**Lab: Subnetting**

*Objective:*

To learn, in a progressive manner, more about subnets, subnet masking, and IP design.

*Background:*

In this lab many different questions (multiple choice, true-false, essays) are used to bring you up to speed on subnetting. This will give you more practice learning about subnetting that does not jump back and forth between topics too much. Each of my students seemed relieved to have something like this…not just here’s topic, here’s two questions and let’s jump ahead, then back. Since IOS version 12 we can use the first and last subnet in our network design. In a nutshell (how did I get in this nutshell?) Cisco added the command **ip-subnet zero** to let us accomplish this. For these exercises please assume the command is enabled. On your Cisco exam it will tell you whether or not the command is used.

**Changing MAC/IP addresses and Network devices**

1. Switchs make low-level, simple comparisons and decisions about whether or not to forward traffic on a network.
   1. True
   2. False.
2. If the Switch determines that the destination MAC address carried by a data packet is part of the same network segment as the source, it does not forward the data to other segments of the network.
   1. False
   2. True
3. Switchs solve the problem of too much traffic on a network by dividing the network into segments and filtering traffic based on the MAC address.
   1. True
   2. False.
4. When a Switch forwards data on a network, it determines precisely what segment of the network the data will be forwarded to.
   1. True
   2. False
5. When a Switch makes a decision about whether to forward data on a network or not, it uses only the IP address carried by the data in its header.
   1. False
   2. True
7. Which of the following definitions best describes what a frame is?
   1. Router or access server, or several routers or access servers, designated as a buffer between any connected public networks and a private network. It ensures security of the private network.
   2. 32-bit address assigned to hosts using TCP/IP. It belongs to one of five classes and is written as 4 octets separated with periods.
   3. Logical grouping of information sent as a data link layer unit over a transmission medium.
   4. Something used with art to give it another unique perspective.
8. At which of the following layers of the OSI model does routing occur?
   1. Physical layer
   2. Data link layer
   3. Network layer
   4. Transport layer
9. At which of the following layers of the OSI model does switching occur?
   1. Physical layer
   2. Data link layer
   3. Network layer
   4. Transport layer
10. At which of the following layers of the OSI model is the MAC address located?
    1. Physical layer
    2. Data link layer
    3. Network layer
    4. Transport layer
11. If a workstation is moved within a network, then what will happen to its MAC and IP addresses?
    1. its MAC address and IP address will stay the same
    2. its MAC address will change but the IP address will stay the same
    3. its IP address will change but the MAC address will stay the same
    4. both IP and MAC address will change
12. If a workstation is moved from one network to another network, then what will happen to its MAC and IP addresses?
    1. its MAC address and IP address will stay the same
    2. its MAC address will change but the IP address will stay the same
    3. its IP address will change but the MAC address will stay the same
    4. both IP and MAC address will change
13. Routers pass packets between \_\_\_\_\_\_\_\_\_\_\_\_\_\_?
    1. servers on the different networks
    2. routers on the same network
    3. hosts on the different networks
    4. hubs on the same network
14. Which part of the IP address does a router ignore during path determination?
    1. the host address
    2. the network address
    3. the source address
    4. the destination address
15. MAC addresses use a \_\_\_\_\_\_\_\_\_\_ scheme while IP addresses use a

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ scheme.

* 1. hierarchical, flat
  2. flat, hierarchical
  3. flat, layered
  4. layered, flat

1. Which type of address is included in an IP header?
   1. source MAC, source IP
   2. destination IP, destination MAC
   3. source IP, destination IP, source MAC
   4. source and destination IP and MAC addresses

**IP addresses**

Are the following statements TRUE or FALSE?

1. If a device on network A is moved to network B, its IP address will change.
   1. True
   2. False
2. IP addresses are used to identify a machine on a network and the network to which it is attached.
   1. True
   2. False
3. Each network connected to the Internet has a unique network number.
   1. False
   2. True
4. The network portion of every IP address is assigned by the local network administrator.
   1. True

False

How many bits are in an IP address?

