ITS 323 – ASSIGNMENT 2 ANSWERS

Due Friday 21 August 2007, 5pm

10% of the final course mark

Name: _____

ID: _____

Mark (max: 62):

Instructions

1. This is an individual assignment. You must complete the assignment *on your own*. You should not work with others on this assignment – if you need help, then you should ask the lecturer!

2. The assignment can be neatly handwritten or typed on a computer.

3. You must give the final answers for questions on the space provided on the Assignment.

4. In Questions 3 and 4 you should include your calculations on the space provided (if there is not enough space, use the back of the sheet or attach additional sheets). Failing to show your calculations for a question may result in reduced or 0 marks, even if the answer is correct. (Calculations for Questions 1, 2 and 5 do not need to be shown, however if you do have calculations, include them on the back of the sheet).

5. Copying and other forms of plagiarism (e.g. copying answers from the Internet or textbooks) will be penalised.

6. You must submit a hardcopy of the assignment. Staple at the top left hand corner. Do not include plastic covers or bind the assignment in other ways. Email submission is not accepted.

7. Hints and/or clarifications of questions may be posted on the ITS323 mailing list.

Assumptions

Unless it is stated in the question, you can make the following assumptions:

1. Speed of transmission is the speed of light: 3×10^8 m/s

2. 1GB = 1000MB; 1MB = 1000KB; 1KB = 1000B; 1B = 8 bits

3. b = bit; B = Byte

4. Give the IP address in dotted decimal notation.

Special Case

If your ID contains zeros (e.g. 4812345670) then replace those zeros with 1 for the calculations. That is, your ID for calculations will be 4812345671. That is, there must be no 0's in the ID you use for calculation.

Question 1 [13 marks: 1, 2, 2, 2, 2, 2, 2]

Reverse your ID, and then using the first eight digits, take every two digits to form a dotted decimal IP address. For example, with ID 4812345678, you first reverse it (8765432148), take the first eight digits (87654321) and take the digits in pairs to create the IP address: 87.65.43.21.

IP Address: _____

Assuming your computer is using this calculated IP address, answer the following questions:

a) If classful addressing is used:

    i.   What is the class of the IP address?   Class: _____

    ii. How many computers, other than yours, can be located on the same network as yours?

Number of computers: _____

    iii. What IP address would your computer send to in order to reach all other computers on your network?

IP Address: _____

b) If classless addressing is used:

    i.   What is the network address with subnet mask /17?

IP Address: _____

    ii. How many computers, other than yours, can be located on the same network as yours?

Number of computers: _____

    iii. What IP address would your computer send to in order to reach all other computers on your network?

IP Address: _____

Answers

Using the example ID of 481234567, the IP address is 87.65.43.21.

Part (a)

With classful addressing, this IP address is a class A address. One way to determine this is that the first bit in all Class A addresses is 0. 87 in binary is 01010111. Also, this means that Class A address start with the range 1 through to 126 – 87 is within this range.

For Class A addresses, the last 24 bits are available for host addresses. Hence there are 2^{24} possible options. However, we cannot count the address with all 0's (used for the network address), the address with all 1's (used for broadcast), and of course the address of our computer. So the answer is $2^{24} - 3 = 16777213$.

As just stated, the host address with all 1's is used for broadcast to all other computers on the network. Hence this is 87.255.255.255.

Part (b)

With classless addressing, we use the subnet mask to determine the network. With a subnet mask of /17 means the first 17 bits of the subnet mask are 1. In dotted decimal notation this corresponds to the subnet mask 255.255.128.0. The network address can be found by taking the first 17 bits of the IP address, and setting the remaining 15 bits to 0. This gives 87.65.0.0.

With subnet mask with 17 bits, there are 15 bits remaining, giving 2^{15} possible hosts. Again, minus the two special cases and your computer, gives: $2^{15} - 3 = 32765$.

To determine the broadcast address, use the network portion (first 17 bits) and set the host portion to all 1's. In the example, this gives 87.65.127.21.

Question 2 [14 marks: 2, 2, 10]

In this question you will generate a network of 8 nodes. Your network can be defined in a 8x8 matrix, where the elements in the matrix identify the link cost from one node (row) to another (column). A value of 0 means there is no link from the node in the row to the node in the column (obviously, there is no link from node 1 to node 1, and so on). To generate your matrix, write your 10 digits (those generated in the previous step) in REVERSE ORDER into the *empty* boxes in the matrix below, row by row (that is, left to right in the first row, then continue left to right in the second row, and so on). Repeat the 10 digits as needed.

