UNIVERSITY OF COLOMBO, SRI LANKA

UNIVERSITY OF COLOMBO SCHOOL OF COMPUTING

DEGREE OF BACHELOR OF INFORMATION TECHNOLOGY (EXTERNAL)

Academic Year 2005/2006 – 2nd Year Examination – Semester 4

IT4102: Data Communication and Computer Networks

PART 2 – Structured Question Paper

18th August, 2007

(ONE AND A HALF HOURS)

To be completed by the candidate

BIT Examination Index No: .....

Important Instructions:

- The duration of the paper is **1 ½ (One and a Half) hours**.
- The medium of instruction and questions is English.
- This paper has **4 questions** and **19 pages**.
- **Answer question 1 (50** marks**) and any 2 of the other questions (25** marks each**) only**.
- **Write your answers** in English using the space provided **in this question paper**.
- Do not tear off any part of this answer book.
- Under no circumstances may this book, used or unused, be removed from the Examination Hall by a candidate.
- Note that questions appear on both sides of the paper.
  If a page is not printed, please inform the supervisor immediately.

Questions Answered

Indicate by a cross (×), (e.g. [X]) the numbers of the questions answered.

To be completed by the candidate by marking a cross (×).	1	2	3	4	
To be completed by the examiners:					

Index No: ……...

1) (a) An analogue television (tv) signal is sampled at 450 x 500 pixels and each pixel is digitized at 32 levels of intensity. Picture frames move at a rate of 30 per second.

(i) Showing all steps clearly, calculate the bit rate of the digitized tv signal.

(03 marks)

ANSWER IN THIS BOX

Number of pixels Per frame = 450 × 500

bits / pixel = 5; (since $32 = 2^5$)

∴ Total number of bits / frame = 5×450×500

∴ bits / sec = 5×450×500×30 ; (since 30 frames per sec)

$= 3375 \times 10^4$

Bit rate = 33.75 Mbps

(ii) The digitized tv signal is to be transmitted over a channel with a bandwidth of 5MHZ and a signal to noise ratio of 35dB. Can the digitized signal be transmitted over this channel? Justify.

(03 marks)

ANSWER IN THIS BOX

Using Shannon's theorem

$C_{max} = W. \log_2 (1+S/N)$

Where W = 5MHz , S/ N 35dB =10 $\log_{10}$ S/N

➔S/N = $10^{3.5} \approx 4096$

$C_{max} = 5 \times 10^6 \log_2 (1+4096)$

$= 5 \times 10^6 \times 12$

= 60Mbps

The digitalize tv signal can be transmitted over the channel,

as 33.75 Mbps <60Mbps

(iii) Suppose now, the digitized tv signal is encoded as a 2 bit per sample signal. Can this encoded signal be transmitted over the above channel of (ii)? Justify.

(03 marks)

ANSWER IN THIS BOX

Now, the digitized tv signal baud rate is 33.75 M baud. With 2- bit /sample

the bit rate become 2 × 33.75 = 67.5 Mbps

But 67.5Mbps > C_{max}

Hence, the encoded signal cannot be transmitted over the channel

(b) The table below characterizes several LAN technologies.

Fill in the boxes in each row with appropriate terms chosen from the corresponding list.

Row(1): UTP/Cat5, STP, single mode fibre, multimode fibre, wireless, co-axial, other

Row(2): 1Mbps, 11Mbps, 54Mbps, 100Mbps, 1Gbps, 10Gbps, other

Row(3): 1m, 10m, 100m, 500m, 5km, 10km, 50km.

Row(4): hub, bridge, L2 switch, L3 switch, access point, router, other, none.

Row(5): TDM/Polling, switched, CSMA/CA, CSMA, CSMA/CD, other

Row(6): client access, campus backbone, server connection, peer-to-peer, Metro Ethernet, other.

