VLSM Subnetting Given IP and Mask
(By Angel Cool; Wednesday, September 5, 2012)

Introduction

The following steps demonstrate how to find the _network number_, _number of assignable IPs_, _first assignable IP_, _last assignable IP_ and _broadcast address_ given an IP/subnet-mask combination. We'll use the table in the last page of this document.

Example 1

* Given 172.168.5.46/29. Find the network number, number of assignable IPs and host range using the table:
1. /29 corresponds to 248 and indicates that VLSM is applied in the fourth octet of the subnetmask and the IP address. So the decimal subment mask is 255.255.255.248 .

2. Find the network increment: 256-248=8, the network increment is 8 .

3. Starting from 0 write all networks until passing the fourth octect (.46) of the given IP address (increments of 8): 0, 8,16, 24, 32, 40, 48 ...

4. We now know the given IP (fourth octect) is in between ...40 and 48... networks, we always choose the lowest one, in this case 40. That is the network number, 172.168.5.40!

5. Finding the number of assignable IPs is easy. From step b): 8-2=6, we can assign 6 IPs (the network can support 6 hosts), we needed to subtract 2 from the network increment because there are two address that cannot be assigned to hosts, the broadcast address (.47 , last IP) and the network address itself (.40).

6. The first assignable IP is always one more than the network number, so the first valid IP address is 172.168.5.41 .

7. The last assignable IP is always one less than the broadcast address, so the last valid IP address is 172.168.5.46 .

 Answers.- Network number: 172.168.5.40 with a subnet mask of 255.255.255.248; Number of assignable IPs: 6; Host range (assignable IPs): 172.168.5.41 - 172.168.5.46 .

Example 2

* Given 172.168.5.157/27. Find the network number, number of assignable IPs and host range using the table:

1. /27 corresponds to 224 and indicates that VLSM is applied in the fourth octet of the subnetmask and the IP address. So the decimal subment mask is 255.255.255.224 .

2. Find the network increment: 256-224=32, the network increment is 32 .

3. Starting from 0 write all networks until passing the fourth octect (.157) of the given IP address (increments of 32): 0, 32, 64, 96, 128, 160 ...

4. We now know the given IP (fourth octect of the IP) is in between ...128 and 160... networks, we always choose the lowest one, in this case 128. That is the network number, 172.168.5.128!

5. Finding the number of assignable IPs is easy. From step b): 32-2=30, we can assign 30 IPs (the network can support 30 hosts), we needed to subtract 2 from the network increment because there are two address that cannot be assigned to hosts, the broadcast address (.159 , last IP) and the network address itself (.128).

6. The first assignable IP is always one more than the network number, so the first valid IP address is 172.168.5.129 .

7. The last assignable IP is always one less than the broadcast address, so the last valid IP address is 172.168.5.158 .

Answers.-Network number: 172.168.5.128 with a subnet mask of 255.255.255.224; Number of assignable IPs: 30; Host range (assignable IPs): 172.168.5.129 - 172.168.5.159.

Example 3

* Given 172.168.5.25/28. Find the network number, number of assignable IPs and host range using the table:

1. /28 corresponds to 240 and indicates that VLSM is applied in the fourth octet of the subnetmask and the IP address. So the decimal subment mask is 255.255.255.240 .

2. Find the network increment: 256-240=16, the network increment is 16 .

3. Starting from 0 write all networks until passing the fourth octet (.25) of the given IP address (increments of 16): 0, 16, 32, 48, 64, 80 ...

4. We now know the given IP (fourth octect of the IP) is in between ...16 and 32... networks, we always choose the lowest one, in this case 16. That is the network number, 172.168.5.16!

5. Finding the number of assignable IPs is easy. From step b): 16-2=14, we can assign 14 IPs (the network can support 14 hosts), we needed to subtract 2 from the network increment because there are two address that cannot be assigned to hosts, the broadcast address (.31 , last IP) and the network address itself (.16).

6. The first assignable IP is always one more than the network number, so the first valid IP address is 172.168.5.17 .

7. The last assignable IP is always one less than the broadcast address, so the last valid IP address is 172.168.5.30 .

Answers.- Network number: 172.168.5.16 with a subnet mask of 255.255.255.240; Number of assignable IPs: 14; Host range (assignable IPs): 172.168.5.17 - 172.168.5.30 .

