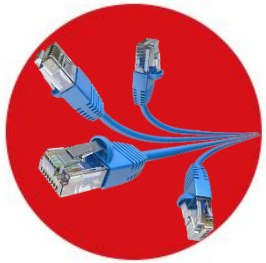
Basics of Computer Networks



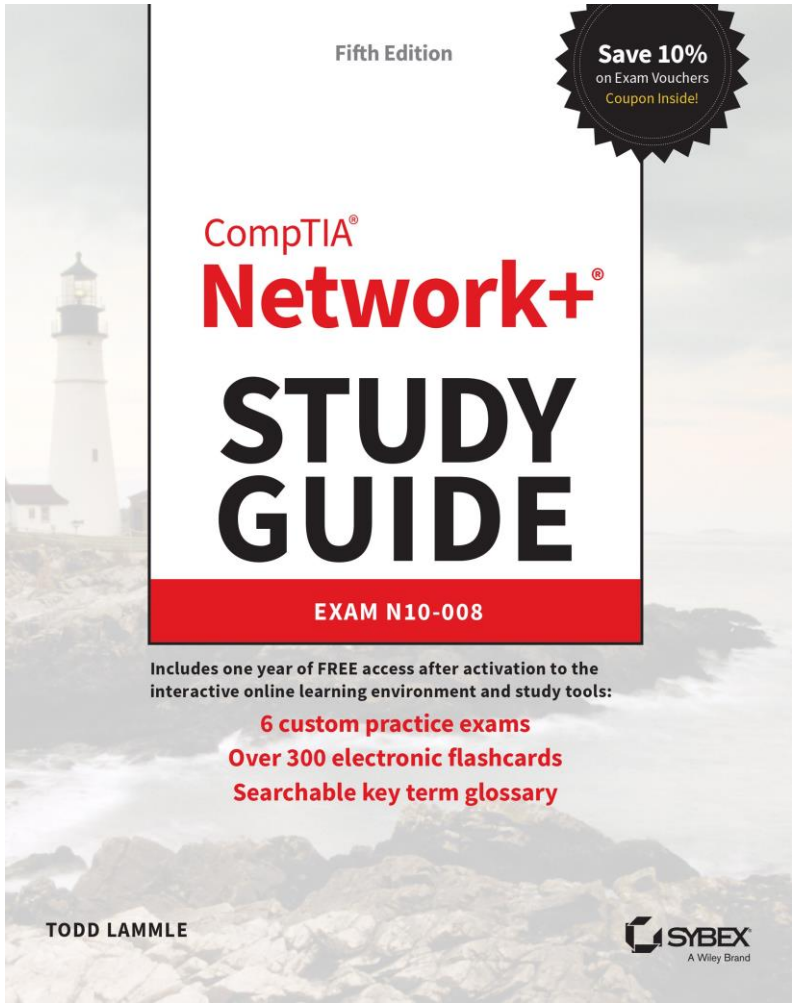
Ardabil University of Medical Sciences

T. Mehri

Master of Computer Engineering

Do we need information about computer networks?

Introduction to computer network science

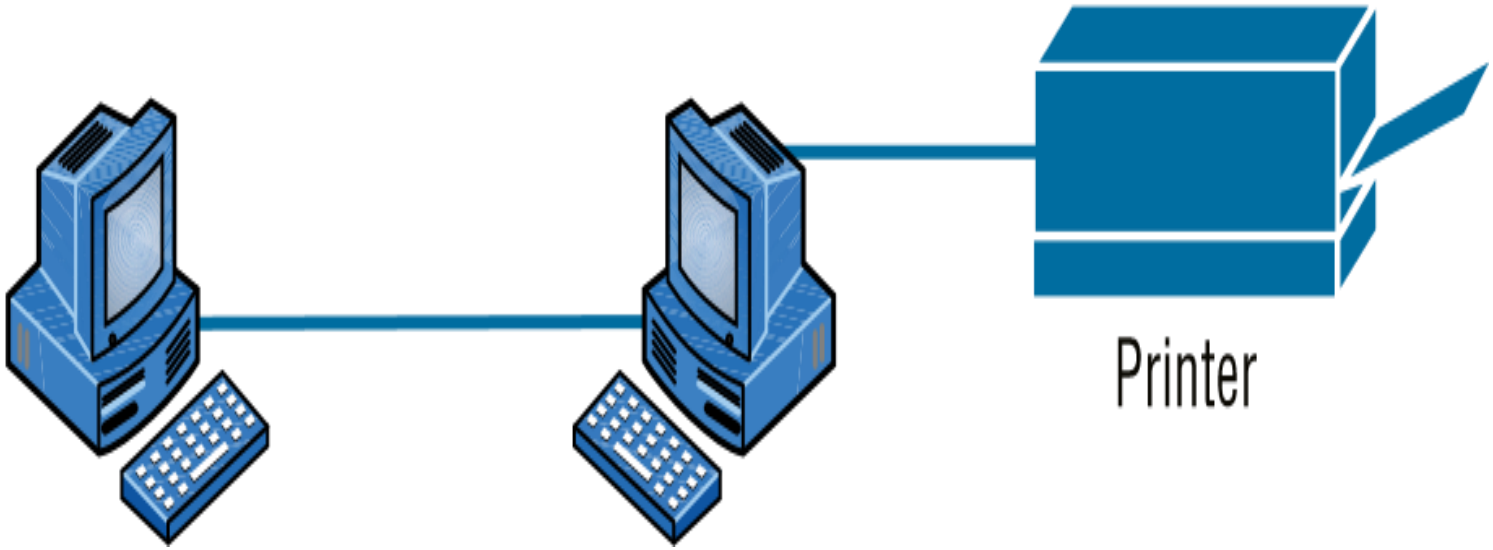


The purpose of creating a network

Sharing resources including:

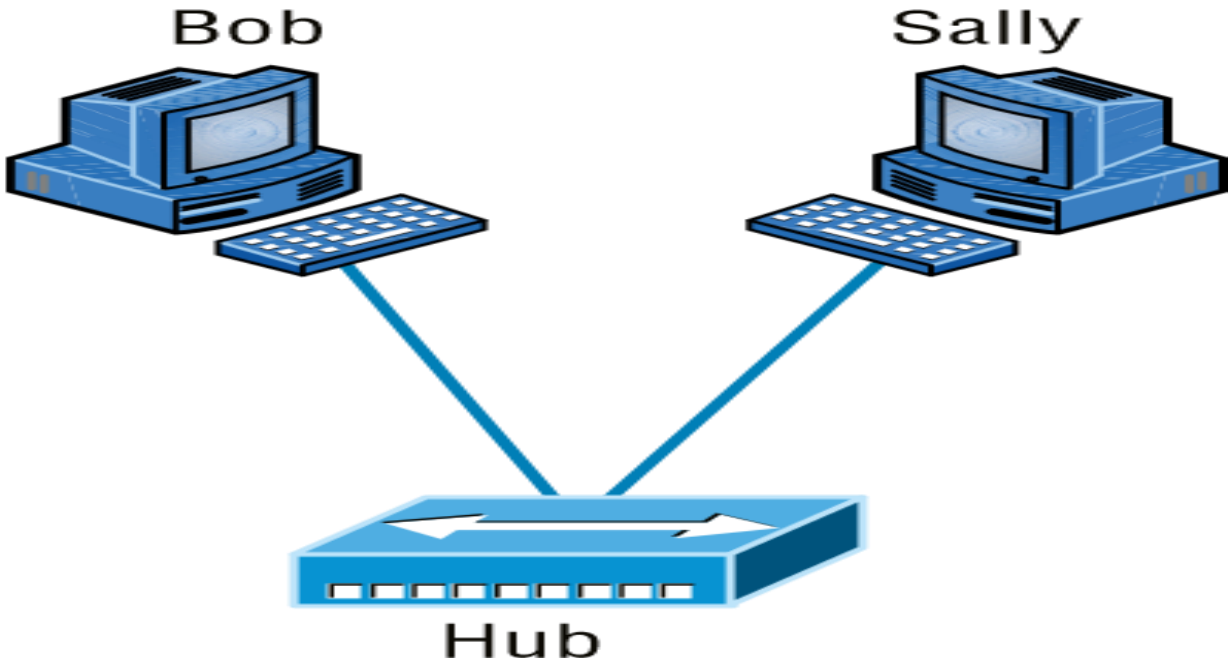
Data and Hardware

The simplest computer network

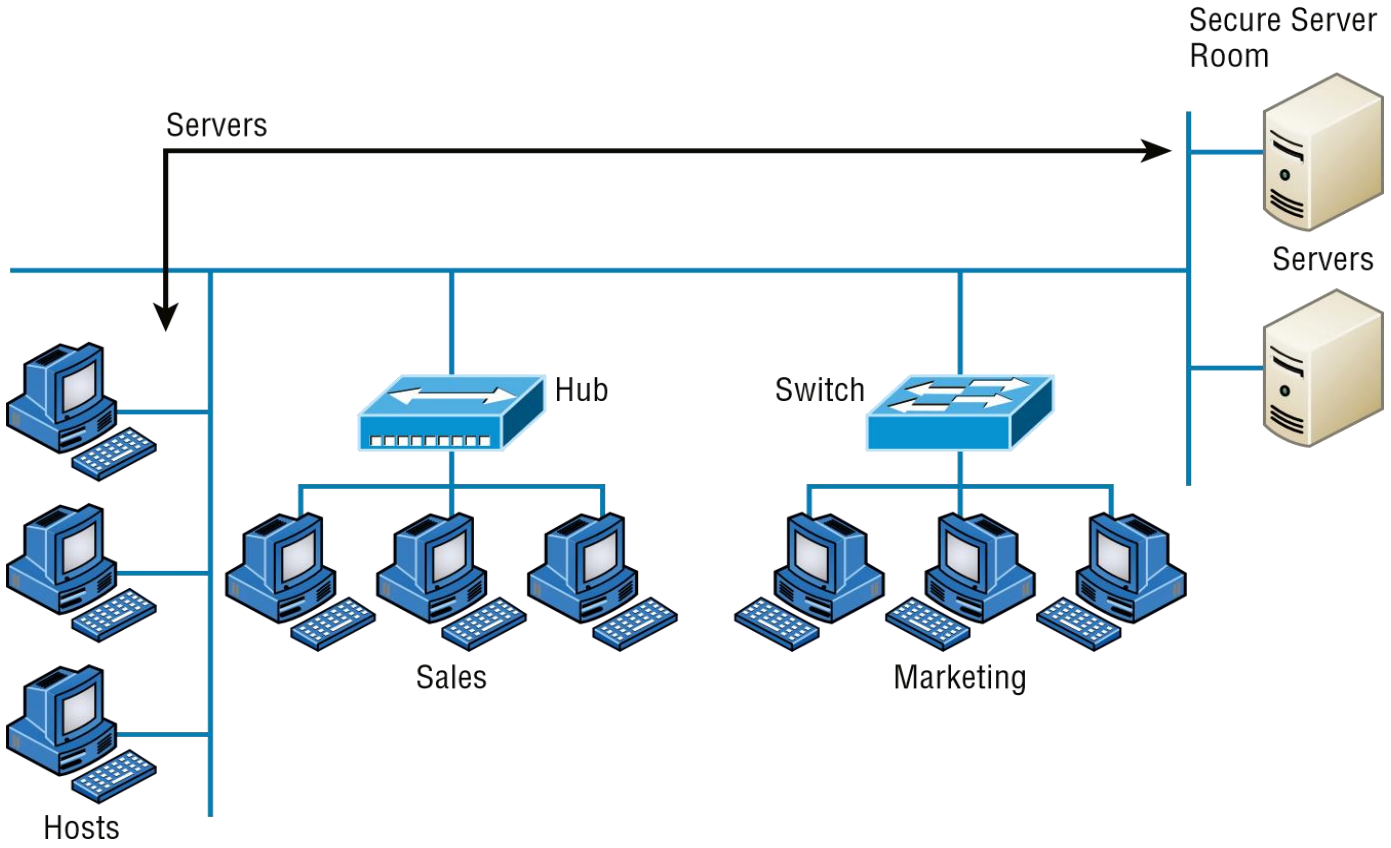


Two Computer Connected Back to Back

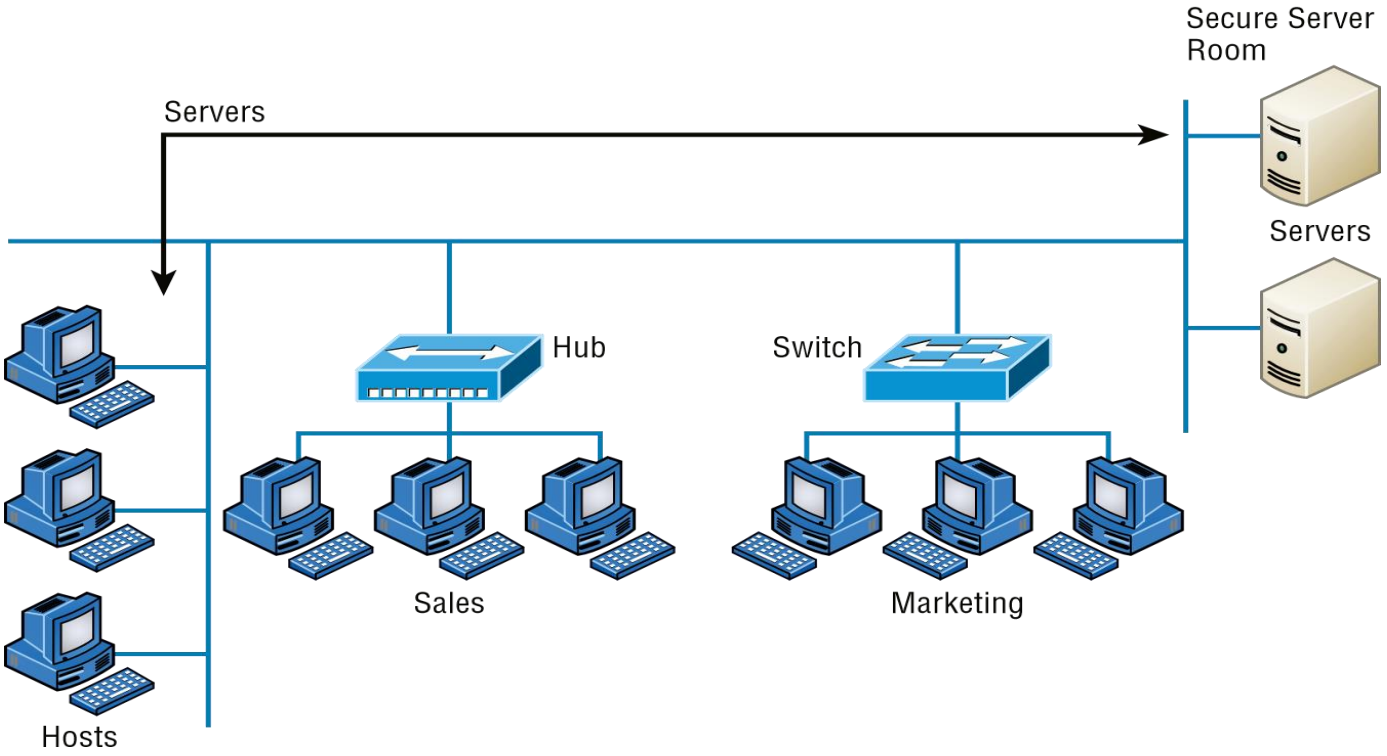
The simplest computer network



But our goal is to share resources on a larger scale

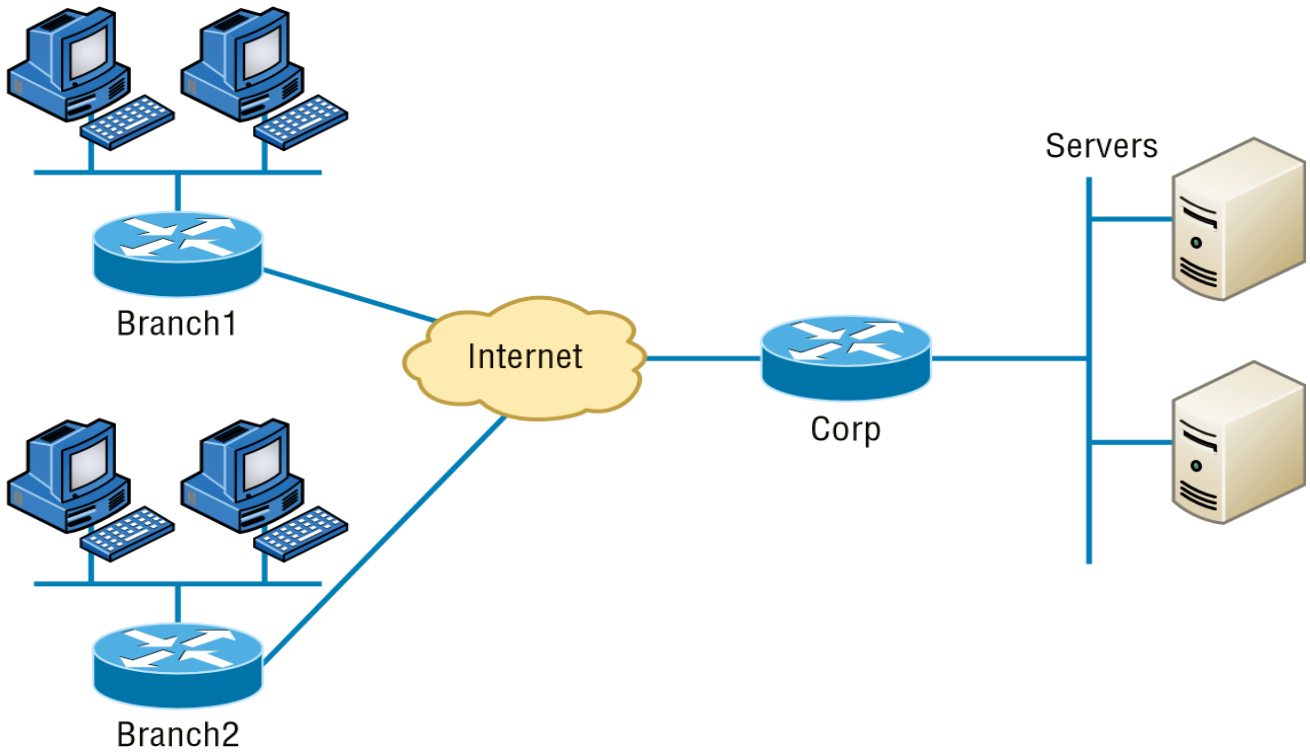


How are networks created?



Answer: By SWITCHES

How are networks connected?