(15marks)

ANSWER IN THIS BOX

LAN Characteristic	100 Base TX	1000 Base LX	10G Base L	802.11 b/g	802.15
(1) Physical medium	**STP** **UTP/Cat 5**	**Single mode fibre** **mmode fibre**	**Single mode fibre**	**Wireless**	**Wireless**
(2) Maximum data rate	**100 Mbps**	**(1Gbps)1000 Mbps**	**10 Gbps**	**11 Mbps** **54 Mbps**	**1 Mbps**
(3) Maximum distance	**100 m** **200m**	**single mode 5 km** **MM 500m**	**10 Km**	**100m**	**1m** **10m** **100m**
(4) Configuration device(s)	**hub or L2 switch or L3 switch**	**L2 switch** **L3 switch**	**other**	**access point**	**None**

Continued…

(5)Media access method	**CSMA/ CD** **Switched**	**Switched**	**Switched**	**CSMA/CA**	**Polling/ TDM**
(6) Position in network hierarchy	**Client accent**	**Campus back bone** **Server connection** **Metro Ethernet**	**Campus back bone** **Metro Ethernet**	**Client access**	**Peer-Peer**

(c) A large number of consecutive IP addresses is available for assignment starting at 192.240.0.0. Suppose there are three organizations A, B and C which request 4000, 2000 and 8000 addresses respectively. For each of the organizational IP allocations, give the first IP address, the last IP address and the network mask in *p.q.r.s/t* notation.

(18 marks)

ANSWER IN THIS BOX

A maximum of 6 subnets, each with a max of 8192 hosts can be created. Select any 2 out of 6

Organization	First IP Address	Last IP Address	Network mask in *p.q.r.s/t* notation
A	**192.240.32.01**	**192.240.63.254**	**192.240.32.0/19**
B	**192.240.64.01**	**192.240.95.254**	**192.240.64.0/19**
C	**192.240.96.01**	**192.240.127.254**	**192.240.96.0/19**

(d) Two client-server applications are to be run on two different network configurations. One configuration has a small pipe size of 2 (i.e., bandwidth x delay product) and the other a pipe size of 100. Application 1 is a long file transfer and application 2 is a DNS query (request-response type).

(i) Which application could use TCP and, which application could use UDP? Why?

(03 marks)

ANSWER IN THIS BOX

TCP →file transfer app; requires guaranteed error free delivery;

UDP→ DNS query; does not require guaranteed delivery; Can re- try if fails;

TCP connection set up too expensive for short query

(ii) If a DNS packet is lost, would it cause a problem? Justify.

(02 marks)

ANSWER IN THIS BOX

No.

Can re-request by DNS client.

(iii) Consider the following table.

	Application 1	Application 2
pipe=2	scenario p	scenario q
pipe=100	scenario r	scenario s

Which scenario, p, q, r or s performs worst if there are significant channel errors?

(03 marks)

ANSWER IN THIS BOX

Scenario 'r' performs worst. Because long file transfer along a long path will

have a large TCP window size. With Go- back-N error recovery, the wasted

bandwidth is significant.

2) (a) A Cat 5/UTP 500m length 100Mbps shared Ethernet utilizes CSMA/CD for access resolution. E-M propagation velocity on copper is 2 x 10^8 m/s.

(i) Find the minimum packet length permissible on the Ethernet. Clearly show all steps.

(02 marks)

ANSWER IN THIS BOX

Min packet length is determined by twice the propagation delay

$\therefore$ one way propagation delay = 500m / 2 $\times$ 10^8 m/s
= 0.5 $\times$ 500$\times 10^{-8}$ sec

no of equivalent bits for one way delay
= (100$\times 10^6$) $\times$ 1/2$\times$500$\times 10^{-8}$

= 250 bits

$\therefore$ min packet length = 2 $\times$ 250 = 500 bits

(ii) What happens if packet length becomes less than this minimum value?

(02 marks)

ANSWER IN THIS BOX

If packet length < Min,

a host will not be able to distinguish between a collision fragment and a good packet

(iii) To maintain the same minimum packet length, how short or long should a 1Gbps copper Ethernet be?

