

IP Addressing

17CS52 - CN: L07/08

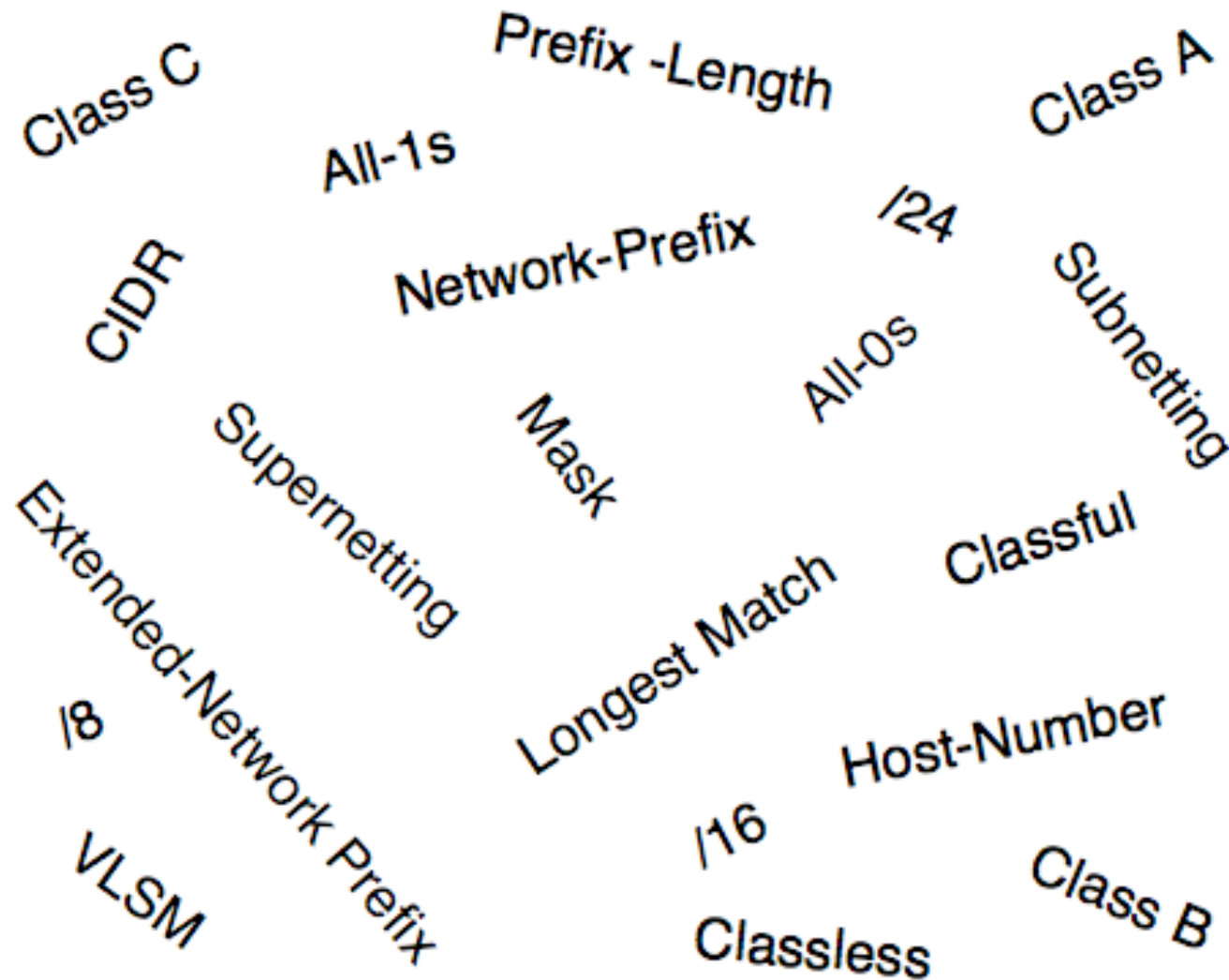
Dr. Ram P Rustagi
Sem V (2019-H2)
Dept of CSE, KSIT
rprustagi@ksit.edu.in

<https://www.youtube.com/watch?v=H4IrvTCDu4M>
<https://www.youtube.com/watch?v=zbOyrZr-Slc>

IP Addressing

- Understanding terms to use
 - Naming
 - Identifies what it is
 - Addressing
 - Identifies where it is
 - Routing
 - Identifies how to reach it
- Examples:
 - Name: KS Institute of Technology
 - Address: Raghuvanhalli, Kankapura Road
 - Routing: Need to map to find directions from starting point.

Understanding IP Addressing: Everything You Ever Wanted To Know



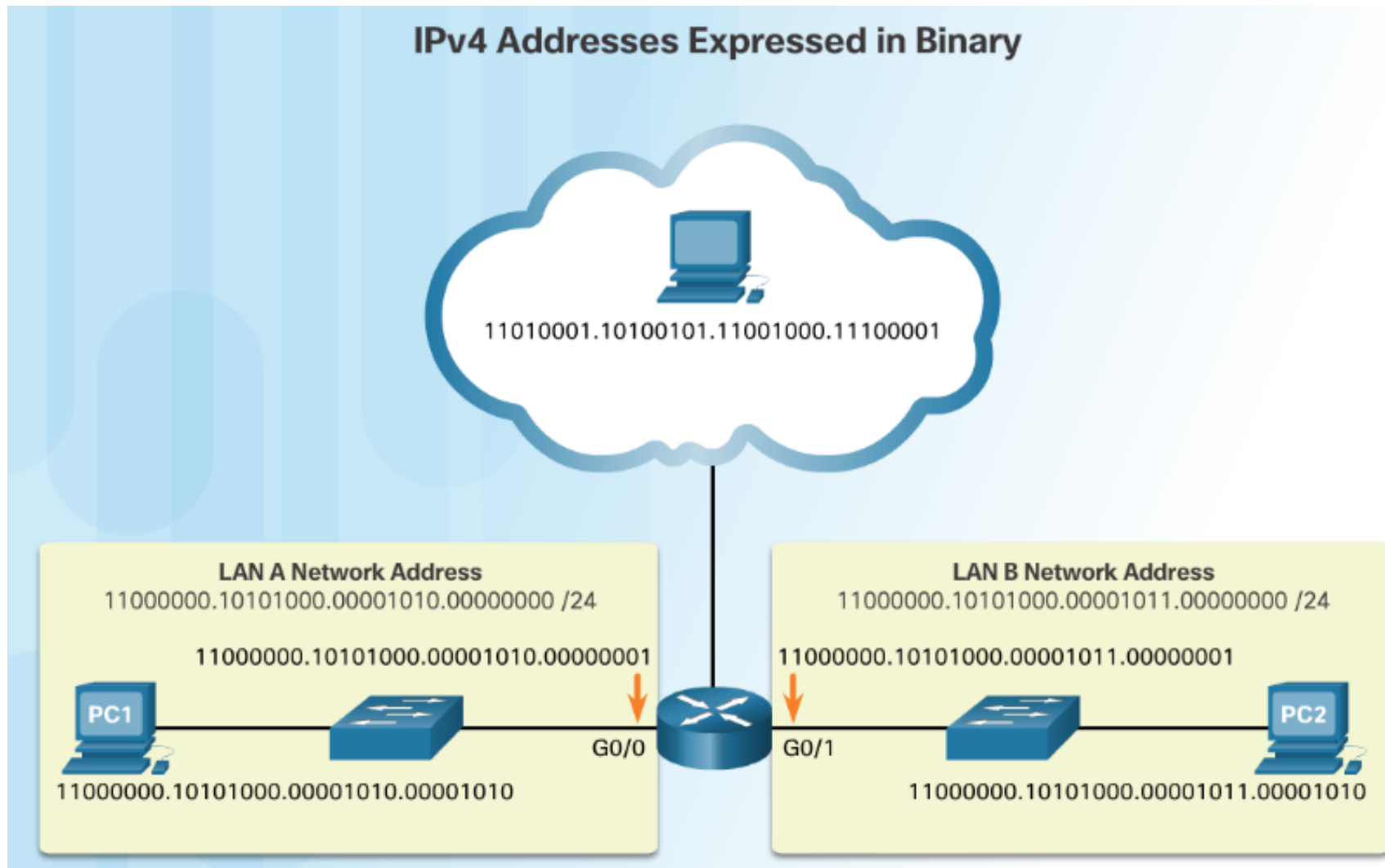
src: Chuck Semeria, NSD Marketing, 3Com Corp, 1996

