UNIVERSITÉ YORK UNIVERSITY

Department of Computer Science and Engineering

COSC 4213: Computer Networks II (Fall 2005)

Instructor: N. Vlajic

Date: November 3, 2005

Midterm Examination

Instructions:

- Examination time: 75 min.
- Print your name and CS student number in the space provided below.
- This examination is closed book and closed notes.
- There are 6 questions. The points for each question are given in square brackets, next to the question title. The overall maximum score is 100.
- Answer each question in the space provided. If you need to continue an answer onto the last page, clearly indicate that and label the continuation with the question number.

FIRST NAME: ______________________________

LAST NAME: ______________________________

STUDENT #: ______________________________

1. Multiple Choice [20 points] *time: 15 min*

Circle the correct answer(s) for following statements. For each statement, you will obtain 0 marks if the number of circled answers is more/less than appropriate.

(1.1) IP Protocol
The checksum in the IP packet covers ____________________ .

(a) just the source and destination addresses

(b) just the header

(c) just the data

(d) the header and the data

(1.2) IP Addressing
Assume classful addressing. Which of the following is true for the IP address 192.0.0.10?

(a) the netid is 192

(b) the hostid is 0.10

(c) the netid is 192.0.0

(d) the hostid is 0.0.10

(1.3) IP Addressing
A subnet mask for a class A network has 14 1s. How many subnets does this network have?

(a) 8

(b) 32

(c) 64

(d) non of the above

(1.4) ICMP Protocol
One way to alert a source host about congestion at the router is by sending an ICMP ____________________ message.

(a) redirection

(b) echo-request

(c) source-quench

(d) destination unreachable

(1.5) ICMP Protocol

An IP datagram (let us call this IP datagram - *datagram A*) cannot reach its destination. An ICMP error message is sent to the source. The data field of the IP datagram that encapsulates the ICMP packet (let us call this second IP datagram - *datagram B*) contains ____________________ .

(a) only the ICMP header

(b) the ICMP header plus 8 bytes of datagram A

(c) only datagram A

(d) the ICMP header, datagram A's header, and 8 bytes of datagram A's data field

(1.6) ICMP Protocol

Which of the following programs utilize (i.e. make use of) ICMP Time Exceeded Messages?

(a) ping

(b) tracert

(c) netstat

(d) ipconfig

(1.7) IGMP Protocol

A query message with an IP destination address of ____________________ goes to all routers on the subnet.

(a) 224.0.0.0

(b) 224.0.0.1

(c) 224.0.0.2

(d) 224.0.0.3

(1.8) Unicast Routing

In Link State routing each router receives information generated directly by ________________ .

(a) every router on the network

(b) every router less than three hops away

(c) one-hop neighbours only

(d) non of the above

(1.9) UDP Protocol

Which of the following does UDP guarantee?

(a) sequence number on each user datagram

(b) acknowledgments to the sender

(c) flow control

(d) non of the above

(1.10) TCP Protocol

Suppose that a process would like to transmit one octet of data to another process using TCP. How many TCP packets, **overall**, would normally be needed to perform this transmission?

(a) TCP does not transmit small-size packets

(b) 1

(c) 7 or 8

(d) none of the above

2. Packet Switching [15 points] *time: 10 - 15 min*

Suppose we would like to transfer a file of K bits from node A to node C using packet switching (see Figure 2.1). The path from node A to node C passes through two links and one intermediate node, B, which is a <u>store-and-forward</u> device. The two links are of rate R [bps]. The packets contain P bits of data (P<K) and a 6 byte header.

What value of P minimizes the time it takes to transfer the file from A to C? (You can assume: propagation delay on each link = 0, and K/P gives an integer number.)

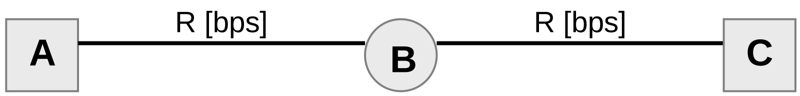


Figure 2.1

# of packets to transmit the file: $\frac{K}{P}[\,packets\,]$

Transmission time per each packet: $t_{packet} = \frac{P+48}{R}\frac{[bits]}{\left[bit/\sec\right]} = \frac{P+48}{R}[\sec]$