* 1. 4
  2. 8
  3. 32
  4. 16

1. How many bytes are in an IP address?
   1. 4
   2. 8
   3. 32
   4. 16
2. What is the minimum decimal value in an octet?
   1. 0
   2. 1
   3. 2
   4. 8
3. What is the maximum decimal value in a byte?
   1. 0
   2. 255
   3. 8
   4. FF
4. How many bits are in a byte?
   1. 2
   2. 4
   3. 6
   4. 8
5. How many bytes are in a MAC address?
   1. 2
   2. 4
   3. 6
   4. 8

**Classes of IP addresses**

1. To which class of IP address would the IP address of 197.22.103.221 belong?
   1. class "A"
   2. class "B"
   3. class "C"
   4. class “D”
   5. class “E”
2. Which of the following dotted notations cannot represent an IP address?
   1. 301.188.12.77
   2. 167.78.35.202
   3. 122.31.22.226
   4. 254.254.254.254
3. In a class "A" network using an IP addressing scheme, the first sixteen bits are used for the network part of the address, and the last two octets are reserved for the host part of the address.
   1. True
   2. False
4. To what class of network would the following IP address belong: 144.26.108.15?
   1. Class "A" network
   2. Class "B" network
   3. Class "C" network
   4. Class “D” network
5. To what class of network would the IP address, 18.12.245.10, belong?
   1. Class "A" network
   2. Class "B" network
   3. Class "C" network
   4. Class “D” network
6. In the IP address, 190.233.21.12, how many octets have been assigned by the NIC?
   1. One
   2. Two
   3. Three
   4. Four
7. In the IP address, 88.224.73.201, how many octets could be assigned locally by the network administrator?
   1. One
   2. Two
   3. Three
   4. Four
8. Select the IP address below which would belong to the largest network.
   1. 69.22.214.158
   2. 144.144.144.3
   3. 220.91.144.222
   4. 255.255.255.255
9. Which of the following best describes a class "B" network?
   1. network.network.host.host
   2. network.network.network.host
   3. network.host.host.host
   4. host.network.host.network
10. There are three classes of commercial networks.
    1. False
    2. True
11. IP addresses with numbers 224 through 255 are reserved for multicast and experimental purposes.
    1. True
    2. False
12. A class "C" network address would have all binary 0s in its final octet.
    1. True
    2. False
13. A class "B" network address would have all binary 0s in its final two octets.
    1. True
    2. False
14. Which of the following is an example of a class "C" network address?
    1. 196.25.10.0
    2. 113.0.0.0
    3. 113.22.104.0
    4. 74.255.255.255
15. Which of the following best describes a class “C” network?
    1. network.network.host.host
    2. network.network.network.host
    3. network.host.host.host
    4. host.host.host.network
16. Which of the following best describes a class “A” network?
    1. network.network.host.host
    2. network.network.network.host
    3. network.host.host.host
    4. host.host.host.network
17. Which of the following is a class “C” IP address?
    1. 220.15.64.126
    2. 191.15.64.126
    3. 127.15.64.126
    4. 242.15.64.126
18. Select the IP address for the smallest network.
    1. 220.15.64.126
    2. 191.15.64.126
    3. 127.15.64.126
    4. 242.15.64.126
19. How many octets have been assigned by InterNIC in a class “C” network?
    1. one
    2. two
    3. three
    4. four
20. If you have a class “A” IP address, then how many bytes have been assigned to you for your hosts?
    1. one
    2. two
    3. three
    4. four

**Binary to decimal conversions**

1. Which of the following decimal numbers equals the binary number 11111111?
   1. 128
   2. 254
   3. 255
   4. 17
2. How would the IP address 197.15.22.31 be expressed in a binary numbering scheme?
   1. 11000101.00001111.00010110.00011110
   2. 11000101.00001111.00010110.00011111
   3. 11000101.00001111.00010110.00010111
   4. 11000101.00001101.00010110.00011110
3. How would the IP address 197.15.22.127 be expressed in a binary numbering scheme?
   1. 11000101.00001111.00010110.01111111
   2. 11000101.00001111.00010110.01111110
   3. 11000101.00001111.00010110.11111110
   4. 11000101.00001111.00010111.11111110
4. In binary notation, the subnet mask for a Class “B” network may be given as: 11111111.11111111.11111110.00000000. What would this be in dotted decimal?
   1. 256.256.255.0
   2. 256.255.254.0
   3. 255.255.254.0
   4. 254.254.254.0
5. What would the correct binary sequence be for a subnet range that borrowed three bits?
   1. 111,110,101,100,011,010,001,000
   2. 000,001,011,010,100,110,101,111
   3. 111,101,110,100,010,011,001,000
   4. 000,001,010,011,100,101,110,111
6. What is the binary to decimal conversion for 01010101?
   1. 128
   2. 127
   3. 85
   4. 4
7. What is the binary to decimal conversion for 01111110?
   1. 126
   2. 63
   3. 85
   4. 124
8. What is the binary to decimal conversion for 00010000?
   1. 15
   2. 32
   3. 1
   4. 16
9. What is the binary to decimal conversion for 01100110?
   1. 102
   2. 103
   3. 4
   4. 104
10. What is the binary to decimal conversion for 00001000?
    1. 8
    2. 12
    3. 16
    4. 4
11. What is the decimal to binary conversion for 17?
    1. 01000111
    2. 00010001
    3. 10001001

11101110

What is the decimal to binary conversion for 128?

