Wiesbaden HS Academy

Calculating Subnets for the Standard Five Router Network

Instructions: Study the Fundamentals section of this exercise carefully. You'll use this technique to derive subnet addresses of your own. This is a very important skill to master so be prepared to solve subnet address for a variety of classes and network addresses.

Fundamentals

You've just been given five routers to configure for a network using the following parameters:

Remember: There are 5 different address classes. You can determine which class any IP address is in by examining the first 4 bits of the IP address.

Class A Networks	001.xxx.xxx.xxx to 127.xxx.xxx.xxx
Class B Networks	128.xxx.xxx.xxx to 191.xxx.xxx.xxx
Class C Networks	192.xxx.xxx.xxx to 223.xxx.xxx.xxx
Class D Networks	224.xxx.xxx.xxx to 239.xxx.xxx.xxx
Class E Networks	240.xxx.xxx.xxx to 254.xxx.xxx.xxx

Addresses beginning with **127**, are reserved for loop-back and for internal testing on a local machine. Pinging **127.0.0.1**, points to yourself. Class D addresses are reserved for multicasting. Class E addresses are reserved for future use. They should not be used for host addresses.

The class also determines, by default, which part of the IP address belongs to the network (N) and which part belongs to the host (H).

Class A -- NNNNNNNN.HHHHHHHH.HHHHHHHH.HHHHHHHH
Class B -- NNNNNNNN.NNNNNNNN.HHHHHHHH.HHHHHHHH
Class C -- NNNNNNNN.NNNNNNNN.NNNNNNNN.HHHHHHHH

Private Subnets

There are also three IP network addresses reserved for private networks. The addresses are **10.0.0.0/8**, **172.16.0.0/12**, and **192.168.0.0/16**. They can be used by anyone setting up internal IP networks, such as a school lab or home network behind a proxy server or router. It's safe to use these IP addresses because routers on the Internet will not forward packets coming from these particular addresses

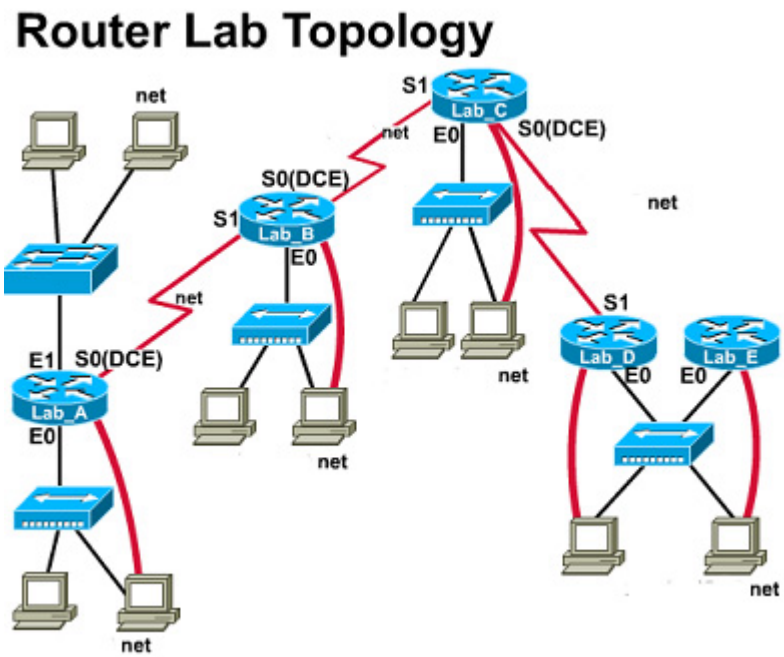


Figure 1. Standard 5 Cisco Router Training Topology

Here's An Example…

- Class B
- Network Address 156.1.0.0
- 5 bits barrowed for the subnet mask
- Use the standard five-router diagram
- 9 Networks need to be configured

Step 1: Calculate the subnet mask.

Subnet Mask: 255.255.248.0

Why? Since this a Class B network, the first two octets in the mask are 255. 5 bits are borrowed from the 3rd octet to create the mask for the subnet portion of the IP address. In binary the mask is 11111111.11111111.11111000.00000000 and the third octet translates to 248.