Overall transmission time:

$$t_{total} = \frac{K}{P}t_{packet} + 1 store-and-forward, \qquad or$$

$$= 2 * t_{packet} + (\frac{K}{P} - 1)\cdot t_{packet} =$$

$$\approx \left(\frac{K}{P} + 1\right)\cdot\frac{P+48}{R}[\sec]$$

Taking the first derivative of t_{total} with respect to packet size P, we obtain:

$$\frac{\partial t_{total}}{\partial P} = \frac{\partial}{\partial P}\left(\frac{K}{R} + \frac{48K}{PR} + \frac{P}{R} + \frac{48}{R}\right) = -\frac{48K}{P^2 R} + \frac{1}{R} = 0$$

$$P = \sqrt{48K} = 4 * \sqrt{3K}$$

3. Subnetting **[20 points]** *time: 15 min*

An organization has a class C network: 200.1.1.0, and it wants to form subnets for 4 departments with the number of hosts as follows:

Subnet A: 72 hosts
Subnet B: 35 hosts
Subnet C: 20 hosts
Subnet D: 18 hosts

There are 145 hosts in total.

(a) [12 points] Provide a possible arrangement of the network address space, together with the respective range of IP addresses for each subnet. Explain your work!

Subnet A:	last byte:	from **0**000 0000 to **0**111 1111, hence
	Address range:	200.1.1.0 to 200.1.1.127
	Max number of hosts:	*128*
Subnet B:	last byte:	from **10**00 0000 to **10**11 1111, hence
	Address range:	200.1.1.128 to 200.1.1.191
	Max number of hosts:	*64*
Subnet C:	last byte:	from **110**0 0000 to **110**1 1111, hence
	Address range:	200.1.1.192 to 200.1.1.223
	Max number of hosts:	*32*
Subnet D:	last byte:	from **111**0 0000 to **111**1 1111, hence
	Address range:	200.1.1.224 to 200.1.1.255
	Max number of hosts:	*32*

(b) [8 points] Suggest what the organization might do if it needs to create the 5th subnet (Subnet E) with 20 new hosts.

One of a few possible answers:

The organization could split Subnet A into 4 subnets with 32 hosts each, as follows, and give the extra space to Subnet E.

Subnet A1:	last byte:	from **000**0 0000 to **000**1 1111, hence
	Address range:	200.1.1.0 to 200.1.1.31
	Max number of hosts:	*32*
Subnet A2:	last byte:	from **001**0 0000 to **001**1 1111, hence
	Address range:	200.1.1.32 to 200.1.1.63
	Max number of hosts:	*32*
Subnet A2:	last byte:	from **010**0 0000 to **010**1 1111, hence
	Address range:	200.1.1.64 to 200.1.1.95
	Max number of hosts:	*32*
Subnet E:	**last byte:**	**from 0110 0000 to 0111 1111, hence**
	Address range:	**200.1.1.96 to 200.1.1.127**
	Max number of hosts:	***32***

4. Routing **[15 points]** *time: 10 min*

(a) [10 points] Run Dijkstra's algorithm on the following network (Figure 4.1) to determine the routing table for **Node 3**. Please show all intermediate steps.

Assume Dijkstra's algorithm gives priority to paths with fewer hops, when choosing between paths of the same overall cost.

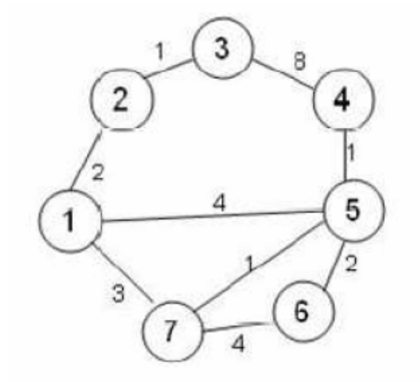
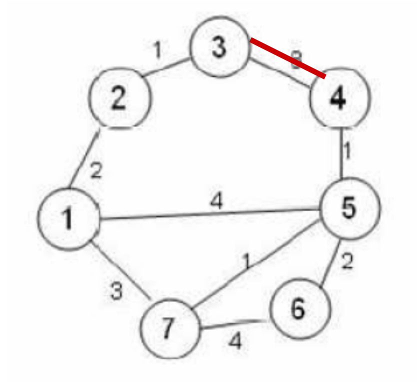


Figure 4.1

Step	Set S	1	2	3	4	5	6	7
0	{}	inf	inf	0	inf	inf	inf	inf
1	{3}	inf	1	0	8	inf	inf	inf
2	{3,2}	3	1	0	8	inf	inf	inf
3	{3,2,1}	3	1	0	8	7	inf	6
4	{3,2,1,7}	3	1	0	8	7	10	6
5	{3,2,1,7,5}	3	1	0	8	7	9	6
6	{3,2,1,7,5,4}	3	1	0	8	7	9	6
7	{3,2,1,7,5,4,6}	3	1	0	8	7	9	6

(b) [5 points] Using the result from (a), show the 'best' path between Node 3 and Node 4.



