UNIVERSITY OF ABERDEEN SESSION 2004-05

Degree Examination in ES 3567 Communications Engineering 1B

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 what is meant by "*End-to-End*" communication at the *Transport Layer*. [6 marks]

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

   (c) The "ping" program sends an IP packet with a message of 1000B. Using the table of protocol headers provided, calculate 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 *Carrier Sense Multiple Access / Collision Detection* 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) Explian how the Ethernet Slot Time is related to the 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 (e.g. the *User Datagram Protocol*, UDP) also include a *Checksum*? [4 marks]

   (d) Figure 1 shows a part of an Ethernet *Preamble*. Describe *Manchester Encoding* and use this to explain the pupose of the *Start of Frame Delimiter*.

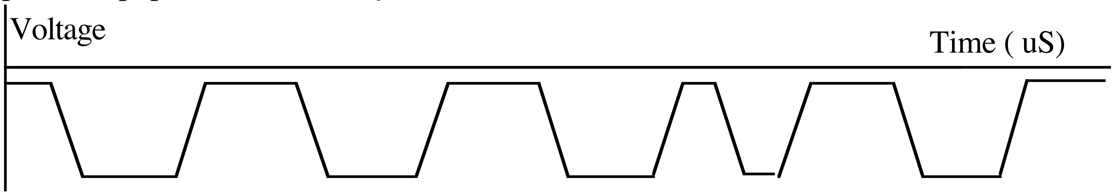

Figure 1: Waveform recorded on a coaxial Ethernet cable [6 marks]

continued over

4. Consider the network shown below in figure 2:

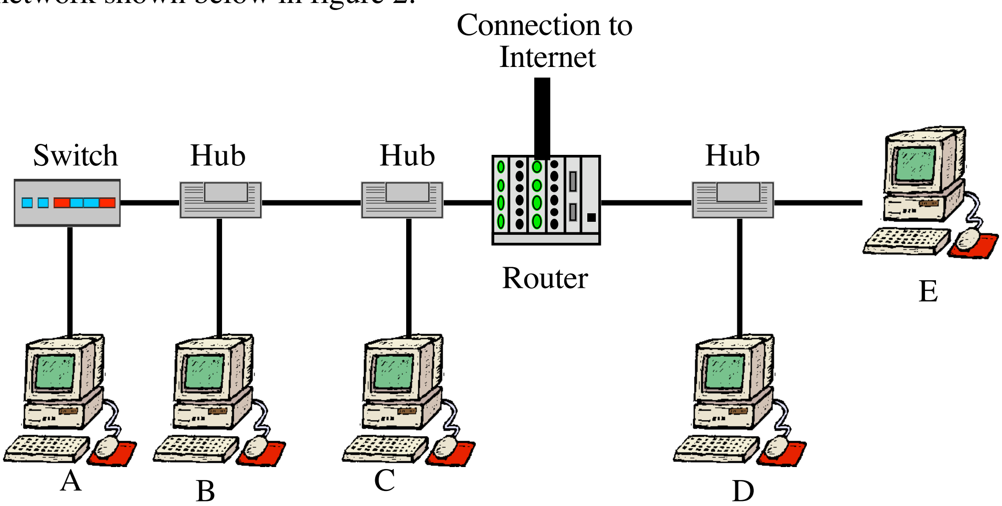

Figure 2: An Ethernet LAN

(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, and C, D, E, explaining which MAC address will be used to communicate with which *End System*. [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 *Domain Name* of the server is *resolved* to the IP destination address. [8 marks]

5. (a)

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

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

Figure 3 shows a hexadecimal dump of the Ethernet and IP headers of a packet. What is the Internet address of the End System that sent this frame? [4 marks]

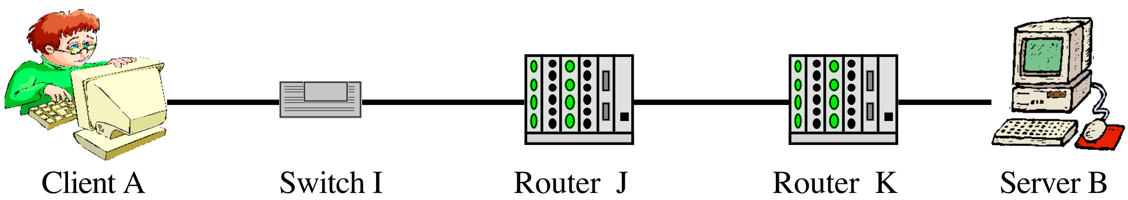

Figure 4: An Internet Path between two End Systems, A and B

(b) Explain how the Switch I (in figure 4) may dynamically learn the values to be placed in the *Address Table* from the Ethernet frames that it receives. [6 marks]

(c) What is meant by the term *Mulitcast*? How does a switch recognise a multicast address? [4 marks]

(d) Explain the term *Maximum Transmission Unit (MTU)*, and the *Path MTU Discovery* procedure that allows system A to determine the smallest MTU available on a path to system B. [6 marks]

PDU Header Chart

0		15	16	31
4	HLen	DSCP/ToS	16-bit total length	
16-bit identification			flags	13-bit fragment offset
TTL		protocol	16-bit header checksum	
32-bit source IP address				
32-bit destination IP address				
options (if any)				
data				

20 bytes

Internet Protocol Datagram (Ethernet Type = 0x800)

0	8	15 16	31
Hardware Type		Protocol Type	
HA Length	PLength	Operation	
Sender HA (octets 0-3)			
Sender HA (octets 4-5)		Sender IP (octets 0-1)	
Sender IP (octets 2-3)		Target HA (octets 0-1)	
Target HA (octets 2-5)			
Target IP (octets 0-3)			

ARP / RARP Packet (Ethernet Type =0x806)

0	7 8	15 16	31
8-bit type	8-bit code	16-bit checksum	
(data depends on type and code)			

ICMP Message

0	15 16	31
16-bit source port	16-bit destination port	
16-bit UDP length	16-bit checksum	
data (if any)		

8 bytes

UDP Packet

0		15	16	31
16-bit source port			16-bit destination port	
32-bit sequence number				
32-bit acknowledgement number				
HLen	reserved	flags	16-bit window size	
16-bit checksum			16-bit urgent pointer	
options (if any)				
data (if any)				

20 bytes

TCP Packet

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

Operation	**ARP Message**
1	ARP request
2	ARP reply
3	RARP request
4	RARP reply

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

Well-Known TCP/UDP Server Ports

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