(02 marks)

ANSWER IN THIS BOX

Suppose for 1 Gbps Ethernet, length is 'l' meters , then;

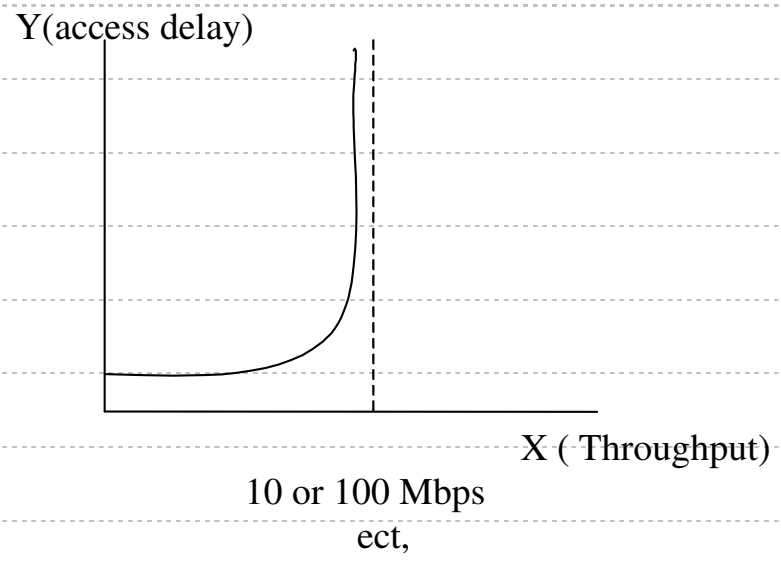
250 bits = $\left(\frac{l}{2\times 10^8}\right)\times 10^9$ **;**

$\therefore$ l = 50 meters

(iv) Plot the access delay (in seconds, y-axis) vs. throughput (in Mbps, x-axis)curve for a typical shared Ethernet.

(02 marks)

ANSWER IN THIS BOX



(v) What implications can be drawn from the above plot in (iv), for real time traffic performance on a heavily loaded Ethernet?

(02 marks)

ANSWER IN THIS BOX

When the Ethernet is heavily loaded, the access delay grows exponentially. As such real time traffic, which require delay bounds, will not be able to be carried over.

(b) Figure 1 shows a switched Ethernet based internal LAN architecture for a small organization. R is the access router and server_1 is for internal access whereas only server_2 is visible to the outside. Within the organization several distinct user groups exist.

