UNIVERSITY OF ABERDEEN SESSION 2004-05

Degree Examination in EG 3567 Communications Engineering 1A

Monday 30 th May 2004 (9:00 pm - 12:00 noon)

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 explain the operation of the *Transport Layer*. [6 marks]

   (b) Provide two examples of protocols that operate at the *Transport Layer*. [2 marks]

   (c) The "*ping*" program sends a message of 1000B, 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]

2. (a) Explain the algorithm used by a *Network Interface Card (NIC)* when transmitting frames over a shared Ethernet cable. [10 marks]

   (b) How is the algorithm modified when using 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) What types of cable are supported in the *Gigabit Ethernet* specification? [2 marks]

3. (a) An *End System* sends 10 packets per second using the *User Datagram Protocol (UDP)* over a full duplex 100 Mbps Ethernet LAN. Each 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) Why does Ethernet define a minimum frame size? [2 marks]

   (c) Given that the Ethernet CRC-32 protects the integrity of frames sent across a *Local Area Network*, why does a transport protocol also include a *Checksum*? [4 marks]

   (d) Figure 1 shows a part of an Ethernet *Preamble*. Describe *Manchester Encoding* and use this to explain which part of the waveform indicates the start of the MAC header.

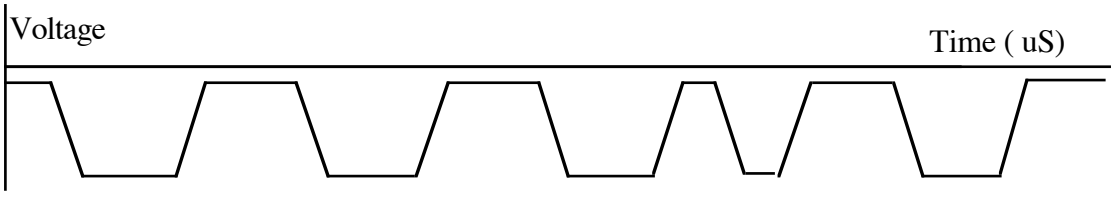


Figure 1: Waveform recorded on a coaxial Ethernet cable [6 marks]

continued over

4. Consider the network shown below in figure 2:

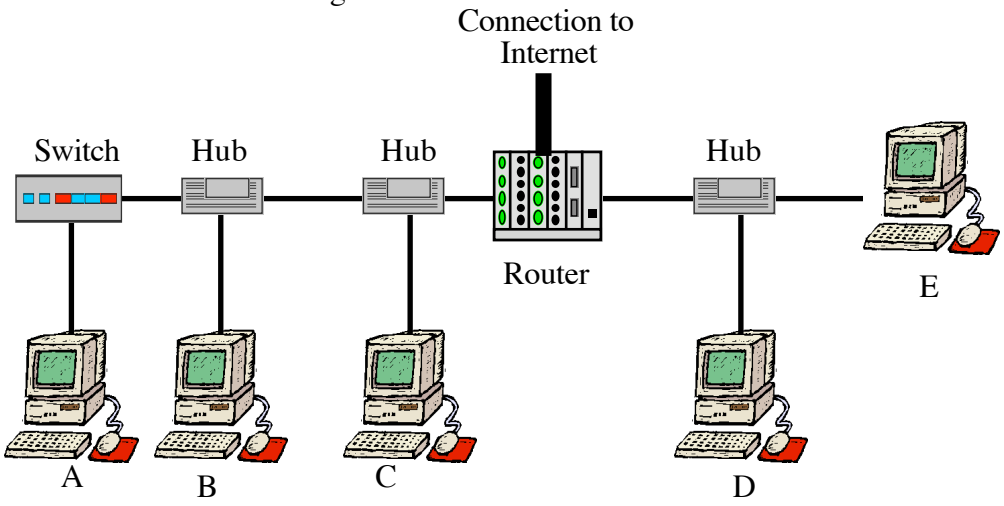


Figure 2: An Ethernet LAN

(a) Provide a diagram of this network clearly labelling each *Collision Domain* [4 marks]

