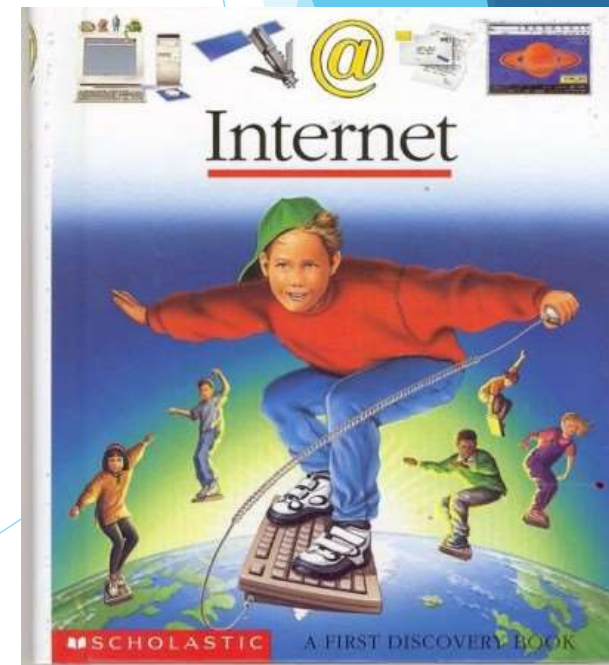# Networking 101.101.101.101
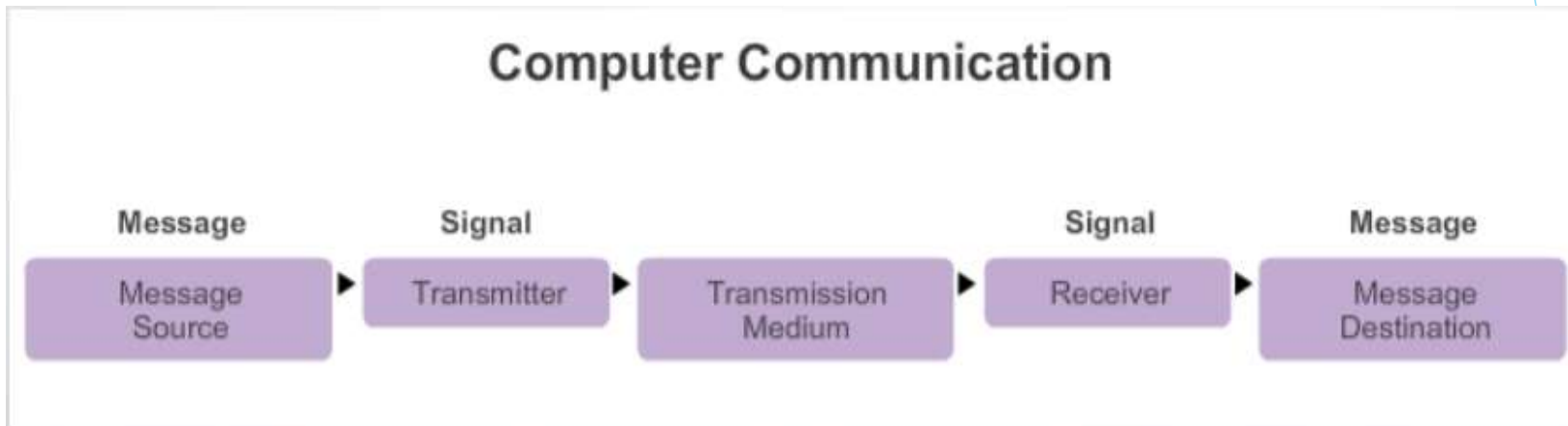
The Internet

▶ The Internet is governed by a series of protocols that form the rules for how communications should happen

▶ The Internet is a network of networks.

    ▶ There is no centralized point.

    ▶ There are no boundaries.

▶ Information that is sent from one location on the internet to another is broken down into smaller, more manageable pieces called "packets"

What is Networking?

▶ The process of connecting two or more computers for information sharing

Computer Communication

Message		Signal		Signal		Message
Message Source	▶	Transmitter	▶	Transmission Medium	▶	Receiver	▶	Message Destination

Local Area Networks (LAN)

- The most basic type of network
- These small networks are the building blocks of the Internet.
  - The "local neighborhood" of devices.
- Devices on the same LAN communicate with one another across a "switch"
- Appropriately segmenting networks and LANs is fundamental to security
- LANs can be organized by:
  - Geography
  - Device type
  - Business need

Wide Area Networks (WAN)