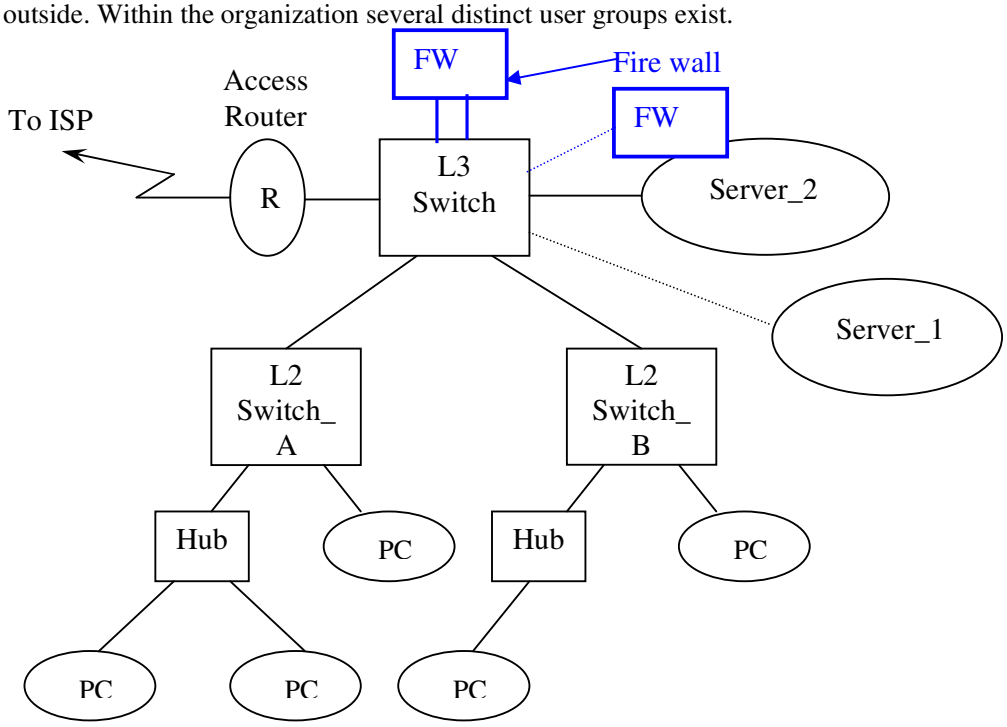


Figure 1

(i) In such an extended LAN architecture, identify the underlying concept on which the above hierarchical network serving different user groups can be efficiently based.

(02 marks)

ANSWER IN THIS BOX

Concept => VLAN (vitual LAN)

(ii) Assuming IP based subnetting is used internally, what is the main purpose of L3 switch?

(02 marks)

ANSWER IN THIS BOX

To route between subnet based VLANS

(iii) If L2 Switch_A and L2 Switch_B serve different user groups, identify three (3) possible subnets (e.g., subnet_1, subnet_2 etc) and the devices which belong to each.

(02 marks)

ANSWER IN THIS BOX

Subnet- 1 : user group of L2 swictch -A

Subnet -2 : user group of L2 swictch -B

Subnet -3 : server 1

Subnet -4 : Access Router R

(iv) What networking device could be used to separate the internal LAN from the outside?

(02 marks)

ANSWER IN THIS BOX

A fire wall

(v) Show on the diagram, a possible place where such a device (as in (iv)) can be connected.

(01 mark)

(vi) If Server_1 is to be accessed only by the user group of Switch_A, and Server_1 is to be physically located at L3 switch, how can this be configured?

(02 marks)

ANSWER IN THIS BOX

Server 1 and user group or switch-A should belong to one VLAN .

(c)

(i) What does DHCP stands for, and for what purpose would one use DHCP?

(02 marks)

ANSWER IN THIS BOX

DHCP – dynamic host configuration protocol

A DHCP sever would issue IP address on demand to clients booting up,

those typically in a WLAN environment etc.

(ii) What is meant by a 'Denial of Service' (DoS) attack?

(02 marks)

ANSWER IN THIS BOX

Dos typically means exploiting protocol "holes" in TCP during "sync"

handshake by clients thereby overloading/ making TCP service not available

of the end host.

similar exploitation of weakness in one application protocol can also be

considered.

3) (a) Use the most suitable terms from the following list and fill in the blanks in the paragraph below:

(1) integrated services	(2) ICMP	(3) multicasting
(4) bandwidth	(5) TFTP	(6) quality of service
(7) throughput	(8) H.323	(9) RSVP
(10) delay	(11) broadband	(12) differentiated services
(13) cost	(14) hop-by-hop	(15) priority
(16) protocols	(17) end-to-end	(18) round robin
(19) topology	(20) UDP	(21) FIFO
(22) circuit switching	(23) TCP	(24) RTP
(25) FTP	(26) unicasting	(27) SMTP
(28) broadcasting	(29) jitter	

(13 marks)

