Introduction to IP Addressing and Subnetting the Easy Way

https://www.udemy.com/subnetting-the-easy-way/learn/lecture/6734348#content

Are you interested in learning about IP addressing and subnetting? Are you an aspiring IT professional that needs to better understand how IP addresses and subnetting works? Then you have come to the right place!

This course will teach you the fundamentals of IP version 4 (IPv4) addressing and how to perform subnetting the easy way!

WHAT YOU'LL LEARN IN THIS COURSE:

- IP Version 4 Addressing Fundamentals
- Public versus Private IP Addresses
- Binary Math Basics
- Why We Subnet
- Subnetting Class C, B & A Networks
- Variable Length Subnetting

LEARN BY WATCHING AND DOING

In this course you'll learn by both watching and doing. This course includes carefully devised follow-along subnetting examples and exercises, as well as student practice worksheets. **You are also provided a 4-page subnetting reference guide to assist you along the way!**

Once you complete this course, you'll be able to easily and quickly subnet Class C, B and A networks!

SO WHAT ARE YOU WAITING FOR? ENROLL TODAY, YOUR 100% RISK-FREE ENROLLMENT IS BACKED BY UDEMY'S 30-DAY, NO QUESTIONS ASKED, MONEY BACK GUARANTEE!

What you'll learn

- Understand the Fundamentals of IPv4 Addressing
- Perform Basic Binary Math
- Subnet Class C, B and A Networks with Full Length Subnet Masks
- Understand the Basics of Variable Length Subnet Masks

Are there any course requirements or prerequisites?

- A Basic Understanding of Computer Networks
- A Desire to Learning IP Addressing and Subnetting

Who this course is for:

- This course is designed for anybody seeking to learn about IP addressing and subnetting.
- Students preparing for networking certifications that need to know and understand subnetting.

Lecture 1: Intro

The bulk of the course is about subnetting. We will subnet class C, B, and A networks. We will also go over VLSN, variable length subnetting.

Lecture 2: About the Instructor

Has worked in many different areas of IT. He is MBA and MS in Network Technology, many IT certifications. Has taught at undergrad level.

Lecture 3: Course Reference Tables

BINARY MATH TABLE

128	64	32	16	8	4	2	1
1	1	1	1	1	1	1	1

SUBNET MASK TABLE

Binary	Decimal
00000000	0
10000000	128
11000000	192
11100000	224
11110000	240
11111000	248
11111100	252

POWER OF 2'S TABLE

$2^1 = 2$	$2^9 = 512$
$2^2 = 4$	$2^{10} = 1,024$
$2^3 = 8$	$2^{11} = 2,048$
$2^4 = 16$	$2^{12} = 4,096$
$2^5 = 32$	$2^{13} = 8,192$
$2^6 = 64$	$2^{14} = 16,384$
$2^7 = 128$	$2^{15} = 32,768$
$2^8 = 256$	$2^{16} = 65,536$

DEFAULT SUBNET MASK

Class	Format	Default Subnet Mask
A	network.host.host.host	255.0.0.0
B	network.network.host.host	255.255.0.0
C	network.network.network.host	255.255.255.0

SUBNET CALCULATION TABLE (2^x)

Host Bits Borrowed	2^x	Number of Subnets Created
1	2^1	2
2	2^2	4
3	2^3	8
4	2^4	16
5	2^5	32
6	2^6	64
7	2^7	128
8	2^8	256
9	2^9	512
10	2^{10}	1,024
11	2^{11}	2,048
12	2^{12}	4,096

SUBNET HOSTS & ADDRESSES CALCULATION TABLE (2^x)

Host Bits Left	2^h	Hosts / Subnet ($2^h - 2$)	Addresses / Subnet (2^h)
~~**1**~~	~~2^1~~	~~0~~	~~2~~
2	2^2	2	4
3	2^3	6	8
4	2^4	14	16
5	2^5	30	32
6	2^6	62	64
7	2^7	126	128
8	2^8	254	256
9	2^9	510	512
10	2^{10}	1,022	1,024
11	2^{11}	2,046	2,048
12	2^{12}	4,094	4,096

CLASS C POSSIBLE SUBNET MASKS

Binary (N.N.N.H)	Decimal	CIDR	# Subnets (2^x)	Block Size (2^y)	# Hosts (2^y - 2)
N.N.N.00000000	255.255.255.0	/24	$2^0 = 1$	$2^8 = 256$	$2^8 - 2 = 254$
N.N.N.10000000	255.255.255.128	/25	$2^1 = 2$	$2^7 = 128$	$2^7 - 2 = 126$
N.N.N.11000000	255.255.255.192	/26	$2^2 = 4$	$2^6 = 64$	$2^6 - 2 = 62$
N.N.N.11100000	255.255.255.224	/27	$2^3 = 8$	$2^5 = 32$	$2^5 - 2 = 30$
N.N.N.11110000	255.255.255.240	/28	$2^4 = 16$	$2^4 = 16$	$2^4 - 2 = 14$
N.N.N.11111000	255.255.255.248	/29	$2^5 = 32$	$2^3 = 8$	$2^3 - 2 = 6$
N.N.N.11111100	255.255.255.252	/30	$2^6 = 64$	$2^2 = 4$	$2^2 - 2 = 2$

CLASS B POSSIBLE SUBNET MASKS

Binary (N.N.H.H)	Decimal	CIDR	# Subnets (2^x)	Block Size (2^y)	# Hosts (2^y - 2)
N.N.00000000.00000000	255.255.0.0	/16	$2^0 = 1$	$2^{16} = 65{,}536$	$2^{16} - 2 = 65{,}534$
N.N.10000000.00000000	255.255.128.0	/17	$2^1 = 2$	$2^{15} = 32{,}768$	$2^{15} - 2 = 32{,}766$
N.N.11000000.00000000	255.255.192.0	/18	$2^2 = 4$	$2^{14} = 16{,}384$	$2^{14} - 2 = 16{,}382$
N.N.11100000.00000000	255.255.224.0	/19	$2^3 = 8$	$2^{13} = 8{,}192$	$2^{13} - 2 = 8{,}190$
N.N.11110000.00000000	255.255.240.0	/20	$2^4 = 16$	$2^{12} = 4{,}096$	$2^{12} - 2 = 4{,}094$
N.N.11111000.00000000	255.255.248.0	/21	$2^5 = 32$	$2^{11} = 2{,}048$	$2^{11} - 2 = 2{,}046$
N.N.11111100.00000000	255.255.252.0	/22	$2^6 = 64$	$2^{10} = 1{,}024$	$2^{10} - 2 = 1{,}022$
N.N.11111110.00000000	255.255.254.0	/23	$2^7 = 128$	$2^9 = 512$	$2^9 - 2 = 510$
N.N.11111111.00000000	255.255.255.0	/24	$2^8 = 256$	$2^8 = 256$	$2^8 - 2 = 254$
N.N.11111111.10000000	255.255.255.128	/25	$2^9 = 512$	$2^7 = 128$	$2^7 - 2 = 126$
N.N.11111111.11000000	255.255.255.192	/26	$2^{10} = 1{,}024$	$2^6 = 64$	$2^6 - 2 = 62$
N.N.11111111.11100000	255.255.255.224	/27	$2^{11} = 2{,}048$	$2^5 = 32$	$2^5 - 2 = 30$
N.N.11111111.11110000	255.255.255.240	/28	$2^{12} = 4{,}096$	$2^4 = 16$	$2^4 - 2 = 14$
N.N.11111111.11111000	255.255.255.248	/29	$2^{13} = 8{,}192$	$2^3 = 8$	$2^3 - 2 = 6$
N.N.11111111.11111100	255.255.255.252	/30	$2^{14} = 16{,}384$	$2^2 = 4$	$2^2 - 2 = 2$

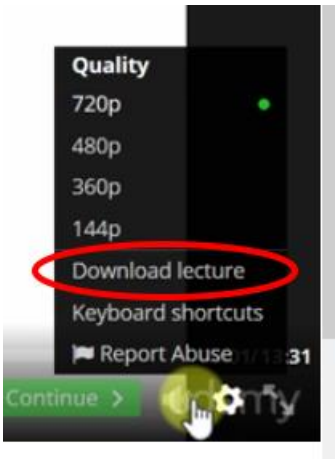
CLASS A POSSIBLE SUBNET MASKS

Binary (N.H.H.H)	Decimal	CIDR	# Subnets (2^x)	Block Size (2^y)	# Hosts (2^y - 2)
N.00000000.00000000.00000000	255.0.0.0	/8	$2^0 = 1$	$2^{22} = 16,777,216$	$2^{22} - 2 = 16,777,214$
N.10000000.00000000.00000000	255.128.0.0	/9	$2^1 = 2$	$2^{23} = 8,388,608$	$2^{23} - 2 = 8,388,606$
N.11000000.00000000.00000000	255.192.0.0	/10	$2^2 = 4$	$2^{22} = 4,194,304$	$2^{22} - 2 = 4,194,302$
N.11100000.00000000.00000000	255.224.0.0	/11	$2^3 = 8$	$2^{21} = 2,097,152$	$2^{21} - 2 = 2,097,150$
N.11110000.00000000.00000000	255.240.0.0	/12	$2^4 = 16$	$2^{20} = 1,048,576$	$2^{20} - 2 = 1,048,574$
N.11111000.00000000.00000000	255.248.0.0	/13	$2^5 = 32$	$2^{19} = 524,288$	$2^{19} - 2 = 524,286$
N.11111100.00000000.00000000	255.252.0.0	/14	$2^6 = 64$	$2^{18} = 262,144$	$2^{18} - 2 = 262,142$
N.11111110.00000000.00000000	255.254.0.0	/15	$2^7 = 128$	$2^{17} = 131,072$	$2^{17} - 2 = 131,070$
N.11111111.00000000.00000000	255.255.0.0	/16	$2^8 = 256$	$2^{16} = 65,536$	$2^{16} - 2 = 65,534$
N.11111111.10000000.00000000	255.255.128.0	/17	$2^9 = 512$	$2^{15} = 32,768$	$2^{15} - 2 = 32,766$
N.11111111.11000000.00000000	255.255.192.0	/18	$2^{10} = 1,024$	$2^{14} = 16,384$	$2^{14} - 2 = 16,382$
N.11111111.11100000.00000000	255.255.224.0	/19	$2^{11} = 2,048$	$2^{13} = 8,192$	$2^{13} - 2 = 8,190$
N.11111111.11110000.00000000	255.255.240.0	/20	$2^{12} = 4,096$	$2^{12} = 4,096$	$2^{12} - 2 = 4,094$
N.11111111.11111000.00000000	255.255.248.0	/21	$2^{13} = 8,192$	$2^{11} = 2,048$	$2^{11} - 2 = 2,046$
N.11111111.11111100.00000000	255.255.252.0	/22	$2^{14} = 16,384$	$2^{10} = 1,024$	$2^{10} - 2 = 1,022$
N.11111111.11111110.00000000	255.255.254.0	/23	$2^{15} = 32,768$	$2^9 = 512$	$2^9 - 2 = 510$
N.11111111.11111111.00000000	255.255.255.0	/24	$2^{16} = 65,536$	$2^8 = 256$	$2^8 - 2 = 254$
N.11111111.11111111.10000000	255.255.255.128	/25	$2^{17} = 131,072$	$2^7 = 128$	$2^7 - 2 = 126$
N.11111111.11111111.11000000	255.255.255.192	/26	$2^{18} = 262,144$	$2^6 = 64$	$2^6 - 2 = 62$
N.11111111.11111111.11100000	255.255.255.224	/27	$2^{19} = 524,288$	$2^5 = 32$	$2^5 - 2 = 30$
N.11111111.11111111.11110000	255.255.255.240	/28	$2^{20} = 1,048,576$	$2^4 = 16$	$2^4 - 2 = 14$
N.11111111.11111111.11111000	255.255.255.248	/29	$2^{21} = 2,097,152$	$2^3 = 8$	$2^3 - 2 = 6$
N.11111111.11111111.11111100	255.255.255.252	/30	$2^{22} = 4,194,304$	$2^2 = 4$	$2^2 - 2 = 2$