* 1. 01000110
  2. 01001000
  3. 10000000
  4. 01111111

1. What is the decimal to binary conversion for 220?
   1. 01000111
   2. 11010001
   3. 00101001
   4. 11011100
2. What is the decimal to binary conversion for 240?
   1. 11110000
   2. 111000001
   3. 10111001
   4. 11101110
3. What is the decimal to binary conversion for 191?
   1. 01000100
   2. 10111111
   3. 10001001
   4. 11101010

**Broadcast and subnet addresses**

1. Which of the following definitions best describes a “broadcast?”
   1. Data packet that will be sent to all nodes on a network segment.
   2. Section of a network that is bounded by Switches, routers, or switches.
   3. Binary digit used in the binary numbering system that can be 0 or 1.
   4. Screaming at the top of your lungs until you can’t breathe.
2. Which of the following is an example of a class "C" broadcast address?
   1. 190.12.253.255
   2. 190.44.255.255
   3. 221.218.253.255
   4. 221.218.253.0
3. In a class "C" subnet address up to six bits can be borrowed from the host field.
   1. True
   2. False
4. Which of the following is a valid class “B” IP broadcast address with no subnets?
   1. 68.140.74.0
   2. 129.37.0.255
   3. 129.37.0.0
   4. 190.37.255.255
5. Which of the following is reserved for the broadcast address in 198.64.74.x/27?
   1. .0
   2. .127
   3. .192
   4. .254
6. Which of the following is a valid class “C” IP subnet number (/27)?
   1. .191
   2. .127
   3. .128
   4. .129
7. Which of the following is a valid class “B” IP subnet broadcast address?
   1. 10101011.01011101.00010000.01011110
   2. 00101011.01011101.00010000.01111111
   3. 10110110.01011101.00000000.01111111
   4. 11100110.01011101.00000000.01111111
8. Which type of IP address can borrow one bit from the last octet to create subnets?
   1. Class “C” IP addresses
   2. Class “B” IP addresses
   3. None can borrow 1 bit from the last octet
   4. Class A, B, and C can borrow 1 bit from the last octet
   5. Both Class “A” and “B”
9. Which of the following best describes the address 147.30.74.1
   1. Class “A” host address
   2. Class “A” broadcast address
   3. Class “B” host address
   4. Class “B” subnet address

**Subnetting possible vs. useable**

Are the following statements TRUE or FALSE?

1. Subnet addresses are assigned locally.
   1. False
   2. True
2. Subnet addresses include only a network number and a host number.
   1. True
   2. False
3. Each time the number of bits borrowed from an eight bit octet decreases, the decimal value representing that octet in the subnet mask increases by a power of two
   1. True
   2. False
4. How many possible subnets can be created if four bits are borrowed from the host field?
   1. 2
   2. 4
   3. 8
   4. 16
5. How many possible subnetworks can be created if five bits are borrowed from the host field?
   1. 5
   2. 8
   3. 16
   4. 32
6. How many possible subnetworks can be created if six are borrowed from the host field?
   1. 6
   2. 12
   3. 32
   4. 64
7. How many actual subnets can be created if four bits are borrowed from the host field? (no ip-subnet zero)
   1. 2
   2. 4
   3. 6
   4. 14
   5. 16
8. How many actual subnetworks can be created if five bits are borrowed from the host field? (no ip-subnet zero)
   1. 15
   2. 20
   3. 25
   4. 30
9. How many possible subnetworks can be created if six are borrowed from the host field?
   1. 6
   2. 16
   3. 62
10. 64
11. On a class "C" network with three bits borrowed for subnets to which subnetwork would the IP subnet and host range 01100001 belong? (no ip-subnet zero)
    1. second subnet
    2. third subnet
    3. fourth subnet
    4. fifth subnet
12. How would the subnetwork 01100001 field for a Class “C” IP address with six useable subnets be expressed in binary numbers?
    1. 001111
    2. 01111
    3. 0111
    4. 011