$2^7 = 128$
$2^6 = 64$
$2^5 = 32$
$2^4 = 16$
$\underline{2^3 = 8}$
248

Step 2: Calculate the number of available subnets.

Total number of subnets available is 32

Why? The parameters listed above state that you are borrowing 5 bits from the host portion of the IP address to build your subnets. $2^5 = 32$ meaning that there are 32 discrete variations that can be represented by 5 bits.

Step 3: Calculate the number of available hosts.

Total number of hosts available on each subnet is 1026.

Why? Remember that 5 bits are being borrowed to create the subnet leaving 3 for the host. Since there are 8 bits available in the 4th octet and 3 bits available in the 3rd octet, the total number of available bits is 11 and $2^{11} = 1028$. The first IP address in the subnet is the subnet itself and the last IP address is used for broadcast signals. Therefore, these addresses cannot be assigned to hosts. Since the first and last IP address cannot be used by hosts… The total number of available hosts in this case is 1028 – 2 or 1026.

Step 4: Create a table of the available subnet and host addresses.

Subnet	Subnet IP	Host Start	Host End
0	156.1.0.0	Not available for use	
1	156.1.8.0	156.1.8.1	156.1.15.255
2	156.1.16.0	156.1.16.1	156.1.23.255
3	156.1.24.0	156.1.24.1	156.1.31.255
4	156.1.32.0	156.1.32.1	156.1.39.255
5	156.1.40.0	156.1.40.1	156.1.47.255
6	156.1.48.0	156.1.48.1	156.1.55.255
7	156.1.56.0	156.1.56.1	156.1.63.255
8	156.1.64.0	156.1.64.1	156.1.71.255
9	156.1.72.0	156.1.72.1	156.1.79.255
10	156.1.80.0	156.1.80.1	156.1.87.255
11	156.1.88.0	156.1.88.1	156.1.95.255
12	156.1.96.0	156.1.96.1	156.1.103.255
13	156.1.104.0	156.1.104.1	156.1.111.255
14	156.1.112.0	156.1.112.1	156.1.119.255
15	156.1.120.0	156.1.120.1	156.1.127.255
16	156.1.128.0	156.1.128.1	156.1.135.255
17	156.1.136.0	156.1.136.1	156.1.143.255
18	156.1.144.0	156.1.144.1	156.1.151.255
19	156.1.152.0	156.1.152.1	156.1.159.255
20	156.1.160.0	156.1.160.1	156.1.167.255
21	156.1.168.0	156.1.168.1	156.1.175.255
22	156.1.176.0	156.1.176.1	156.1.183.255
23	156.1.184.0	156.1.184.1	156.1.191.255
24	156.1.192.0	156.1.192.1	156.1.199.255
25	156.1.200.0	156.1.200.1	156.1.207.255
26	156.1.208.0	156.1.208.1	156.1.215.255
27	156.1.216.0	156.1.216.1	156.1.223.255
28	156.1.224.0	156.1.224.1	156.1.231.255
29	156.1.232.0	156.1.232.1	156.1.239.255
30	156.1.240.0	156.1.240.1	156.1.247.255
31	156.1.248.0	Subnet Mask Limit	

Subnet: This refers to the total number of available subnets. As calculated above, the total number of subnets is 32… or 0 through 31.

IP: The very first IP address represents the Network Address defined in the parameters.

Each subsequent IP address is identified multiples of 8 in the third octet.

Why? When we borrowed 5 bits from the 3rd octet to identify the subnet. The least significant bit borrowed was 2^3 or 8. That's the least significant digit of the subnet. To create the next subnet this bit is incremented and every time it's incremented… it's incremented by 8. In binary…

00000xxx = 0 in the 3rd Octet
00001xxx = 8 in the 3rd Octet
00010xxx = 16 in the 3rd Octet
00011xxx = 24 in the 3rd Octet

Host Start: This address represents the first available address for a network host. This is 1 address greater than the subnet IP.

