CSC/ECE 573 Section 001

Spring 2017

Homework #1

Keywords: Classless Addressing, CIDR, Sub-netting, Super-netting

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Instructions

- You can do this homework in groups of two (at most).
- The total number of points is 30.
- You must answer all questions for full credit.
- Use only this paper for your answers, in the space provided.
- The due date is as posted on the web page (please submit your answers through Wolfware).

Question 1: [9 pts]

[1] **[2 points]** Given the following two address/mask combinations assigned to devices A and B. Determine if these devices are on the same subnet or different subnets.
Device A: 172.16.17.30/20
Device B: 172.16.28.15/20

Subnet mask = 0b11111111111111111111000000000000 = 0xFFFF F000

172.16.17.30 AND 0xFFFFF000 = 172.16.16.0
172.16.28.15 AND 0xFFFFF000 = 172.16.16.0

Upon applying the subnet mask to the IP addresses, we get the same network ID. Hence these two addresses belong to the same subnet.

[2] Given the Class C network of 204.15.5.0/24. An administrator needs to subnet his network and has the following requirements:

Subnet A: must support 14 hosts
Subnet B: must support 28 hosts
Subnet C: must support 2 hosts
Subnet D: must support 7 hosts
Subnet E: must support 28 host

A) **[3 points]** Provide the address/mask of the 5 subnets when all 5 subnets have the same size.

Given a class C address and the number of hosts per network will be 2^8 = 256. All the 5 subnets have the same size and the maximum number of hosts in a subnet is 28. So, we divide the network equally subnets of 32 hosts each (to accommodate a maximum of 28 in a network) = 32 hosts * 8 subnets = 256 hosts.

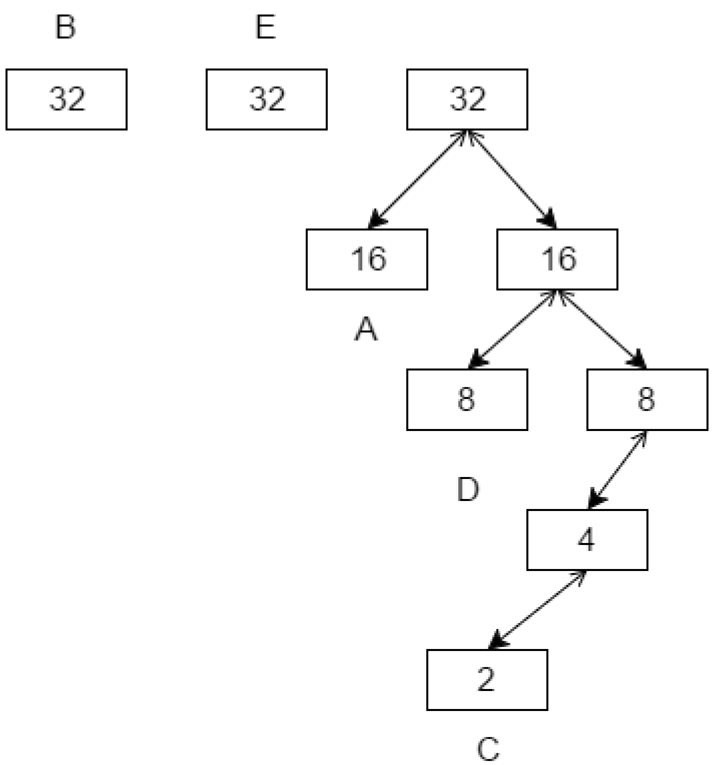
Hence, the subnet masks for the networks A to E in the same order are:
A to E order:
A: 204.15.5.0/27; mask = 255.255.224.0
B: 204.15.5.32/27; mask = 255.255.224.0
C: 204.15.5.64/27; mask = 255.255.224.0
D: 204.15.5.96/27; mask = 255.255.224.0
E: 204.15.5.128/27; mask = 255.255.224.0

B) **[4 points]** Provide the address/mask of the 5 subnets when all 5 subnets have the minimal possible *power of two* size. For example, a subnet with 7 hosts should accommodate at most 2^3=8 hosts.

