address? Suppose now that 5,000 multicast groups are ongoing at the same time and choose their multicast group addresses at random. What is the probability that they interfere with each other?