- LANs are connected together to form WANs
  - LANs connect as WANs through routers
  - The Internet is one big WAN
  - Connecting LANs to WANs can be done through wireless and wired connections
 - WANs can span much larger geographic distances than LANs
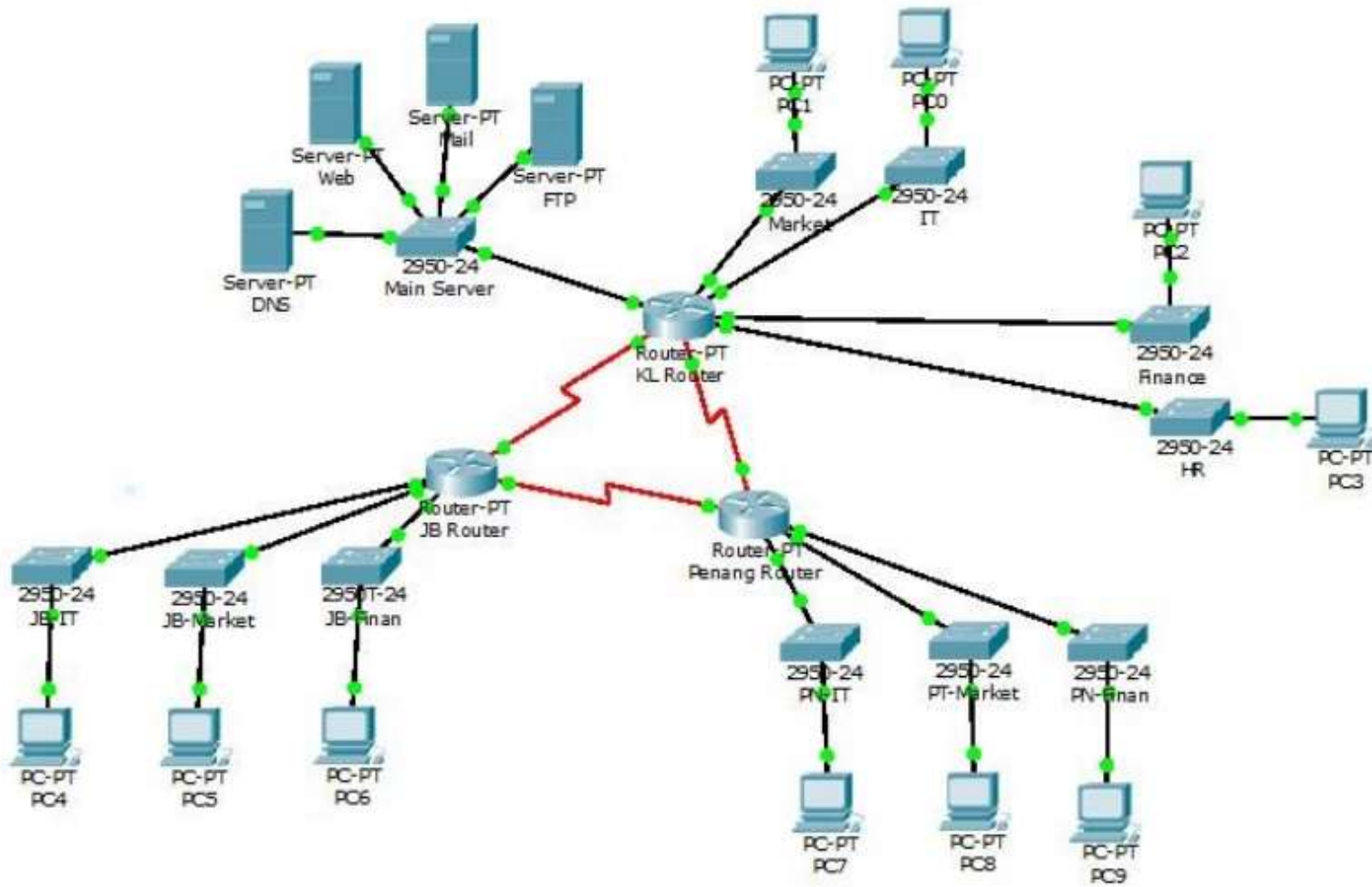
Demilitarized Zone (DMZ)

▶ A physical or logical sub-network that separates an internal local area network (LAN)

▶ External-facing servers, resources and services are located in the DMZ so they are accessible from the Internet but the rest of the internal LAN remains unreachable.

▶ This provides an additional layer of security to the LAN as it restricts the ability of hackers to directly access internal servers and data via the Internet.

Clients

▶ Clients access servers for information and resources

▶ Connected to a network (LAN/ WAN)

▶ Usually found behind the DMZ

▶ Most likely segmented on a VLAN(Virtual Local Area Network)

▶ Could be devices such as smartphones, tablets, PCs
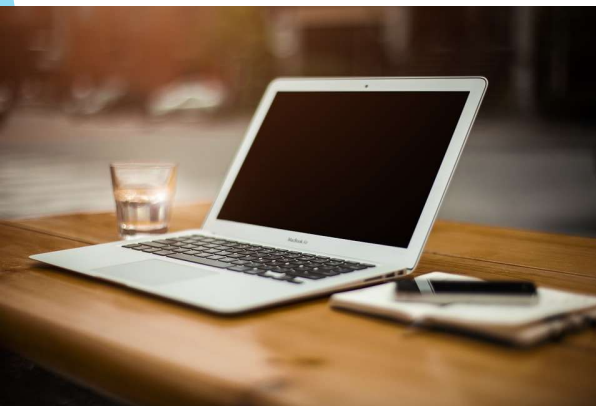
Servers

- Servers store information and contain resources that clients can access
- Provides a service to users or specific programs
- Can be used to run a variety of applications
- Types of Servers:
    - File, SQL, Websites, Active directory, Virtualization
- Does not necessarily have to look like a server to be a server
- Found on either side of the DMZ

Common Networking Devices

- Router - Forwards data packets to and receives data packets from the Internet

- Switch - Connects end devices using network cables

- Wireless access point - Consists of a radio transmitter capable of connecting end devices wirelessly

- Firewall appliance - Secures outgoing traffic and restricts incoming traffic

- Your home router often includes all of these devices into one

Ports (logical, not physical)