The Internet is a remarkable piece of technology. With origins in packet switching, it has now evolved into an efficient ----(i)---- network. The IP protocol is its backbone. The IP was designed for robust routing over a heterogeneous connection of networks with a widely varying ----(ii)----, resource limitations and a dynamically changing ----(iii)----. Client-server protocols such as ----(iv)---- and ----(v)---- support applications which require guaranteed and sequenced ----(vi)---- packet delivery as provided by an underlying protocol such as ----(vii)---- over IP. Group applications such as distributed database access and video conferencing have peculiar additional requirements. A common requirement of these applications is the network's ability to support ----(viii)----. Hosts are able to join and leave ----(viii)---- groups at their nearest router via a protocol such as ----(ix)----. To carry real time traffic, like voice and video, and to guarantee a certain quality of service, additional mechanisms have to be incorporated into IP. For example, the ----(x)----- protocol attempts to reserve ----(ii)---- across a fixed path from the source host to the destination host. With integrated traffic, routers have to admit and mark real time packets for ----(xi)----- service and to make their rate regulated. Final touches can be provided to the end to end quality of such traffic by means of application layer protocols such as ----(xii)---- where it can be used to minimize delay ----(xiii)----.

ANSWER IN THIS BOX

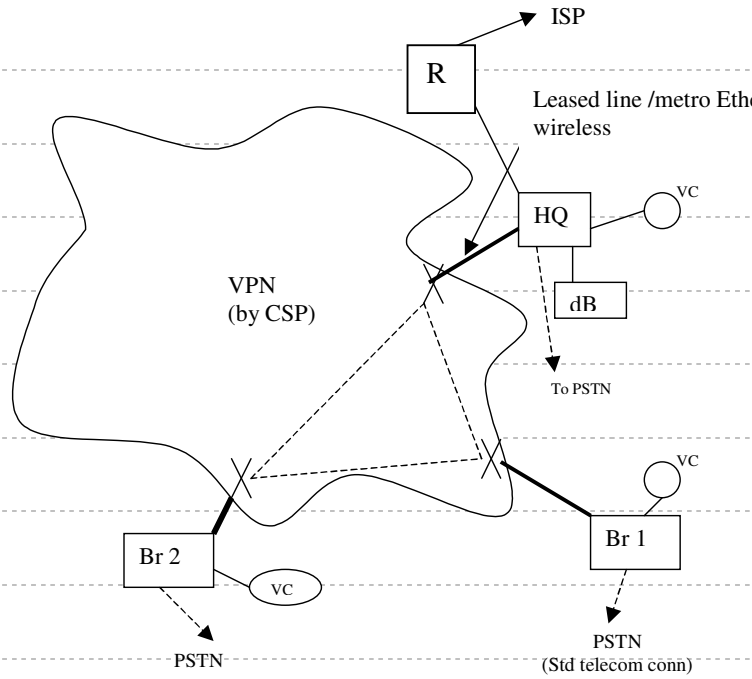
(i) **1** ……..	(ii) **4** ……..	(iii) **19** ……..
(iv) **25 or 27**	(v) **25 or 27**	(vi) **17**
(vii) **23** ……..	(viii) **3** ……..	(ix) **2** ……..
(x) **9** ……..	(xi) **15** ……..	(xii) **24** ……..
(xiii) **29** ……..		

(b) A Company with headquarters (HQ) in Colombo and branches spread around cities is planning to set up a Virtual Private Network interconnecting the HQ with all its branches. The intended services are, branch to HQ central database access, a video conference facility and Internet access. It is assumed that there is one or more communication service providers (CSP) in the island offering a range of access technologies from dedicated leased lines, Metro Ethernet, fixed wireless etc. Each of the branches is to have a back up data connection to HQ in case the permanent connection fails.

(i) Draw a schematic diagram to show the wide area network connectivity, with associated resources.

(02 marks)

ANSWER IN THIS BOX



(ii) State two (2) advantages of a VPN as a concept for such connectivity.

(02 marks)

ANSWER IN THIS BOX

allows secure, private channels to all users of a common group over a common network (shared by many users)

Lower cost than dedicated end to end connections

(iii) State two (2) alternative technologies available for the backup data connection.