Example

- Consider the website: www.rprustagi.com
- Name:
 - Identifies the website rprustagi.com
- Address (IP Address)
 - 69.161.146.196
- Route: Use **tracert** to find the route
 - 192.168.1.1
 - abts-kk-dynamic-001.4.179.122.airtelbroadband.in
 - abts-kk-static-017.33.166.122.airtelbroadband.in
 - 125.62.180.9
 - 182.79.146.194
 - ...

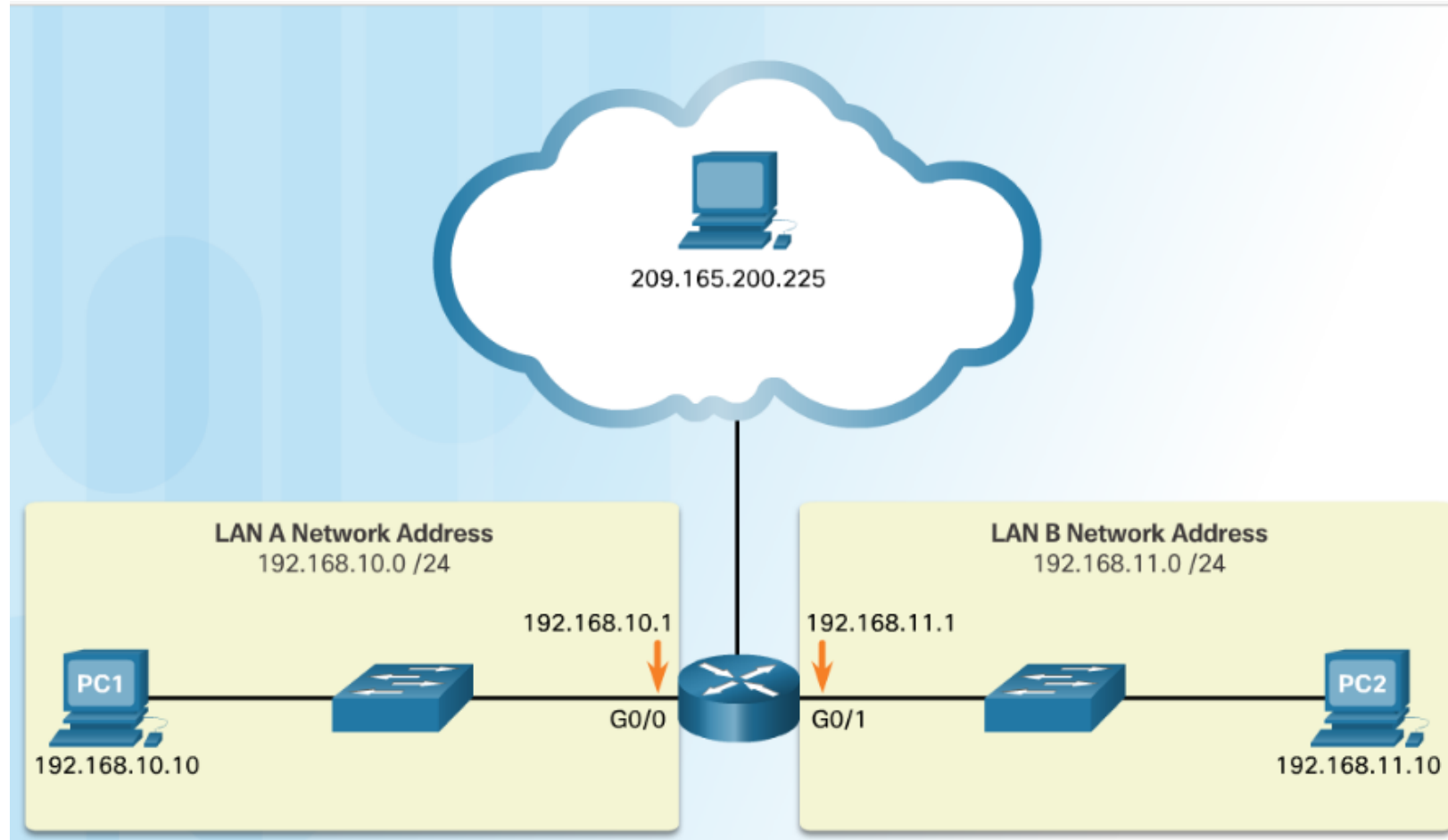
IP Address

- IPv4 addresses are expressed in 32 binary bits divided into 4 octets (8 bits)



IP Address

- IPv4 addresses are commonly expressed in dotted decimal notation i.e. a.b.c.d/n
- Example: **192.168.10.1**

