

UNIVERSITY OF ABERDEEN Exam 2010

Degree Examination in ES 3567 Communications Engineering 1B

Xday 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 ...
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[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 work better in a wireless environment? [2 marks]
- (d) Explain the use of the *Preamble Sequence* in Ethernet, including the *Start of Frame Delimiter (SFD)*. 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 showing the first few bits of an Ethernet frame, as they appear on the cable. [5 marks]

continued over

2.

- (a) How do bridges learn the *Medium Access Control* (MAC) address associated with systems and use this information to forward Ethernet frames? [10 marks]
- (b) Explain how the frame *Cyclic Redundancy Check* (CRC) included at the end of each Ethernet frame is used to verify the integrity of a frame. [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) How did the use of 8b/10b encoding and *Pulse Amplitude Modulation* (PAM-5) allow an order of magnitude increase in the capacity for Gigabit Ethernet over UTP standard compared to that offered by *Fast Ethernet*? [6 marks]

3

- (a) List the set of fields that are modified in the Ethernet frame header and IP packet header 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) Sketch each of the protocol headers present when a computer sends an *Internet Control Message Protocol* (ICMP) message with 1000 bytes of data over a 10 Mbps cable segment. [5 marks]
- (d) Explain how the *Domain Name System* (DNS) is used to resolve a *network name* to a *network address*. Your answer should highlight the role of the DNS server and explain how caching is needed to improve the performance. [7 marks]

continued over

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

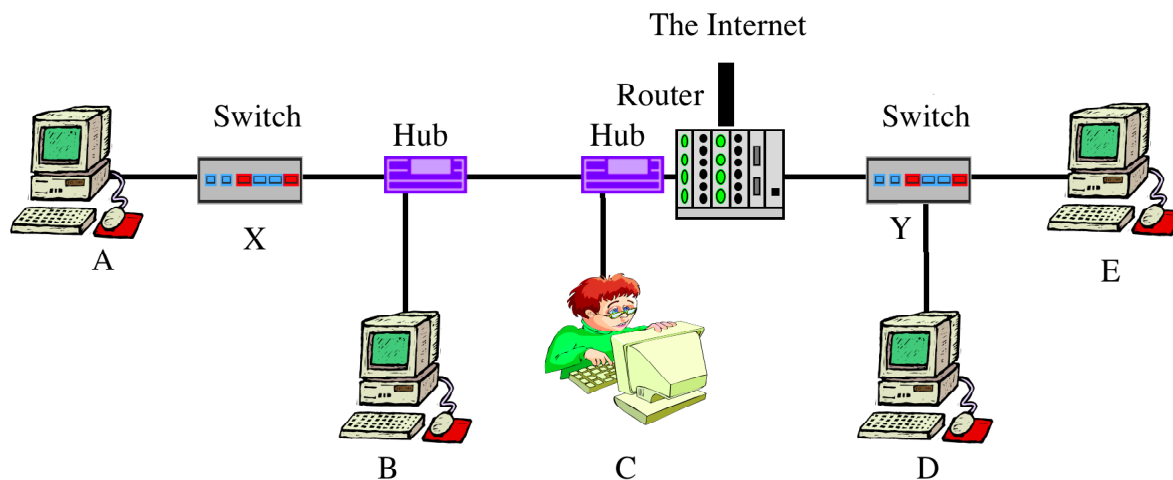


Figure 1: Five computers connected using 4 Intermediate Systems

- (a) Explain how the switch X in the above diagram processes a sequence of frames sent by computer C to computer A. [6 marks]
- (b) Computer C sends a frame using the type value of 0x800 to computer D. Sketch MAC header of the frame, as received by the router and the MAC header of the frame that sent by the router. Your answer should highlight the use of the MAC addresses. [6 marks]
- (c) Explain in detail how the router processes network-layer IP packets sent from the computer C to a computer in the Internet. [8 marks]

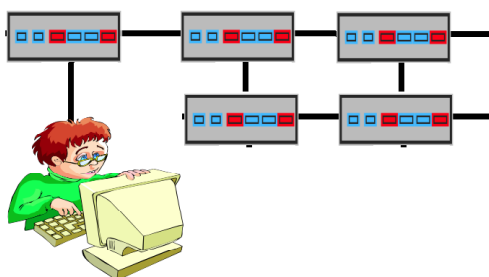


Figure 2: A computer connected using 5 Ethernet Switches

- (d) Five Ethernet switches are connected to form a loop according to the diagram shown above. Why is the *Spanning Tree Algorithm* needed to ensure correct operation of this network? [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.

