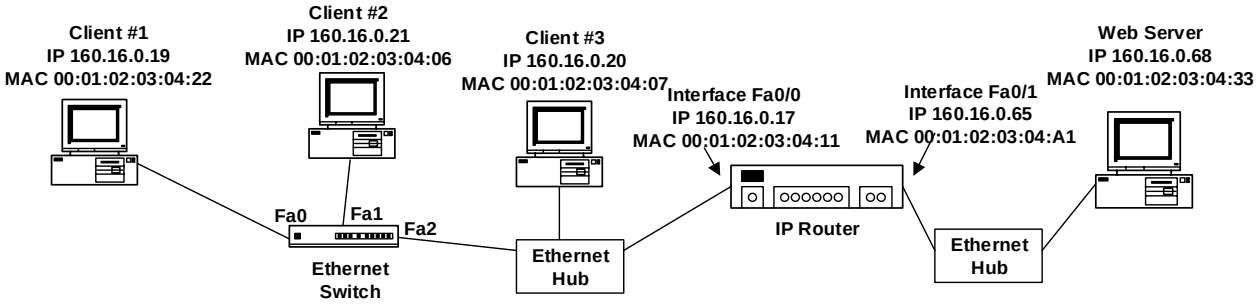
NET 363-501
Homework #1
Answers



Refer to the network figure above, showing two Ethernet Subnets connected through an IP Router, for questions #1 to #4. For each device interface, both its Internet Protocol (IP) address and its MAC address (also called the Physical address) are shown. The Subnet Mask used by all devices is 255.255.255.248.

1. (3 points) The IP Subnet ID for the right subnet (containing the Web Server) is 160.16.0.64/29. What is the first and last assignable IP address in this subnet?

   Answer: First assignable is 160.16.0.65. Last assignable is 160.16.0.70.

   Explanation: This is a /29 subnet. There are 32-29 = 3 host bits. Subnet size is 2^3 = 8 IP addresses. The Network Address is 160.16.0.64.

   First Assignable IP = (Network Address + 1), which is 160.16.0.65. Broadcast IP = Network Address + 8 – 1 = 160.16.0.71. Last Assignable IP = Broadcast IP – 1 = 160.16.0.70.

2. (3 points) If Client #1 wants to send an IP broadcast packet to all devices on the left subnet, what IP destination should it send to? In other words, what is the IP Broadcast address for the left subnet?

   Answer: Left Subnet Broadcast IP is 160.16.0.23.

   Explanation: (a) Binary Method: Take any Left Subnet IP address and set last 3 bits (Host bits) to 1s and you get 160.16.0.23. (b) Jump Factor Method: the Network Address for Left Subnet is 160.16.0.16 because the largest multiple of 8 less than 4th byte of any Left Subnet IP is 16. So the 4th byte of Broadcast IP is 16 + Jump Factor – 1 = 16 + 8 – 1 = 23, so Broadcast IP is 160.16.0.23.

3. Assume that Client #1 and Web Server have already completed a TCP 3-way handshake and now Client #1 transmits an HTTP Request packet to the Web Server. What are the specific numeric address values (copied from the diagram above) that will be in each of the following header fields of this packet when it is sent out by Client #1?

   a) (2 points) Source MAC Address in Ethernet header
   Source MAC Address is 00:01:02:03:04:22 (MAC Address of Client #1)
   b) (3 points) Destination MAC Address in Ethernet header
   Dest MAC Address is 00:01:02:03:04:11 (MAC Address of Router Fa0/0)
   c) (2 points) Source IP Address in IP header
   Source IP Address is 160.16.0.19 (IP Address of Client #1)
   d) (3 points) Destination IP Address in IP header
   Dest IP Address is 160.16.0.68 (IP Address of Web Server)

e) (3 points) Destination Port Address in TCP header

Dest Port is <u>80</u> (for HTTP Web service) [or <u>443</u> (for HTTPS web service)]

4. (4 points) Assume that the Web Server wants to send 2 data packets – Packet A and Packet B (in that order) - to Client #1. Packet A is sent with TCP Sequence Number = 2280 and contains 700 data bytes. Packet B contains 1400 data bytes. Assuming no errors, what Sequence Number value will the Web Server put in the TCP header of Packet B (sent right after Packet A)?

