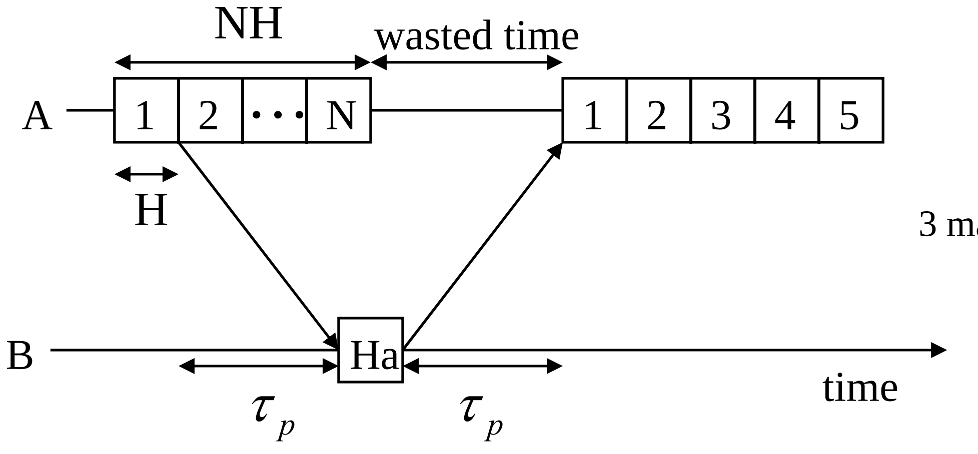
EE4004 Summer 2003

Question 2(b) (i)



3 marks

H = time to send one frame or packet
Ha = time to send acknowledgement
N = no of frames
τ_p= propagation delay
Total time sending N packets = H+Ha+2τ_p

$$U = 100 \times \frac{\text{Useful Time}}{\text{Total Time}} \quad \%$$

$$U = 100 \times \min\left(1\,,\ \frac{NH}{H + Ha + 2\tau_p}\right) \quad \%$$

3 marks

Total 6 marks

Question 2(b) (ii)

$$U = 100\% \Rightarrow \frac{NH}{H + Ha + 2\tau_p} \geq 1 \Rightarrow N \geq \frac{H + Ha + 2\tau_p}{H}$$

1 mark

$$H = \frac{2500}{155 \times 10^6} = 16.13\mu s \quad Ha = \frac{100}{155 \times 10^6} = 0.65\mu s \quad \tau_p = 100 \times 5 = 500\mu s$$

$$N \geq \frac{H + Ha + 2\tau_p}{H} = \frac{16.13 + 0.65 + 2 \times 500}{16.13} = 63.04$$

Therefore N has to be at least 64.

3 marks

Total 4 marks

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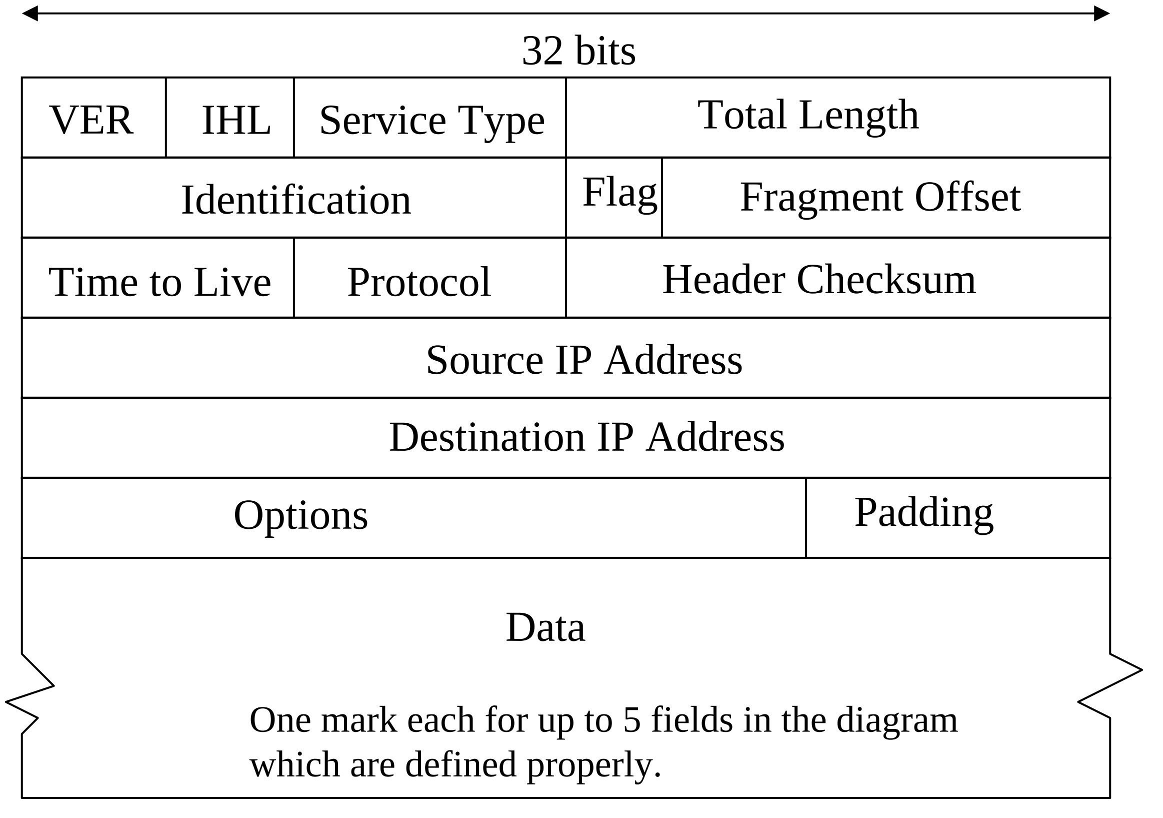
Question 3(a)

IP Packet



Source IP Address: This is the 32 bit address of the computer sending the data

Destination IP Address: The 32 bit address of the destination

Total Length: This gives the length of the packet in bytes. This field has 16 bits so the maximum length of an IP packet is 2^{16} bytes. In practice the IP packets are usually much smaller than this.

