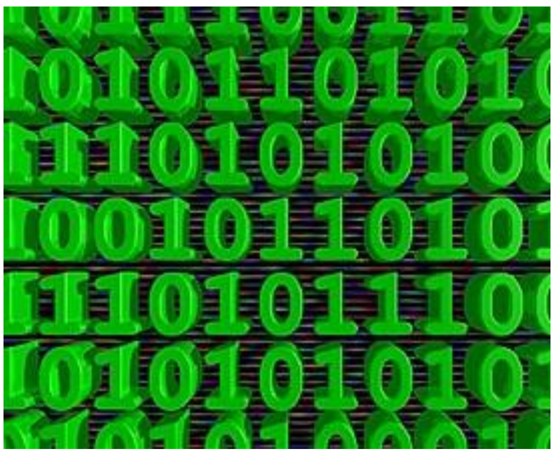

# SUBNETTING

The Core of Networking


ABSTRACT

***<u>The Elders of the Internet were a little short-sighted. Their Class based system didn't take into account Al Gore. His invention blew up the internet and created a need for Subnetting. In this class we explain the rest of the story. This workbook is not intended to used by itself.</u>***



Jeff Lockhart

Standard Nerd


Student:

| IPv4 Address Classes | | |
|---|---|---|
| IP Address Classes are determined by the value in the first Octet | | |
| **Classes** | **Default Subnet Mask** | **Total number of Available Addresses** |
| **Class A** 0 – 127 | 255.0.0.0 | 16,777,214 |
| **Class B** 128 – 191 | 255.255.0.0 | 65,534 |
| **Class C** 192 – 223 | 255.255.255.0 | 254 |
| Class D 224 – 239 | NA | Multicast |
| Class E 240 – 255 | NA | Research and Experimental |

Only Classes A, B, and C are used for public addresses

IPv4 formatting is called dotted decimal and is broken up into 4 Octets, each 1 byte (8 bits)

| Special Addresses | |
|---|---|
| 0.0.0.0 | Default Route (No address can have a zero in the first octet) |
| 127.x.x.x | any address that starts 127…Set aside to test loopback functions |
| :: | This is the IPv6 loopback address |
| 169.254.x.x | Assigned by APIPA (This address indicates a problem with DHCP) |

| Private Addresses (RFC 1918) | |
|---|---|
| Class A | 10.0.0.0 -- 10.255.255.255 |
| Class B | 172.16.0.0 -- 172.31.255.255 |
| Class C | 192.168.0.0 -- 192.168.255.255 |

| Notes: | |
|---|---|
| IPv4 | 32 binary bits |
| IPv6 | 128 binary bits |

Every IP address is made up of 2 parts, Network and Host
The Network Address is revealed by ANDing the IP address and the (Sub)netmask
In ANDing, 1 AND 1 make 1, everything else (0 AND 1, 1 AND 0, 0 AND 0) makes 0.

If the Host portion (in binary) is all 0's, you have found the Network Address.
If the Host portion (in binary) is all 1's, you have found the Broadcast Address.
*The Network and Broadcast addresses are special and are not assigned to any Host on the network.*

| Address Class (Exercise) | |
|---|---|
| **Address** | **Class** |
| 177.100.18.4 | B |
| 119.18.45.0 | A |
| 192.249.234.191 | |
| 10.10.251.12 | |
| 223.32.232.190 | |
| 129.132.24.2 | |
| 18.250.1.1 | |
| 150.10.15.0 | |
| 197.14.2.0 | |
| 174.17.9.1 | |
| 148.17.9.1 | |
| 193.42.1.1 | |
| 126.8.156.0 | |
| 220.220.23.1 | |
| 117.18.54.0 | |
| 249.214.87.90 | |
| 191.155.77.65 | |
| 95.0.21.90 | |
| 33.2.5.97 | |