5. Multicast Routing **[20 points]** *time: 15 min*

Consider the following multicast network (Figure 5.1), with multicast-enabled routers labelled R1 through R6, and hosts labelled A through J.
Hosts A, B, D, E, F, G, H and I are participating in a multicast group X. The routers use

- Distance-Vector Algorithm for unicast routing (corresponding routing tables are provided in Figure 4.2), and
- Reverse Path Forwarding Algorithm for multicast routing.

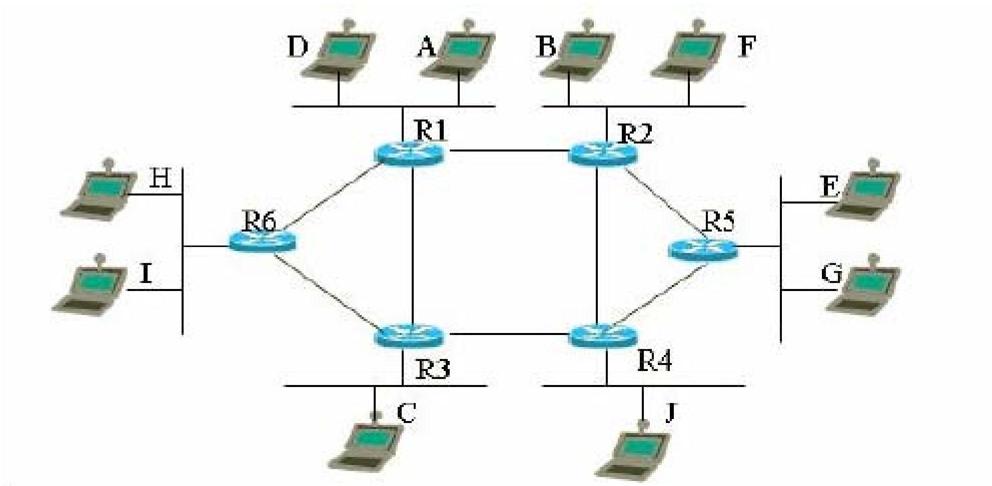
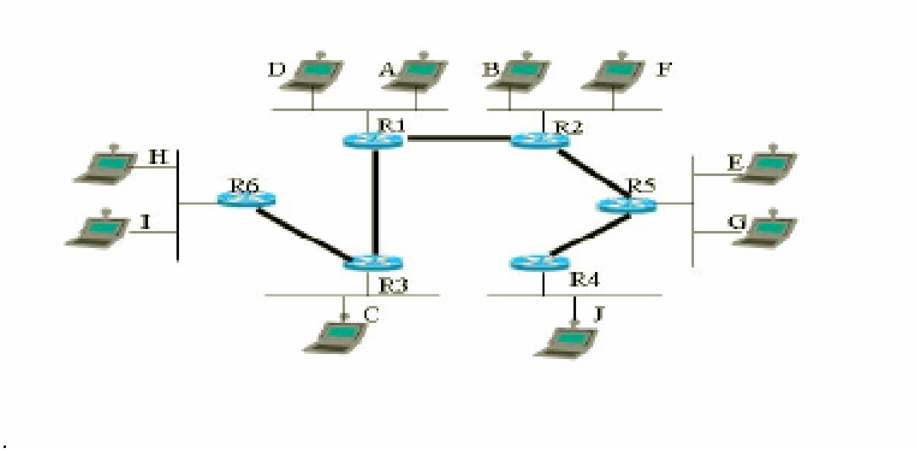


Figure 5.1

	Routing Table of R1		Routing Table of R2		Routing Table of R3		Routing Table of R4		Routing Table of R5		Routing Table of R6	
Desti-nation	Next Hop	Dist-ance	Next Hop	Dist-ance	Next Hop	Dist-ance	Next Hop	Dist-ance	Next Hop	Dist-ance	Next Hop	Dist-ance
R1	R1	0	R1	1	R1	2	R5	5	R2	3	R3	3
R2	R2	1	R2	0	R1	3	R5	4	R2	2	R3	4
R3	R3	2	R1	3	R3	0	R5	7	R2	5	R3	1
R4	R2	5	R5	4	R1	7	R4	0	R4	2	R3	8
R5	R2	3	R5	2	R1	5	R5	2	R5	0	R3	6
R6	R3	3	R1	4	R6	1	R2	8	R2	6	R6	0

Figure 5.2

(a) [6 points] Assume all prune and graft message have been sent. Draw the resulting multicast spanning tree from <u>source J</u>.