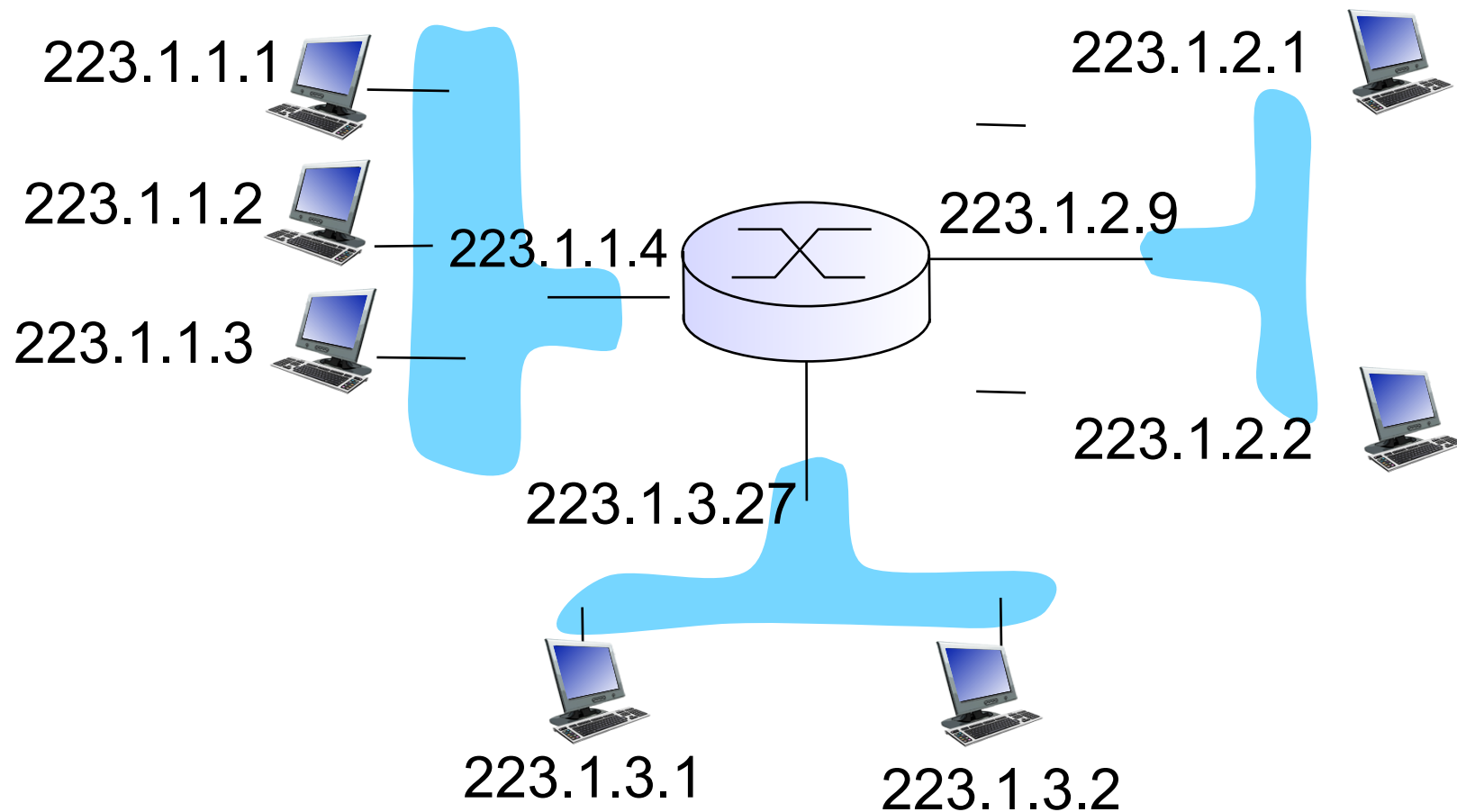


src: CCNA R&S M1: Intro to Networking

IP addressing: introduction

- Analogy: A house has multiple doors opening on different streets. What is its address?
 - Do all doors have same number?
- **IP address:** A 32-bit identifier for interface of an host, router etc.
- **interface:** A connection between host/router and physical link
 - A router typically has multiple interfaces
 - A host typically has one or two interfaces (e.g., wired Ethernet, wireless 802.11)
 - A host also has a loopback address (127.0.0.1)
- *Note: IP addresses associated with each interface*

IP addressing: introduction



223.1.3.27 = $\underbrace{11011111}_{223} \underbrace{00000001}_1 \underbrace{00000011}_3 \underbrace{00011011}_{27}$

src: Kurose & Ross: Computer Networks

IP addressing: introduction

- *IP address*: 32-bit identifier for host, router interface
- *interface*: connection between host/router and physical link
 - router's typically have multiple interfaces
 - host typically has one or two interfaces (e.g., wired Ethernet, wireless 802.11)
- *IP addresses associated with each interface*

src: Kurose & Ross: Computer Networks

IP Address: Decimal to Binary

- Consider **192.168.10.11**
 - Convert 1st octet

Example: **192**.168.10.11

128	64	32	16	8	4	2	1

--

IP Address: Decimal to Binary

- Consider **192.168.10.11**
 - Convert 2nd octet

Example: 192.**168**.10.11

Positional Value

128

64

32

16

8

4

2

1

IP Address: Decimal to Binary

- Consider **192.168.10.11**
 - Convert 3rd octet

Example: 192.168.**10**.11

Positional Value

128

64

32

16

8

4

2

1

IP Address: Decimal to Binary

- Consider **192.168.10.11**
 - Convert 4th octet

Example: 192.168.10.11

Positional Value

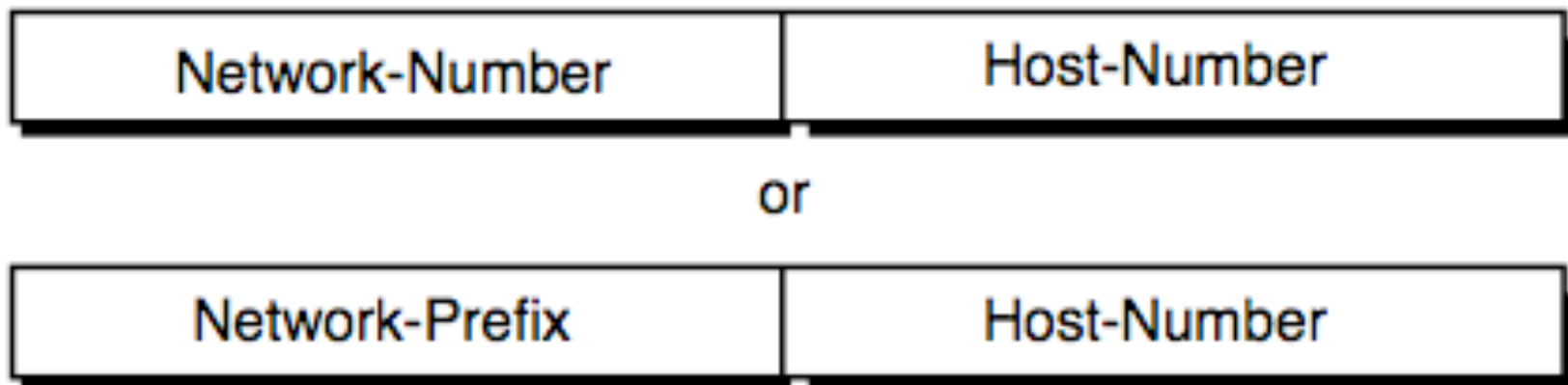
128	64	32	16	8	4	2	1
-----	----	----	----	---	---	---	---

--	--	--	--	--	--	--	--

--	--	--	--	--	--	--	--

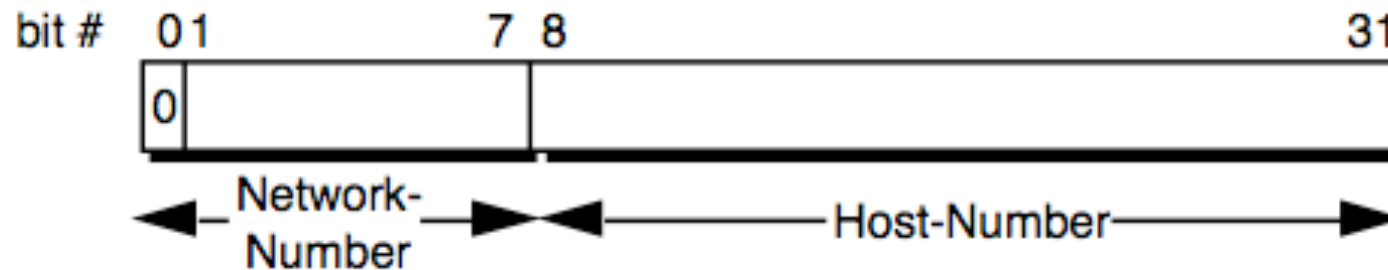
IP Address and Network

- An IPv4 address is hierarchical.
 - Composed of a Network portion and Host portion.
- All devices on the same network must have the identical network portion.
- The Subnet Mask helps devices identify the network portion and host portion.

