Solution sheet – Mid-Semester Test 2009

Question 1 – Short Answer Questions

1.1 Match the following to one or more layers of the OSI model:

a) Communicates directly with the user's application program – application layer
b) Error correction and retransmission – Data link layer and transport layer
c) Mechanical, electrical, and functional interface – physical layer
d) Responsibility for carrying frames between adjacent nodes. – data link layer

[2 marks]

1.2 Which error detection method consists of just one redundant bit per data unit?

a) Simple parity check
b) Two-dimensional parity check
c) CRC
d) Checksum

[1 mark]

1.3 We add *r* redundant bits to each block to make the length $n = k + r$. The resulting *n*-bit blocks are called:

a) Datawords
b) Blockwords
c) Codewords
d) None of the above

[1 mark]

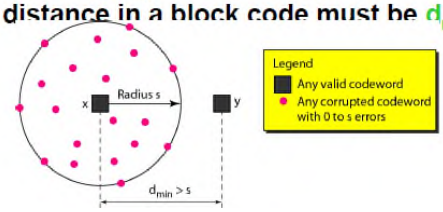
1.4 To guarantee the detection of up to 5 errors in all cases, the minimum Hamming distance in a block code must be:

a) 5
b) 6
c) 11
d) None of the above

Provide a brief explanation for your selection

$d_{min} = s + 1$ Where d_{min} is the minimum Hamming Distance

To guarantee the detection of up to s errors in all cases, the minimum Hamming distance in a block code must be $d_{min} = s + 1$.



[2 marks]

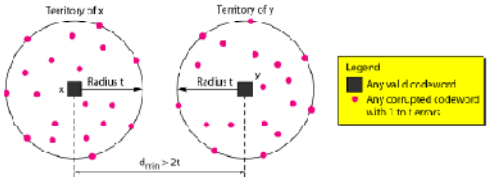
1.5 To guarantee correction of up to 5 errors in all cases, the minimum Hamming distance in a block code must be:

a) 5
b) 6
c) 11
d) None of the above

Provide a brief explanation for your selection

$d_{min} = 2t + 1$ Where d_{min} is the minimum Hamming Distance *[2 marks]*

To guarantee correction of up to t errors in all cases, the minimum Hamming distance in a block code must be $d_{min} = 2t + 1$.



1.6 The number of addresses in a class B block is:

a) 65,536
b) 16,777,216
c) 256
d) None of the above *[1 mark]*

1.7 An IPv6 address can have up to ___ hexadecimal digits.

a) 16
b) 32
c) 8
d) None of the above *[1 mark]*

1.8 In an IPv4 header, an HLEN value of decimal 10 means ____.

a) there are 10 bytes of options
b) there are 40 bytes of options
c) there are 10 bytes in the header
d) there are 40 bytes in the header

HLEN defines the length of the header in 4-byte words so its value must be multiplied by 4 to give the overall length in bytes. *[1 mark]*

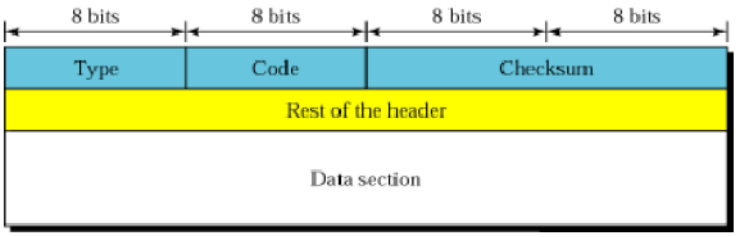
1.9 ICMP messages are divided into two broad categories: ____.

a) query and error reporting messages
b) request and response messages
c) request and reply messages
d) None of the above *[1 mark]*

1.10 An ICMP message has ___ header and a variable-size data section.

a) a 16-byte
b) a 32-byte
c) an 8-byte
d) None of the above

- **An ICMP message starts with a 64-bit header consisting of the following:**
  - **Type (8 bits): specifies the type of ICMP message.**
  - **Code (8 bits): used to specify parameters of the message that can be encoded in one or a few bits.**
  - **Checksum (16 bits): checksum of the entire ICMP message. This is the same checksum algorithm used for IP.**
  - **Parameters (32 bits): Used to specify more lengthy parameters.**



[1 mark]

1.11 The Open Shortest Path First (OSPF) protocol is an intra-domain routing *[1 mark]*

protocol based on _____ routing.

a) distance vector
b) link state
c) path vector
d) None of the above

1.12 The _____ protocol allows the administrator to assign a cost, called the metric, to each route.

a) OSPF
b) RIP
c) BGP
d) None of the above

Provide two (2) example metrics that could be used for this protocol.