(b) Which End Systems are in the same *Broadcast Domain* as system B? [2 marks]

(c) Sketch the contents of the *Address Resolution Protocol* (ARP) cache after the computer B 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) Explain the role of the *Domain Name Server* when the computer C communicates with a remote server in the Internet. Your answer should include a diagram showing the sequence of packets exchanged at the start of this communication. [8 marks]

5. (a)

```
0100 5e00 000d 00e0 f726 3ff1 0800 45c0
0036 5a3f 0000 0167 226b 8b85 d064 e000
000d 2300 ad3c 0100 8b85 d0d2 0001 00d2
```

Figure 3: Hexadecimal dump of the Header of a Packet received on an Ethernet interface

Figure 3 shows a hexadecimal dump of the first bytes of an Ethernet frame, what is the Internet address of the End System that sent this frame? [4 marks]

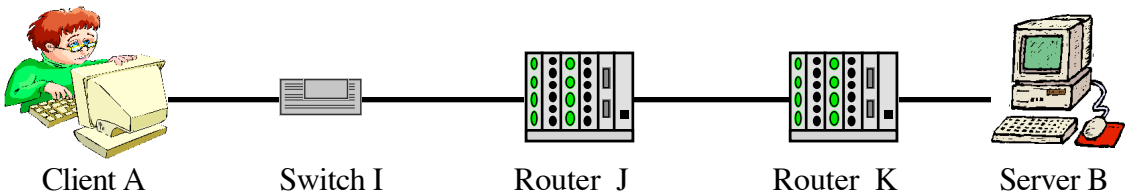


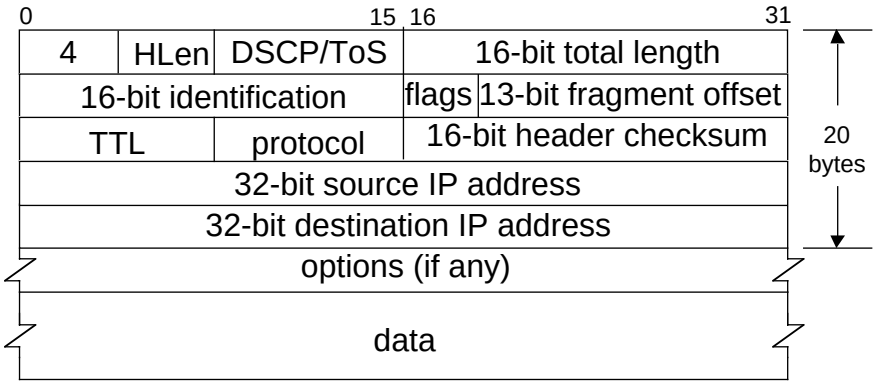
Figure 4: An Internet Path between two End Systems, A and B

(b) Explain how the Switch I (in figure 4) may dynamically build an *Address Table*. [6 marks]

(c) What is meant by the term *Mulitcast*? How does the Switch I recognise a multicast frame sent by A? [4 marks]

(d) Explain the term *Maximum Transmission Unit (MTU)*, and the *Path MTU Discovery* procedure used by the the client A, when sending to the server B. [6 marks]

PDU Header Chart



Internet Protocol Datagram (Ethernet Type = 0x800)