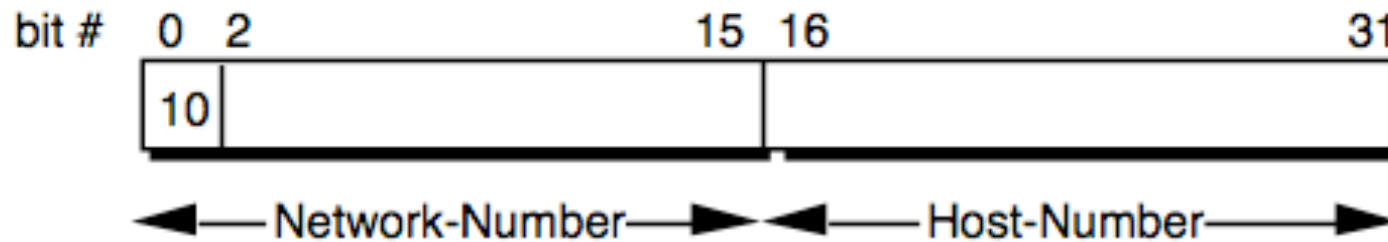


Initial IP Addressing (Classful)

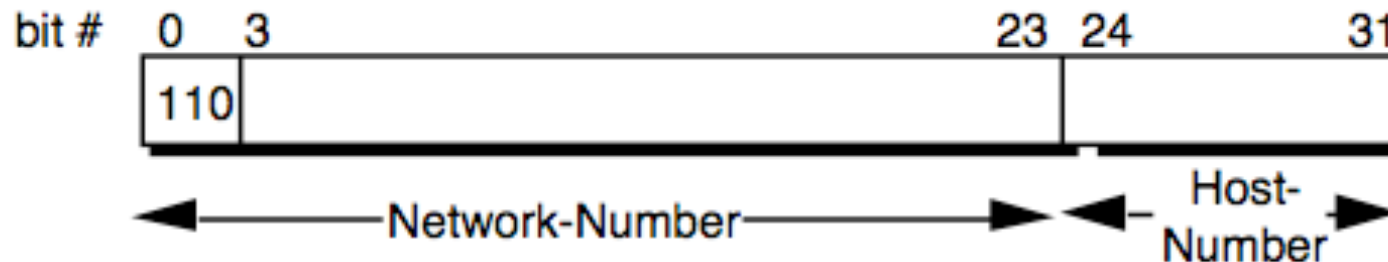
Class A



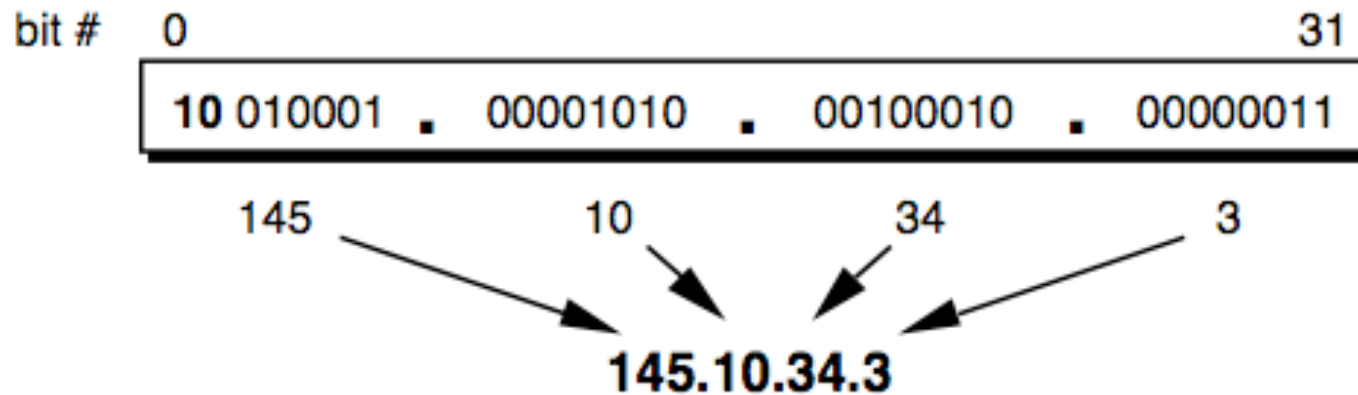
Class B



Class C



Dotted Decimal Notation



Address Class	Dotted-Decimal Notation Ranges
A (/8 prefixes)	1.xxx.xxx.xxx through 126.xxx.xxx.xxx
B (/16 prefixes)	128.0.xxx.xxx through 191.255.xxx.xxx
C (/24 prefixes)	192.0.0.xxx through 223.255.255.xxx

Case Study 01

- A: Take your laptop/desktop and connect to internet on wifi. Identify IP addresses of all interfaces (e.g. loopback and Wifi interface)
- B: Take your smartphone and connect to internet. Identify the IP address assigned to your wifi interface of the phone.
- C: Convert your phone into wifi hotspot and connect your laptop to this hotspot. Note down the IP address of your laptop.