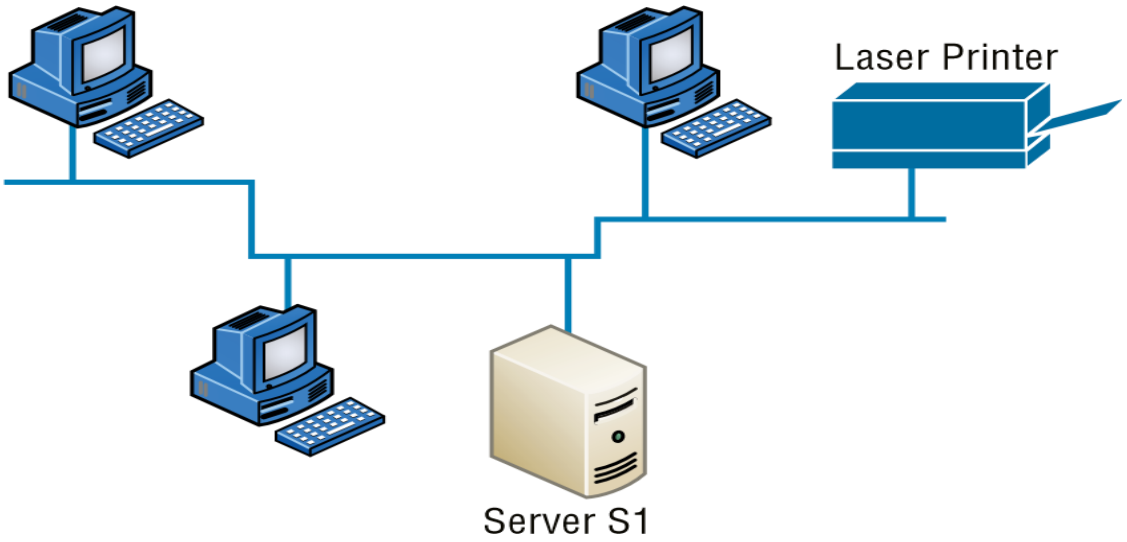
Answer: By ROUTERS

Physical Networks Topologies

- Bus
- Ring
- Mesh
- Point- to- point
- Point- to- multipoint
- Hybrid
- Star

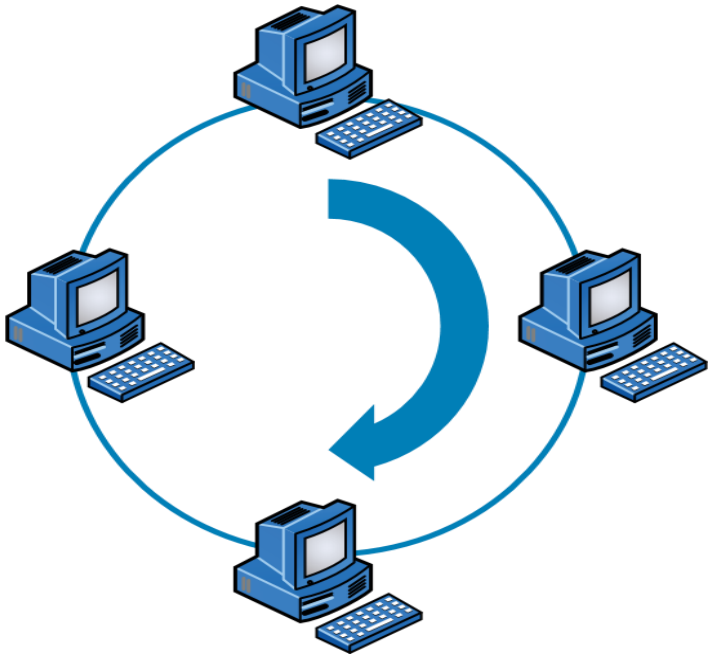
Physical Networks Topologies

Bus



Physical Networks Topologies

Ring



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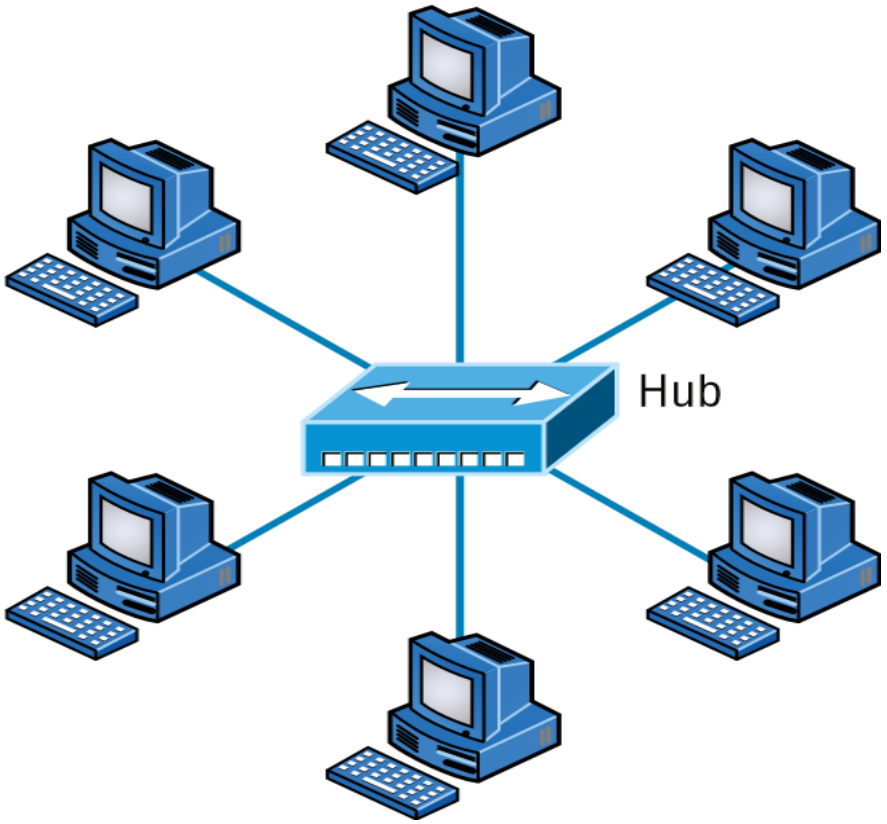
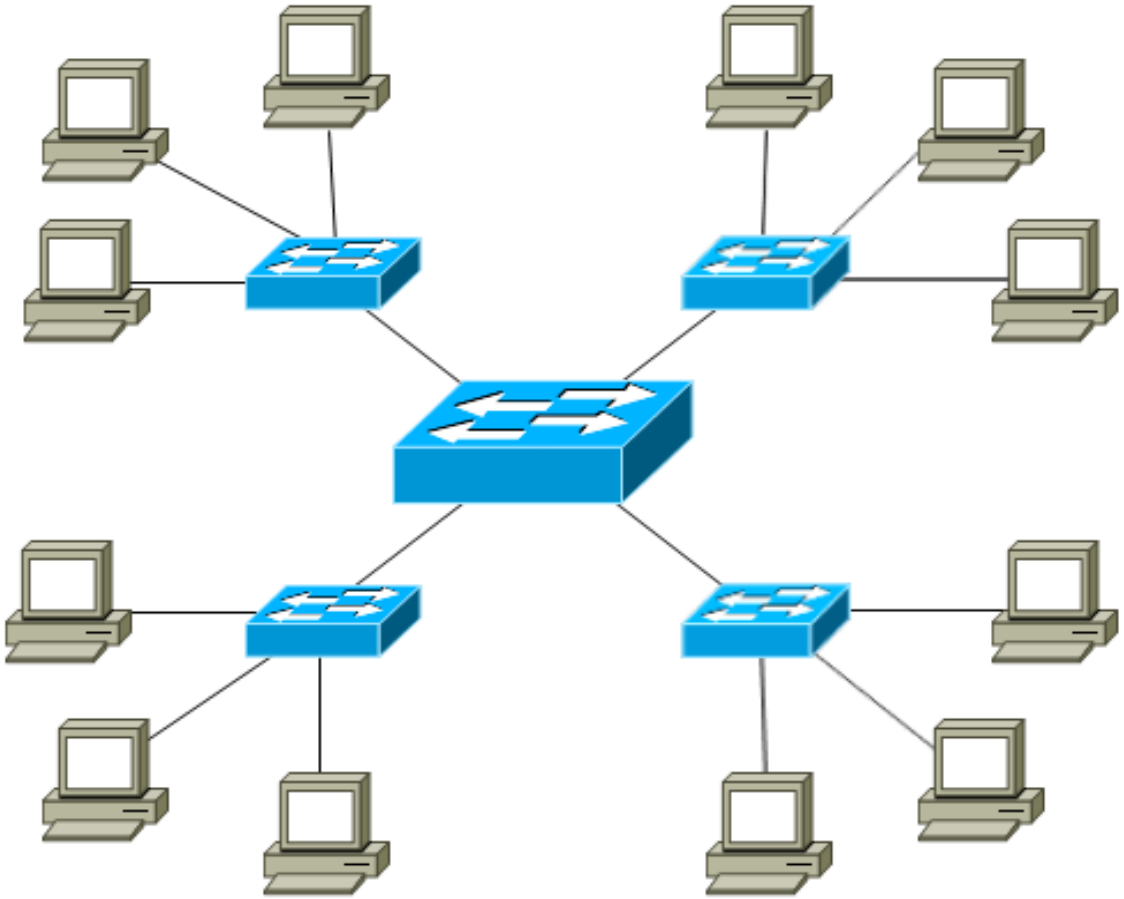
Physical Networks Topologies

Star



Physical Networks Topologies

Star



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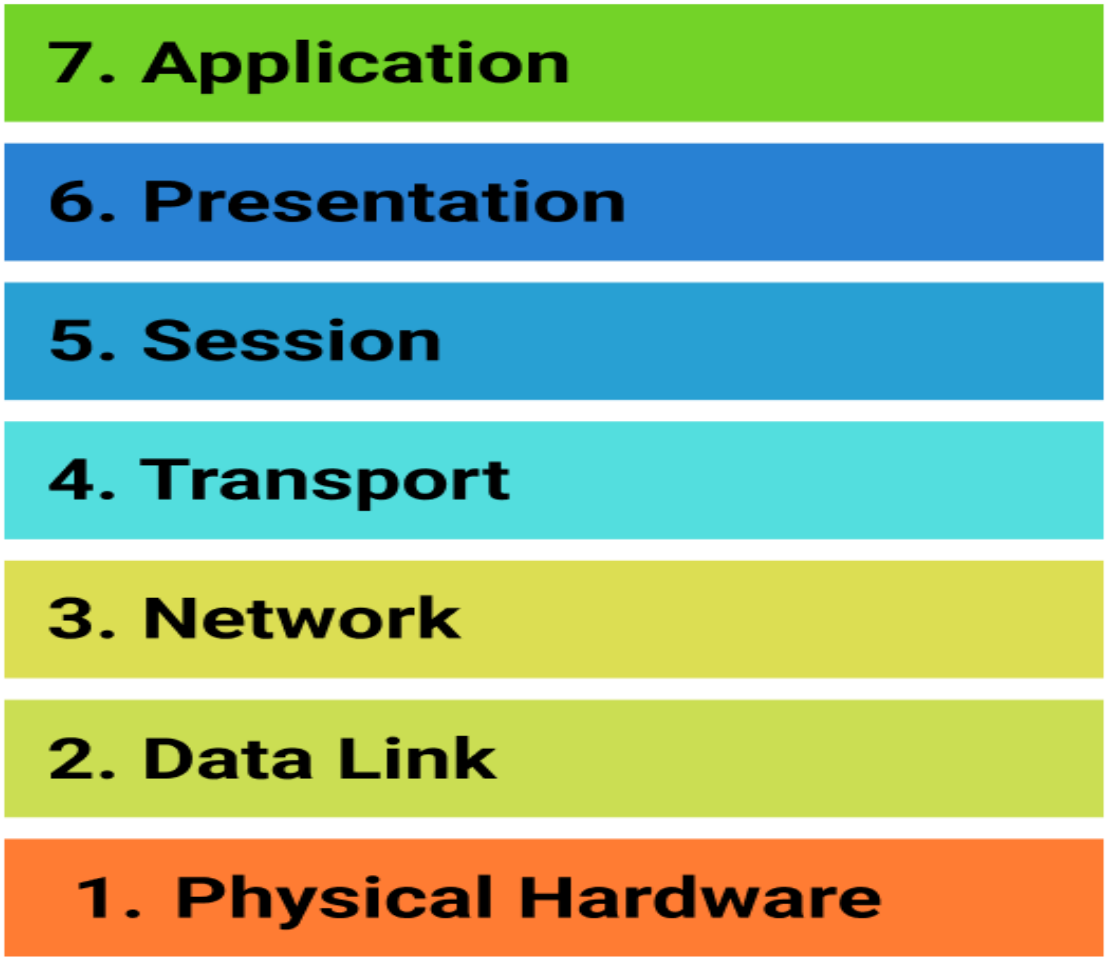
Network types in terms of scale

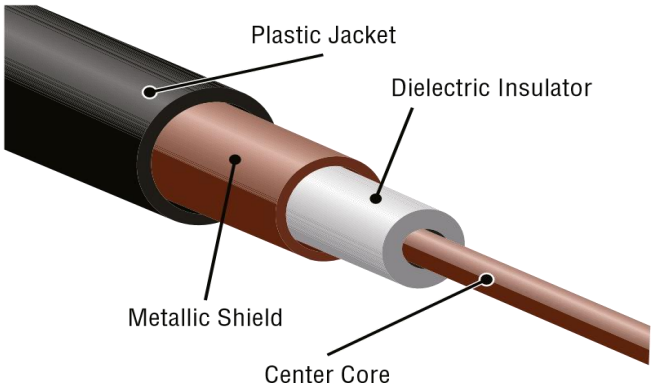
- PAN (Personal Area Network)
- LAN (Local Area Network)
- MAN (Metropolitan Area Network)
- WAN (Wide Area Network)

Network Layers (OSI Ref. Model)

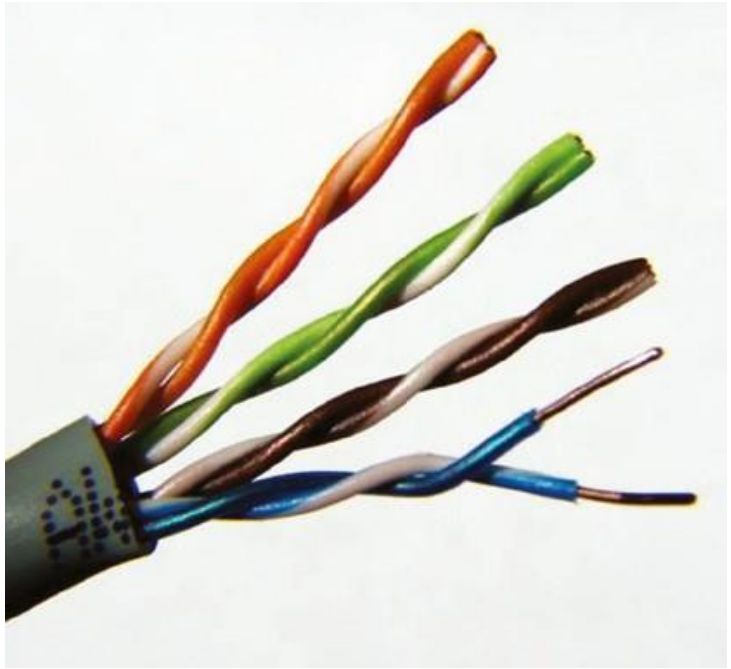


Network Physical Medias

Physical Media



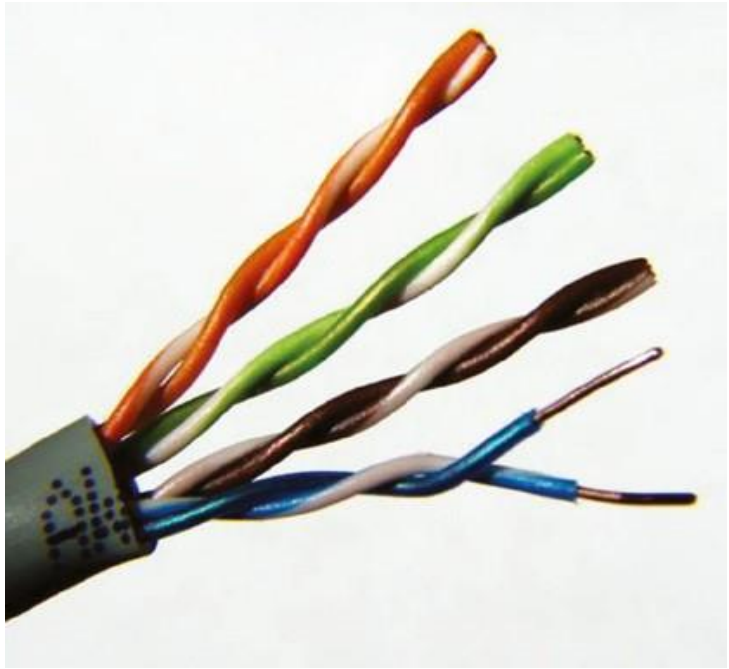
Physical Media

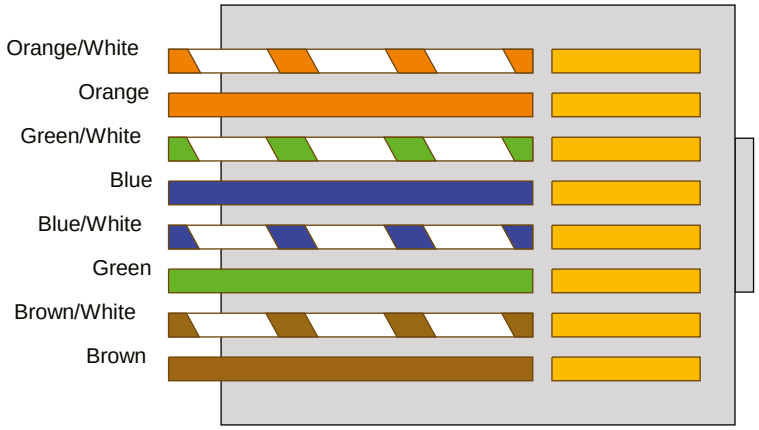


RJ-11

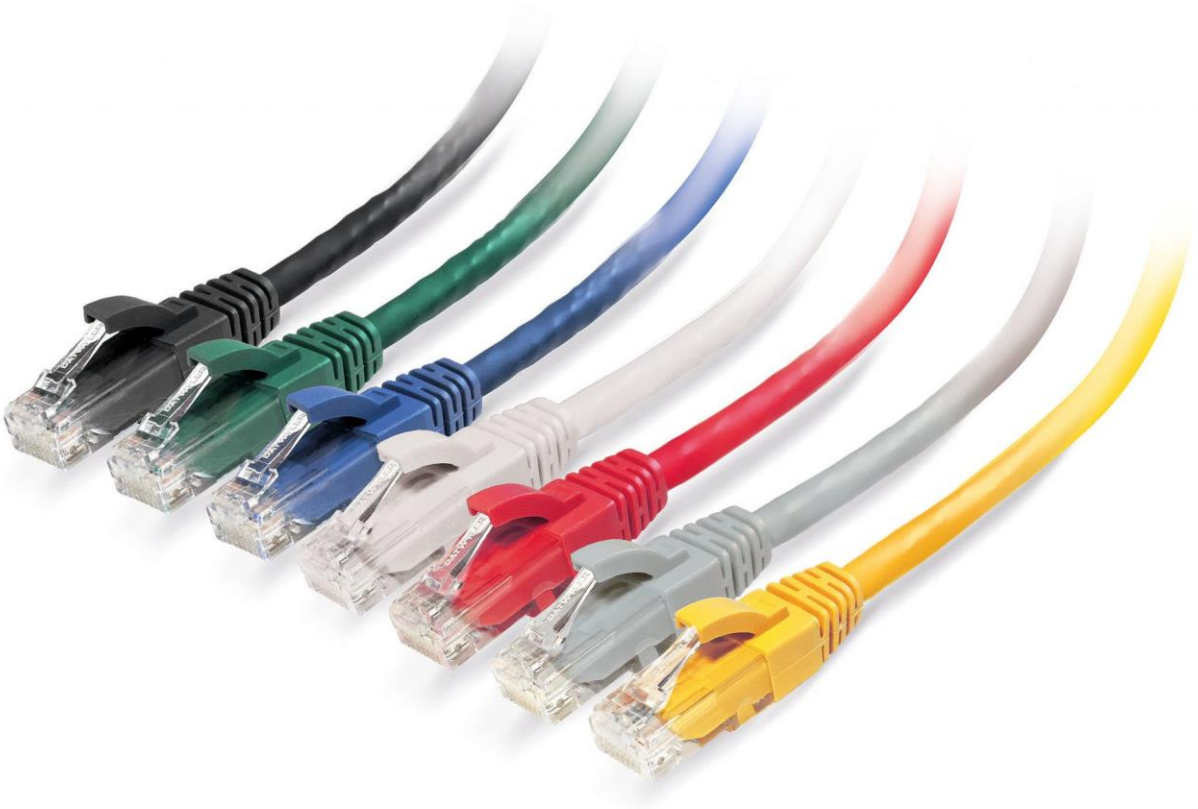
RJ-45

Physical Media

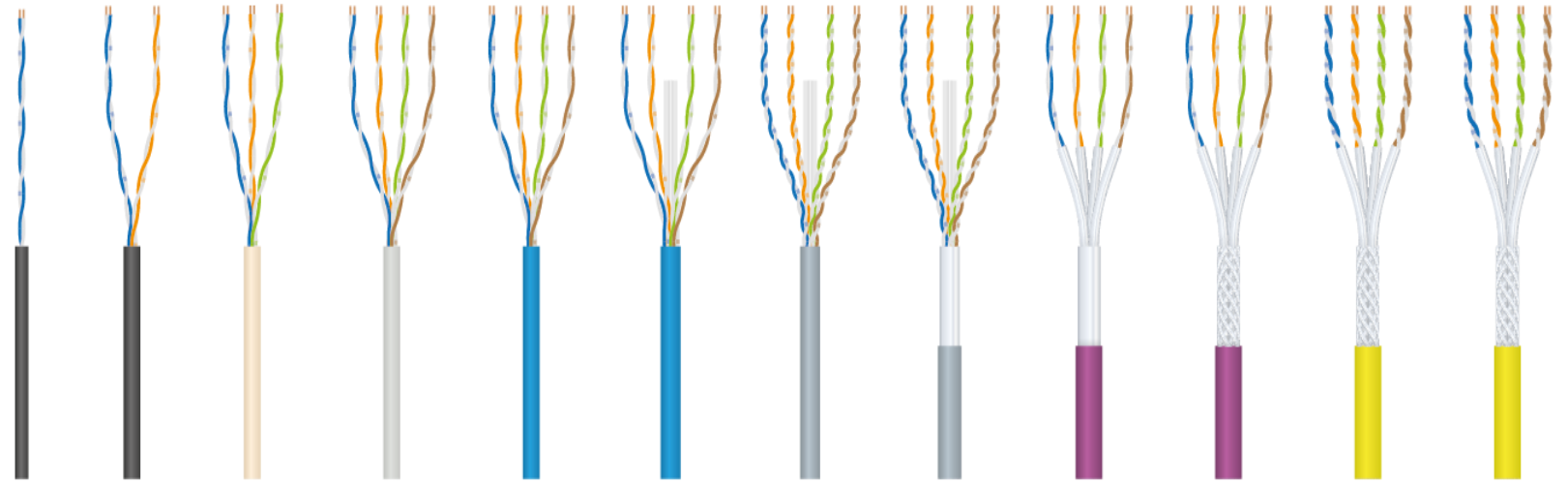




Physical Media



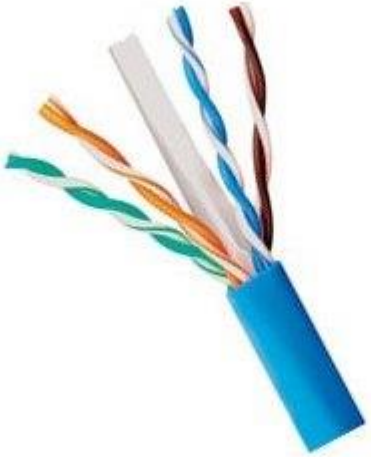
Physical Media



CAT 1	CAT 2	CAT 3	CAT 4	CAT 5	CAT 5e	CAT 6	CAT 6A	CAT 7	CAT 7A	CAT 8.1	CAT 8.2
1 Mbps	4 Mbps	10 Mbps	16 Mbps	100 Mbps	1 Gbps	1 Gbps	10 Gbps	10 Gbps	10 Gbps	25 Gbps	40 Gbps
400 KHz	4 MHz	16 MHz	20 MHz	100 MHz	100 MHz	250 MHz	500 MHz	600 MHz	1000 MHz	2000 MHz	2000 MHz
1983	1987	1991	1993	1995	2001	2002	2008	2010	2013	2016	2018

