UNIVERSITY OF ABERDEEN Exam 2010

Degree Examination in EG 3567 Communications Engineering 1A

Xday X X 9.00 a.m. – 12 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 OF PROTOCOL HEADERS IS PROVIDED

PLEASE NOTE THE FOLLOWING

(i) You **must not** have in your possession any material other than that expressly permitted in the rules appropriate to this examination. Where this is permitted, such material **must not** be amended, annotated or modified in any way.

(ii) You **must not** have in your possession any material that could be determined as giving you an advantage in the examination.

(iii) You **must not** attempt to communicate with any candidate during the exam, either orally or by passing written material, or by showing material to another candidate, nor must you attempt to view another candidate's work.

Failure to comply with the above will be regarded as cheating and may lead to disciplinary action as indicated in the Academic Quality Handbook (www.abdn.ac.uk/registry/quality/appendix7x1.pdf) Section 4.14 and 5.

Candidates should attempt FOUR questions. All questions carry 25 marks.

1.

(a) An Ethernet frame (represented below in hexadecimal) was recorded by a network monitor. Explain how this frame may be decoded to show the network layer destination address and the transport protocol that was used.

```
001f 5b38 7354 001a 2f52 4841 0800 4500
0089 bba8 4000 fe11 0e58 8b85 cc52 8b85
cf05 0035 ccbf 0075 20df 9b49 8583 …
```

[5 marks]

(b) Explain how *Network Interface Cards (NICs)* share the available capacity between the computers using a 10B2 Ethernet cable segment. [8 marks]

(c) How may this method be updated to better work in a wireless environment? [2 marks]

(d) Explain the use of the *Preamble Sequence* in Ethernet. Please illustrate your answers with appropriate diagrams. [5 marks]

(e) Explain how *Manchester Encoding* may be used to encode the binary sequence {0 1 1 0}, your answer must include appropriate diagrams. [5 marks]

continued over

2.

(a) How do bridges determine the *port*(s) on which a frame must be forwarded? [10 marks]

(b) Explain the role of a frame *Cyclic Redundancy Check* (CRC). [3 marks]

(c) *Unshielded Twisted Pair* (UTP) cabling was originally used as the physical layer for 10BT LANs. What challenges were faced when using this links operating at 100 Mbps? [6 marks]

(d) What new techniques were introduced in the Gigabit Ethernet over UTP standard to allow an order of magnitude increase in the capacity over that offered by *Fast Ethernet*? [6 marks]

3

(a) List the set of fields that are modified in the Layer 2 and Layer 3 protocol headers as a *router* processes and forwards an IP packet. [8 marks]

(b) A *router* can forward 100,000 packets in each second. What is the maximum *Utilisation* that may be achieved when it sends the smallest allowed size of Ethernet frame over a 10 Mbps Ethernet interface? [5 marks]

(c) Use a diagram describe the *Open Systems Interconnection (OSI)* model and provide detailed notes that explain why this has come to be adopted as a standard reference for communications architectures. [12 marks]

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4. Figure 1 shows five computers connected to *a Local Area Network (LAN)* using a Router to provide connectivity to the Internet.