Throughput and delay *[2 marks]*

1.13 One of the responsibilities of the transport layer protocol is to create a _____ communication.

a) host-to-host
b) process-to-process
c) node-to-node
d) None of the above *[1 mark]*

1.14 UDP is called a _____transport protocol.

a) connectionless, reliable
b) connection-oriented, unreliable
c) connectionless, unreliable
d) None of the above *[1 mark]*

1.15 Change the following IP addresses from dotted decimal notation to binary notation:

a. 124.74.3.8

b. 218.24.54.42

Binary notation:

a. Binary: 124.74.3.8 is 01111100 01001010 00000011 00001000

b. Binary: 218.24.54.42 is 11011010 00011000 00110110 00101010 *[2 marks]*

1.16 Which **TWO** of the following statements correctly relate to the OSPF routing protocol?

a) Each router maintains a "view" of the overall topology total and calculates its own "best path" to each other router.
b) Routing tables are exchanged between adjacent routers at 90 second intervals (typically).
c) Slow convergence is a particular OSPF feature.
d) "Hop-count" is the significant metric.
e) Routing table recalculation updates are triggered by topology changes.
f) OSPF only considers information concerning the status of static routes. *[2 marks]*

1.17 Briefly explain the two army problem and the implications of that example to the development of transport layer protocols.

Answer (taken directly from Lecture notes but a summary is actually *[4 marks]*

sufficient in the answer)

Consider two warring armies, the Blue Army, and the White Army. The White Army is camping in a mountain valley. The Blue Army, while larger and more powerful, is divided into two groups hiding in the surrounding mountains. If the two Blue Army platoons attack the White Army together and at exactly the right time, they will prevail. The longer they wait, the more surprised the White Army will be by the attack. But if they wait too long, they will run out of supplies, grow weak, and starve. The timing is critical. But if they are not coordinated, they will surely lose. They must attack at exactly the same time. When the time is right B1 will send a messenger to B2 that says, "Attack at dawn!" But B1 may become concerned that B2 did not get the message and consequently not attack. If that happens, B1 will be defeated. Alternately, B2 may become concerned that B1 will become concerned, so they may not attack, leaving B1 to be defeated in solitude.

Conclusion

The moral of this story is that there is no solution to this problem if the communications *medium* is *unreliable*.
Please note that we said the *medium*, not the *protocol*.
This is an important distinction.
A reliable protocol above an unreliable medium can guarantee that a message will *eventually* be sent provided of course that the recipient eventually becomes ready and accessible.
But no protocol can guarantee that a message will be delivered within a finite amount of time – error conditions may persist for long and indeterminate amounts of time.

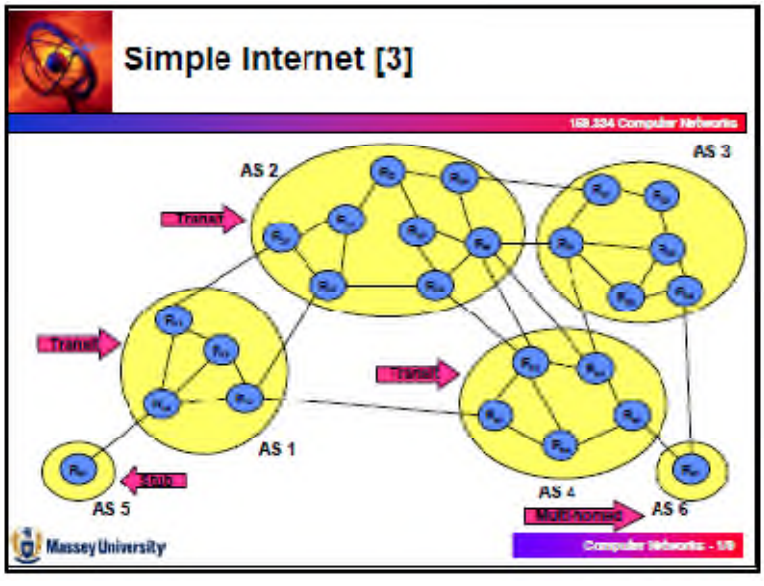
1.18 For the BGP4 routing protocol, using a simple sketch, explain the differences between the following three types of Autonomous Systems:

a. Stub AS

b. Multi-homed AS

c. Transit AS

Answer should resemble something like this:



[2 marks]

1.19 What is the main difference between the delivery of a frame in the data link layer and the delivery of a packet in the network layer? *[2 marks]*

Answer:

The delivery of a frame in the data link layer is ***node-to-node.*** The delivery of a packet at the network layer is ***host-to-host***.