Lecture 4: Downloading Course Materials

All lectures can be downloaded. There are also PDF lecture files.

Click on Course Content. Then click All Resources on the right. This exposes the entire outline of the course, here you will see links to download PDF files of the lectures. In the new format you will see a downward pointing arrow on the right, click to expand. Then you will see a folder, click to download.



There is also a link to a website called IPv4 Subnetting Calculator at the address: https://www.site24x7.com/tools/ipv4-subnetcalculator.html

To download video of the lecture …

Lecture 5: Udemy Mobile App

There is an application you can download.

Lecture 6: Understanding IPv4 Addresses

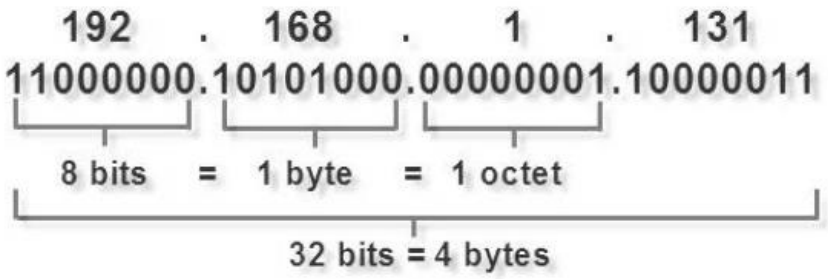
• An IP Address is a **logical** address used in order to **uniquely identify** a device on an IP network. There is also a MAC address which is physically burned onto the device by the manufacturer before they ship it out. The MAC address never changes.

A network administrator has to design a network address schema which assigns addresses to devices which wish to connect to the network. This is the IP address. These addresses operate on the network layer of the "oh-phy" model.

• It's a **Network Layer** Address
• There are Two Versions:
  – IP version 4 (IPv4)
  – IP version 6 (IPv6)
• This course focuses on IPv4 Addresses. Certifying agencies want users to understand IPv4.

Made up of 32 binary bits, which can be divided into a **network portion** and a **host portion** with the help of a **subnet mask**.

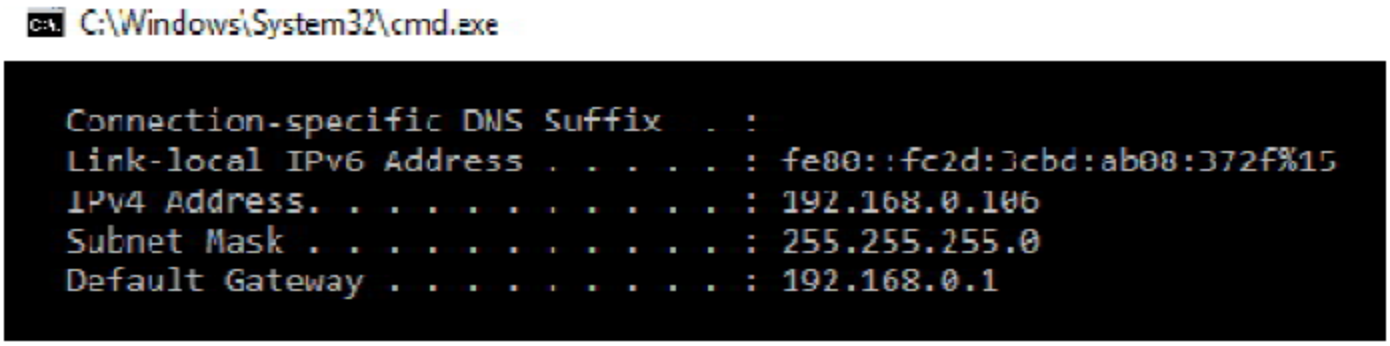
  – The 32 binary bits are broken into four octets (1 octet = 8 bits).
  – Each octet is converted to decimal and separated by a period (dot).
  – For this reason, an IP address is said to be expressed in **dotted decimal format**.



First Octet		Second Octet		Third Octet		Fourth Octet
192	.	168	.	1	.	10
11000000	.	10101000	.	00000001	.	00001010
8 bits		8 bits		8 bits		8 bits

An IP Address is a combination of a network address and a host address.
• An IP address is broken down into two parts:
  – **Network Address**
    • Uniquely identifies each network
      – Your Street Name: 7682 **Wilshire Drive**
  – **Host Address**
    • Uniquely identifies each machine on a network
      – Your House Address: **4682** Wilshire Drive
  • **Network Address** + **Host Address** = **IP Address**
  • **4682** + **Wilshire Drive** = **4682 Wilshire Drive**

• Each device on a network is assigned an IP address, subnet mask and default gateway:
  – **IP Address**: Unique logical address assigned to each device on a network.
  – **Subnet mask**: Used by the device to determine what subnet it's on.
  – **Default Gateway**: The router's IP address that allows the device to communicate outside it's local subnet.



For any given network, each device on the network, in order to communicate with other devices on the same network, must have the same **subnet mask**.

Lecture 7: IP Address Anatomy

	8 bits	8 bits	8 bits	8 bits
Decimal	0 - 255.	0 - 255.	0 - 255.	0 - 255
Binary	00000000 - 11111111.	00000000 - 11111111.	00000000 - 11111111.	00000000 - 11111111

Each 8-bit group is called an octet.

Lecture 8: Basics of Binary Math

– Convert Binary to Decimal
– Convert Decimal to Binary

* We need to know basic binary math to perform subnetting

	128	64	32	16	8	4	2	1	
Binary	1	1	1	1	1	1	1	1	
Decimal	128	+ 64	+ 32	+ 16	+ 8	+ 4	+ 2	+ 1	= **255 Decimal**

	128	64	32	16	8	4	2	1	
Binary	1	0	1	0	1	0	1	0	
Decimal	128	+ 0	+ 32	+ 0	+ 8	+ 0	+ 2	+ 0	= **170 Decimal**

	128	64	32	16	8	4	2	1	
Binary	1	1	1	0	0	1	1	1	
Decimal	128	+ 64	+ 32	+ 0	+ 0	+ 4	+ 2	+ 1	= **231 Decimal**

	128	64	32	16	8	4	2	1	
Binary	1	0	0	0	0	0	1	1	
Decimal	128	+ 0	+ 0	+ 0	+ 0	+ 0	+ 2	+ 1	= **131 Decimal**

	128	64	32	16	8	4	2	1	
Binary	1	1	0	0	0	0	0	0	= **11000000**
Decimal	128	+ 64	+ 0	+ 0	+ 0	+ 0	+ 0	+ 0	= **192 Decimal**

	128	64	32	16	8	4	2	1	
Binary	1	1	0	0	1	0	1	0	= **11001010**
Decimal	128	+ 64	+ 0	+ 0	+ 8	+ 0	+ 2	+ 0	= **202 Decimal**

	128	64	32	16	8	4	2	1	
Binary	0	0	1	1	0	1	1	0	= **00110110**
Decimal	0	+ 0	+ 32	+ 16	+ 0	+ 4	+ 2	+ 0	= **54 Decimal**

	128	64	32	16	8	4	2	1	
Binary	0	1	0	0	1	1	0	0	= **01001100**
Decimal	0	+ 64	+ 0	+ 0	+ 8	+ 4	+ 0	+ 0	= **76 Decimal**

192.	168.	32.	4	Dotted Decimal
11000000.	10101000.	00100000.	00000100	Binary
1st Octet	2nd Octet	3rd Octet	4th Octet	

Lecture 9: Binary Math Worksheet

1. CONVERT 11110000 TO DECIMAL

	128		64		32		16		8		4		2		1		
Binary	1		1		1		1		0		0		0		0	=	
Decimal	128	+	64	+	32	+	16	+	0	+	0	+	0	+	0	=	**240 Decimal**

2. CONVERT 10011001 TO DECIMAL

	128		64		32		16		8		4		2		1		
Binary	1		0		0		1		1		0		0		1	=	
Decimal	128	+	0	+	0	+	16	+	8	+	0	+	0	+	1	=	**153 Decimal**

3. CONVERT 01101011 TO DECIMAL

	128		64		32		16		8		4		2		1		
Binary	0		1		1		0		1		0		1		1	=	
Decimal	0	+	64	+	32	+	0	+	8	+	0	+	2	+	1	=	**107 Decimal**

4. CONVERT 10110011 TO DECIMAL

	128		64		32		16		8		4		2		1		
Binary	1		0		1		1		0		0		1		1	=	
Decimal	128	+	0	+	32	+	16	+	0	+	0	+	2	+	1	=	**179 Decimal**

5. CONVERT 240 TO BINARY

	128		64		32		16		8		4		2		1		
Binary	1		1		1		1		0		0		0		0	=	**11110000 Binary**
Decimal	128	+	64	+	32	+	16	+	0	+	0	+	0	+	0	=	

6. CONVERT 163 TO BINARY

	128		64		32		16		8		4		2		1		
Binary	1		0		1		0		0		0		1		1	=	**10100011 Binary**
Decimal	128	+	0	+	32	+	0	+	0	+	0	+	2	+	1	=	

Lecture 10: IP Address Classification and Subnet Masks

Class	Leading Bits	Network Bits	Remaining Bits	Number of Networks	Hosts Per Network	Default Subnet Mask
Class A	0 (1-126)	8	24	128 (2^7)	16,777,216 (2^{24})	255.0.0.0
Class B	10 (128-191)	16	15	16,384 (2^{14})	65,536(2^{16})	255.255.0.0
Class C	110 (192-223)	24	8	2,097,152 (2^{21})	256(2^8)	255.255.255.0
Class D (multicast)	1110 (224-239)	Not Defined	Not Defined	Not Defined	Not Defined	Not Defined
Class E (reserved)	1111 (240-254)	Not Defined	Not Defined	Not Defined	Not Defined	Not Defined

When IPv4 came out it had something called Class Full IP Addressing (shown above). At this time companies would be assigned IP addresses and they would use only those address and their subnets. We will focus on Class A to Class D. What sets these classes apart is the number of bits they use for the **network portion** of the address and the number of bits they use for the **host portion** of the address. Also, notice that A, B, and C each have a different subnet mask. The subnet mask tells us which network we are on.

