IP Addressing

IPv4 Addressing : 8 -1

Internet Protocol Version 4 (IP*v*4) Addressing:

- Written in *dotted-decimal* notation
  - 10.1.2.3
  - 172.21.243.67
- Each IPv4 address is divided into 4 separate numbers and divided by dots
- Each of these division are call octets due to having 8 bits assigned
- 32-bits in length

	1st Octet	2nd Octet	3rd Octet	4th Octet
Dotted-Decimal	192	168	1	4
Binary Digits	11000000	10101000	00000001	00000100

IPv4 Addressing:

- IPv4 address is divided into network and host portions
- Subnet mask defines the network portion
  - Network portion if a binary 1
  - Host portion if binary 0

IP Address (In Decimal)	192	168	1	4
IP address	11000000	10101000	00000001	00000100
Subnet mask	255	255	255	0
Subnet mask	11111111	11111111	11111111	00000000
	Network bits	*Network bits*	*Network bits*	*Host bits*

Classes of IP Addresses:

- Default subnet mask assigned by first octet
  - Classful Masks if using default subnet mask

- Defines the Class of IP Address

Address Class	Value in First Octet	Classful Mask (Dotted Decimal)	Classful Mask (Prefix Notation)
Class A	1 – 126	255.0.0.0	/8
Class B	128 – 191	255.255.0.0	/16
Class C	192 – 223	255.255.255.0	/24
Class D	224 – 239	n/a	n/a

Notice that 127 is skipped between Class A and Class B, It is a reserved block for the loopback address (127.0.0.1)

Routable IPs:

- Publically routable IP addresses are globally managed by ICANN
  - Internet Corporation for Assigned Names and Numbers
    - ARIN, LACNIC, AFNIC, APNIC, and RIPE NCC
- Public IP's must be purchased before use through your Internet Service Provider

Private IPs:

- Private IP's can be used by anyone
- Not routable outside your local area network
- Network Address Translation (NAT) allows for routing of private IPs through a public IP

Address Class	Address Range	Default Subnet Mask
Class A	10.0.0.0 – 10.255.255.255	255.0.0.0
Class B	172.16.0.0 – 172.31.255.255	255.255.0.0
Class C	192.168.0.0 – 192.168.255.255	255.255.255.0

Specialized IPs:

- Loopback addresses (127.x.x.x range)
  - Refers to the device itself and used for testing
  - Most commonly used as 127.0.0.1

- Automatic Private IP Addresses (APIPA)
  - Dynamically assigned by OS when DHCP server is unavailable and address not assigned manually
  - Range of 169.254.x.x

Description	Address Class	Address Range	Default Subnet Mask
Loopback	Class A	127.0.0.1 – 127.255.255.255	255.0.0.0
APIPA	Class B	169.254.0.0 – 169.254.255.255	255.255.0.0

Special address ranges never assigned by an administrator or DHCP server

Identifying Networks and Hosts in IPv4 :

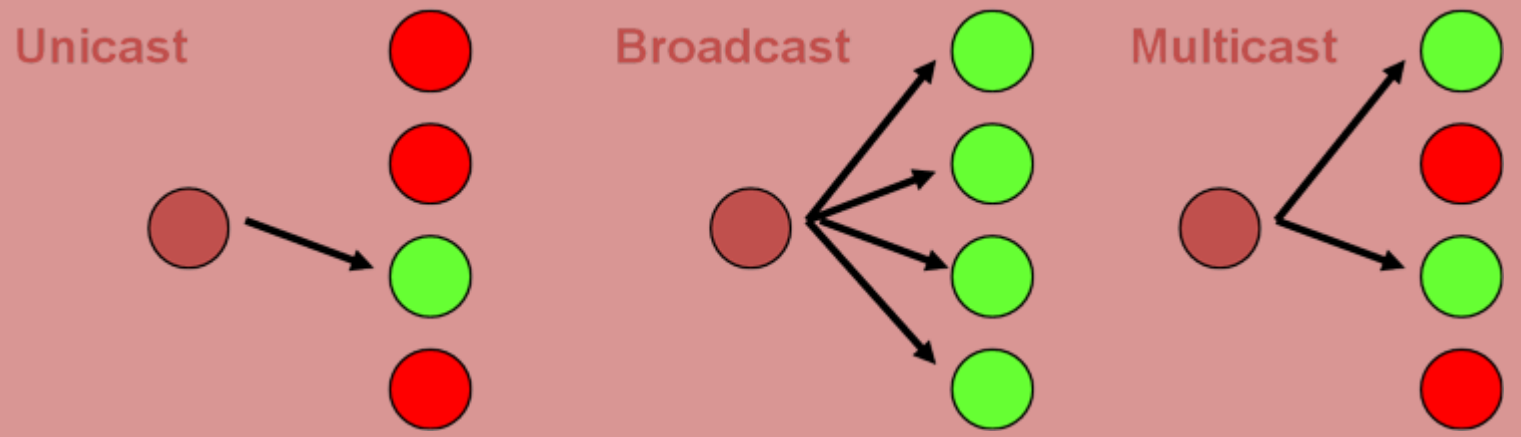
- Class A network address example:
  - IP Address: 114.56.20.33
    Subnet Mask: 255.0.0.0

- Class B network address example:
  - IP Address: 147.12.38.81
  - Subnet Mask: 255.255.0.0

- Class C network address example:
  - IP Address: 214.51.42.7
  - Subnet: 255.255.255.0