Total [30 marks]

Question 2 – More Detailed Answers Required

2.1 a) When the Bellman-Ford algorithm is applied to the network of Figure 1, how many repetitions of the Relax process are required? Explain your answer.

b) Initialise the data structures and then perform two (2) iterations **(ONLY!)** of the Bellman-Ford Algorithm using the following sequence for the 16 links and summarise your results for the distances d_j for these links. The origin node is node "A".

The link processing order to be used for your Relax process is as follows:

{AB, FH, GH, CD, AD, EH, BC, CG, AC, DG, DF, BE, CE, CF, EF, FG}

c) Apply the Dijkstra algorithm to the network of Figure 1 and compare this optimal result with the results obtained in b) and comment. (No need to show detailed working.)

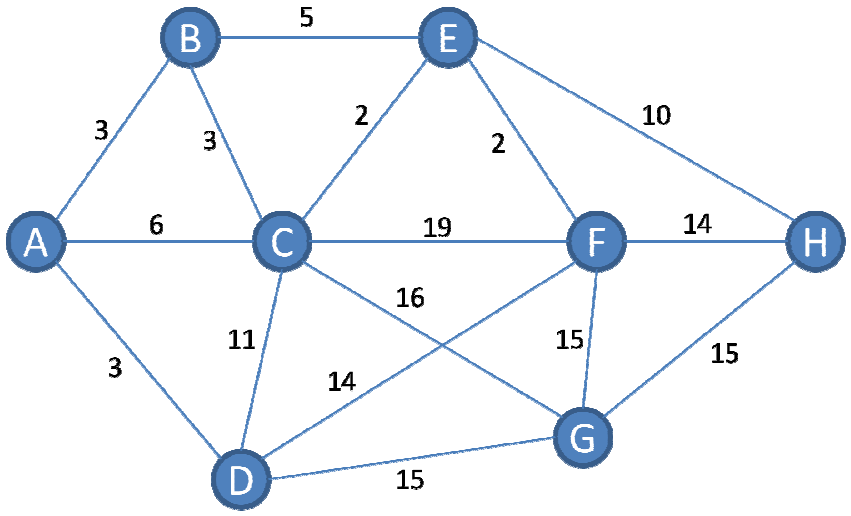


Figure 1: Sample Network from the Internet

Answers:

a) There are 8 nodes in this network, and hence there needs to be 8 – 1= 7 repetitions required for the Relax method to complete be completed. This number of iterations required to cover case where diameter of network is 7:

Worst case scenario – 7 links
Requires all 7 iterations of the Relax process to confirm the shortest path

b) The two iterations are:

Status after iteration #1

Node A: Label = 0 : Previous Node :0
Node B: Label = 3 : Previous Node :A
Node C: Label = 6 : Previous Node :B
Node D: Label = 3 : Previous Node :A
Node E: Label = 8 : Previous Node :B
Node F: Label = 10 : Previous Node :E
Node G: Label = 18 : Previous Node :D

[(1+2)+5+4 = 12 marks]

