

## UNIVERSITY OF ABERDEEN Exam 2009

## Degree Examination in EG 3567 Communications Engineering 1A

Sample 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](http://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 transport protocol that was used and the expected application.

```
001e c2be 4c73 001a 2f18 9790 0800 4510
0040 c72f 4000 4006 4aa3 0a0a 0ac1 0a0a
0a01 c059 0017 404b be89 0000 0000 b002
ffff 54ff 0000 0204 05b4 0103 0303 0101
080a 2863 d181 0000 0000 0402 0000
```

[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) *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? [4 marks]
- (e) 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]

2.

- (a) How do bridges determine the *port(s)* on which a packet must be forwarded? [10 marks]
- (b) What *forwarding rate* would be required by a bridge port to fully utilise a 1 Gbps Ethernet output interface? [3 marks]
- (c) Explain the following terms in relation to an Ethernet Switch/Bridge. Please illustrate your answers with appropriate diagrams:
- (i) The Preamble Sequence [4 marks]
  - (ii) A Contents Addressable Memory [4 marks]
  - (iii) A Filter Table [4 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 100 Mbps Ethernet interface? [6 marks]
- (c) Most link protocols add a group of bytes at the end of a frame to verify correct reception of the data. What is this called, and what is its function? [5 marks]
- (d) Explain how the routing used in an IP network may be verified using common tools. Provide an example of using the tool between a local computer and a remote computer in the connected Internet. [6 marks]

*continued over*

4. Figure 1 shows two computers A and B that are connected to a *networking node* (Node I) and one computer C connected to a different networking node (Node II). Node III provides connectivity to the Internet.

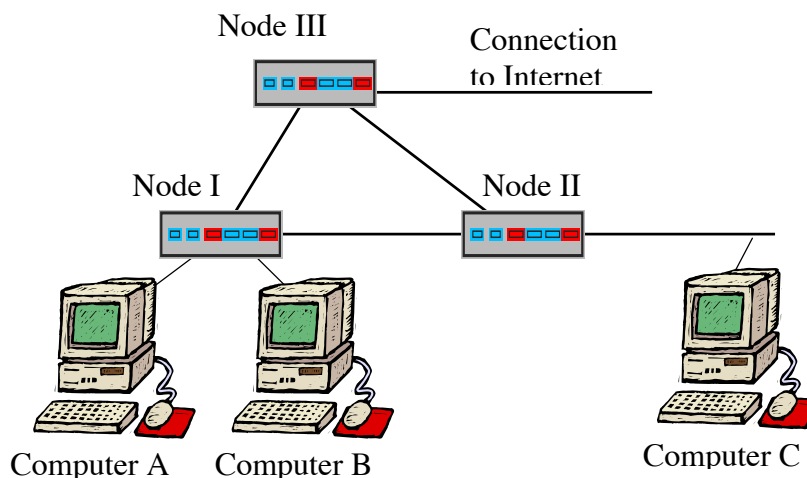


Figure 1: Three computers connected using 3 Intermediate Systems

- (a) Consider the case where nodes I, II, and III are all *Ethernet Switches*. Explain how the switches process frames sent between the computers and the remotely connected Internet. Your answer should discuss the strengths and weaknesses of this design. [6 marks]
- (b) Consider the case where nodes I, II, and III are all *IP Routers*. Explain how the router process packets sent between the computers and the connected Internet. Your answer should discuss the strengths and weaknesses of this design. [6 marks]
- (c) A pair of Ethernet switches are connected via a Fast Ethernet link. A computer monitoring the link observes a significantly greater number of *Address Resolution Protocol (ARP)* request messages than it sees ARP response messages. Describe reasons why this may occur in normal practice. [6 marks]
- (d) A *User Datagram Protocol (UDP)* packet is transmitted with 1400 bytes of UDP payload data over an Ethernet cable segment. Draw a series of diagrams showing the transmitted frame. The diagrams must indicate the overhead added by *each* layer of the Open Systems Interconnection (OSI) reference model. [6 marks]