(02 marks)

ANSWER IN THIS BOX

PSTN

ADSL

ISDN

(iv) Identify a suitable tunneling protocol for the VPN.

(1.5 marks)

ANSWER IN THIS BOX

IPSec; Layer 2 tunnel protocol (L2TP)

SSL; Open VPN etc

(c) SMTP, POP and IMAP are three well known e-mail Transfer Agents (TA). Fill in each row of the following table, with the options **A**, **B**, **C**, **D**, **E** and **F** given below.

(4.5 marks)

	TA / **Feature**	**SMTP**	**POP**	**IMAP**
(1)	store and forward delivery	**A**	**B**	**B**
(2)	storage location	**C**	**D**	**C**
(3)	mail reading mode	**E**	**F**	**E**

Row(1)

A - between all intermediate hops including user

B - between last hop and user only

Row(2)

C - ISP servers

D - user PC

Row(3)

E - online

F - off line

4) (a) Consider the rate policing technique based on a token bucket scheme as used in implementing Quality of Service over IP networks, shown in Figure 2.

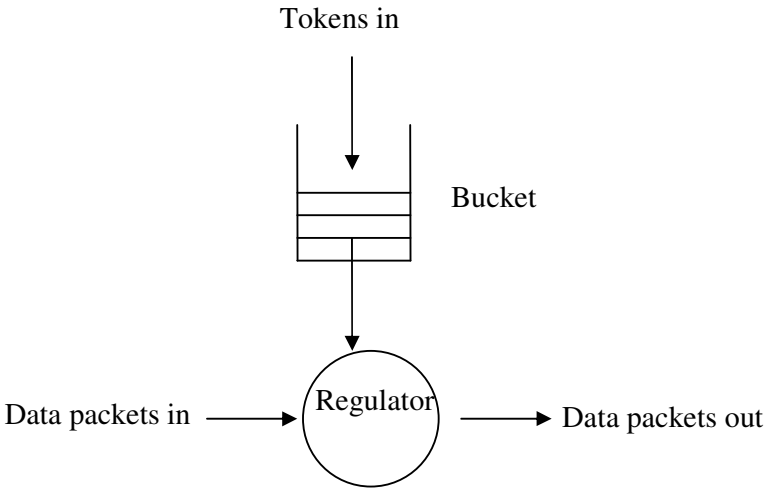


Figure 2

The token bucket size is B (packets), and tokens arrive at a constant rate of R (packets per second) and the maximum data output rate is M (packets per second), where M > R.

(i) What is the minimum inter packet gap (in seconds) possible on the output link?

(01 mark)

ANSWER IN THIS BOX

Minimum inter packet gap means highest rate possible. On the output link the max rate in M (PKts/ Sec)

∴ Inter packet gap = $\frac{1}{M}$ **(Sec / pkt)**

(ii) Suppose we start with an empty bucket and the data packets arrive at a rate say W which is greater than R. What would be the inter packet gap on the output link?

(02 marks)

ANSWER IN THIS BOX

Packets would be released to output link on the availability of tokens. If W> R, then irrespective of input rate, packets will be released at R packets/ sec, if and only if initially token bucket is empty

∴ inter packet gap = $\frac{1}{R}$ **(sec/ pkt)**

(iii) Derive an expression for the maximum burst time on the output say S, in terms of B, R and M.

(04 marks)

ANSWER IN THIS BOX

When the bucket in full, a burst can happen. If burst duration is 's', then, assuming, input has a higher rate,

M.S = B + R.S.

Packets released on output link = bucket to be emptied + no of incoming tokens during 'S'

$$S = \frac{B}{(M - R)}$$

(b) Figure 3 shows the schematic diagram of the possible participants in a Domain Name Resolution system.

