Assignment # 3

(CS-3001 Computer Networks – Fall-2024)

Due Date and Time: 17th November 2024 (11:59 PM) Marks: 100

Instructions:

• Late assignment will not be accepted

• Only handwritten attempt will be graded, i.e., printed attempts will not be graded • There will be no credit if the given requirements are changed

• Your solution will be evaluated in comparison with the best solution

• Whenever a calculation is involved, your solution should show complete steps and a final answer. There will be significant marks for the correct final answer (as far as assignments are concerned). • You must write your roll number, name, and section (Computer Networks Course section) on your submitted attempt.

• Submit scan copy of your written assignment on GCR before deadline.

Question 1 [10 Marks]:

An ISP is granted the block 200.100.50.0/21. The ISP needs to allocate addresses for:

- three organizations, each requiring 400 addresses
- two organizations, each requiring 150 addresses
- four organizations, each requiring 30 addresses

a. Find the number and range of addresses in the ISP block.

b. Find the range of addresses for each organization and the range of unallocated addresses.

c. Show the outline of the address distribution and the forwarding table.

Question 2 [10 Marks]:

Combine the following four blocks of addresses into a single block:

a. 72.15.40.0/26

b. 72.15.40.64/26

c. 72.15.40.128/25

d. 72.15.41.0/24

Question 3 [10 Marks]:

What are the underlying challenges posed by Network Address Translation (NAT) in peer-to-peer (P2P) communication systems? What strategies or techniques can be employed to circumvent these challenges, and is there a specialized terminology associated with the methodologies used to address NAT traversal in such applications?

Question 4 [10 Marks]:

Consider a subnet with prefix 203.0.113.128/26. Give an example of one IP address (of the form xxx.xxx.xxx.xxx) that can be assigned to this network. Suppose an ISP owns the block of addresses of the form 203.0.113.0/26. Suppose it wants to create five 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 five subnets?

Question 5 [10 Marks]:

Consider a router that interconnects four subnets: Subnet1, Subnet2, Subnet3, and Subnet4. Suppose all of the interfaces in each of these four subnets are required to have the prefix 198.51.100.0/24. Also suppose that:

- Subnet #1 is to support at least 50 interfaces,
- Subnet #2 is to support at least 120 interfaces,
- Subnet #3 is to support at least 30 interfaces,
- Subnet #4 is to support at least 10 interfaces.

Provide four network addresses (of the form a.b.c.d/x) that satisfy these constraints.

Question 6 [10 Marks]:

Suppose you are tasked with detecting the number of hosts behind a NAT device. You observe that the IP layer stamps an identification number sequentially on each IP packet. The identification number of the first IP packet generated by a host is a random number, and the identification numbers of the subsequent IP packets are assigned sequentially. Additionally, assume that all IP packets generated by hosts behind the NAT are sent to the outside world and that the NAT is a full-cone NAT (i.e., once a mapping is established, any external host can communicate with the internal host).

a. Based on the assumption that you can observe and sniff all packets sent by the NAT to the outside world, outline a technique that detects the number of unique hosts behind the NAT. Assume that the NAT doesn't alter the identification numbers of packets but does perform port address translation. Justify the effectiveness of your technique, taking into account possible variations in the behavior of the NAT.

b. Now consider a scenario where the identification numbers are not sequential but are instead randomly assigned. Additionally, the NAT in use is a symmetric NAT, meaning it maps the same internal IP and port to a different external port depending on the destination address. Would your technique still work under these conditions? Justify your answer, addressing the challenges posed by both the randomization of identification numbers and the behavior of a symmetric NAT.

c. In a more complex network setup where IP fragmentation occurs frequently, describe how fragmentation might impact the ability of your technique to accurately determine the number of unique hosts. Discuss the potential complications in interpreting identification numbers in fragmented packets, especially when the NAT modifies the IP header. What additional techniques could be employed to handle fragmentation in this context?

d. Assume that the hosts behind the NAT are using UDP packets for communication. Given that UDP does not have built-in mechanisms for ensuring sequential identification numbers (unlike TCP), how would this affect your detection technique? Could you still identify the number of unique hosts, and if so, what modifications would you need to make to your approach to accommodate for the lack of sequential numbering?

Question 7 [10 Marks]:

Consider sending a 13,120-byte datagram into a link that has a Maximum Transmission Unit (MTU) of 1,500 bytes. The original datagram is stamped with the identification number 8721, and the Don't Fragment (DF) flag is set to 0 (indicating that fragmentation is allowed).

The datagram consists of the following:

1. The IP header is 20 bytes long.
2. The link's MTU is 1,500 bytes.

a. How many fragments will be generated? What is the size of each fragment (including the IP header)?

