



Mastering IPv4 Addressing & Subnetting

ine.com



Keith Bogart

CCIE #4923



kbogart@ine.com



@keithbogart1



linkedin.com/in/keith-bogart-2a75042



CCIE Routing & Switching

Course Objectives

- + Summarize The Structure of IPv4 Addresses
- + Explain The Functionality of IPv4 Subnet Masks
- + Identify Host, Broadcast & Network Addresses
- + Subnet IPv4 Networks
- + Identify IPv4 Address Classes & Reserved Addresses

Course Prerequisites

+ None





Network Communications Methods

ine.com

Topic Overview

- + Unicast
- + Broadcast
- + Multicast

Packet Delivery Options

- + Unicast
- + Broadcast
 - + General Broadcast / Limited Broadcast
 - + Directed Broadcast
- + Multicast





A Review Of Binary

ine.com

Topic Overview

- + Counting In Binary – A Review

Why Learn Binary?

- + IPv4 addresses are binary numbers
- + In order to master IPv4 addressing and subnetting, one must be able to rapidly convert between binary and decimal values

Decimal = **Base-10**

Binary = **Base-2**





IPv4 Address Representation

ine.com

Topic Overview

- + IPv4 Address Length & Representation

IPv4 Address Representation

- + IPv4 Addresses are 32-bits in length
- + Addresses are represented in dotted-decimal notation
- + IPv4 addresses have two components;
 - + Network portion
 - + Host portion





IPv4 Subnet Masks

ine.com

Topic Overview

+ IPv4 Subnet Masks

Purpose & Construction Of Masks

- + Subnet masks are required to identify the network portion of an address
- + Subnet Masks are 32-bits in length, represented in dotted-decimal notation or “slash” notation.
- + Each bit of a subnet mask is compared against corresponding bit-position in IPv4 address
 - + A “1-bit” in mask indicates corresponding bit in IPv4 address is part of the network portion.
 - + A “0-bit” in mask indicates corresponding bit in IPv4 address is part of the host portion.

Important Values To Remember

Binary Value	Decimal Value
00000000	0
10000000	128
11000000	192
11100000	224
11110000	240
11111000	248
11111100	252
11111110	254
11111111	255

Exercises

Translate each subnet mask shown below into decimal:

11111111. 11111111.11111111.00000000 = 255.255.255.0

11111111. 11111111.11111111.11000000 =

11111111. 11111111.11111000.00000000 =

11111111. 11111100.00000000.00000000 =

11111111. 00100100.00000000.11110000 = **NOT a valid subnet mask!**

If these subnet masks were applied against an IPv4 address, how many bits of that address would be “network bits”?:

255.255.255.0 = 24-bits of the address are networking bits.

255.255.255.192 = ____-bits of the address are networking bits.

255.255.224.0 = ____-bits of the address are networking bits.

255.240.0.0 = ____-bits of the address are networking bits.





Identifying Host, Network & Broadcast Addresses

ine.com

Topic Overview

- + Identifying Host, Network & Broadcast Addresses From A Single IP Address

Extracting Data From IPv4 Addresses

- + Once an IPv4 address has been identified (along with the associated subnet mask) critical information can be gleaned:
 - + The IPv4 network/subnet assigned to this host
 - + The IPv4 broadcast address of the local network
 - + First and last IPv4 host addresses

All zeros in the host-bits indicates the network address.

100.201.32. 0 0 0 0 0 0 0 0 /24

All ones in the host-bits indicates the broadcast address.

100.201.32. 1 1 1 1 1 1 1 1 /24

Exercises

- + Given the IP addresses below, determine if they represent network, host, or broadcast addresses:

Network	Host	Broadcast	
	X		10.20.33.39 255.255.255.224
			170.62.100.8 255.255.255.248
			27.18.130.0 255.255.192.0
			192.168.3.3 255.255.255.252
			101.38.48.0 255.255.240.0

Exercises

- + Given the IPv4 host addresses below, determine their corresponding network and broadcast addresses:

Network	Broadcast	
1.1.6.0	1.1.6.255	1.1.6.15 /24
		170.82.100.26 /29
		27.18.130.18 /25
		192.188.39.3 /18
		101.38.48.17 /30





Hey...You're In My Network!

ine.com

<https://t.me/learningnets>

Topic Overview

- + Identifying Network Ranges From Subnet Masks

Same Or Different?

- + When there is no unicast connectivity between two IPv4 hosts...troubleshooting needs to commence.
- + One of the first common troubleshooting tools is “ping”...but what to ping?
 - + If both hosts reside in the same network, ping won't help.
 - + If both hosts reside in different networks, one should ping the respective default-gateway IP addresses.
 - + So the question is, are both hosts in the same network...or different networks?