- Associated with a protocol type, used for connections along with an IP Address
  - HTTPS : PORT 443
  - HTTP: 80, 8080
  - FTP: 21
  - SSH: 22
  - TELNET:23
  - DNS-:53

Network Protocols

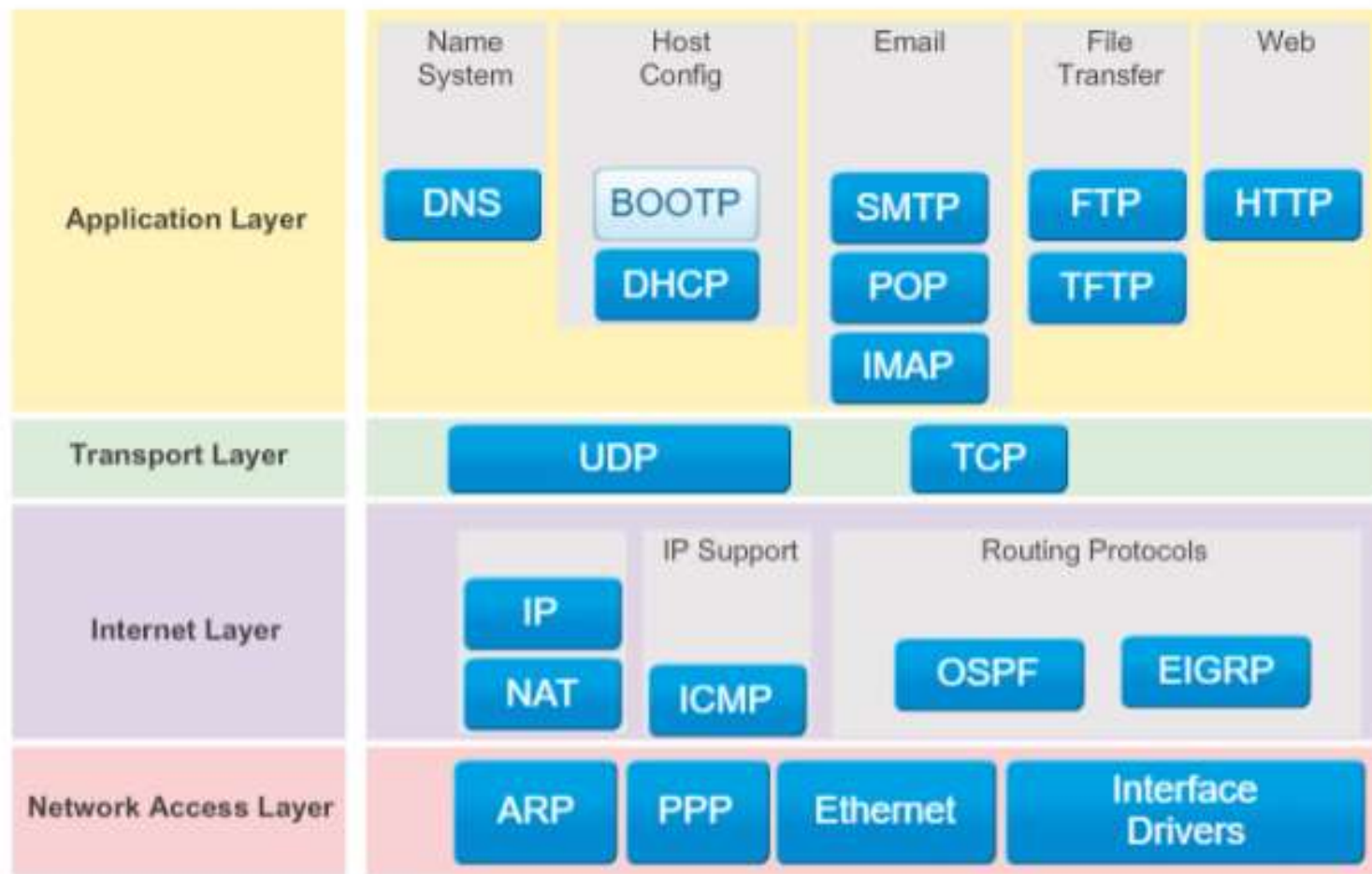- Routers use these to communicate with one another