*continued over*

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

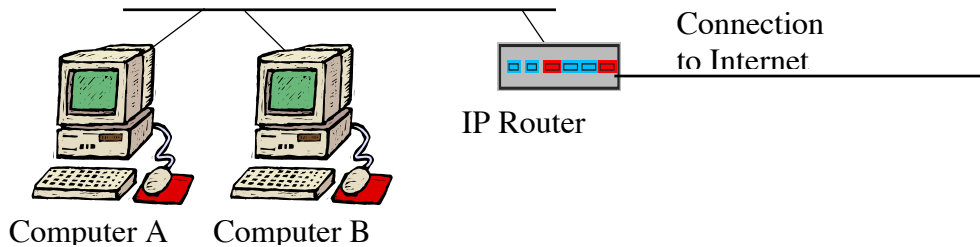


Figure 2: Two computers connected via a LAN to an IP Router

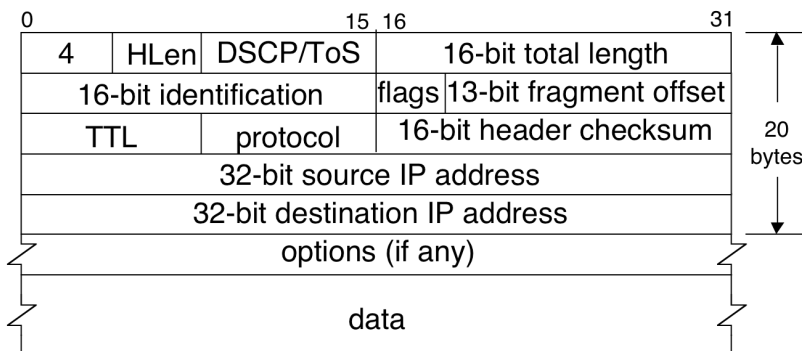
Interface	IP Address	Subnet Mask	MAC Address
Computer A	192.0.2.2	192.0.2.0/24	00:01:00:00:01:00
Computer B	192.0.2.3	192.0.2.0/24	00:01:00:00:02:00
Remote Computer C	208.77.188.166	208.77.188.0/24	00:01:00:00:03:00
Router Interface I	192.0.2.1	192.0.2.0/24	00:02:00:00:01:00
Router Interface II	192.168.1.1	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 2 to explain the process by which computer A determines the *Medium Access Control (MAC)* address to be used to reach computer B and the remote computer C. 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) 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 that explain why this has come to be adopted as a standard reference for communications architectures.
- or**
- (ii) Describe the various approaches to building a data communications network and explain why *packet-switching* has become the dominant technology for all communications.

[15 marks]

**PDU Header Chart**



**IP Protocol Types**

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

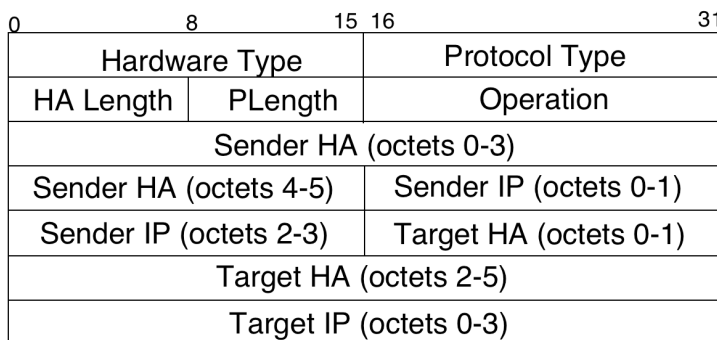
**IPv4 Flags**

- 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

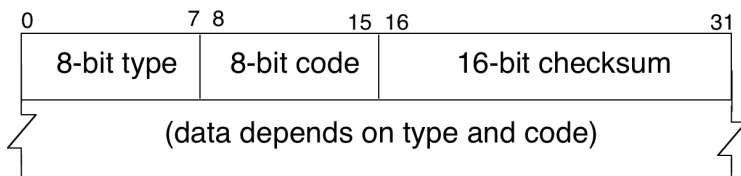
**Internet Protocol Datagram (Ethernet Type = 0x800)**



**Operation ARP Message**

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

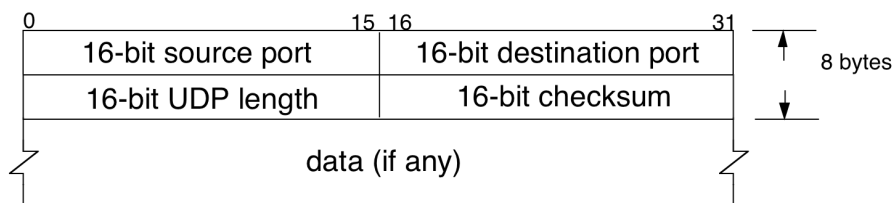
**ARP / RARP Packet (Ethernet Type = 0x806)**



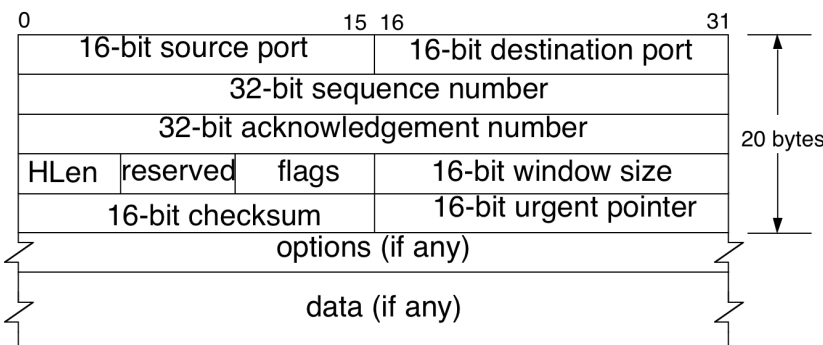
**ICMP Message**

- 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**