For example, if the ID is 4812345678, then we first reverse the digits (8765432148), then the first empty entry (column 2, row 1) would be 8, the second empty entry (column 3, row 1) would be 7, and the third empty entry (column 1, row 2) would be 6. The last empty entry (column 7, row 8) would be 1.

a) Complete your network connectivity matrix.

Network Connectivity Matrix

		To node …							
		1	2	3	4	5	6	7	8
From Node …	1	0			0	0	0	0	0
	2		0	0			0		0
	3		0	0	0			0	0
	4	0		0	0				0
	5	0				0		0	0
	6	0	0				0	0	
	7	0		0		0	0	0	
	8	0	0	0	0	0			0

b) Draw your network, indicating the direction of links and costs, on the figure below.
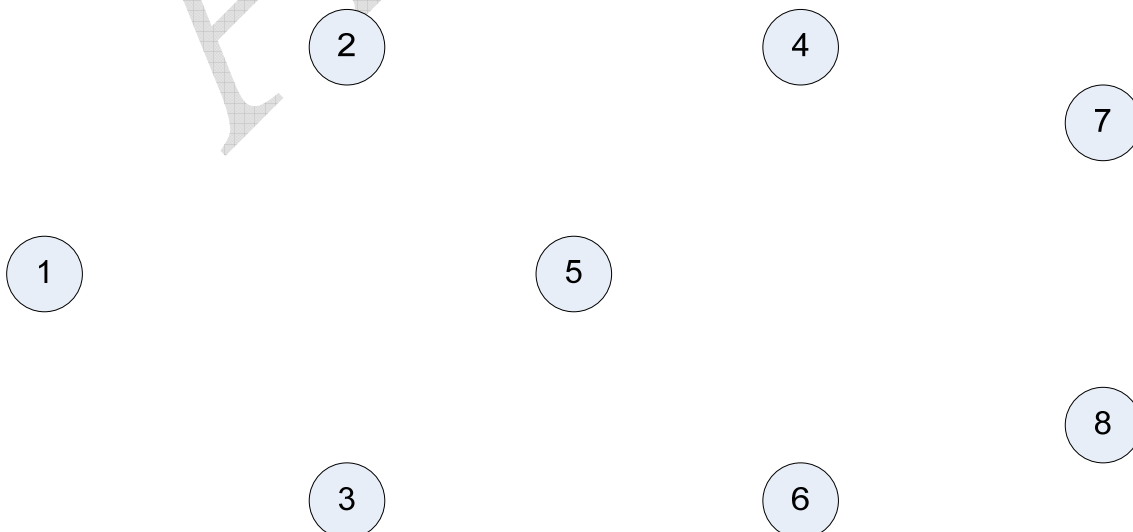
c) Using Dijkstra's algorithm, determine the least cost paths from node 1. You must manually perform the steps, using the table approach followed in the lecture. Show your steps in the table below, using as many rows as necessary.
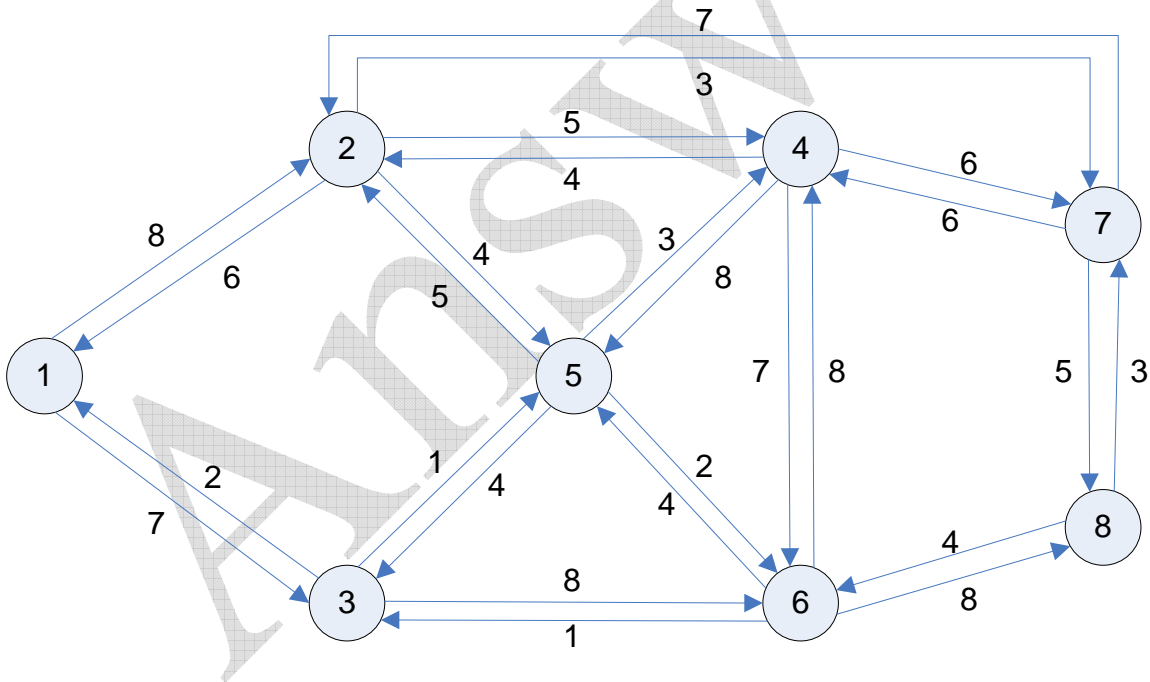
Step	T	L(2)	P(2)	L(3)	P(3)	L(4)	P(4)	L(5)	P(5)	L(6)	P(6)	L(7)	P(7)	L(8)	P(8)
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