Host End: This is the last available address available to hosts. 255 in the 4th octet initiates a broadcast to all hosts on that network and is not used by hosts. This is 1 address less than the next subnet IP.

Step 5: Select the number of the subnets to cover the number of networks you have to create.

The five-router model used in this problem requires a total 8 configured networks that connect between routers. Select the first 8 subnets from the table above to identify your networks.

Resources Links

Site	URL	Description
RalphB.Net	http://www.ralphb.net/IPSubnet/	Excellent tutorial on calculating IP address and subnets.

Wiesbaden HS Academy

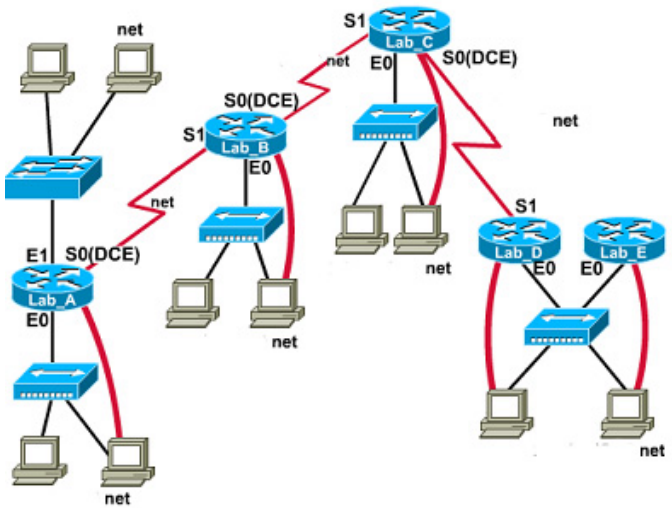
Calculating Subnets for the Standard Five Router Network

Router Configuration Guide

Network	156.	1.	0.	0

Instructions: This tool will help you configure a router stack. Before you get started, you'll need the basic network address (above), Network Class, the number of bits borrowed to create a subnet, and the calculated subnet mask. First… Fill in the network address, the Host Names, and subnet masks. You can copy the rest of the information from the table of available subnets you just created. Identify the networks by writing their addresses on the drawing to the right. You're now ready to configure the router.

Router Lab Topology



Host Name 1	Lab_A			
Ethernet 0	156.	1.	8.	1
Ethernet 1	156.	1.	16.	1
Serial 0	156.	1.	24.	1
Subnet Mask	255.	255.	248.	0

Host Name 2	Lab_B			
Ethernet 0	156.	1.	32.	1
Serial 0	156.	1.	40.	1
Serial 1	156.	1.	24.	2
Subnet Mask	255.	255.	248.	0

Host Name 3	Lab_C			
Ethernet 0	156.	1.	48.	1
Serial 0	156.	1.	56.	1
Serial 1	156.	1.	40.	2
Subnet Mask	255.	255.	248.	0

Host Name 4	Lab_D			
Ethernet 0	156.	1.	64.	1
Serial 1	156.	1.	56.	2
Subnet Mask	255.	255.	248.	0

Host Name 5	Lab_E			
Ethernet 0	156.	1.	64.	2
Subnet Mask	255.	255.	248.	0

Notes: Networks 156.1.8.0,
156.1.16.0, 156.1.24.0, 156.1.32.0
156.1.40.0, 156.1.48.0, 156.1.56.0
156.1.64.0