Physical Media

Cat 5e

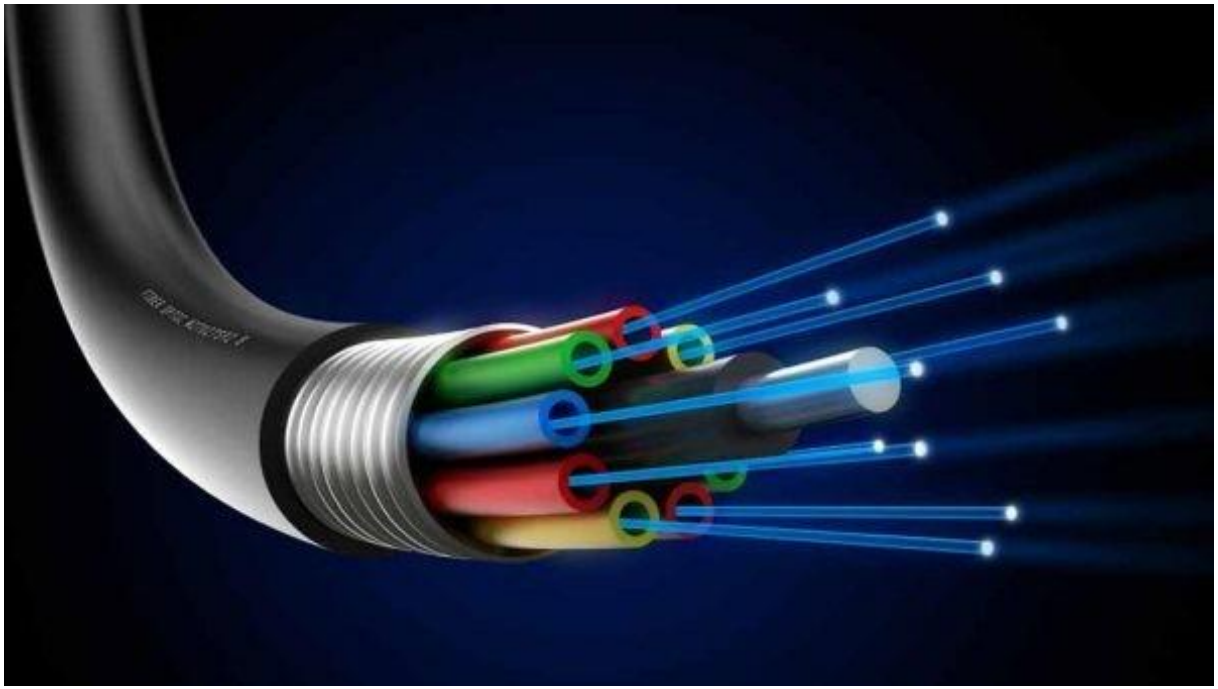


Cat 6

Cat 6e

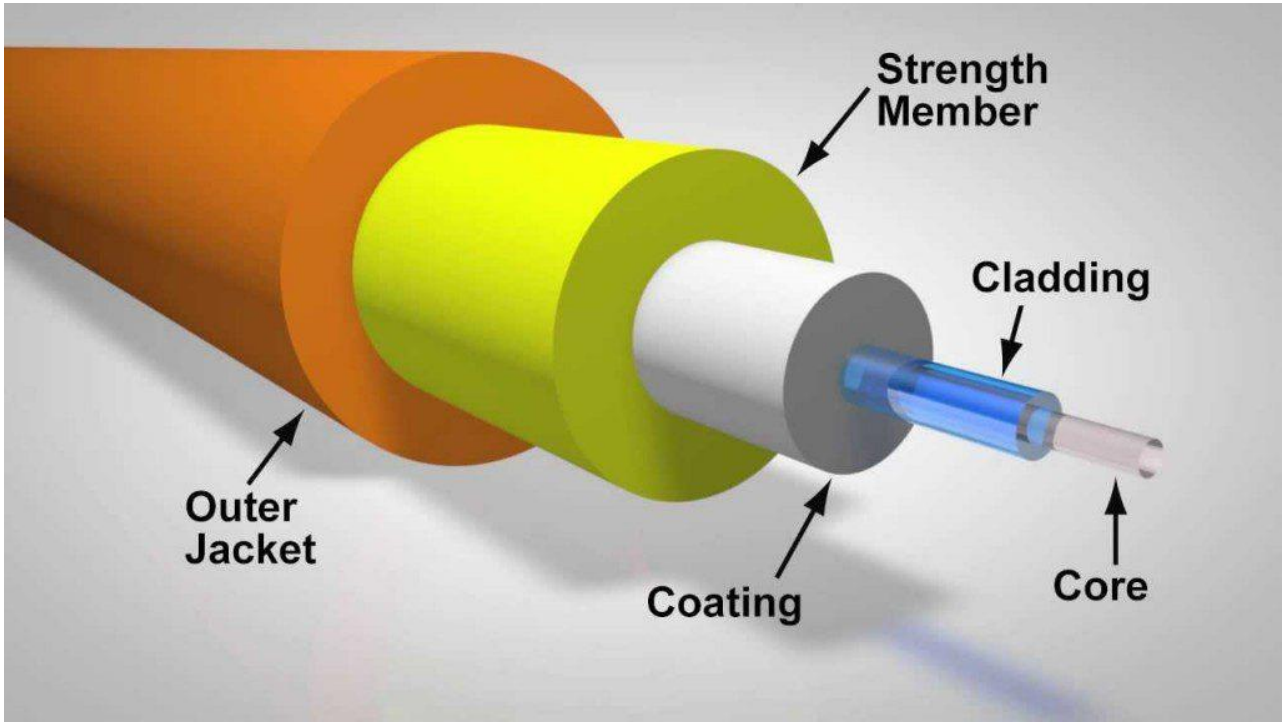
Physical Media

Fiber-Optic Transceivers



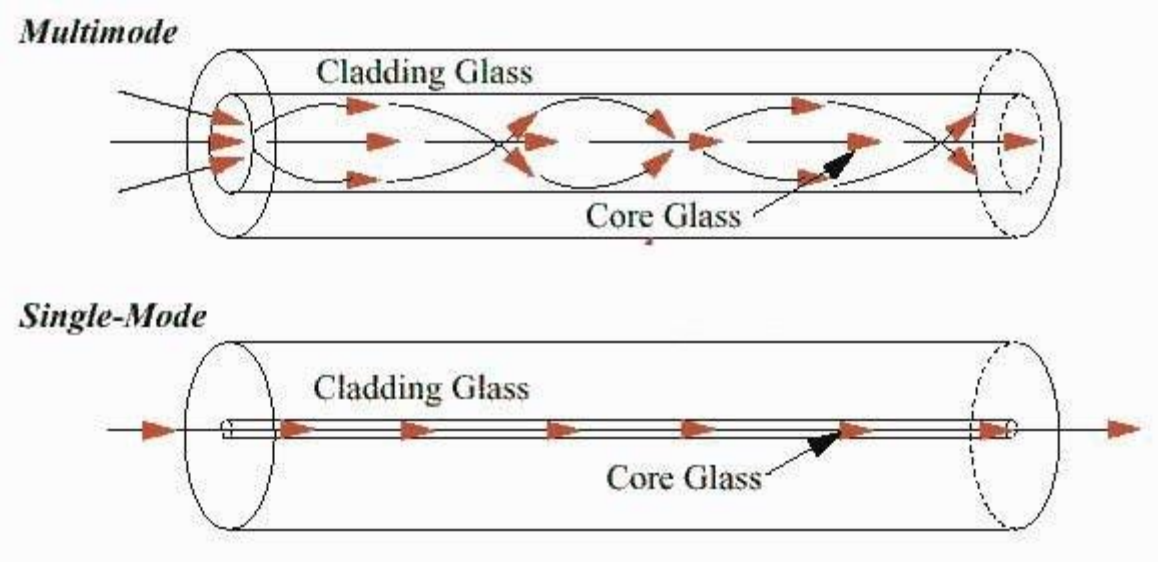
Physical Media

Fiber-Optic Transceivers



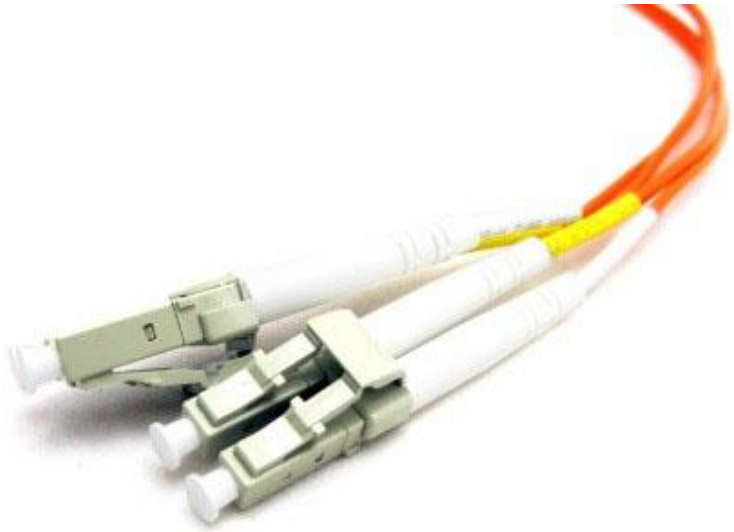
Physical Media

Fiber-Optic Transceivers



Physical Media

Fiber-Optic Transceivers

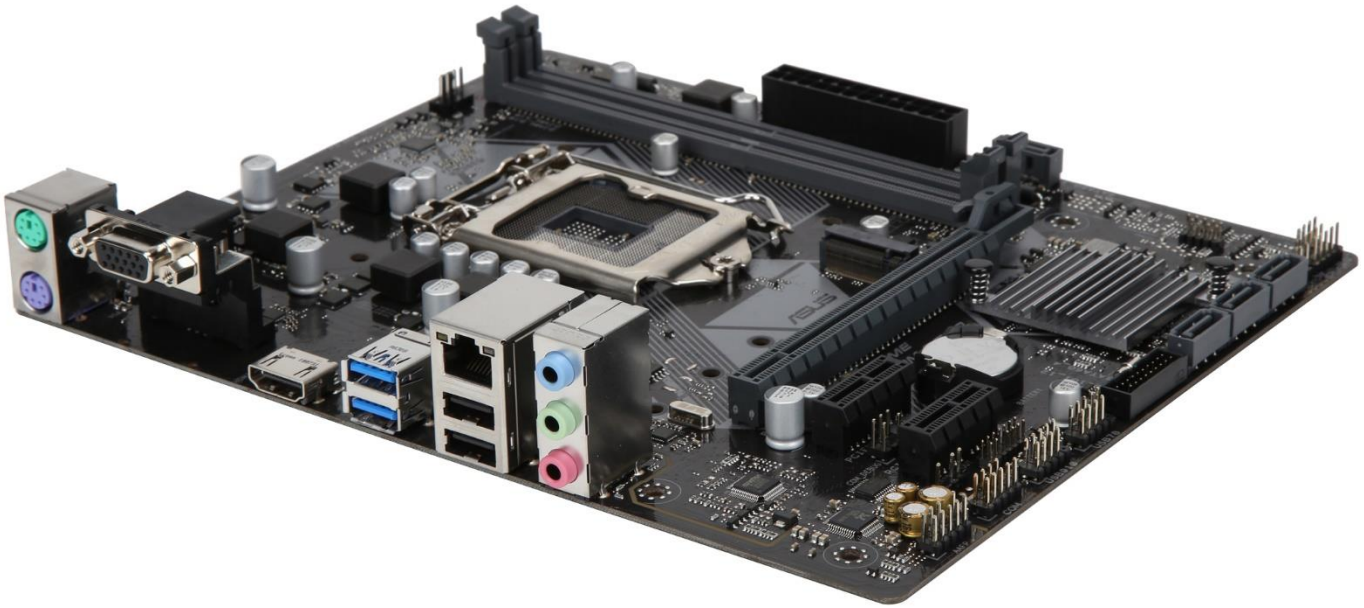


Network Connectivity Devices

Network Interface Card

NIC **Ethernet Adapter**

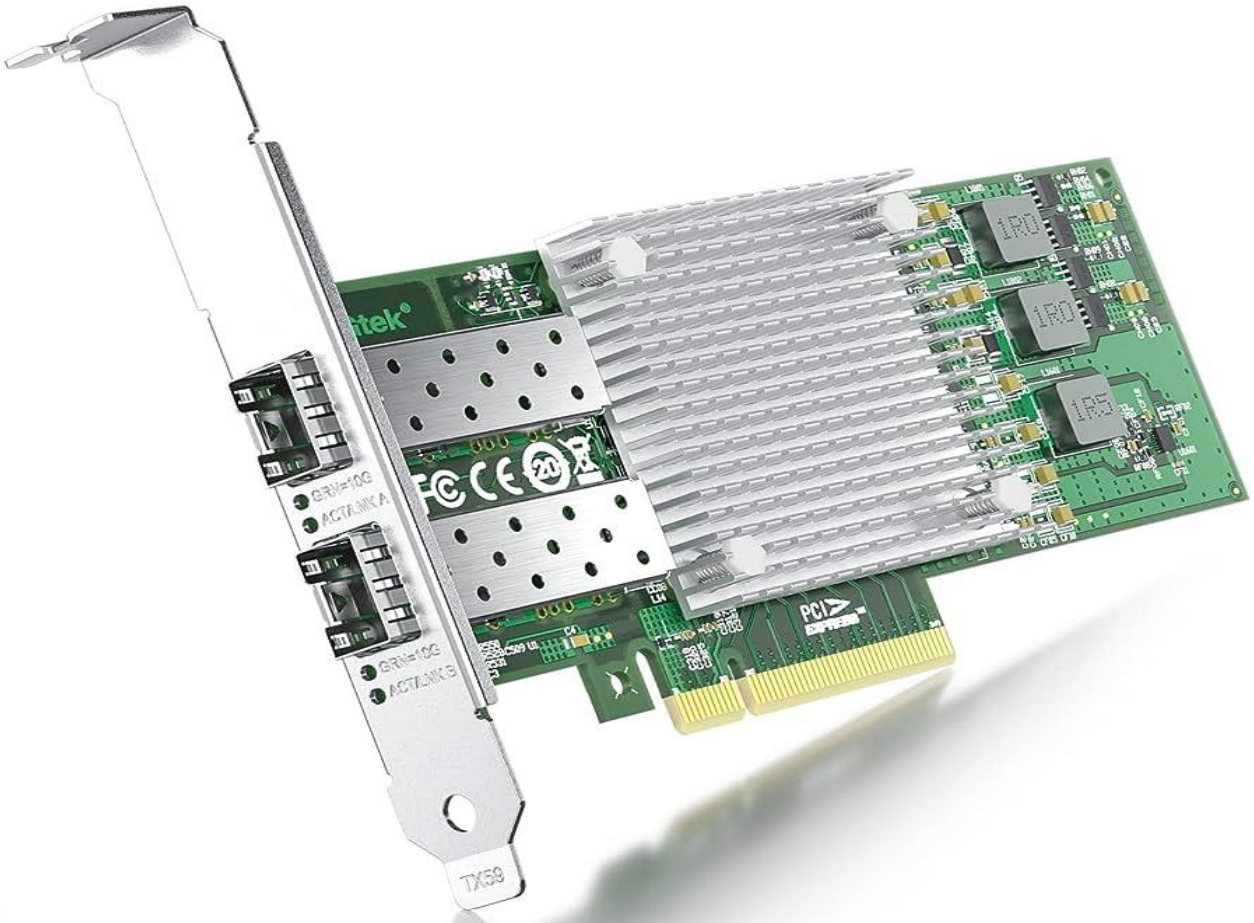
Network Interface Card



Network Interface Card

Network Interface Card

Network Interface Card



Network Interface Card

Network Interface Card

Each of NICs have a MAC Address (Physical Address)

e.g.: 7F:D2:68:71:4E:FF

e.g.: 00-5A-0C-B9-DA-8F

it contains 48 bit or 6 byte

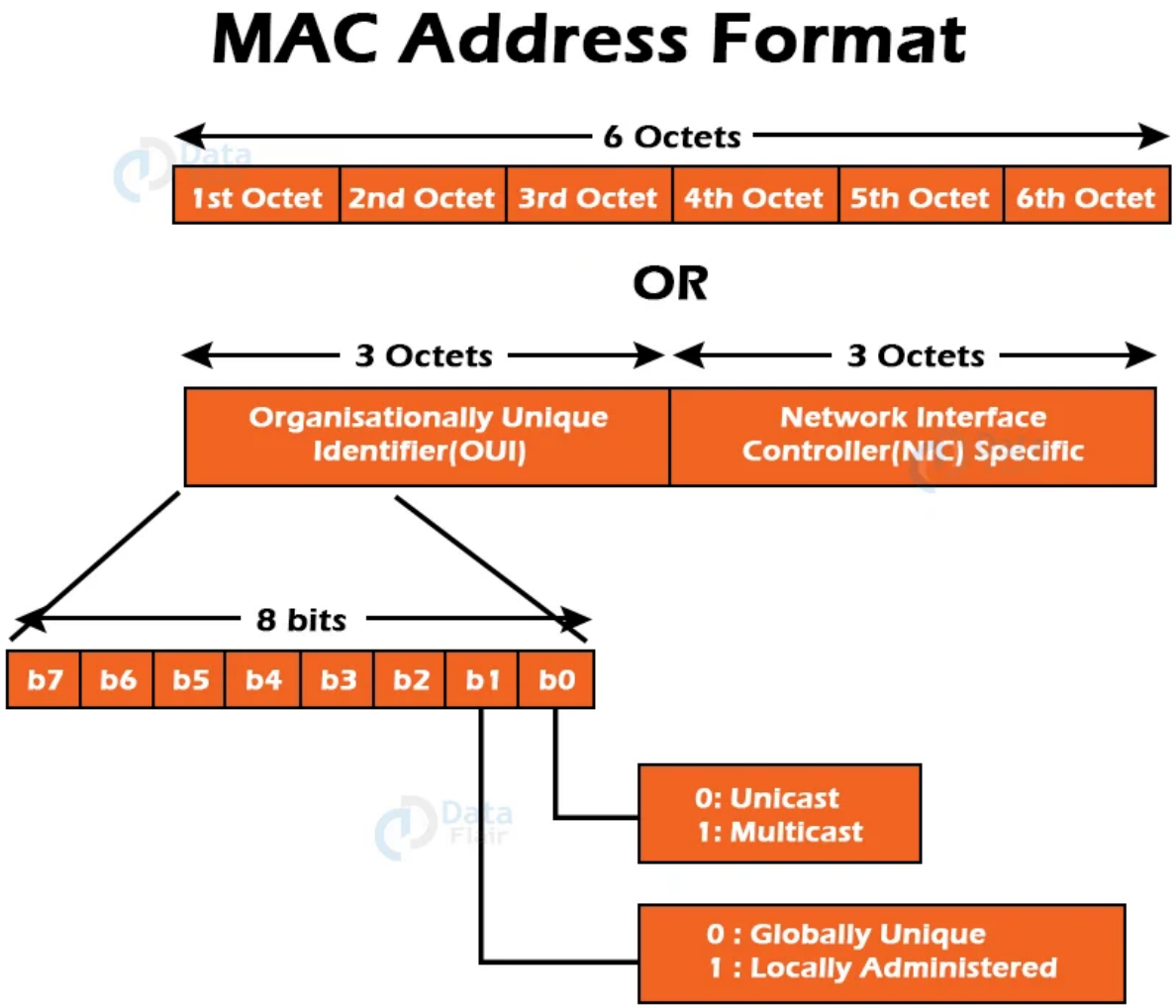
Network Interface Card

00-5A-0C-B9-DA-8F

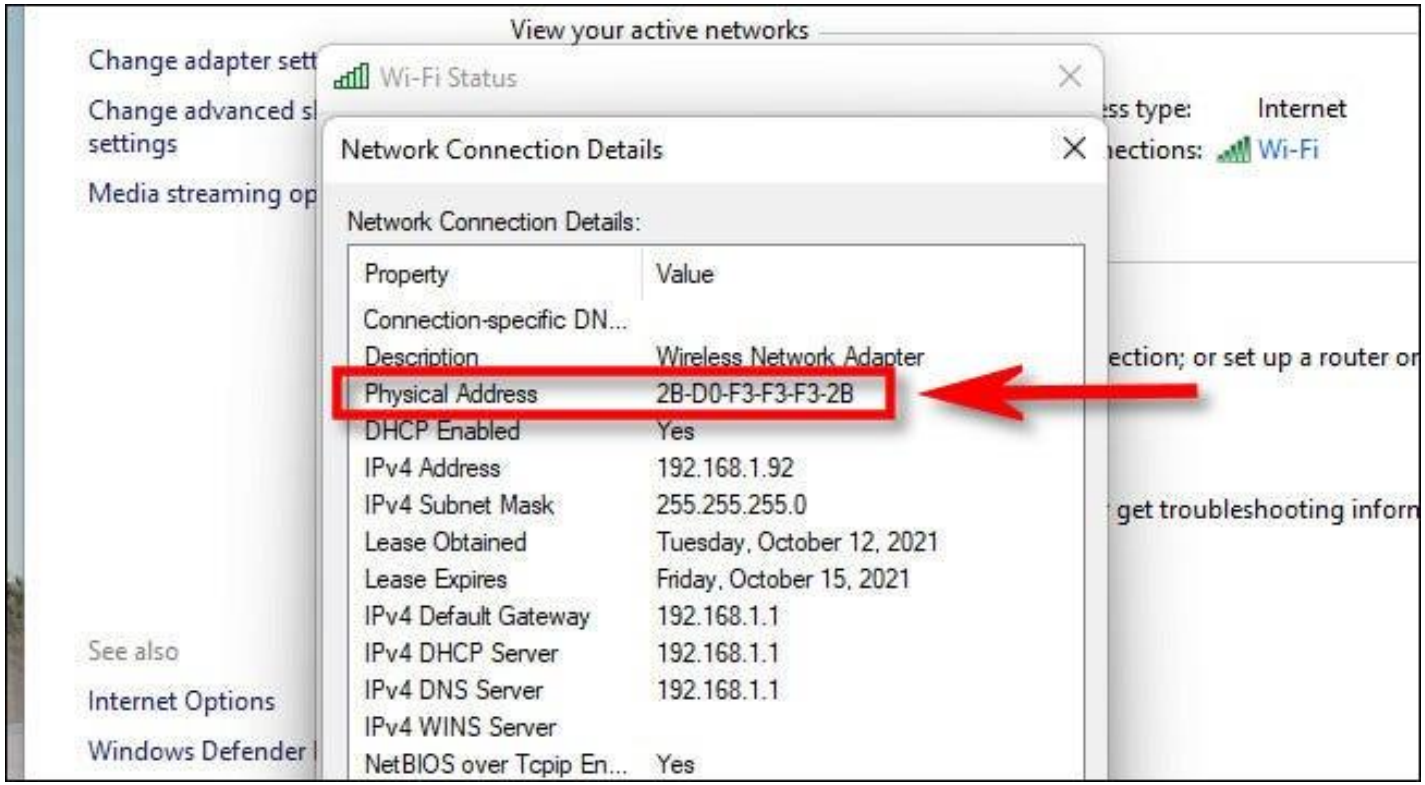
it contains 48 bit or 6 byte

(a 48-bit address space with 2 possible values for each positio n (either 0 or 1) gives you 2^{48}, or 281 thousands billion).

Network Interface Card



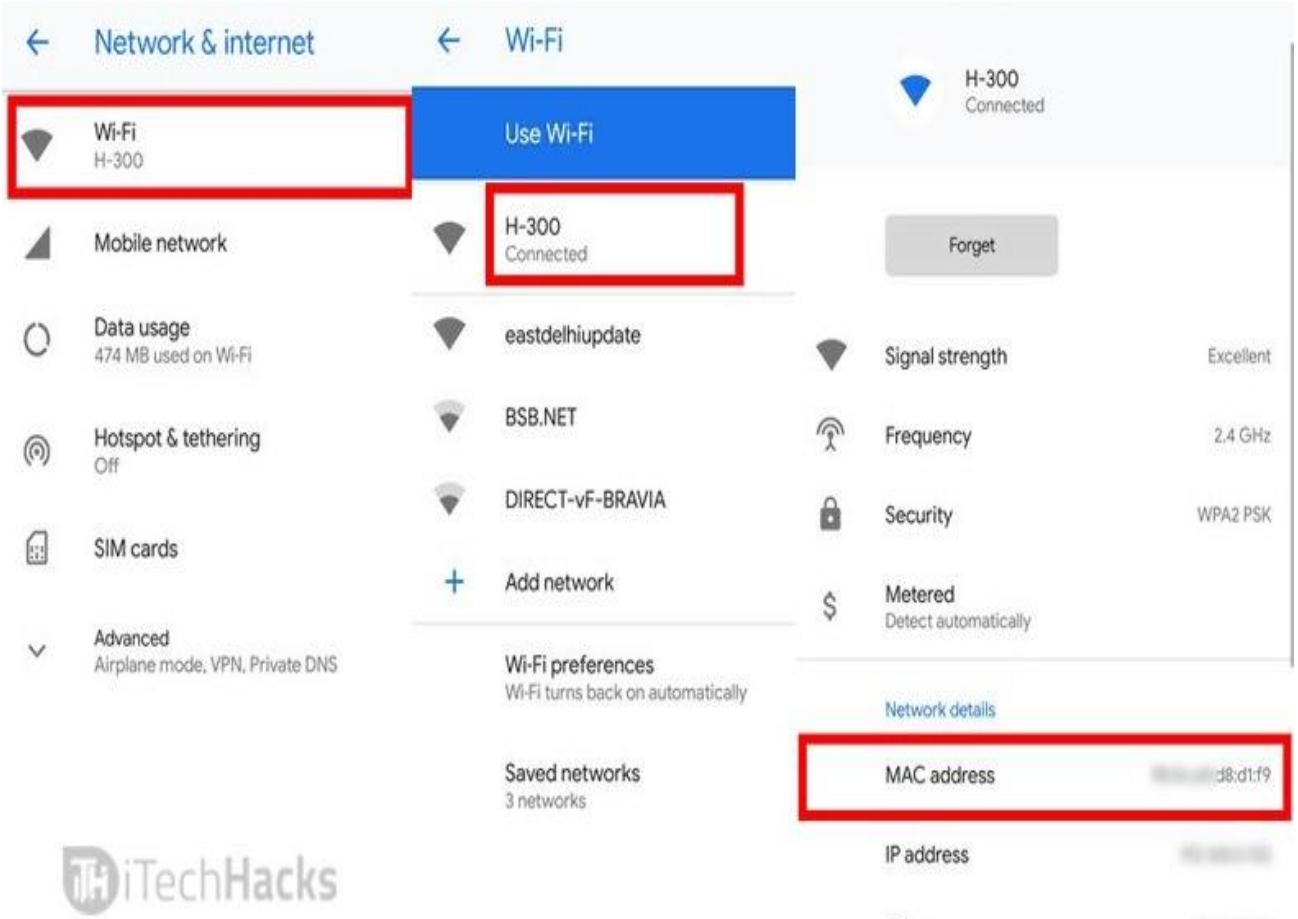
Network Interface Card



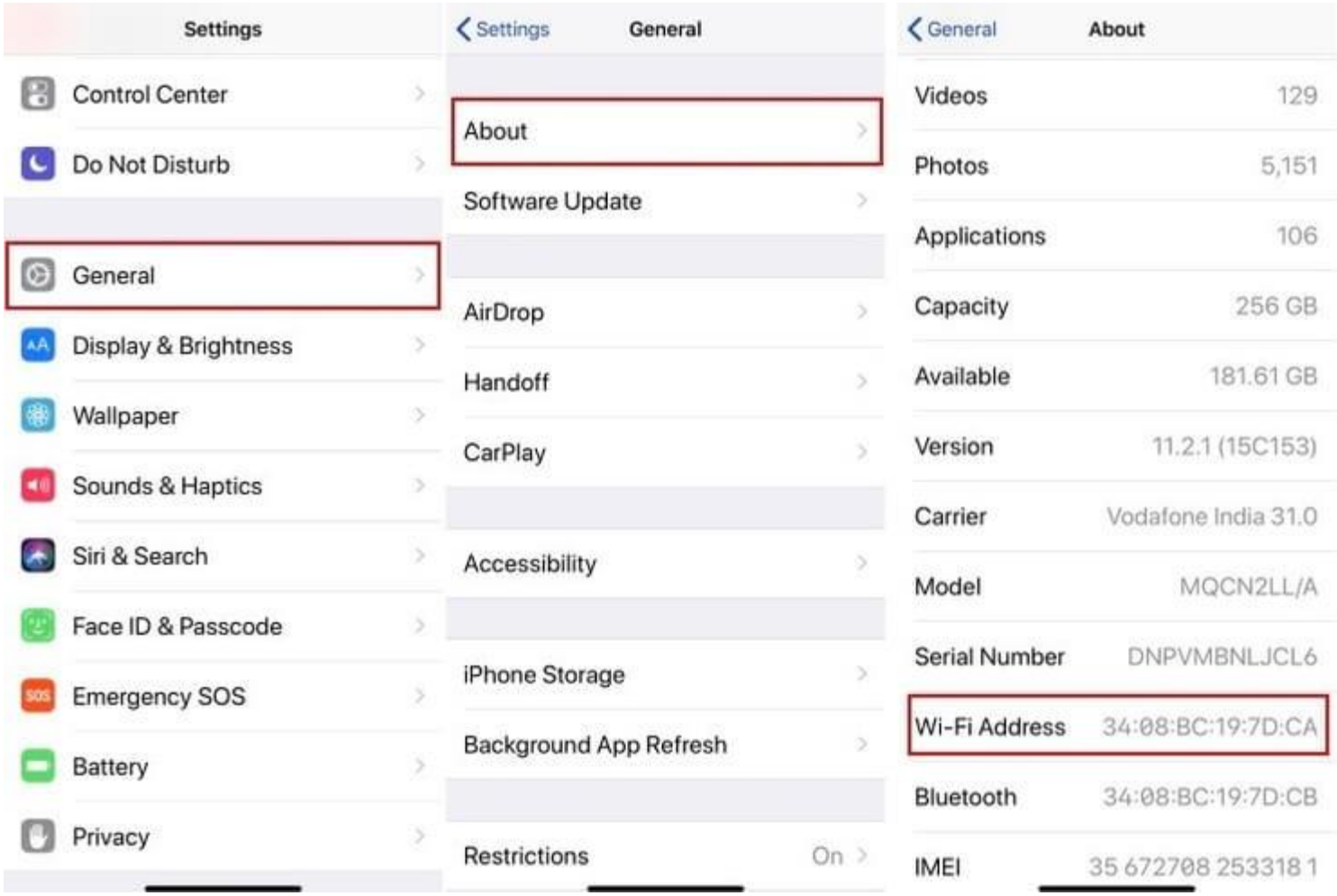
In Windows:

Control Panel -- Network and Internet -- Network Connections
Double Click on NIC – Details – Physical Address

Network Interface Card



Network Interface Card



HUB

Switch

Switch

What is difference between Hub and Switch?