How would the third useable subnet range of a Class “C” IP address with eight possible subnets be expressed in decimal numbers? (no ip-subnet zero)

* 1. 64
  2. 96
  3. 128
  4. 32

1. How would the decimal number 220 be expressed as a binary number written as an octet?
   1. 11011100
   2. 11011101
   3. 01101110
   4. 11101101
2. How would the sixth possible subnetwork field of a Class “C” IP address be expressed in binary numbers?
   1. 100
   2. 101
   3. 110
   4. 111
3. To what subnetwork on a Class “C” network with three bits for a subnet would a fourth octet expressed as 10101101 belong? (no ip-subnet zero)
   1. first
   2. sixth
   3. fifth
4. seventh
5. How would the host field be expressed in binary numbers of a Class “C” IP address which has 6 useable subnets for host number 13? (no ip-subnet zero)
   1. 01101
   2. 01100
   3. 01110
   4. 01111
6. Which of the following best describes the maximum number of bits that can be borrowed in a Class “C” network? (no ip-subnet zero)
   1. 6
   2. 8
   3. 14
   4. 12
7. Which of the following best describes the maximum number of bits that can be borrowed in a Class “B” network? (no ip-subnet zero)
   1. 14
   2. 6
   3. 8
   4. 4
8. If two bits are borrow from the host field of a Class “C” network, then how many possible subnetworks can be created?
   1. 16
   2. 4
   3. 8
   4. 2
9. If four bits are borrowed from the host field of a Class “B” network, then how many subnetworks can be created? (no ip-subnet zero)
   1. 16
   2. 32
   3. 8
   4. 4
10. If four bits are borrowed from the host field of a Class "B” network, then how many possible hosts per subnetwork can be created?
    1. 256
    2. 4096
    3. 16
    4. 8

If two bits are borrowed from the host field of a Class “C” network, then, how many possible hosts per subnetwork can be created?

* 1. 2048
  2. 256
  3. 64
  4. 32

1. If we have 4 possible subnets in our network then how many bits have been borrowed from the host field?
   1. 4
   2. 3
   3. 2
   4. 6
2. If we have 4 possible subnets in our network then what will the range of binary host field numbers be for the first subnetwork?
   1. 00000-11111
   2. 00000000-111111111
   3. 000000-111111
   4. 0000-1111
3. If we have 4 possible subnets in our network then what decimal value would be assigned to an octet expressed as 01011011?
   1. .191
   2. .67
   3. .91
   4. .92
4. If we have 2 possible subnets in our network then what would the binary subnetwork field number be for the decimal host number expressed as .196?
   1. 01
   2. 10
   3. 11
   4. 00
5. In a network with two bits borrowed for subnets, what would the binary host field number be for the decimal host number expressed as .49?
   1. 011001
   2. 110001
   3. 00110001

111001

* 1. **Subnet masking**
  2. How would the subnet mask 255.255.255.0 be represented in dotted binary notation?
     1. 1111111.1111111.1111111.00000000
     2. 11111111.11111111.11111111.00000000
     3. 11111111.11111111.11111111.11111111
     4. 11111111.11111111.11111111.10000000

1. If only seven bits are borrowed in a Class “B” network then what would the subnet mask be in dotted decimal notation?
   * 1. 255.255.255.0
     2. 255.255.254.0
     3. 254.255.255.0
     4. 254.254.254.0
2. What would the subnet mask be in dotted decimal notation if only five bits were borrowed from the third octet in a class “B” address? (no ip-subnet zero)
   * 1. 255.255.254.0
     2. 255.255.255.0
     3. 255.255.248.0
     4. 254.254.248.0
3. What would the subnet mask be in dotted decimal notation if only one bit were borrowed from the third octet in a Class “A” address? (no ip-subnet zero)
   * 1. 128.255.128.0
     2. 255.255.255.0
     3. 255.255.128.0
     4. cannot borrow only one bit
4. Subnet masks tell devices which part of an address is the network number including the subnet and which part is the host.
   * 1. True
     2. False
5. Subnet masks are 16 bits long and are divided into two octets.
   * 1. False
     2. True
6. Subnet masks have all 0’s in the network and subnetwork portions of their addresses.
   * 1. False
     2. True

Binary bits in the subnet mask are used to represent which of the following:

* 1. host bits
  2. subnet bits
  3. network bits
  4. both b and c

1. What will the use of subnets do regarding the amount of broadcast traffic?
   1. decrease, because broadcasts are not forwarded outside
   2. decrease, because it will take less time for a host to get broadcasts from the router
   3. increase, because packets are forwarded to all subnets
   4. increase, because bandwidth will decrease