Network | Host

IPv4 Data Flows : 8 - 2



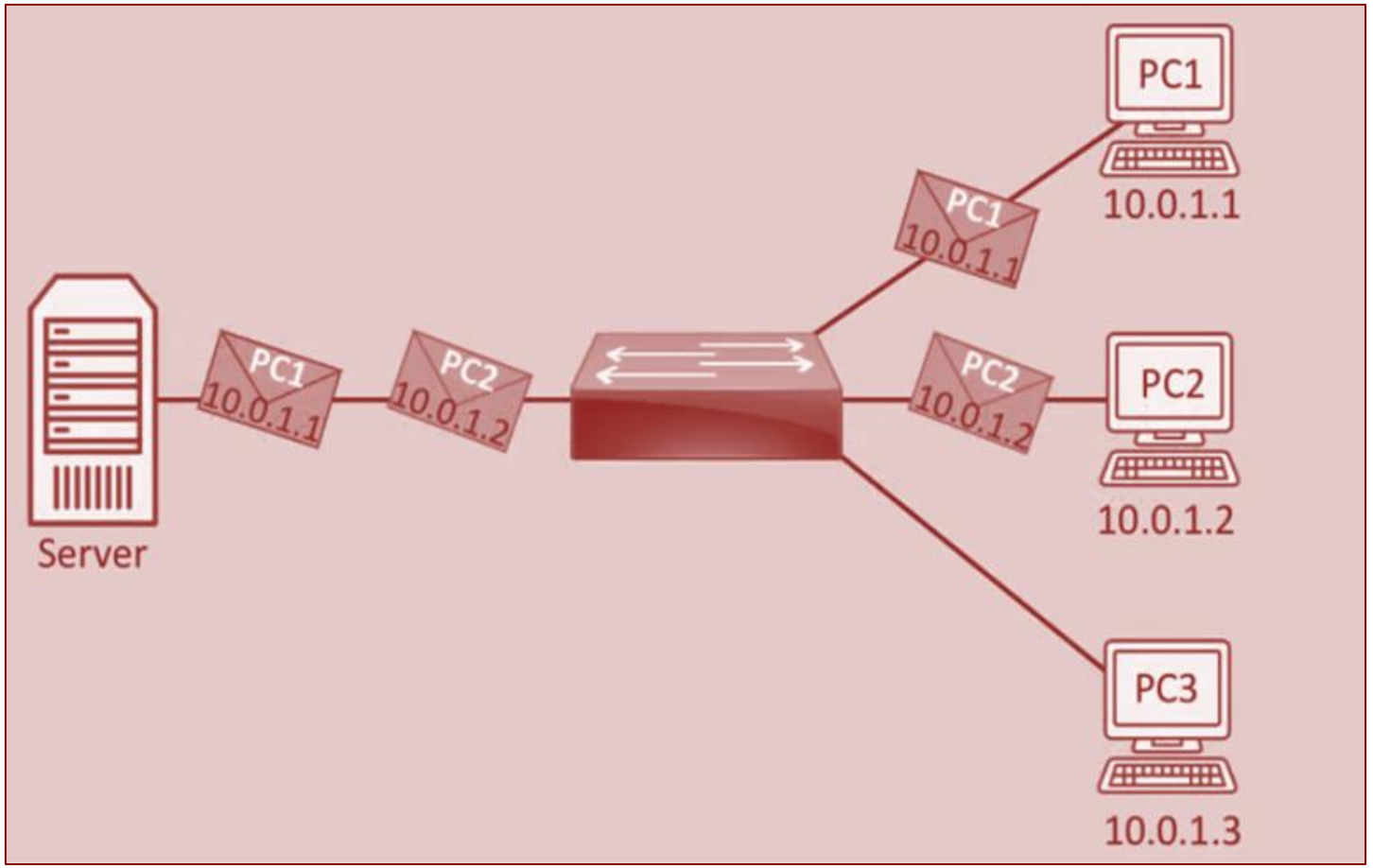
Data Flows Types:

- Unicast
  - Data travels from a single source device to a single destination device
- Multicast
  - Data travels from a single source device to multiple (but specific) destination devices
- Broadcast
  - Data travels from a single source device to all devices on a destination network

Multicast Range:	223- 239

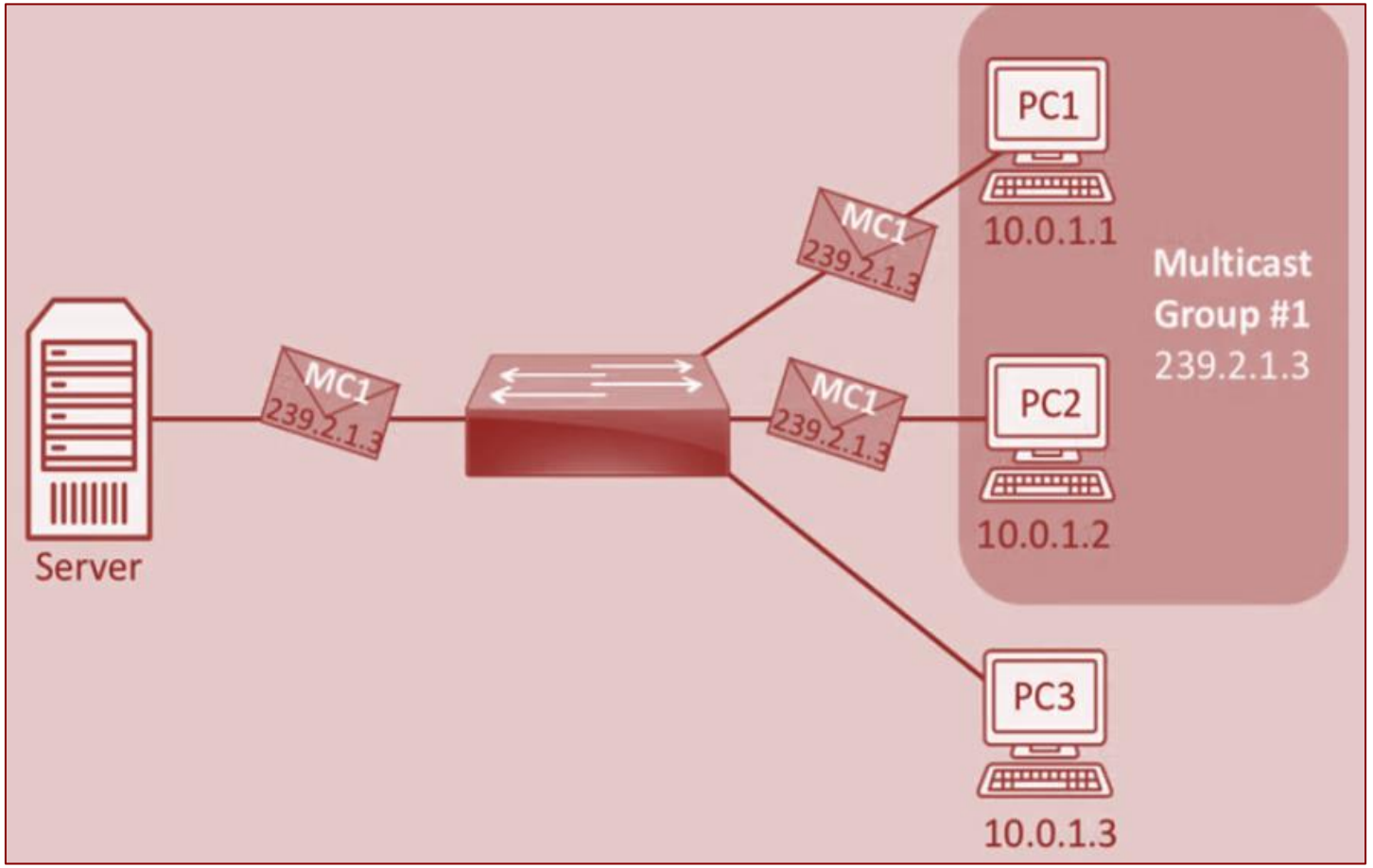
Unicast Data Flow:

Data travels from a single source device to a single destination device



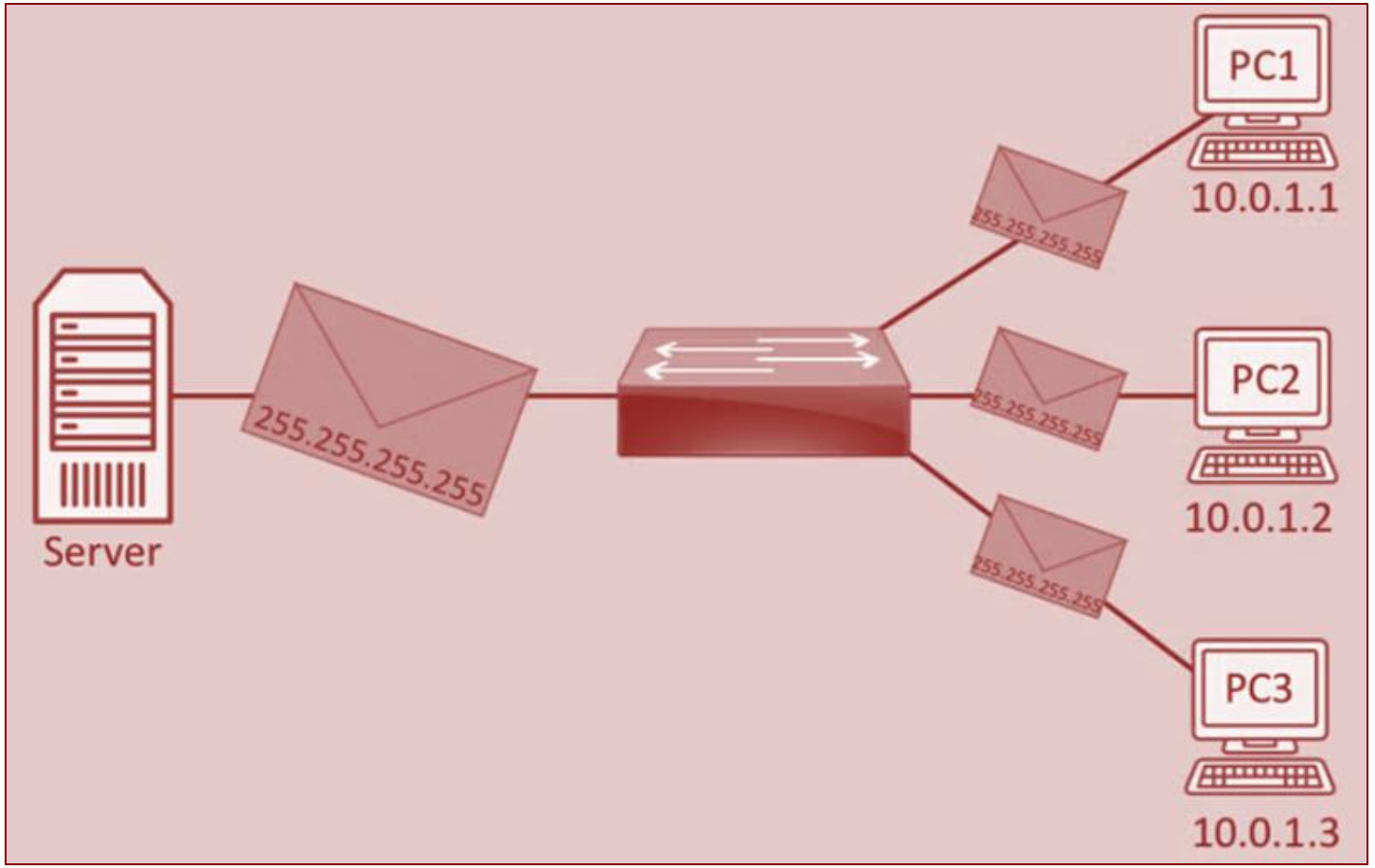
Multicast Data Flow:

Data travels from a single source device to a Multiple (*but specific*) destination devices



Broadcast Data Flow:

Data travels from a single source device to all devices on a destination network



Assigning IP Addresses: 8 - 3

Assigning IP Addresses::

