Note: Provide Detailed solutions and not just final answers. Final Answers only will get a mark of zero.

Problem-1:[15]

Suppose two packets arrive to two different input ports of a router at exactly the same time. Also suppose there are no other packets anywhere in the router.

a. Suppose the two packets are to be forwarded to two different output ports. Is it possible to forward the two packets through the switch fabric at the same time when the fabric uses a shared bus?
b. Suppose the two packets are to be forwarded to two different output ports. Is it possible to forward the two packets through the switch fabric at the same time when the fabric uses switching via memory?
c. Suppose the two packets are to be forwarded to the same output port. Is it possible to forward the two packets through the switch fabric at the same time when the fabric uses a crossbar?

Solution:

a) No, you can only transmit one packet at a time over a shared bus.

b) No, as discussed in the text, only one memory read/write can be done at a time over the shared system bus.

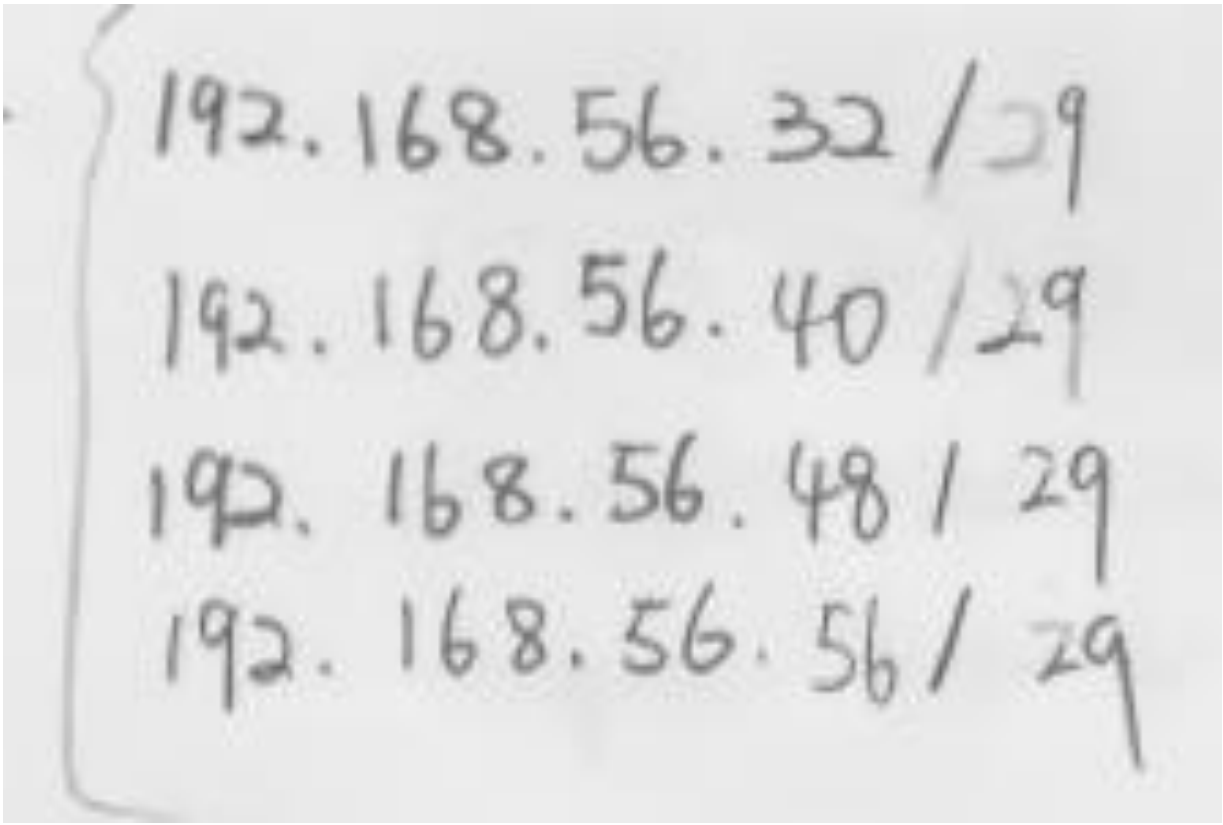
c) No, in this case the two packets would have to be sent over the same output bus at the same time, which is not possible.