## Network and Host Identification

| Circle the **Network** portion of these addresses: | Circle the **Host** portion of these addresses: |
|---|---|
| 177.100.18.4 | 10.51.132.51 |
| 119.18.45.0 | 171.2.191.13 |
| 193.249.234.191 | 198.125.78.145 |
| 10.10.251.12 | 223.252.211.241 |
| 223.32.232.190 | 17.54.22.54 |
| 129.132.24.2 | 126.102.231.45 |
| 9.250.1.1 | 191.41.35.112 |
| 150.10.15.0 | 155.25.168.227 |
| 192.14.2.0 | 194.15.155.2 |
| 174.17.9.1 | 123.102.45.254 |
| 148.17.9.1 | 148.17.9.155 |
| 194.42.1.1 | 100.25.1.1 |
| 126.8.156.0 | 195.0.21.98 |
| 220.220.23.1 | 25.250.135.46 |
| 119.18.54.0 | 171.102.77.55 |
| 249.214.87.90 | 55.250.5.6 |
| 199.155.77.65 | 218.155.234.18 |
| 95.0.21.90 | 12.25.5.6 |
| 33.2.5.97 | 148.18.91.5 |

| Binary Place Value (Examples) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Decimal** | **128** | **64** | **32** | **16** | **8** | **4** | **2** | **1** |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 10 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 12 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |
| 14 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| 15 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 31 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 63 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 127 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 128 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 192 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 224 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 240 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 248 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 252 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| 254 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 255 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 160 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 96 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 112 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 120 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 170 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |

EXAMPLE: 170 = 128 + 32 + 8 + 2

| Binary to Decimal Conversion Exercise | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Decimal** | **128** | **64** | **32** | **16** | **8** | **4** | **2** | **1** |
| | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |
| | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| 250 | | | | | | | | |
| 150 | | | | | | | | |
| 190 | | | | | | | | |
| 119 | | | | | | | | |
| 220 | | | | | | | | |
| 177 | | | | | | | | |
| 249 | | | | | | | | |
| 199 | | | | | | | | |
| 215 | | | | | | | | |
| 219 | | | | | | | | |
| 123 | | | | | | | | |
| 217 | | | | | | | | |
| 88 | | | | | | | | |
| 59 | | | | | | | | |
| 69 | | | | | | | | |
| 135 | | | | | | | | |

| Network Address Exercise | | |
|---|---|---|
| Using the IP address shown and default subnet mask, write out the network address: | | |
| 1 | 188.10.18.2 | 188.10.0.0 |
| 2 | 10.10.48.80 | 10.0.0.0 |
| 3 | 192.149.24.191 | |
| 4 | 150.203.23.19 | |
| 5 | 12.10.10.1 | |
| 6 | 186.13.23.110 | |
| 7 | 223.69.230.250 | |
| 8 | 200.120.135.15 | |
| 9 | 27.125.200.151 | |
| 10 | 199.20.150.35 | |
| 11 | 191.55.165.135 | |
| 12 | 28.212.250.254 | |
| 13 | 177.100.18.4 | |
| 14 | 119.18.45.5 | |
| 15 | 191.249.234.191 | |
| 16 | 223.220.215.109 | |
| 17 | 126.123.23.1 | |

| CIDR and Subnet masks | |
|---|---|
| /31 | 255.255.255.254 |
| /30 | 255.255.255.252 |
| /29 | 255.255.255.248 |
| /28 | 255.255.255.240 |
| /27 | 255.255.255.224 |
| /26 | 255.255.255.192 |
| /25 | 255.255.255.128 |
| /24 | 255.255.255.0 |
| /23 | 255.255.254.0 |
| /22 | 255.255.252.0 |
| /21 | 255.255.248.0 |
| /20 | 255.255.240.0 |
| /19 | 255.255.224.0 |
| /18 | 255.255.192.0 |
| /17 | 255.255.128.0 |
| /16 | 255.255.0.0 |
| /15 | 255.254.0.0 |
| /14 | 255.252.0.0 |
| /13 | 255.248.0.0 |
| /12 | 255.240.0.0 |
| /11 | 255.224.0.0 |
| /10 | 255.192.0.0 |
| /9 | 255.128.0.0 |
| /8 | 255.0.0.0 |
| /7 | 254.0.0.0 |

| Powers of 2 | |
|---|---|
| $2^{24}$ | 16,777,216 |
| $2^{23}$ | 8,388,608 |
| $2^{22}$ | 4,194,304 |
| $2^{21}$ | 2,097,152 |
| $2^{20}$ | 1,048,576 |
| $2^{19}$ | 524,288 |
| $2^{18}$ | 262,144 |
| $2^{17}$ | 131,072 |
| $2^{16}$ | 65,536 |
| $2^{15}$ | 32,768 |
| $2^{14}$ | 16,384 |
| $2^{13}$ | 8,192 |
| $2^{12}$ | 4,096 |
| $2^{11}$ | 2,048 |
| $2^{10}$ | 1,024 |
| $2^{9}$ | 512 |
| $2^{8}$ | 256 |
| $2^{7}$ | 128 |
| $2^{6}$ | 64 |
| $2^{5}$ | 32 |
| $2^{4}$ | 16 |
| $2^{3}$ | 8 |
| $2^{2}$ | 4 |
| $2^{1}$ | 2 |
| $2^{0}$ | 1 |