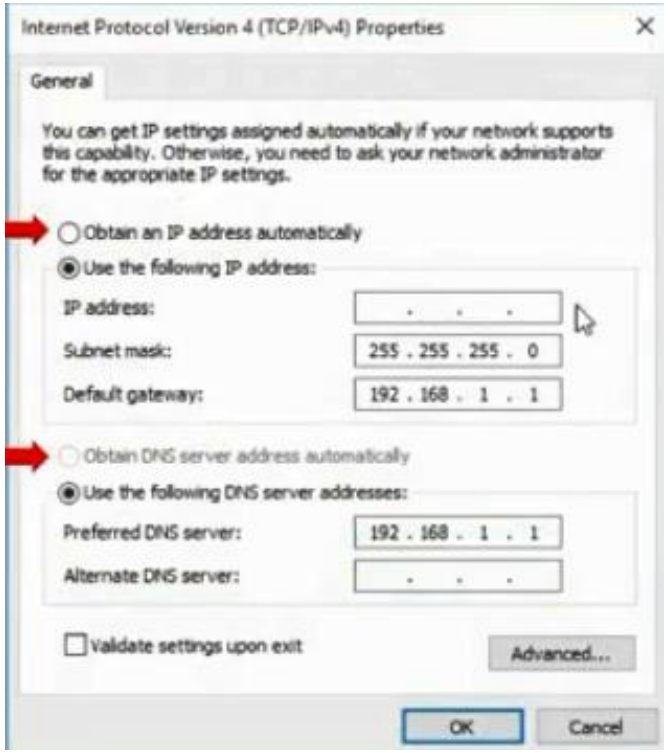
- Static
  - Simple
  - Time-consuming
  - Prone to human errors
  - Impractical for large networks
- Dynamic
  - Quicker
  - Easier
  - Less confusing
  - Simplistic for large networks

Components on an IP Address:

- Information assigned from static or dynamic
  - IP Address
  - Subnet Mask
  - Default Gateway
  - Server addresses
    - DNS
      - Converts domain names to IP address
    - WINS (optional)
      - Converts NetBIOS computer name into an IP address

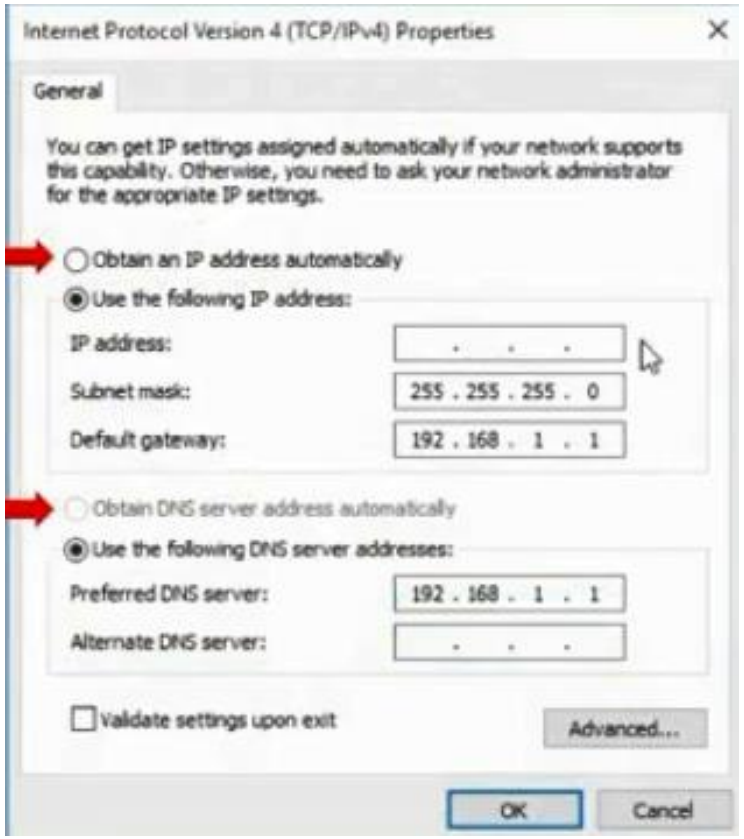
Dynamic Host Configuration Protocol (DHCP) Configuration:

- Based on the older Bootstrap Protocol (BOOTP for short)
  - Required static database of IP and MAC to assign
- DHCP service assigns an IP from an assignable pool (scope)
- IP Address Management is a piece of software used to manage the IP's being assigned



Dynamic Host Configuration Protocol (DHCP) Configuration:

- Provides clients with
  - IP
  - Subnet mask
  - Default gateway
  - DNS server
  - WINS server
  - Other variables needed for VoIP
- Each IP is leased for a given amount of time and given back to the pool when lease expires (TTL)



Automatic Private IP Address (APIPA):

- Used when device does not have a static IP address and cannot reach a DHCP server
- Allows a network device to self-assign an IP address from the 169.254.0.0/16 network
- Designed to allow quick configuration of a LAN without need for DHCP
- Non-routable but allows for network connectivity inside the local subnet

Zero Configuration (Zeroconf):

- Newer technology based on APIPA providing:
  - Assigning link-local IP addresses
    - Non-routable IP usable only on local subnet
  - Resolving computer names to IP addresses without the need for DNS server on local network
    - mDNS - Multicast Domain Name Server
  - Locating network services
    - Provides service discovery protocols
      - Service Location Protocol (SLP)
      - Microsoft's Simple Service Discovery Protocol (SSDP)
      - Apple's DNS-based Service Discovery (DNS-SD)

Computer Mathematics : 8 - 4

Computer Mathematics:

- Humans count using Base-10 numbers
  - Decimals
  - 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, …
- Computers and networks do not understand decimal numbers natively
- Process numbers using Base-2 numbers
  - Binary
  - 0, 1, 10, 11, …

Converting Binary to Decimal:

- Use table to convert from binary to decimal
- Each number is a factor of 2
- Starting from the right and go to the left

128 (2^7)	64 (2^6)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	2 (2^1)	1 (2^0)

Converting Binary to Decimal:

- Populate the table with the binary digits
- Add up any columns that contain a 1

128 (2^7)	64 (2^6)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	2 (2^1)	1 (2^0)

10010110

128 (2^7)	64 (2^6)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	2 (2^1)	1 (2^0)
1	0	0	1	0	1	1	0

Converting Binary to Decimal:

128 (2^7)	64 (2^6)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	2 (2^1)	1 (2^0)
1	0	0	1	0	1	1	0

10010110

→ 128 + 16 + 4 + 2

→ 150

Converting Decimal to Binary :

- Use subtraction to convert decimal to binary

Convert 167 into decimal

128 (2^7)	64 (2^6)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	2 (2^1)	1 (2^0)
1	0	1	0	0	1	1	1

Computer Mathematics Practice: 8 - 5

Converting Binary to Decimal:

Convert 01101011
to decimal

128 (2^7)	64 (2^6)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	2 (2^1)	1 (2^0)

Converting Binary to Decimal:

Convert 01101011
to decimal

128 (2^7)	64 (2^6)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	2 (2^1)	1 (2^0)
0	1	1	0	1	0	1	1

→ 64 + 32 + 8 + 2 + 1

→ 107

Converting Binary to Decimal:

Convert 10010100
to decimal

128 (2^7)	64 (2^6)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	2 (2^1)	1 (2^0)

Converting Binary to Decimal:

128 (2^7)	64 (2^6)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	2 (2^1)	1 (2^0)
1	0	0	1	0	1	0	0

→ 128 + 16 + 4

→ 148

Converting Decimal to Binary :

Convert 49
to binary

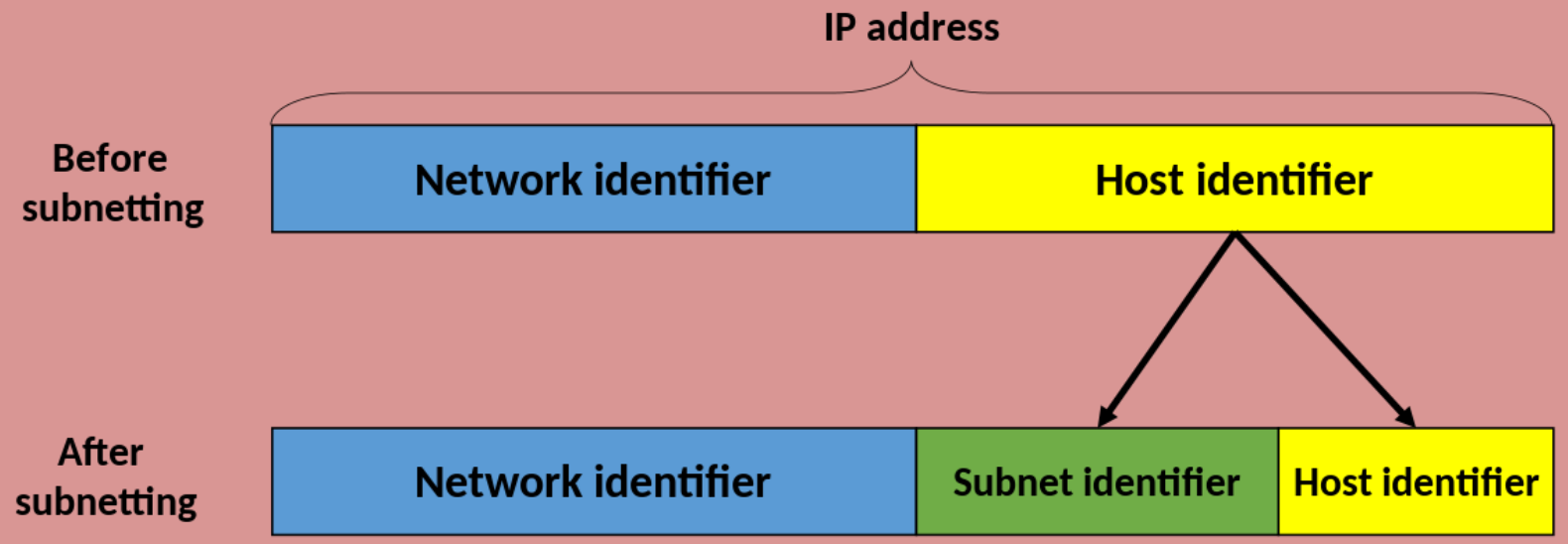
128 (2^7)	64 (2^6)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	2 (2^1)	1 (2^0)

Converting Decimal to Binary :

Convert 49
to binary

128 (2^7)	64 (2^6)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	2 (2^1)	1 (2^0)
0	0	1	1	0	0	0	1

Subnetting: 8 - 6



Subnetting:

- Default classful subnet masks are rarely the optimal choice for a subnet size
- Subnets can be modified using subnet masks to create networks that are better scoped
- Creating a subnet involves borrowing bits from the original host portion and adding them to the network portion

Purpose of Subnets:

- More efficient use of IP addresses than classful default
- Enables separation of networks for security
- Enables bandwidth control

Address Class	Default Subnet Mask	Assignable IP Calculation	Assignable IP Addresses
Class A	255.0.0.0	$2^{24} - 2 =$	16,777,214
Class B	255.255.0.0	$2^{16} - 2 =$	65,534
Class C	255.255.255.0	$2^{8} - 2 =$	254

Subnet Masks:

Classful Subnets

Dotted-Decimal Notation	CIDR	Binary Notation
255.0.0.0	/8	11111111.00000000.00000000.00000000
255.255.0.0	/16	11111111.11111111.00000000.00000000
255.255.255.0	/24	11111111.11111111.11111111.00000000
255.255.255.128	/25	11111111.11111111.11111111.10000000
255.255.255.192	/26	11111111.11111111.11111111.11000000
255.255.255.224	/27	11111111.11111111.11111111.11100000
255.255.255.240	/28	11111111.11111111.11111111.11110000
255.255.255.248	/29	11111111.11111111.11111111.11111000
255.255.255.252	/30	11111111.11111111.11111111.11111100

Subnetting Formulas:

- Number of Created Subnets = 2^s,
  where *s* is the number of borrowed bits

- Number of Assignable IP Addresses = $2^h - 2$,
  where *h* is the number of host bits

Classful *VS* Subnetted Networks:

- Classful subnet (192.168.1.0/24)
  - 1 network (2^0), where *s* is the number of borrowed bits
  - 256 IPs (2^8), where *h* is the number of host bits

192	168	1	0
255	255	255	0
11111111	11111111	11111111	00000000
Network Bits			Host Bits

- Classless subnet (192.168.1.64/26)
  - 4 networks (2^2), where *s* is the number of borrowed bits
  - 64 IPs (2^6), where *h* is the number of host bits