**Router functions**

1. In the graphic below (on the next page), if device A3 is sending data to device C3, out of what port will the router send the data?
   1. A5
   2. C4
   3. C1
   4. A4
2. In the graphic below (on the next page), how many IP addresses does the router have?
   1. 1
   2. 15
   3. 4
   4. 5
3. In the graphic, if device A2 wants to send data to device A4, will the router forward the data to Network B?
   1. Yes
   2. No
4. How many ports does the router in this graphic have?
   1. 8
   2. 4
   3. 1
   4. 5

Diagram

Description automatically generated

**Whole enchilada problems**

1. Which of the following is the dotted decimal notation value of the host portion of a Class “A” IP address 38.0.53.228 with a subnet mask of 255.255.252.0?
   1. 0.228
   2. 53.228
   3. 1.228
   4. 5.228
2. Which of the following subnet masks will not be applicable to a Class “C” IP address but can be used with a Class “B” IP address?
   1. 255.2555.0
   2. 255.255.255.192
   3. 255.255.255.240
   4. 255.255.255.128
3. Which of the following is a valid address for a Class “A” IP address with a subnet mask of 255.255.240.0?
   1. 38.255.240.2
   2. 38.0.192.0.
   3. 38.0.240.255
   4. 38.255.255.255
4. Which of the following is a valid Class “B” IP address with a subnet mask of 255.255.255.224?
   1. 18.200.3.55
   2. 130.0.0.1
   3. 154.255.0.31

147.255.0.48

1. Which of the following is the first available address for a Class “A” IP address of 2.x.x.x. with a subnet mask of 255.255.255.128?
   1. 2.1.1.1
   2. 2.0.0.129
   3. 2.1.2.3
   4. 2.0.0.1
2. Which of the following addresses is a valid address when using a subnet mask of 255.255.255.192?
   1. 2.0.0.0
   2. 129.1.0.63
   3. 177.255.255.195
   4. 215.1.8.188

Having trouble with the “whole enchiladas?” Hint: Look to eliminate any addresses where subnet portion or host portions contain all zeros or all ones.

**Network Design with Subnets**

*Objective:*

To learn how to design networks from “essay” type information.

*Background:*

In this lab you will be presented with a variety of networking scenarios. For each you are to design the networks, subnets, and IP addresses. Each one here will be progressively more difficult. Do not become upset if you have trouble with this…sometimes it takes doing this many times before some people “get it.” Its actually like getting struck by lightning. After many times of not getting it you feel like lightning knocks you out of your chair and you suddenly get it. So let’s keep hammering the examples so everyone can get it…after all we learn by doing. There are many different ways that these can be done…so the answers I give are not necessarily the only answers.

**Real Estate Office**

You are working as an independent consultant for a real estate broker. He has 16 agents and one receptionist working for him. There are three printers and one file server in the office. He wants to have Internet access and email accounts for everyone with a DSL line. Please design him a network for the least amount of money possible. Those small businesses typically do not have a lot of money. Don’t forget to include your expenses (figure $150 an hour for installation and setup).

* Internet - DSL Line
* Printer - 3
* File Server - 1
* Email Accounts - 16
* Agents -16
* Receptionist - 1
* Installation/Setup -Hourly rate at $150, estimated completion 32 hours ($4,800)

**Please see file attached assignment “Real Estate Office Assignment 4.pkt”**

**Veterinarian’s Office**

Your cousin is a vet in the Jacksonville, Florida area. He has asked you to help design and set up a network for him as inexpensively as possible. (Since it’s for family you are doing it for free). He has a main office in Mandarin where he spends 5 days (all but Wednesday) with his receptionist (who does scheduling on the database server), an office manager (who does accounting, billing, etc on the database server), and his office computer (where he keeps all his medical stuff). He also has a dot matrix and a laser jet printer there. He would like to connect to the Internet with a DSL line and have dial-in access to his home computer. His office in St. Augustine (open only on Wednesdays) will have a computer for the doctor and for the receptionist. They need to have access to the database server at the main office (use dial-in via the PSTN). There is a laser jet at the St. Augustine office.