Notice the Class A subnet of 255.0.0.0. This tells us they use 8-bits (255) for the network portion and a total of 24-bits (0.0.0) for the host portion. We see in Class B they have two octets on for the network portion (16-bits) and 2 octets on for the host portion (16-bits). Lastly, Class C uses the first three octets for the network portion and only the last octet for the host portion. The more bits left for the host portion the larger the network size.

The more bits left for the host portion the larger the network size. In a Class A network there are a total of 2^7 = 128 possible devices [2^7 instead of 8 because Class A networks were designed with a leading 0, this means that digit cannot be used to generate a larger address space]. This leaves 2^24 = 16,777,216 possible hosts per network.

Now consider a Class B network. First, notice in the table above, Class B networks have leading bits “10” or 2-bits. These bits are not available to be used to generate address space so the total number of network bits is 16 – 2 = 14 leaving 2^14 = 16,384 possible networks. But we can use all of the remaining 16-bits to calculate the number of possible hosts per network. This value turns out to be 2^16 = 65,536.

Class C is designed to be a very small network. It has 3 leading bits so the total number of possible networks is 24 – 3 = 21 bits for 2^21 = 2,097,152 networks and the remaining 8-bits can produce 2^8 = 256 hosts per network.

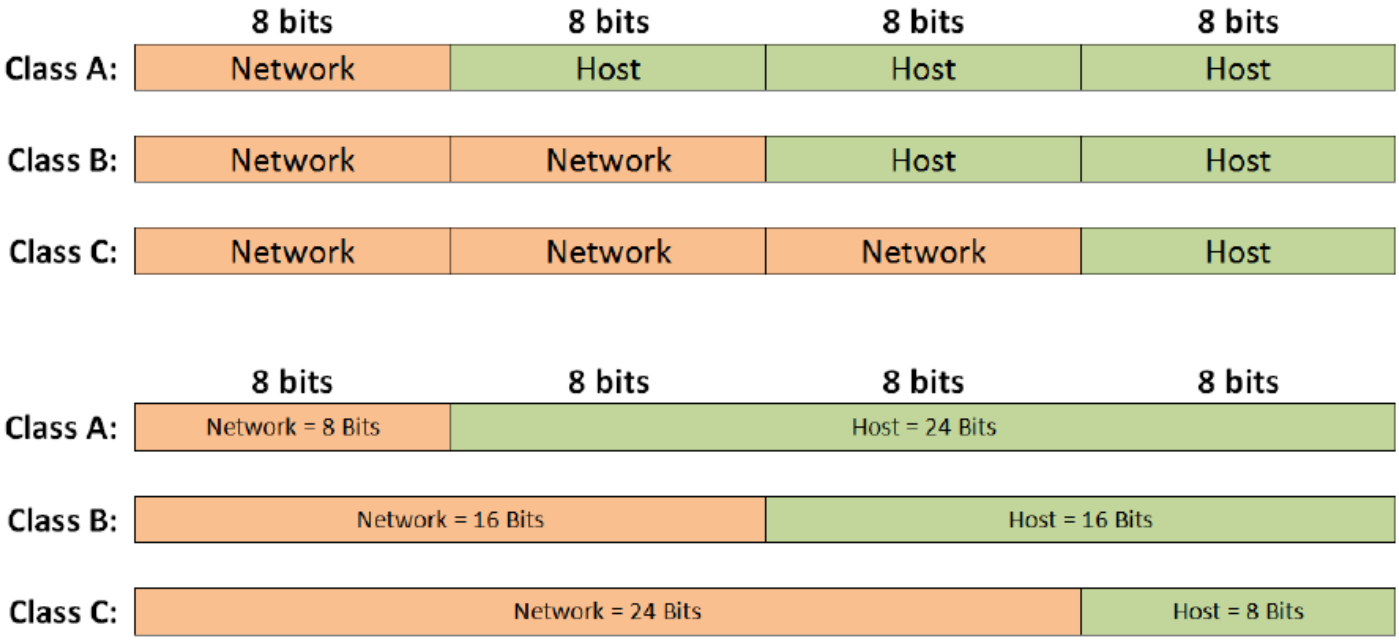
Class D networks are reserved for multicast applications and Class E for R&D.

IP Address Classes (Simplified)

Class	Network Bits	Host Bits	Address Range
A	8	24	1.0.0.0 – 127.255.255.255
B	16	16	128.0.0.0 – 191.255.255.255
C	24	8	192.0.0.0 – 233.255.255.255

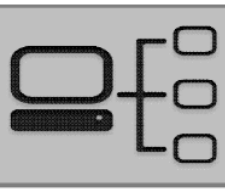
The above table shows the address range for each network type.

Network and Host Bits



Here we are looking at Class A, B, and C from a bits and octets perspective.

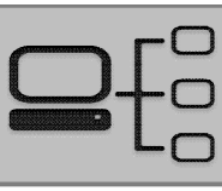
IP Addresses & Subnet Masks



	8 bits	8 bits	8 bits	8 bits
Class A:	Network	Host	Host	Host
IP Address	10.	0.	0.	15
Subnet Mask	11111111.	00000000.	00000000.	00000000
	255.	0.	0.	0
Class B:	Network	Network	Host	Host
IP Address	172.	16.	0	.110
Subnet Mask	11111111.	11111111.	00000000.	00000000
	255.	255.	0.	0
Class C:	Network	Network	Network	Host
IP Address	192.	168.	1.	50
Subnet Mask	11111111.	11111111.	11111111.	00000000
	255.	255.	255.	0

Keep in mind you can identify the type of network by the subnet mask.

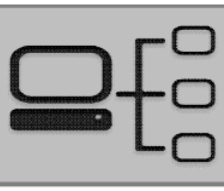
Default Subnet Masks



- The Subnet Mask tells you which portion of the IP address identifies the network and which portion of the address identifies the host.
- Below are default Class A, B and C Subnet Masks.

Class A:	Network	Host	Host	Host
Subnet Mask	11111111.	00000000.	00000000.	00000000
	255.	0.	0.	0
Class B:	Network	Network	Host	Host
Subnet Mask	11111111.	11111111.	00000000.	00000000
	255.	255.	0.	0
Class C:	Network	Network	Network	Host
Subnet Mask	11111111.	11111111.	11111111.	00000000
	255.	255.	255.	0

Let's Practice



- What class are the following IP Addresses?
  - **IP Address**: 9.10.40.15
  - **Subnet Mask**: 255.0.0.0

A

  - **IP Address**: 135.240.110.100
  - **Subnet Mask**: 255.255.0.0

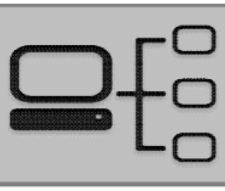
B

  - **IP Address**: 200.200.10.5
  - **Subnet Mask**: 255.255.255.0

C

We could figure these questions out by examining the address but it more straightforward to use the subnet mask as a guide.

CIDR Notation



- "Slash" Notation tells you how many bits are associated with Subnet Mask
- It's a shortcut way of telling us what the Subnet Mask is:

/8 = 11111111.00000000.00000000.00000000
/8 = 255.0.0.0

- 192.168.1.0 **/24** = 255.255.255.0
- 10.1.0.0 **/16** = 255.255.0.0

CIDR or "Slash" Notation

"Slash" notation tells you how many bits are associated with the subnet mask. It is a shortcut way of tells us what the subnet mask is.

/8 = 11111111.00000000.00000000.00000000 … OR … **255**.0.0.0

192.168.1.0 **/24** … MEANS … 192.168.1.0 with subnet **255.255.255**.0

10.1.0.0 /16 … MEANS … 10.1.0.0 with subnet **255.255**.0.0

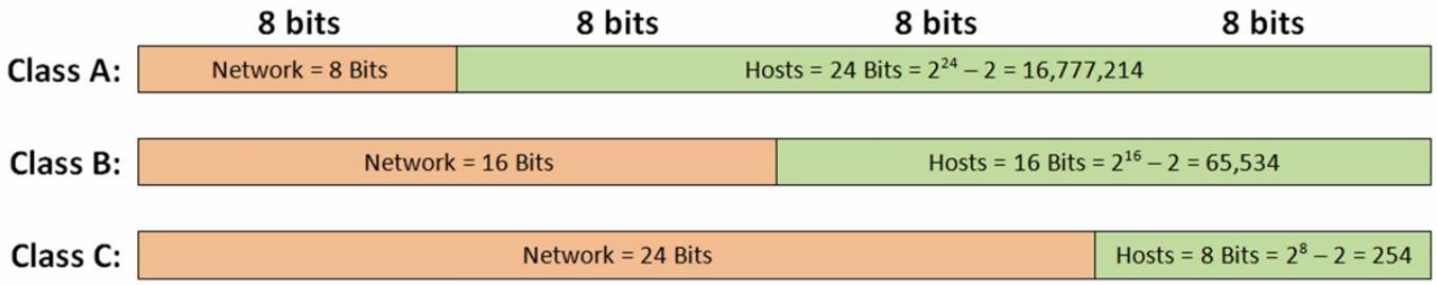
The number after the slash tells us how many bits are on in the subnet mask.

Lecture 10: The Power of 2's

- We use the power of 2 in IP addressing and subnetting.
- It's important to memorize the power of 2.