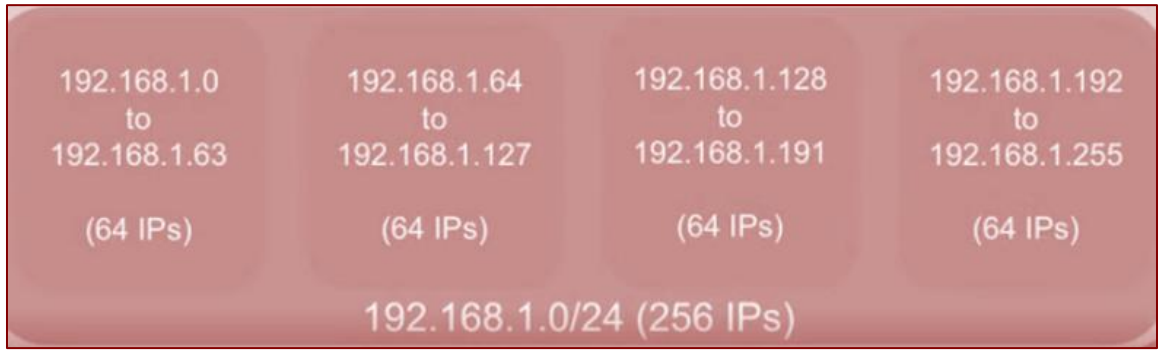
192	168	1	64	0
255	255	255	192	0
11111111	11111111	11111111	11	000000
Network Bits			Sub	Host Bits

Calculating Number of Subnets:

192.168.1.0/26

- Default mask is /24, so we *borrowed* 2 bits from the host space

$2^s = 2^2 = 4$,
which means there are four created subnets



Calculating Number of IPs:

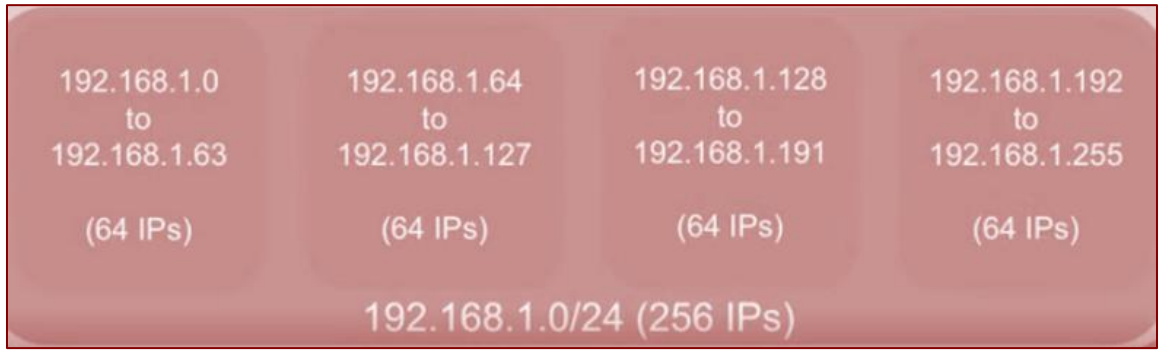
192.168.1.0/26

- Total bits are 32 and the mask is /26

32 – 26 = 6 host bits (h)

$2^h - 2 = 2^6 - 2 = 64 - 2 = 62$

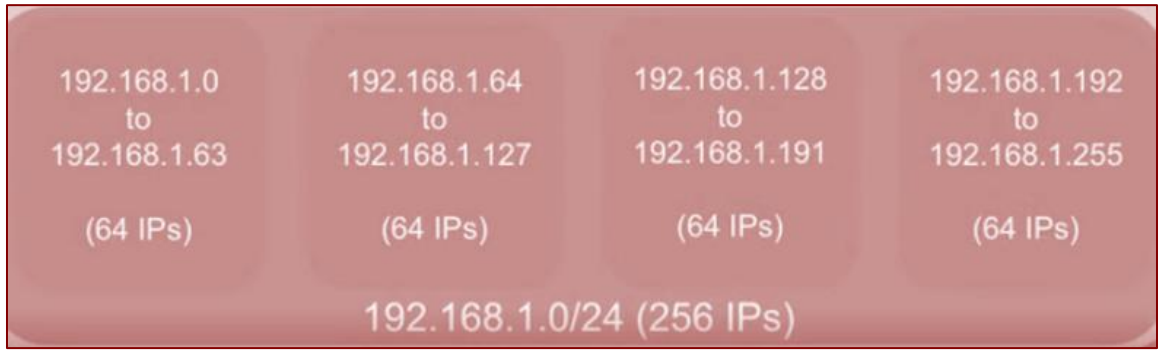
62 assignable IPs in each subnet



Listing Subnets:

192.168.1.0/26

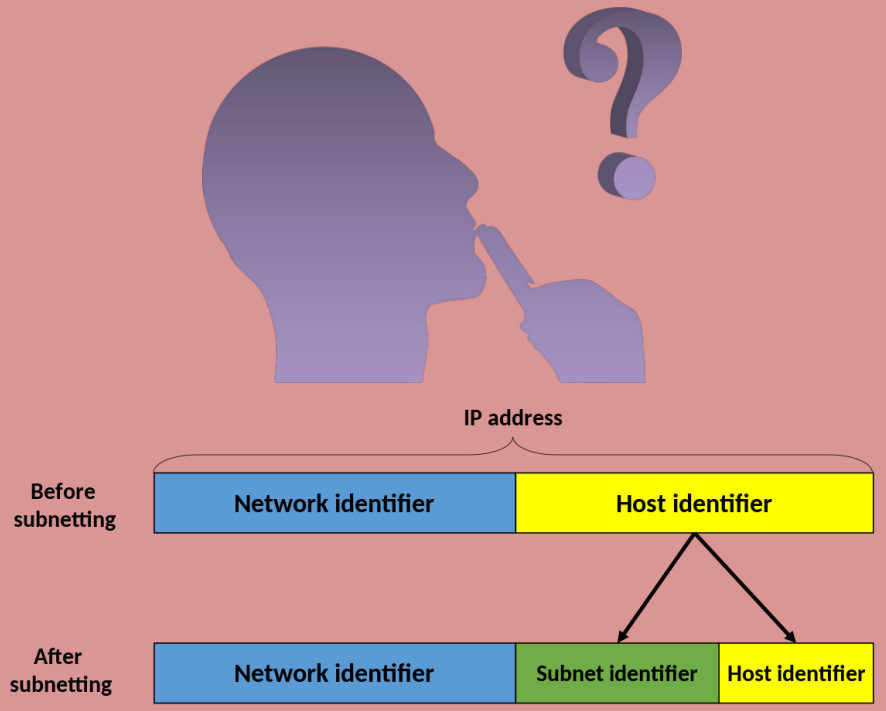
- *Created 4 subnets of 62 usable IPs each*
- *Where does each network begin and end?*
- *Network ID (First IP)*
  0, 64, 128, 192
- *Broadcast (Last IP)*
  63, 127, 191, 255