Assuming that the order of the allocation for subnets is not required, subnet with maximum size is given higher preference during address allocation. And it is also assumed that the given number of hosts also includes the Broadcast and network IP (example subnet with 7 hosts would require maximum of 8 hosts and not 16 hosts).

Given the case address/mask of the 5 subnets when all 5 subnets have the minimal possible *power of two* size, we'll say,

Subnet B: $2^5 = 32$ hosts
Subnet E: $2^5 = 32$ hosts
Subnet A: $2^4 = 16$ hosts
Subnet D: $2^3 = 8$ hosts
Subnet C: $2^1 = 2$ hosts



Therefore, the subnet masks will be:

204.15.5.0/27 = B; mask = 255.255.255.224
204.15.5.32/27 = E ; mask = 255.255.255.224
204.15.5.64/28 = A ; mask = 255.255.255.240
204.15.5.80/29 = D; mask = 255.255.255.248
204.15.5.88/31 = C; mask = 255.255.255.254

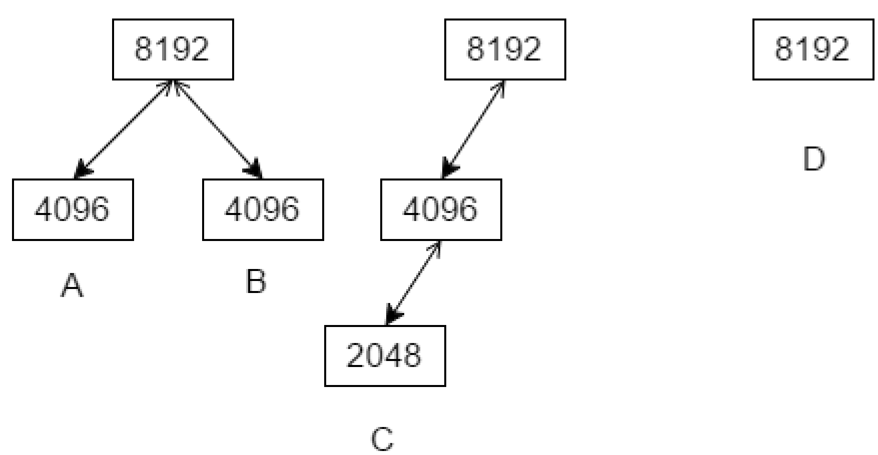
If we assume two extra hosts are required per subnet for broadcast and network ID, then the subnets will be:

204.15.5.0/27 = B; mask = 255.255.255.224
204.15.5.32/27 = E; mask = 255.255.255.224
204.15.5.64/28 = A; mask = 255.255.255.240
204.15.5.80/28 = D; mask = 255.255.255.240
204.15.5.96/30 = C; mask = 255.255.255.252

Question 2: [8 points]
A large number of consecutive IP addresses are available starting at 204.16.0.0. Suppose that four organizations A, B, C, and D, request 4000, 4000, 2000, and 8000 addresses, respectively and in that order.

A) **[5 points]** For each of these, give the first IP address assigned, the last IP address assigned, and the mask in the *w.x.y.z/s* notation.

Allocating in the order given i.e. A, B, C, D. Given the addresses are starting from 204.16.0.0, the 65536 (2^16) can be divided into eight sub-networks of 8192 hosts – given the highest number of hosts in the network is 8000. The division of subnetworks can be done as:



Hence, the range of usable IP address for the subnet will be:
204.16.0.1/20 to 204.16.15.254/20 ; Broadcast = 204.16.15.255/20 ; Network = 204.16.0.0/20 - A
204.16.16.1/20 to 204.16.31.254/20 ; Broadcast = 204.16.31.255/20 ; Network = 204.16.16.0/20 - B
204.16.32.1/21 to 204.16.39.254/21 ; Broadcast = 204.16.39.255/21 ; Network = 204.16.32.0/21 - C
204.16.64.1/19 to 204.16.95.254/19 ; Broadcast = 204.16.95.255/19 ; Network = 204.16.64.0/19 - D

Hence, the range of usable IP address for the network will be:
204.16.0.1/20 to 204.16.15.160/20 ; Broadcast = 204.16.15.255/20 ; Network = 204.16.0.0/20 - A
204.16.16.1/20 to 204.16.31.160/20 ; Broadcast = 204.16.31.255/20 ; Network = 204.16.16.0/20 - B
204.16.32.1/21 to 204.16.39.208/21 ; Broadcast = 204.16.39.255/21 ; Network = 204.16.32.0/21 - C
204.16.64.1/19 to 204.16.95.64/19 ; Broadcast = 204.16.95.255/19 ; Network = 204.16.64.0/19 - D

B) **[3 points]** Later it is found that all of them need to be forwarded to the same router, anyway. Can any of them be aggregated? Explain.