Switch

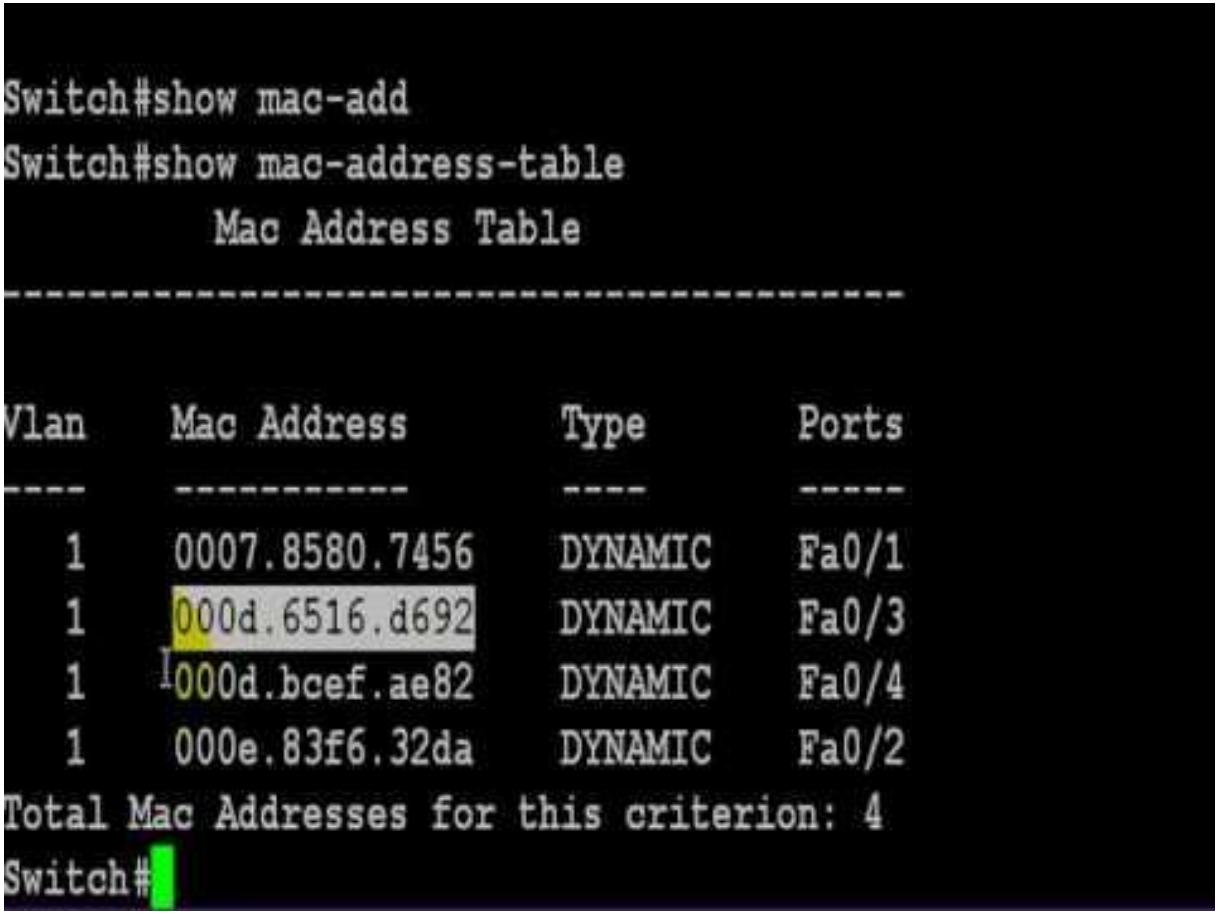
The hubs broadcasts

Switch

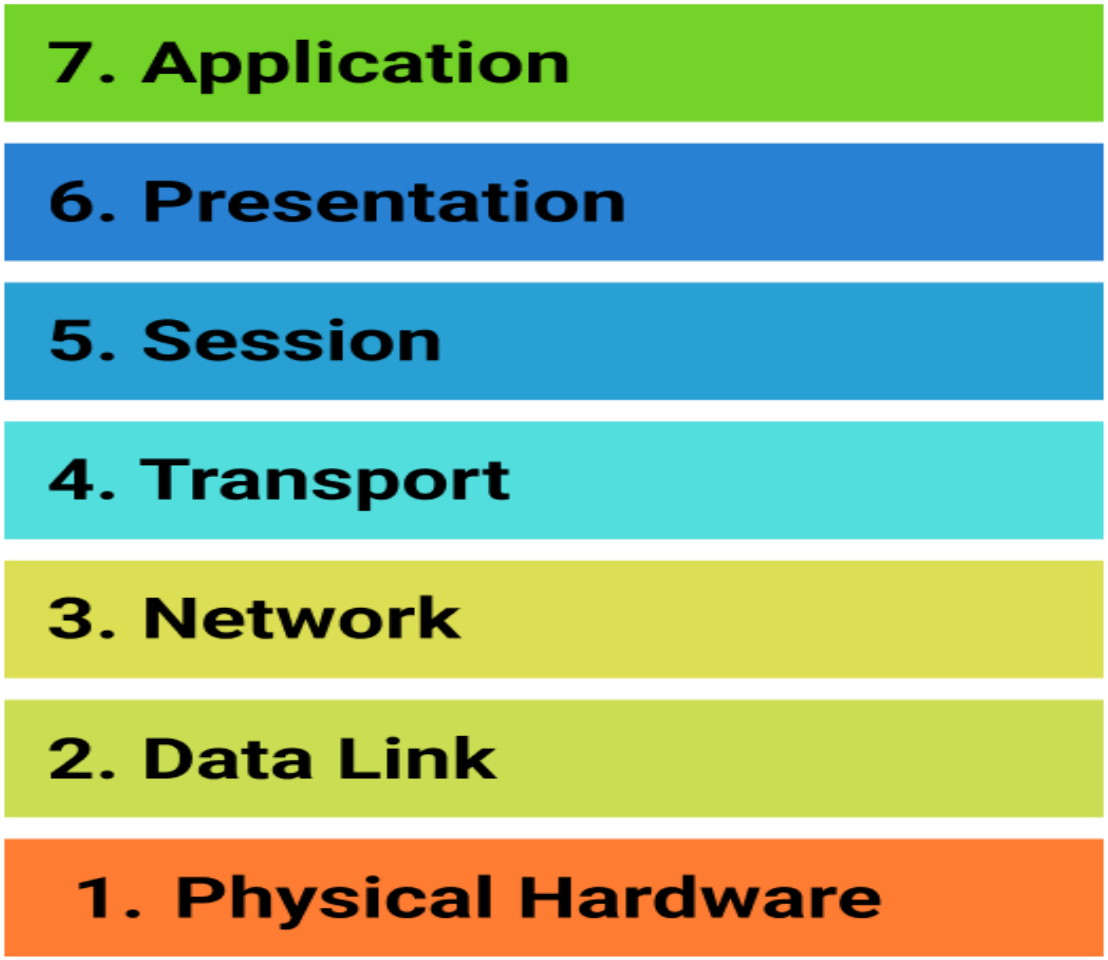
But the switch does unicast

- Each of NICs has a MAC address (physical address).
- The switch reads the physical addresses that connected to each port.
- Switch make a MAC address table.

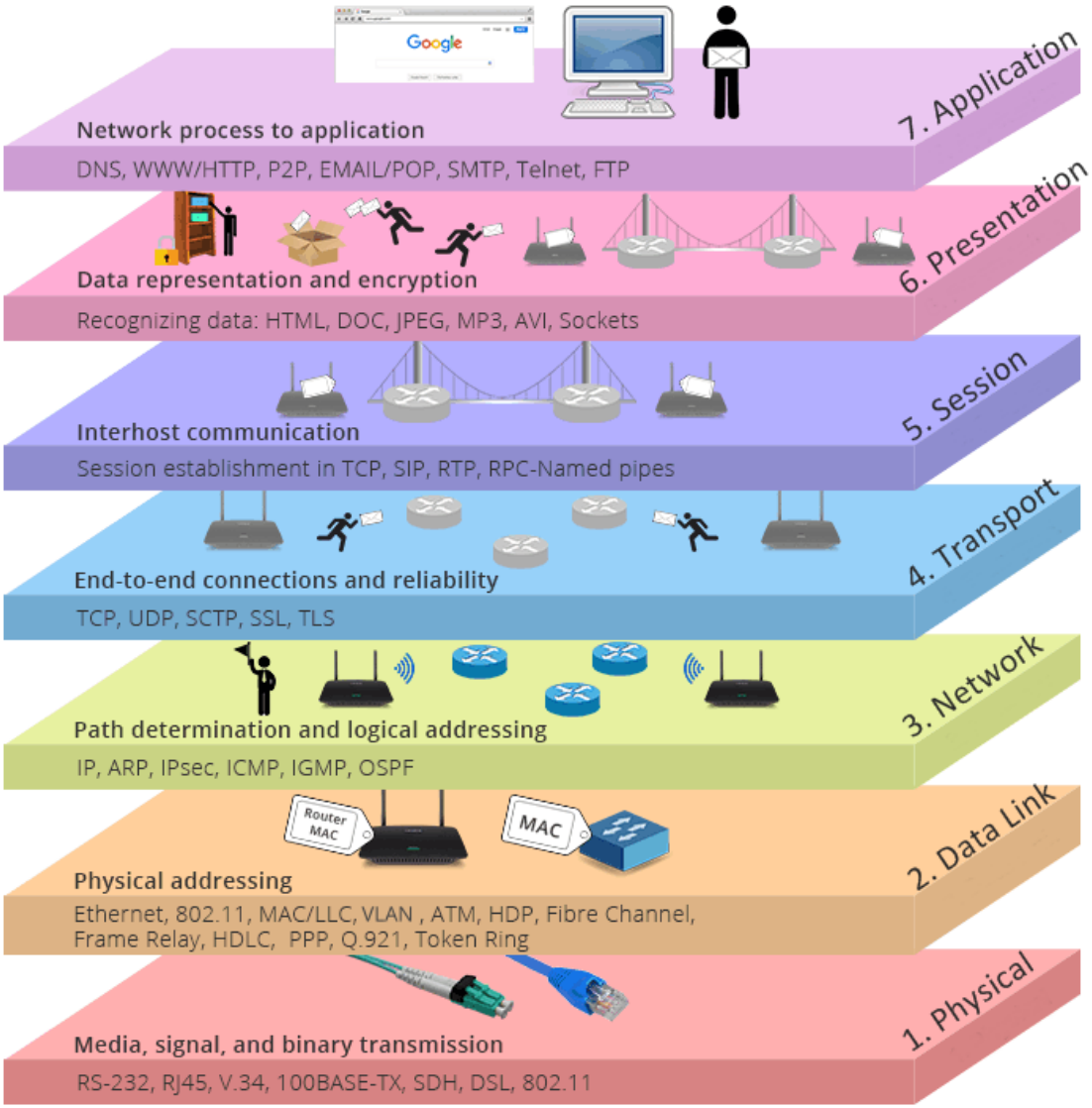
Switch


Switch#show mac-add
Switch#show mac-address-table
Mac Address Table
Vlan Mac Address Type Ports
1 0007.8580.7456 DYNAMIC Fa0/1
1 000d.6516.d692 DYNAMIC Fa0/3
1 000d.bcef.ae82 DYNAMIC Fa0/4
1 000e.83f6.32da DYNAMIC Fa0/2
Total Mac Addresses for this criterion: 4
Switch#

Network Layers (OSI Ref. Model)



Network Layers (OSI Ref. Model)



IP Addressing

IP Addressing

Wait…, let me see again

We have here an Address

MAC Address

IP Addressing

What is difference between IP & MAC

- **Local identification vs Global identification**
- Layer 2 vs Layer 3 operation
- Physical address vs logical address
- Number of bits
- Address assignment and permanence
- Address formatting

IP Addressing

- An IPv4 address consists of 32 bits of information
- These bits are divided into 4 sections, referred to as octets or bytes
- Four octets sum up to 32 bits (8 × 4 = 32)
- Every octet can be 0~255 in decimal base
  - Decimal: 172 . 16 . 30 . 56
  - Binary: 10101100.00010000.00011110.00111000

IP Addressing

Decimal: 1 . 0 . 0 . 0

Binary: 00000001.00000000.00000000.00000000

~

Decimal: 254 . 255 . 255 . 255

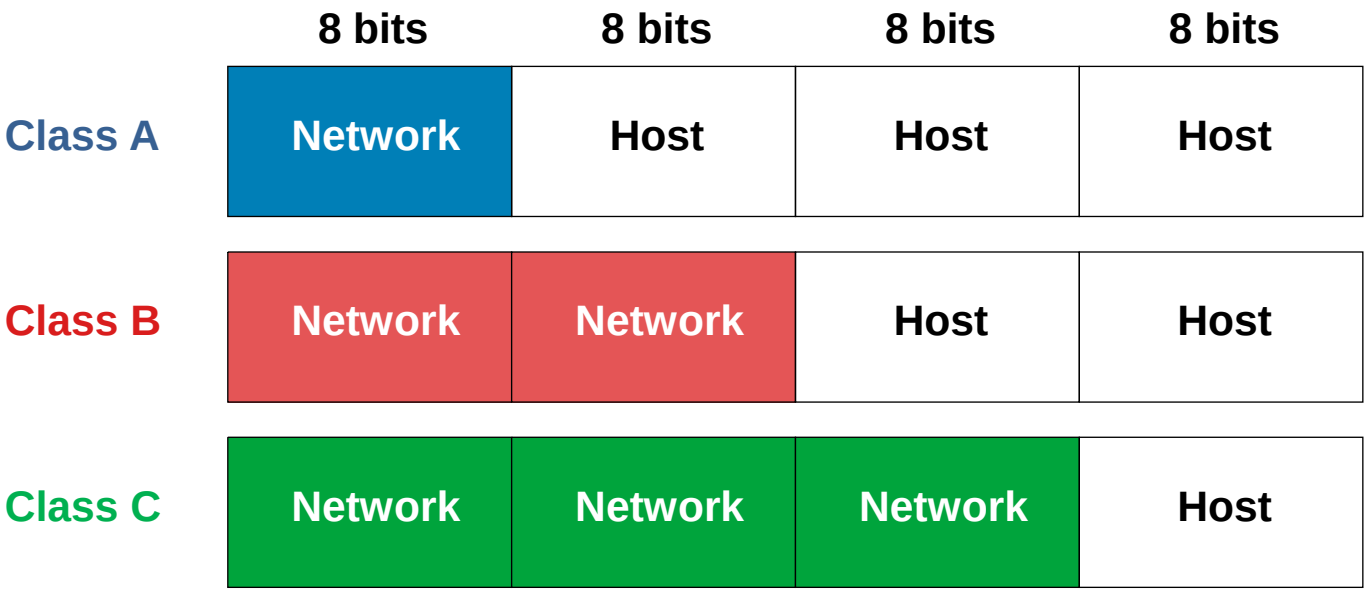
Binary: 11111110. 11111111. 11111111. 11111111

IP Addressing

Namely, 4.3 billion (a 32-bit address space with 2 possible values for each position (either 0 or 1) gives you 2^{32}, or 4,294,967,296).

IP Addressing

Depending on how many bits of IPv4 are fixed in the network, we have three classes of addresses



IP Addressing

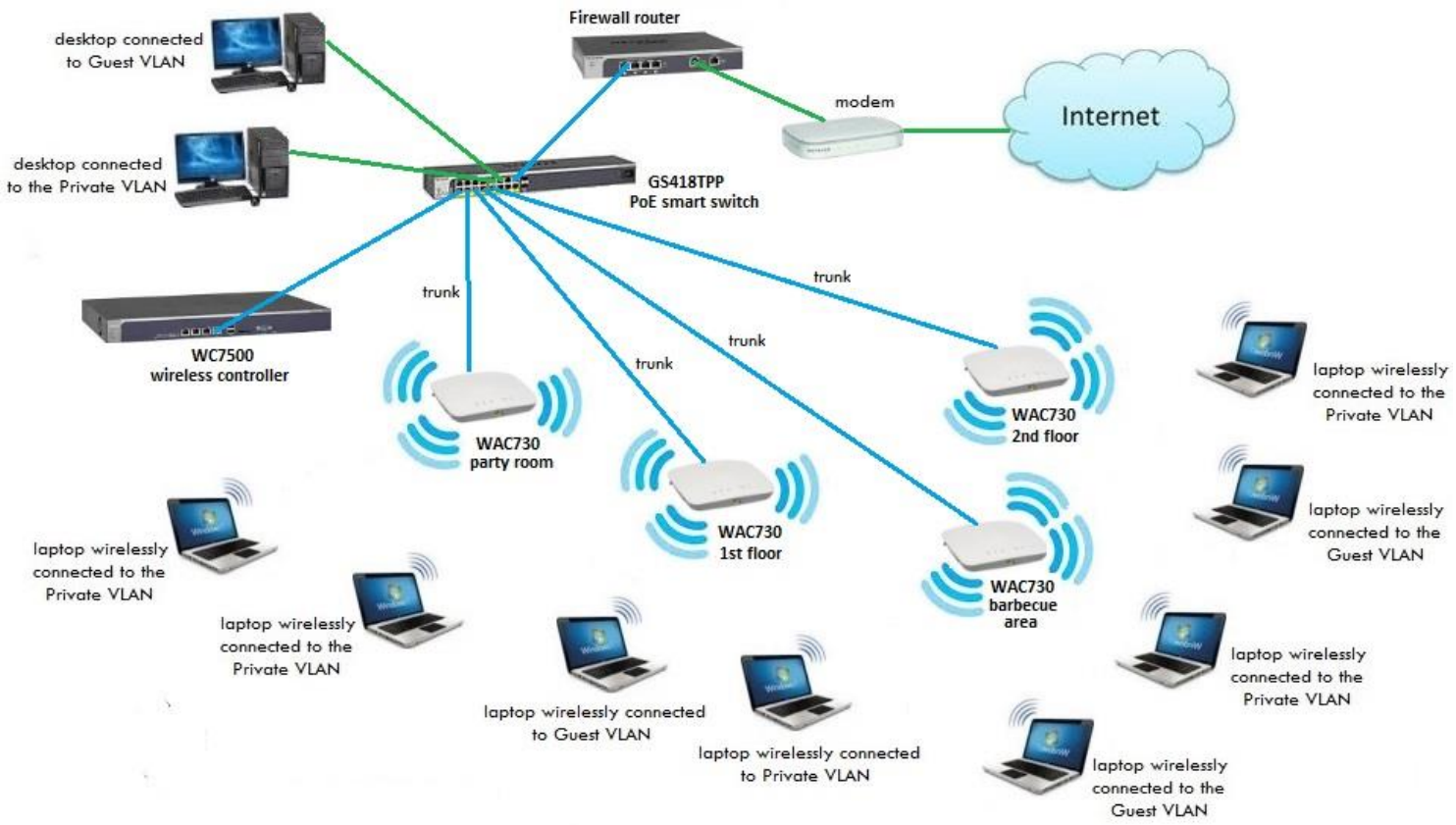
Address Class	RANGE	Default Subnet Mask
A	1.0.0.0 to 126.255.255.255	255.0.0.0
B	128.0.0.0 to 191.255.255.255	255.255.0.0
C	192.0.0.0 to 223.255.255.255	255.255.255.0
D	224.0.0.0 to 239.255.255.255	Reserved for Multicasting
E	240.0.0.0 to 254.255.255.255	Experimental

Note: Class A addresses 127.0.0.0 to 127.255.255.255 cannot be used and is reserved for loopback testing.

IP Addressing

In your opinion

Is the number of IPv4s **enough** for our world today?



IP Addressing

Communication Devices, Servers, Storages, Computers,

Portable Devices, TVs, Homs, Organizations, ...

What is the solution?