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## Custom Subnet Masks

**Problem 1**

Number of needed subnets: **14**

Number of needed usable IPs: **14**

Network address: **192.10.10.0**

Address Class: C

Default Subnet mask: 255.255.255.0

Number of bits converted: 4

Custom Subnet mask: 255.255.255.240

Total number of subnets: 16

Total number of IP addresses: 16

Number of usable addresses: 14

Show your work for this problem below.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 128 | 192 | 224 | 240 | 248 | 252 | 254 | 255 |
| | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| | /25 | /26 | /27 | /28 | /29 | /30 | /31 | /32 |
| 240 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |

$2^4 = 16$

Formula: Networks = $2^S$ (where S is equal to number of bits converted.)

Hosts = $2^H$ -2 (where H is equal to number of bits needed for hosts. The -2 is because of the Network ID and Broadcast address.

## Custom Subnet Masks

**Problem 2**

Number of needed subnets: **1000**

Number of needed usable IPs: **60**

Network address: **165.100.10.0**

Address Class: *B*

Default Subnet mask: *255.255.0.0*

Number of bits converted: *10*

Custom Subnet mask: *255.255.255.192*

Total number of subnets: *1,024*

Total number of IP addresses: *64*

Number of usable addresses: *62*

Show your work for this problem below.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 128 | 192 | 224 | 240 | 248 | 252 | 254 | 255 |
| | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| | /17 | /18 | /19 | /20 | /21 | /22 | /23 | /24 |
| | /25 | /26 | /27 | /28 | /29 | /30 | /31 | /32 |
| | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 192 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

$2^{10} = 1,024$

## Custom Subnet Masks

**Problem 3**

/25 indicates the total number of bits used for the network and subnetwork portion of the address. All bits remaining belong to the host portion of the address.

Network address: **148.75.0.0/25**

Address Class: B

Default Subnet mask: 255.255.0.0

Number of bits converted: 9

Custom Subnet mask: 255.255.255.128

Total number of subnets: 512

Total number of IP addresses: 128

Number of usable addresses: 126

Show your work for this problem below.

| 128 | 192 | 224 | 240 | 248 | 252 | 254 | 255 |
|---|---|---|---|---|---|---|---|
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| /17 | /18 | /19 | /20 | /21 | /22 | /23 | /24 |
| /25 | /26 | /27 | /28 | /29 | /30 | /31 | /32 |

1 1 1 1 1 1 1 1

128 1 0 0 0 0 0 0 0

$2^9 = 512$

# Custom Subnet Masks

**Problem 4**

Number of needed subnets: **6**

Number of needed usable IPs: **30**

Network address: **195.85.8.0**

Address Class ______________________________

Default Subnet mask ______________________________

Number of bits converted ______________________________

Custom Subnet mask ______________________________

Total number of subnets ______________________________

Total number of IP addresses ______________________________

Number of usable addresses ______________________________

Show your work for this problem below.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 128 | 192 | 224 | 240 | 248 | 252 | 254 | 255 |
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| /25 | /26 | /27 | /28 | /29 | /30 | /31 | /32 |

# Custom Subnet Masks

**Problem 5**

Number of needed subnets: **4**

Number of needed usable IPs: **32**

Network address: **210.100.56.0**

Address Class ______________________________

Default Subnet mask ______________________________

Number of bits converted ______________________________

Custom Subnet mask ______________________________

Total number of subnets ______________________________

Total number of IP addresses ______________________________

Number of usable addresses ______________________________

Show your work for this problem below.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 128 | 192 | 224 | 240 | 248 | 252 | 254 | 255 |
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| /25 | /26 | /27 | /28 | /29 | /30 | /31 | /32 |