Using the **Longest Common Prefix** method from all the IP addresses, we get:

A = 11001100.00010000.00000000.00000000
B = 11001100.00010000.**0**0010000.00000000
C = 11001100.00010000.**0**0100000.00000000
D = 11001100.00010000.01000000.00000000

Aggregated Supernet= **204.16.0.0/17**

Because of the order of allocation, lot of addresses are unused causing a lot of wastage of IP address space.

Another solution is to aggregate the first two IP addresses creating a supernet of fully used IP addresses.

A = 11001100.00010000.00000000.00000000
B = 11001100.00010000.**000**10000.00000000

Aggregated Supernet= **204.16.0.0/19**

Question 3: [7 points]

An organization purchases a Class B address space and plans to use subnetting to assign addresses to its end nodes, which are spread across multiple physical networks. There are 30 networks, and the network with the largest number of hosts has 100 hosts. The administrator desires to use the same subnet mask in all routes of all internal routers if this is possible.

A) **[4 points]** What are the possible subnet masks it could use?

In Class B, we can have 65536 possible IP addresses. Since the number of networks is 30, we can create **32 networks of 2048 hosts each**. Since the maximum hosts in a network is 100, this subnet satisfies both the constraints and hence is an acceptable subnet mask of 21 bits.

Since the maximum possible hosts is 100, we can divide the network into **subnets of size 128 hosts**. **512 such subnets** can be created. So, a subnet mask of 25 bits will satisfy the given constraints.

So, the other subnet masks of 22, 23 and 24 bits are also possible:

With 22 bits of subnet mask = 64 subnets of 1024 hosts
With 23 bits of subnet mask = 128 subnets of 512 hosts
With 24 bits of subnet mask = 256 subnet of 256 hosts

So, the possible subnet masks are:

21 bits of subnet mask = 0xFF80
22 bits of subnet mask = 0xFFC0
23 bits of subnet mask = 0xFFE0
24 bits of subnet mask = 0xFFF0
25 bits of subnet mask = 0xFFF8

B) **[3 points]** Suppose it is known that one of the networks will later grow to 150 hosts. Which of the masks identified in part (A) will continue to work and which will not?

Since the maximum possible hosts is 150, we cannot use subnet mask of 25 bits anymore as it can accommodate 128 hosts in it. The rest of the bits masks can still support the given configuration.

So, the possible subnet masks are:
21 bits of subnet mask = 0xFF80
22 bits of subnet mask = 0xFFC0
23 bits of subnet mask = 0xFFE0
24 bits of subnet mask = 0xFFF0

Question 4: [6 points]

A router has just received the following new IP addresses: 88.62.104.0/21, 88.62.112.0/21, 88.62.120.0/21 and 88.62.128.0/21. If all of them use the same outgoing interface, can they be aggregated? If so, to what? If not, why not?

88.62.104.0	=	**01011000.00111110.011**01000.00000000
88.62.112.0	=	**01011000.00111110.011**10000.00000000
88.62.120.0	=	**01011000.00111110.011**11000.00000000
88.62.128.0	=	01011000.00111110.10000000.00000000

As can be seen above the First 3 subnets (88.62.104.0/21, 88.62.112.0/21, 88.62.120.0/21) can be aggregated into a supernet (using longest prefix method) with the mask 88.62.96.0/19. But when the forth subnet is added into the supernet, the supernet mask changes to 88.62.0.0/16 which creates many unused IP addresses. Hence it would be possible but not optimal solution to aggregate all the subnets into a supernet.

Another solution is to aggregate 88.62.112.0 and 88.62.120.0 into a supernet of 88.62.112.0/20.

88.62.112.0	=	**01011000.00111110.0111**0000.00000000
88.62.120.0	=	**01011000.00111110.0111**1000.00000000