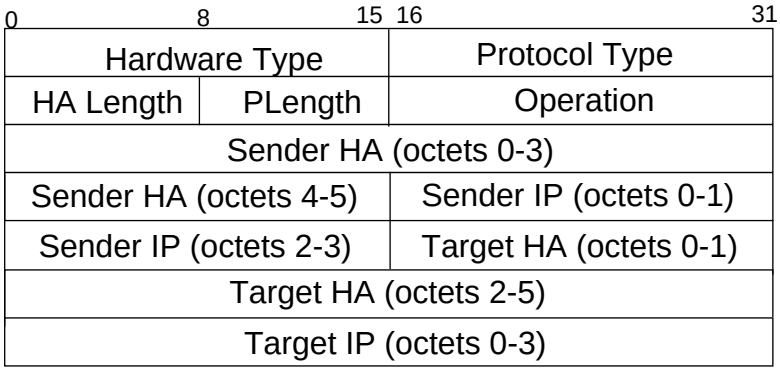
IP Protocol Types

0	IP
1	ICMP
2	IGMP
6	TCP
17	UDP

IPv4 Flags

- - X	More
- X -	Don't Fragment
X - -	Unused

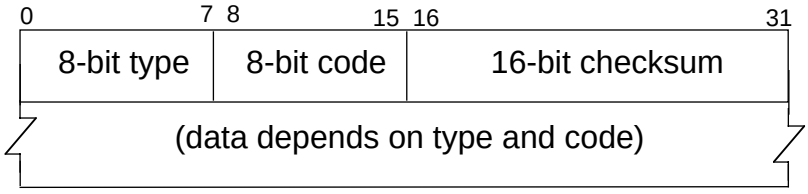
IPv4 DSCP/ToS
XXXXXX - - DSCP Value
- - - - - - 0 0 Discard in congestion
- - - - - - 0 1 ECN enabled (A)
- - - - - - 1 0 ECN enabled (B)
- - - - - - 1 1 Congestion indication



ARP / RARP Packet (Ethernet Type =0x806)

Operation ARP Message

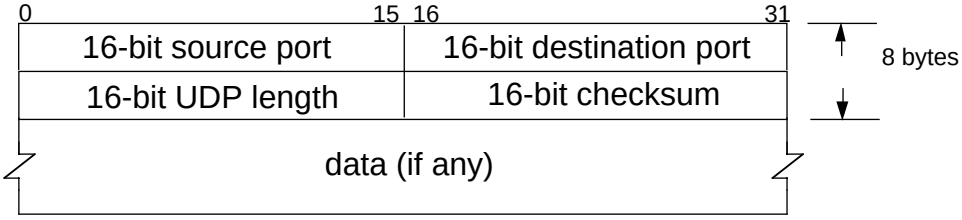
1	ARP request
2	ARP reply
3	RARP request
4	RARP reply



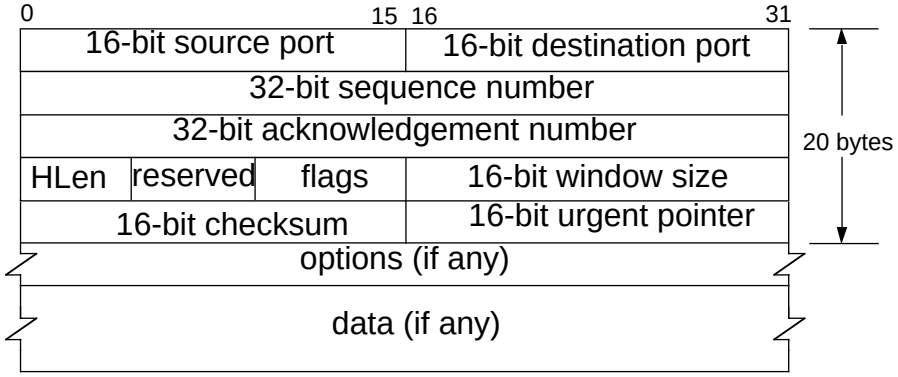
ICMP Message

ICMP Message Type

0	Echo reply
3	Destination unreachable (also used by PMTUD)
4	Source quench
5	Redirect
8	Echo request



UDP Packet



TCP Packet

Well-Known TCP/UDP Server Ports

Port (decimal)	Service
23	Telnet
25	Mail
69	TFTP
80	WWW (http)

Copies of this chart will be issued in EG/ES 3567 Examinations G. Fairhurst, 2006 (c) 07)