$2^1 = 2$	$2^2 = 4$	$2^3 = 8$	$2^4 = 16$
$2^5 = 32$	$2^6 = 64$	$2^7 = 128$	$2^8 = 256$
$2^9 = 512$	$2^{10} = 1,024$	$2^{11} = 2,048$	$2^{12} = 4,096$

Typically, there are two things we want to know when subnetting;
How many Networks are we creating, 2^x
How many **Hosts per Network** will we have access to, 2^h – 2. Here, h is the number of host bits available. We subtract 2 because each network includes a **network address** and a **broadcast address** that are not available for use by the network end devices.



At the beginning of the network the very first address is going to be the **network address** which we cannot use. This is an address which identifies that network. The very last address within that network is called the **broadcast address** which is used to send out broadcast messages on that subnet or network. So these are the two addresses we are subtracting off of our total. The total, minus the two, is called the **usable hosts**.

Lecture 11: Public vs Private IP Addresses

Public IP Addresses	Private IP Addresses
• Original Design of Internet • Used "**Registered**" Public IP Addresses • By Early 1990's, the World was Running out of Public IP Addresses • Private IP Addresses & Network Address Translation (NAT) were Born!	• "**Unregistered**" – Free for Use by anyone! • Cannot be Used or Routed on a Public Network • Used Within Organizations' Private Internal Networks • Utilizes NAT to "Speak" to Public Networks, aka the Internet!

The router is the boundary between the internal addresses the company may use but cannot put out on the internet and the world of internet addresses.

Private IP Address Ranges

Class	IP Address Range	Network ID(s) (CIDR Notation)	Number of Addresses
A	10.0.0.0 – 10.255.255.255	10.0.0.0 /8 • 1 Private Class A Network	16,777,216 IP Addresses Per Network ID
B	172.16.0.0 – 172.31.255.255	172.16.0.0 – 172.31.0.0 / 16 • 16 Private Class B Networks	65,534 IP Addresses Per Network ID
C	192.168.0.0 – 192.168.255.255	192.168.0.0 – 192.168.255.0 /24 • 256 Private Class C Networks	254 IP Addresses Per Network ID

The table above shows the IP address ranges which were created when private IP address ranges were implemented. So now private networks, such as those used by companies, have access to a much larger address space. This is made possible by the NAT/router which 'routes' data into and out from the private network. The organization now needs much fewer private addresses. Pretty much the public addresses are used for routers. There is much more to NAT and port address.

Now the question becomes, if we have all these "private" addresses available to us (inside out business network) why do we need a subnet?

The answer lies in manageability, efficiency, and network performance particularly in respect to route summarization. Still, for small organizations there is an argument for using something like a class C network and not having to subnet.

Lecture 12: Introduction to Subnetting

Why Subnet?

- Using default Class A, B and C subnets (called **Classful IP Addressing**) is inefficient:
  - Wastes unused IP Addresses (Public IP Addresses)

- Allows you to create multiple logical networks that exist within a single Class A, B, or C network.
  - break a major network down into multiple smaller sub-networks, i.e. **subnets**!

- Allows for more efficient routing via **router summarization**.

Organizations are only given a certain amount of IP address and so they must use them efficiently. Subnets allow routers to preform more efficient router summarization, it allows networks to preform at a higher performance level.

Fixed Length Subnetting

- We will begin learning about fixed length subnetting, known as a **Fixed-Length Subnet Mask (FLSM)**

"Subnet" and "network" can be used interchangeably. Take a single potential subnet or network, say a Class C network with 256 block size addresses and 254 of those available for us to use for hosts. If we broke this network up into two even chunks this is called a Fixed Length Subnet Mask. The key is that the two networks are broken up into even sizes.

Process of Subnetting

- We **borrow** host bits to create more **subnetworks (subnets)** from a Class A, B, or C network.
- When you borrow hosts bits you are doing two different things:
  - You create additional sub-networks, i.e. subnets
  - You also decrease the amount of host IP addresses available to use

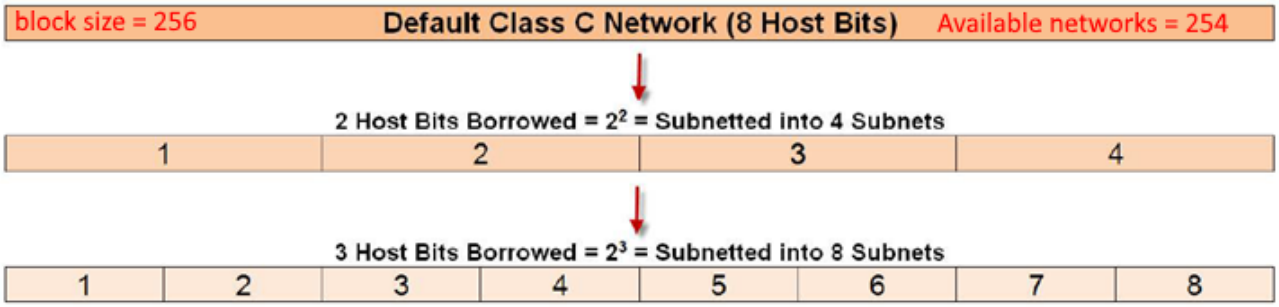
The key is we are barrowing hosts bits to create more subnetworks.

How to Create Subnets

- Borrow bits from the host portion of an IP address
- Each bit we borrow is equal to 21 Subnets
    - Borrow 1 Bit = 2^1 = 2 subnets created
    - Borrow 2 Bits = 2^2 = 4 subnets created
    - Borrow 3 Bits = 2^3 = 8 subnets created
    - Etc.

Each bit that we barrow creates 2^(number bits we barrow) subnetworks.

Creating Subnets Visualized



What do we mean by "Blocks" when speaking of FLSM? Say in this Class C network example we start with 256 block size and we break it into 4 equal size networks of 64 bits each, this means each block now represents 64 host IDs. Taking it further, if we barrow 3 bits we break up into 8 equal size subnets of 32 bits each. Each is the same size, thus "fixed length".

Subnetting Questions

- When trying to decide whether or not to create a subnet, ask yourself the following questions:
    - How many subnets are needed?
    - How many hosts do you need per subnet?

You must always leave two bits available for the host. If you do not the #host would be 1 or less meaning there are not 2 hosts available to be the network and broadcast address. This means you can barrow up to 6 host bits.

Class C Possible Subnets

[the first row of one of these tables is always the default network configuration]

Binary (N.N.N.H)	Decimal	CIDR	# Subnets (2^x)	Block Size (2^y)	# Hosts (2^y - 2)
N.N.N.00000000	255.255.255.0	/24	$2^0 = 1$	$2^8 = 256$	$2^8 - 2 = 254$
N.N.N.10000000	255.255.255.128	/25	$2^1 = 2$	$2^7 = 128$	$2^7 - 2 = 126$
N.N.N.11000000	255.255.255.192	/26	$2^2 = 4$	$2^6 = 64$	$2^6 - 2 = 62$
N.N.N.11100000	255.255.255.224	/27	$2^3 = 8$	$2^5 = 32$	$2^5 - 2 = 30$
N.N.N.11110000	255.255.255.240	/28	$2^4 = 16$	$2^4 = 16$	$2^4 - 2 = 14$
N.N.N.11111000	255.255.255.248	/29	$2^5 = 32$	$2^3 = 8$	$2^3 - 2 = 6$
N.N.N.11111100	255.255.255.252	/30	$2^6 = 64$	$2^2 = 4$	$2^2 - 2 = 2$

Now you will want to ask yourself, how do I create subnets in the most efficient way? This table can help! The table shows all the possible subnets when starting from a Class C network. X = number of hosts bits, Y = number of bits remaining for block size. The Class A and B tables below work in the same way.
For example, in row 2 above, we have barrowed 1 bit which gives us up to 2 subnets with up to 128 hosts per block size. The useable host IDs will be the block size minus two (broadcast and network addresses).

Class B Possible Sunets

[the first row of one of these tables is always the default network configuration]

Binary (N.N.H.H)	Decimal	CIDR	# Subnets (2^x)	Block Size (2^y)	# Hosts (2^y - 2)
N.N.00000000.00000000	255.255.0.0	/16	$2^0 = 1$	$2^{16} = 65,536$	$2^{16} - 2 = 65,534$
N.N.10000000.00000000	255.255.128.0	/17	$2^1 = 2$	$2^{15} = 32,768$	$2^{15} - 2 = 32,766$
N.N.11000000.00000000	255.255.192.0	/18	$2^2 = 4$	$2^{14} = 16,384$	$2^{14} - 2 = 1,.382$
N.N.11100000.00000000	255.255.224.0	/19	$2^3 = 8$	$2^{13} = 8,192$	$2^{13} - 2 = 8,190$
N.N.11110000.00000000	255.255.240.0	/20	$2^4 = 16$	$2^{12} = 4,096$	$2^{12} - 2 = 4,094$
N.N.11111000.00000000	255.255.248.0	/21	$2^5 = 32$	$2^{11} = 2,048$	$2^{11} - 2 = 2,046$
N.N.11111100.00000000	255.255.252.0	/22	$2^6 = 64$	$2^{10} = 1,024$	$2^{10} - 2 = 1,022$
N.N.11111110.00000000	255.255.254.0	/23	$2^7 = 128$	$2^9 = 512$	$2^9 - 2 = 510$
N.N.11111111.00000000	255.255.255.0	/24	$2^8 = 256$	$2^8 = 256$	$2^8 - 2 = 254$
N.N.11111111.10000000	255.255.255.128	/25	$2^9 = 512$	$2^7 = 128$	$2^7 - 2 = 126$
N.N.11111111.11000000	255.255.255.192	/26	$2^{10} = 1,024$	$2^6 = 64$	$2^6 - 2 = 62$
N.N.11111111.11100000	255.255.255.224	/27	$2^{11} = 2,048$	$2^5 = 32$	$2^5 - 2 = 30$
N.N.11111111.11110000	255.255.255.240	/28	$2^{12} = 4,096$	$2^4 = 16$	$2^4 - 2 = 14$
N.N.11111111.11111000	255.255.255.248	/29	$2^{13} = 8,192$	$2^3 = 8$	$2^3 - 2 = 6$
N.N.11111111.11111100	255.255.255.252	/30	$2^{14} = 16,384$	$2^2 = 4$	$2^2 - 2 = 2$

Class B and A work the same way except you have more octets.