Answers

For the ID of 4812345678, the network connectivity table is:

		To node …							
		1	2	3	4	5	6	7	8
From Node …	1	0	**8**	**7**	0	0	0	0	0
	2	**6**	0	0	**5**	**4**	0	**3**	0
	3	**2**	0	0	0	**1**	**8**	0	0
	4	0	**4**	0	0	**8**	**7**	**6**	0
	5	0	**5**	**4**	**3**	0	**2**	0	0
	6	0	0	**1**	**8**	**4**	0	0	**8**
	7	0	**7**	0	**6**	0	0	0	**5**
	8	0	0	0	0	0	**4**	**3**	0

This gives a network that looks like:

Step	T	L(2)	P(2)	L(3)	P(3)	L(4)	P(4)	L(5)	P(5)	L(6)	P(6)	L(7)	P(7)	L(8)	P(8)
1	1	8	1-2	**7**	1-3	Inf	-	Inf	-	Inf	-	Inf	-	Inf	-
2	1,3	**8**	1-2	7	1-3	Inf	-	8	1-3-5	15	1-3-6	Inf	-	Inf	-
3	1,2,3	8	1-2	7	1-3	13	1-2-4	**8**	1-3-5	15	1-3-6	11	1-2-7	Inf	-
4	1,2,3,5	8	1-2	7	1-3	11	1-2-4	8	1-3-5	**10**	1-3-5-6	11	1-2-7	Inf	-
5	1,2,3,5,6	8	1-2	7	1-3	**11**	1-3-5-4	8	1-3-5	10	1-3-5-6	11	1-2-7	18	1-3-5-6-8
6	1 to 6	8	1-2	7	1-3	11	1-3-5-4	8	1-3-5	10	1-3-5-6	11	1-2-7	18	1-3-5-6-8
7	1 to 7	8	1-2	7	1-3	11	1-3-5-4	8	1-3-5	10	1-3-5-6	**11**	1-2-7	**16**	1-2-7-8
8	1 to 8	8	1-2	7	1-3	11	1-3-5-4	8	1-3-5	10	1-3-5-6	11	1-2-7	16	1-2-7-8
9															
10															
11															
12															

Question 3 [18 marks: 6, 6, 6]

In your network from Question 2, if the least cost path is used to route packets from node 1 to node 8, calculate the total time it takes to transfer 1000 bytes if datagram packet switching is used with maximum packet sizes of:

a) 500 bytes   Time [msec]: _____

b) 250 bytes   Time [msec]: _____

c) 100 bytes   Time [msec]: _____

You should make the following assumptions:

- Give your answer in milliseconds

- Each packet has a 40 byte header added to it

- All links have a transmission speed of 100,000 bytes/sec

- Propagation delay of each link is the link cost, given in milliseconds. For example, if the link cost from node 1 to node 2 is 5, then the propagation delay for that link is 5ms.