**Problem 6**

Number of needed subnets: **126**

Number of needed usable IPs: **88,500**

Network address: **118.0.0.0**

Address Class ______________________________

Default Subnet mask ______________________________

Number of bits converted ______________________________

Custom Subnet mask ______________________________

Total number of subnets ______________________________

Total number of IP addresses ______________________________

Number of usable addresses ______________________________

Show your work for this problem below.

| 128 | 192 | 224 | 240 | 248 | 252 | 254 | 255 |
|---|---|---|---|---|---|---|---|
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

**Problem 7**

Number of needed subnets: **2000**

Number of needed usable IPs: **5**

Network address: **178.100.0.0**

Address Class ________________________________

Default Subnet mask ________________________________

Number of bits converted ________________________________

Custom Subnet mask ________________________________

Total number of subnets ________________________________

Total number of IP addresses ________________________________

Number of usable addresses ________________________________

Show your work for this problem below.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 128 | 192 | 224 | 240 | 248 | 252 | 254 | 255 |
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| /17 | /18 | /19 | /20 | /21 | /22 | /23 | /24 |
| /25 | /26 | /27 | /28 | /29 | /30 | /31 | /32 |

**Problem 8**

Network address: **93.75.0.0/19**

Address Class ______________________________

Default Subnet mask ______________________________

Number of bits converted ______________________________

Custom Subnet mask ______________________________

Total number of subnets ______________________________

Total number of IP addresses ______________________________

Number of usable addresses ______________________________

Show your work for this problem below.

| 128 | 192 | 224 | 240 | 248 | 252 | 254 | 255 |
|---|---|---|---|---|---|---|---|
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

**Problem 9**

Network address: **9.0.0.0/16**

Address Class ______________________________

Default Subnet mask ______________________________

Number of bits converted ______________________________

Custom Subnet mask ______________________________

Total number of subnets ______________________________

Total number of IP addresses ______________________________

Number of usable addresses ______________________________

Show your work for this problem below.

| 128 | 192 | 224 | 240 | 248 | 252 | 254 | 255 |
|---|---|---|---|---|---|---|---|
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

## Problem 10

Network address: **164.199.0.0/26**

Address Class ______________________________

Default Subnet mask ______________________________

Number of bits converted ______________________________

Custom Subnet mask ______________________________

Total number of subnets ______________________________

Total number of IP addresses ______________________________

Number of usable addresses ______________________________

Show your work for this problem below.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 128 | 192 | 224 | 240 | 248 | 252 | 254 | 255 |
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

| Valid and Non-Valid IP Addresses | | |
|---|---|---|
| Identify which of the addresses below are correct/usable/assignable. If they are not usable, explain why. | | |
| 1 | 0.230.190.192<br>255.0.0.0 | |
| 2 | 192.10.10.1<br>255.255.255.0 | |
| 3 | 245.150.190.111<br>255.255.255.0 | |
| 4 | 135.70.254.255<br>255.255.254.0 | |
| 5 | 127.100.100.10<br>255.0.0.0 | |
| 6 | 93.0.128.1<br>255.255.224.0 | |
| 7 | 200.10.10.128<br>255.255.255.224 | |
| 8 | 165.10.255.189 /26 | |
| 9 | 190.35.0.10 /26 | |
| 10 | 218.350.50.195 /16 | |
| 11 | 200.10.10.175 /22 | |
| 12 | 135.70.254.255 /19 | |
| 13 | 144.80.191.255<br>255.255.254.0 | |

To determine if an address is local or remote, you have to first identify the Network Address. If you are using the default class-based subnet mask, you should be able to get to the point where you can simply look at the addresses and make the determination. Take a look at this example:

- 119.254.192.1 119.1.2.3

This is a Class A example. In Class A, only the first octet represents the network. In this case, the Network address is 119.0.0.0 for both addresses, therefore these nodes are local to each other. Let's look at another example:

- 187.116.254.23 187.115.254.23

This is a Class B example. In Class B, the first 2 octets represent the network. Let me highlight the network portion for you….

- 187.116.254.23 187.115.254.23

Are the highlighted portions identical? No. Therefore these nodes are remote to each other. Now it is your turn.