Note: Provide Detailed solutions and not just final answers. Final Answers only will get a mark of zero.

Problem-2:[8]

Consider a subnet with prefix 192.168.56.128/26. Give an example of one IP address (of form xxx.xxx.xxx.xxx) that can be assigned to this network. Suppose an ISP owns the block of addresses of the form 192.168.56.32/26. Suppose it wants to create four subnets from this block, with each block having the same number of IP addresses. What are the prefixes (of form a.b.c.d/x) for the four subnets?

Solution:



Note: Provide Detailed solutions and not just final answers. Final Answers only will get a mark of zero.

Problem-3:[10]

Consider sending a 1,600-byte datagram into a link that has an MTU of 500 bytes. Suppose the original datagram is stamped with the identification number 291.

a. How many fragments are generated?
b. What are the values in the various fields in the IP datagram(s) generated related to fragmentation?

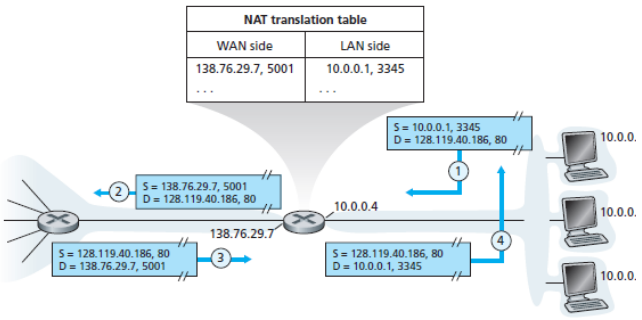
Solution:

a. The maximum size of data field in each fragment = 680 (because there are 20 bytes IP header). Thus the number of required fragments $= \left\lceil \frac{2400-20}{680} \right\rceil = 4$

b. Each fragment will have Identification number 422. Each fragment except the last one will be of size 700 bytes (including IP header). The last datagram will be of size 360 bytes (including IP header). The offsets of the 4 fragments will be 0, 85, 170, 255. Each of the first 3 fragments will have flag=1; the last fragment will have flag=0.

Note: Provide Detailed solutions and not just final answers. Final Answers only will get a mark of zero.

Problem-4:[12]



Consider the network setup shown in the figure. Suppose that the ISP instead assigns the router the address 24.34.112.235 and that the network address of the home network is 192.168.1.0/24.

a. Assign addresses to all interfaces in the home network.
b. Suppose each host has two ongoing TCP connections, all to port 80 at host 128.119.40.86. Provide the six corresponding entries in the NAT translation table.

Solution:

a) Home addresses:
- 192.168.1.1,
- 192.168.1.2,
- 192.168.1.3
- With the router interface being 192.168.1.4

b)

NAT Translation Table

WAN Side	LAN Side
24.34.112.235, 5000	192.168.1.1, 3345
24.34.112.235, 5001	192.168.1.1, 3346
24.34.112.235, 5002	192.168.1.2, 3445
24.34.112.235, 5003	192.168.1.2, 3446
24.34.112.235, 5004	192.168.1.3, 3545
24.34.112.235, 5005	192.168.1.3, 3546

Note: Provide Detailed solutions and not just final answers. Final Answers only will get a mark of zero.

Problem-5:[15]

Suppose datagrams are limited to 1,500 bytes (including header) between source Host A and destination Host B. Assuming a 20-byte IP header, how many datagrams would be required to send an MP3 consisting of 5 million bytes? Explain how you computed your answer.

Solution:

MP3 file size = 5 million bytes. Assume the data is carried in TCP segments, with each TCP segment also having 20 bytes of header. Then each datagram can carry 1500-40=1460 bytes of the MP3 file

Number of datagrams required $= \left\lceil \frac{5\times10^6}{1460} \right\rceil = 3425$. All but the last datagram will be 1,500 bytes; the last datagram will be 960+40 = 1000 bytes. Note that here there is no fragmentation – the source host does not create datagrams larger than 1500 bytes, and these datagrams are smaller than the MTUs of the links.