Case Study 02

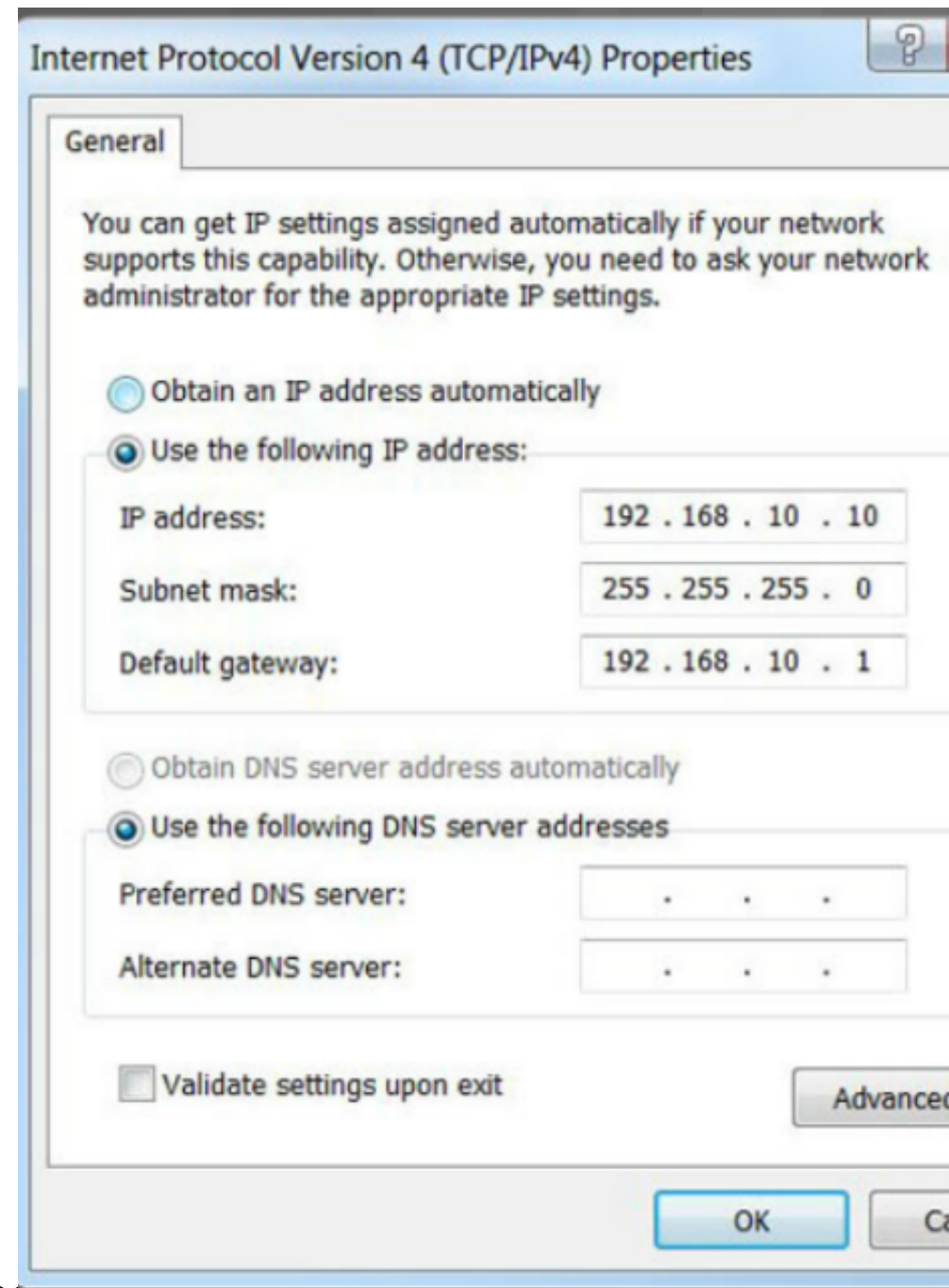
- A: List the 5 websites you use regularly, e.g.
 - google.com, facebook.com, instagram.com, twitter.com, linkedin.com
 - Find the IP addresses of these websites. E.g example to find IP address of rprustagi.com, use `ping` to find the latency and IP Address
 - (Linux/Mac): `ping -c 2 www.rprustagi.com`
 - (Windows): `ping -n 2 www.rprustagi.com`
- B: Use `tracert` (Linux) / `tracert` (Window) to find all the routers in the path from your machine to these websites.

IP Subnet

- Consider your house where you stay.
- It is part of a small locality (or even a street)
- Locality is part of sub-city e.g. south Blore.
- Which is further part of Blore, and in turn
 - Karnataka state and country India.
- The house is part of each of these
- Similarly, IP address is hierarchical
 - It is part of small network, which could be part of bigger network and so on. e.g.
 - Lab network, part of dept network, part of college network etc.

The Subnet Mask

- Identifies the network to which the host belongs
 - Subnet mask - identifies the network/host portion of the IPv4 address.
 - Default gateway -IP address of the local router which connects you to internet



The Subnet Mask

- The subnet mask is specified as / n , which implies that first n bits out of 32 (known as network portion) are set to 1 (from left to right) and remaining bits (known as host portion) are set to 0

/8 = 255.0.0.0

=11111111 00000000 00000000 00000000

/20 = 255.255.240.0

=11111111 11111111 11110000 00000000

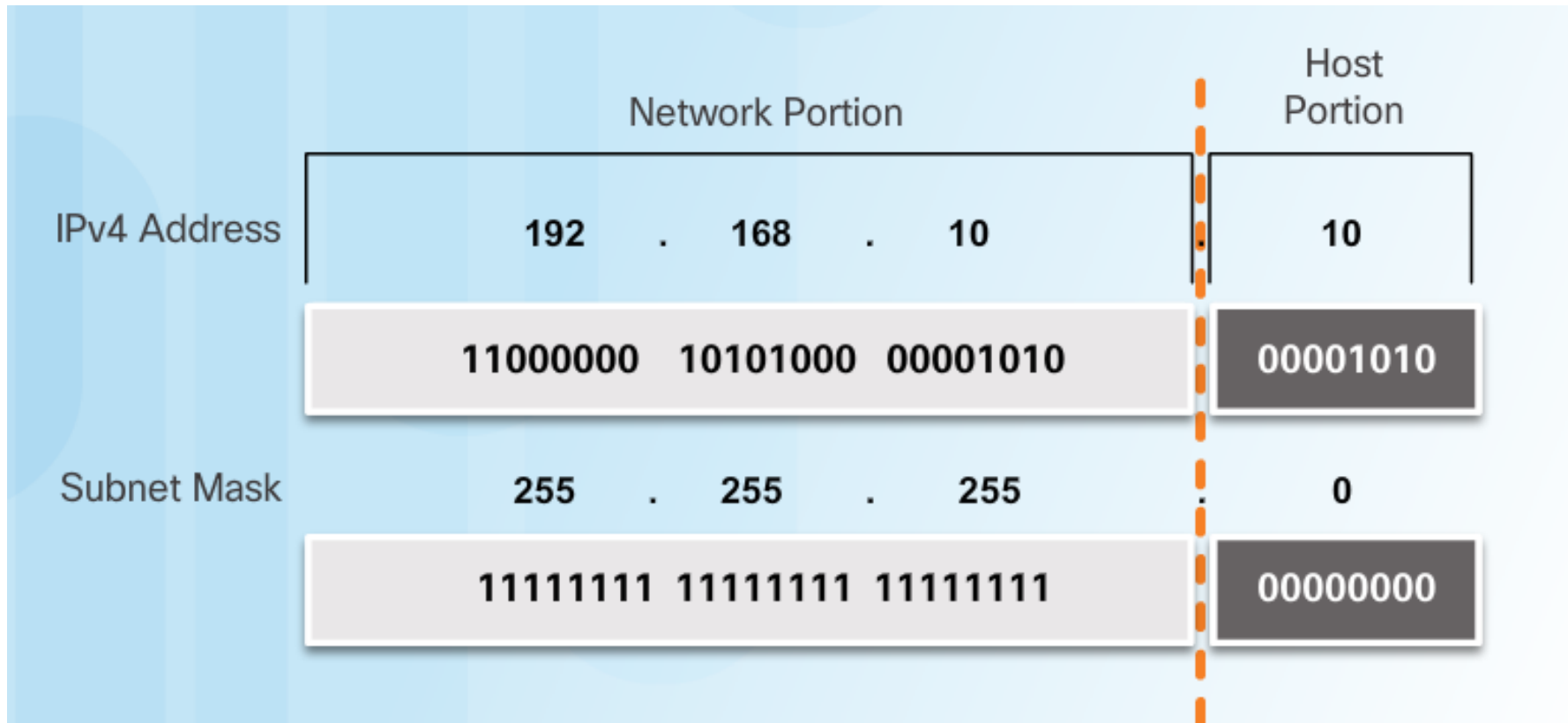
/29 = 255.255.255.248

=11111111 11111111 11111111 11111000

- The Logical AND subnet mask and IP address gives network number of the host.