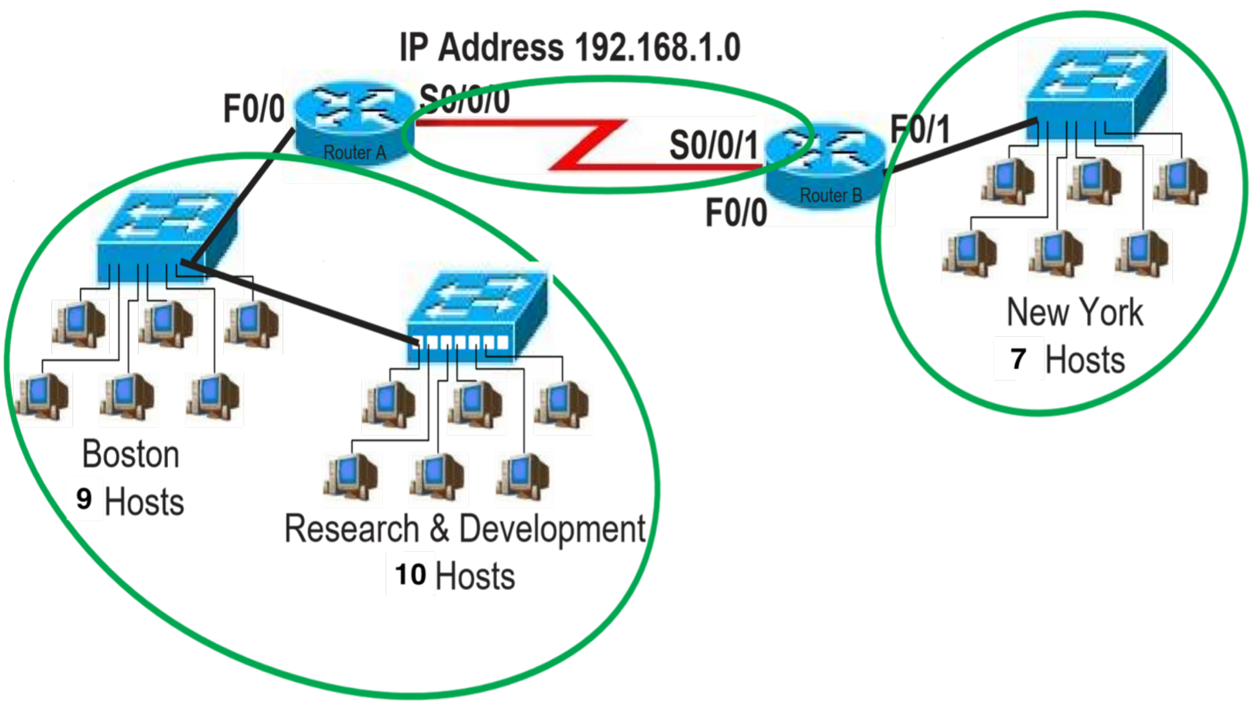
b. For each fragment, list the values in the following fields of the IP header:

- Identification Number
- Flags (specifically the More Fragments (MF) flag)
- Fragment Offset
- Total Length (including the IP header)

c. If the Don't Fragment (DF) flag had been set to 1, what would happen to the datagram in this case? Explain in detail how fragmentation and the handling of the datagram would differ from the case where DF = 0.

Question 8 [10 Marks]:

Based on the information in the figure shown below, design a network addressing scheme that will supply the minimum number subnets and answer the questions below.



Address class ________________

Custom subnet mask _______________

Minimum number of subnets needed ______

Number of host addresses in the largest subnet group ______

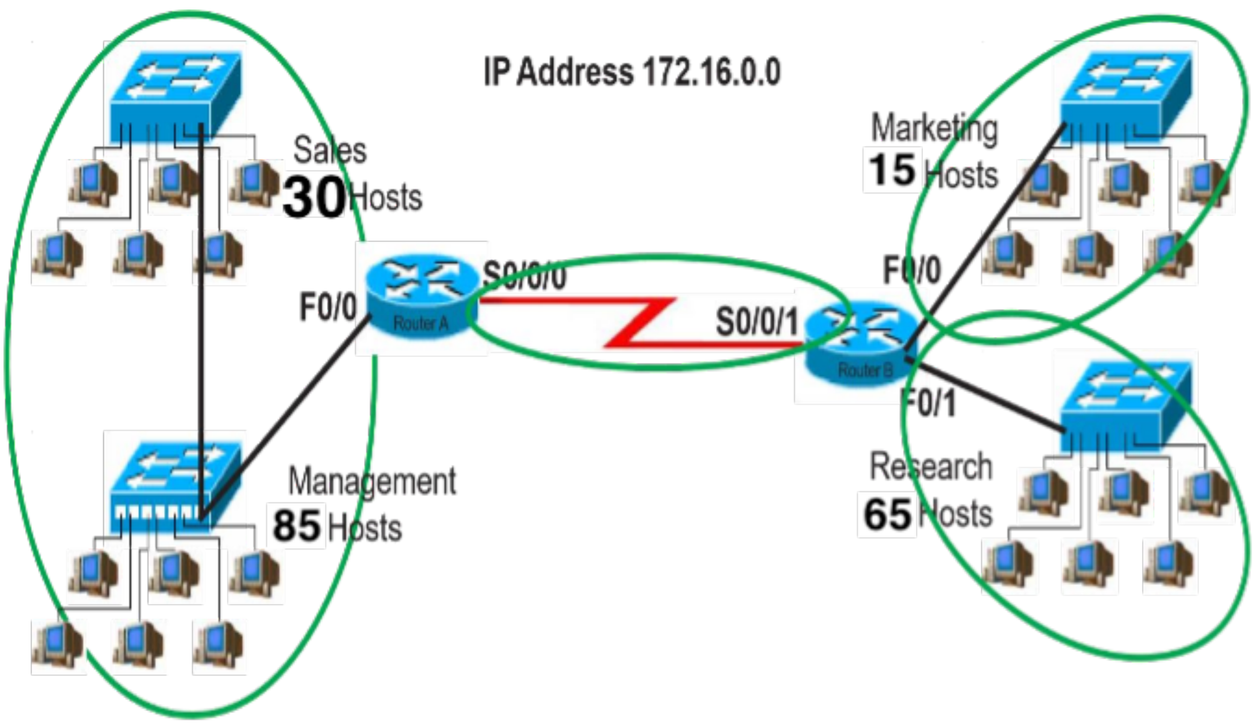
Start with the first subnet and arrange your sub-networks from the largest group to the smallest.
IP address range for Router A F0/0 _________________