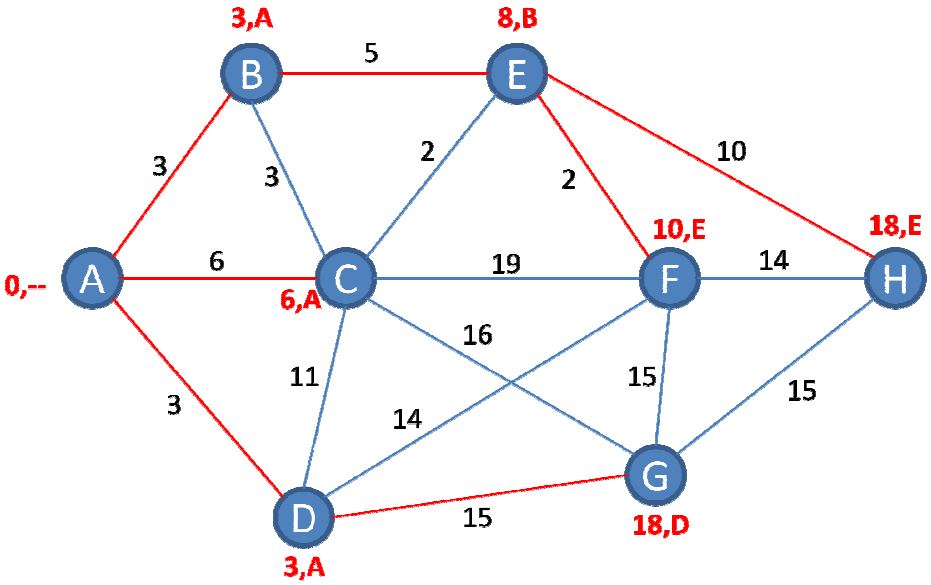
Node H: Label = INFINITY: Previous Node :0

Status after iteration #2

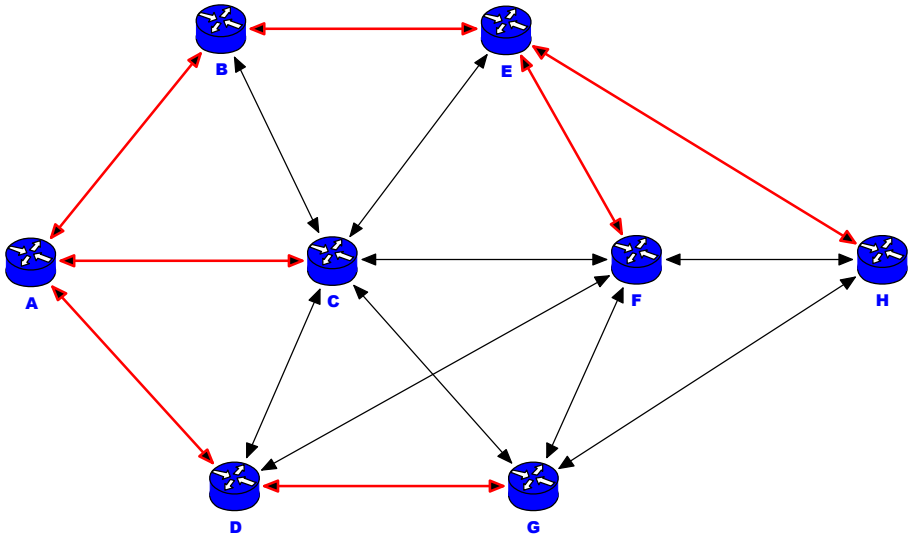
Node A: Label = 0 : Previous Node :0
Node B: Label = 3 : Previous Node :A
Node C: Label = 6 : Previous Node :B
Node D: Label = 3 : Previous Node :A
Node E: Label = 8 : Previous Node :B
Node F: Label = 10 : Previous Node :E
Node G: Label = 18 : Previous Node :D
Node H: Label = 18 : Previous Node :E

Note: There are multiple solutions for the predecessor nodes in this example.

c) Good comparison, the Bellman-Ford method had actually converged after only two iterations.

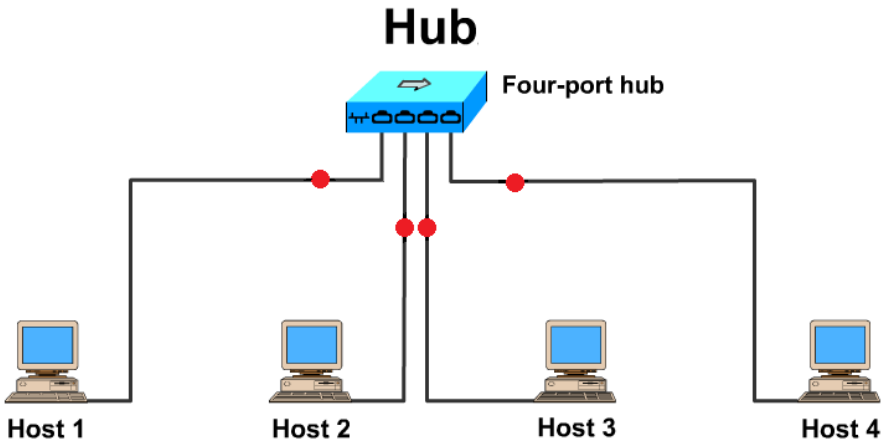


Actual solution using Dijkstra shown but specific working not required. (Note that there are multiple solutions for the predecessor nodes in this example.)