  - Send messages to one another
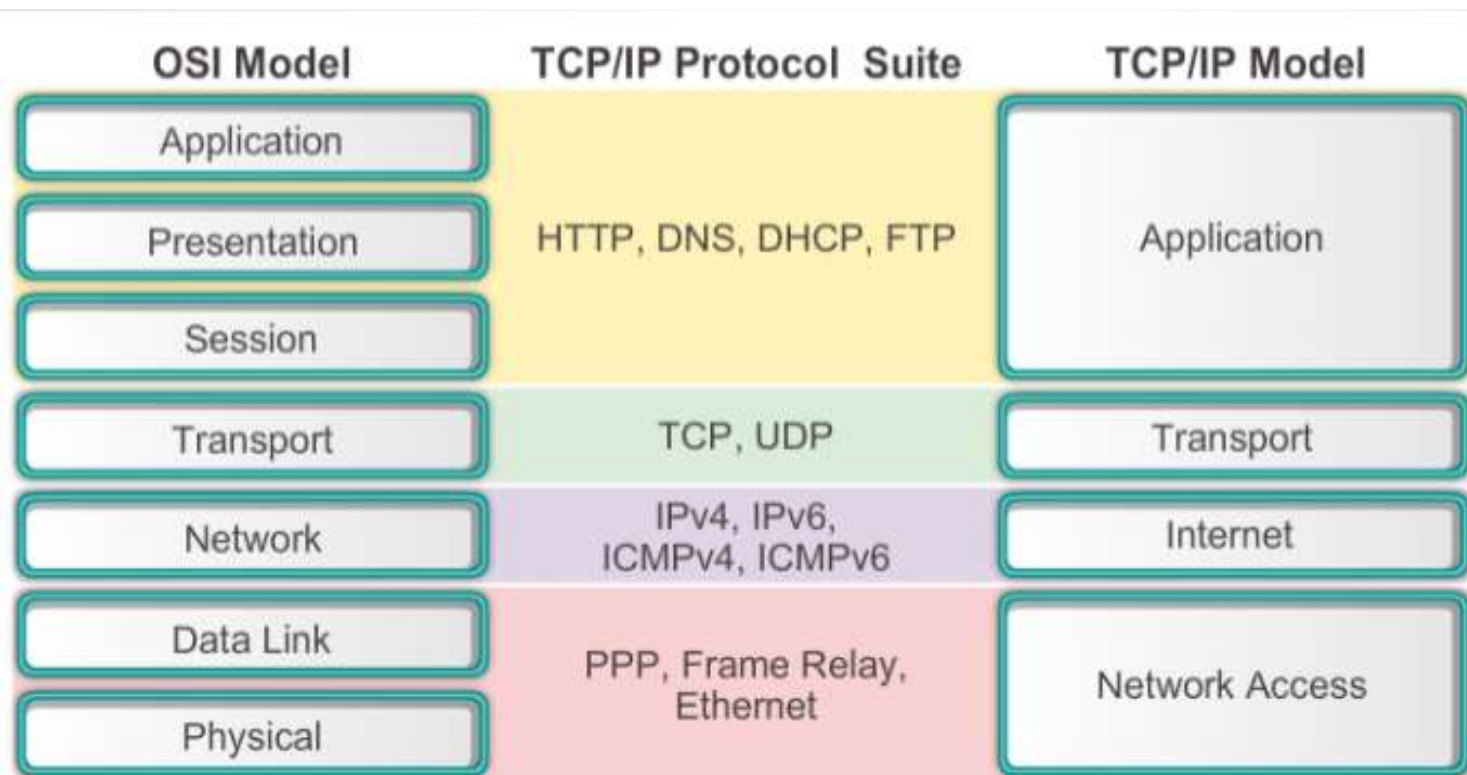 - Establish communication
  - Establish Routing tables
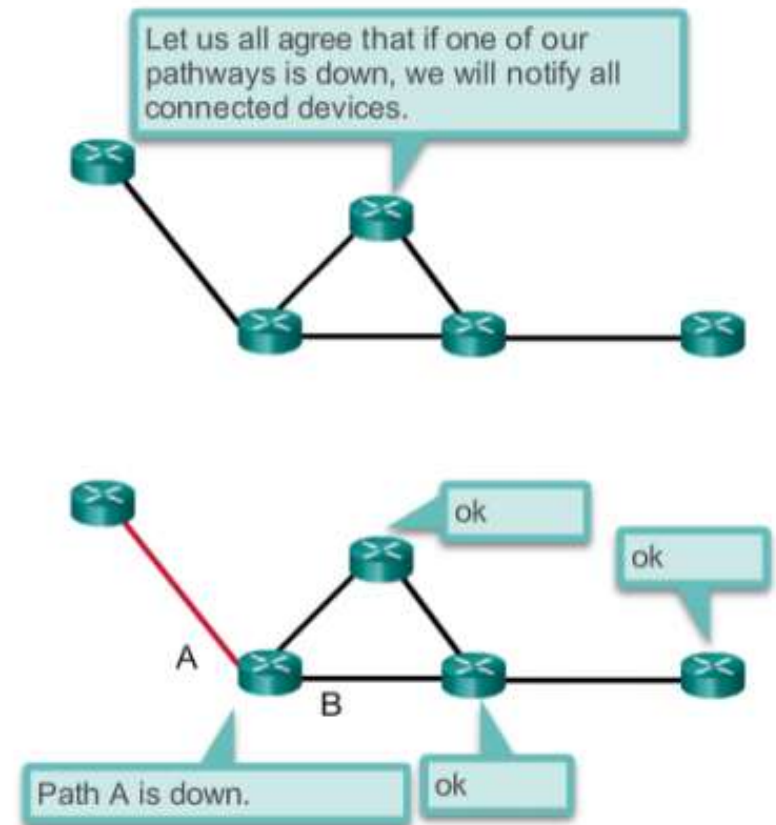
Transmission Control Protocol/Internet Protocol (TCP/IP) Model