Example 4

* Given 192.168.10.231/27. Find the network number, number of assignable IPs and host range using the table:

1. /27 corresponds to 224 and indicates that VLSM is applied in the fourth octet of the subnetmask and the IP address. So the decimal subment mask is 255.255.255.224 .

2. Find the network increment: 256-224=32, the network increment is 32 .

3. Starting from 0 write all networks until passing the fourth octet (.231) of the given IP address (incremets of 32): 0, 32, 64, 96, 128, 160, 196, 224, 256 (we always stop when we get to 256).

4. We now know the given IP (fourth octect of the IP) is in between ...224 and 256... networks, we always choose the lowest one, in this case 224. That is the network number, 192.168.10.224!

5. Finding the number of assignable IPs is easy. From step b): 32-2=30, we can assign 30 IPs (the network can support 30 hosts), we needed to subtract 2 from the network increment because there are two address that cannot be assigned to hosts, the broadcast address (.255) and the network address itself (.224).

6. The first assignable IP is always one more than the network number, so the first valid IP address is 192.168.10.225 .

7. The last assignable IP is always one less than the broadcast address, so the last valid IP address is 192.168.10.254 .

Answers.- Network number: 192.168.10.224, subnet mask of 255.255.255.224; Number of assignable IPs: 30; Host range (assignable IPs): 192.168.10.225 - 192.168.10.254 .

Example 5

* Given 172.168.97.91/18. Find the network number, number of assignable IPs and host range using the table:

1. /18 corresponds to 192 and indicates that VLSM is applied in the third octet of the subnetmask and the IP address. So the decimal subment mask is 255.255.192.0 .

2. Find the network increment: 256-192=64, the network increment is 64 .

3. Starting from 0 write all networks until passing the third octet (.97) of the given IP address (increments of 64): 0, 64, 128 ...

4. We now know the given IP is in between ...64 and 128... networks, we always choose the lowest one, in this case 64. That is the network number, 172.168.64.0!

(we write zeros in the octects to the right of the octect where VLSM is applied).

5. To find the number of assignable IPs when dealing with schemes where VLSM is not applied in the fourth octect (255.255.255.128 vs 255.255.128.0) binary is the way to go. Steps:

    1. We need the subnet mask in /X format, in this case /18 was given (use the table to convert X.X.X.X formatted subnet mask to /X format. Example: 255.255.248.0, we look for 248 in the table and since VLSM is applied in the third octect its corresponding equivalent is /21).

    2. IP addresses are 32 bit long. So, 32-18=14 ; Each etwork in this VLSM design are allocated 14 bits each.

    3. Finally, we find the number of usable IPs using the formula 2b-2; where b is the number of bits allocated to a network, we also need to subtract 2 because we cannot assign the broadcast and network addresses. 214 - 2 = 16382 ; We can have a total of 16,382 hosts in this network.

6. The first assignable IP is always one more than the network number, so the first valid IP address is 172.168.64.1 .

7. The broadcast address is one less than the next network. The network relating to this example is 172.168.64.0, the next network is 172.168.128.0 (because the network increment is 64); so, we subtract 1 from the third octect of the next network, 128-1=127. The broadcast address is 172.168.127.255 (we write 255s in the octects to the right of the octect where VLSM is applied).

8. The last assignable IP is always one less than the last octect of the broadcast address. 172.168.127.254 .

Answers.- Network number: 172.168.64.0, subnet mask of 255.255.192.0; Number of assignable IPs: 16,382; Host range (assignable IPs): 172.168.64.1 - 172.168 .127.254

Example 6

* Given 10.29.45.6/21. Find the network number, number of assignable IPs and host range using the table:

    1. /21 corresponds to 248 and indicates that VLSM is applied in the third octet of the subnetmask and the IP address. So the decimal subment mask is 255.255.248.0 .

    2. Find the network increment: 256-248=8, the network increment is 8 .

    3. Starting from 0 write all networks until passing the third octet (.45) of the given IP address (increments of 8): 0, 8, 16, 24, 32, 40, 48...

    4. We now know the given IP is in between ...40 and 48... networks, we always choose the lowest one, in this case 40. That is the network number, 10.29.40.0!
    (we write zeros in the octects to the right of the octect where VLSM is applied).

