Activity 6.7.4: IPv4 Address Subnetting Part 2

Learning Objectives

Upon completion of this activity, you will be able to determine subnet information for a given IP address and subnetwork mask.

Background

Borrowing Bits

How many bits must be borrowed to create a certain number of subnets or a certain number of hosts per subnet?

Using this chart, it is easy to determine the number of bits that must be borrowed.

Things to remember:

- Subtract 2 for the usable number of hosts per subnet, one for the subnet address and one for the broadcast address of the subnet.

2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
1,024	512	256	128	64	32	16	8	4	2	1
Number of bits borrowed:										
10	9	8	7	6	5	4	3	2	1	1
1,024	512	256	128	64	32	16	8	4	2	1
			Hosts or Subnets							

Possible Subnet Mask Values

Because subnet masks must be contiguous 1's followed by contiguous 0's, the converted dotted decimal notation can contain one of a certain number of values:

Dec.	Binary
255	11111111
254	11111110
252	11111100
248	11111000
240	11110000
224	11100000
192	11000000
128	10000000
0	00000000

Scenario

When given an IP address, network mask, and subnetwork mask, you will be able to determine other information about the IP address such as:

- The subnet address of this subnet
- The broadcast address of this subnet
- The range of host addresses for this subnet
- The maximum number of subnets for this subnet mask
- The number of hosts for each subnet
- The number of subnet bits
- The number of this subnet

Task 1: For a Given IP Address and Subnet Mask, Determine Subnet Information.

Given:

Host IP Address	172.25.114.250
Network Mask	255.255.0.0 (/16)
Subnet Mask	255.255.255.192 (/26)

Find:

Number of Subnet Bits	
Number of Subnets	
Number of Host Bits per Subnet	
Number of Usable Hosts per Subnet	
Subnet Address for this IP Address	
IP Address of First Host on this Subnet	
IP Address of Last Host on this Subnet	
Broadcast Address for this Subnet	

Step 1: Translate host IP address and subnet mask into binary notation.

	172	25	114	250
IP Address	10101100	11001000	01110010	11111010
	11111111	11111111	11111111	11000000
Subnet Mask	255	255	255	192

Step 2: Determine the network (or subnet) where this host address belongs.

1. Draw a line under the mask.

2. Perform a bit-wise AND operation on the IP Address and the Subnet Mask.

   Note: 1 AND 1 results in a 1' 0 AND anything results in a 0.

3. Express the result in dotted decimal notation.

4. The result is the Subnet Address of this Subnet, which is **172.25.114.192**

	172	25	114	250
IP Address	10101100	11001000	01110010	11111010
Subnet Mask	11111111	11111111	11111111	11000000
Subnet Address	10101100	11001000	01110010	11000000
	172	25	114	192

Add this information to the table:

Subnet Address for this IP Address	172.25.114.192

Step 3: Determine which bits in the address contain network information and which contain host information.

1. Draw the *Major Divide* (M.D.) as a wavy line where the 1s in the major network mask end (also the mask if there was no subnetting). In our example, the major network mask is 255.255.0.0, or the first 16 left-most bits.

2. Draw the *Subnet Divide* (S.D.) as a straight line where the 1s in the given subnet mask end. The network information ends where the 1s in the mask end.

3. The result is the Number of Subnet Bits, which can be determined by simply counting the number of bits between the M.D. and S.D., which in this case is 10 bits.

Step 4: Determine the bit ranges for subnets and hosts.

1. Label the *subnet counting range* between the M.D. and the S.D. This range contains the bits that are being incremented to create the subnet numbers or addresses.

2. Label the *host counting range* between the S.D. and the last bits at the end on the right. This range contains the bits that are being incremented to create the host numbers or addresses.

Step 5: Determine the range of host addresses available on this subnet and the broadcast address on this subnet.

1. Copy down all of the network/subnet bits of the network address (that is, all bits before the S.D.).

2. In the host portion (to the right of the S.D.), make the host bits all 0s except for the right-most bit (or least significant bit), which you make a 1. This gives us the *first* host IP address on this subnet, which is the *first part* of the result for *Range of Host Addresses for This Subnet*, which in the example is **172.25.114.193.**

3. Next, in the host portion (to the right of the S.D.), make the host bits all 1s except for the right-most bit (or least significant bit), which you make a 0. This gives us the *last* host IP address on this subnet, which is the last part of the result for *Range of Host Addresses for This Subnet*, which in the example is **172.25.114.254.**

4. In the host portion (to the right of the S.D.), make the host bits all 1s. This gives us the broadcast IP address on this subnet. This is the result for *Broadcast Address of This Subnet,* which in the example is **172.25.114.255.**