IP Addressing

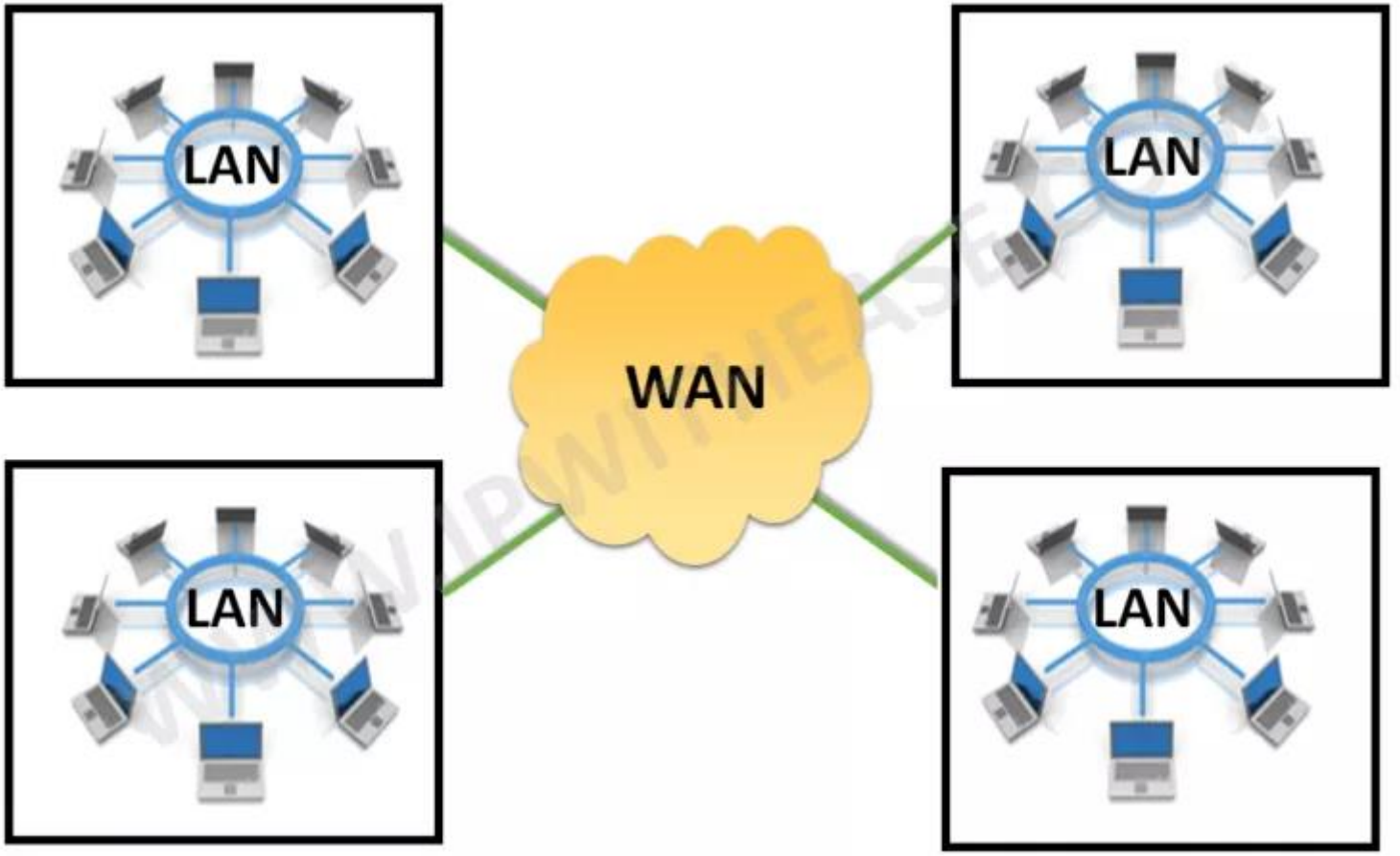
Private & Public IP

	Private address range	
Class	start address	finish address
A	10.0.0.0	10.255.255.255
B	172.16.0.0	172.31.255.255
C	192.168.0.0	192.168.255.255

	Public address range	
Class	start address	finish address
A	0.0.0.0	126.255.255.255
B	128.0.0.0	191.255.255.255
C	192.0.0.0	223.255.255.255
D	224.0.0.0	239.255.255.255
E	240.0.0.0	254.255.255.255

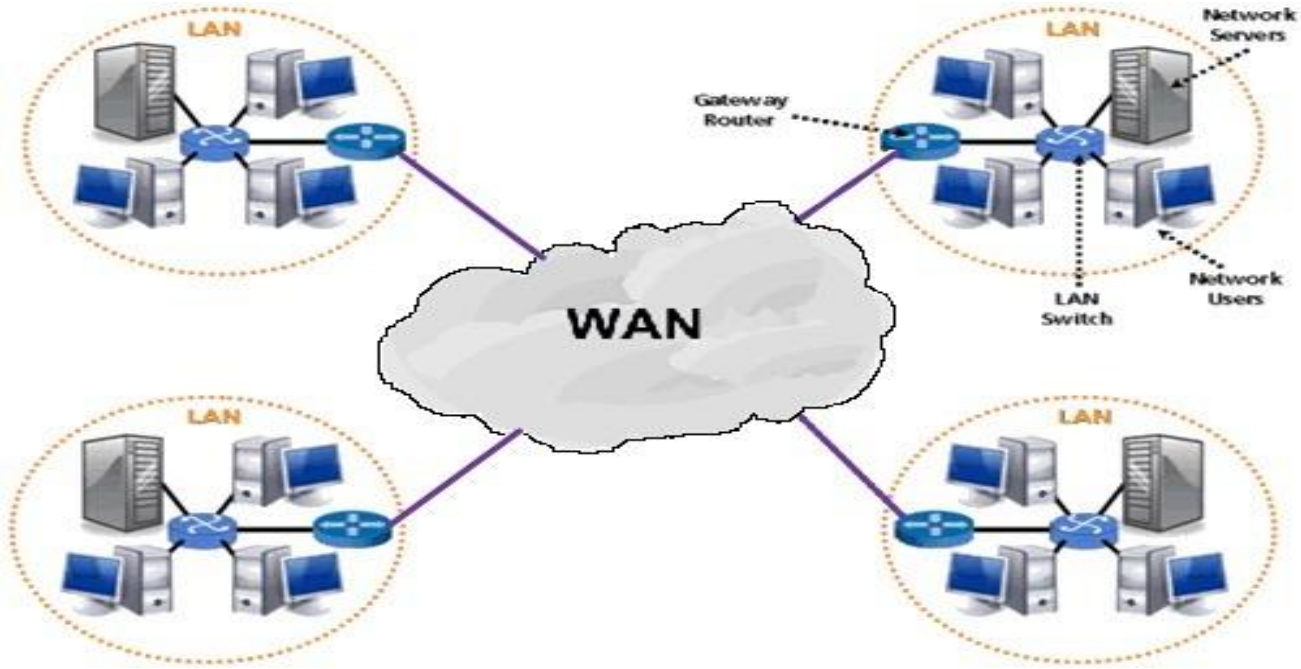
IP Addressing

Private & Public IP



IP Addressing

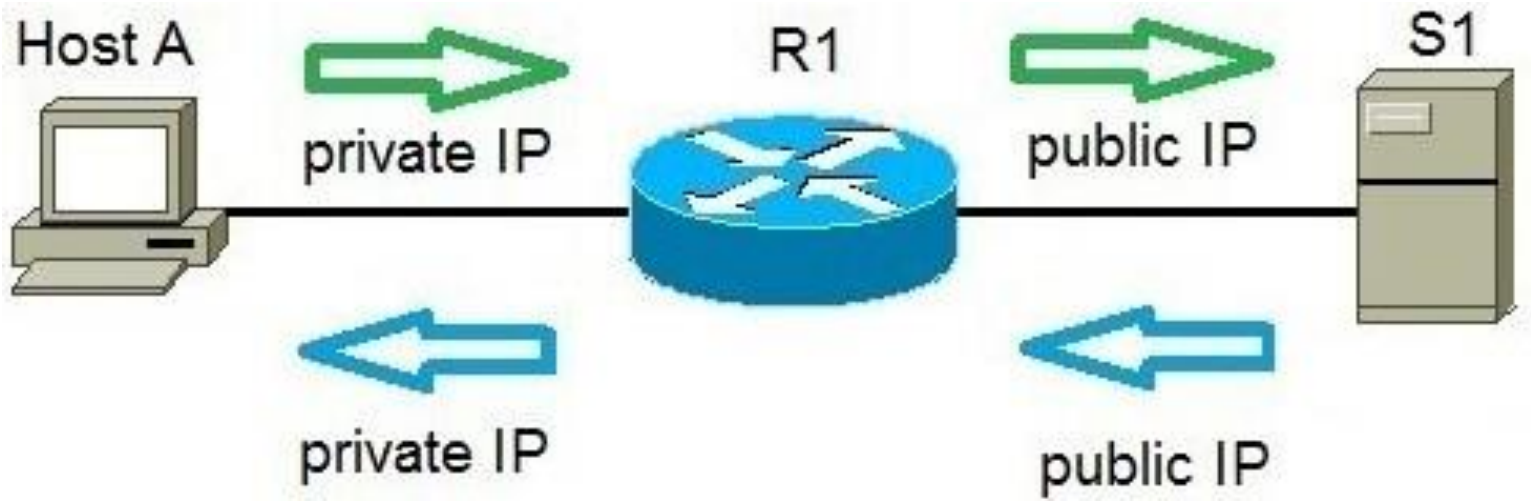
Private IPs in edge of network translate to Public IPs



Network Address Translation (NAT)

IP Addressing

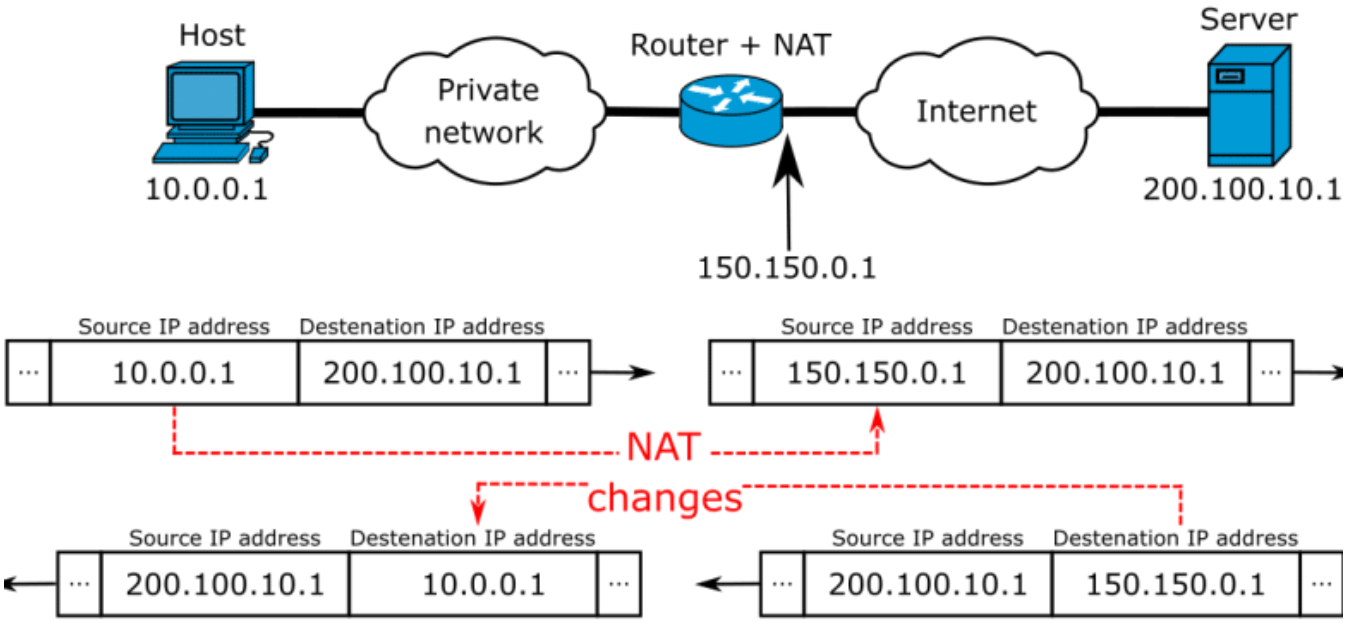
Private IPs in edge of network translate to Public IPs



Network Address Translation (NAT)

IP Addressing

Private IPs in edge of network translate to Public IPs



Network Address Translation (NAT)

IP Addressing

However, the number of IPv4s is running out

What is the solution for IPv4 running out problem?

IP Addressing

IPv6

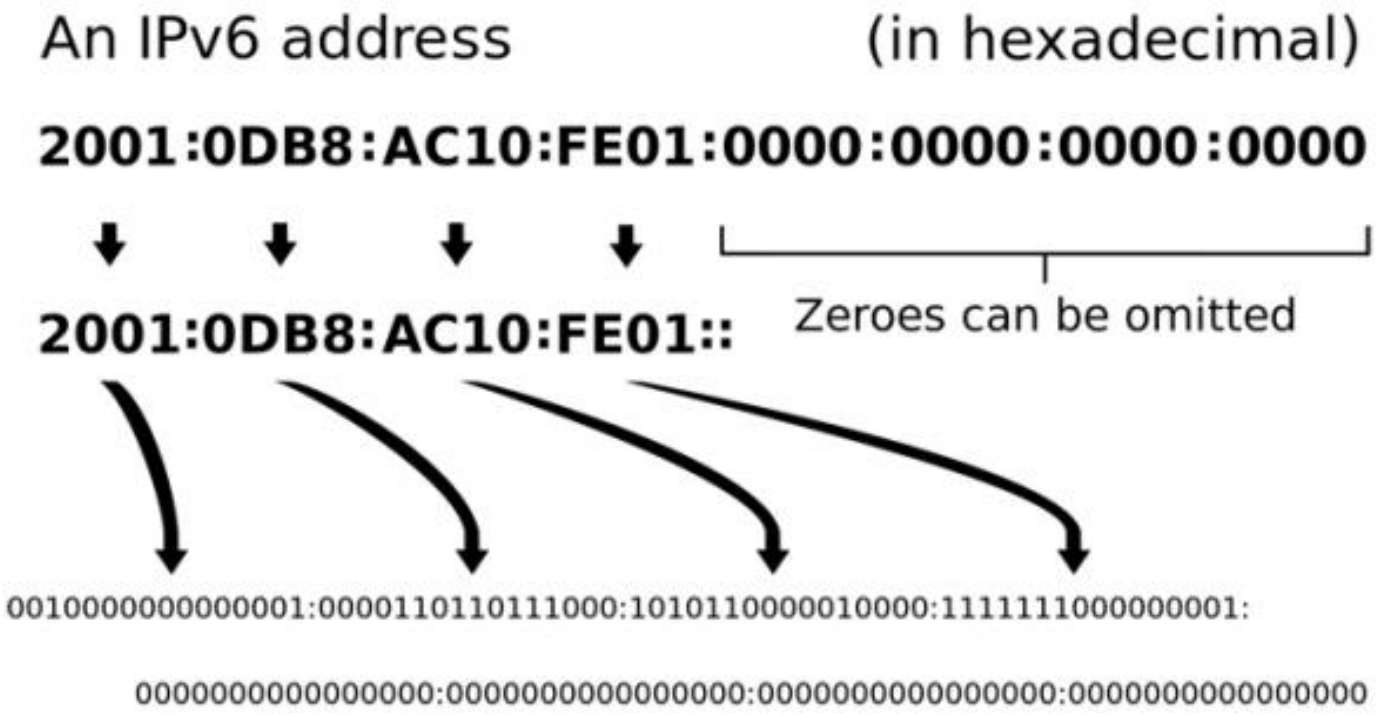
- IPv6 was developed by Internet Engineering Task Force (IETF) in 1998
- IPv6 is a 128-bits address
- IPv6 use Hexa-Decimal format separated by colon :
- There are 8 groups and each group represents 2 Bytes (16-bits)

FE80:CD00:0000:0CDE:1257:0000:211E:729C

FE80:CD00::CDE:1257::211E:729C

IP Addressing

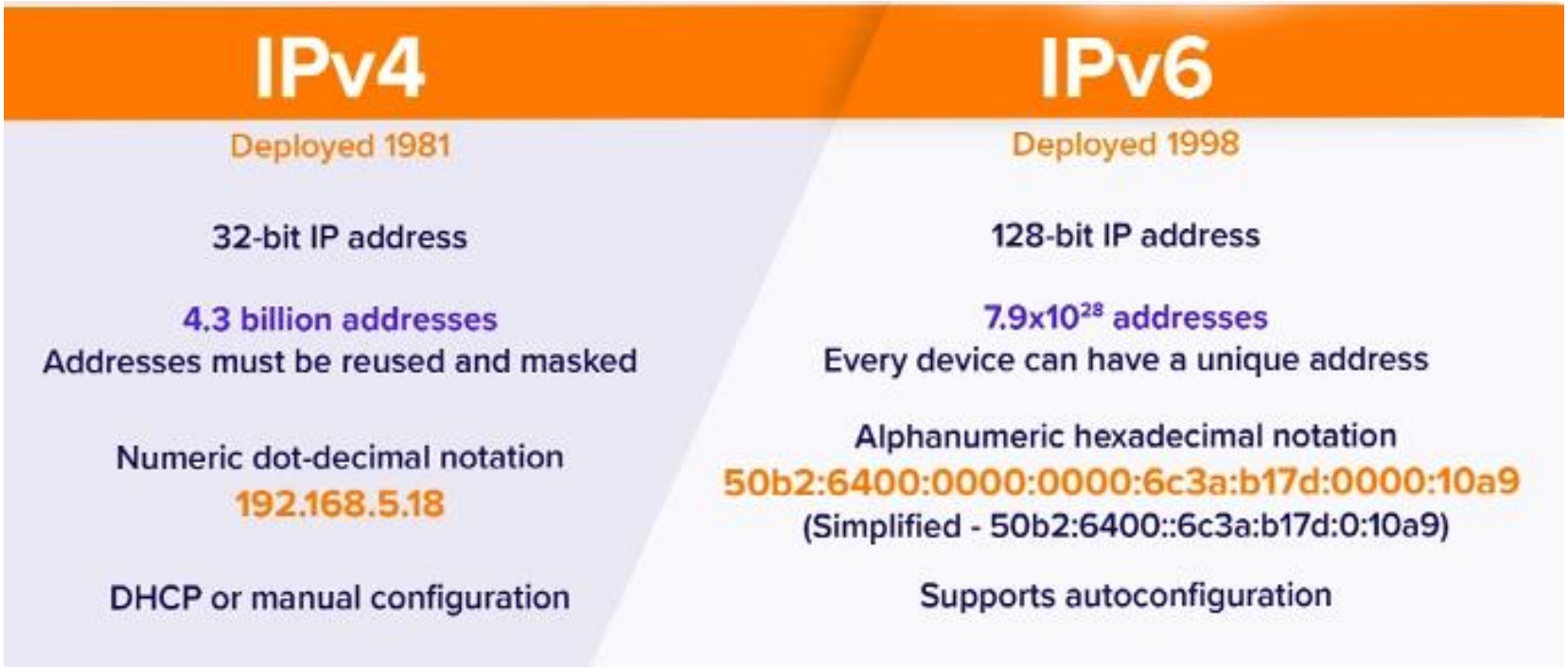
IPv6



2 Byte (16 Bit) * 8 = 16 Byte (128 Bit)

IP Addressing

IPv6



IP Addressing

IPv6

Advantages of IPv6

- No more NAT (Network Address Translation)
- Auto-configuration
- No more private address collisions
- Better multicast routing
- Simpler header format
- Simplified, more efficient routing
- True quality of service (QoS), also called "flow labeling"
- Built-in authentication and privacy support

IP Addressing

IPv6

On March 2023, Google's statistics

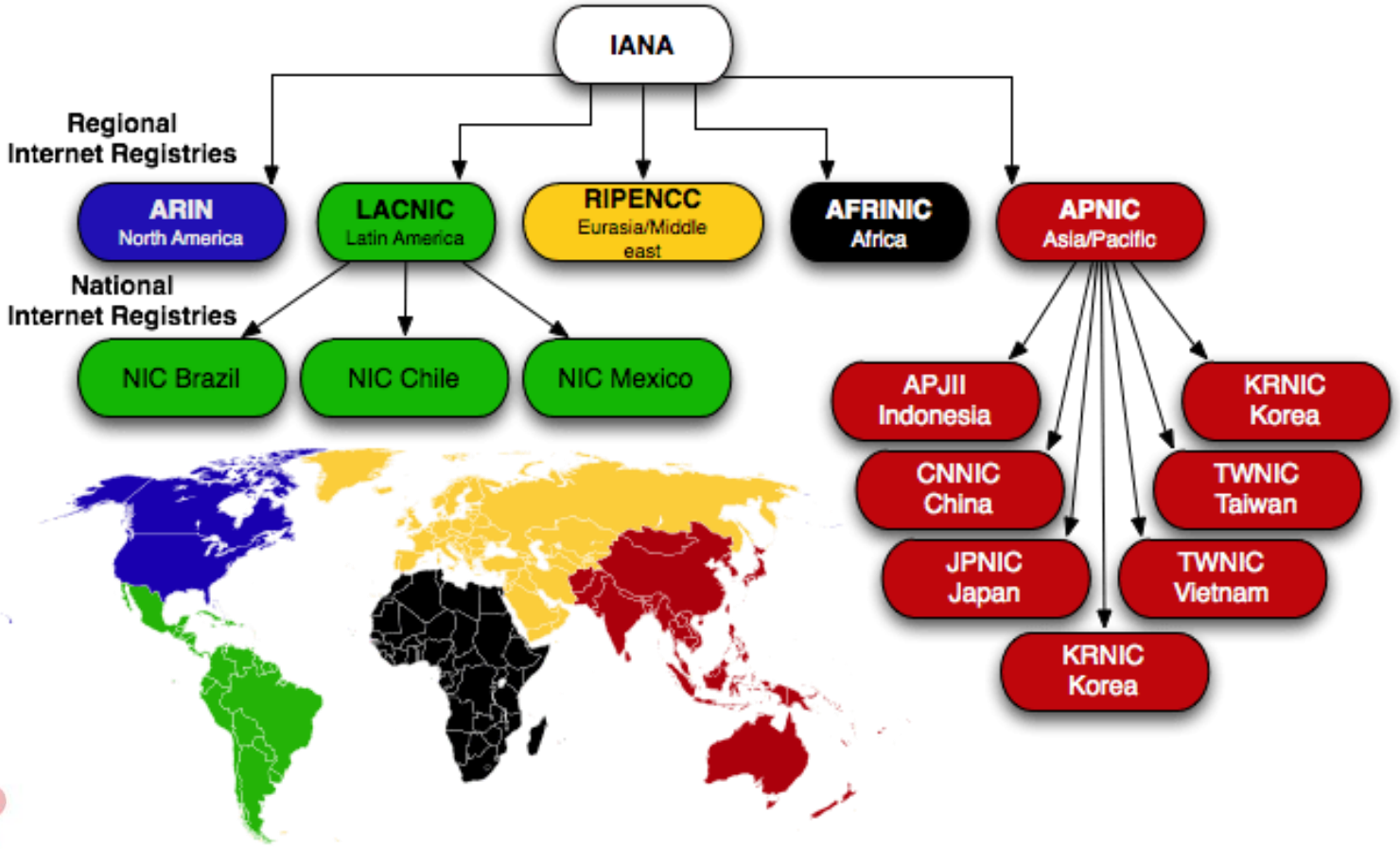
show IPv6 availability of its global user base at around

39 – 43%

depending on the day of the week. (greater on weekends)

IP Addressing

Public IPs



IP Addressing

Public IPs

- ARIN — Canada, USA, and some Caribbean Islands
- APNIC — Asia/Pacific Region
- RIPE NCC — Europe, the Middle East, and Central Asia
- LACNIC — Latin America and some Caribbean Islands
- AFRINIC — Africa Region

IP Addressing

Public IPs

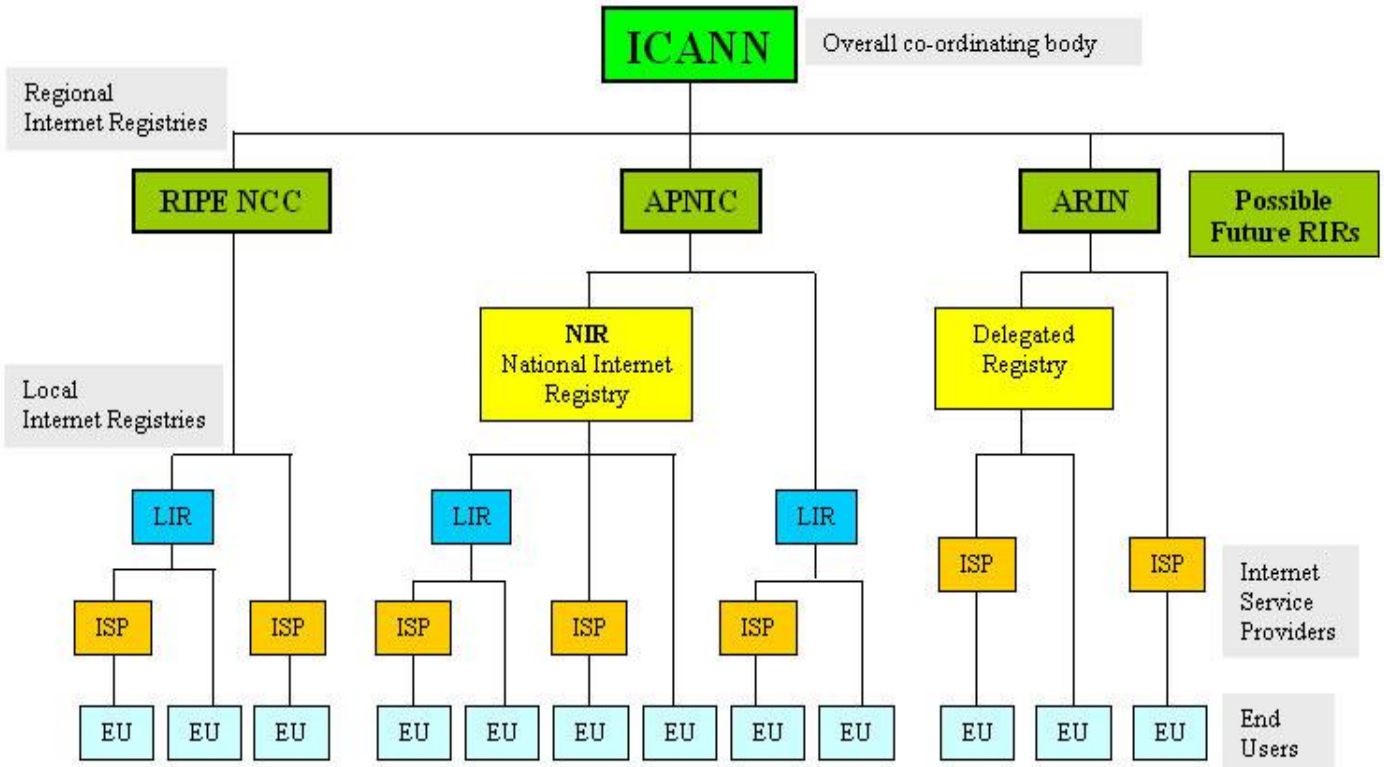


Figure 1. Internet Registry System structure

IP Addressing

Public IPs

- https://ipshu.com
- https://lite.ip2location.com/ip-address-ranges-by-country
- https://www.iana.org/numbers

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IP Addressing

Private IPv4s

Class	Private IP address range	Subnet mask
A	10.0.0.0 – 10.255.255.255	255.0.0.0
B	172.16.0.0 – 172.16.31.255	255.255.0.0
C	192.168.0.0 – 192.168.255.255	255.255.255.0

IP Addressing

Ooh!!