- Queuing delays and processing delays are 0.

Calculations (use the back of this sheet and/or attach additional sheets if needed)

Answers

The time can be calculated manually, similar to the examples in the lectures, however lets generate an equation to calculate the time. Lets define the variables as:

- DataRate = 100,000 bytes/sec

- Message = 1000 bytes

- Header = 40 bytes

- Hops = number of links or hops in the path

- Prop(N) = propagation time of link N

The transfer of packets can be illustrated as follows:
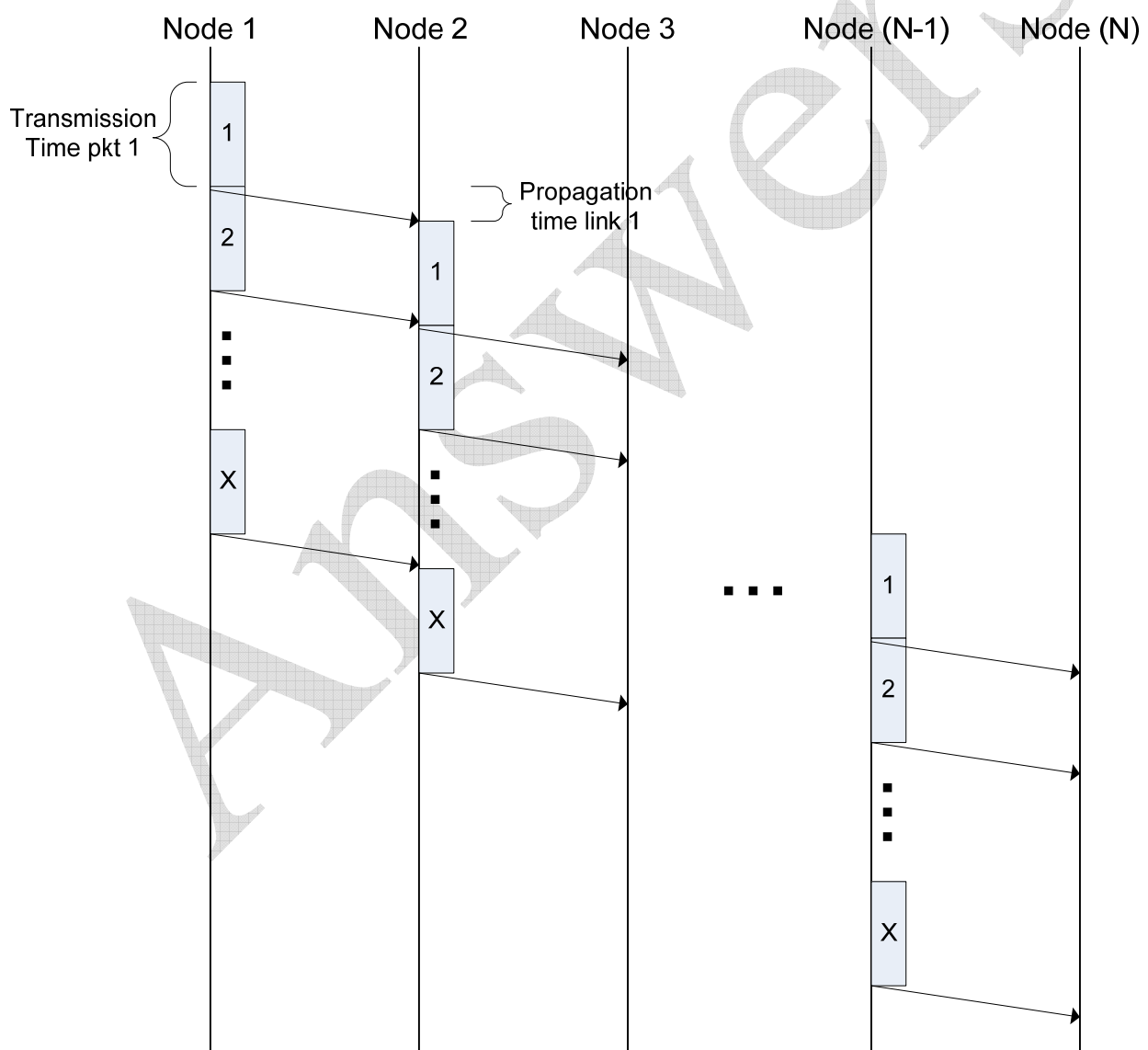
We can see that for N nodes and X packets the total time to receive all data consists of:

1. The time to transmit all X packets
2. The time for a bit to propagate over all (N-1) links

3. The time for the last packet to propagate through the network

The total delay can be calculated as:

$$Delay = \frac{\left(\dfrac{Message}{PacketSize} + Hops - 1\right)\left(PacketSize + Header\right)}{DataRate} + \sum_{i=1}^{N} \Pr op(i)$$

We determine the propagation delay from the costs of the path. From Question 2 we calculated the shortest path from 1 to 8 as 1-2-7-8 with a cost of 16. And hence the total propagation delay is 16ms. And the number of hops is 3. Hence the answers are:

1. 500 byte packets: 37.6ms

2. 250 byte packets: 33.4ms

3. 100 byte packets: 32.8ms

Question 4 [10 marks: 8, 2]

In Question 2, least-cost routing was used in your network. In this question, instead of least-cost routing, flooding is used. Make the following assumptions:

- Each packet has a unique identifier. A copy of a packet uses the same identifier as the original.

- If a node receives a packet that it has previously transmitted, then the node does not retransmit the copy. (That is, each node will only send a packet on each output link once).

- There is no hop count used.

- A node does not send a copy of the packet to a node that it has already received the packet from.

- The cost of transmitting a packet is equivalent to the link cost. For example, if a packet is transmitted on a link with cost 5, then the packet incurs a cost of 5.

- Transmissions occur in phases (or steps), similar to the example given in the lecture. Node 1 transmits in step 1. Then in step 2, the nodes the received from node 1 transmit at the same time.

A single packet is sent using flooding by node 1. The destination is node 8.

a) What is the total cost of transmission in the network to send the single packet? (That is, the sum of the costs of all packets transmitted).

Cost: _____

b) What is the total cost of transmission in the network to send the single packet if least-cost routing was used instead of flooding (ignore any cost of determining the route)?
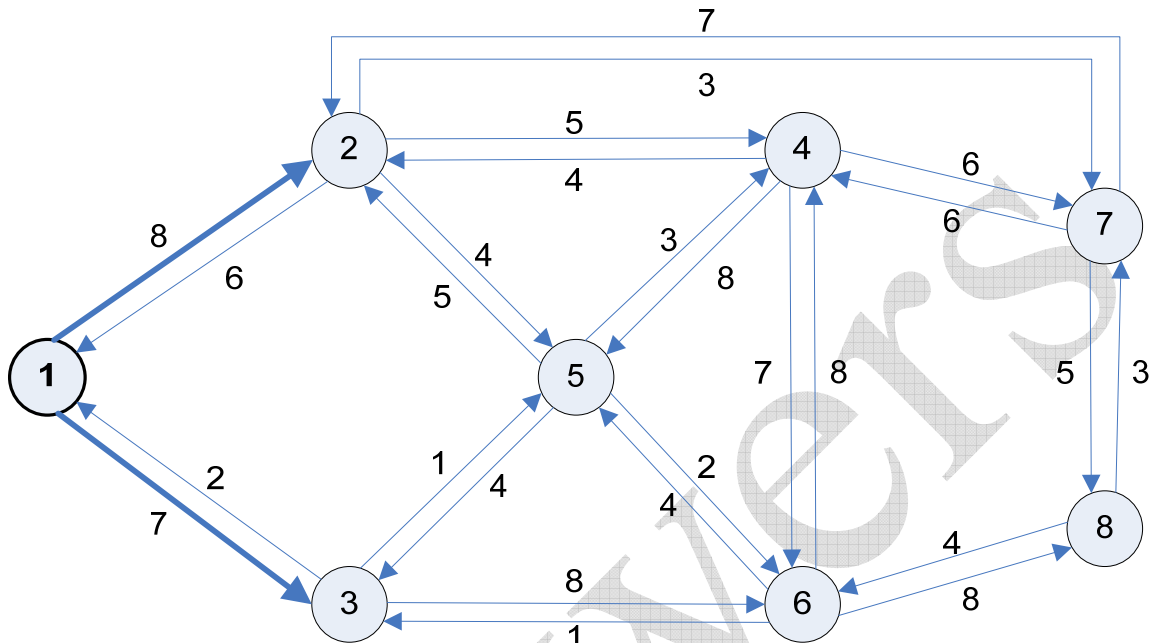
Cost: _____