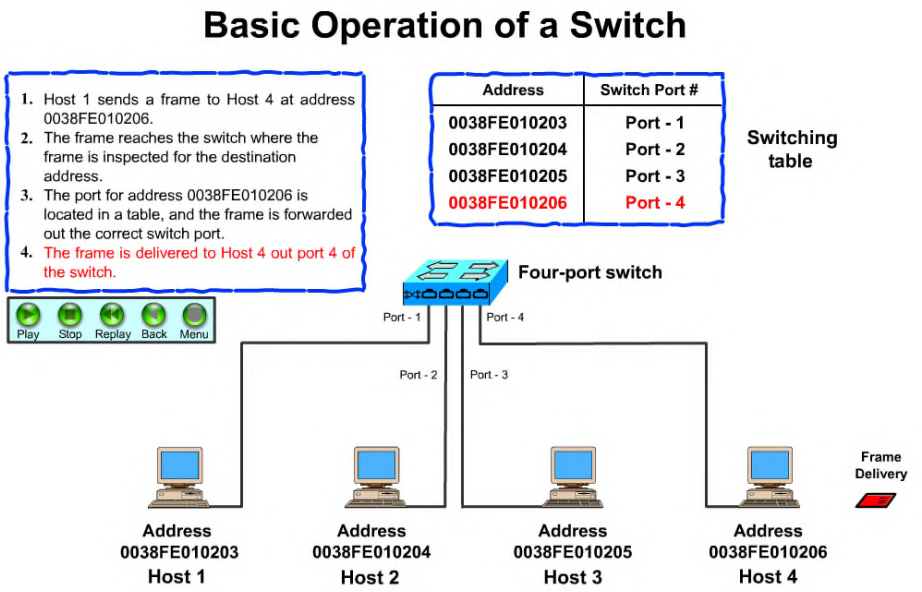


2.2 In a few brief sentences, briefly explain the principal differences in operation and functions of a hub, a switch and a router.

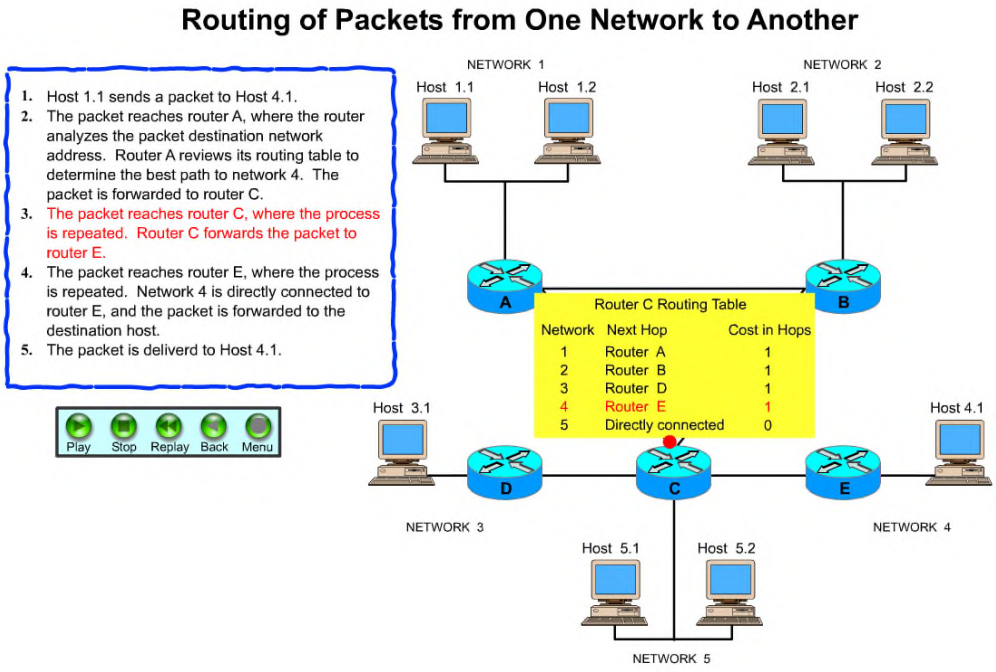
Answers:



Hub acts as a repeater. It receives packets and broadcasts them across the network. The destination host picks up the packet and all other hosts discard the packet if it is not destined for them. *[3 marks]*



Switch only sends packet to the correct address as indicated in its table.