Class A Possible Subnets

[the first row of one of these tables is always the default network configuration]

Binary (N.H.H.H)	Decimal	CIDR	# Subnets (2^x)	Block Size (2^y)	# Hosts (2^y - 2)
N.00000000.00000000.00000000	255.0.0.0	/8	$2^0 = 1$	$2^{22} = 16,777,216$	$2^{22} - 2 = 16,777,214$
N.10000000.00000000.00000000	255.128.0.0	/9	$2^1 = 2$	$2^{23} = 8,388,608$	$2^{23} - 2 = 8,388,606$
N.11000000.00000000.00000000	255.192.0.0	/10	$2^2 = 4$	$2^{22} = 4,194,304$	$2^{22} - 2 = 4,194,302$
N.11100000.00000000.00000000	255.224.0.0	/11	$2^3 = 8$	$2^{21} = 2,097,152$	$2^{21} - 2 = 2,097,150$
N.11110000.00000000.00000000	255.240.0.0	/12	$2^4 = 16$	$2^{20} = 1,048,576$	$2^{20} - 2 = 1,048,574$
N.11111000.00000000.00000000	255.248.0.0	/13	$2^5 = 32$	$2^{19} = 524,288$	$2^{19} - 2 = 524,286$
N.11111100.00000000.00000000	255.252.0.0	/14	$2^6 = 64$	$2^{18} = 262,144$	$2^{18} - 2 = 262,142$
N.11111110.00000000.00000000	255.254.0.0	/15	$2^7 = 128$	$2^{17} = 131,072$	$2^{17} - 2 = 131,070$
N.11111111.00000000.00000000	255.255.0.0	/16	$2^8 = 256$	$2^{16} = 65,536$	$2^{16} - 2 = 65,534$
N.11111111.10000000.00000000	255.255.128.0	/17	$2^9 = 512$	$2^{15} = 32,768$	$2^{15} - 2 = 32,766$
N.11111111.11000000.00000000	255.255.192.0	/18	$2^{10} = 1,024$	$2^{14} = 16,384$	$2^{14} - 2 = 1,.382$
N.11111111.11100000.00000000	255.255.224.0	/19	$2^{11} = 2,048$	$2^{13} = 8,192$	$2^{13} - 2 = 8,190$
N.11111111.11110000.00000000	255.255.240.0	/20	$2^{12} = 4,096$	$2^{12} = 4,096$	$2^{12} - 2 = 4,094$
N.11111111.11111000.00000000	255.255.248.0	/21	$2^{13} = 8,192$	$2^{11} = 2,048$	$2^{11} - 2 = 2,046$
N.11111111.11111100.00000000	255.255.252.0	/22	$2^{14} = 16,384$	$2^{10} = 1,024$	$2^{10} - 2 = 1,022$
N.11111111.11111110.00000000	255.255.254.0	/23	$2^{15} = 32,768$	$2^9 = 512$	$2^9 - 2 = 510$
N.11111111.11111111.00000000	255.255.255.0	/24	$2^{16} = 65,536$	$2^8 = 256$	$2^8 - 2 = 254$
N.11111111.11111111.10000000	255.255.255.128	/25	$2^{17} = 131,072$	$2^7 = 128$	$2^7 - 2 = 126$
N.11111111.11111111.11000000	255.255.255.192	/26	$2^{18} = 262,144$	$2^6 = 64$	$2^6 - 2 = 62$
N.11111111.11111111.11100000	255.255.255.224	/27	$2^{19} = 524,288$	$2^5 = 32$	$2^5 - 2 = 30$
N.11111111.11111111.11110000	255.255.255.240	/28	$2^{20} = 1,048,576$	$2^4 = 16$	$2^4 - 2 = 14$
N.11111111.11111111.11111000	255.255.255.248	/29	$2^{21} = 2,097,152$	$2^3 = 8$	$2^3 - 2 = 6$
N.11111111.11111111.11111100	255.255.255.252	/30	$2^{22} = 4,194,304$	$2^2 = 4$	$2^2 - 2 = 2$

In Class A we are working with 24 possible hosts bits.

Subnet Calculation Table (2^h)

Host Bits Borrowed	2^x	Number of Subnets Created
1	2^1	2
2	2^2	4
3	2^3	8
4	2^4	16
5	2^5	32
6	2^6	64
7	2^7	128
8	2^8	256
9	2^9	512
10	2^{10}	1,024
11	2^{11}	2,048
12	2^{12}	4,096

Subnet Hosts & Addresses Calculation Table (2^h)

Host Bits Left	2^h	Hosts / Subnet ($2^h - 2$)	Addresses / Subnet (2^h)
~~1~~	~~2^1~~	~~0~~	~~2~~
2	2^2	2	4
3	2^3	6	8
4	2^4	14	16
5	2^5	30	32
6	2^6	62	64
7	2^7	126	128
8	2^8	254	256
9	2^9	510	512
10	2^{10}	1,022	1,024
11	2^{11}	2,046	2,048
12	2^{12}	4,094	4,096

Lecture 13: Subnetting a Class C Network, Example 1

Class C Example #1

Subnet	#1	#2
Network Address	192.168.1.0	192.168.1.128
First Host IP	192.168.1.1	192.168.1.129
Last Host IP	192.168.1.126	192.168.1.254
Broadcast Address	192.168.1.127	192.168.1.255

- **Details & Requirements**
  - Network Address: 192.168.1.0
  - Default Subnet Mask: 255.255.255.0
  - Requires 2 Subnets

We know from the subnet mask that we are working with a Class C network. The IP address also falls into a Class C range. We need to create 2 subnets, how many host nets do we need to barrow? (below)

- **How many host bit do we need to borrow?**
  - 1 host bit, 2^1 = 2 Subnets

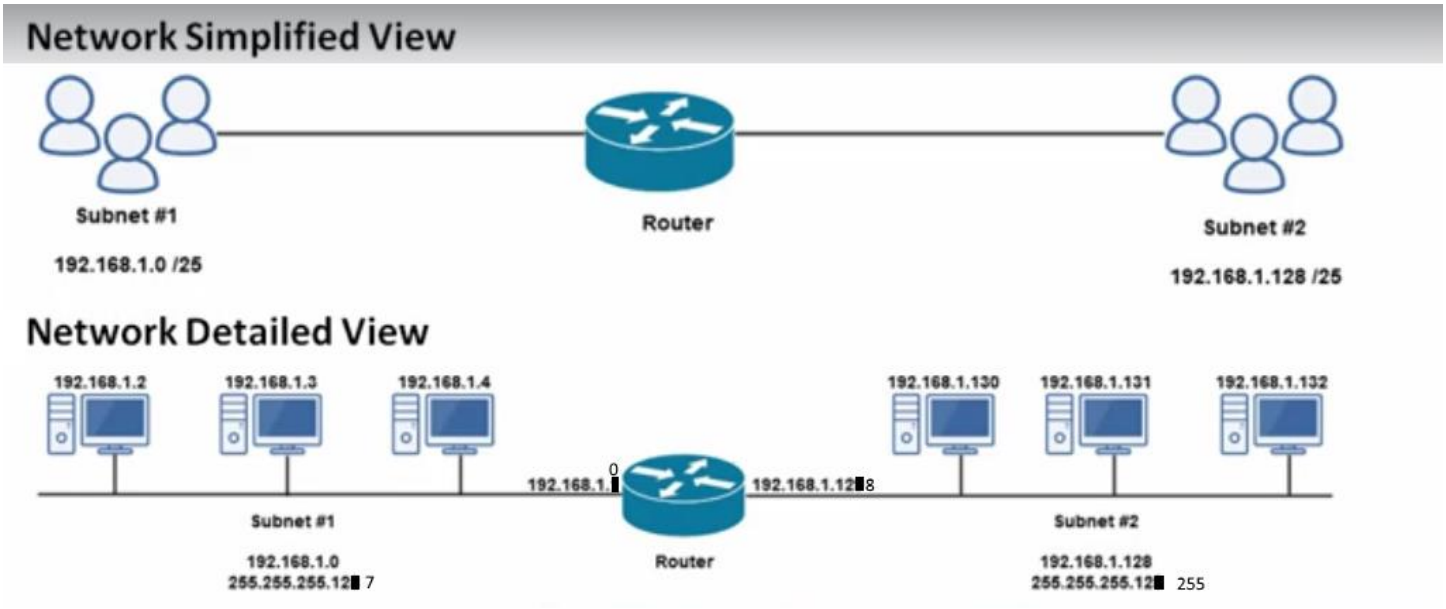
- **How many addresses hosts per subnet?**
  - 7 host bits left, 2^7 = 128 Addresses / Subnet
  - 2^7 - 2= 126 valid host Addresses / Subnet

- **What are the valid subnets?**
  - 192.168.1.0 and 192.168.1.128

When creating the subnets we always start with address .0. So addresses .0 through .127.
The second subnet begins at address .128.

- **New Subnet Mask?**
  - 11111111.11111111.11111111.10000000
  - 255.255.255.128 or /25 (25 1s)

Lecture 14: Subnetting Example 1, Detailed Discussion



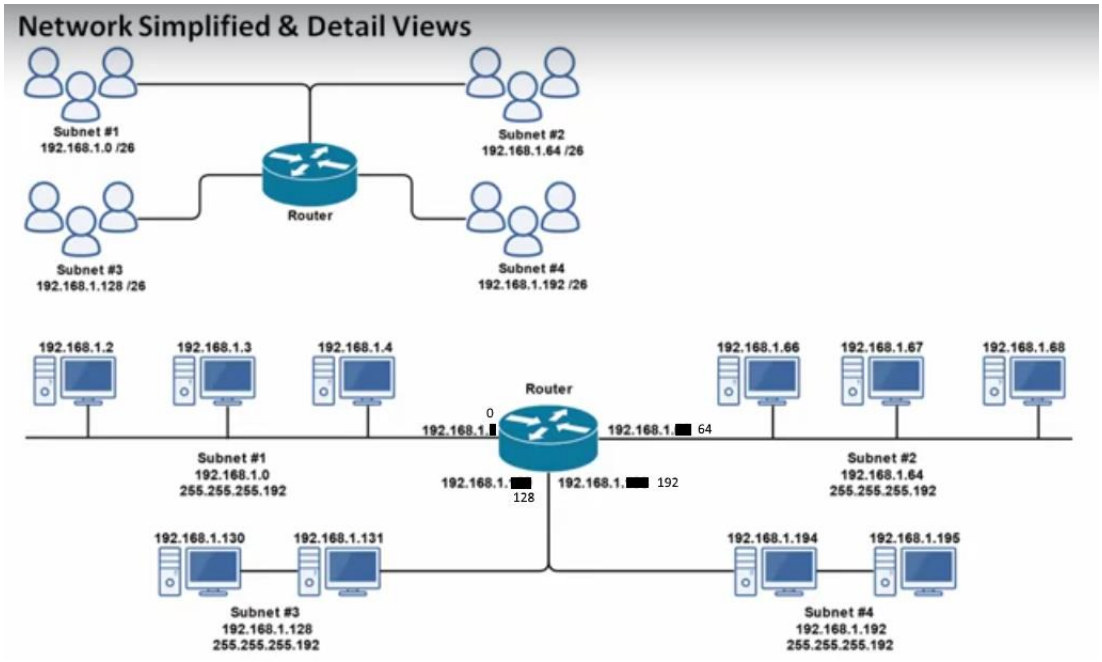
The router address is the default gateway address.

