Cisco Certified Network Associate CCNA

About CCNA Exam: CCNA Certification is offered by Cisco®. CCNA tests your knowledge and skills in the areas of simple LAN/WAN switching, Cisco IOS, and routing technologies. Topics include TCP/IP model of internetworking, configuring, and troubleshooting RIP, RIP v2, IGRP, EIGRP, OSPF, NAT, Remote Access using some of the most widely used Cisco switches and routers. Please visit the Cisco website for current objectives. Two recommended resources for Cisco certification preparation are Cisco Press "Cisco CCNA Preparation Library" and CCNA by Sybex. There are many others that are very good, but not widely known. CCNA is the foundation exam for CCNP (Cisco Certified Networking Professional). The exam notes is a brief review of important points that help in quick review of key points.

Cram Notes:

1. Internetwork IP addressing:

IP addresses are written using decimal numbers separated by decimal points. This is called dotted decimal notation of expressing IP addresses.

The different classes of IP addresses is as below:

Class	**Format**	**Leading Bit pattern**	**Network address Range**	**Maximum networks**	**Maximum Hosts/ Nodes**
A	N.H.H.H	0	0-126	127	16,777,214
B	N.N.H.H	10	128-191	16,384	65,534
C	N.N.N.H	110	192-223	2,097,152	254

- Network address of all zeros means "This network or segment".
- Network address of all 1s means " all networks", same as hexadecimal of all Fs.
- Network number 127 is reserved for loop-back tests.
- Host (Node) address of all zeros mean "This Host (Node)".
- Host (Node) address of all 1s mean "all Hosts (Nodes) " on the specified network.

2. The range of numbers from 224.0.0.0 to 239.255.255.255 are used for multicast packets. This is known as Class D address range.

3. Subnetting is nothing but creating networks within a network. Subnetting allows an organization with a single IP address (Class A /ClassB /ClassC) to have multiple subnetworks, thus allowing several physical networks within the organization.

4. How to maximize the number of subnets for a given number of hosts:

Let us take a network ID of 168.8.0.0, and find the maximum number of possible subnets and the corresponding subnet mask that can accommodate at least 500 hosts. The steps involved are outlined below:

i. Find the Class of the IP address; in this case it is a class B network. Class B network has the form N.N.H.H. Therefore; we have a total of 16 bits (two octets) for assigning to internal networks and hosts. The minimum number of host addresses required is 500. The last octet corresponds to $2^8 = 256$ hosts, which is still less than 500 Hosts. Therefore, you have to borrow one more bit from the third octet to make it 256*2 = 512 Hosts. This leaves 7 bits in the third octet for assigning subnet addresses. This is equal to 2^7=128 subnets.

ii. Write the 7 bits available for subnetting in third octet in the form 11111110 (last bit being the Host bit). The decimal equivalent of the first seven bits is $2^7+2^6+2^5+2^4+2^3+2^2+2^1$

$$= 128 + 64 + 32 + 16 + 8 + 4 + 2 = 254.$$

iii. Therefore, the subnet mask required is 255.255.254.0.

6. How to maximize the number of hosts for a given number of subnets:

Determining the subnet mask that allows maximum number of hosts:

Let us consider an IP address 196.202.56.0 with four subnets and maximize the number of host for the given subnets. The steps involved are as below:

i. The number of subnets required are four. We need to add subnets of all ones and all zeros to this. This is because all zeros and all ones subnets belong to "this subnet" and "all subnets" broadcasts and cannot be used. Therefore, the total number of subnets to be reserved is 4+2 = 6.

ii. We want to implement maximum possible Hosts. Therefore, we need to minimize the number of subnets. This minimum number is 6 here. If we reserve 2 bits, it results in only 2^2=4 subnets which is less than 6. Therefore, we have to reserve 3 bits for implementing subnets, resulting in 2^3=8 subnets. This is now optimized for maximum number of Hosts (as we have optimized for minimum number of subnets).

iii. Write the 3 bits available for subnetting in fourth octet in the form 11100000 (Five 0s being Host bits). The decimal equivalent is 2^7+2^6+2^5

= 128 + 64 +32 = 224.

IV. Therefore, the subnet mask required is 255.255.255.224.

7. 127.0.0.1 is the local loop back address.

