Classful Subnetting Explained

When given an IP Address and a Subnet Mask, how can you determine other information 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 this subnet
- The number of subnet bits and the slash number
- The number of this subnet

Let's step through an example:

Host IP Address	Class	Subnet Mask	No. of Subnet Bits	Maximum # of Subnets s = (n – 2)	Ordinal Number of this Subnet
138.101.114.250		**255.255.255.192**			
Subnet Address of This Subnet or Wire		**Range of Host Addresses For this subnet**		**Broadcast Address of This Subnet**	

Step 1:
Translate Host IP Address and Subnet Mask into binary notation

	138.	**101.**	**114.**	**250**
IP Address	10001010	01100101	01110010	11111010
Mask	11111111	11111111	11111111	11000000
	255.	**255.**	**255.**	**192**

Step 2:
Determine the Network (or Subnet) where this Host address lives:

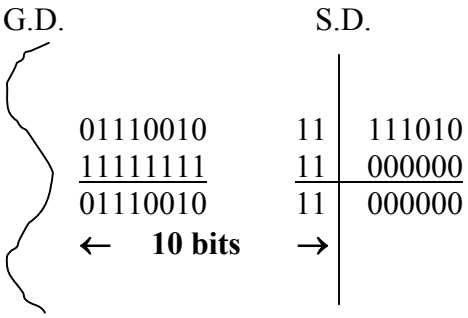
1. Draw a line under the mask
2. Perform a bit-wise AND operation on the IP Address and the Subnet Mask
   Note: 1 AND 1 results in a 1, 0 AND anything results in a 0
3. Express the result in Dotted Decimal Notation
4. The **result** is the **Subnet Address of this Subnet or "Wire"** which is **138.101.114.192**

	138.	**101.**	**114.**	**250**
IP Address	10001010	01100101	01110010	11111010
Mask	11111111	11111111	11111111	11000000
Network	10001010	01100101	01110010	11000000
	138	**101**	**114**	**192**

Step 3:
Determine which bits in the address contain Network information and which contain Host information:

1. Draw the **"Great Divide" (G.D)** as a wavy line where the 1's in the Default Subnet Mask would end for this class address (if no subnetting occurred). In our example, the IP Address is a Class B address, and so the Default Subnet Mask is 255.255.0.0.

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

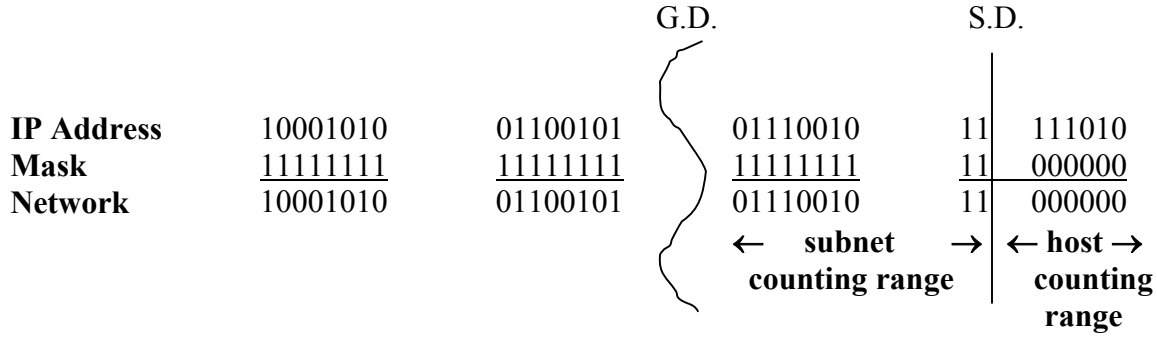


3. The **result** is the **"Number of Subnet Bits"** may be determined by simply counting the number of bits between the G.D. and S.D., which in this case is **10 bits**.

Step 4:
Determine bit ranges that are for subnets and for hosts:

1. Label the **"subnet counting range"** between the G.D. and the S.D. (these are the bits that are being incremented to make the subnet numbers or addresses).

2. Label the **"host counting range"** between the S.D. and all of the way to the end on the right (these are the bits that are being incremented to make 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(i.e. all bits before the S.D.)

2. In the host portion (to the right of the S.D.) make the host bits all 0's except for the right most bit (or least significant bit), which you make a 1. This gives you the *first* Host IP Address on this subnet, which is the *first part* of the **result** for **"Range of Host Addresses for This Subnet,"** or in our example **138.101.114.193.**

3. Now, in the host portion (to the right of the S.D.) make the host bits all 1's except for the right most bit (or least significant bit), which you make a 0. This gives you the *last* Host IP Address on this subnet, which is the **last part** of the **result** for **"Range of Host Addresses for This Subnet,"** or in our example **138.101.114.254.**

4. In the host portion (to the right of the S.D.) make the host bits all 1's. This gives you the *Broadcast* IP Address on this subnet. This is the **result** for **"Broadcast Address of This Subnet,"** or in our example **138.101.114.255.**

			G.D.	S.D.	
IP Address	10001010	01100101	01110010	11	111010
Mask	11111111	11111111	11111111	11	000000
Network	10001010	01100101	01110010	11	000000
			← subnet counting range →		**← host counting range →**
First Host	10001010 138	01100101 101	01110010 114	11	000001 193
Last Host	10001010 138	01100101 101	01110010 114	11	111110 254
Broadcast	10001010 138	01100101 101	01110010 114	11	111111 255

Step 6:
Determine the maximum number of subnets and usable subnets:

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

Two methods:
Exponents
1. Use the formula $2^n - 2$, where n is the number of bit in the *subnet counting range*.
2. $2^{10} - 2 = 1024 - 2 = 1022$
3. Subtract 2 for the number of usable subnets

Charting

1024	**512**	**256**	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**
	1	1	1	1	1	1	1	1	1	1

1. Make 10 columns for the 10 subnet bits
2. Convert from binary to decimal.
3. Subtract 2 for the number of usable subnets

Put the **result** in "**Maximum # of Subnets s = (n – 2),"** where n is the total number of subnets and s is the number of usable subnets. In our example **1022 = (1024 –2)**

Step 7:
Determine the ordinal number of this subnets (i.e. which one of this subnet, out of the maximum number of subnets available:

1. Write down all of the bits in the subnet counting range (i.e. between the G.D. and the S.D).
2. Convert this number to decimal.

0111001011 = 459

Or use the chart

1024	**512**	**256**	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**
	0	1	1	1	0	0	1	0	1	1

256 + 128 + 64 + 8 + 2 + 1 = 459

This is the **result** for the **"Number of This Subnet,"** which is the **459th** subnet

Answers

Host IP Address	Class	Subnet Mask	No. of Subnet Bits	Maximum # of Subnets s = (n – 2)	Ordinal Number of this Subnet
138.101.114.250		**255.255.255.192**	10	1022=(1024-2)	459
Subnet Address of This Subnet or Wire		**Range of Host Addresses For this subnet**		**Broadcast Address of This Subnet**	
138.101.114.192		138.101.114.193 through 138.101.114.254		138.101.114.255	