Calculations (use the back of this sheet and/or attach additional sheets if needed)
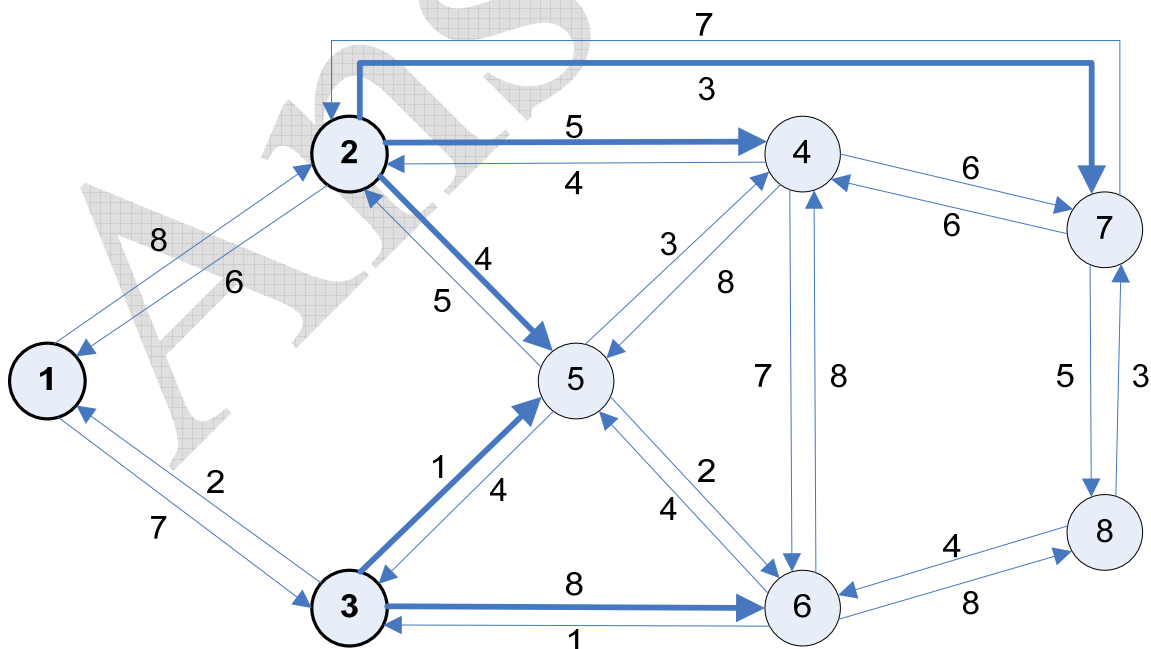
Answers

With flooding, every node sends a copy of the packet to all its neighbour nodes (with the exception that a node will only send to the nodes that I thinks haven't received the packet before).

In the example network, in the first step, Node 1 sends to Nodes 2 and 3.

This contributes a cost of 15.

In the second step, Node 2 sends to its neighbours, as does Node 3.

This contributes a cost of 21.

In the third step, Nodes 4, 5, 6 and 7 send to their neighbours. However note that Node 5 received a packet from both 2 and 3, but Node 5 knows that it is the same packet, and so only sends one copy. Also Node 5 knows nodes 2 and 3 have already received the packet, and so Node 5 does

