Department of Computer Science
University College London

Cover Sheet for Examination Paper to be sat in May 2000

COMPC329, COMPD15: Communications and Networks

Time allowed 2.5 hours

Calculators are permitted

Answer THREE questions

Checked by First Examiner: Date:

Approved by External Examiner: Date:

Answer THREE questions

Calculators are permitted

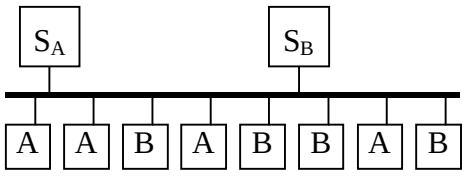
1. a) Explain the operation of the *Carrier-Sense, Multiple Access* (*CSMA*) channel allocation algorithm. Distinguish between the *persistent*, *non-persistent* and *p-persistent* versions of the algorithm and indicate the effect each of these approaches has on performance as network load increases.

[12 Marks]

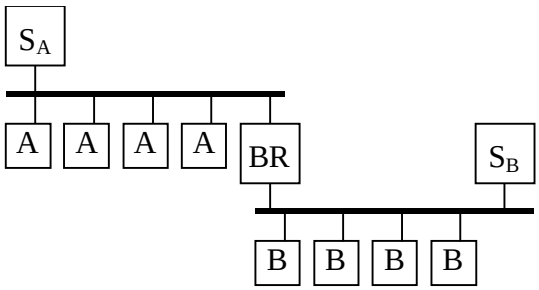
b) Explain the operation of the *Carrier-Sense, Multiple Access with Collision Detection* (*CSMA-CD*) channel allocation algorithm and discuss how its performance compares with that of pure CSMA strategies. Show (possibly with the aid of a diagram) that the CSMA-CD algorithm requires a minimum frame size to be set.

[10 Marks]

c) Diagram (1) below shows two servers (S_A and S_B) and several clients on an Ethernet LAN. The clients labelled *A* communicate mainly but not exclusively with S_A those labelled *B* communicate mainly but not exclusively with S_B. Diagram (2) shows the same components this time arranged on two separate LANs connected via a *transparent MAC bridge*.



(1)



(2)

i) Explain the operation of a *transparent MAC bridge*. How does the bridge acquire information for its forwarding table?

[6 Marks]

ii) The configuration in diagram (2) above was adopted in order to improve the overall performance of the system compared with the configuration in diagram (1). Discuss whether this would be the case, giving reasons for any conclusions you draw.

[5 Marks]

[TURN OVER]

2. a) i) Distinguish between *weak* (or *simple*) and *strong* authentication. Explain why one is considered more secure than the other.

[5 Marks]

ii) A computer system allows users to choose passwords consisting of at least eight alpha-numeric characters. Passwords are encrypted and stored in a file which is publicly readable. Comment on the security of this system and its sensitivity to the way in which users choose passwords.

[5 Marks]

iii) In February 2000 several *denial of service* attacks were made on high-profile web-servers making for headlines in the national press. How were these attacks perpetrated? Discuss the role authentication might play in combating such attacks.

[4 Marks]

b) It is common today for electronic mail messages to contain multimedia information: images, sounds and so on. Carrying multimedia content posed a problem for the original Internet electronic mail message format (RFC 822). Describe this problem and the solution which has been adopted in the Internet community.

[8 Marks]

c) i) Internet transport protocols have header formats which carry source and destination *port numbers*. Explain how these port numbers are used when a client makes a request to a server.

[6 Marks]

ii) On Unix systems the "*inetd*" process acts as a *dynamic server*. Explain how inetd operates. What are the advantages of this approach to server management?

[5 Marks]

3. a) Consider a communication system where the language is limited to the following four codewords,

1010101010101
1101011010101
1010101101101
1011010110101

i) What is the minimum Hamming distance?

[4 Marks]

ii) How many bit errors can be detected?

[3 Marks]

iii) How many bit errors can be corrected?

[3 Marks]

b) The binary string 101111010111 represents a 7-bit ASCII character using Hamming coding and odd parity. Detect and correct any possible single-bit error.

[8 Marks]

c) *Cyclic Redundancy Checks* (*CRC*) are used to detect errors in longer messages. If the polynomial used is x^5+x^3+1:

i) What is the degree of this polynomial?