- A suite of protocols used to interconnect network devices on the internet
- Specifies how data over the internet is
  - Broken into packets
  - Addressed
  - Transmitted
  - Routed
  - Received at destination

TCP/IP Protocol Suite and Communication Process

TCP/IP vs. OSI Model

OSI Model	TCP/IP Protocol Suite	TCP/IP Model
Application	HTTP, DNS, DHCP, FTP	Application
Presentation		
Session		
Transport	TCP, UDP	Transport
Network	IPv4, IPv6, ICMPv4, ICMPv6	Internet
Data Link	PPP, Frame Relay, Ethernet	Network Access
Physical		

OSI vs TCP/IP cont

- OSI Model
  - It is used for data network design, operation specifications, and troubleshooting.
- TCP/IP
  - Less advanced model than OSI
  - Internet Model
  - Both Models are the primary models used when discussing network functionality.

Transport Layer

- TCP
  - Connection oriented
  - Three way handshake
  - Reliable
- UDP
  - Not Reliable
 - Used for faster transmission such as streaming

IP Packets

- An IP packet contains two IP addresses:

    - Source IP address -The IP address of the sending device.

    - Destination IP address -The IP address of the receiving device. The destination IP address is used by routers to forward a packet to its destination.

    - Source MAC Address

    - Destination MAC addresses- used by switches to forward packets

- Frame Check Sequence(FCS)

    - Checks to see if there are errors in packets, if there is. It's dropped for a new one.

Types of Addresses

- IP address -Together with subnet mask, uniquely identifies end device on the network

- Subnet mask - Determines which part of a larger network is used by an IP address

- Default Gateway –Way out of the network, think of a gate out of your yard

  - Routers have a GOLR-Gateway of Last resort

IP Address
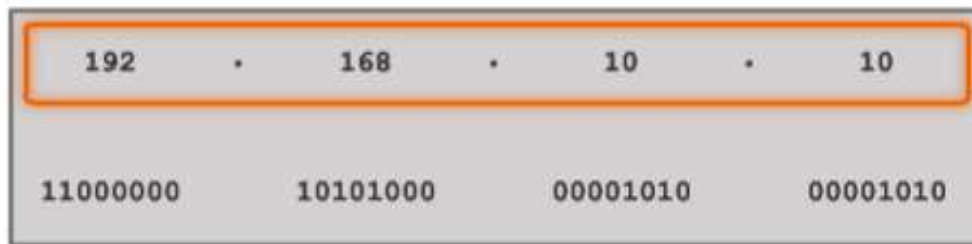
192.168.10.10 is an IP address that is assigned to a computer.
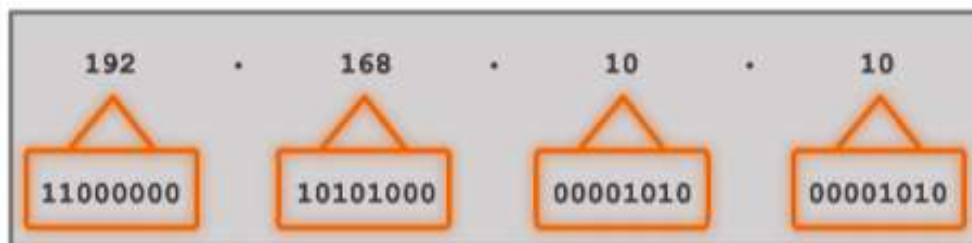
This address is made up of four different octets.

32-Bit IP Address

	Octet 1	Octet 2	Octet 3	Octet 4
Octet Bit Values	128 64 32 16 8 4 2 1	128 64 32 16 8 4 2 1	128 64 32 16 8 4 2 1	128 64 32 16 8 4 2 1
Binary Address	1 1 0 0 0 0 0 0	1 0 1 0 1 0 0 0	0 0 0 0 1 0 1 0	0 0 0 0 1 0 1 0
Binary Bit Values	128 64 0 0 0 0 0 0	128 0 32 0 8 0 0 0	0 0 0 0 8 0 2 0	0 0 0 0 8 0 2 0