(b) [4 points] How many total IGMP queries will be generated in the given network? Justify your answer!

6 IGMP queries will be generated.
Each of the routers, R1 through R6 will generate 1 query.

(c) [4 points] How many IGMP responses will be generated for Group X in the network? Justify your answer!

4 IGMP response will be generated.
1 IGMP response will be generated from each subnet that has a member of Group X (subnets attached to routers R1, R2, R5 and R6.)

(d) [4 points] Suppose J needs to send a file of size 100 kbytes to A, B, D, E, F, G, H and I. J breaks the file into packets of size 1kbyte, and sends them. Compute the number of packets in the following links, if J used unicast to reach all members of Group X.

R1 - R2: _____4*100_______ **[packets]**

R1 - R3: _____2*100_______ **[packets]**

R1 - R6: _____0*100_______ **[packets]**

R2 - R4: _____0*100_______ **[packets]**

R2 - R5: _____6*100_______ **[packets]**

R3 - R4: _____0*100_______ **[packets]**

R3 - R6: _____2*100_______ **[packets]**

R4 - R5: _____8*100_______ **[packets]**

(e) [2 points] Repeat part (b) if J used multicast to send the file to the members of Group X.

R1 - R2: _____1*100_______ **[packets]**

R1 - R3: _____1*100_______ **[packets]**

R1 - R6: _____0*100_______ **[packets]**

R2 - R4: _____0*100_______ **[packets]**

R2 - R5: _____1*100_______ **[packets]**

R3 - R4: _____0*100_______ **[packets]**

R3 - R6: _____1*100_______ **[packets]**

R4 - R5: _____1*100_______ **[packets]**

6. Queueing Theory **[10 points]** *time: 10 min*

Consider a simple (one input line / one output line) router-queue, as shown in Figure 6.1. Suppose:

- all packets are L [bits] long,
- the transmission rate is R [bps], on both input and output line,
- N packets simultaneously arrive at the buffer every LN/R [seconds].

Find the average queueing delay of a packet in the given system.

You can assume that the Nth packet of the first batch of packets has already been processed (i.e. transmitted) when the second batch of packets arrives. As for 'packet service time' ($T_{service}$), you can assume $T_{service}$ = packet transmission time.

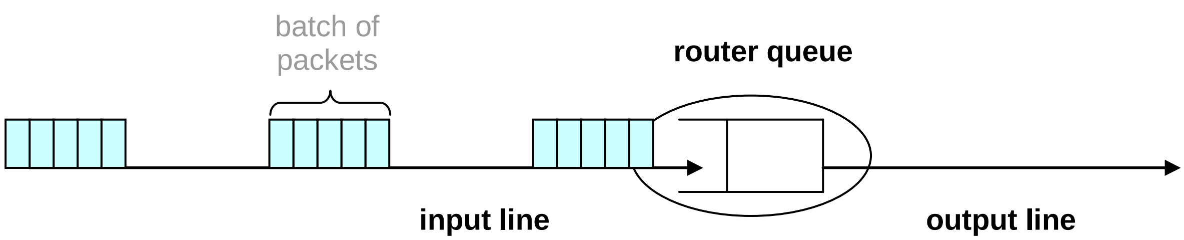


Figure 6.1

Thus, the buffer is empty when the next batch of N packets arrive. Hence, we find the average delay just by observing one of the batches.

The first of the N packets has no queueing delay. The 2nd packet has a queueing delay of L/R seconds. The n th packet has a delay of $(n-1)L/R$ seconds.

The average delay is:

$$\frac{1}{N}\sum_{n=1}^{N}(n-1)L/R = \frac{L}{R}\frac{1}{N}\sum_{n=0}^{N-1}n = \frac{L}{R}\frac{1}{N}\frac{(N-1)N}{2} = \frac{L}{R}\frac{(N-1)}{2}.$$