Router as discussed has multiple interfaces between networks

2.3 A data transmission system uses a CRC generator (key) of: **1101**

Determine the FCS and the transmitted frame for the message: **100100**

Answer:

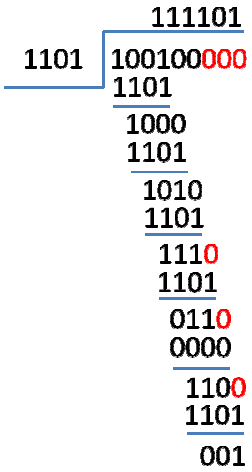
The FCS is **001**

Transmitted frame is: **100100001**

Working: *[3 marks]*

Number of bits in divisor is 4, so we append 3 bits to the dividend:

$1101\overline{)100100000}$ → Remainder is **001.**



2.4 An organisation is granted the block 130.56.0.0/16. The administrator wants to create 1024 subnets:

a. Find the subnet mask required

b. Find the number of addresses in each subnet

c. Find the first and last allocatable addresses in subnet 1

d. Find the first and last allocatable addresses in subnet 32

Answers:

a) $1024 = 2^n$ where n = 10. The address is a Class B address so the default mask is /16 and so if we require 10 bits for the subnets then the required subnet mask is /16+10 = /26. (Could be specified as 0xffffffc0, or 255.255.255.192 in dotted decimal format)

b) The remaining bits must be used for the addresses in each subnet ie we shall have 32 – 26 = 6 bits for the address component, or 2^6 = 64 bits. We lose two addresses per subnet as they are not actually allocatable

c) The first and last allocatable addresses in subnet 1 are

130.56.0.1 to 130.56.0.62

Working

The first address for the block is found by ANDing the address 130.56.0.0 with the subnet mask /26 giving

10000010 00111000 00000000 00000000 (130.56.0.0)

But this is not an allocatable address, so the next one is

10000010 00111000 00000000 00000001 (130.56.0.1)

Finally, we note that the broadcast address is the last one of the 64 addresses so the last allocatable one is the one before that broadcast address so it must be

10000010 00111000 00000000 00111110 (130.56.0.62)

d) The first and last allocatable addresses in subnet 32 are: *[6 marks]*

130.56.7.193 to 130.56.7.254

Working

To find the 32nd subnet we have to add 31 to the subnet number of the first subnet. We can add this amount to the first allocatable address of the first subnet as we know that the first address in every block is not allocatable as it is a special address.

The format is: nnnnnnnn.nnnnnnnn.ssssssss.sshhhhhh

$31_{10} = 11111_2$ inserted in bit positions 22-26 inclusive

10000010 00111000 00000111 11000001 (130.56.7.193)

As there are 64 addresses in the range with the first and last being reserved, the last allocatable one must be 61 addresses after the above first allocatable address. Now

$61_{10} = 111101_2$ is added to the first allocatable address to get:

10000010 00111000 00000111 11000001 (130.56.7.193)
+
00000000 00000000 00000000 00111101 (0.0.0.61)

10000010 00111000 00000111 11111110 (130.56.7.254)

Thus the final allocatable address must be 130.56.7.254

Summary:

IP Address format summary
Hex: 823807fe
Octal: 20216003776
Decimal: 2184710142
Binary: 10000010 00111000 00000111 11111110
IP Address: 130.56.7.254
IP Class is: Class B
Default mask: /16

Length of the mask required: /26

Network mask format summary
Hex: ffffffc0
Octal: 37777777700
Decimal: 4294967232
Binary: 11111111 11111111 11111111 11000000
IP Address: 255.255.255.192

Number of subnets: 1024 (Bits borrowed for subnets: 10)
Number of hosts : 64 (Bits used for hosts: 6)

Network address only details
Hex: 82380000
Octal: 20216000000
Decimal: 2184708096
Binary: 10000010 00111000 00000000 00000000
IP Address: 130.56.0.0

Subnet address only details
Hex: 7c0

Octal: 3700
Decimal: 1984
Binary: 00000000 00000000 00000111 11000000
IP Address: 0.0.7.192
Subnet #: (31)

Host address only details
Hex: 3e
Octal: 76
Decimal: 62
Binary: 00000000 00000000 00000000 00111110
IP Address: 0.0.0.62

2.5 The IETF has identified three possible strategies for making the transition between IPv4 and IPv6. These strategies are:

1) Dual stack
2) Tunnelling
3) Header translation

Briefly describe the operation of each strategy.