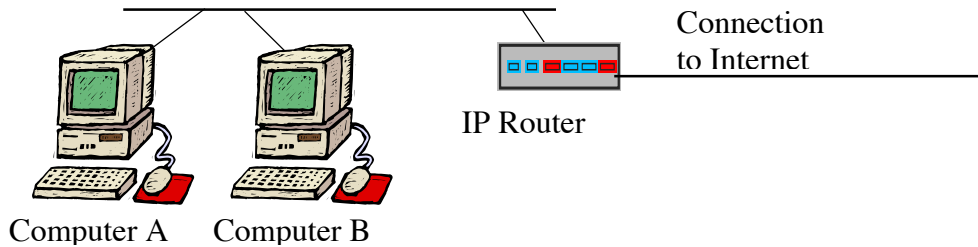


Figure 3: Two computers connected via a LAN to an IP Router

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 (Remote)	201.77.188.166	208.77.188.0/24	00:01:00:00:03:00
Router Interface to LAN	140.0.2.3	140.0.2.0/24	00:02:00:00:01:00

Table 1: Address assignments to the computers and router interfaces

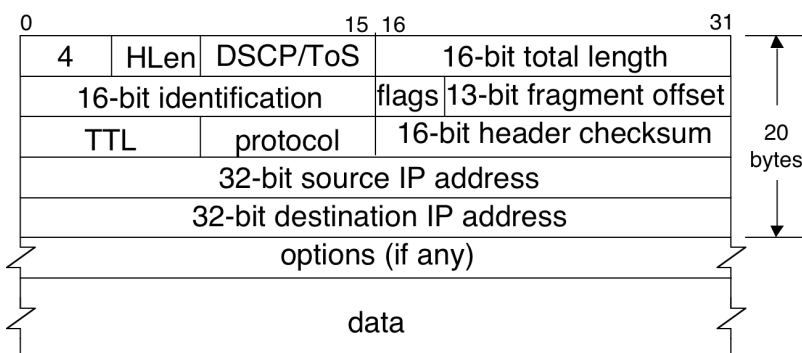
- (a) Use the LAN shown in Figure 3 and the information in Table 1 to explain the process by which computer A determines the *Medium Access Control (MAC)* address to be used to reach a remote computer C connected via the Internet connection. Your answer should indicate the destination IP address and MAC address used. [8 marks]
- (b) Explain how a unique *MAC* address is allocated to each computer within a LAN. [2 marks]
- (c) Provide diagrams and a detailed explanation on *either* of the two following topics:
- (i) Use a diagram describe the *Open Systems Interconnection (OSI)* model and provide detailed notes highlighting the functions and protocols used at each of the seven layers.

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 through a network of routers.

[15 marks]

PDU Header Chart



IP Protocol Types

- 0 IP
- 1 ICMP
- 2 IGMP
- 6 TCP
- 17 UDP

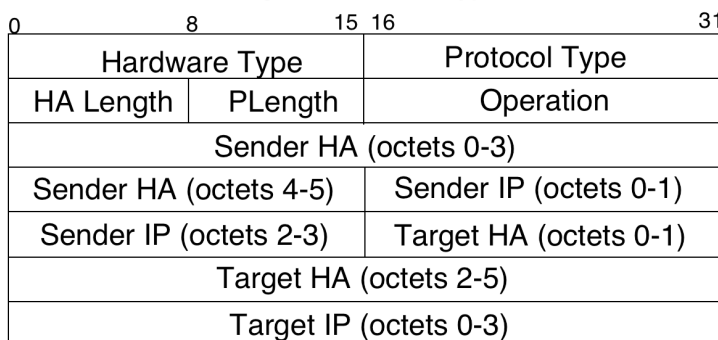
IPv4 Flags

- 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

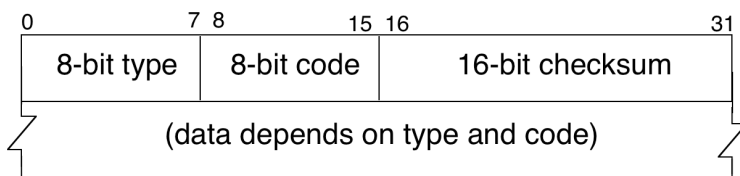
Internet Protocol Datagram (Ethernet Type = 0x800)



Operation ARP Message

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

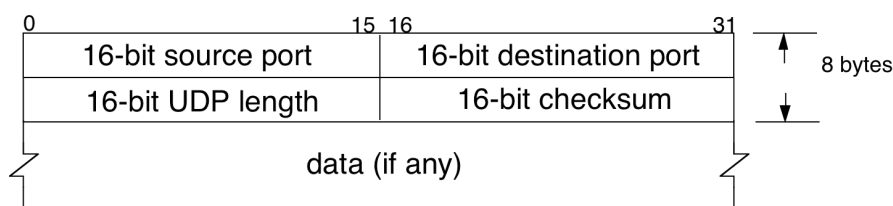
ARP / RARP Packet (Ethernet Type = 0x806)



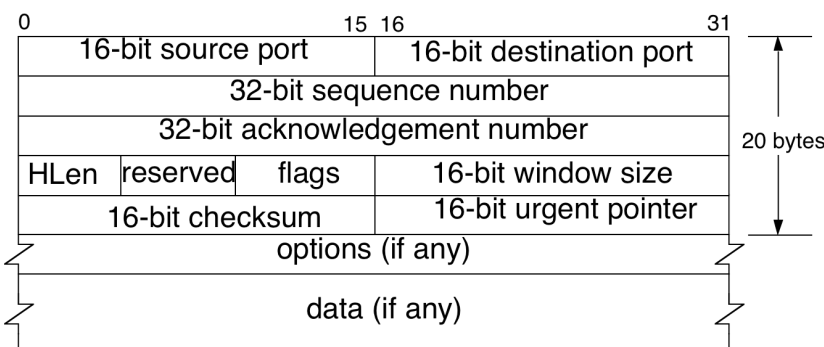
ICMP Message

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

ICMP Message



UDP Packet



Well-Known TCP/UDP Server Ports

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

TCP Packet