The Subnet Mask

- It determines the network number of address
- The network number is obtained by performing bitwise AND operation between subnet mask and IP address.



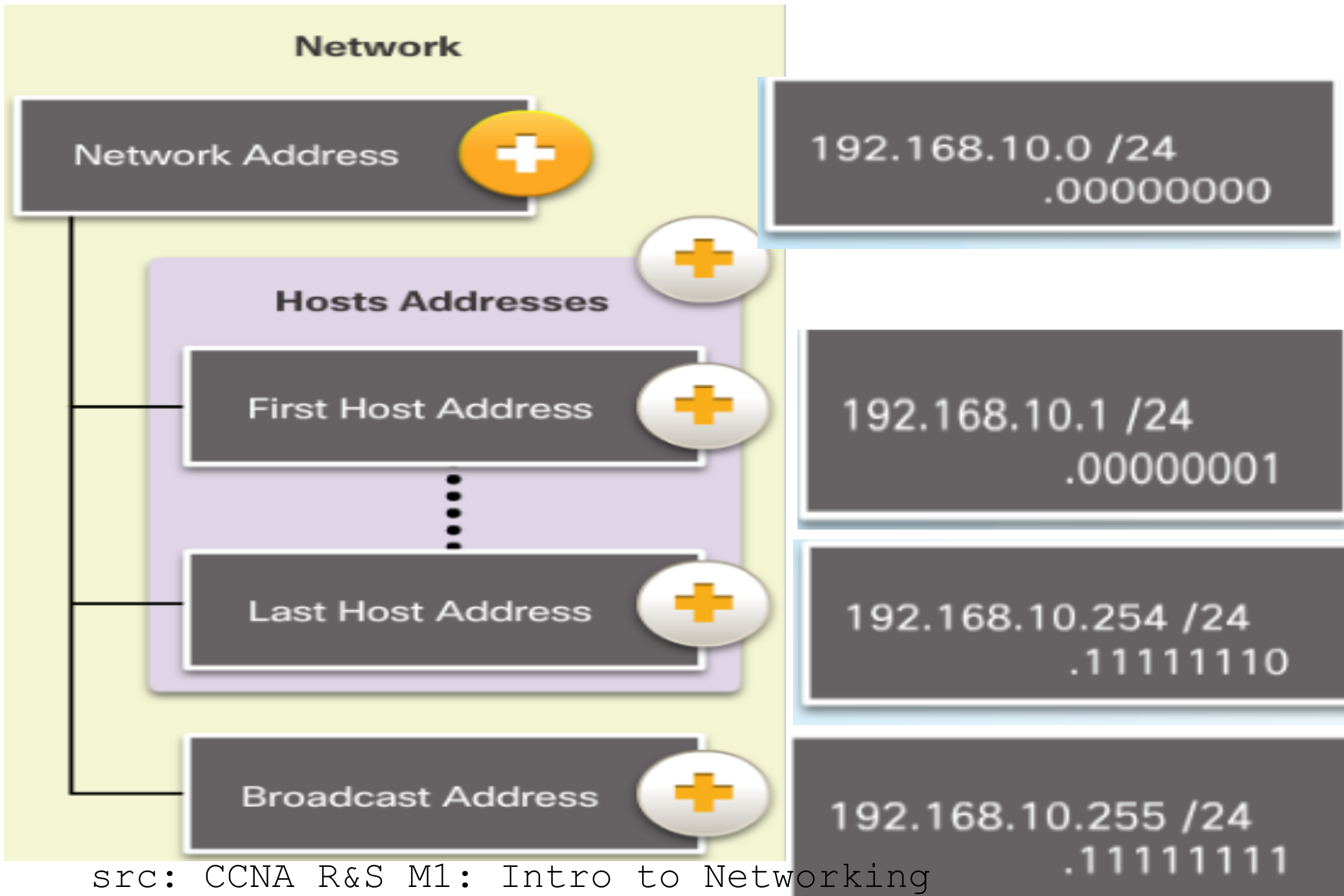
The Subnet Mask

IP Address	192	.	168	.	10	.	10
Binary	11000000		10101000		00001010		00001010
Subnet mask	255	.	255	.	255	.	0
	11111111		11111111		11111111		00000000
AND Results	11000000		10101000		00001010		00000000
Network Address	192	.	168	.	10	.	0