			M.D.	S.D.		
IP Address	10101100	11001000	01110010	11	111010	
Subnet Mask	11111111	11111111	11111111	11	000000	
Subnet Add.	10101100	11001000	01110010	11	000000	
			← subnet → counting range		← host → counting range	
First Host	10101100	11001000	01110010	11	000001	
	172	25	114		193	
Last Host	10101100	11001000	01110010	11	111110	
	172	25	114		254	
Broadcast	10101100	11001000	01110010	11	111111	
	172	25	114		255	

Let's add some of this information to our table:

Host IP Address	172.25.114.250
Major Network Mask	**255.255.0.0 (/16)**
Major (Base) Network Address	172.25.0.0
Major Network Broadcast Address	172.25.255.255
Total Number of Host Bits Number of Hosts	16 bits or 2^{16} or 65,536 total hosts 65,536 – 2 = 65,534 usable hosts
Subnet Mask	**255.255.255.192 (/26)**
Number of Subnet Bits Number of Subnets	
Number of Host Bits per Subnet Number of Usable Hosts per Subnet	
Subnet Address for this IP Address	
IP Address of First Host on this Subnet	
IP Address of Last Host on this Subnet	
Broadcast Address for this Subnet	

Step 6: Determine the number of subnets.

The number of subnets is determined by how many bits are in the *subnet counting range* (in this example, 10 bits).

Use the formula 2^n, where *n* is the number of bits in the *subnet counting range*.

1. $2^{10} = 1024$

Number of Subnet Bits Number of Subnets (all 0s used, all 1s not used)	10 bits $2^{10} = 1024$ subnets

Step 7: Determine the number usable hosts per subnet.

The number of hosts per subnet is determined by the number of host bits (in this example, 6 bits) minus 2 (1 for the subnet address and 1 for the broadcast address of the subnet).

$2^6 – 2 = 64 – 2 = 62$ hosts per subnet

Number of Host Bits per Subnet Number of Usable Hosts per Subnet	6 bits $2^6 – 2 = 64 – 2 = 62$ hosts per subnet

Step 8: Final Answers

Host IP Address	172.25.114.250
Subnet Mask	255.255.255.192 (/26)
Number of Subnet Bits Number of Subnets	10 bits 2^{10} = 1024 subnets
Number of Host Bits per Subnet Number of Usable Hosts per Subnet	6 bits $2^{6} - 2 = 64 - 2 = 62$ hosts per subnet
Subnet Address for this IP Address	172.25.114.192
IP Address of First Host on this Subnet	172.25.114.193
IP Address of Last Host on this Subnet	172.25.114.254
Broadcast Address for this Subnet	172.25.114.255

Task 2: Challenge.

For all problems:

Create a Subnetting Worksheet to show and record all work for each problem.

Problem 1

Host IP Address	172.30.1.33
Subnet Mask	255.255.255.0
Number of Subnet Bits	
Number of Subnets	
Number of Host Bits per Subnet	
Number of Usable Hosts per Subnet	
Subnet Address for this IP Address	
IP Address of First Host on this Subnet	
IP Address of Last Host on this Subnet	
Broadcast Address for this Subnet	

Problem 2

Host IP Address	172.30.1.33
Subnet Mask	255.255.255.252
Number of Subnet Bits	
Number of Subnets	
Number of Host Bits per Subnet	
Number of Usable Hosts per Subnet	
Subnet Address for this IP Address	
IP Address of First Host on this Subnet	
IP Address of Last Host on this Subnet	
Broadcast Address for this Subnet	

Problem 3

Host IP Address	192.192.10.234
Subnet Mask	255.255.255.0
Number of Subnet Bits	
Number of Subnets	
Number of Host Bits per Subnet	
Number of Usable Hosts per Subnet	
Subnet Address for this IP Address	
IP Address of First Host on this Subnet	
IP Address of Last Host on this Subnet	
Broadcast Address for this Subnet	

Problem 4

Host IP Address	172.17.99.71
Subnet Mask	255.255.0.0
Number of Subnet Bits	
Number of Subnets	
Number of Host Bits per Subnet	
Number of Usable Hosts per Subnet	
Subnet Address for this IP Address	
IP Address of First Host on this Subnet	
IP Address of Last Host on this Subnet	
Broadcast Address for this Subnet	

Problem 5

Host IP Address	192.168.3.219
Subnet Mask	255.255.255.0
Number of Subnet Bits	
Number of Subnets	
Number of Host Bits per Subnet	
Number of Usable Hosts per Subnet	
Subnet Address for this IP Address	
IP Address of First Host on this Subnet	
IP Address of Last Host on this Subnet	
Broadcast Address for this Subnet	

Problem 6

Host IP Address	**192.168.3.219**
Subnet Mask	**255.255.255.252**
Number of Subnet Bits	
Number of Subnets	
Number of Host Bits per Subnet	
Number of Usable Hosts per Subnet	
Subnet Address for this IP Address	
IP Address of First Host on this Subnet	
IP Address of Last Host on this Subnet	
Broadcast Address for this Subnet	

Task 3: Clean Up

Remove anything that was brought into the lab, and leave the room ready for the next class.