Lecture 15 & 16: Subnetting Class C Network, Example 2

Class C Example #2

Subnet	Network /Subnet Address	Host IP Addresses	Broadcast Address
1	192.168.1.0	1 thru 62	192.168.1.**63**
2	192.168.1.**64**	65 thru 126	192.168.1.**127**
3	192.168.1.**128**	129 thru 190	192.168.1.**191**
4	192.168.1.**192**	193 thru 254	192.168.1.**255**

- **Details & Requirements**
  - Network Address: 192.168.1.0
  - Default Subnet Mask: 255.255.255.0
  - Requires 4 Subnets
- **How many host bit do we need to borrow?**
  - 2 host bit, 2^2 = 4 Subnets
- **How many addresses hosts per subnet?**
  - 6 host bits left, 2^6 = 64 Addresses / Subnet
  - 2^6 - 2= 62 Addresses / Subnet
- **What are the valid subnets?**
  - 192.168.1.**0**, 192.168.1.**64,** 192.168.1.**128**, 192.168.1.**192**
- **New Subnet Mask?**
  - 11111111.11111111.11111111.00000000
  - 255.255.255.192 or /26



Lecture 17 & 18: Subnetting Class C Network, Example 2

Class C Example #3

- **Details & Requirements**
  - Network Address: 192.168.1.0
  - Default Subnet Mask: 255.255.255.0 or /24
  - Requires 22 hosts / Subnet
- **How many host bits must we borrow?**
  - 3 host bits, 2^3 = 8 Subnets
- **How many addresses hosts per subnet?**
  - 5 host bits left, 2^5 = 32 Addresses / Subnet
  - 2^5 - 2= 30 Addresses / Subnet
- **What are the valid subnets?**
  - .0, .32, .64, .96…….. .224
- **New Subnet Mask?**
  - 11111111.11111111.11111111.11100000
  - 255.255.255.224 or /27

Subnet	Network Address	Host IP Addresses	Broadcast Address
1	192.168.1.0	1 thru 30	192.168.1.31
2	192.168.1.32	33 thru 62	192.168.1.63
3	192.168.1.64	65 thru 94	192.168.1.95
4	192.168.1.96	97 thru 126	192.168.1.127
5	192.168.1.128	129 thru 128	192.168.1.159
6	192.168.1.160	161 thru 190	192.168.1.191
7	192.168.1.192	193 thru 222	192.168.1.223
8	192.168.1.224	225 thru 254	192.168.1.255

CLASS C POSSIBLE SUBNET MASKS

Binary (N.N.N.H)	Decimal	CIDR	# Subnets (2^x)	Block Size (2^y)	# Hosts (2^y - 2)
N.N.N.00000000	255.255.255.0	/24	$2^0 = 1$	$2^8 = 256$	$2^8 - 2 = 254$
N.N.N.10000000	255.255.255.128	/25	$2^1 = 2$	$2^7 = 128$	$2^7 - 2 = 126$
N.N.N.11000000	255.255.255.192	/26	$2^2 = 4$	$2^6 = 64$	$2^6 - 2 = 62$
N.N.N.11100000	255.255.255.224	/27	$2^3 = 8$	$2^5 = 32$	$2^5 - 2 = 30$
N.N.N.11110000	255.255.255.240	/28	$2^4 = 16$	$2^4 = 16$	$2^4 - 2 = 14$
N.N.N.11111000	255.255.255.248	/29	$2^5 = 32$	$2^3 = 8$	$2^3 - 2 = 6$
N.N.N.11111100	255.255.255.252	/30	$2^6 = 64$	$2^2 = 4$	$2^2 - 2 = 2$

Default Class C Network (8 Host Bits)

3 Host Bits Borrowed = 2^3 = Subnetted into 8 Subnets

1	2	3	4	5	6	7	8

Lecture 19 & 20: Practice Worksheet & Answers

Subnetting Class C Networks Practice Worksheet

1. You are given a 192.168.1.0 /24 Class C Network:

a. What is the default subnet mask?
255.255.255.0 or /24
11111111.11111111.11111111.00000000

b. You need to subnet it into 16 sub-networks, how many host bits do you need to borrow?
2^4 = 16, which means we need to borrow 4 bits

c. How many host bits will be left?
8 – 4 = 4 host bit left

d. What is your new subnet mask?
11111111.11111111.11111111.11110000
255.255.255.240 or /28

e. How many hosts available per subnet?
$2^h - 2 = 2^4 - 2 = 16 - 2 = 14$ Hosts / Subnets

Subnet	Network Address	Host Range	Broadcast Address
1	199.10.0.0	1 thru 30	199.10.0.31
2	199.10.0.32	33 thru 62	199.10.0.63
3	199.10.0.64	63 thru 94	199.10.0.95
4	199.10.0.96	97 thru 126	199.10.0.127
5	199.10.0.128	129 thru 158	199.10.0.159
6	199.10.0.160	161 thru 190	199.10.0.191
7	199.10.0.192	193 thru 222	199.10.0.223
8	199.10.0.224	225 thru 254	199.10.0.255

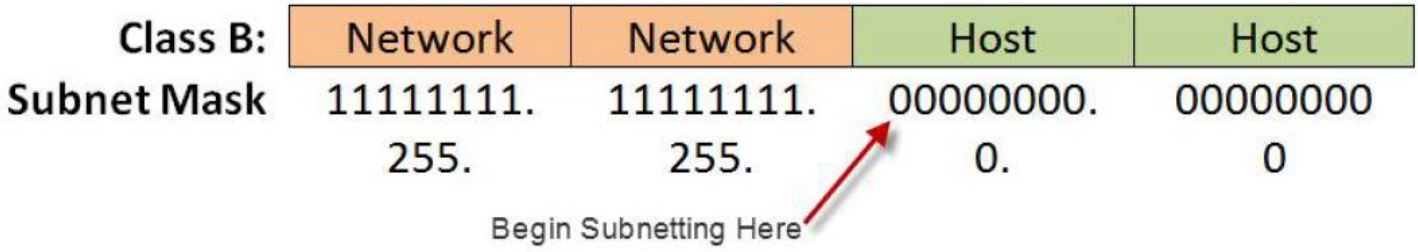
Lecture 21: Course Review Request

Instructor request 5 star review.

Lecture 22: Subnetting Class B Networks

Subnetting Class B Networks

Subnetting a class B network is no different than subnetting a class C network. The only difference is that we begin subnetting in the 3rd octet.



Lecture 23: Subnetting Class B Networks, Ex. 1

Class B Example #1

- **Details & Requirements**
  - Network Address: 136.18.0.0
  - Default Subnet Mask: 255.255.0.0
  - Requires 2 Subnets
- **How many host bit do we need to borrow?**
  - 1 host bit, $2_1 = 2$ Subnets
- **How many addresses hosts per subnet?**
  - 15 host bits left, $2_{15} = 32{,}768$ Addresses / Subnet
  - $2_{15} - 2 = 32{,}766$ Addresses / Subnet
- **New Subnet Mask?**
  - 11111111.11111111.**1**0000000.00000000
  - 255.255.128.0 or /17
- **What are the valid subnets?**
  - Equation: 256 – Subnet Mask = 256 – 128 = **128**
  - 0 and 128 in 3rd Octet:
    - 136.18.0.0 & 136.18.128.0

Subnet	#1	#2
Network Address	136.18.0.0	136.18.128.0
First Host IP	136.18.0.1	136.18.128.1
Last Host IP	136.18.127.254	136.18.255.254
Broadcast Address	136.18.127.255	136.18.255.255

Lecture 24: Subnetting Class B Networks, Ex. 2

Class B Example #2

- **Details & Requirements**
  - Network Address: 155.14.0.0
  - Default Subnet Mask: 255.255.0.0
  - Requires 4 Subnets
- **How many host bit do we need to borrow?**
  - 2 host bit, $2_2 = 4$ Subnets
- **How many addresses hosts per subnet?**
  - 14 host bits left, $2_{14} = 16{,}384$ Addresses / Subnet
  - $2_{14} - 2 = 16{,}382$ Addresses / Subnet
- **New Subnet Mask?**
  - 11111111.11111111.**11**000000.00000000
  - 255.255.192.0 or /18
- **What are the valid subnets?**
  - Equation: 256 – Subnet Mask = 256 – 192 = **64**
  - 0, 64, 128 and 192 in 3rd Octet:
  - 155.14.0.0, 155.14.64.0, 155.14.128.0, 155.14.192.0

Subnet	Network /Subnet Address	Host IP Addresses	Broadcast Address
1	155.14.0.0	155.14.0.1 to .63.254	155.14.63.255
2	155.14.64.0	155.14.64.1 to .127.254	155.14.127.255
3	155.14.128.0	155.14.128.1 to .191.254	155.14.191.255
4	155.14.192.0	155.14.192.1 to .255.254	155.14.255.255

Lecture 25: Subnetting Class B Networks, Ex. 3 Part 1

Class B Example #3

- **Details & Requirements**
  - Network Address: 155.14.0.0
  - Default Subnet Mask: 255.255.0.0
  - Requires 8,000 Hosts Per Subnet
- **How many addresses hosts per subnet?**
  - 13 host bits Required, 2_{13} = 8,192 Addresses / Subnet
  - 2_{13} - 2= 8,190 Addresses / Subnet
- **How many host bit do we need to borrow?**
  - 3 host bit, 2_3 = 8 Subnets
- **New Subnet Mask?**
  - 11111111.11111111.**111**00000.00000000
  - 255.255.224.0 or /19
- **What are the valid subnets?**
  - Equation: 256 – Subnet Mask = 256 – 224 = **32**
  - 0, 32, 64, 96, 128, 160, 192, 224 in 3rd Octet