[2 Marks]

ii) What is the binary representation of this polynomial?

[2 Marks]

iii) Outline how the transmitter would encode a message including a CRC.

[4 Marks]

iv) The sequence 00100110001101111111101100110011100001 is a message followed by a CRC generated using the polynomial above. Write down the message and the CRC.

[2 Marks]

v) Show how the sequence in iv) would be encoded in the data link layer if the system used transparent bit-oriented framing.

[5 Marks]

4. a) i) "*Packet-switching provides more efficient communication of data between computers than is possible with circuit-switching*". Explain the terms *circuit-switching* and *packet-switching* used in this statement. Provide arguments to justify the statement.

[6 Marks]

ii) Packet-switched networks may operate using either *virtual circuits* (*VC*) or *datagrams*; explain the differences between these two approaches and their advantages and disadvantages.

[6 Marks]

iii) In a network which runs a *distance vector* routing protocol, node *A* has two neighbours *B* and *C*. Currently, *A*'s routing table is:

Destination	**Next Hop**	**Metric**
B	*B*	2
C	*C*	1
D	*B*	3
E	*B*	4
F	*C*	6

Node *A* now receives distance vectors from *B* and *C* as follows:

From *B*

Destination	Metric
A	2
B	-
C	2
D	2
E	5
F	1

From *C*

Destination	Metric
A	1
B	2
C	-
D	2
E	3
F	3

Construct the new routing table for node *A*.

[4 Marks]

[Question 4 continued on next page]

[Question 4 continued]

b) *Automatic Repeat Request* (*ARQ*) protocols aim to provide a *Connection Oriented* style service based on simple services providing only framing. "*Go-back-N*" and "*Selective Re-transmissions*" are two such ARQ protocols.

i) Give illustrated examples of how Go-back-N and selective re-transmissions work.

[6 Marks]

ii) Briefly discuss the relationship between sequence numbers and window sizes in ARQ protocols.

[3 Marks]

iii) Briefly discuss the use of windows for flow control.

[3 Marks]

iv) Illustrate how the sliding window protocol works for the *Transmission Control Protocol (TCP)*. [You do not need to cover the case where the receiver varies the window dynamically].

[5 Marks]

5. A company is divided between two sites. Both sites operate local computer services that are connected by a single point-to-point link.

a) Discuss the factors contributing to the *Round Trip Delay* (*RTD*) between the two sites

[5 Marks]

b) The RTD for a 20 Kbyte message is 116 msec. while the RTD for a 27 Kbyte message is 122 msec. Assuming that the processing delays at both computers and the transmission time for an acknowledgement are all negligible and that the line is unloaded:

i) Outline the factors contributing to the RTD under these circumstances and determine the bit-rate of the connection.

[4 Marks]

ii) What is the approximate distance between the two sites if the signal travels at the speed of light (300,000 km/sec)?

[4 Marks]

[Question 5 continued on next page]

[Question 5 continued]

c) A communication line is currently multiplexing 10 identical channels over a 25 Mbit/sec line using *Time Division Multiplexing* (*TDM*).

i) Explain how TDM works.

[4 Marks]

ii) How is the receiver able to separate the traffic associated with the channels?

[3 Marks]

d) The company has plans to replace the TDM system in part c) with a system using *Statistical Multiplexing* (*SM*) over the same 25 Mbit/sec line.

i) Explain how SM works.

[4 Marks]

ii) How is the receiver able to separate the traffic associated with the channels?

[3 Marks]

iii) You may find the following formulae useful in this part:

Given an M/M/1 queuing system with an infinite queue and customers arriving at mean rate λ with service rate μ:

Probability that there are n customers in the system is $\rho^n(1-\rho)$, *where* $\rho = \lambda/\mu$.

Mean number of customers in the system = $\frac{\rho}{1-\rho}$.

Under the TDM scheme outlined in part c), four of the channels were using 10% of the bandwidth available to them, another four were using half the bandwidth available to them while the final two channels each had a utilisation of 0.95. Assuming these channels now share the communication line using SM and that the normal M/M/1 queuing requirements are met, how much memory will the statistical multiplexor need, on average, to store messages waiting for transmission?

[6 Marks]

[END OF PAPER]