Answer: 2980.

The TCP Sequence Number represents the number given to the <u>first</u> byte in a packet and then every data byte is numbered. TCP Sequence for any packet = TCP Sequence of previous packet plus the size of previous packet. So Sequence Number for Packet B = 2280 + 700 = <u>2980</u>.

Another way to look at it: Packet A header has TCP Sequence Number of 2280, so first byte is byte #2280. The packet contains 700 data bytes, which would be byte #2280 – byte #2979. The first byte of Packet B, will be byte #2980, so it puts <u>2980</u> in its TCP Sequence number field.

5. (3 points) My IP address is 177.39.59.38 and my subnet mask is 255.255.255.224. What are the first and last assignable IP addresses in my subnet?

First assignable is <u>177.39.59.33</u>. Last assignable is <u>177.39.59.62</u>.

Explanation: This is a /27 subnet. There are 32-27 = 5 host bits. Subnet size is 2^5 = 32 IP addresses. First, we must find the network address where the subnet begins. Host bits must be all zeros in network address.

Binary method: 4th byte is 38, which is 00100110. Zeroing last 5 bits gives 00100000, which is 32. so subnet ID is <u>177.39.59.32/27</u>. For Broadcast IP, setting last 5 bits to 1 gives 00111111, which is 63, so Broadcast IP = <u>177.39.59.63.</u> The First Assignable IP = Network Address + 1 = <u>177.39.59.33</u>. Last Assignable IP = Broadcast IP – 1 = <u>177.39.59.62.</u>

Jump Factor method: Jump Factor = Subnet Size = 32. So 4th byte of network address is largest multiple of 32 less than 38, which is 32. So subnet ID is <u>177.39.59.32/27</u> and First Assignable IP = (Network Address + 1), which is <u>177.39.59.33</u>. Broadcast IP = Network Address + JF – 1, so last byte is 32+32-1 = 63. So Broadcast IP = <u>177.39.59.63</u> and Last Assignable IP = <u>177.39.59.62.</u>

6. (3 points) My IP address is 177.39.59.38 and my subnet mask is 255.255.248.0. What are the first and last assignable IP addresses in my subnet?

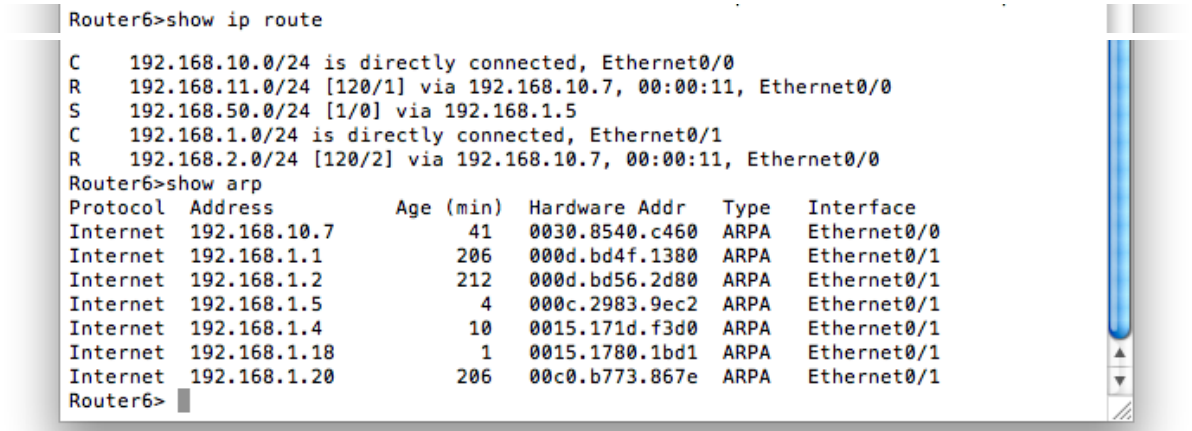
First assignable is <u>177.39.56.1</u>. Last assignable is <u>177.39.63.254</u>.

