THE UNIVERSITY OF AUCKLAND

FIRST SEMESTER, 2003

Campus: City

COMPUTER SCIENCE

Data Communications Fundamentals

(Time allowed: **TWO** hours)

NOTES:

- Attempt ALL questions.
- Calculators are NOT permitted.
- Marks for each question are as shown.
- Start the answer to each question on a new page.
- Answer lengths should be in line with 1 minute per mark
- Most answers need some explanations — *no explanation* → *no mark*!

Question 1.

A packet on an IEEE 802.3 *or* Ethernet network is seen to start with the following octets (on the top line of the diagram).

(*These octets do not include the preamble and start delimiter.*

Below each octet is a sequential number so that you can identify it in your answers.)

00	00	66	33	B5	49	00	00	A7	12	36	B7	08	00	AA	AA	03	00	00	00	08	00	48	45	4C	50
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

(i) What octet numbers are occupied by the destination address? **[2 marks]**

(ii) What is the hexadecimal value of the length/type field? **[2 marks]**

(iii) What can you say about the value of the FCS (or CRC)? **[2 marks]**

(iv) What is the significance of length/type value for the interpretation of the ~~Ethernet~~ payload? **[2 marks]**

(v) What are the first four octets of the user data? **[2 marks]**

Question total = 10 marks

Question 2.

The bit string B=011101101 is to be protected by a CRC checksum with generator polynomial $x^4 + x^2 + 1$, (or, the generator bit vector is 10101).

(a) Calculate the CRC checksum for B and hence the final transmitted codeword. Show your working. **[6 marks]**

(*Hint :the division should give the quotient* 011010101.)

(b) Now assume that B gets corrupted in transit and becomes $B' = 011001001$ (two bit errors: on the 4th and 7th bit), with the checksum from part (a) not shown.

Show by explanation and calculation how the receiver can detect that there is a problem. Show your working

(*Hint: the quotient should now be* 011111000.) **[6 marks]**

Question total = 12 marks

Question 3.

When stations share a communication medium (as in many LANs) there is usually some rule or rules stating when each station may first attempt to transmit data. (*Ignore any rules that apply if the initial transmission attempt fails*.)

(a) What are these rules for each of –

(i) Aloha,

(ii) Ethernet,

(iii) Token ring,

(iv) Token bus. **[4 marks]**

(b) For each of the above networks and given that a particular station (**A**) is transmitting, what can you say about the first station that might be able to send data just after **A** has finished transmission? **[4 marks]**

Question total = 8 marks

Question 4.

An important recent development in networking is the Virtual LAN, or VLAN.

(i) Briefly describe how VLANs differ from traditional LANs.

(Say what a VLAN does and how it appears to users, *but not how it works*.) **[3 marks]**

(ii) Give three (3) advantages of VLANs. **[3 marks]**

(iii) Discuss how a VLAN is implemented if all of its stations are connected to a single switch. **[4 marks]**

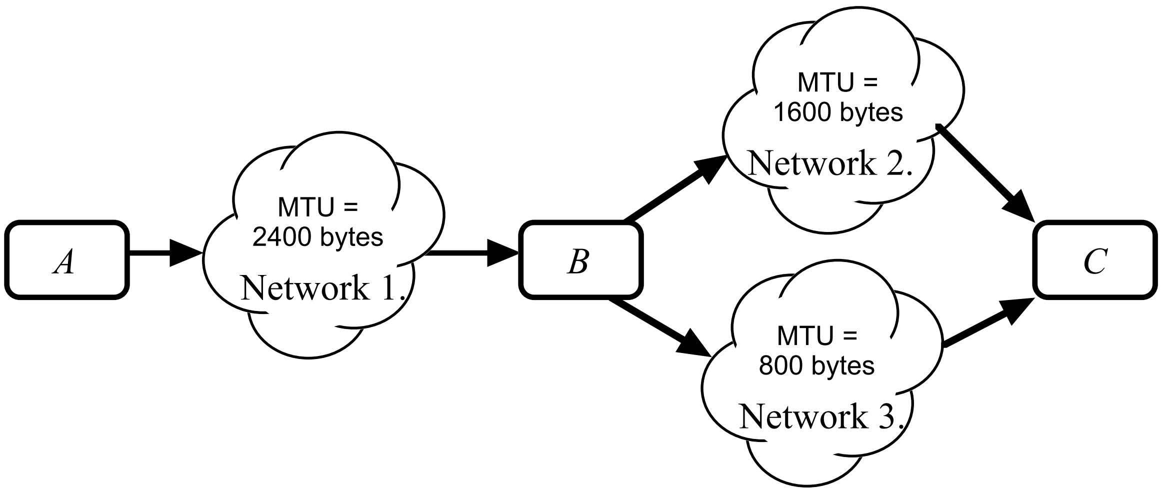
(iv) Briefly discuss the implementation of a VLAN across several connected switches. **[4 marks]**

Question total = 14 marks

Question 5.