128 + 64 = 192   128 + 32 + 8 = 168   8 + 2 = 10   8 + 2 = 10

192.168.10.10
Dotted Decimal Address
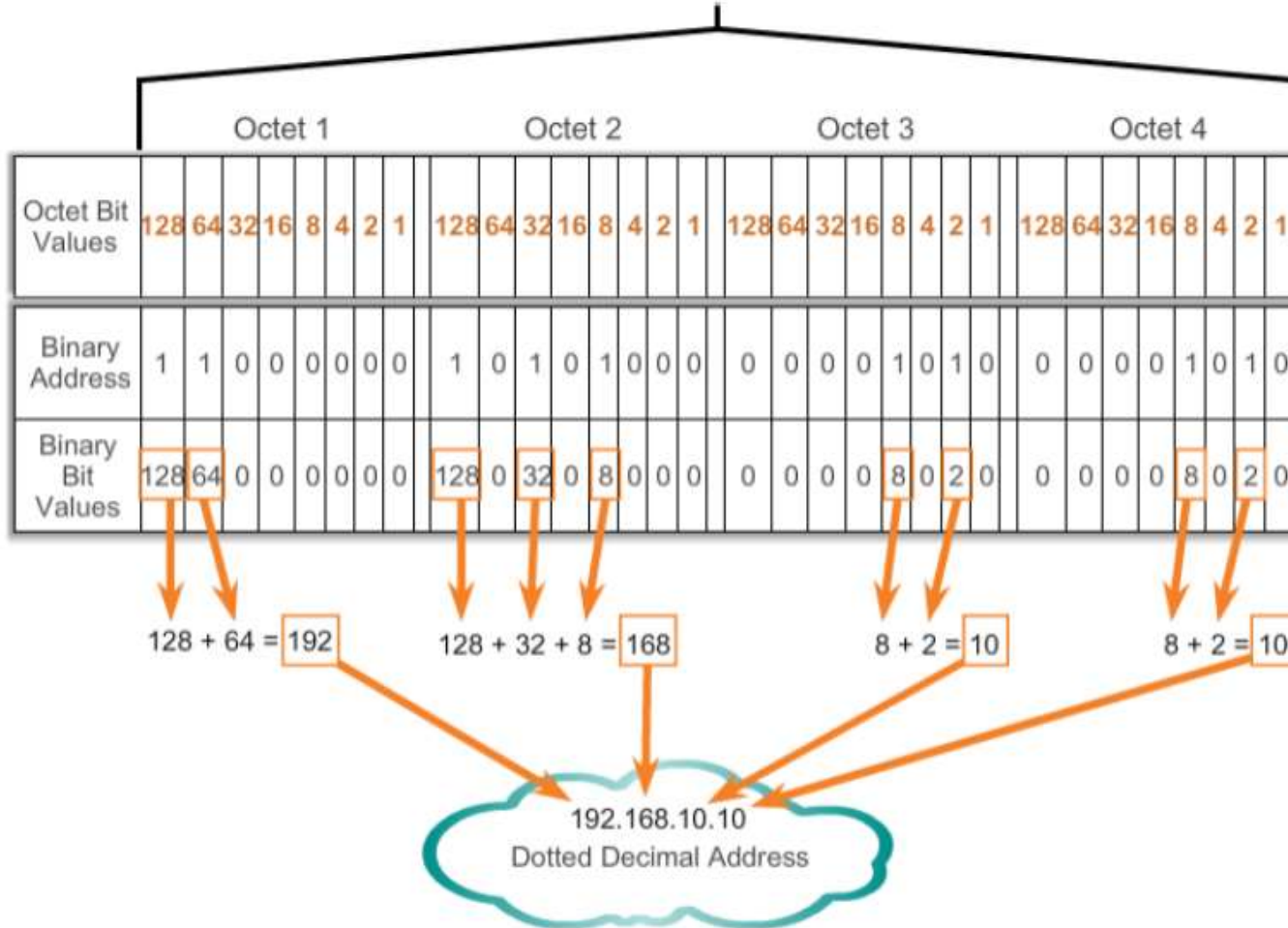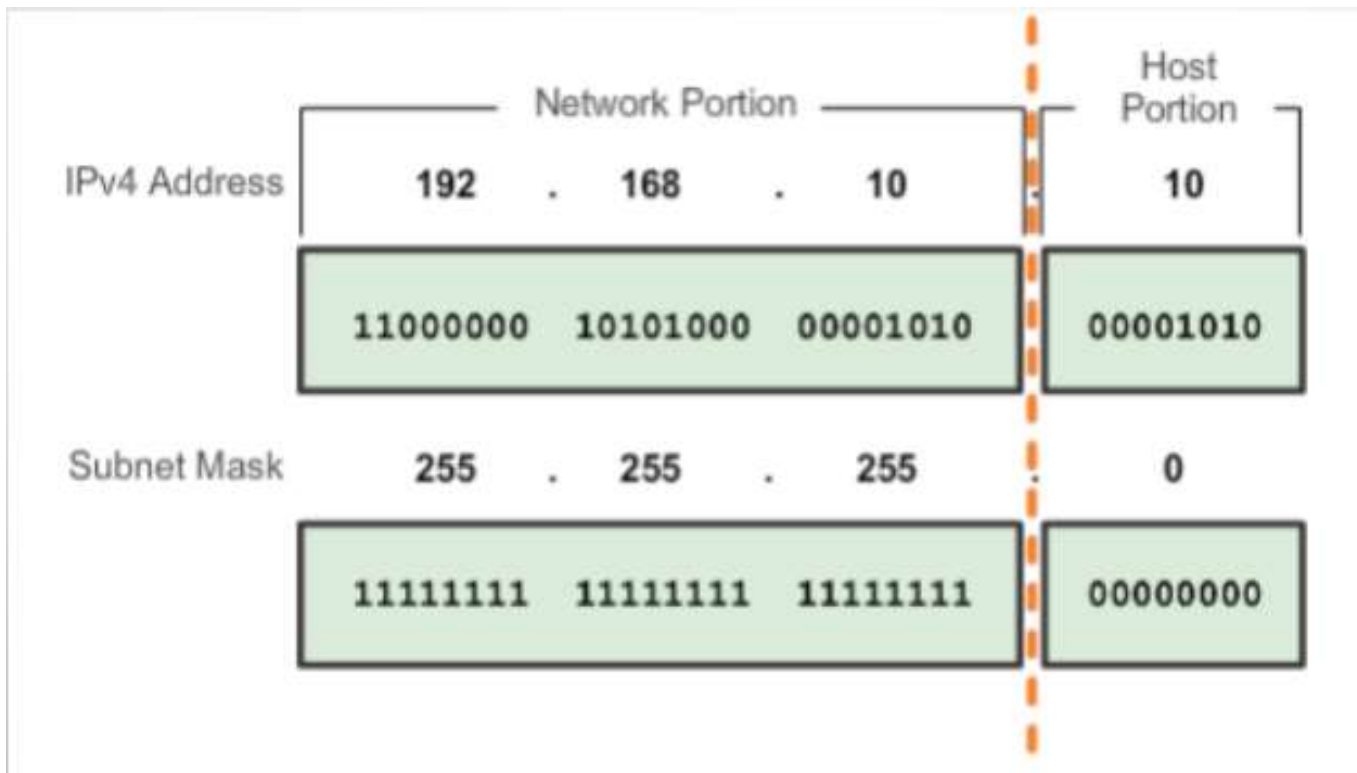
Subnet Masks