Answer:

1) Dual stack means running IPv4 and IPv6 simultaneously until everyone is ready for IPv6. (To figure out which version of IP to use when sending a packet to the destination, the source must send a query to the DNS server. If the DNS server returns an IPv4 address then the source sends an IPv4 packet, else it sends an IPv6 packet.)

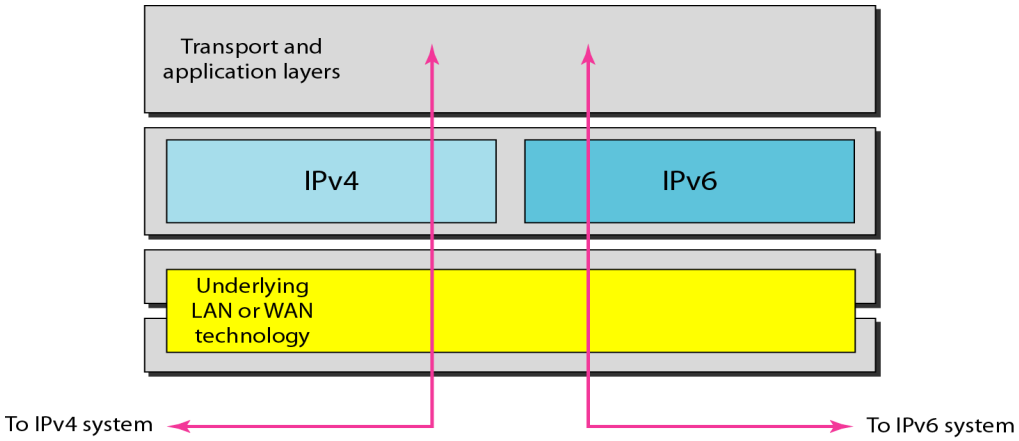
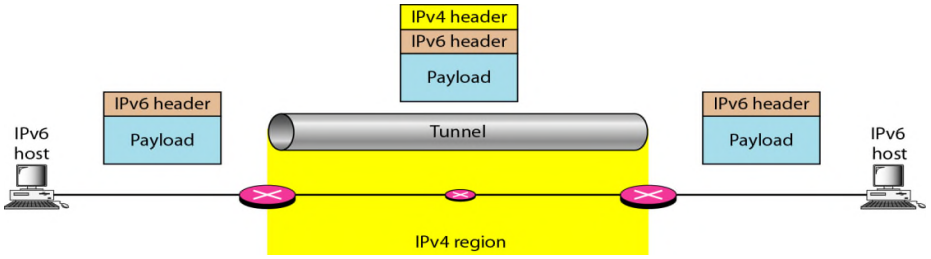


Figure 2: Demonstrating Dual Stack

2) Tunnelling involves encapsulating an IPv4 packet inside an IPv6 packet or vice versa and setting the protocol indicator for the packet as "IP"



[2 + 2 + 2 = 6 marks]

Figure 3: Demonstrating tunnelling process

3) Header translation used if the receiver doesn't understand IPv4and you are using IPv6. Translation is required at the router that connects to the IPv4 destination network.

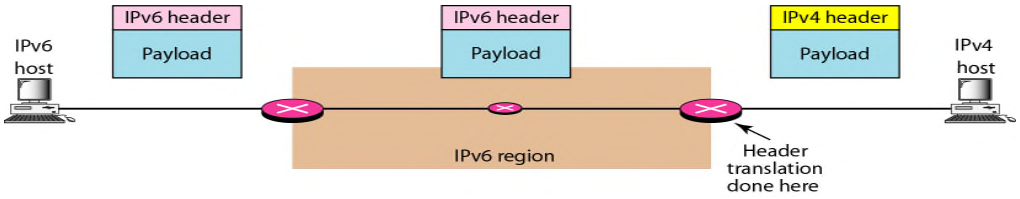


Figure 4: Demonstrating header translation

Total [30 marks]