* Internet - DSL Line and Dial-Up
* Dot Matrix/Mandarin - 1
* Laserjet/Mandarin - 1
* Laserjet/Agustine - 1
* Database Server - 1
* Computers/Mandarin - 3
* Computers/Augustine - 2 (cousin could use same laptop in both locations)
* Receptionist - 1
* Installation/Setup - Free

**Please see file attached assignment “Vet Office Assignment 4.pkt”**

**ABC Packaging Company—Part 1**

You are working as the network administrator for ABC Packaging Company in Tarpon Springs. You are to design a network that focuses upon scalability and adaptability. There are five departments: Administration (14 people, 5 printers), Engineering (22 people, 5 printers, 1 file server), Production (5 people), Accounting (11 people, 4 printers, 1 database and file server), and Sales/Marketing (11 people, 4 printers, 1 file server). Each department will require a separate subnet. The servers will have their own subnet. Be sure to connect them to the Internet with a T-1 line.

Subnet = /27

172.10.50.0 255.255.255.224

Five Departments

* Administration
  + 14 People
  + 5 Printers

Subnet = /26

172.10.51.0 255.255.255.192

* Engineering
  + 22 People
  + 5 Printers

Subnet = /29

172.10.55.0 255.255.255.224

* + 1 File Server
* Production

Subnet = /28

172.10.54.0 255.255.255.224

* + 5 People
* Accounting
  + 11 People

Subnet = /27

172.10.52.0 255.255.255.224

* + 4 printers
  + 1 DB / File server

Subnet = /29

172.10.55.0 255.255.255.224

* Sales/Marketing

Subnet = /27

172.10.53.0 255.255.255.224

* + 11 People
  + 4 printers
  + 1 File Server

Subnet = /29

172.10.55.0 255.255.255.224

**Website Company**

You are the network administrator for an upstart website publishing company. They have offices in two adjacent buildings on different floors. Lately, they have realized the costs of their individual Internet accounts far exceeds the costs of installing and maintaining a T-1 line. As the network guru you are to design a network that will utilize FDDI between the buildings. The west building uses floors 3, 4, and 5 for the sales and admin staff. Here you will want to use a CISCO Catalyst 5000 with a FDDI module, a management module, and a 24-port switch module. From there each floor will distribute access via a CISCO 1924 switch to each of its 20 nodes (workstations, servers, and printers). The east building uses floors 1 through 5 for the design and engineering staff. Here you will want to use a CISCO Catalyst 5500 with a FDDI module, a management module, and a 24-port switch module. You will also have a CISCO 2610 router with T-1 module, and a Kentrox CSU/DSU for your full T-1 line. Your ISP, ComBase has sold you two blocks of 62 IP addresses: 198.74.56.x (1-62) and (65-126). Combase will also provide the DNS services, unlike most ISP’s where more than 24 IP’s are ordered. Design your network, including cabling and grounds, to include all IP’s, subnet masks, gateways, and anything else you need to include.

**Quickie Subnetting**

**When borrowing three bits**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| Subnet number | 1st available host IP | Last available host IP | Broadcast Address |
| 0 | ***1*** | ***30*** | 31 |
| 32 | 33 | 62 | 63 |
| 64 | 65 | 94 | 95 |
| 96 | 97 | 126 | 127 |
| 128 | 129 | 158 | 159 |
| 160 | 161 | 190 | 191 |
| 192 | 193 | 222 | 223 |
| 224 | ***225*** | ***254*** | 255 |

**Italicized**—useable only with the **ip subnet-zero** command

When borrowing three bits the wildcard mask becomes “31”

|  |  |  |  |
| --- | --- | --- | --- |
|  | **When borrowing four bits** | |  |
|  |  |  |  |
| Subnet number | 1st available host IP | Last available host IP | Broadcast Address |
| 0 | ***1*** | ***14*** | 15 |
| 16 | 17 | 30 | 31 |
| 32 | 33 | 46 | 47 |
| 48 | 49 | 62 | 63 |
| 64 | 65 | 78 | 79 |
| 80 | 81 | 94 | 95 |
| 96 | 97 | 110 | 111 |
| 112 | 113 | 126 | 127 |
| 128 | 129 | 142 | 143 |
| 144 | 145 | 158 | 159 |
| 160 | 161 | 174 | 175 |
| 176 | 177 | 190 | 191 |
| 192 | 193 | 206 | 207 |
| 208 | 209 | 222 | 223 |
| 224 | 225 | 238 | 239 |
| 240 | ***241*** | ***254*** | 255 |

**Italicized**—useable only with the **ip subnet-zero** command

When borrowing four bits the wildcard mask becomes “15”

**Subnetting Example: John’s Brewhouse**

*Objective:*

To use your subnet knowledge to design an IP addressing scheme for the John’s Brewhouse Restaurant Network.