not send to 2 or 3. [Many people lost 3 marks because of this – they assumed Node 5 sent two copies of the packet]
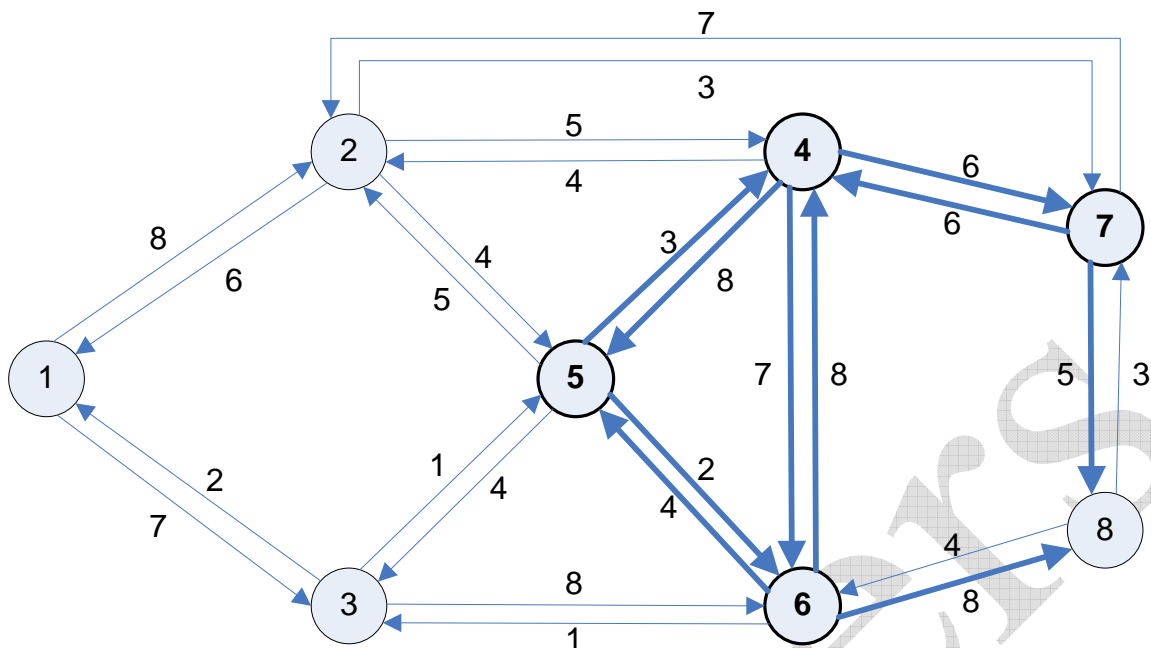
This contributes a cost of 57.

Now Node 8 has received the packet – Node 8 will not send any more copies. Also, every other node in the network has received and forwarded the packet, so they will not forward any more copies. So no more transmissions occur.

The total cost is 93.

In the case of using the least-cost path, a cost of 16 is incurred. This is determined from the previous question that calculated the least-cost paths.

Question 5 [7 marks: 0, 2, 1, 2, 2]

On your PC you can use programs and commands to view and edit the details of your computers interfaces and connections. In this question you will use some simple commands on your own computer.

Perform the following tasks either on:

1. Your personal PC or laptop while connected to the Internet (that is, if you are using your laptop, make sure you have an active Internet connection when performing the tasks).

2. An SIIT lab computer.

Do not use your friends computer – that is, make sure you perform the tasks yourself on your own computer. The intention is that everyone performs the tasks on their own.

In Microsoft Windows XP, the following tasks can be performed by opening a Command prompt (e.g. go to "Start" menu, select "Run…" and enter the program "cmd").

In Linux (such as Ubuntu) you can perform the tasks in a shell.

    a) What computer did you use for the tests? (circle only one)

        a. Home/Dormitory desktop computer

        b. Personal Laptop

        c. SIIT Lab computer in Room _____ (enter the room number)

        d. Other (describe) _____

    b) Look at the interfaces of your computer and record the details in the table below.

      • Windows XP: `ipconfig /all`

      • Ubuntu Linux: `ifconfig`

    If you have multiple interfaces, record them all (e.g. draw another table for the second one).

Hardware Address	
IP Address	
Subnet Mask	
Broadcast Address	

    c) Using the IEEE address assignment database at http://standards.ieee.org/regauth/oui/, determine the manufacturer of your Ethernet card.

            Manufacturer: _____

d) Look at the routing table for your computer and record *up to* 4 routes.

- Windows XP: `route print`

- Ubuntu Linux: `route`

Note that Gateway refers to the Next Router.

Route	Destination	Gateway	Interface	Metric
1				
2				
3				
4				

e) When you are browsing the web (or using another Internet application such as instant messaging), which router do you think your traffic is sent via. Why?

