

UNIVERSITY OF ABERDEEN

SESSION 2003-04

Degree Examination in ES 3567 Communications Engineering 1B

XXday XXth May 2004 (2:00 pm - 5:00 pm)

Notes:

- (i) Candidates are permitted to use approved calculators
- (ii) Candidates are not permitted to use the Engineering Mathematics Handbook
- (iii) An information sheet providing details of protocol headers is provided

Candidates should attempt **THREE** questions. All questions carry **20** marks.

1. (a) Use the *Open Systems Interconnection Reference Model* to compare the operation of the protocol layers above and below the *Network Layer*. [6 marks]
- (b) An *End System* uses the “ping” program to determine if another *End System* is operational. If each ICMP message has a size 150B, what is the total size of the Ethernet frame? [4 marks]
- (c) By comparing the operation of the “ping” program and the “traceroute” programs describe the key differences between these two programs. [8 marks]
- (d) Use the *Open Systems Interconnection Reference Model* to explain what is meant by the term *Service Access Point (SAP)*. [2 marks]
2. (a) What is the *Carrier-Sense Multiple Access (CSMA/CD)* algorithm? [10 marks]
- (b) How is the algorithm modified when a *Network Interface Card* operates in the full duplex mode? [2 marks]
- (c) Is it possible to use the full duplex mode with (i) a Hub (ii) a Switch? [2 marks]
- (d) Using suitable diagrams, explain the purpose of the Ethernet Frame Type Field. [4 marks]
- (e) Provide 2 examples of network layer protocols whose operation relies on the presence of the Ethernet Frame Type Field. [2 marks]
3. (a) An *End System* sends 5 packets per second using the *User Datagram Protocol (UDP)* over a full duplex 100 Mbps Ethernet LAN connection. The UDP message is 1000 bytes in size (including the UDP Protocol Control Information).
 - (i) What is the throughput, when measured at the transport layer? [4 marks]
 - (ii) Calculate the total frame size, and hence the utilisation of the link. [4 marks]
- (b) What may limit the maximum utilisation of a shared Ethernet network? [2 marks]
- (c) What is the smallest size of frame that is permitted in an Ethernet network? [2 marks]
- (d) Why does Ethernet define a minimum frame size, and what would be the implication of sending a frame smaller than this size? [4 marks]
- (e) Given that the Ethernet CRC-32 protects the integrity of frames sent across a *Local Area Network*, why does a transport protocol (e.g., the *User Datagram Protocol, UDP*) also include a checksum? [4 marks]

4. Consider the network shown below in figure 1:

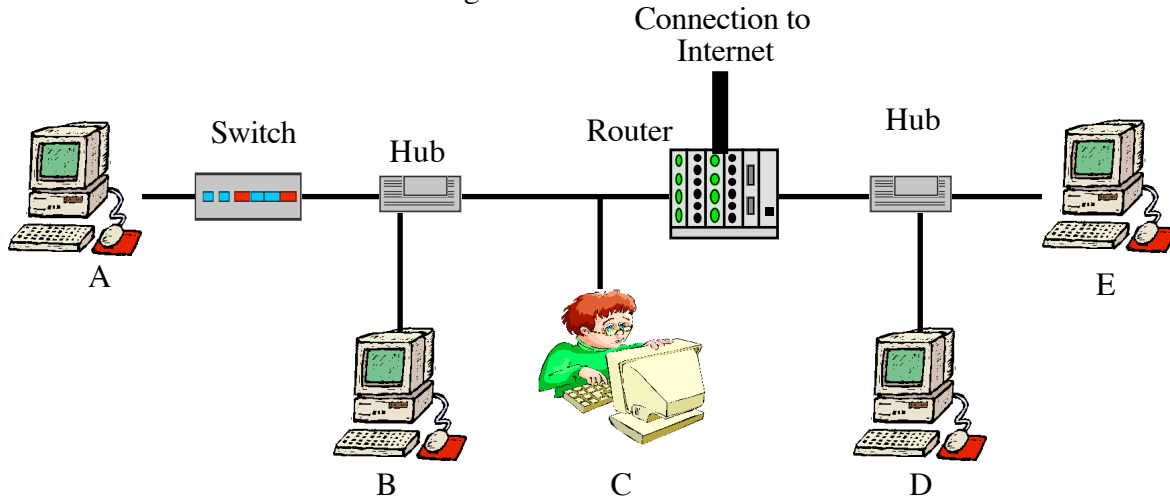


Figure 1: An Ethernet LAN

- (a) Provide a diagram of this network clearly labelling each *Collision Domain* [4 marks]
- (b) Given that C and D are in different IP networks, list the set of *End Systems* present in each of the two IP networks. [2 marks]
- (c) Sketch the contents of the *Address Resolution Protocol (ARP)* cache after the computer C has communicated with the computers A,B, and D, E, explaining the set of MAC addresses used. [4 marks]
- (d) If computer B is reconnected directly to the switch, does the ARP cache change? [2 marks]
- (e) If computer C wishes to communicate with a remote server in the Internet. Explain the process by which the C uses the name of the server to identify where to send the packets. [8 marks]

- 5. (a) The *End System A* (in figure 2) uses the *Transmission Control Protocol (TCP)* to send a packet to the *End System B* with a payload of 10 bytes. Sketch the Ethernet frame that is sent, showing each of the protocol headers, and the packet payload. Ensure that your sketch also shows the **addresses at both the MAC and IP layers**. [6 marks]

A	MAC 0x00:11:22:33:44:55	IP 192.7.1.1
J	MAC 0x22:33:44:55:66:77	IP 192.7.1.2 (towards A)
J	MAC 0x44:55:66:77:88:99	IP 192.8.8.8 (towards K)
B	MAC 0x66:77:88:99:00:11	IP 192.8.8.2

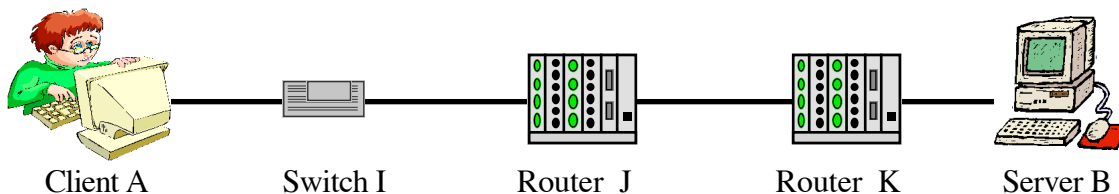


Figure 2: An Internet Path between two End Systems, A and B

- (b) Explain how the Switch I (in figure 2) uses a *Learning Algorithm* to build an *Address Table* that indicates the correct place to forward the frames that it receives. [4 marks]
- (c) How does the Switch I recognise a multicast and broadcast address in the frames sent by A? Are these two types of frames forwarded by the switch? [4 marks]
- (d) Explain the term *Maximum Transmission Unit (MTU)*, and the *Path MTU Discovery* procedure that allows A to determine the smallest MTU available on a path to B. [6 marks]