*Tools and Materials:*

Word

Background:

John Harvard’s Brewhouse is a microbrewery/restaurant chain in New England. They have locations in CamSwitch (MA), Framingham (MA), Wayne (PA), Springfield (PA), Pittsburgh (PA), Manchester (CT), Wilmington (DE), Providence (RI), Lake Grove (NY), and Washington DC. Three network topologies are provided here. You task is to design an IP addressing scheme that will address all current needs as well as future expandability. If you see anything that may want to address feel free to note it. Scalability, adaptability, reliability and performance are the key issues in this design. You will be using private addressing in your network. All lines are 10BaseT unless noted.

*Lab Design:*

Typical Restaurant:

Diagram

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Telephone

Company

Dial-up for Credit Card

Authorization and

Application support

 Dial-up to HQ

2-NCR 3259 Pentium 200 (NT 4.0 Servers)

(code, inventory, payment, RAS)

(5) NCR 7453 Point-of-Sale Terminals

HQ in Boston

T -1 to RCS

telco

HP Vectra P200 Vectra

RAS server

HP NetServer E45 P2/266 (NT 4.0)

(inventory, payment, PDC)

Compaq ProLiant 2500

(Netware 4.10 Server)

1. Compaq ProLiant 200 PC’s with Win 95

Restaurant Consulting Services (RCS) Danvers, Mass.

From HQ  Internet 

Diagram

Description automatically generated

|  |  |  |  |
| --- | --- | --- | --- |
| Dedicated | CISCO | CISCO |  |
| T-1 | 2501 | 2514 | T-1 |
| Adtran |  |  | Adtran |

CISCO 2501

(25) Compaq ProLiant 200 PC’s

with Win 95

HP NetServer E45 HP NetServer2H2 HPNetServerLH2

(NT 4.0) Backup SQL Database (NT 4.0) Proxy Server (NT 4.0)

From Networking Computing Magazine Centerfold: John Harvard’s Brewhouse. http://www.networkcomputing.com/1005/1005centerfoldtext.html

**Lab: Variable Length Subnet Masking (VLSM)**

*Objective:*

To learn how to implement VLSM in subnet design.

*Background:*

When designing networks it is preferable to be as efficient as possible when assigning IP addresses. As we have seen in previous labs sometimes we even need to use contiguous (sequential) numbers for our subnet schemes. As your skills in networking and networking design increase you will need to know how to efficiently utilize VLSM (RFC 1219).

*Tools and Materials:*

Word

Super VLSM chart is at http://www.spjc.edu/star/cisco/Matt/New%20Subnetting%20VLSM%20tables.xls or http://www.spjc.edu/star/cisco/Matt/list\_of\_current\_papers\_and\_brief.htm and look for it. It looks nasty in the Excel spreadsheet but it prints nicely on one page.

*Lab Diagram:*

to: IT HQ

A picture containing shape

Description automatically generated

(servers: 2 IP’s)

(24 IP’s) A picture containing text, clipart

Description automatically generated

 (39 IP’s)

(57 IP’s)

(6 IP’s) (14 IP’s)

(12 IP’s) (28 IP’s)

*Problems:*

For the network diagrammed design an IP addressing scheme using VLSM to be as efficient as possible with IP address distribution.

1. You have been assigned the class “C” private IP address by the upper-level IT staff. Other divisions have other Class “C” IP addresses. For now, you only need to know you have the 192.168.70.0/24 network to design.
2. You have been assigned the class “B” private IP address by the upper-level IT staff. Other divisions have other Class “B” IP addresses. For now, you only need to know you have the 172.168.128.0/18 network to design.
3. You have been assigned the class “A” private IP address by the upper-level IT staff. Other divisions have other Class “A” IP addresses. For now, you only need to know you have the 10.16.0.0/12 network to design.

*Supplemental Lab*

If the router to HQ was used for DHCP could you set this network up with RIP and make it work? Try it.

Let’s go through one example using the above network design and a class “C” network address given as 212.14.17.x/24.