IP Classes

- Class A – 16,777,216 hosts
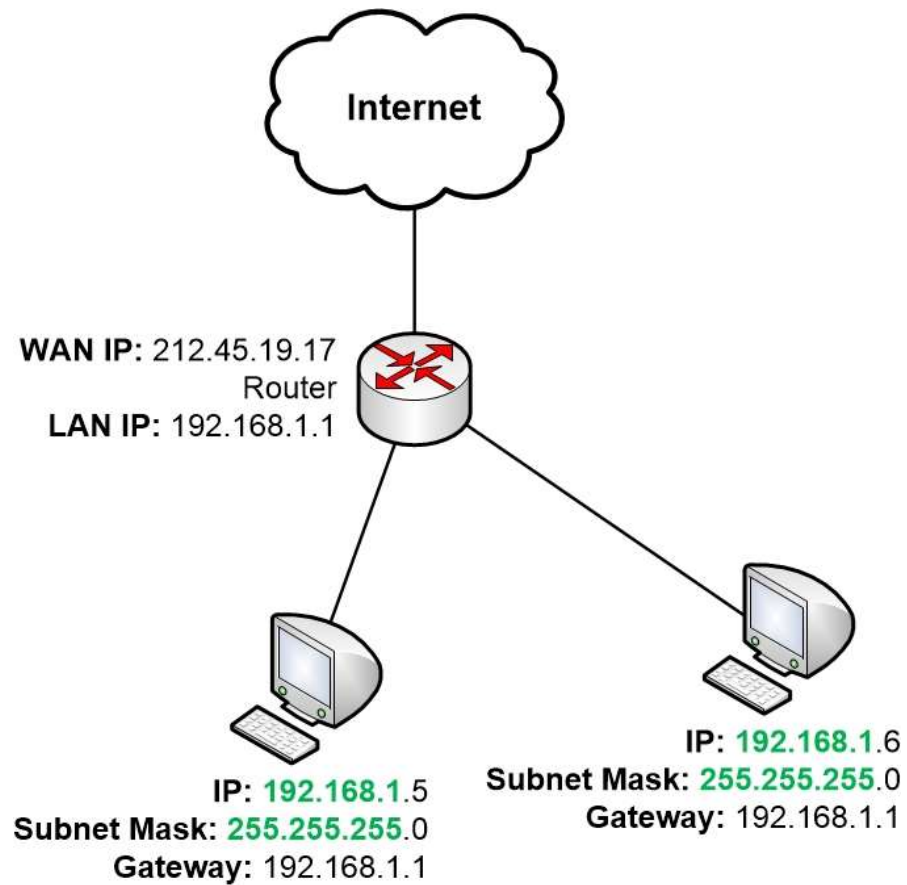- Class B – 1,048,576 hosts
- Class C- 65,536 hosts

Class	Private Networks	Subnet Mask	Address Range
A	10.0.0.0	255.0.0.0	10.0.0.0 - 10.255.255.255
B	172.16.0.0 - 172.31.0.0	255.240.0.0	172.16.0.0 - 172.31.255.255
C	192.168.0.0	255.255.0.0	192.168.0.0 - 192.168.255.255

Default Gateway

Flow of Data and Packets

▶ The IP layer determines if the client you're sending a packet to resides on your LAN by looking at:

  ▶ Your client's IP address

  ▶ Your client's subnet mask

  ▶ Your destination's IP address

```
                              Does
     No  ◄─────────────    Destination IP    ─────────────►  Yes
     │                     Exist on LAN?                        │
     ▼                                                          ▼
  Send Packet to                                          Send Packet to
  The Gateway                                             The Destination
                                                            (located on
                                                             same LAN)
```
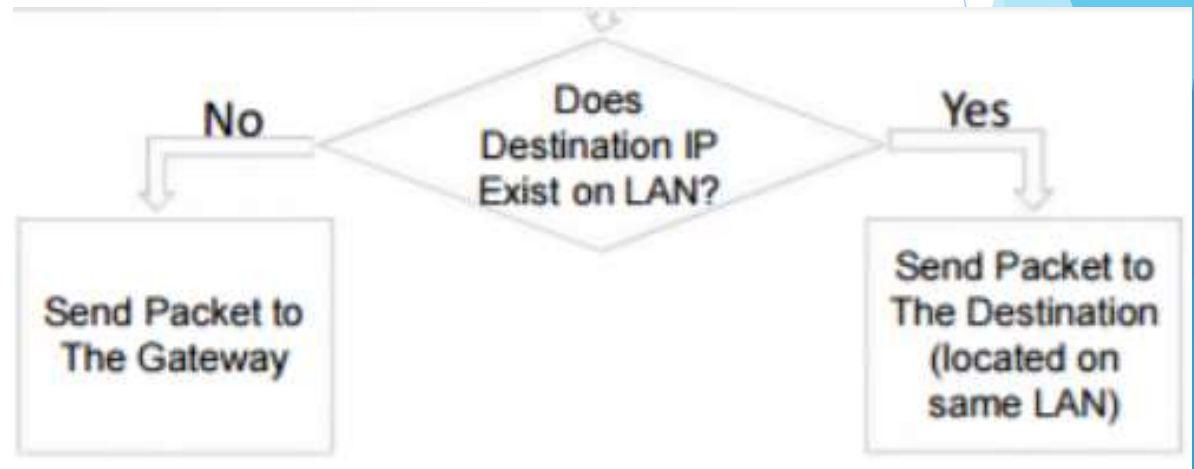
MAC Addresses