## Local vs. Remote Network Determination

**Determine if the pairs of IP addresses are local to each other or if they are on remote networks. The following items use the default class-based subnet masks:**

1. 172.16.45.60 172.16.255.254
2. 192.168.7.34 192.168.7.219
3. 10.35.12.23 10.255.212.198
4. 212.214.56.100 212.113.40.227
5. 5.9.3.5 5.211.3.2
6. 209.245.211.240 214.245.211.241
7. 45.187.12.45 45.187.222.197
8. 192.249.234.191 192.249.232.190
9. 129.132.24.2 129.132.255.1
10. 223.32.232.190 223.31.232.54
11. 150.10.15.0 150.10.16.1
12. 193.14.2.0 193.14.2.54
13. 174.17.9.1 173.17.9.2
14. 148.17.8.2 148.17.99.124
15. 95.0.21.90 95.21.0.10

When using custom subnet masks, we have to do a little decimal to binary conversion before we can determine Local or Remote. First we look at the IP address and Subnet Mask and we focus on the first octet that is not 255, I call this the interesting octet. Next, we convert that octet to binary and mark the mask. For example:

| | | |
|---|---|---|
| Source IP: | 177.100.181.201 | Here we would focus on the third octet. |
| Destination IP: | 177.100.126.160 | |
| Subnet Mask: | 255.255.192.0 | |

| | | |
|---|---|---|
| Source (3$^{rd}$) | 181 | 10 \| 110101 The highlighted portion represent the network bits. |
| Dest. (3$^{rd}$) | 126 | 01 \| 111110 |
| | | network \| host |

Notice that the network portions of these addresses do not match. Therefore they are remote to each other.

## Local vs. Remote with Custom Subnet Masks

**Determine if the pairs of IP addresses are local to each other or if they are on remote networks. The subnet mask is also supplied:**

1. 192.168.5.71 192.168.5.76
   - **255.255.255.224**
2. 212.42.78.14 212.42.78.35
   - **255.255.255.252**
3. 199.45.76.20 199.45.76.34
   - **255.255.255.240**
4. 201.154.79.197 201.154.79.204
   - **255.255.255.248**
5. 215.16.190.45 215.16.190.52
   - **255.255.255.252**
6. 215.16.190.45 215.16.190.52
   - **255.255.255.224**
7. 130.204.170.5 130.204.191.89
   - **255.255.224.0**
8. 223.99.169.5 223.99.192.98
   - **255.255.224.0**
9. 126.42.78.98 126.42.78.132
   - **255.255.255.192**
10. 152.255.171.76 152.255.168.2
    - **255.255.252.0**

## Valid IP address range

First example: **63.128.152.141 /22**

Following the steps on the previous page we need to find the interesting octet. In this case it is the third octet but don't take my word for it. Let's convert the CIDR into dotted decimal. /22 means that the first 22 bits represent the network. It looks like this in binary:

11111111.11111111.11111100.00000000 which is 255.255.252.0 in dotted decimal.

Now that we have found the interesting octet, let's convert it to binary and mark the mask.

Source IP: 63.128.152.141 Here we would focus on the third octet.
Subnet Mask: 255.255.252.0

IP (3rd) 152 10011000 The portion highlighted in yellow represent the network bits.
SM (3rd) 252 11111100 The portion highlighted in green represent the node bits.

We now covert all node bits to 0. This will give us the Network Address.

63 . 128 . 152 . 141 63 . 128 . 152 . 0

IP 00111111.10000000.10011000.10001101 into 00111111.10000000.10011000.00000000

We now covert all node bits to 1. This will give us the Broadcast Address

63 . 128 . 152 . 141 63 . 128 . 155 . 255

IP 00111111.10000000.10011000.10001101 into 00111111.10000000.10011011.11111111

To find the 1st host IP, add 1 to the Network address. To find the Last Host IP, subtract 1 from the Broadcast address. This give us the following range of valid IP addresses.

| **63.128.152.141 /22** | |
|---|---|
| Network Address | 63.128.152.0 |
| First Host IP Address | 63.128.152.1 |
| Last Host IP Address | 63.128.155.254 |
| Broadcast Address | 63.128.155.255 |

Now it is your turn…

**Problem 1**

| 141.106.236.47 /20 | |
|---|---|
| Network Address | |
| First Host IP Address | |
| Last Host IP Address | |
| Broadcast Address | |