Explanation: This is a /21 subnet. There are 32-21 = 11 host bits. Subnet size is 2^{11} = 2048 IP addresses. First, we must find the network address where the subnet begins. Host bits must be all zeros in network address.

Binary method: To zero out all 11 Host bits, we must set 4th byte (8 bits) to 0 and also set last 3 bits of 3rd byte to 0. 3rd byte is 59, which is 00111011. Zeroing last 3 bits gives 00111000, which is 56. so subnet ID is <u>177.39.56.0/21</u>. For Broadcast IP, setting last 3 bits of 3rd byte to 1 gives 00111111, which is 63, and all 8 bits set to 1 in 4th byte gives 255, so Broadcast IP = <u>177.39.63.255</u> The First Assignable IP = Network Address + 1 = <u>177.39.56.1</u>. Last Assignable IP = Broadcast IP – 1 = <u>177.39.63.254.</u>

Jump Factor method: JF = 8 in 3rd byte (= 2048/256 or 256-248). So 3rd byte of network address is largest multiple of 8 less than 59, which is 56. So subnet ID is 177.39.56.0/21. First Assignable IP = Network Address + 1 = 177.39.56.1. Broadcast IP = (Network Address + JF) – 1. Network Address + JF = 177.39.64.0, And 177.39.64.0 – 1 = 177.39.63.255. So Broadcast IP = 177.39.63.255 and Last Assignable IP = 177.39.63.254.

7. Consider the routing table and ARP table below from a Cisco router. This router has two Ethernet interfaces: Ethernet0/0 and Ethernet0/1.



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Router6>show ip route

C    192.168.10.0/24 is directly connected, Ethernet0/0
R    192.168.11.0/24 [120/1] via 192.168.10.7, 00:00:11, Ethernet0/0
S    192.168.50.0/24 [1/0] via 192.168.1.5
C    192.168.1.0/24 is directly connected, Ethernet0/1
R    192.168.2.0/24 [120/2] via 192.168.10.7, 00:00:11, Ethernet0/0
Router6>show arp
Protocol  Address          Age (min)  Hardware Addr   Type   Interface
Internet  192.168.10.7           41   0030.8540.c460  ARPA   Ethernet0/0
Internet  192.168.1.1           206   000d.bd4f.1380  ARPA   Ethernet0/1
Internet  192.168.1.2           212   000d.bd56.2d80  ARPA   Ethernet0/1
Internet  192.168.1.5             4   000c.2983.9ec2  ARPA   Ethernet0/1
Internet  192.168.1.4            10   0015.171d.f3d0  ARPA   Ethernet0/1
Internet  192.168.1.18            1   0015.1780.1bd1  ARPA   Ethernet0/1
Internet  192.168.1.20          206   00c0.b773.867e  ARPA   Ethernet0/1
Router6>
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a) (4 points) Assume that this router receives a packet with destination IP address 192.168.2.5

i) Which interface (Ethernet0/0 or Ethernet0/1) will this packet will be sent out?

This destination IP address matches the 5th entry in the routing table (Subnet 192.168.2.0/24). The routing table entry indicates that the packet will be sent out Ethernet0/0.

ii) What is the value of the Ethernet (MAC) Destination Address in the packet that is sent out? (specify numerical value in hexadecimal, not just a description)

The routing table entry for destination 192.168.2.0/24 shows that the packet is sent to the Next Hop router at IP address 192.168.10.7. The value of the destination MAC address in the outgoing message is the one corresponding to IP 192.168.10.7 in the ARP table, this MAC address is 0030:8540:c460.

b) (4 points) Assume that this router receives a packet with destination IP address 192.168.1.5

i) Which interface (Ethernet0/0 or Ethernet0/1) will this packet will be sent out?

