

2.3 IPv4 Address Subnetting Part 2

Objective

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

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 the 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

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.

¹⁰ 2	⁹ 2	⁸ 2	⁷ 2	⁶ 2	⁵ 2	⁴ 2	³ 2	² 2	¹ 2	⁰ 2
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:

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

Step 1 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 for First Host on Subnet	
IP Address for Last Host on Subnet	
Broadcast Address for this Subnet	

Convert the host IP address and subnet mask to binary:

	172	25	114	250
IP Address				
	10101100	00011001	01110010	11111010
	11111111	11111111	11111111	11000000
Subnet Mask				
	255	255	255	192

To determine the network (or subnet) address, draw a line under the mask. 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.

Express the results in dotted decimal notation. The result is the subnet address of this subnet, which is **172.25.114.192**

	172	25	114	250
IP Address	10101100	00011001	01110010	11111010
Subnet Mask	11111111	11111111	11111111	11000000
Subnet Address	10101100	00011001	01110010	11000000
	172	25	114	192

Add this information to the table:

Subnet Address for this IP Address	172.25.114.192
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Step 2 Subnet and Host parts

To determine which bits in the address that 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. 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 the S.D., which in this case is 10 bits. This is called the *Subnet Counting Range*.
4. The bits between the S.D. and the last bit at the end on right are called the *Host Counting Range*. This range contains the bits that are being incremented to create the host numbers or addresses.

		M.D.	S.D.	
IP Address	10101110	11001000	01110010	11 111010
Subnet Mask	11111111	11111111	11111111	11 000000
Subnet Add.	10001010	11001000	01110010	11 000000
			← subnet counting range →	← host counting range →

Step 3 Determine the range of host addresses and broadcast address

1. Copy down all of the network/subnet bits of the network address (all bits before the S.D.). 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*. In this example it is **172.25.114.193**.
2. Next, in the host portion (to the right of the S.D.), make the host bits all 1s except for the right-most 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*. In this example it is **172.25.114.254**.
3. 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	10101110	11001000	01110010	11 111010
Subnet Mask	11111111	11111111	11111111	11 000000
Subnet Add.	10101110	11001000	01110010	11 000000
			- subnet - counting range	- host - counting range
First Host	10101110	11001000	01110010	11 000001
	172	25	114	193
Last Host	10101110	11001000	01110010	11 111110
	172	25	114	254
Broadcast	10101110	11001000	01110010	11 111111
	172	25	114	255

Now, this information can be added 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 4 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
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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).

$$2^6 - 2 = 64 - 2 = 62 \text{ hosts per subnet}$$

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

Step 5 Determine the number of subnets

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	8
Number of Subnets	256
Number of Host Bits per Subnet	8
Number of Usable Hosts per Subnet	254
Subnet Address for this IP Address	172.30.1.0
IP Address of First Host on this Subnet	172.30.1.1
IP Address of Last Host on this Subnet	172.30.1.254
Broadcast Address for this Subnet	172.30.1.255

Problem 2

Host IP Address	172.30.1.33
Subnet Mask	255.255.255.252
Number of Subnet Bits	14
Number of Subnets	2^{14}
Number of Host Bits per Subnet	2
Number of Usable Hosts per Subnet	2
Subnet Address for this IP Address	172.30.1.32
IP Address of First Host on this Subnet	172.30.1.33
IP Address of Last Host on this Subnet	172.30.1.34
Broadcast Address for this Subnet	172.30.1.35

Problem 3

Host IP Address	192.192.10.234
Subnet Mask	255.255.255.0
Number of Subnet Bits	0
Number of Subnets	1 (one network)
Number of Host Bits per Subnet	8
Number of Usable Hosts per Subnet	254
Subnet Address for this IP Address	192.192.10.0
IP Address of First Host on this Subnet	192.192.10.1
IP Address of Last Host on this Subnet	192.192.10.254
Broadcast Address for this Subnet	192.192.10.255

Problem 4

Host IP Address	172.17.99.71
Subnet Mask	255.255.0.0
Number of Subnet Bits	0
Number of Subnets	1
Number of Host Bits per Subnet	16
Number of Usable Hosts per Subnet	65534
Subnet Address for this IP Address	172.17.0.0
IP Address of First Host on this Subnet	172.17.0.1
IP Address of Last Host on this Subnet	172.17.255.254
Broadcast Address for this Subnet	172.17.255.255

Problem 5

Host IP Address	192.168.3.219
Subnet Mask	255.255.255.0
Number of Subnet Bits	0
Number of Subnets	1
Number of Host Bits per Subnet	8
Number of Usable Hosts per Subnet	254
Subnet Address for this IP Address	192.168.3.0
IP Address of First Host on this Subnet	192.168.3.1
IP Address of Last Host on this Subnet	192.168.3.254
Broadcast Address for this Subnet	192.168.3.255

Problem 6

Host IP Address	192.168.3.219
Subnet Mask	255.255.255.252
Number of Subnet Bits	6
Number of Subnets	64
Number of Host Bits per Subnet	2
Number of Usable Hosts per Subnet	2
Subnet Address for this IP Address	192.168.3.216
IP Address of First Host on this Subnet	192.168.3.217
IP Address of Last Host on this Subnet	192.168.3.218
Broadcast Address for this Subnet	192.168.3.219