Answer (and explanation):

Answers

Using Windows XP to collect results on my computer at home:

```
C:\WINDOWS\system32\cmd.exe                                           _ □ ×
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\Documents and Settings\Steve>ipconfig /all

Windows IP Configuration

        Host Name . . . . . . . . . . . . : chilli
        Primary Dns Suffix  . . . . . . . :
        Node Type . . . . . . . . . . . . : Unknown
        IP Routing Enabled. . . . . . . . : No
        WINS Proxy Enabled. . . . . . . . : No

Ethernet adapter Local Area Connection:

        Connection-specific DNS Suffix  . :
        Description . . . . . . . . . . . : Realtek RTL8168/8111 PCI-E Gigabit E
thernet NIC
        Physical Address. . . . . . . . . : 00-17-31-7E-50-7D
        Dhcp Enabled. . . . . . . . . . . : No
        IP Address. . . . . . . . . . . . : 192.168.1.2
        Subnet Mask . . . . . . . . . . . : 255.255.255.0
        IP Address. . . . . . . . . . . . : fe80::217:31ff:fe7e:507d%4
        Default Gateway . . . . . . . . . : 192.168.1.1
        DNS Servers . . . . . . . . . . . : 203.113.15.99
                                            203.113.15.100
                                            fec0:0:0:ffff::1%1
                                            fec0:0:0:ffff::2%1
                                            fec0:0:0:ffff::3%1

Tunnel adapter Teredo Tunneling Pseudo-Interface:

        Connection-specific DNS Suffix  . :
        Description . . . . . . . . . . . : Teredo Tunneling Pseudo-Interface
        Physical Address. . . . . . . . . : FF-FF-FF-FF-FF-FF-FF-FF
        Dhcp Enabled. . . . . . . . . . . : No
        IP Address. . . . . . . . . . . . : fe80::ffff:ffff:fffd%5
        Default Gateway . . . . . . . . . :
        NetBIOS over Tcpip. . . . . . . . : Disabled

C:\Documents and Settings\Steve>_
```

Hardware Address	00-17-31-7E-50-7D
IP Address	192.168.1.2
Subnet Mask	255.255.255.0
Broadcast Address	192.168.1.255

If the broadcast address is not shown, then you can easily calculate it from the classless IP address and subnet mask.

Using http://standards.ieee.org/regauth/oui/index.shtml I find that the manufacturer of my Ethernet card is: ASUSTek COMPUTER INC. Note that the first 6 digits (00-17-31) identify the manufacturer.

```
ex C:\WINDOWS\system32\cmd.exe                                         _ □ ×

Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\Documents and Settings\Steve>route print
===========================================================================
Interface List
0x1 ........................... MS TCP Loopback interface
0x2 ...00 17 31 7e 50 7d ...... Realtek RTL8168/8111 PCI-E Gigabit Ethernet NIC
- Packet Scheduler Miniport
===========================================================================
===========================================================================
Active Routes:
Network Destination        Netmask          Gateway       Interface  Metric
          0.0.0.0          0.0.0.0      192.168.1.1    192.168.1.2     20
        127.0.0.0        255.0.0.0        127.0.0.1      127.0.0.1      1
      192.168.1.0    255.255.255.0      192.168.1.2    192.168.1.2     20
      192.168.1.2  255.255.255.255        127.0.0.1      127.0.0.1     20
    192.168.1.255  255.255.255.255      192.168.1.2    192.168.1.2     20
        224.0.0.0        240.0.0.0      192.168.1.2    192.168.1.2     20
  255.255.255.255  255.255.255.255      192.168.1.2    192.168.1.2      1
Default Gateway:       192.168.1.1
===========================================================================
Persistent Routes:
  None

C:\Documents and Settings\Steve>_
```

Route	Destination	Gateway	Interface	Metric
1	192.168.1.0	192.168.1.2	192.168.1.2	20
2	224.0.0.0	192.168.1.2	192.168.1.2	20
3	127.0.0.0	127.0.0.1	127.0.0.1	1
4	0.0.0.0	192.168.1.1	192.168.1.2	20

My computer is 192.168.1.2. The default gateway is 192.168.1.1 – Internet traffic is most likely to be sent via this router since the other destinations are special computers/address on the network.

Another way to answer the question: It is important to note that the Gateway corresponds to the Next Router/Node. If we look at the set of gateways we see they are 192.168.1.1 (another computer), 192.168.1.2 (my computer) and 127.0.0.1 (a special address for my computer). So if sending to the Internet, then my computer is *not* going to send to the address 192.168.1.2 or 127.0.0.1, since these are my computer. Hence it must send to 192.168.1.1, which is a router connected to another network.