8. In an Internetwork, the number of distinct IPs' required are

1. One each per client computer
2. One each per server computer
3. One each per router interface.

For example, your network has 2 servers, 26 clients machines, and 2 router interfaces the total number of IP addresses required are 30.

9. Finding the number of Hosts and subnets available for a **given** subnet mask: For example, let us find the number of hosts and subnets available for an IP 156.233.42.56 with a subnet mask of 7 bits.

a. Class B network has the form N.N.H.H, the default subnet mask is 16 bits long. There is additional subnet mask of 7 bits long.

b. 7 bits of subnet mask corresponds to (2^7-2)=128-2 = 126 subnets.

c. 9 bits (16-7) of host addresses corresponds to (2^9-2)=512-2 = 510 hosts.

Some times, the subnet mask is specified with the bits available in the default subnet mask. In this case the bits available in default subnet mask is 16. Therefore, total number of bits available in the subnet mask are 16+7=23. If you are given a subnet mask of 23 bits long for a class B address, it is understood that it contains the bits from the default subnet mask as well.

Hence, 126 subnets and 510 hosts are available.

10. The directed broadcast should reach all Hosts on the intended network (or subnet, if sub netted). For example, the directed broadcast address for an IP network 196.233.24.15 with default subnet mask is 196.233.24.255. This is arrived by putting all 1s for the host potion of the IP address.

Seven Steps to Subnetting

Creating Class C Subnetting Scheme
Basic subnetting is very easy when performed in seven steps. This example uses the Class C address 211.212.10.0. Using the seven steps provided here, you could create a subnetting scheme that allows you to use this address on your network.

Step 1: Determining Number of Subnets Needed
Determining the number of subnets you need is the very first step in subnetting. The number really depends upon your particular network. In Figure 2-3, the network consists of three routers connected via serial links. Each router also has a single Ethernet network attached.
Each shared serial link requires one subnet. Therefore, you need two subnets for the serial links between Router A and Routers B and C. You must also have one subnet per Ethernet interface on each router. Since you have three Ethernet networks, you need three subnets. Using this very simple counting method, you find that you need a total of five subnets. Unfortunately, you have been assigned a Class C address. The network address 211.212.10.0 allows for a single network of 254 hosts. You must borrow host ID bits to make this address work for you.

Step 2: Determining Number of Bits You Can Borrow
In Step 2, you must determine the number of bits that you can borrow. This number changes depending on the type of network address you start with. For Class A addresses, you have 24 host ID bits, but you can only borrow up to 22. For Class B addresses, you have 16 host ID bits, but you must have a minimum of two host bits; therefore, you can borrow 14 bits. Your Class C address (211.212.10.0) has eight total.

Host ID bits, but you can only borrow a maximum of six. The easiest way to determine the number of bits you can borrow is to write the number of octets that contain host ID bits in binary. In the Class C example network 211.212.10.0, you have the following bits to "play" with: 00000000

Step 3: Determining Number of Bits You Must Borrow to Get Needed Number of Subnets
After you determine the number of subnets you need and the number of bits you can borrow, you must calculate the number of host ID bits you must borrow to get the needed number of subnets. The formula for determining the number if bits you must borrow is 2*n*-2= # of subnets. The *n* represents the number of bits you borrow. In other words, raise two to the power of the number of bits you borrow and subtract two from that number. The result is the number of useable subnets created when you borrow that number of bits. For the example network, you need five subnets. If you borrow three bits, the formula's result is six usable subnets: 23 = 8-2 = 6.

Step 4: Turning On Borrowed Bits and Determining Decimal Value
In Step 4, using the bits you determined were available in Step 2, you turn on (set to 1) the number of bits determined you must borrow in Step 3. You must always begin with the high-order bits (the bits starting on the left of a binary number). Using the number of bits you can work with and the number of bits you must borrow (from Step 3), your result is the following: 11100000. In other words, from the eight total bits from Step 2 (six of which you could borrow), you borrow three host ID bits. In Step 4, you also need to determine the decimal value of the octets from which you borrow host ID bits. In this example, 11100000 equals 224. (128 + 64 + 32 = 224)

Step 5: Determining New Subnet Mask
Step 5 calculates the new subnet mask after you borrow the host ID bits in Step 4. You must add the decimal value from Step 4 to the default subnet mask for the class of address you are subnetting. The example is a Class C address, so the default mask is 255.255.255.0. The new mask after borrowing three bits becomes 255.255.255.224.