Protocol: This specifies the upper level protocol (TCP or UDP) which requested transmission of the message to indicate to the receiver how the message should be handled.

VER: This refers to the version number of the IP protocol being used.

IHL: This is the number of 4-byte words in the header.

Service Type: This indicates the type of service (TOS) requested. TOS refers to the delay, throughput and reliability of the route. This field is ignored in many cases on the assumption that the network is providing a “best effort service anyway.

Identification: This is a two-byte field which holds the packet sequence number i.e. the frame number.

Flags and Fragmentation: Long packets may need to be fragmented into a sequence of smaller packets at the link layer. The flags and fragmentation offset field keep track of this.

Time to Live: This one byte field is set to a value by the source. Every time the IP packet passes through a network node, this value is decremented by one. When it reaches 0 the packet is discarded and an error message is sent to the source. This prevents a packet clogging up the network if it cannot be delivered.

Header Checksum: This is used to perform error detection on the header only.

Options: This is used for some optional services that may have been requested such as recording the route of the packet through the network, following a specific route or time stamping of the packet by each node that it travels through.

Total 5 marks

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Question 3(b)(i)

When computer A on LAN1 with internet address e.g. IP1.4 wants to send data to computer B on LAN2 with internet address e.g. IP2.3 the following sequence takes place:

1. Assuming A knows B's "name" e.g. rennes.ucc.ie then it determines B's internet address using a directory service (database) known as DNS (Distributed Name System)
2. A places the data in an IP packet. This packet contains the data, the source address (A – IP1.4) and the destination address (B – IP2.3). The packet is [IP1.4 | IP2.3 | Data].
3. A knows that the address IP2.3 is not on LAN1 and therefore the data must be sent to its "default gateway" (Router R1 with IP address IP1.1] for further processing.
4. To send [IP1.4 | IP2.3 | Data] to R1 over LAN1, this packet must be placed in a frame as defined by the protocol of LAN1. If LAN1 is an Ethernet LAN then this frame is of the form [F1] = [mac(IP1.1) | mac(IP1.4) | IP1.4 | IP2.3 | Data | CRC]. mac(IP1.1) and mac(IP1.4) are the MAC (Ehernet) addresses of port A of R1 and of computer A respectively. CRC is a error-detection field.
5. When R1 receives [F1] = [mac(IP1.1) | mac(IP1.4) | IP1.4 | IP2.3 | Data | CRC] it removes the Ethernet wrapping to get the IP packet [IP1.4 | IP2.3 | Data]. It determines that the data is destined for IP2.3 which is in subnet IP2 i.e. LAN2 on its port B.
6. R1 now has to send the IP packet to computer B on LAN2. It has to determine the MAC address of B and encapsulate the IP packet in a frame suitable for LAN2. If LAN2 is also an Ethernet then this frame looks like: [F2]=[mac(IP2.3) | mac(IP2.1) | IP1.4 | IP2.3 | Data | CRC]
7. When B receives the frame [F2]=[mac(IP2.3) | mac(IP2.1) | IP1.4 | IP2.3 | Data | CRC] it removes the "data" from the LAN protocol to give [IP1.4 | IP2.3 | Data]. The IP layer then extracts the useful data [Data] from this IP packet.

Total 7 marks

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Question 3(b)(ii)

If computer A wants to send data to computer C "somewhere" on the internet a similar sequence of events takes place but Router 1 sends the data to its internet connection rather than to LAN2.

1. A determines C's internet address using DNS
2. A places the data in an IP packet of the form [IP1.4 | IP5.3 | Data].
3. The address IP5.3 is not on LAN1 so A sends the IP packet to Router R1 for further processing.
4. To send [IP1.4 | IP5.3 | Data] to R1 over LAN1, the packet is placed in an Ethernet frame of the form [F2] = [mac(IP1.1) | mac(IP1.4) | IP1.4 | IP5.3 | Data | CRC].
5. When R1 receives [F2] = [mac(IP1.1) | mac(IP1.4) | IP1.4 | IP2.3 | Data | CRC] it removes the Ethernet wrapping to get the IP packet [IP1.4 | IP5.3 | Data]. It determines that the data is destined for IP5.3. It looks up its routing table and determines that none of its ports are connected to an IP subnet of the form IP5.x Therefore the packet must be destined for a computer in "the internet" to which it is not directly connected. Such packets are sent to Router R2 which is at the Point of Presence (PoP) of the internet provider.
6. R1 takes the IP packet [IP1.4 | IP5.3 | Data] and puts it in a frame of the format required by the connection from R1 to R2. It then sends this new frame [F4] along the link L to R2.
7. When R2 receives [F2] it extracts the IP packet [IP1.4 | IP5.3 | Data]. It reframes this IP packet as [F5] for transmission along the next link of the journey…
8. Eventually…computer C receives a frame [FX] from which it extracts the IP packet [IP1.4 | IP5.3 | Data]. The IP layer of C then extracts the useful data [Data].

Total 8 marks