    5. To find the number of assignable IPs when dealing with schemes where VLSM is not applied in the fourth octect (255.255.255.128 vs 255.255.128.0) binary is the way to go. Steps:

        1. We need the subnet mask in /X format, in this case /21 was given (use the table to convert X.X.X.X formatted subnet mask to /X format. Example: 255.255.248.0, we look for 248 in the table and since VLSM is applied in the third octect its corresponding equivalent is /21).

        2. IP addresses are 32 bit long. So, 32-21=11 ; Each etwork in this VLSM design are allocated 11 bits each.

        3. Finally, we find the number of usable IPs using the formula 2b-2; where b is the number of bits allocated to a network, we also need to subtract 2 because we cannot assign the broadcast and network addresses. 211 - 2 = 2046 ; We can have a total of 2,046 hosts in this network.

    6. The first assignable IP is always one more than the network number, so the first valid IP address is 10.29.40.1 .

    7. The broadcast address is one less than the next network. The network relating to this example is 10.29.40.0, the next network is 10.29.48.0 (because the network increment is 8); so, we subtract 1 from the third octect of the next network, 48-1=47. The broadcast address is 10.29.47.255 (we write 255s in the octects to the right of the octect where VLSM is applied).

    8. The last assignable IP is always one less than the last octect of the broadcast address. 10.29.47.254 .

Answers.- Network number: 10.29.40.0, subnet mask of 255.255.248.0; Number of assignable IPs: 2,046; Host range

Example 7

* Given 10.9.68.14/15. Find the network number, number of assignable IPs and host range using the table:

1. /15 corresponds to 254 and indicates that VLSM is applied in the second octet of the subnetmask and the IP address. So the decimal subment mask is 255.254.0.0 .

2. Find the network increment: 256-254=2, the network increment is 2 .

3. Starting from 0 write all networks until passing the second octet (.9) of the given IP address (increments of 2): 0, 2, 4, 6, 8, 10...

4. We now know the given IP is in between ...8 and 10... networks, we always choose the lowest one, in this case 8. That is the network number, 10.8.0.0!
(we write zeros in the octects to the right of the octect where VLSM is applied).

5. To find the number of assignable IPs when dealing with schemes where VLSM is not applied in the fourth octet (255.255.255.128 vs 255.255.128.0) binary is the way to go. Steps:

   1. We need the subnet mask in /X format, in this case /15 was given (use the table to convert X.X.X.X formatted subnet mask to /X format. Example: 255.255.248.0, we look for 248 in the table and since VLSM is applied in the third octet its corresponding equivalent is /21).

   2. IP addresses are 32 bit long. So, 32-15=17 ; Each etwork in this VLSM design are allocated 17 bits each.

   3. Finally, we find the number of usable IPs using the formula 2b-2; where b is the number of bits allocated to a network, we also need to subtract 2 because we cannot assign the broadcast and network addresses. 2$17$ - 2 = 131070 ; We can have a total of 131,070 hosts in this network.

6. The first assignable IP is always one more than the network number, so the first valid IP address is 10.8.0.1 .

7. The broadcast address is one less than the next network. The network relating to this example is 10.8.0.0, the next network is 10.10.0.0 (because the network increment is 2); so, we subtract 1 from the second octet of the next network, 10-1=9. The broadcast address is 10.9.255.255 (we write 255s in the octects to the right of the octect where VLSM is applied).

8. The last assignable IP is always one less than the last octect of the broadcast address. 10.9.255.254 .

Answers.- Network number: 10.8.0.0, subnet mask of 255.254.0.0; Number of assignable IPs: 131,070; Host range (assignable IPs): 10.8.0.1 - 10.9.255.254 .

Conclusion
Using these steps we were able to find several parameters given an IP address and a subnet mask. Remarks or comments, go to:
http://www.angelcool.net/sphpblog/comments.php?y=12&m=09&entry=entry120905-103011

1st Octect	2nd Octect	3rd Octect	4th Octect		
/1	/9	/17	/25	**128**	
/2	/10	/18	/26	**192**	
/3	/11	/19	/27	**224**	
/4	/12	/20	/28	**240**	-256
/5	/13	/21	/29	**248**	
/6	/14	/22	/30	**252**	
/7	/15	/23	/31	**254**	
/8	/16	/24	/32	**255**	