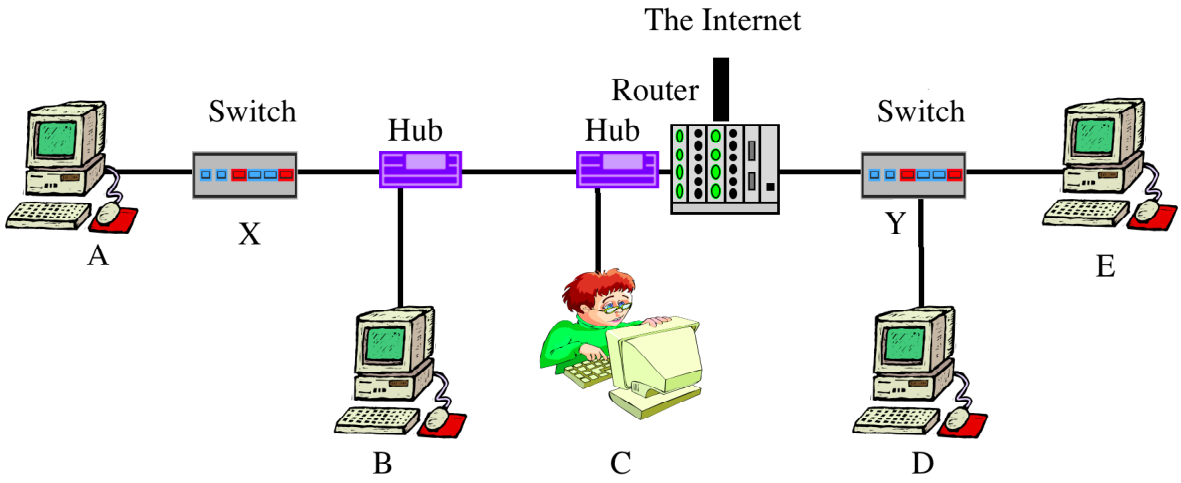


Figure 1: Five computers connected using 4 Intermediate Systems

(a) Explain how ***each*** of the two switches X and Y in the above diagram process a sequence of frames sent by computer C to computer A. [6 marks]

(b) Computer C sends a packet using the type value of 0x800 to computer A and one frame to computer D. For each of the two frames, sketch the MAC header of the ***received*** frame showing all MAC addresses. [6 marks]

(c) Explain in detail how the router process packets sent from the computer C to a computer in the Internet. [8 marks]

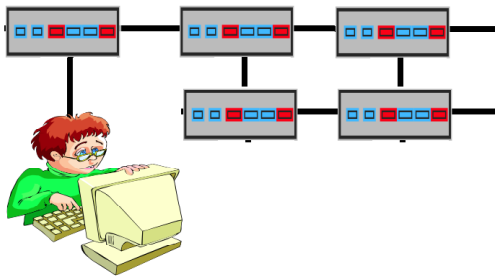


Figure 2: A computer connected using 5 Ethernet Switches

(d) Five Ethernet switches are connected according to the diagram shown above. Provide notes commenting on the strengths and weaknesses of this design. [5 marks]

5. The figure below shows two computers on a local Local Area Network (LAN). The computers are used for communication with each other using the IP router interface I and also with a remote computer, Computer C (not shown) that is connected via IP router interface II. The addresses that have been allocated to the computers are shown in the following table.

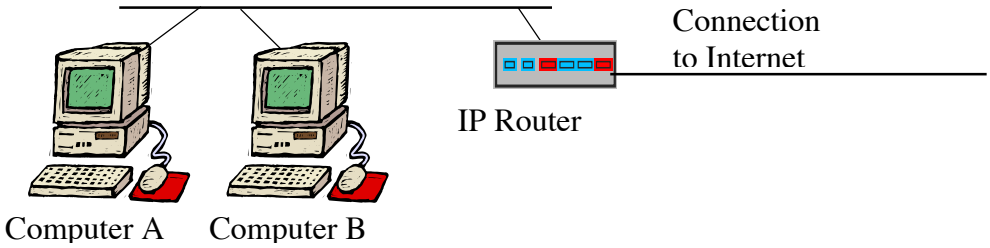


Figure 3: Two computers connected via a LAN to an IP Router

Interface	IP Address	Subnet Mask	MAC Address
Computer A	140.0.2.2	140.0.2.0/24	00:01:00:00:01:00
Computer B	140.0.2.3	140.0.2.0/24	00:01:00:00:02:00
Computer C	201.77.188.166	208.77.188.0/24	00:01:00:00:03:00
Router Interface I	140.0.2.3	140.0.2.0/24	00:02:00:00:01:00
Router Interface II	192.168.1.1	192.168.1.0/24	00:02:00:00:02:00

Table 1: Address assignments to the computers and router interfaces

(a) Use the LAN shown in Figure 3 and the information in Table 1 to explain the process by which computer A determines the *Medium Access Control (MAC)* address to be used to reach the computer B and a remote computer C connected via the Internet connection. Your answer should indicate the destination IP address and MAC address used in each case. [8 marks]

(b) Explain how a unique *MAC* address is allocated to each computer within a LAN. [2 marks]

(c) Using a diagram provide a detailed explanation on ***either*** of the two following topics:

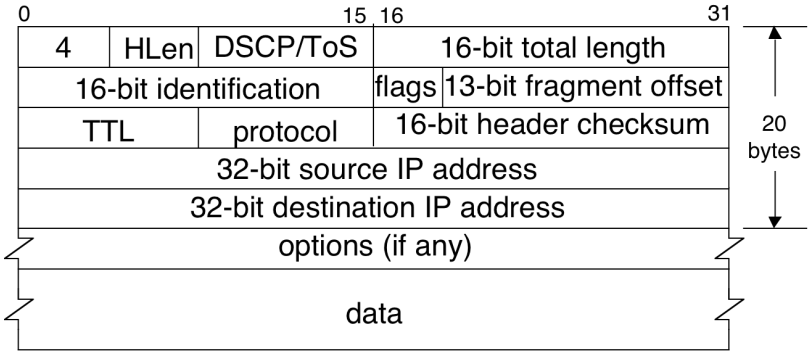
(i) Using appropriate diagrams explain how the *Domain Name System* (DNS) is used to resolve a *network name* to a *network address*.

or

(ii) Describe the operation of the traceroute program and explain in detail how this may be used to trace the *path* taken by an IP datagram.

[15 marks]

PDU Header Chart



Internet Protocol Datagram (Ethernet Type = 0x800)

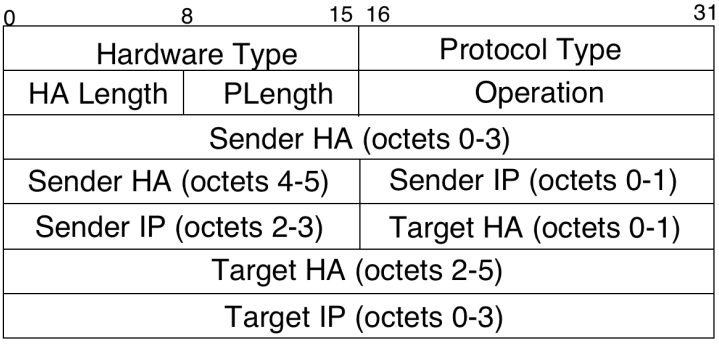
IP Protocol Types

0	IP
1	ICMP
2	IGMP
6	TCP
17	UDP

IPv4 Flags

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

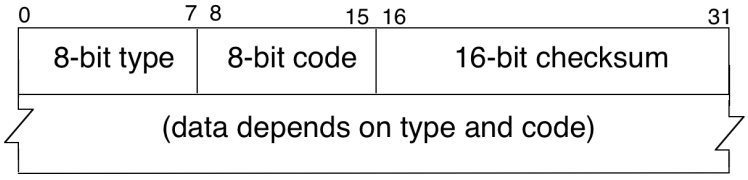
IPv4 DSCP/ToS
XXXXXX - - DSCP Value
- - - - - - 0 0 Discard in congestion
- - - - - - 0 1 ECN enabled (A)
- - - - - - 1 0 ECN enabled (B)
- - - - - - 1 1 Congestion indication



ARP / RARP Packet (Ethernet Type =0x806)

Operation ARP Message

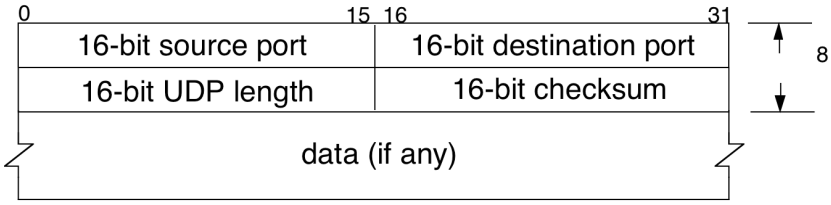
1	ARP request
2	ARP reply
3	RARP request
4	RARP reply



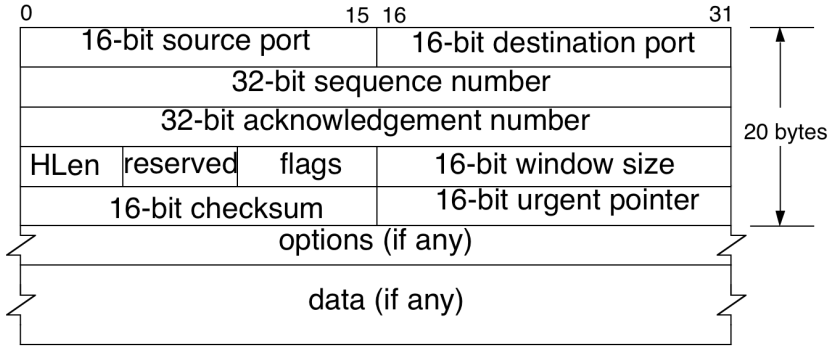
ICMP Message

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, 2007.