Wiesbaden HS Academy

Calculating Subnets for the Standard Five Router Network

Performance Test - Calculating Subnet Networks

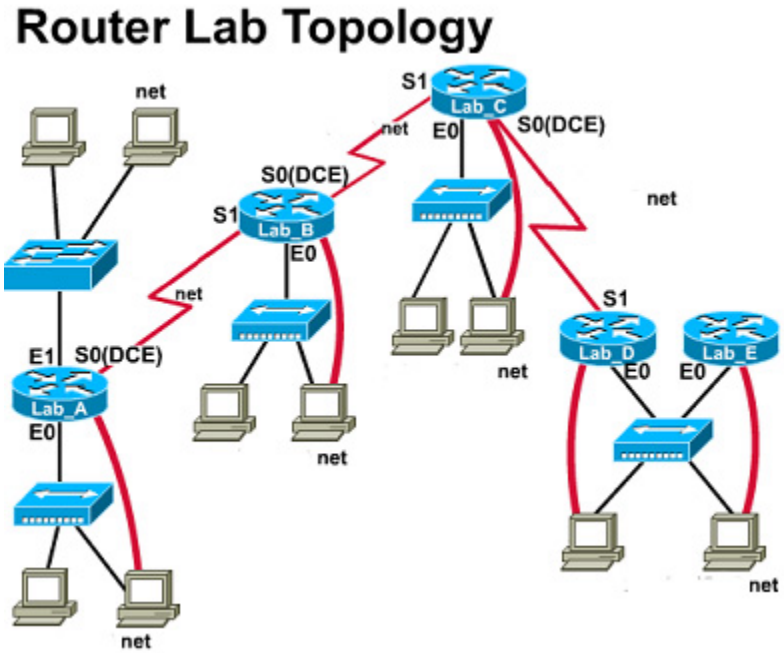
Challenge

The IT department wants you to configure a five-router stack using the topology shown below. They've given you a network address to work from. Borrow the minimum number of bits to cover the number of subnets for this network. Complete the Available Subnets Table and the Router Configuration Guide using the calculated information.

Specifications:

Network Address 192.11.2.0

Network Class			
Subnet Mask			
.	.	.	.
Req. Subnets			
Avail. Subnets			
Avail. Hosts			



Notes:

What about the broadcast IP for each subnet address?

Subnet	Subnet IP	Host Start	Host End
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			

Table 1. Available Subnet Addresses

Wiesbaden HS Academy

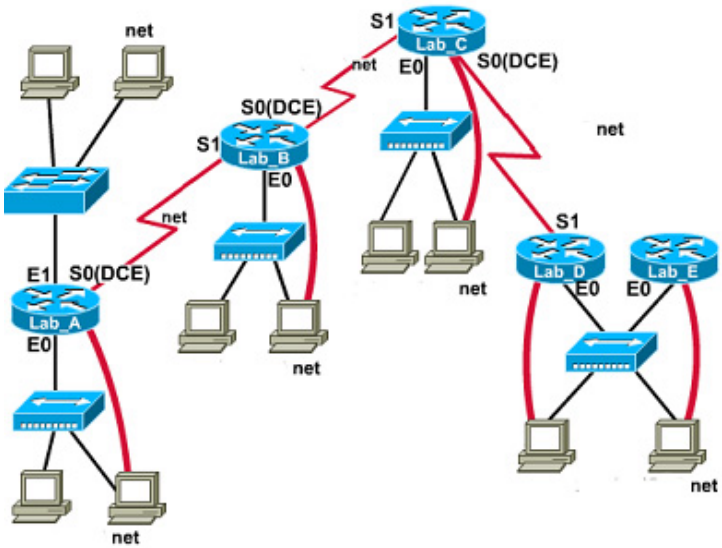
Calculating Subnets for the Standard Five Router Network

Performance Test: Router Configuration Guide

Network	.	.	.

Instructions: This tool will help you configure a router stack. Before you get started, you'll need the basic network address (above), Network Class, the number of bits borrowed to create a subnet, and the calculated subnet mask. First… Fill in the network address, the Host Names, and subnet masks. You can copy the rest of the information from the table of available subnets you just created. Identify the networks by writing their addresses on the drawing to the right. You're now ready to configure the router.

Router Lab Topology



Host Name 1	
Ethernet 0	. . .
Ethernet 1	. . .
Serial 0	. . .
Subnet Mask	. . .

Host Name 3	
Ethernet 0	. . .
Serial 0	. . .
Serial 1	. . .
Subnet Mask	. . .

Host Name 5	
Ethernet 0	. . .
Subnet Mask	. . .

Host Name 2	
Ethernet 0	. . .
Serial 0	. . .
Serial 1	. . .
Subnet Mask	. . .

Host Name 4	
Ethernet 0	. . .
Serial 1	. . .
Subnet Mask	. . .

Notes:
What happens with the broadcast
IP address for each subnet?