Subnetting Tip:

CIDR	# Subnets	# IPs
/30	64	4
/29	32	8
/28	16	16
/27	8	32
/26	4	64
/25	2	128

Subnetting Practice: 8 - 7



Subnetting Practice – 1:

CIDR	# Subnets	# IPs
/30	64	4
/29	32	8
/28	16	16
/27	8	32
/26	4	64
/25	2	128

- How many **assignable** IP addresses exist in a network 172.16.1.0/27?

1.	**30**
2.	32
3.	14
4.	64

Subnetting Practice – 2:

CIDR	# Subnets	# IPs
/30	64	4
/29	32	8
/28	16	16
/27	8	32
/26	4	64
/25	2	128

- How many **assignable** IP addresses exist in a network 192.168.1.0/28?

1.	30
2.	16
3.	**14**
4.	64

Subnetting Practice – 3:

CIDR	# Subnets	# IPs
/30	64	4
/29	32	8
/28	16	16
/27	8	32
/26	4	64
/25	2	128

You are a network administrator for a company, The company decided to open a new departments in its new branch, You will need to subnet the private IP address range given to you into several smaller networks to serve each department.

The new office location has been assigned the range of **10.10.10.0/24**

When you setup the network, You need to configure separate subnets for each department in the new offices. **You should allocate the addressing using CIDR notation and prove each department the minimum number of IP addresses that will meet their needs.**

The new departments have the following number of users shown in the table

Department name	Number of users
IT	54
Instructors	32
Sales	5
Administrative	3
Unused	------

Subnetting Practice – 3:

Since you have a CIDR of (10.10.10.0/24), Which means you have 256 IP to work with.

CIDR	# Subnets	# IPs
/30	64	4
/29	32	8
/28	16	16
/27	8	32
/26	4	64
/25	2	128

Department name	Number of users
IT	54
Instructors	32
Sales	5
Administrative	3
Unused	------

- First, We round up our department number to the next highest multiple of 2. **Remember, the numbers provided are for the users (computers), we still need to add 2 IPs (one for the Network and the other for the broadcast).**
- IT: 54+2 = 56 → Now, Round (56) to the nearest multiple of (2) → (64)
- Instructors: 32+2 = 34 → Now, Round (34) to the nearest multiple of (2) → (64)
- Sales: 5+2 = 7 → Now, Round (7) to the nearest multiple of (2) → (8)
- Administrative: 3+2 = 5 → Now, Round (5) to the nearest multiple of (2) → (8)
- Unused: 256-64-64-8-8 = 112 → Now, **Round down (112) because it is Unused** to the nearest multiple of (2) → (64) Unused IPs.

- The New Subnets CIDR are:
- IT= / 26
- Instructors= / 26
- Sales= / 29
- Administrative= /29
- Unused= / 26

IPv6 Addresses: 8 - 8

IPv6

Internet Protocol version 6 (IP *V*6):

- We've essentially ran out of IPv4 addresses due to proliferation of networked devices
- IPv6 addressing provides enough IP addresses for generations to come
- Enough IPv6 addresses for every person on the planet (5×10^{28})

IPv4 = 2^{32} = 4.2 billion addresses

IPv6 = 2^{128} = 340 undecillion addresses

IP*v*6 Benefits:

- No broadcasts
- No fragmentation
  - Performs MTU (maximum transmission units) discovery for each session
- Can coexist with IPv4 during transition
  - Dual stack (run IPv4 and IPv6 simultaneously)
  - IPv6 over IPv4 (tunneling over IPv4)
- Simplified header
  - 5 fields instead of 12 fields

Headers (IP*v*4 and IP*v*6):

Headers IP *V*4

Headers IP *V*6

IP*v*6 Address Structure:

- Each hexadecimal digit is 4-bits
- 128-bits in an IPv6 address
- No more than 32 hexadecimal digits

201b:5c86:11d1:456e:3456:abc0:ddea:12ab

2018:0:0:0000:0:000:4815:54ae

Consecutive groups of 0's can be summarized as ::

2018::4815:54ae

IP*v*6 Address Types:

- Globally routable unicast addresses
  - Begins with 2000 to 3999
- Link-local address
  - Begins with FE80
- Multicast addresses
  - Begins with FF

Do we need DHCP for IP*v*6?

- IPv6 uses auto configuration to discover the current network and selects its own host ID based on its MAC using the EUI64 process
- If you want to still use DHCP, there is a DHCPv6 protocol
- IPv6 uses Neighbor Discovery Protocol (NDP) to learn the Layer 2 addresses on the network

Chapter 8- Questions:

Question#1:

A networked host with unknown address can be reached via:

A. Unicast

B. Multicast

C. Broadcast

Question#2:

A type of network traffic intended for a particular group of hosts is called:

A. Unicast

B. Multicast

C. Broadcast

Question#3:

A type of network traffic intended for a single host identified by a unique IP address is referred to as:

A. Unicast

B. Multicast

C. Broadcast

Question#4:

An IPv4 address consists of:

A. 32 bits

B. 48 bits

C. 64 bits

D. 128 bits

Question#5:

Which of the answers listed below refers to a binary representation of the decimal number 192?

A. 10101100

B. 11000000

C. 01100010

D. 10101010

Question#6:

IPv4 addresses are expressed with the use of:

A. Octagonal numbers

B. Binary numbers

C. Hexadecimal numbers

D. Decimal numbers

Question#7:

Which of the following answers lists a decimal notation of the binary number 10101100?