**Problem 2**

| 172.5.48.143 /21 | |
|---|---|
| Network Address | |
| First Host IP Address | |
| Last Host IP Address | |
| Broadcast Address | |

**Problem 3**

| 216.148.147.152 /28 | |
|---|---|
| Network Address | |
| First Host IP Address | |
| Last Host IP Address | |
| Broadcast Address | |

## Final Exam

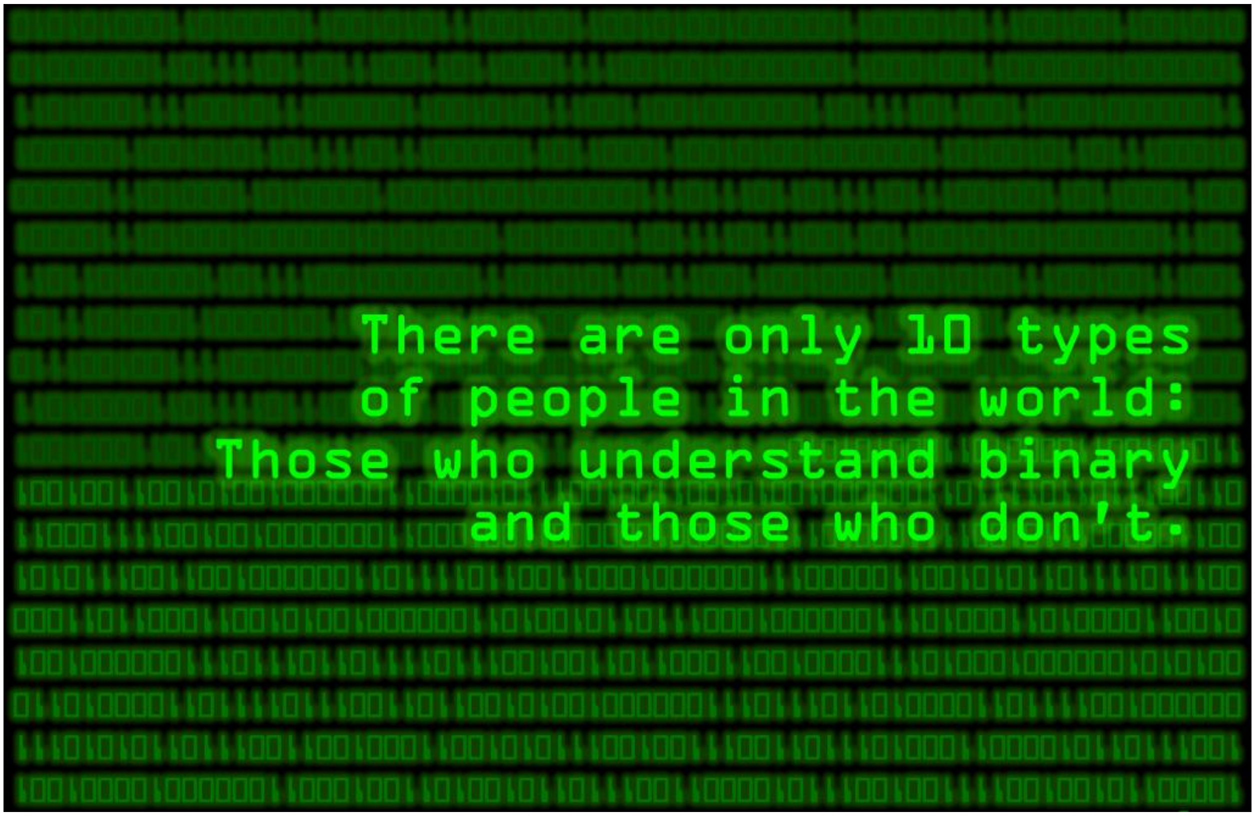
## Given the following information, determine subnet IDs and Range of Host IDs

| | |
|---|---|
| Number of physical segments (subnets) needed: | 5 |
| Minimum number of hosts per segment needed: | 5000 |
| Network Address: | **154.77.0.0** |

1. Proposed Custom Subnet Mask:
2. Total number of subnets supported:
3. Total number of hosts per subnet:

(Bonus) List the Subnet ID's:

(Bonus) List the Host ID ranges per subnet:




You are now one of those that understands binary.  Now, don't 0100get it.