Determining Equivalency

- + The current subnet mask assigned to a host, paired with that host's IPv4 address will tell you:
 - + The Network Address for that host
 - + The size of that network (quantity of addresses)
- + Given this information along with two IP addresses, one can easily determine if those addresses reside in the same network or different networks.

Exercises

- + Given the pairs of IPv4 host addresses and masks below, determine if both addresses reside in the same network or different networks:

Same Network	Different Networks	
	X	1.1.1.61 /27 & 1.1.1.65
		170.82.100.26 /29 & 170.82.100.30
		27.18.130.126 /25 & 27.18.130.129
		192.188.70.3 /18 & 192.188.80.1
		101.38.48.121 /30 & 101.38.48.125





The Relationship of Masks & Hosts

ine.com

Topic Overview

- + Identifying Quantities Of Available Hosts Per Network

Masks & Hosts

- + IPv4 Subnet Masks have an inverse relationship to host quantities:
 - + The more “1s” that are in the mask...the less hosts that are available in the network
 - + The less “1s” that are in the mask...the more hosts that are available in the network
- + Which of the following subnet masks support the greatest quantity of host addresses for its respective network?
 - + 255.255.255.248
 - + 255.255.255.192

Masks & Hosts

- + The quantity of usable host addresses available within a network/subnet can be derived using a simple formula:

$$2^h - 2 = \text{Available Hosts}$$

“h” = available host bits.

Exercises

- + Identify the maximum quantity of host addresses that are available given the following Subnet Masks:

Mask	Hosts Available
255.255.255.0	254
255.255.255.192	
255.255.255.248	
255.255.252.0	
255.255.224.0	





IPv4 Subnetting

Overview & Same-Length Method

ine.com

Topic Overview

- + IPv4 Subnetting Using Same-Length Subnetting Method

Purpose & Practice Of IPv4 Subnetting

- + Why do we need to subnet IPv4 networks?
- + Same-Length subnetting method

Same Length Subnetting

- + Subnetting based on quantities of networks needed:

$$2^{\text{sn}} = \text{Available Subnets}$$

“sn” = subnetting bits.

Exercises

Starting Network & Mask	Quantity of Subnets Needed	Subnet Bits Needed	New Subnet Mask	Subnet Increments	Third Subnet
190.1.1.0/24	8	3	/27 or 255.255.255.224	32	190.1.1.64
55.2.32.0/24	22				
3.42.100.0/24	55				
99.10.32.0/19	140				
120.18.96.0/22	241				





IPv4 Subnetting

Variable Length Subnetting

ine.com

Topic Overview

- + IPv4 Subnetting Using VLSM Method

VLSM

- + What is VLSM?
- + Why do we need VLSM?

VLSM Chart

Total Addresses Available / Network Increments	Host Addresses Available	Subnet Mask
4	2	/30 or 255.255.255.252
8	6	/29 or 255.255.255.248
16	14	/28 or 255.255.255.240
32	30	/27 or 255.255.255.244
64	62	/26 or 255.255.255.192
128	126	/25 or 255.255.255.128
256	254	/24 or 255.255.255.0
512	510	/23 or 255.255.254.0

VLSM Example

Starting Network = 50.50.50.0 /24

Subnet Identifier	Quantity of Hosts Needed	Host Bits Needed	New Subnet Mask	Subnet Increments	Subnet Address
A	2				
B	22				
C	12				
D	61				
E	5				

VLSM Exercise

Starting Network = 40.40.8.0 /21

Subnet Identifier	Quantity of Hosts Needed	Host Bits Needed	New Subnet Mask	Subnet Increments	Subnet Address
A	59				
B	305				
C	12				
D	176				
E	5				





IPv4 Address Classes

ine.com

Topic Overview

- + IPv4 Address Classes & Their Relevance For Today

IPv4 Address Classes

- + Brief history of IPv4
- + What were the IPv4 address classes?
- + Why do we still need to know this?





IPv4 Address Types

ine.com

Topic Overview

- + Identifying Different Reserved & Special IPv4 Addresses

IPv4 Address Types

- + IPv4 addresses fall into different categories
- + Some categories can be assigned to a NIC, and others can't.
- + Some categories of addresses are suitable for packet handling on the public Internet...others are not.
- + IPv4 Address Types
 - + Private Addresses
 - + Loopback Addresses
 - + APIPA
 - + Default Route
 - + Public Addresses





Course Conclusion

ine.com