Step 6: Finding Host / Subnet Variable
In Step 6, you must find the lowest of the high-order bits (bits starting from the left) turned "on." Step 6 takes you all the way back to earlier in the chapter to the values found in each bit position within the octet. Our example defines the octets from which we borrow as 11100000. The highest order bit turned on represents 25, which equals 32. Since 25 is the last high-order bit turned on, the Host/Subnet variable you use in Step 7 is 32.

Step 7: Determining Range of Addresses
The final step allows you to take the Host/Subnet variable from Step 6 (32) and create your subnet ranges. Using the Class C network above, the range of subnets when you borrow three bits are:

211.212.10.0 to 211.212.10.31
211.212.10.32 to 211.212.10.63
211.212.10.64 to 211.212.10.95
211.212.10.96 to 211.212.10.127
211.212.10.128 to 211.212.10.159
211.212.10.160 to 211.212.10.191
211.212.10.192 to 211.212.10.223
211.212.10.224 to 211.212.10.255

IP addresses cannot be all ones or all zeros; therefore, in most cases the first range of addresses and the last range of addresses are unusable. (In some special circumstances, you can use the first range of addresses, or subnet 0. Only certain manufacturers' equipment, such as Cisco Systems, fully supports the use of subnet zero.) In each subnet, the first IP address is unusable because it represents the subnet ID. The final address is also unusable because it is the broadcast address for the subnet. Due to these two restrictions, in subnet one, 211.212.10.33 is the first useable host ID and 211.212.10.62 is the last useable host ID.

Tailoring a Class B Address
This example takes a Class B address and tries to fit it within the needs of a network containing 1000 subnets. You are assigned the Class B address 131.107.0.0. Using the following seven steps, you are going to subnet the Class B address to meet your needs.

Step 1: Determining Number of Subnets Needed
Examine your network and determine your needs based on current network configuration and future growth (in this case, 1000 subnets).

Step 2: Determining Number of Bits You Can Borrow
With this Class B network address, you have 16 total bits to work with. You can only borrow up to 14 of these. On your sheet of paper, you should write the number of bits you have in the host ID portion of the address:
00000000.00000000

Step 3: Determining Number of Bits You Must Borrow to Get Number of Subsets Needed
Using the formula 2n-2= # of usable subnets, you can easily see that you need to borrow 10 bits. When you plug in 10 borrowed bits, you get the following result:
210 = 1024 – 2 = 1022 useable subnets

Step 4: Turning on Borrowed Bits and Determining Decimal Value
If you turn on 10 bits, you get the following:
11111111.11000000
The decimal values for the octets are 255.192.

Step 5: Determining New Subnet Mask
Your example is a Class B address. In Class B addresses, the default subnet mask is 255.255.0.0. To get your new mask, you add the default mask to the decimal values found in Step 4. The new mask becomes:
255.255.255.192

Step 6: Finding Host/Subnet Variable
In the next-to-last step, you must find the value of the lowest high-order bit turned on in each octet, from which you borrowed host bits. Since this example is a Class B network and you must borrow a great number of bits to get the proper number of subnets, the borrowing crosses an octet boundary. As a result, you have two Host/Subnet variables. In this example, the variable in the third octet is 1, and the variable for the fourth octet is 64. You get these values by looking at the binary numbers in Step 4. The third octet has the final bit position, or the 20-bit position, turned on. Since 20 = 1, your variable is 1 in the third octet. In the fourth octet, the second high-order bit or 26 is turned on. The variable in this octet is 64.

Step 7: Determining Range of Addresses
Figuring the range of addresses for Class B networks is much harder than for Class C. This is especially true in cases like this scenario in which you must borrow a large number of bits. Using 1 as the variable in the third octet and 64 as the variable in the fourth octet, the range of the first 9 subnets world be:

131.107.0.0 To 131.107.0.63
131.107.0.64 To 131.107.0.127
131.107.0.128 To 131.107.0.191
131.107.0.192 To 131.107.0.255
131.107.1.0 To 131.107.1.63
131.107.1.64. To 131.107.1.127
131.107.1.128 To 131.107.1.191
131.107.1.192 To 131.107.1.255
131.107.2.0 To 131.107.2.63

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iii. Therefore, the subnet mask required is 255.255.254.0.

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