Network, Host, and Broadcast Addresses

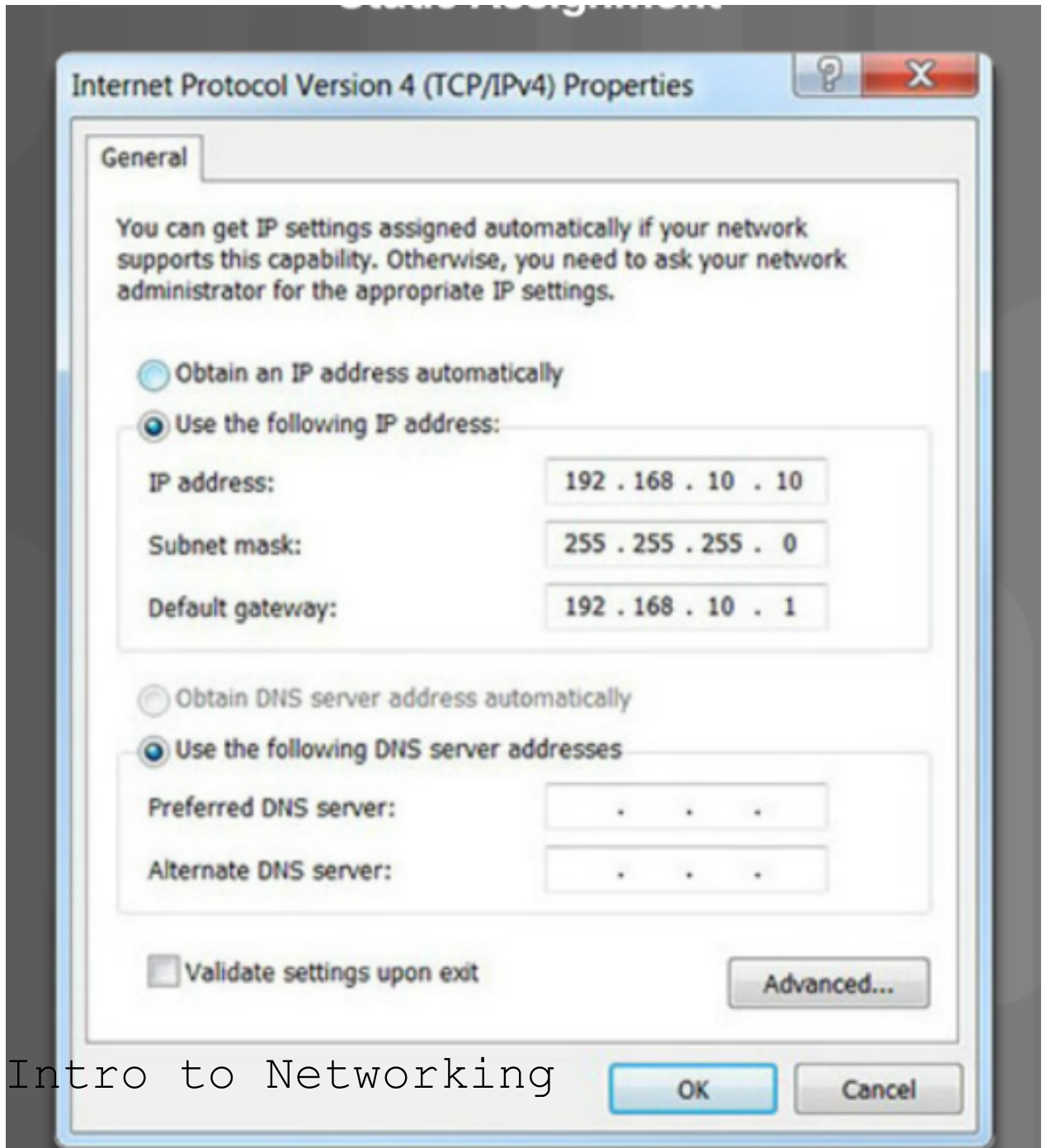
- Types of addresses in network $192.168.10.0/24$
 - Network Address -
 - host portion is all 0s ($.00000000$)
 - First Host address - host portion is all 0s and ends with a 1 ($.00000001$)
 - Last Host address - host portion is all 1s and ends with a 0 ($.11111110$)
 - Broadcast Address -
 - host portion is all 1s ($.11111111$)
 - Total number of assignable addresses: $2^8 - 2$
 - Total assignable addresses with mask $/n$: $2^{(32-n)} - 2$
 - all 0s is n/w number, all 1s is broadcast

Network, Host, and Broadcast Addresses



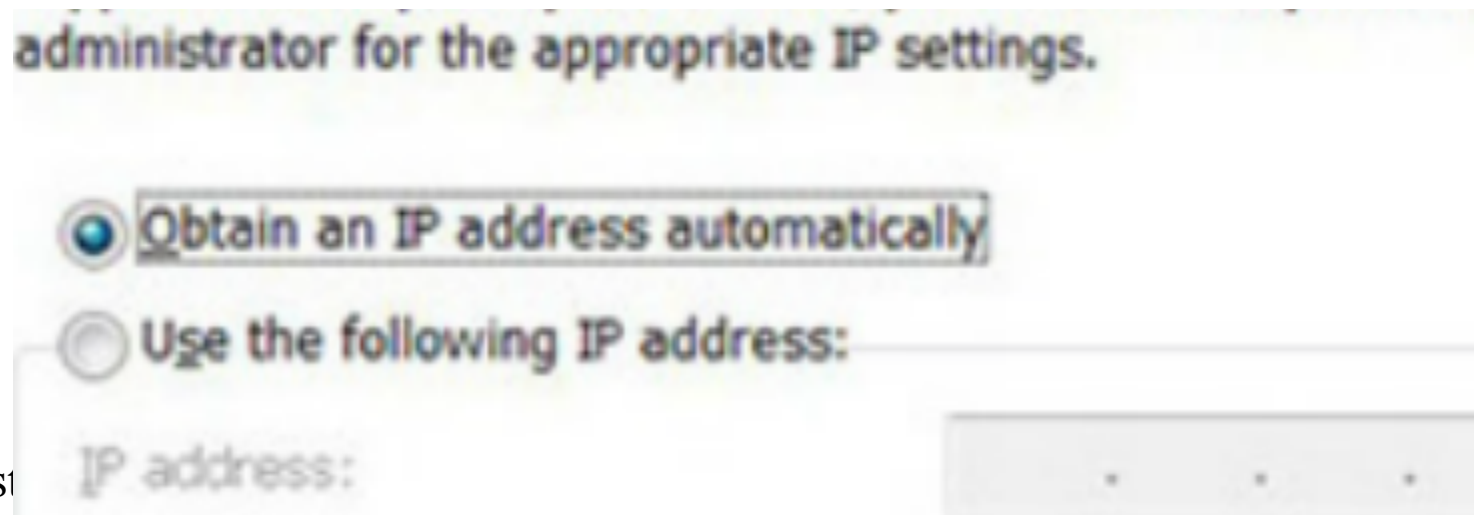
Static IPv4 Address Assignment to a Host

- Some devices like printers, servers and network devices require a fixed IP address.
- Hosts in a small network can also be configured with static addresses.



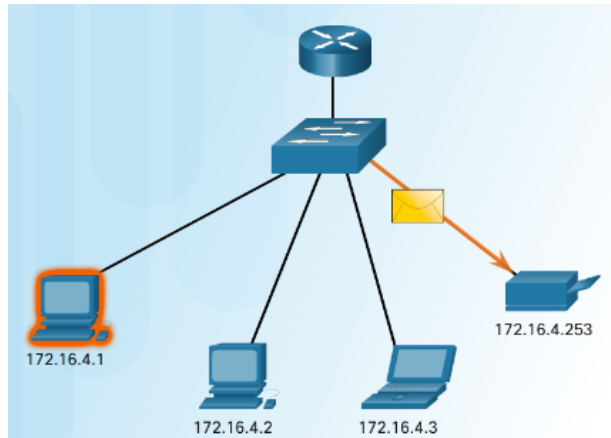
Dynamic IPv4 Address Assignment to a Host

- Most networks use Dynamic Host Configuration Protocol (DHCP) to assign IPv4 addresses dynamically.
- The DHCP server provides an IPv4 address, subnet mask, default gateway, and other configuration information.
- DHCP leases the addresses to hosts for a certain length of time.
- If the host is powered down or taken off the network, the address is returned to the pool for reuse.