What does this Subnet Mask say?

Don't worry!!

Its Only says that how many devices can be in our network?

Is the subnet mask immutable?

Of course not!!

You can change it and make your network bigger or smaller

Subnetting or Superneting

IP Addressing Subnet Mask

But however, in order to devices be in same network (able to see each other), they must:

1- Be physically connected.

2- Be in the same IP range.

IP Addressing Subnet Mask

The subnet mask determines whether two IPs are in the same range or not

172.16.10.25 172.16.40.25

255.255.0.0 255.255.0.0

Is in same range

192.168.1.10 192.168.40.220

255.255.255.0 255.255.255.0

Isn't in same range

IP Addressing Subnet Mask

Are in the same range or not?

172.16.10.25	172.16.40.25
255.255.255.0	255.255.0.0
192.168.1.10	192.168.1.220
255.255.255.0	255.255.255.0
10.145.89.55	10.201.22.235
255.0.0.0	255.0.0.0

IP Addressing Subnet Mask

Are in the same range or not?

172.30.10.25	172.16.40.25
255.255.0.0	255.255.0.0
192.168.1.10	192.168.12.220
255.255.255.0	255.255.255.0
10.10.10.10	10.20.30.40
255.0.0.0	255.0.0.0

IP Addressing

Subnet Mask

Default Subnet Mask	Network / Host	Number of networks	Maximum nodes in a network
255.0.0.0	N.H.H.H	126	16,777,214
255.255.0.0	N.N.H.H	16,384	65,534
255.255.255.0	N.N.N.H	2,097,152	254

Maximum nodes in a network = (2^n)-2

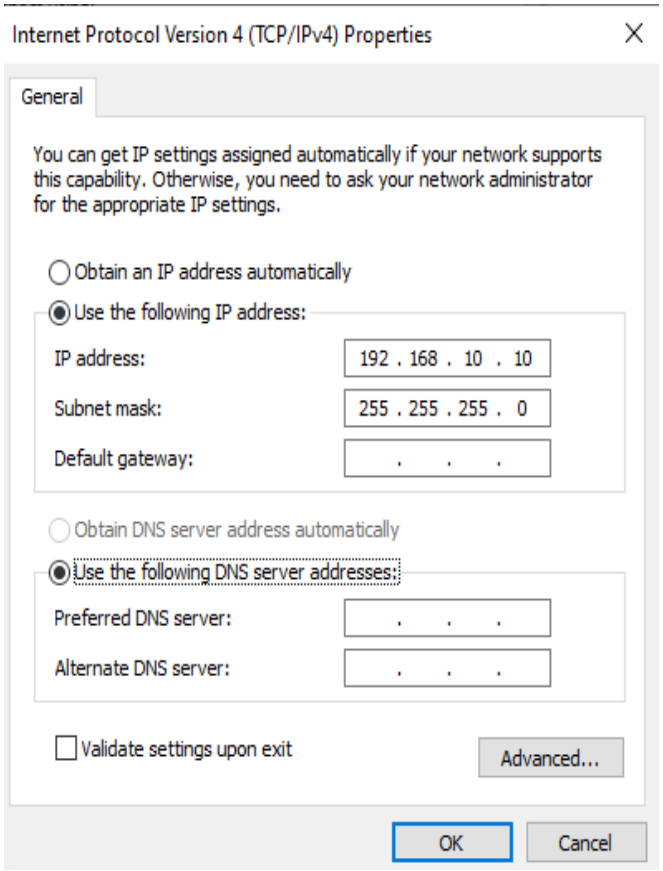
n= Number of host bit

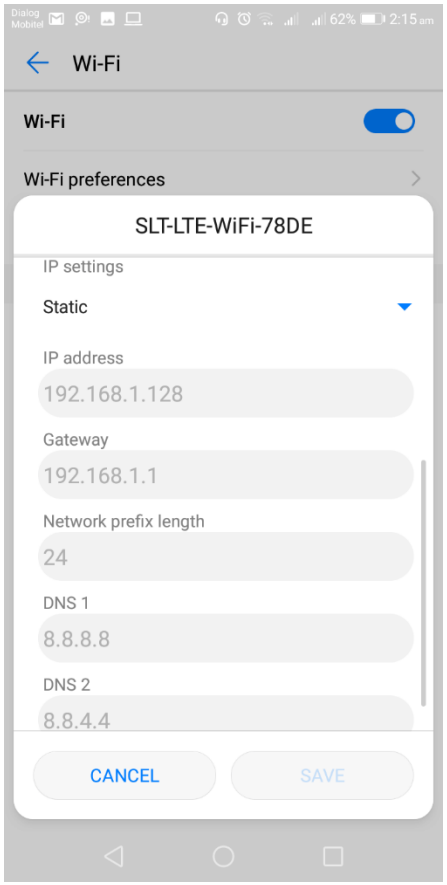
IP Addressing Subnet Mask

CIDR (Classless Inter-Domain Routing) Table

No. of bits within the		No. of hosts per network	Newtwork mask		No. of equivalent classful addressing network		
Prefix	Host ID		Prefix notation	Dotted decimal notation	Class A	Class B	Class C
1	31	2147483646	/1	128.0.0.0	128	2^{-15}	2^{23}
2	30	1073741822	/2	192.0.0.0	64	2^{-14}	2^{22}
3	29	536870910	/3	224.0.0.0	32	2^{-13}	2^{21}
4	28	268435454	/4	240.0.0.0	16	4096	2^{20}
5	27	134217726	/5	248.0.0.0	8	2048	2^{19}
6	26	67108862	/6	252.0.0.0	4	1024	2^{18}
7	25	33554430	/7	254.0.0.0	2	512	2^{17}
8	24	16777214	/8	255.0.0.0	1	256	2^{16}
9	23	8388606	/9	255.128.0.0	1/2	128	2^{15}
10	22	4194302	/10	255.192.0.0	1/4	64	2^{14}
11	21	2097150	/11	255.224.0.0	1/8	32	2^{13}
12	20	1048574	/12	255.240.0.0	1/16	16	4096
13	19	524286	/13	255.248.0.0	1/32	8	2048
14	18	262142	/14	255.252.0.0	1/64	4	1024
15	17	131070	/15	255.254.0.0	1/128	2	512
16	16	65534	/16	255.255.0.0	1/256	1	256
17	15	32766	/17	255.255.128.0	1/512	1/2	128
18	14	16382	/18	255.255.192.0	1/1024	1/4	64
19	13	8190	/19	255.255.224.0	1/2048	1/8	32
20	12	4094	/20	255.255.240.0	1/4096	1/16	16
21	11	2046	/21	255.255.248.0	2^{-13}	1/32	8
22	10	1022	/22	255.255.252.0	2^{-14}	1/64	4
23	9	510	/23	255.255.254.0	2^{-15}	1/128	2
24	8	254	/24	255.255.255.0	2^{-16}	1/256	1
25	7	126	/25	255.255.255.128	2^{-17}	1/512	1/2
26	6	62	/26	255.255.255.192	2^{-18}	1/1024	1/4
27	5	30	/27	255.255.255.224	2^{-19}	1/2048	1/8
28	4	14	/28	255.255.255.240	2^{-20}	1/4096	1/16
29	3	6	/29	255.255.255.248	2^{-21}	2^{-13}	1/32
30	2	2	/30	255.255.255.252	2^{-22}	2^{-14}	1/64

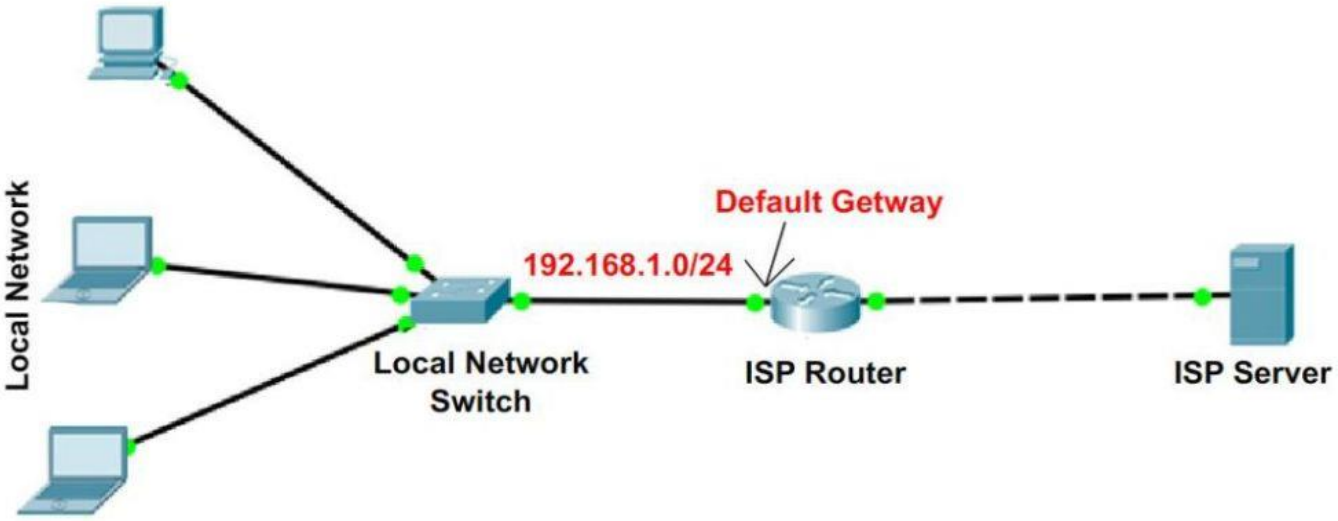
IP Addressing





Gateway & Routing

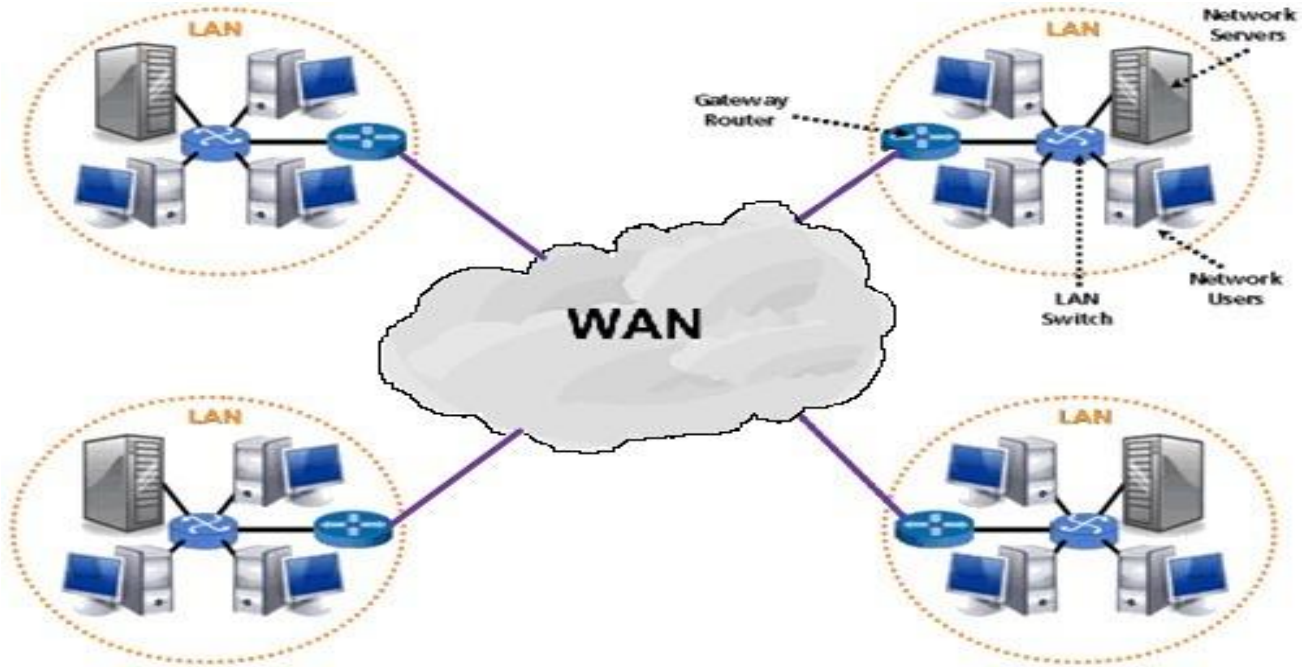
Gateway & Routing



When an address is inside the network, it is routed by the **Switch**.

But when an out-of-network address is requested, it is delivered to **Gateway (Router)** to continue the route.

Gateway & Routing



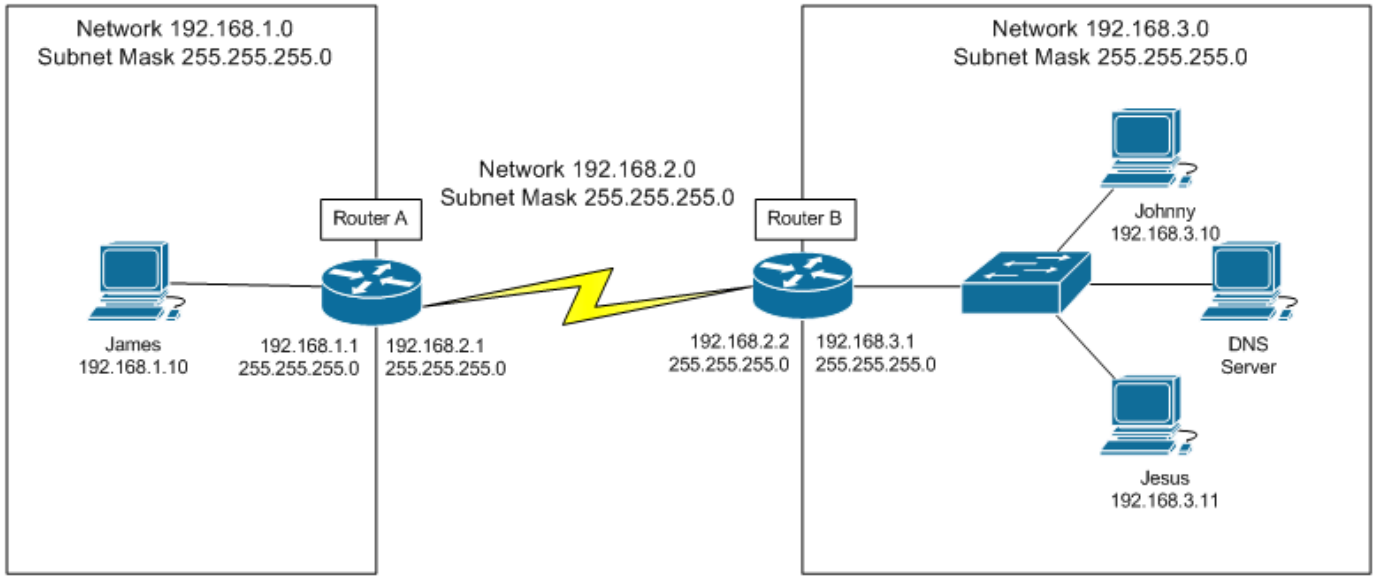
Whether an address is inside the network or not is determined by ANDing the IP address with the subnet mask.

Gateway & Routing

A router is a physical or virtual appliance that passes information between two or more networks.
A router inspects a given data packet's destination IP address, calculates the best way for it to reach its destination and then forwards it accordingly.

Gateway & Routing

There are several types of routers, routers packets between 2 Local network or routers pass data between LANs and WANs



Routers can configured by Static Routes or Dynamic Route

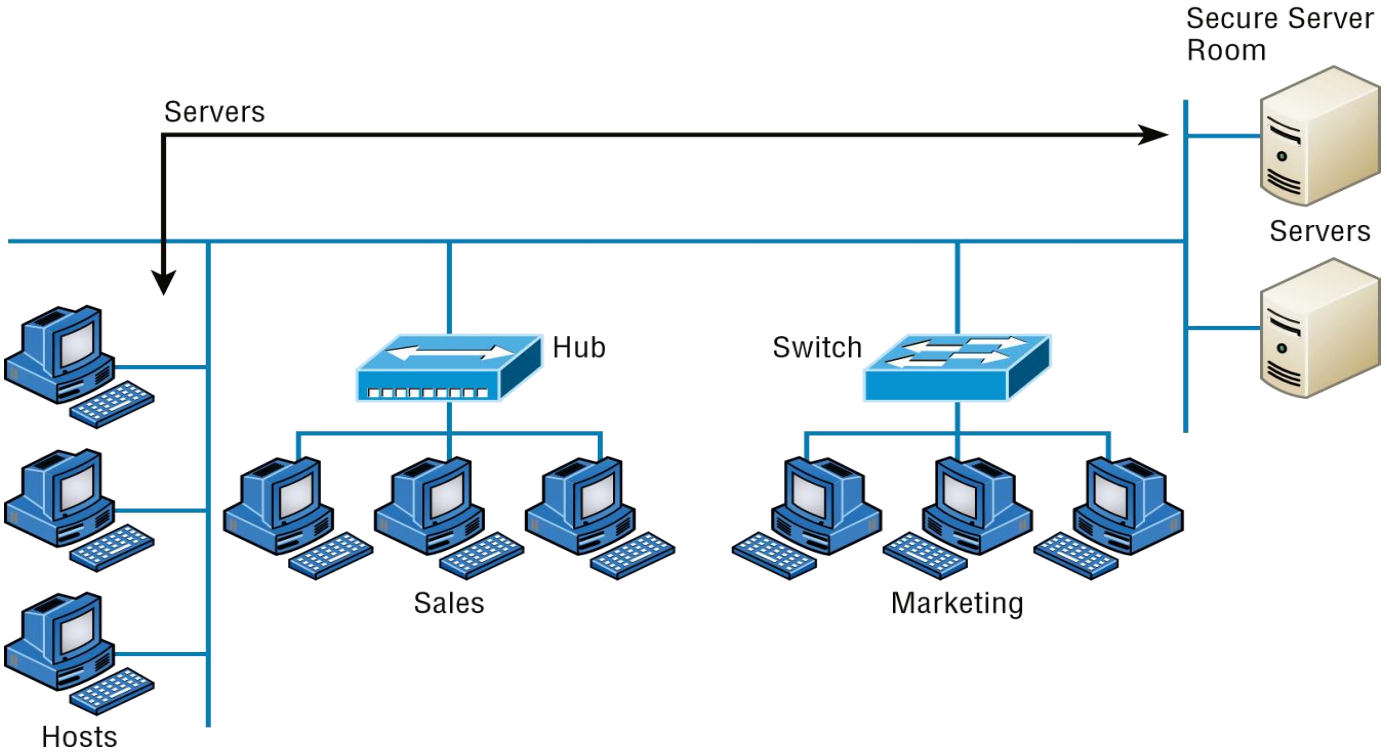
Gateway & Routing

Modem Router

A modulator-demodulator or (modem) is a device that converts data from a digital format into a format suitable for an analog transmission medium such as telephone or radio.

Gateway & Routing

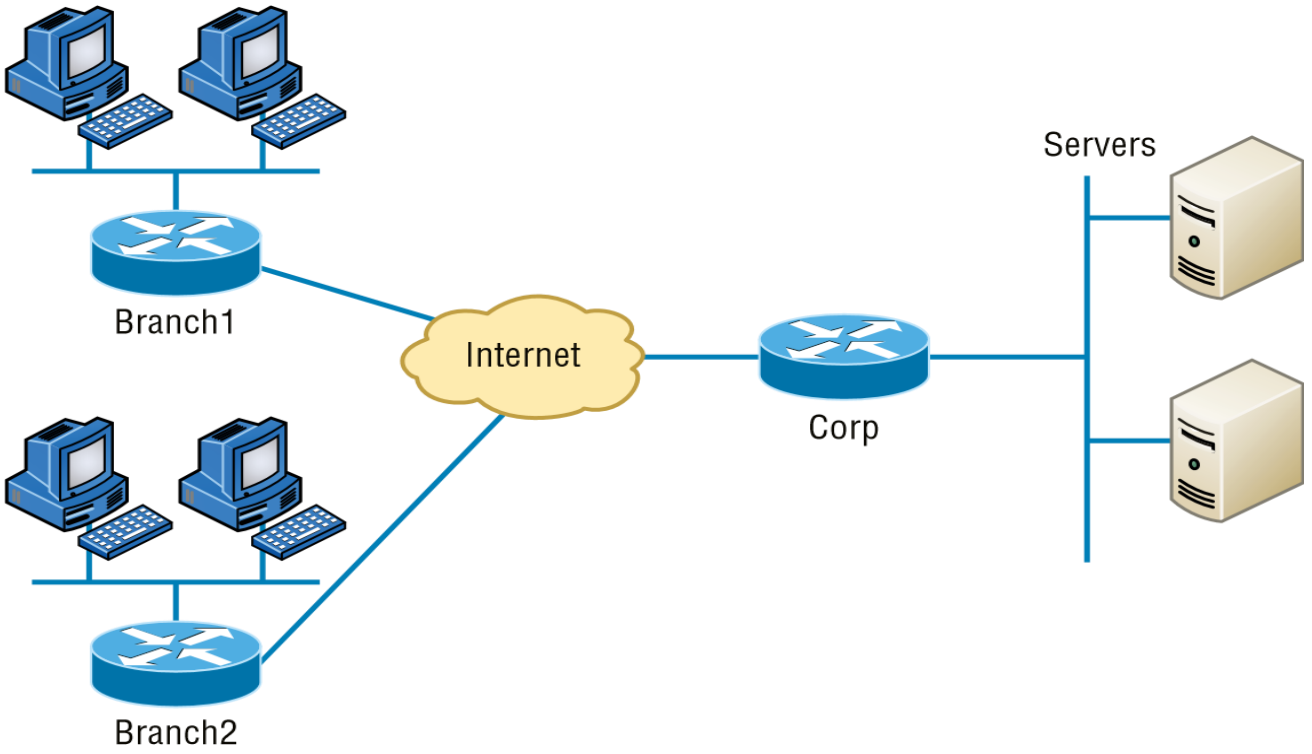
How are networks created?



Answer: By SWITCHES

Gateway & Routing

How are networks connected?