The router at A in the figure receives an IP packet with 6000 data bytes, fragments the packet and routes the fragments to B via Network 1.

B in turn routes all fragments except the second one to C via network 3, but sends the second fragment to C via Network 2.



Show the fragments that C receives and the values that are important for reassembly/defragmentation.

Ignore the IP headers added during fragmentation. For example if a packet of 2000 octets were to be sent over a path with MTU=1500, assume that there would be one packet of 1500 octets and one of 500 octets, rather than one of (20+1480) and one of (20+520).

- Present your answer as a table with a row for each received fragment and a column for each value associated with fragmentation/reassembly.
- The precise fragment order at C does not matter, but packets sent over a path must remain in the order of sending.

Question total = 16 marks

Question 6.

When a user message of about 1000 bytes is sent over TCP/IPv4 and Ethernet we find that different amounts of the message (and headers etc) are covered by checksums at each level of the protocol stack.

(i) Explain and justify these differences in checksum coverage. **[6 marks]**

(ii) Explain what changes to checksumming might occur if the transfer used IPv6 rather than IPv4? **[2 marks]**

Question total = 8 marks

Question 7.

Use Dijkstra's algorithm to calculate the shortest path from A to G in the following network, assuming that each link has the cost shown beside it.

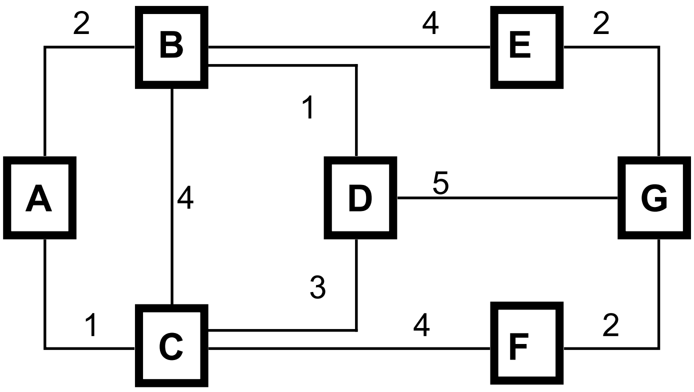
While you may present your answer in any appropriate manner, it is enough to indicate the path added at each stage and its cost to the root.

For example if routing from B, acceptable answers for the first stages might be

connect D to B, cost to B = 1

connect A to B, cost to B = 2

connect C to A, cost to B = 3, and so on



Question total = 6 marks

Question 8.

A (12,8) Hamming code uses *odd* parity for each of its parity groups.

(i) Explain the significance of the "(12,8)" description, including any relationship between the two numbers. **[2 marks]**

(ii) The received codeword is 1111 1111 1111. Correct the error (if any) in the received word and extract the corrected data bits (deleting the parity bits).
You must state the bit order. **[4 marks]**

Question total = 6 marks

Question 9.

(a) Networks are sometimes subject to "congestion".

(i) Why, in the most general case, does congestion occur? **[2 marks]**

(ii) What is the general way of reducing congestion in a network (apart from increasing its capacity or bandwidth)? **[2 marks]**

(iii) How is congestion handled in TCP? **[4 marks]**

(b) An extreme form of congestion is "deadlock".

(i) What are the two types of deadlock? **[2 marks]**

(ii) Give one way of preventing deadlock. **[2 marks]**

(iii) If a deadlock does occur, give one way by which it may be broken. **[2 marks]**

Question total = 14 marks

Question 10.

(i) Why is the signal encoding for multiplexed digital telephone systems usually based on a $125\mu s$ frame? **[1 mark]**

(ii) Why do telephone circuits normally use 64 kbps digital coding? **[1 mark]**

(iii) The North American T1 standard multiplexes 24 telephone circuits into a frame with composite bit rate of 1.554 Mbps.
Briefly describe the format of the T1 frame. **[2 marks]**

(iv) The European and CCITT equivalent of T1 is E1, with 30 user circuits and a composite bit rate of 2.048 Mbps
Briefly describe the format of the E1 frame. **[2 marks]**

Question total = 6 marks