A. 168

B. 172

C. 192

D. 224

Question#8:

Which of the answers listed below refer to an IPv4 loopback address?

A. ::1

B. FE80::/10

C. 0:0:0:0:0:0:0:1

D. 169.254/16

E. 127.0.0.1

Question#9:

An IPv6 address consists of:

A. 32 bits

B. 48 bits

C. 64 bits

D. 128 bits

Question#10:

IPv6 addresses are expressed with the use of:

A. Octagonal numbers

B. Binary numbers

C. Hexadecimal numbers

D. Decimal numbers

Question#11:

A double colon in an IPv6 address indicates that part of the address containing only zeros has been compressed to make the address shorter.

A. True

B. False

Question#12:

Which of the following answers refer to IPv6 loopback addresses? (Select 2 answers)

A. 127.0.0.1

B. 0:0:0:0:0:0:0:1

C. 169.254/16

D. ::1

E. FE80::/10

Question#13:

Which of the answers listed below refers to an IPv6 link-local address?

A. 2002::/16

B. FE80::/10

C. 2001::/32

D. ::1/128

Question#14:

Which of the following answers lists a valid address of

FE80:00A7:0000:0000:02AA:0000:4C00:FE9A after compression?

A. FE80:00A7::2AA:0:4C:FE9A

B. FE80:A7::2AA::4C00:FE9A

C. FE80:00A7::2AA:0:4C00:FE9A

D. FE80:A7::2AA:0:4C00:FE9A

Question#15:

A limited IPv4-to-IPv6 transition mechanism that allows for encapsulation of IPv6 packets in IPv4 packets transmitted over IPv4 networks is referred to as:

A. 6to4

B. 802.3af

C. eDiscovery

D. Miredo

Question#16:

The term "Dual-stack IP" refers to a solution that relies on implementing both IPv4 and IPv6 protocol stacks on various network devices to facilitate seamless migration from IPv4 to IPv6.

A. True

B. False

Question#17:

An IPv6 protocol performing the function of IPv4's Address Resolution Protocol (ARP) is called:

A. NCP

B. NDP

C. NTP

D. NDR

Question#18:

Which IPv6 protocol is used by networked hosts to determine the link layer address of adjacent nodes?

A. NCP

B. NDP

C. NTP

D. NDR

Question#19:

An IPv6 protocol used by routers to advertise their presence on a network is known as:

A. NCP

B. NDP

C. NTP

D. NDR

Question#20:

Which of the following answers refer to the characteristic features of the 10.0.0.0 - 10.255.255.255 (10.0.0.0/8) IPv4 address space? (Select 2 answers)

A. Class A range

B. Public IP address range

C. Class B range

D. Non-routable (private) IP address range

E. Class C range

Question#21:

Which of the answers listed below refer to the 172.16.0.0 - 172.31.255.255 (172.16.0.0/12) IPv4 address space? (Select 2 answers)

A. Class A range

B. Public IP address range

C. Class B range

D. Non-routable (private) IP address range

E. Class C range

Question#22:

What are the characteristic features of the 192.168.0.0 - 192.168.255.255 (192.0.0.0/24) IPv4 address space? (Select 2 answers)

A. Class A range

B. Public IP address range

C. Class B range

D. Non-routable (private) IP address range

E. Class C range

Question#23:

Which of the following answers refers to an IPv4 address range used for loopback addresses?

A. 0.0.0.0 – 0.255.255.255 (0.0.0.0/8)

B. 127.0.0.0 – 127.255.255.255 (127.0.0.0/8)

C. 169.254.0.0 – 169.254.255.255 (169.254.0.0/16)

D. 240.0.0.0 – 255.255.255.254 (240.0.0.0/4)

Question#24:

Which of the answers listed below refers to an IPv4 address range reserved for future use?

A. 10.0.0.0 - 10.255.255.255 (10.0.0.0/8)

B. 172.16.0.0 - 172.31.255.255 (172.16.0.0/12)

C. 192.168.0.0 - 192.168.255.255 (192.0.0.0/24)

D. 240.0.0.0 – 255.255.255.254 (240.0.0.0/4)

Question#25:

In a network using subnets, the term "Default gateway" refers to a network device (e.g. router) that enables exchange of data between hosts residing in different subnets.

A. True

B. False

Question#26:

An IP address that doesn't correspond to any actual physical network interface is called a virtual IP address (VIP/VIPA).

A. True

B. False

Question#27:

Which of the following allows to determine which network segment an IP address belongs to?

A. Physical address

B. Dynamic Host Configuration Protocol (DHCP)

C. Address Resolution Protocol (ARP)

D. Subnet mask

Question#28:

In IPv4 addressing, the leading octet of an IP address with a value of 1 through 126 denotes that the IP address within that range belongs to the:

A. Class A address space

B. Class B address space

C. Class C address space

D. Class D address space

Question#29:

Which of the answers listed below refers to an example of a valid subnet mask?

A. 255.255.225.0

B. 255.255.191.0

C. 255.255.127.0

D. 255.255.64.0

E. None of the above is a valid subnet mask

Question#30:

Which of the following answers lists the default (classful) subnet mask for a class A network?

A. 255.0.0.0

B. 255.128.0.0

C. 224.0.0.0

D. 255.224.0.0

Question#31:

What is the leading octet value range for an IPv4 address belonging to a class B network?

A. 128 - 191

B. 1 – 126

C. 192 – 223

D. 224 - 239

Question#32:

Which of the following answers refer to the IPv4 multicast address block? (Select 2 answers)

A. 128 – 191

B. Class B range

C. 192 – 223

D. Class C range

E. 224 – 239

F. Class D range

Question#33:

Which of the answers listed below refers to a solution that replaces the classful network design?

A. VLAN

B. RSTP

C. SNAT

D. CIDR

Question#34:

Which of the following answers lists the CIDR notation of the 255.255.255.224 subnet mask?

A. /25

B. /26

C. /27

D. /28

Question#35:

Which of the answers listed below refers to a permanent assignment of an IP address?

A. Static IP address

B. Private IP address

C. Dynamic IP address

D. Public IP address

End