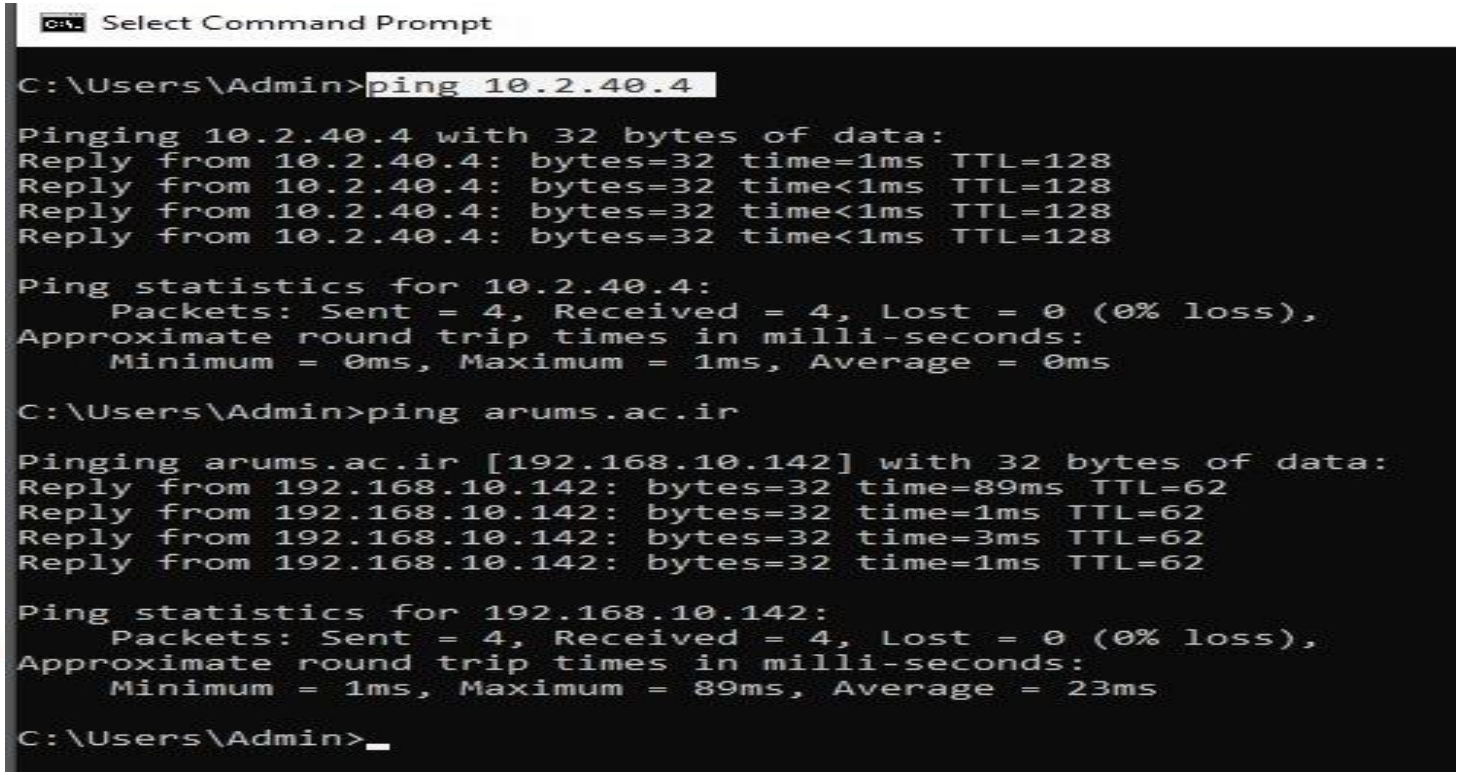
Answer: By ROUTERS

Gateway & Routing

4 network Command

1- Ping

Ping is used to testing a network connect with another host

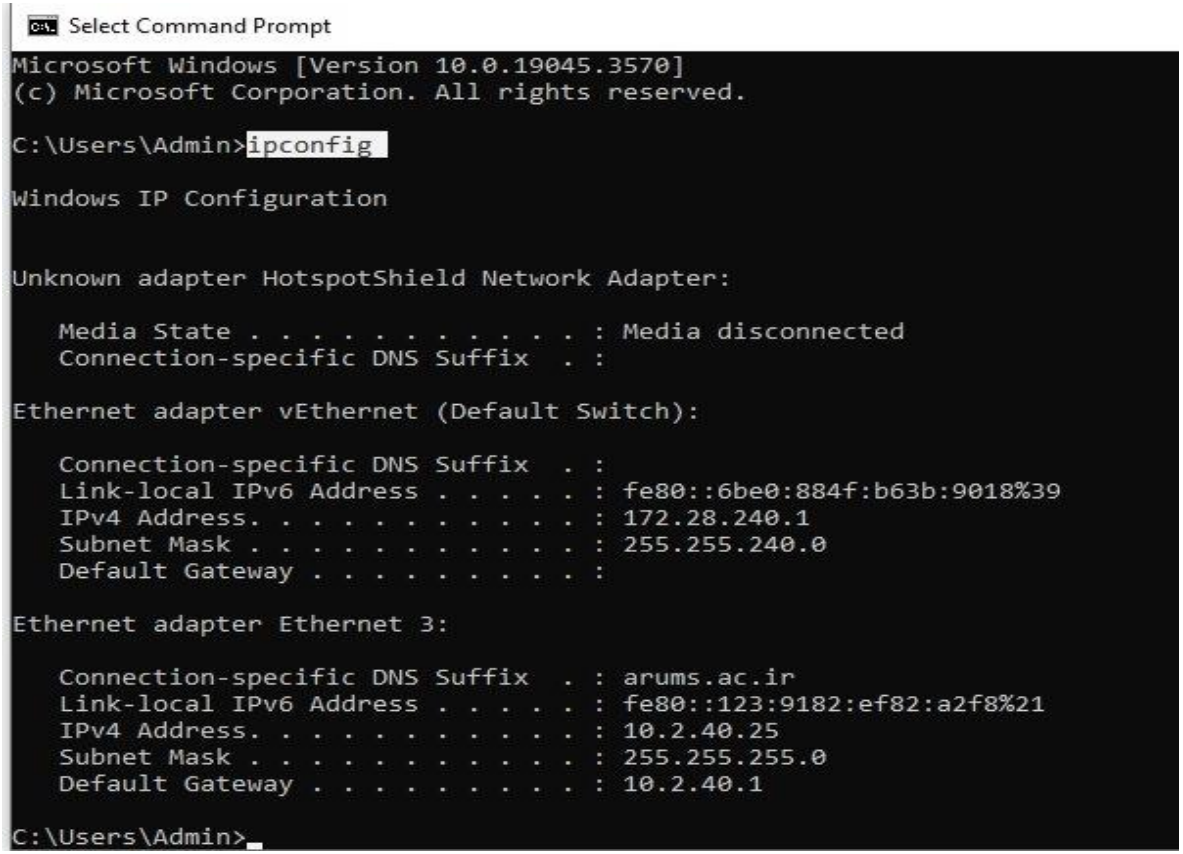


Gateway & Routing

4 network Command

2- Ipconfig

To display basic details about the device's (NICs) IP address

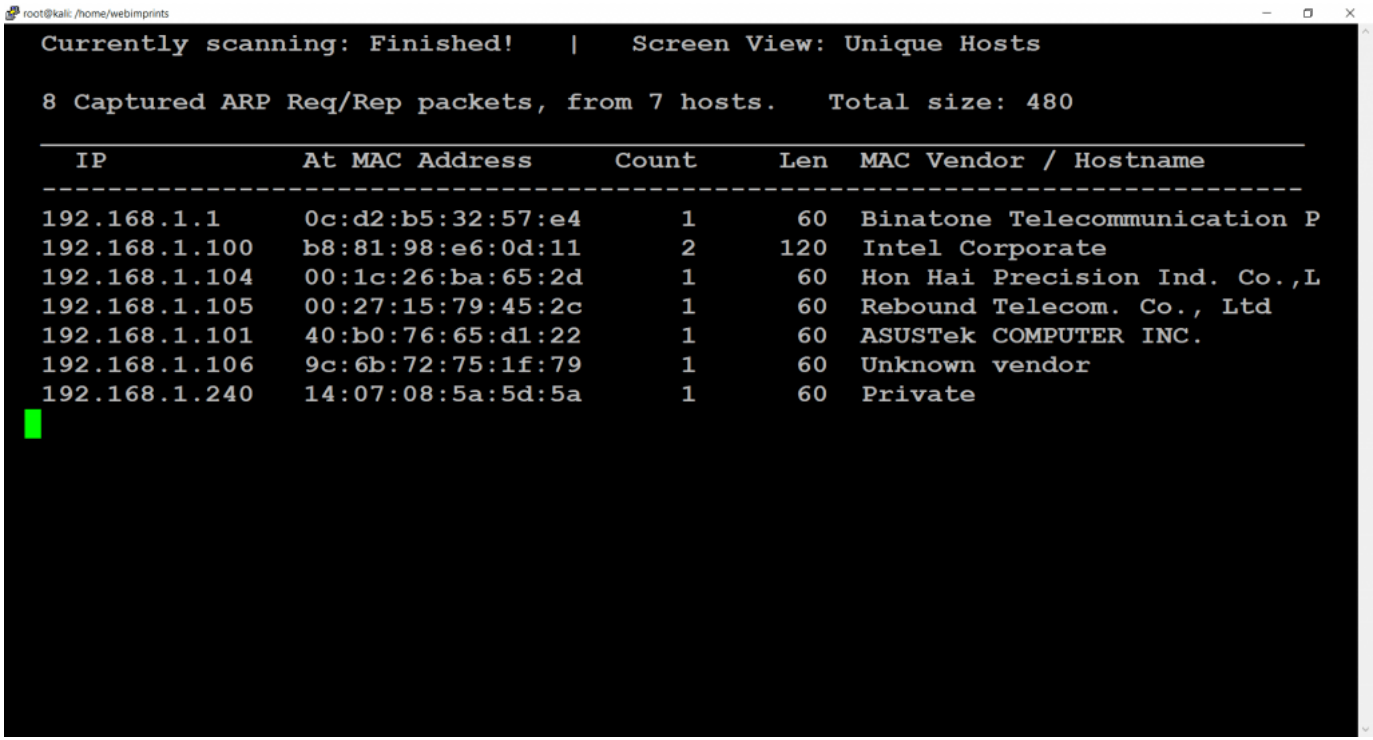


Gateway & Routing

4 network Command

3- Arp /a

ARP stands for Address Resolution Protocol. Although network communications can readily be thought of as an IP address, the packet delivery depends ultimately on the media access control (MAC)



Gateway & Routing

4 network Command

4- Tracert

is used to get the network packet being sent and received and the number of hops required for that packet to reach to target.

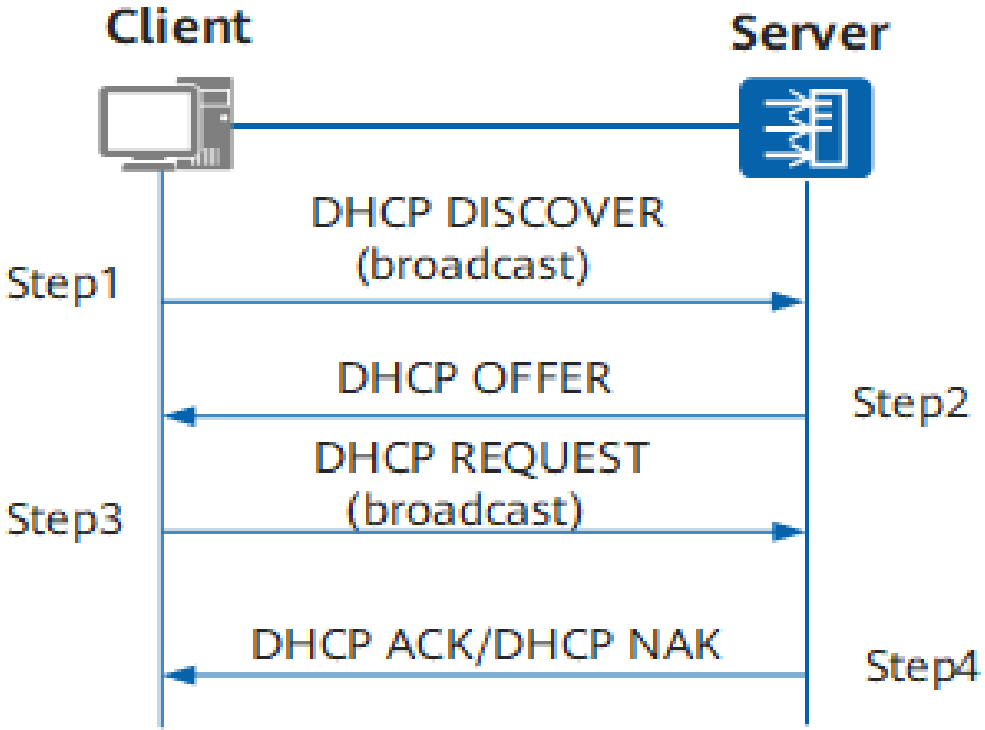
```
Microsoft Windows [Version 10.0.14393]
(c) 2016 Microsoft Corporation. All rights reserved.

C:\Users\Ease >tracert 8.8.8.8

Tracing route to google-public-dns-a.google.com [8.8.8.8]
over a maximum of 30 hops:

  1    <1 ms    <1 ms    <1 ms  192.168.10.254
  2     4 ms     7 ms     1 ms  n4l-akl-internet.mdr-bng1.as45177.net.nz [14.1.43.222]
  3     1 ms     1 ms     1 ms  ae3-1303.mdr-cr1.as45177.net.nz [120.136.0.131]
  4    24 ms    24 ms    25 ms  xe-4-0-1-0.sy3-cr1.as45177.net.au [120.136.0.118]
  5    24 ms    24 ms    24 ms  as15169-ip-119.cust.sy3-cr1.as45177.net.au [120.136.0.119]
  6    25 ms    25 ms    25 ms  216.239.40.233
  7    25 ms    25 ms    25 ms  216.239.40.255
  8    25 ms    25 ms    25 ms  google-public-dns-a.google.com [8.8.8.8]

Trace complete.

C:\Users\
```

DHCP

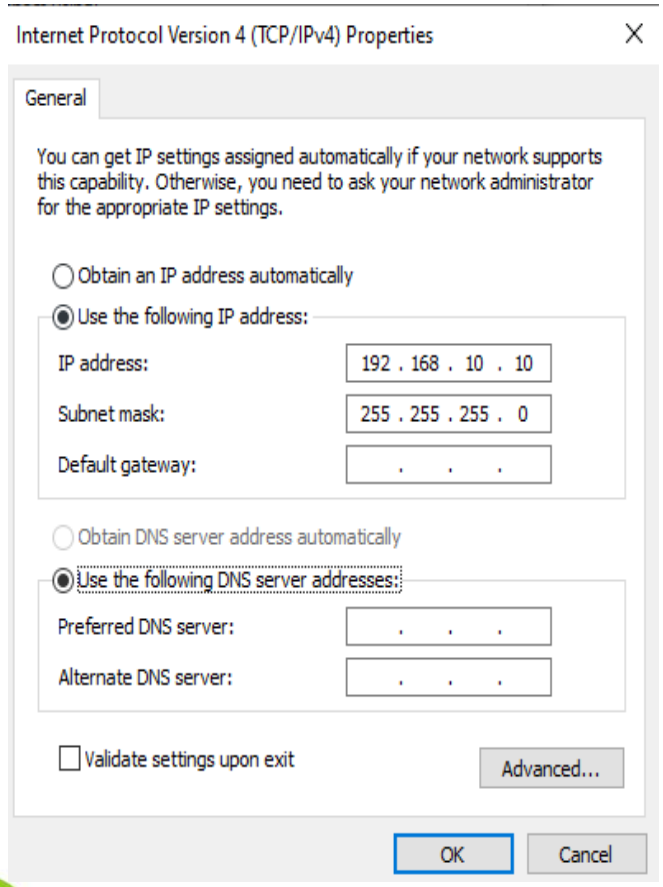
DHCP

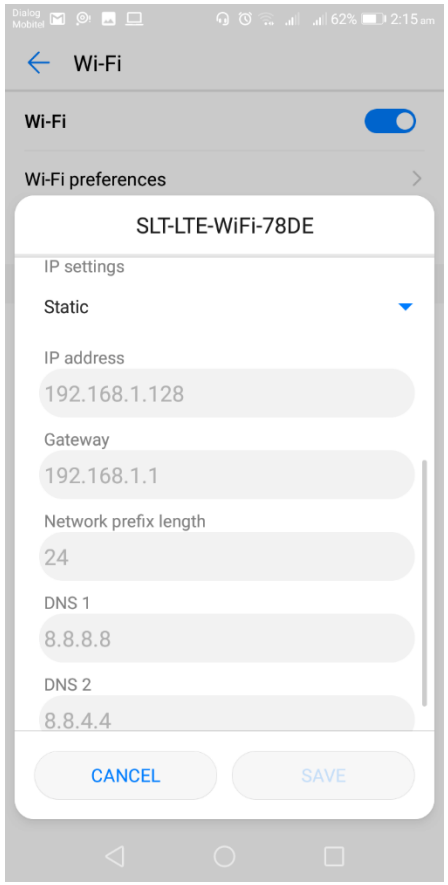
Dynamic Host Configuration Protocol (DHCP) is a client/server protocol (Service) that automatically provides an Internet Protocol (IP) host with its IP address and other related configuration information such as the subnet mask and default gat eway.

DHCP Service has a Lease Duration. For example: 10 Days



DHCP





Automatic IP

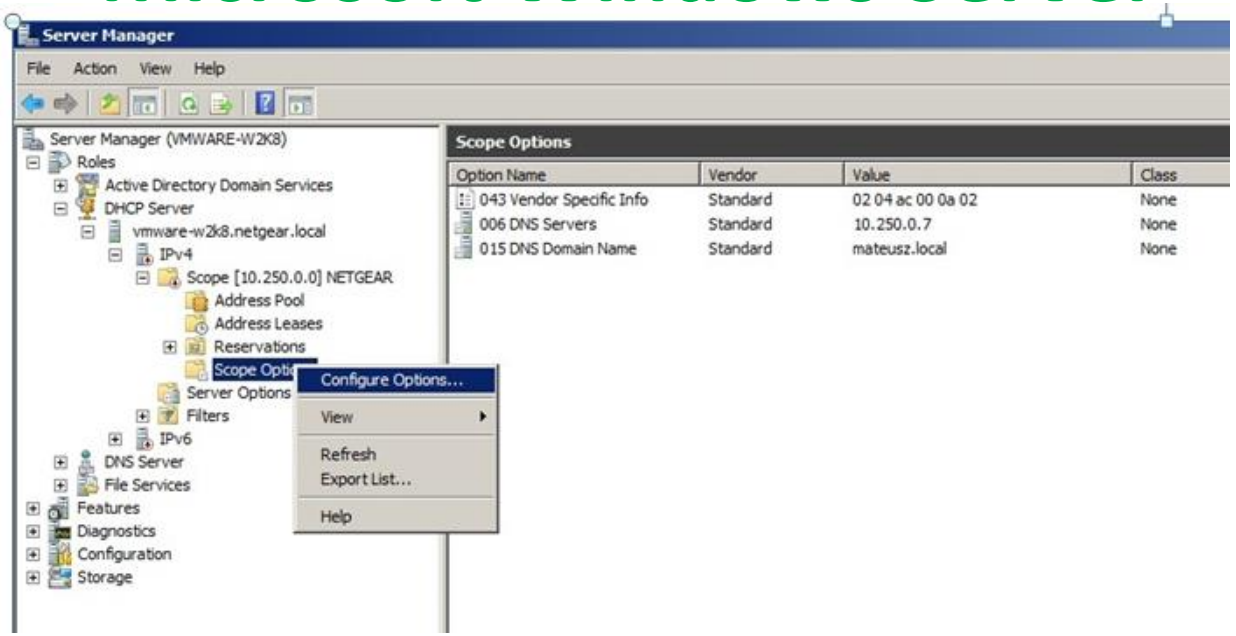
Dynamic IP

DHCP

DHCP

DHCP Servers

Microsoft Windows Server



DHCP

DHCP Servers

Linux Server

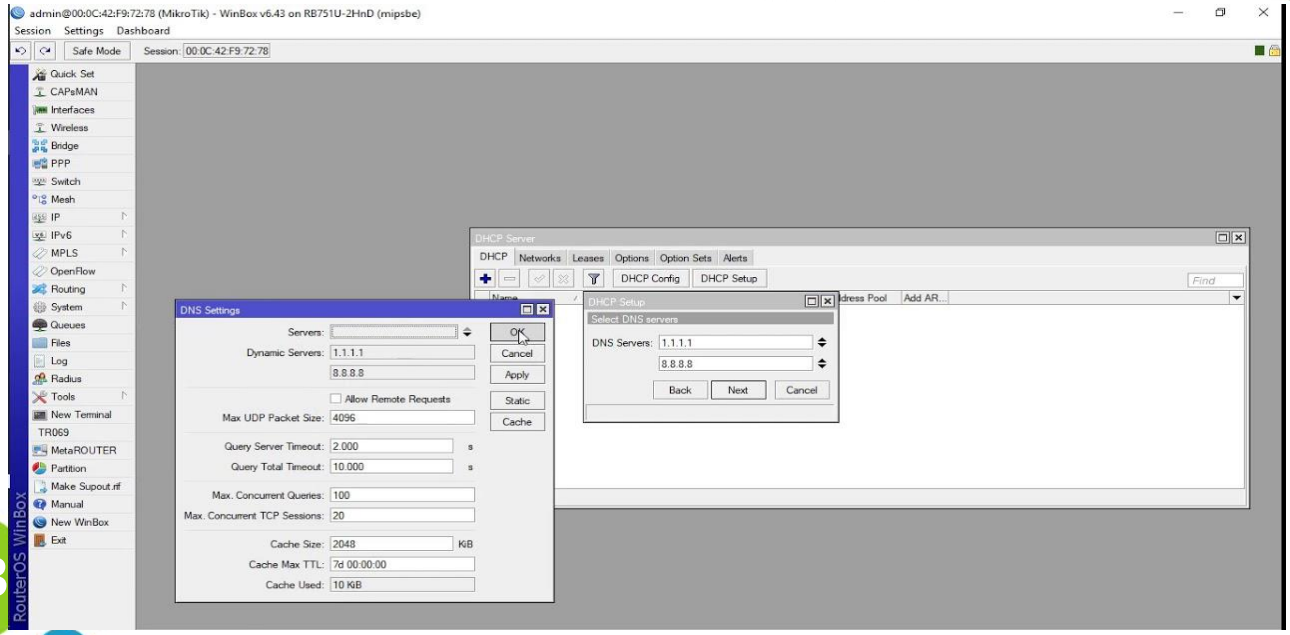
taimoor@taimoor: ~

File Edit View Search Terminal Help

```
  GNU nano 4.8                 /etc/dhcp/dhcpd.conf                 Modified
#   range dynamic-bootp 10.254.239.40 10.254.239.60;
#   option broadcast-address 10.254.239.31;
#   option routers rtr-239-32-1.example.org;
#}

# A slightly different configuration for an internal subnet.
subnet 192.168.114.0 netmask 255.255.255.0 {
  range 192.168.114.20 192.168.114.254;
  option domain-name-servers server.example.org;
  option domain-name "example.org";
  option subnet-mask 255.255.255.0;
  option routers 192.168.114.1;
  option broadcast-address 192.168.137.255;
  default-lease-time 600;
  max-lease-time 7200;
}


^G Get Help  ^O Write Out  ^W Where Is  ^K Cut Text  ^J Justify
^X Exit      ^R Read File  ^\ Replace   ^U Paste Text^T To Spell
```