This destination IP address matches the 4th entry in the routing table (Subnet 192.168.1.0/24). The routing table entry indicates that the packet will be sent out Ethernet0/1.

ii) What is the value of the Ethernet (MAC) Destination Address in the packet that is sent out? (specify numerical value in hexadecimal, not just a description)

The routing table shows that subnet 192.168.1.0/24 is directly connected, so the router will put the MAC address corresponding to destination IP address 192.168.1.5 in the Ethernet destination address field of the outgoing packet. According to the ARP table, this MAC address is 000c.2983.9ec2.

8. (7 points) Consider a router that has the following Routing Table contents. Note that "0.0.0.0/0" is the notation for the "default route".

Destination Subnet	***Outgoing Interface***	***Next Hop***
50.62.8.0/22	**Fa0/0**	**118.2.77.4**
24.19.66.80/28	**Fa0/1**	**59.16.1.1**
0.0.0.0/0	**Fa0/2**	**18.12.52.43**

First step is to write out the range of IP addresses represented by each of these Subnet IDs:

First subnet: 50.62.8.0/22 contains IP addresses from 50.62.8.0 to 50.62.11.255

Second subnet: 24.19.66.80/28 contains IP addresses from 24.19.66.80 up to 24.19.66.95

Any packet with a destination address that is within one of these ranges will be sent out the corresponding outgoing interface (either Fa0/0 or Fa0/1). Any packet with a destination address that is NOT within either of these address ranges will be sent out interface Fa0/2, corresponding to the default route.

a) A packet with destination IP address 50.62.8.249 arrives to this router. Out what interface will this packet be sent?

IP address 50.62.8.249 is in the First subnet range, so it is sent out Fa0/0.

b) A packet with destination IP address 50.62.11.199 arrives to this router. Out what interface will this packet be sent?

IP address 50.62.11.199 is in the First subnet range, so it is sent out Fa0/0.

c) A packet with destination IP address 24.19.66.99 arrives to this router. Out what interface will this packet be sent?

IP address 24.19.66.99 is not in either subnet range, so it matches the default route and is sent out Fa0/2.

9. (6 points) Company A has been allocated the Class B address block 18.169.0.0/16, which contains 65,536 IP addresses. Internally, they have 30 departments, so they want to break this address block into 32 internal subnets of equal size.

a) What Subnet Mask will they use on all internal device interfaces to achieve this?

Here are two ways to do this problem:

i) Since they need 32 subnets and $2^5 = 32$, they need to borrow 5 bits, so the new prefix length is 16+5 = 21. The new subnets will be /21, which is 255.255.248.0.

ii) They have 65,536 addresses in their /16 block. To split into 32 subnets, each will have size 65,536/32 = 2048. The only subnet mask that gives subnets of this size is 255.255.248.0.

b) What is the maximum number of devices (each using 1 IP address) that can be deployed in each department subnet before its assignable IP addresses are used up?

As noted above, each department subnet will have 2048 IP addresses total, so the number of assignable IPs is 2048-2 = 2046. Thus, the maximum number of devices that can be deployed in each department is <u>2046</u>.

(Also correct if you note that 1 IP must be allocated to a router's Default Gateway IP for the subnet, so each department can have maximum of <u>2045</u> devices in addition to the router).

c) Out of these 32 subnets, choose any 3 subnets and list the Subnet ID (containing Network Address and Prefix Length) and the first and last assignable host address in each of these 3 subnets.

You can choose any 3 of the 32 subnets. Here are the first 3 and a general rule for others:

i) 1st subnet: Subnet ID = 18.169.0.0/21, First assignable host IP = 18.169.0.1, last assignable host IP = 18.169.7.254

ii) 2nd subnet: Subnet ID = 18.169.8.0/21, First assignable host IP = 18.169.8.1, last assignable host IP = 18.169.15.254

iii) 3rd subnet: Subnet ID = 18.169.16.0/21, First assignable host IP = 18.169.16.1, last assignable host IP = 18.169.23.254

iv) In general, any Subnet ID 18.169.8*k.0/21, for any integer k between 0 and 31, is a valid Subnet ID for this problem (3rd byte is multiple of Jump Factor = 8, 4th byte is 0 in all Network Addresses).