1. Determine largest network needed: 57 IP’s. This will fit into a network in our first column (62 hosts max). So we put down 212.14.17.64/26 for that network and color out the ip address ranges from .64 to .124 on our chart (all the way across the chart). Our actual usable addresses are .65 to .126…the columns all the way on the left are not that specific.
2. Determine the next largest network needed: 39 IP’s. This will fit into a network in our first column (62 hosts max). So we put down 212.14.17.128/26 for that network and color out the ip address ranges from .128 to .188 on our chart (all the way across the chart). Our actual usable addresses are .129-.190.
3. Determine the next largest network needed: 28 IP’s. This will fit into a network in our second column (30 hosts max). So we put down 212.14.17.32/27 for that network and color out the ip address ranges from .32 to .60 on our chart (all the way across the chart). Our actual usable addresses are .33-.62.
4. Determine the next largest network needed: 24 IP’s. This will fit into a network in our second column (30 hosts max). So we put down 212.14.17.192/27 for that network and color out the ip address ranges from .192 to .220 on our chart (all the way across the chart). Our actual usable addresses are .193-.222.
5. Determine the next largest network needed: 14 IP’s. This will fit into a network in our third column (14 hosts max). So we put down 212.14.17.16/28 for that network and color out the ip address ranges from .16 to .28 on our chart (all the way across the chart). Our actual usable addresses are .17-.30.
6. Determine the next largest network needed: 12 IP’s. This will fit into a network in our third column (14 hosts max). So we put down 212.14.17.224/28 for that network and color out the ip address ranges from .224 to .236 on our chart (all the way across the chart). Our actual usable addresses are .225-.238.
7. Determine the next largest network needed: 6 IP’s. This will fit into a network in our fourth column (6 hosts max). So we put down 212.14.17.8/29 for that network and color out the ip address ranges from .8 to .12 on our chart (all the way across the chart). Our actual usable addresses are .9-.14.
8. Determine the next largest network needed: 2 IP’s. This will fit into a network in our fifth column (2 hosts max). So we put down 212.14.17.4/30 for that network and color out the ip address ranges from .4 to .8 on our chart (all the way across the chart). Our actual usable addresses are .5-.6.
9. Don’t forget about those serial lines between our routers! They need subnets with IP’s too. For those we picked, basically what is left. 212.14.17.240/30 (useable .241-.242), 212.14.17.244/30 (useable .245-.246), and 212.14.17.248/30 (useable .249-

.250).

These are the addresses for this lab…can you “see” the ***variable* length subnet mask**?

|  |  |
| --- | --- |
| 212.14.17.x/**24** | 212.14.17.224/**28** |
| 212.14.17.64/**26** | 212.14.17.8/**29** |
| 212.14.17.128/**26** | 212.14.17.4/**30** |
| 212.14.17.32/**27** | 212.14.17.240/**30** |
| 212.14.17.192/**27** | 212.14.17.244/**30** |
| 212.14.17.16/**28** | 212.14.17.248/**30** |

*So What Have I Learned Here?*

In this lab you learned about VLSM. This is a topic in the CCNP classes. So why did I put it here? Simple, I have seen it on the CCNA test AND it makes sense. I have no idea why it is introduced in the CCNP stuff and not here. It makes more sense as an extension to subnetting. We learned about dis-contiguous routes and classful boundaries earlier. Now, with your knowledge that RIP does not pass subnet mask information you can make an intelligent decision not to use VLSM if you are using RIP. See how it all starts to come together? Let’s look at the difference between static and dynamic routing. You have already been doing dynamic routing with the router rip command.

**What’s Wrong with these Subnets?**

The objective of these labs is to give you some hands-on experience in troubleshooting subnetting problems before you even start putting these into the routers. So I put in a bunch of them here with some of the more common faults. Being able to do these well will help you with a big chunk of the test items and make your hands-on labs go more smoothly.

Diagram

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So what is wrong with this and what are the possible fixes?

For the first couple I will fill in the answers…after that you will have to check with your answer guide or instructor. This one has a few different answers. First, there are no subnets used here. There is one big flat subnet. The routers will not know how to route their information. They use the subnets to know which interface to send information out. One possible solution is to change all the ip’s on the serial lines to usable ip’s with 30 bit masks (ie. 1-2, 5-6, 9-10). Or, we could switch subnets altogether (ie. 192.168.1.0, 192.168.2.0, and 192.168.3.0 with a 24 bit mask).

Diagram

Description automatically generated

So what is wrong with this and what are the possible fixes?

Possible solution#1: switch the mask on the bottom serial line to 30-bit masks. Possible

solution #2: switch the ip’s to a different subnet (ie. 192.168.2.0/24). Possible solution #3: switch the ip’s to a different subnet within the subnet range with the remain usable ip numbers (on the bottom serial line switch them to 192.168.1.253/24 and 192.168.1.254/24).

Diagram

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So what is wrong with this and what are the possible fixes?

Diagram

Description automatically generated

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