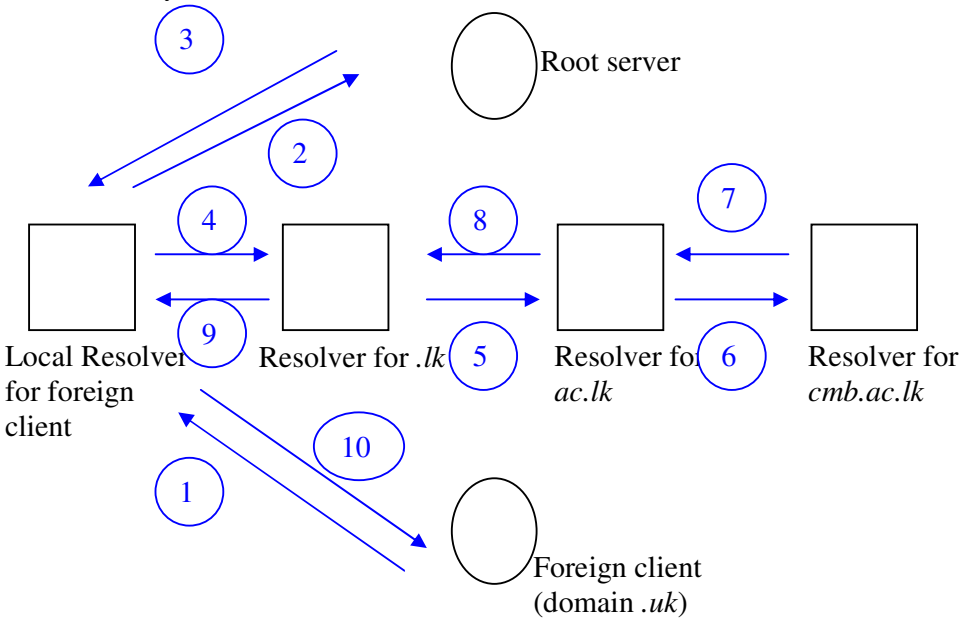


Figure 3

(i) What is the main function of DNS?

(02 marks)

ANSWER IN THIS BOX

resolving Domain Name to IP address

(ii) Show by numbered arrows on the above diagram (Figure 3), the steps in sequence (e.g., (1), (2) etc) taken by the foreign client query to resolve the host name mail.cmb.ac.lk .

(04 marks)

(iii) Why is it necessary to have multiple root servers worldwide?

(02 marks)

ANSWER IN THIS BOX

Multiple root servers are required for 'fault tolerance' (ie; if one fails others can respond) and for 'load balancing' (ie: request load is balanced among many)

(iv) Can a machine with a single DNS host name have more than one IP address? How can this happen?

(02 marks)

ANSWER IN THIS BOX

Can .

Eg; a Router or "multi homed" host,

where these is > 1 network interface

(c) An ISP serves a large number of ADSL customers who need to be connected on-line for 24 hours. Each customer has to have a dedicated IP address but the ISP has only a single class C IPV4 block.

(i) What solution can be proposed to solve the problem of insufficient number of public IPs?

(02 marks)

ANSWER IN THIS BOX

Solution – all dial in hosts to have "virtual IP's " with a NAT (Network address translation router to map real to virtual IP's .

(ii) Could the E-mail, Web and other servers of the ISP work with the proposed solution? How?

(02 marks)

ANSWER IN THIS BOX

Yes.

For external requests to come for servers, the servers should have real IP's.Therefore assign real IP'S for servers only

(iii) State two (2) significant shortcomings of the proposed solution with respect to established protocol concepts.

(02 marks)

ANSWER IN THIS BOX

(a) NAT box become a "Terminating" point for the purpose of header rewriting . But conventionally, only TCP is an end – to-end protocol . Here it is violated.

(b) some NAT boxes (port-NAT) will require looking in to TCP port of application. Again it is a violation of conventional protocols.

(iv) How does IPV6 solve the problem of the scarcity of IPV4 addresses?

(02 marks)

ANSWER IN THIS BOX

Instead of 32- bits IPV 4 addresses, IPV 6 addresses are of 128 bits allocating a very wide range of allocations.

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