Subnet	Network /Subnet Address	Host IP Addresses	Broadcast Address
1	155.14.0.0	155.14.0.1 to .31.254	155.14.31.255
2	155.14.32.0	155.14.32.1 to .63.254	155.14.63.255
3	155.14.64.0	155.14. to	155.14.
4	155.14.96.0	155.14. to	155.14.
5	155.14.128.0	155.14. to	155.14.
6	155.14.160.0	155.14. to	155.14.
7	155.14.192.0	155.14. to	155.14.
8	155.14.224.0	155.14. to	155.14.255.255

Lecture 26: Subnetting Class B Networks, Ex. 3 Part 2

Class B Example #3

- **Details & Requirements**
  - Network Address: 155.14.0.0
  - Default Subnet Mask: 255.255.0.0
  - Requires 8,000 Hosts Per Subnet
- **How many addresses hosts per subnet?**
  - 13 host bits Required, 2_{13} = 8,192 Addresses / Subnet
  - 2_{13} - 2= 8,190 Addresses / Subnet
- **How many host bit do we need to borrow?**
  - 3 host bit, 2_3 = 8 Subnets
- **New Subnet Mask?**
  - 11111111.11111111.**111**00000.00000000
  - 255.255.224.0 or /19
- **What are the valid subnets?**
  - Equation: 256 – Subnet Mask = 256 – 224 = **32**
  - 0, 32, 64, 96, 128, 160, 192, 224 in 3rd Octet

Subnet	Network /Subnet Address	Host IP Addresses	Broadcast Address
1	155.14.0.0	155.14.0.1 to .31.254	155.14.31.255
2	155.14.32.0	155.14.32.1 to .63.254	155.14.63.255
3	155.14.64.0	155.14. to	155.14.
4	155.14.96.0	155.14. to	155.14.
5	155.14.128.0	155.14. to	155.14.
6	155.14.160.0	155.14. to	155.14.
7	155.14.192.0	155.14. to	155.14.
8	155.14.224.0	155.14. to	155.14.255.255

Lecture 27 & 28: Practice Worksheet & Answers

Subnetting Class B Networks Practice Worksheet

1. You are given a 172.20.10.0 /16 Class B Network:

a. What is the default subnet mask?
255.255.0.0 or 11111111.11111111.00000000.00000000

b. You need to subnet it into 64 sub-networks, how many host bits do you need to borrow?
2^6 = 64, so we need to borrow 6 host bits to create 64 subnets

c. How many host bits will be left?
16 – 6 = 10 Host Bits Remain

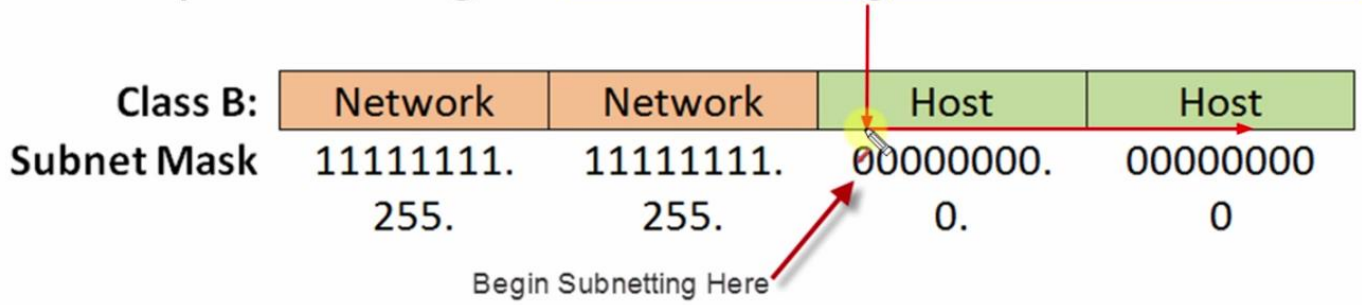
d. What is your new subnet mask?
11111111.11111111.**11111**00.00000000 = 255.255.252.0

e. How many hosts available per subnet?
2^{10} – 2 = 1,022 Usable Hosts Address / Subnet

Subnet	Subnet Address	Host Range	Broadcast Address
1	172.14.0.0	172.14.0.1 to 63.254	172.14.63.255
2	172.14.64.0	172.14.64.1 to 127.254	172.14.127.255
3	172.14.128.0	172.14.128.1 to 191.254	172.14.191.255
4	172.14.192.0	172.14.192.1 to 255.254	172.14.255.255

Lecture 29: Caveat to Subnetting Class B and Class A Networks

- The exact same process as before...
- Except we begin subnetting in the 3rd octet!



Lecture 30: Subnetting Class A Networks

Subnetting Class A Networks

- The exact same process as before...
- Except we begin subnetting in the 2nd octet!

	8 bits	8 bits	8 bits	8 bits
Class A:	Network	Host	Host	Host
Subnet Mask	11111111.	00000000.	00000000.	00000000
	255.	0.	0.	0

Lecture 31: Subnetting a Class A Network, Ex. 1

Class A Example #1

Subnet	#1	#2
Network Address	15.0.0.0	15.1.0.0
First Host IP	15.0.0.1	15.1.0.1
Last Host IP	15.0.255.254	15.1.255.254
Broadcast Address	15.0.255.255	15.1.255.255

- **Details & Requirements**
  - Network Address: 15.0.0.0
  - Default Subnet Mask: 255.0.0.0
  - Requires 256 Subnets
  -
- **How many host bit do we need to borrow?**
  - 8 host bit, 2_8 = 256 Subnets
  -
- **How many addresses hosts per subnet?**
  - 16 host bits left, 2_{16} = 65,536 Addresses / Subnet
  - 2_{16} - 2= 65,534 Addresses / Subnet
  -
- **New Subnet Mask?**
  - 11111111.**11111111**.00000000.00000000
  - 255.255.0.0 or /16
  -
- **What are the valid subnets?**
  - Equation: 256 – Subnet Mask = 256 – 255 = **1**
  - – 0 to 255 in 3rd Octet:

Lecture 32: Subnetting a Class A Network, Ex. 2

Class A Example #2

Details & Requirements

- Network Address: 15.0.0.0
- Default Subnet Mask: 255.0.0.0
- Requires 4096 Subnets

How many host bit do we need to borrow?

- 12 host bit, 2^{12} = 4,096 Subnets

How many addresses hosts per subnet?

- 12 host bits left, 2^{12} = 4,096 Addresses / Subnet
- 2^{12} - 2= 4,094 Hosts / Subnet

New Subnet Mask?

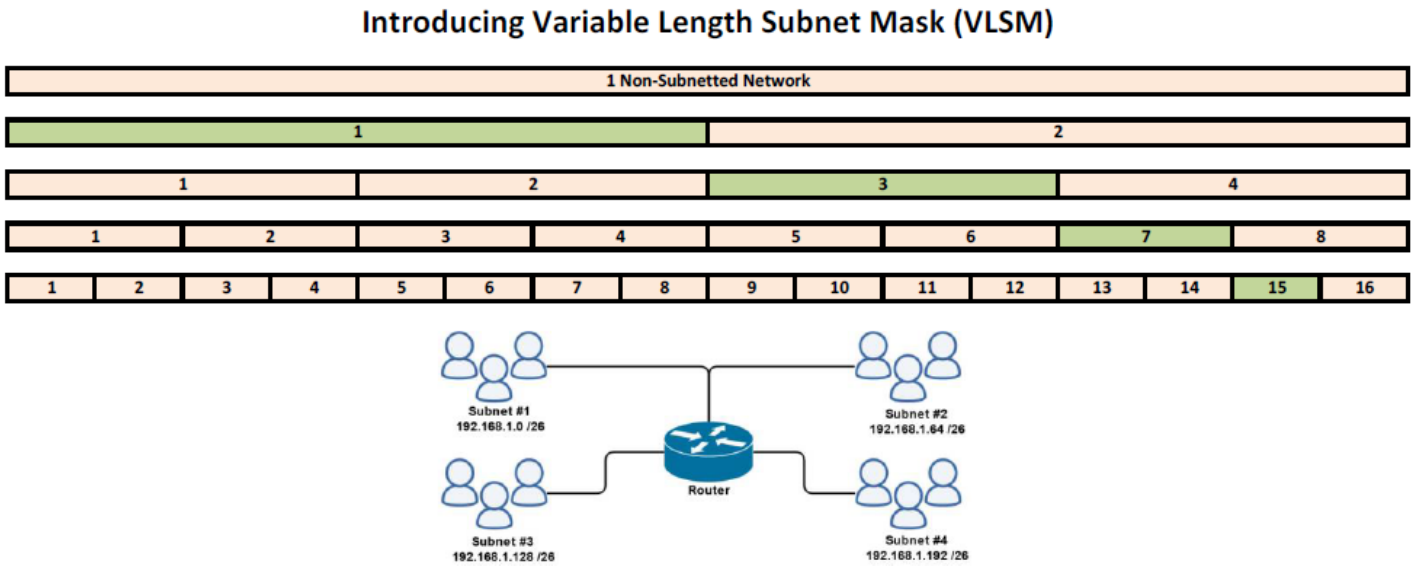
- 11111111. **11111111**.**1111**0000.00000000
- 255.255.240.0 or /20

What are the valid subnets?

- Equation: 256 – Subnet Mask = 256 – 240 = **16**
- 0, 16, 32, 48, 64, 80, 96, 112, 128, 144, 160, 176, 192, 208, 224, 240 in 3rd Octet • Increment 1 in 2nd Octet and repeat sequence in 3rd Octet.

Subnet	Subnet Address	Host IP Addresses	Broadcast Address
1	15.0.0.0	15.0.0.1 to 15.0.15.254	15.0.15.255
2	15.0.16.0	15.0.16.1 to 15.0.31.254	15.0.31.255
3	15.0.32.0	15.0.32.1 to 15.0.47.254	15.0.47.255
↓			
16	15.0.240.0	15.0.240.1 to 15.0.255.254	15.0.255.255
17	15.1.0.0	15.1.0.1 to 15.1.15.254	15.1.15.255
18	15.1.16.0	15.1.16.1 to 15.1.31.254	15.1.31.255
19	15.1.32.0	15.1.32.1 to 15.1.63.254	15.1.63.255

Lecture 33: Introduction to VLSM



The key here is that the green sections do not overlap so you can create this network.