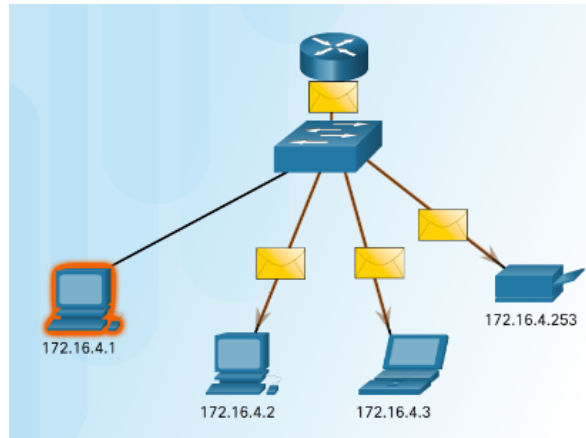


IPv4 Communication

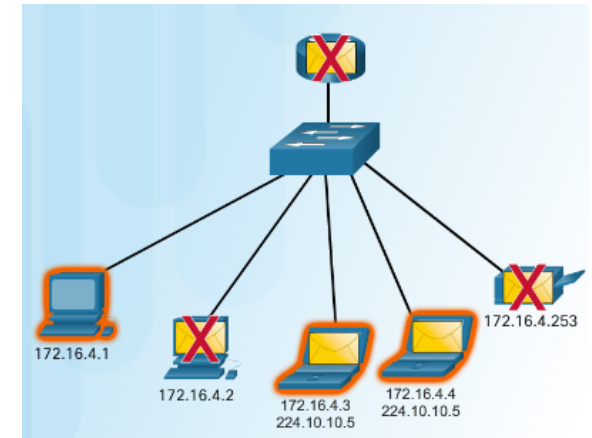
- Address categories



- Unicast – one to one communication.



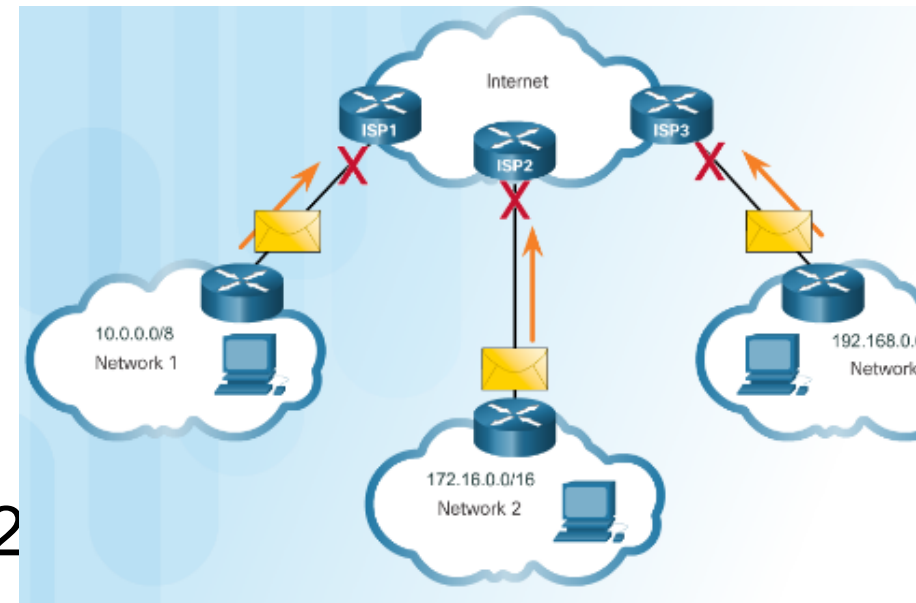
- Broadcast – one to all.



- Multicast – one to a select group.

Public and Private IPv4 Addresses

- Private Addresses
 - Not routable
 - Introduced in mid 1990s due to depletion of IPv4 addresses
 - Used only in internal networks.
 - Must be translated to a public IPv4 to be routable.
 - Defined by RFC 1918
- Private Address Blocks
 - 10.0.0.0 /8 or
– 10.0.0.0 to 10.255.255.255
 - 172.16.0.0 /12 or
– 172.16.0.0 to 172.31.255.255
 - 192.168.0.0 /16, or
– 192.168.0.0 to 192.168.255.255



Special User IPv4 Addresses

- **Loopback addresses** ($127.0.0.0/8$ or $127.0.0.1$)
 - Used on a host to test if the TCP/IP configuration is operational.
- **Link-Local addresses** ($169.254.0.0/16$ or $169.254.0.1$)
 - Commonly known as Automatic Private IP Addressing (APIPA) addresses.
 - Used by Windows client to self configure if no DHCP server available.
- **TEST-NET addresses** ($192.0.2.0/24$ or $192.0.2.0$ to $192.0.2.255$)
 - Used for teaching and learning.

Special User IPv4 Addresses

```
C:\Users\NetAcad> ping 127.0.0.1
```

```
Pinging 127.0.0.1 with 32 bytes of data:
```

```
Reply from 127.0.0.1: bytes=32 time<1ms TTL=128
```

```
Reply from 127.0.0.1: bytes=32 time<1ms TTL=128
```

```
Reply from 127.0.0.1: bytes=32 time<1ms TTL=128
```

```
Reply from 127.0.0.1: bytes=32 time<1ms TTL=128
```

```
Ping statistics for 127.0.0.1:
```

```
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
```

```
Approximate round trip times in milli-seconds:
```

```
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

```
C:\Users\NetAcad> ping 127.1.1.1
```

```
Pinging 127.1.1.1 with 32 bytes of data:
```

```
Reply from 127.1.1.1: bytes=32 time<1ms TTL=128
```

```
Reply from 127.1.1.1: bytes=32 time<1ms TTL=128
```

```
Reply from 127.1.1.1: bytes=32 time<1ms TTL=128
```

```
Reply from 127.1.1.1: bytes=32 time<1ms TTL=128
```

Case Study 03

- A machine has been assigned the IP address 192.168.37.241/27. Find the following for the network to which this host belongs.
 - Subnet mask (using DDN notation)
 - Network number
 - First assignable IP address
 - Last assignable IP address
 - Broadcast address

Case Study 04

- Connect your laptop/desktop to internet.
 - Mostly this would be assigned using DHCP
- Note down the IP address and subnet mask.
 - e.g. 192.168.1.11/24
- Change the configuration to static IP and assign the same IP address/mask as before.
 - `ping google.com` (verifies it works).
- Change the IP address by adding 16 to last octet (e.g. 192.168.1.27) and netmask by adding 4 i.e /28
 - You will be unable to access internet
- Restore the mask to its earlier value /24, and internet works.
- Analyze the role of subnet masks

Case Study 05

- Take two machines (any of laptops/desktops etc) and call them A and B. If these are windows, disable the firewall.
- **Assign the following IP Address (Static config)**
 - A:192.168.1.11/26, B:192.168.1.66/26
- Ping A and B from each other, check if it fails
- Change both subnet masks to /25 and ping again.
 - Verify ping is successful.
 - Analyze why it failed earlier
- Experiment with different IP Address and netmask
 - Analyze your results (both success & failure)

Case Study 06

- Issue the following command on your terminal.
 - `ping 127.1` (don't type two middle octets).
 - Does ping work successfully? Analyze the results.
- Note: This is called shorthand notation. If the address contains less than 4 octets, then host interprets it by adding required number of 0s just before last the octet. Examples
 - `127.1` \Rightarrow `127.0.0.1`
 - `3` \Rightarrow `0.0.0.3`
 - `127.1.3` \Rightarrow `127.1.0.3`

Summary

- IP Address
- 32 bits (4 octets)
- Decimal dotted notation (DDN)
IP Subnets
 - netmask (in DDN form) and in / n form
- Terms with IP subnet
 - Network number
 - Broadcast address
 - First assignable and last assignable address
- IP Address types:
 - Unicast, multicast and broadcast address