IP address range for New York ____________________

IP address range for Router A to Router B serial connection ___________________

Question 9 [10 Marks]:

Based on the information in the figure shown below, design a network addressing scheme that will supply the minimum number subnets and answer the questions below.



Address class _______________

Custom subnet mask _____________

Minimum number of subnets needed ______

Number of host addresses in the largest subnet group ______

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

IP address range for Sales/Management ________________

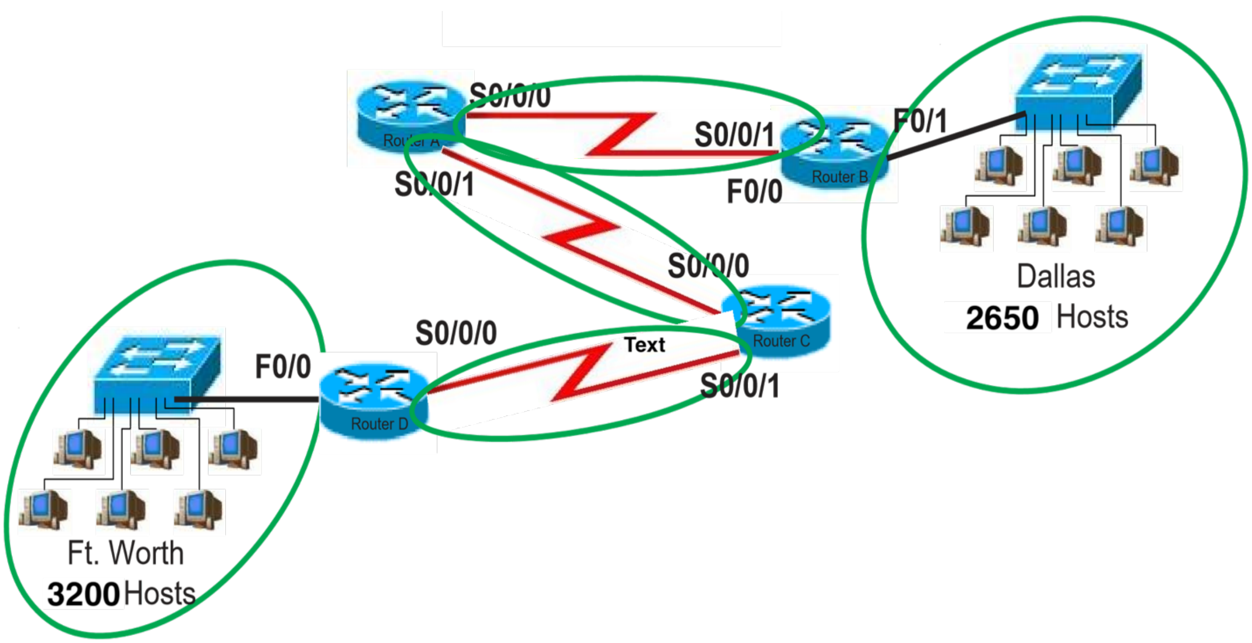
IP address range for Marketing _____________________

IP address range for Research ______________________

IP address range for Router A to Router B serial connection _____________

Question 10 [10 Marks]:

Based on the information in the figure shown below, design a network addressing scheme that will supply the minimum number subnets and answer the questions below.



Choose an appropriate IP Address for the above network

IP Address ______________________________

Address class ______________________________

Custom subnet mask ______________________________

Minimum number of subnets needed ________

Number of host addresses in the largest subnet group ___

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

IP address range for Ft. Worth _____________

IP address range for Dallas _________________

IP address range for Router A to Router B serial connection _________

IP address range for Router A to Router C serial connection __________

IP address range for Router C to Router D serial connection ___________