Lecture 34: Implementing VLSM

192.168.100.0 /25, 2 Subnets, 126 hosts / Subnet

Subnet ID	Subnet Address	Host Address Range	Broadcast Address
1	192.168.100.0	192.168.100.1 - 192.168.100.126	192.168.100.127
~~2~~	~~192.168.100.128~~	~~192.168.100.129 - 192.168.100.254~~	~~192.168.100.255~~

192.168.1.100 /26, 4 Subnets, 62 Hosts / Subnet

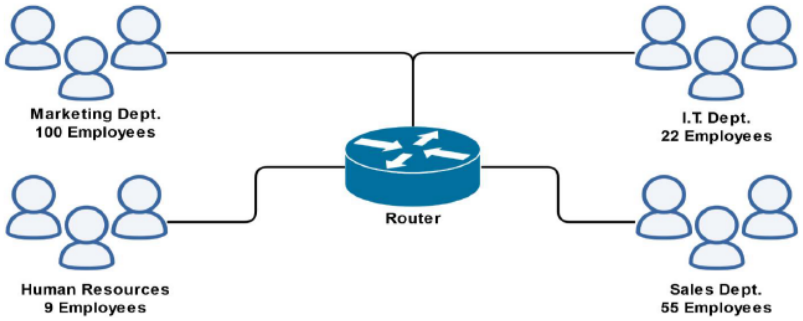
Subnet ID	Subnet Address	Host Address Range	Broadcast Address
~~1~~	~~192.168.100.0~~	~~192.168.100.1 - 192.168.100.62~~	~~192.168.100.63~~
~~2~~	~~192.168.100.64~~	~~192.168.100.65 - 192.168.100.126~~	~~192.168.100.127~~
3	192.168.100.128	192.168.100.129 - 192.168.100.190	192.168.100.191
~~4~~	~~192.168.100.192~~	~~192.168.100.193 - 192.168.100.254~~	~~192.168.100.255~~

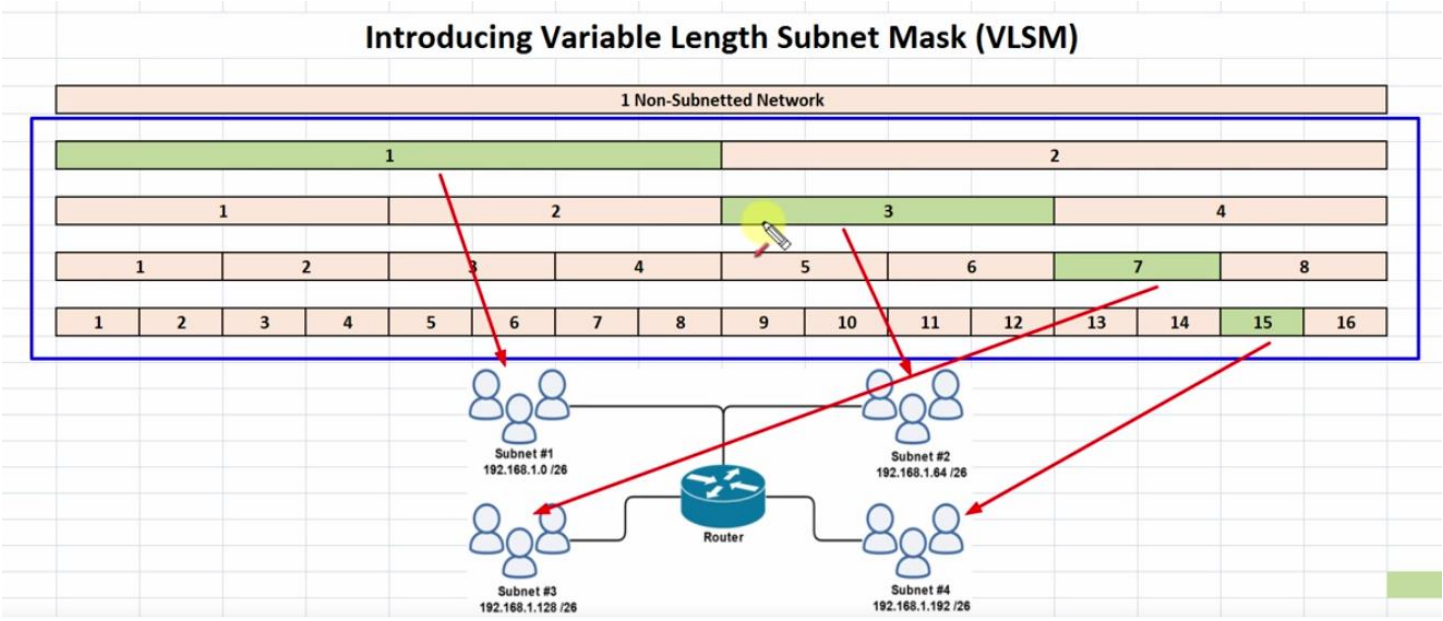
192.168.1.100 /27, 8 Subnets, 30 Hosts / Subnet

Subnet ID	Subnet Address	Host Address Range	Broadcast Address
~~1~~	~~192.168.100.0~~	~~192.168.100.1 - 192.168.100.30~~	~~192.168.100.31~~
~~2~~	~~192.168.100.32~~	~~192.168.100.33 - 192.168.100.62~~	~~192.168.100.63~~
~~3~~	~~192.168.100.64~~	~~192.168.100.65 - 192.168.100.94~~	~~192.168.100.95~~
~~4~~	~~192.168.100.96~~	~~192.168.100.97 - 192.168.100.126~~	~~192.168.100.127~~
~~5~~	~~192.168.100.128~~	~~192.168.100.129 - 192.168.100.158~~	~~192.168.100.159~~
~~6~~	~~192.168.100.160~~	~~192.168.100.161 - 192.168.100.190~~	~~192.168.100.191~~
7	192.168.100.192	192.168.100.193 - 192.168.100.222	192.168.100.223
~~8~~	~~192.168.100.224~~	~~192.168.100.225 - 192.168.100.254~~	~~192.168.100.255~~

192.168.1.100 /28, 16 Subnets, 14 Hosts / Subnet

Subnet ID	Subnet Address	Host Address Range	Broadcast Address
~~1~~	~~192.168.100.0~~	~~192.168.100.1 - 192.168.100.14~~	~~192.168.100.15~~
~~2~~	~~192.168.100.16~~	~~192.168.100.17 - 192.168.100.30~~	~~192.168.100.31~~
~~3~~	~~192.168.100.32~~	~~192.168.100.33 - 192.168.100.46~~	~~192.168.100.47~~
~~4~~	~~192.168.100.48~~	~~192.168.100.49 - 192.168.100.62~~	~~192.168.100.63~~
~~5~~	~~192.168.100.64~~	~~192.168.100.65 - 192.168.100.78~~	~~192.168.100.79~~
~~6~~	~~192.168.100.80~~	~~192.168.100.81 - 192.168.100.94~~	~~192.168.100.95~~
~~7~~	~~192.168.100.96~~	~~192.168.100.97 - 192.168.100.110~~	~~192.168.100.111~~
~~8~~	~~192.168.100.112~~	~~192.168.100.113 - 192.168.100.126~~	~~192.168.100.127~~
~~9~~	~~192.168.100.128~~	~~192.168.100.129 - 192.168.100.142~~	~~192.168.100.143~~
~~10~~	~~192.168.100.144~~	~~192.168.100.145 - 192.168.100.158~~	~~192.168.100.159~~
~~11~~	~~192.168.100.160~~	~~192.168.100.161 - 192.168.100.174~~	~~192.168.100.175~~
~~12~~	~~192.168.100.176~~	~~192.168.100.177 - 192.168.100.190~~	~~192.168.100.191~~
~~13~~	~~192.168.100.192~~	~~192.168.100.193 - 192.168.100.206~~	~~192.168.100.207~~
~~14~~	~~192.168.100.208~~	~~192.168.100.209 - 192.168.100.222~~	~~192.168.100.223~~
15	192.168.100.224	192.168.100.225 - 192.168.100.238	192.168.100.239
16	192.168.100.240	192.168.100.241 - 192.168.100.254	192.168.100.255





Certificate of Completion

This is to certify that Howard Williams successfully completed 4 hours of Introduction to IP Addressing and Subnetting the Easy Way online course on May 12, 2019

Alton Hardin

Alton Hardin, Instructor

&

Udemy

#BeAble

Certificate no: **UC-IM2S3UR3**
Certificate url: **ude.my/UC-IM2S3UR3**

http://jodies.de/ipcalc

IP Calculator

ipcalc takes an IP address and netmask and calculates the resulting broadcast, network, Cisco wildcard mask, and host range. By giving a second netmask, you can design subnets and supernets. It is also intended to be a teaching tool and presents the subnetting results as easy-to-understand binary values.

Enter your netmask(s) in CIDR notation (/25) or dotted decimals (255.255.255.0). Inverse netmasks are recognized. If you omit the netmask ipcalc uses the default netmask for the class of your network.

Look at the space between the bits of the addresses: The bits before it are the network part of the address, the bits after it are the host part. You can see two simple facts: In a network address all host bits are zero, in a broadcast address they are all set.

The class of your network is determined by its first bits.

If your network is a private internet according to RFC 1918 this is remarked. When displaying subnets the new bits in the network part of the netmask are marked in a different color

The wildcard is the inverse netmask as used for access control lists in Cisco routers.

Do you want to split your network into subnets? Enter the address and netmask of your original network and play with the second netmask until the result matches your needs.

You can have all this fun at your shell prompt. Originally ipcalc was not intended for creating HTML and still works happily in /usr/local/bin/ :-)

IPv4 Subnet Calculator

https://www.site24x7.com/tools/ipv4-subnetcalculator.html

IPv4 Subnet Calculator

The IPv4 Subnet Calculator performs subnet calculations for the given network address block, subnet mask, maximum required hosts per subnet and determines the resulting broadcast address, subnet, Cisco wildcard mask and host range.

Network Address Block	10.0.0.0/8	Host Address Range	10.0.0.1 - 10.255.255.254
Subnet Mask	255.0.0.0/8	Broadcast Address	10.255.255.255
No. of Hosts/Subnet	16777216	Wildcard Mask	0.255.255.255
Number of Subnets	1	CIDR Notation	10.0.0.0/8

Subnet Details

Subnet ID	Subnet Address	Host Address Range	Broadcast Address
1	10.0.0.0	10.0.0.1 - 10.255.255.254	10.255.255.255

Look up on youtube how to configure RW VLANs and Smartports

Follow up with these videos on RW equip.

Networking Essentials

https://www.youtube.com/playlist?list=PLwSeJ8UtSBoJOrY2DU-GIFxgRW4ahZ-Cm