▶ Hardcoded addresses into a computer's Network Interface Card (NIC)

▶ 48-Bit Address

    ▶ Made of Organsationally Unique Identifier (OUI) and NIC Addresses

▶ LAN traffic is handled through MAC Addresses

    ▶ Switches use Address Resolution Protocol (ARP) requests to tie IP to MAC address

Ipconfig /all

```
Connection-specific DNS Suffix   . :
Description . . . . . . . . . . : Realtek PCIe GBE Family Controller
Physical Address. . . . . . . . : B8-97-5A-64-A0-FA
DHCP Enabled. . . . . . . . . . : Yes
Autoconfiguration Enabled . . . . : Yes
Link-local IPv6 Address . . . . : fe80::19ae:242f:51ef:49c3%4(Preferred)
IPv4 Address. . . . . . . . . . : 192.168.1.4(Preferred)
Subnet Mask . . . . . . . . . . : 255.255.255.0
Lease Obtained. . . . . . . . . : Monday, September 11, 2017 9:23:22 AM
Lease Expires . . . . . . . . . : Thursday, September 14, 2017 12:40:45 PM
Default Gateway . . . . . . . . : 192.168.1.1
DHCP Server . . . . . . . . . . : 192.168.1.1
DHCPv6 IAID . . . . . . . . . . : 62429018
DHCPv6 Client DUID. . . . . . . : 00-01-00-01-1B-6E-D3-69-B8-97-5A-64-A0-FA
DNS Servers . . . . . . . . . . : 192.168.1.1
```

DHCP vs Static Addressing

▶ Static addressing means manually assigning each address

    ▶ IP address remains constant

    ▶ Good for devices like printers and VoIP phones

▶ DHCP dynamically assigns addresses throughout the network

    ▶ The preferred method of assigning IPv4 addresses to hosts on large networks because it reduces the burden on network support staff and virtually eliminates entry errors

   ▶ Usually needs a DHCP server and DHCP Client

Domain Name System

- Translates an IP address to a name
- Humans are bad at remembering numbers that's why DNS was created
- Example 128.205.201.56 is mapped to www.buffalo.edu
- DNS translates a domain name to an IP address to connect to websites

IPv6

▶ Created to replace IPv4

    ▶ There are no more IPv4 addresses to give out

▶ 8 x 16 bit (128 bit) alphanumeric addresses in decimal notation separated by '.'s. For example 2001:0000:3238:DFE1:63:0000:0000:FEFB – IPV6

▶ There are a lot more possible IPv6 addresses compared to IPv4

Network Address Translation

Translating Between Private and Public
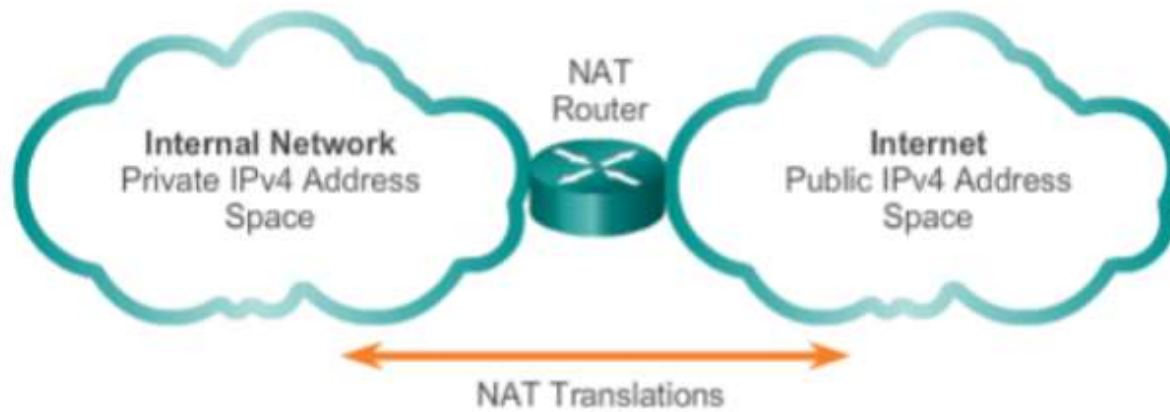
Public Addresses Vs. Private addresses

- Public is used for intranet communication
- Private is used mainly in home networks or companies
- UB is public addressed
- Think, if you go to anyone's house an run an ipconfig, you'll get an IP of 192.168.1.x or something similar

Testing Connection

▶ Ping – checks for network connection

▶ Tracert - shows hops to a destination

▶ Nslookup (windows) – shows the dns server information

▶ Ipconfig (Windows) – displays generic IP addressing info

▶ Ipconfig /all (Windows) – shows detailed information for all network adapters

▶ Ifconfig (linux) – displays generic IP addressing info

▶ Netstat- Shows active connections

My Home Network

Internet

192.168.1.1

192.168.1.8   192.168.1.9   192.168.1.3   192.168.1.4