DHCP

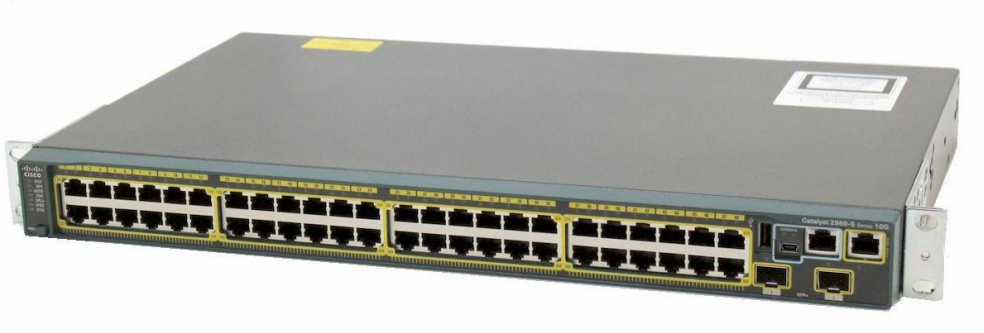
DHCP Servers



MikroTik Router

DHCP

DHCP Servers

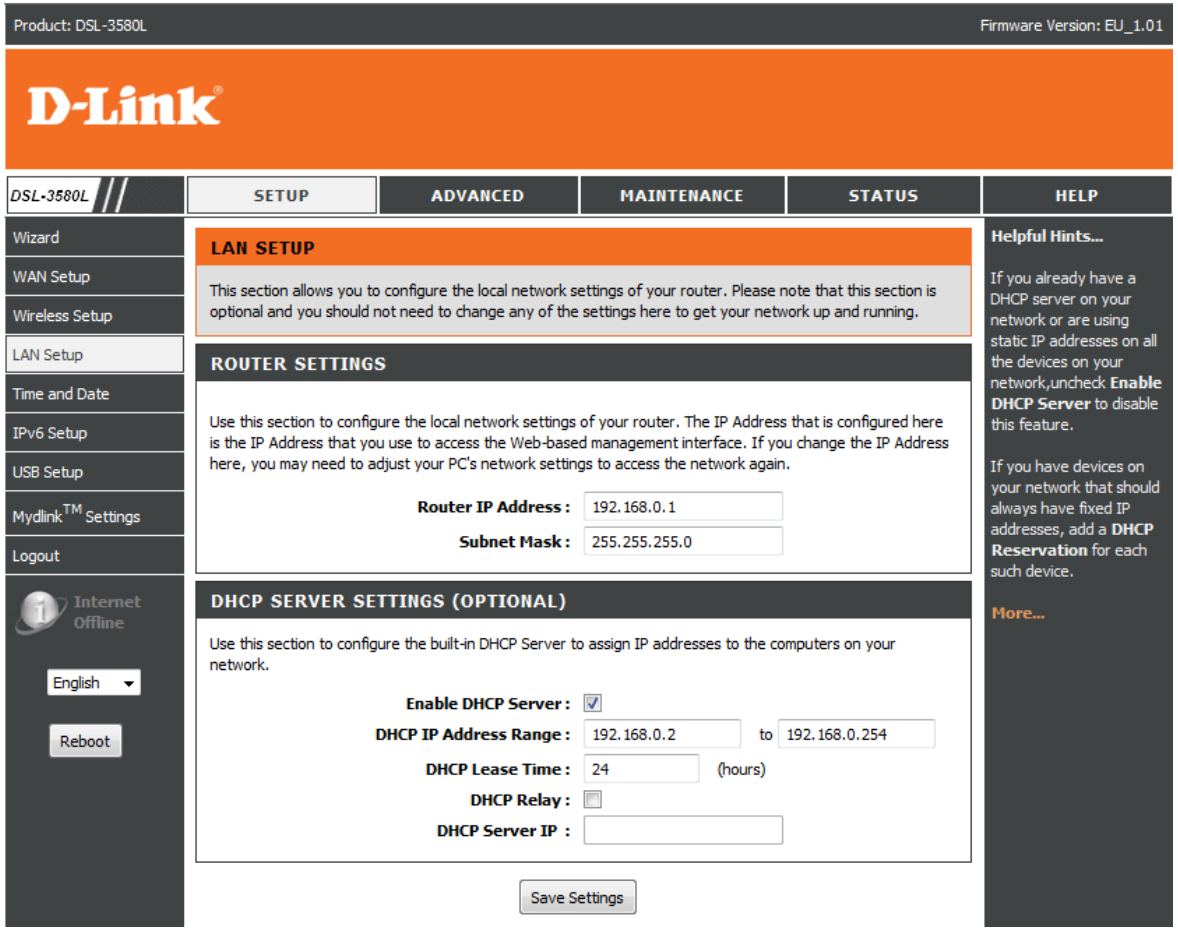


```
Router>enable
Router#configure terminal
Router#ip dhcp excluded-address 10.0.0.1 10.0.0.10
Router(config)#ip dhcp pool mypool
Router(dhcp-config)#network 10.0.0.0 255.255.255.0
Router(dhcp-config)#default-router 10.0.0.1
Router(dhcp-config)#dns-server 10.0.0.2
Router(dhcp-config)#lease 3 0 0
Router(dhcp-config)#end
Router#write memory
```

DHCP

DHCP Servers

Modem-Router



DNS

DNS

A Domain Name Service (DNS) server is one of the most important servers in your network and on the Internet as well.

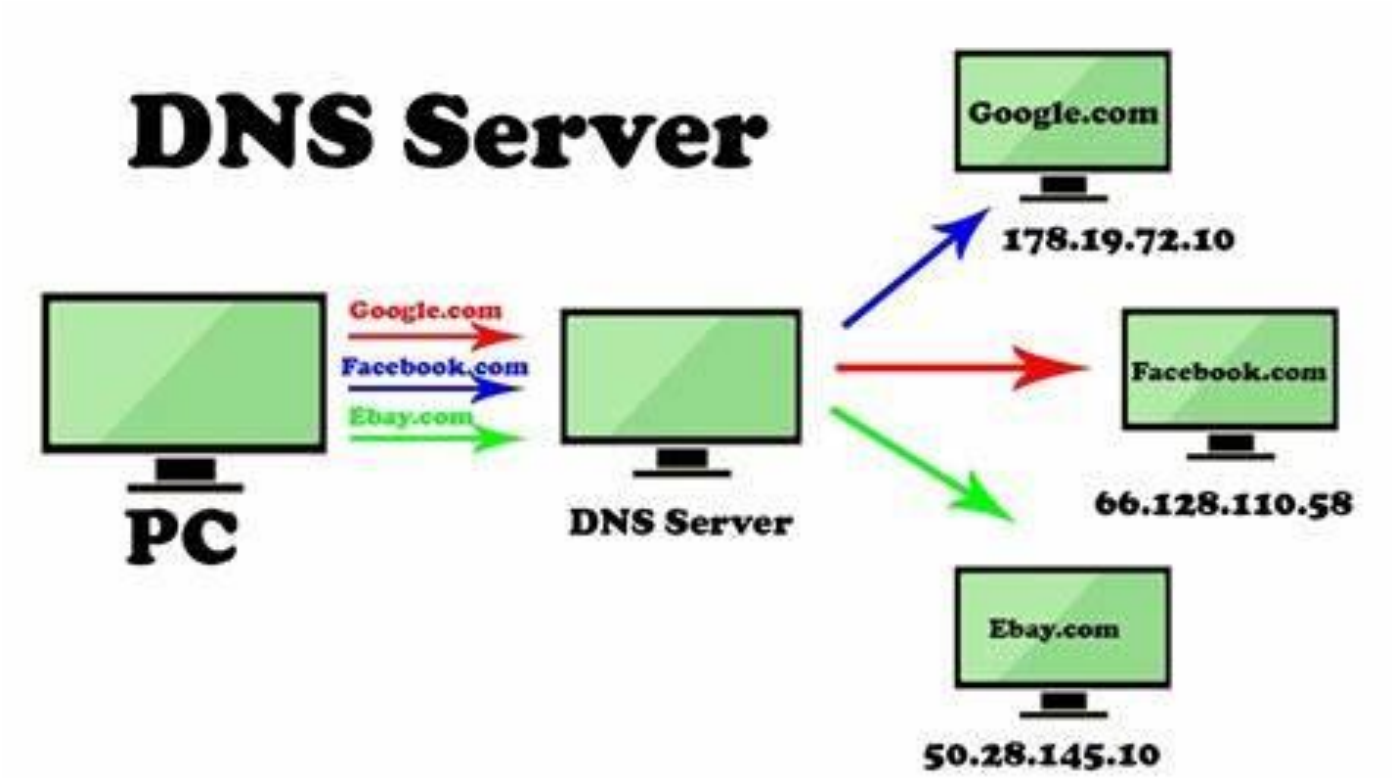
Why?

Because without a DNS server, you would have to

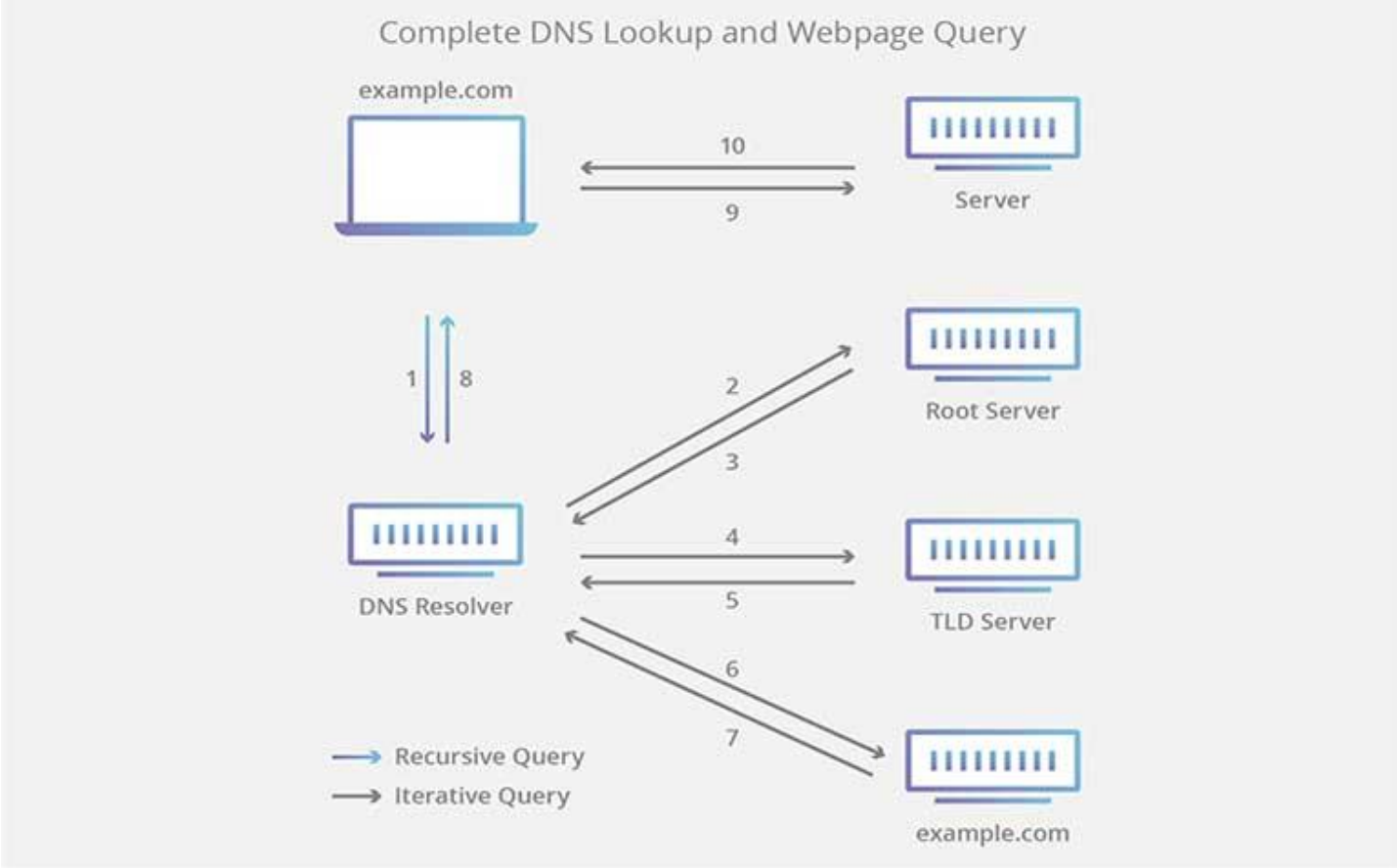
type https://94.182.113.53 for entering http://www.varzesh3.com
Or
type https://185.188.104.10 for entering https://www.digikala.com

DNS system as the **phone book** of the Internet.

DNS


DNS Server
Google.com
178.19.72.10
Google.com
Facebook.com
Ebay.com
Facebook.com
66.128.110.58
PC
DNS Server
Ebay.com
50.28.145.10

DNS


Complete DNS Lookup and Webpage Query
example.com
10
9
Server
1
8
2
3
Root Server
DNS Resolver
4
5
TLD Server
6
7
Recursive Query
Iterative Query
example.com

DNS

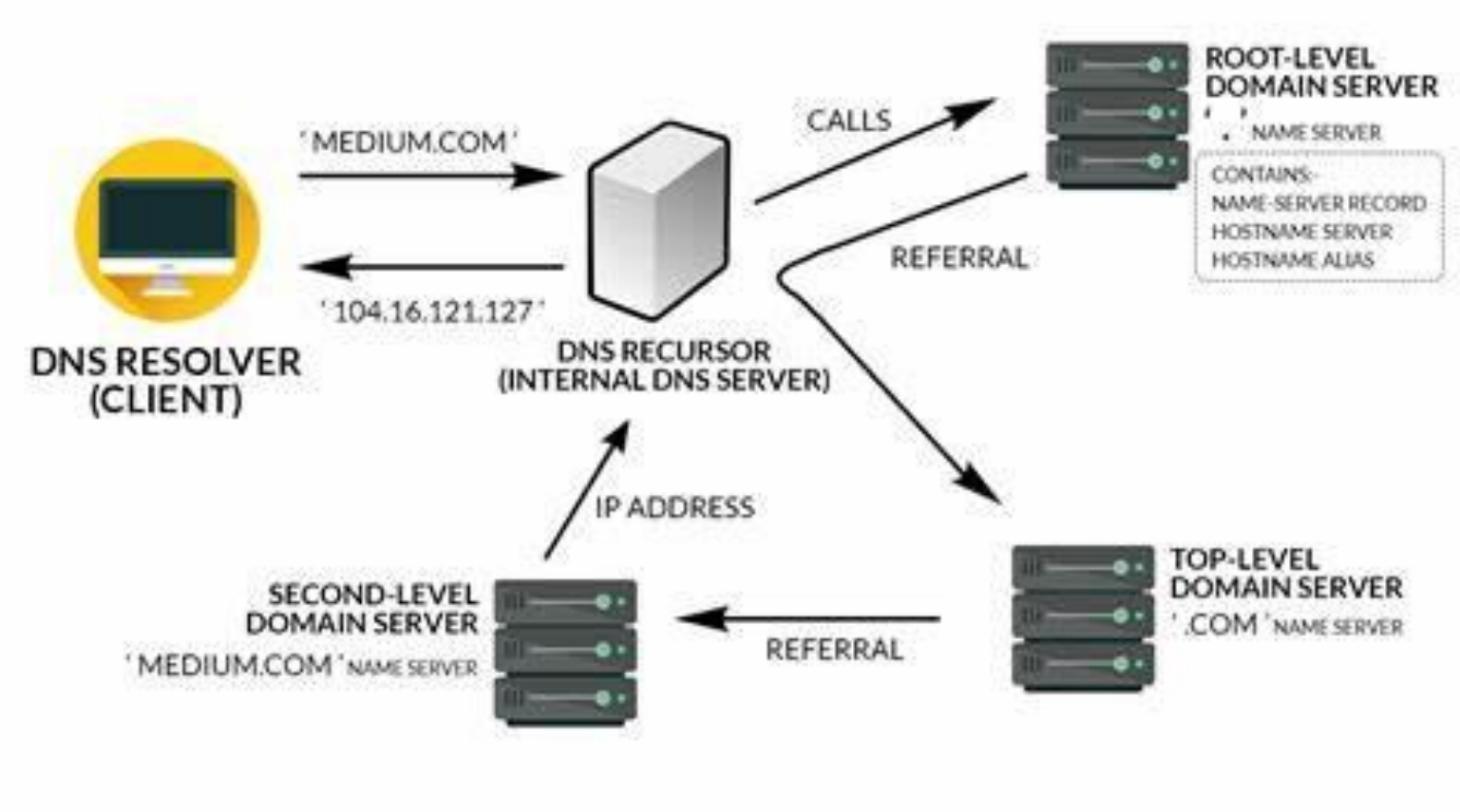
Root server

There are 13 root domain name servers in the world, one of which is the main root server in the United States, operated by Network Solutions, an American Internet agency.

The other 12 are secondary root servers,
9 of which are in the US,
2 in Europe (located in the UK and Sweden),
and 1 in Asia (located in Japan).

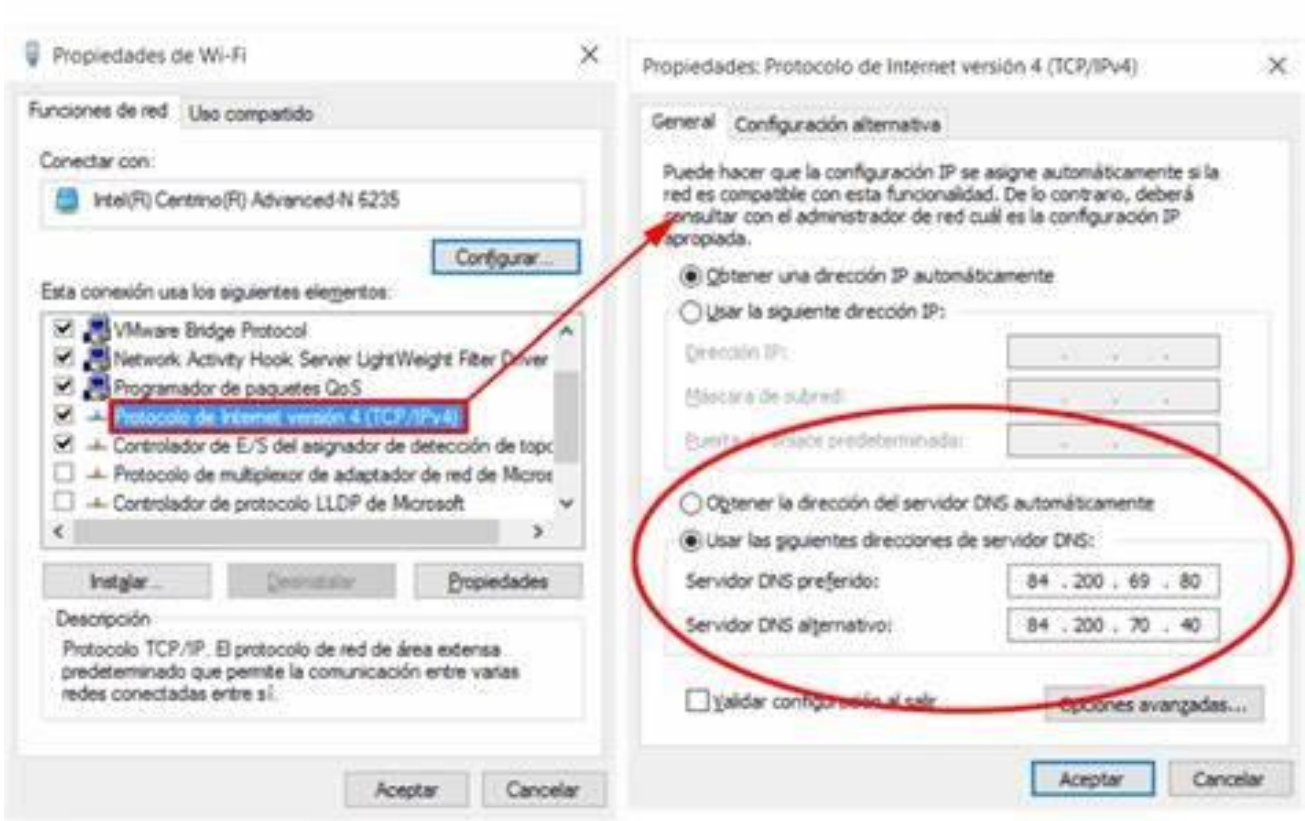
If there is no cache response, the resolver initiates a query request to the root server. The root server registers the top-level domain name (.com, .net, .org, etc.) and the corresponding host. After the recursive resolver receives the initial response, it sends another request to the TLD name server.

DNS


'MEDIUM.COM'
'104.16.121.127'
DNS RESOLVER
(CLIENT)
DNS RECURSOR
(INTERNAL DNS SERVER)
CALLS
REFERRAL
ROOT-LEVEL
DOMAIN SERVER
' . ' NAME SERVER
CONTAINS:
NAME-SERVER RECORD
HOSTNAME SERVER
HOSTNAME ALIAS
IP ADDRESS
SECOND-LEVEL
DOMAIN SERVER
'MEDIUM.COM' NAME SERVER
REFERRAL
TOP-LEVEL
DOMAIN SERVER
'.COM' NAME SERVER

DNS

DNS can assign by DHCP Service on client.
Also can set manually, independent IP, Subnet Mask and Default Gateway.



DNS

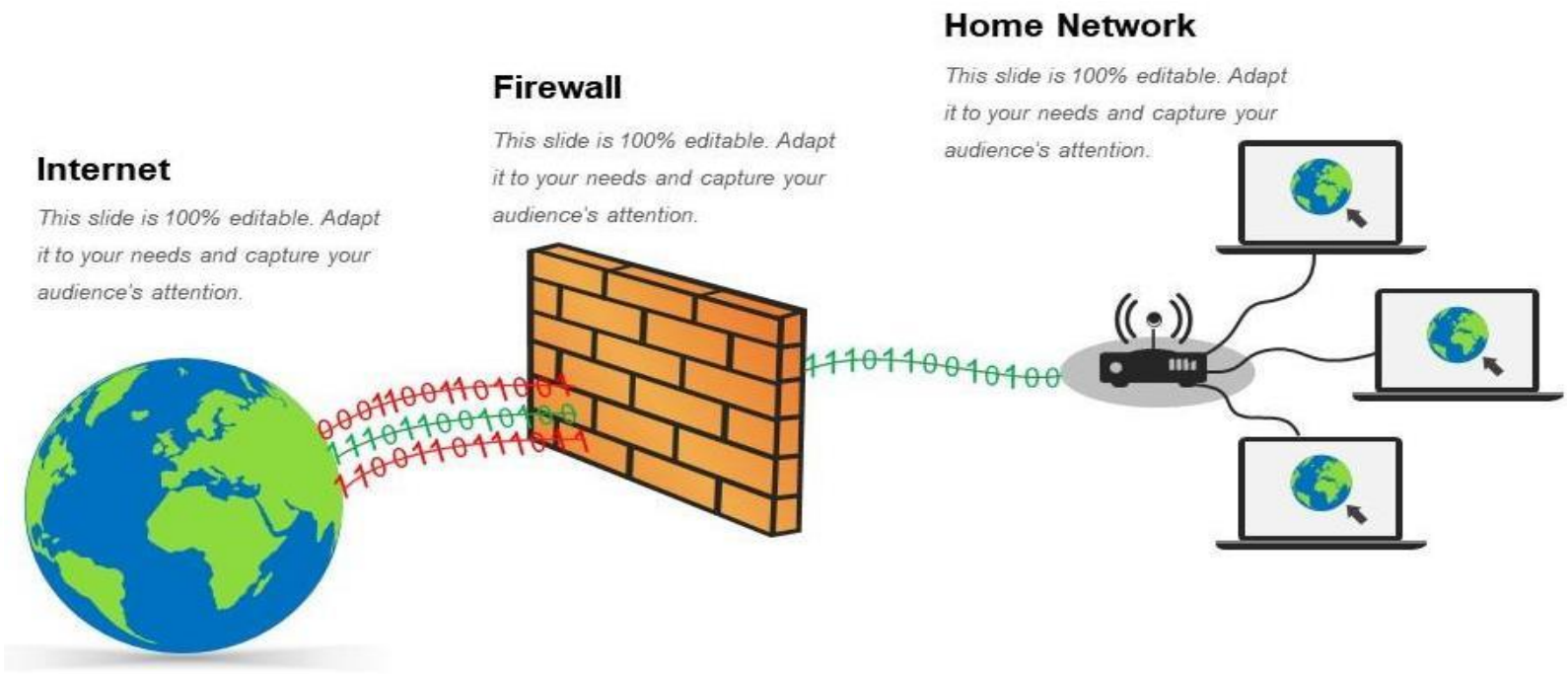
Best Global Public DNS Servers

Other Network Protocols

Firewall

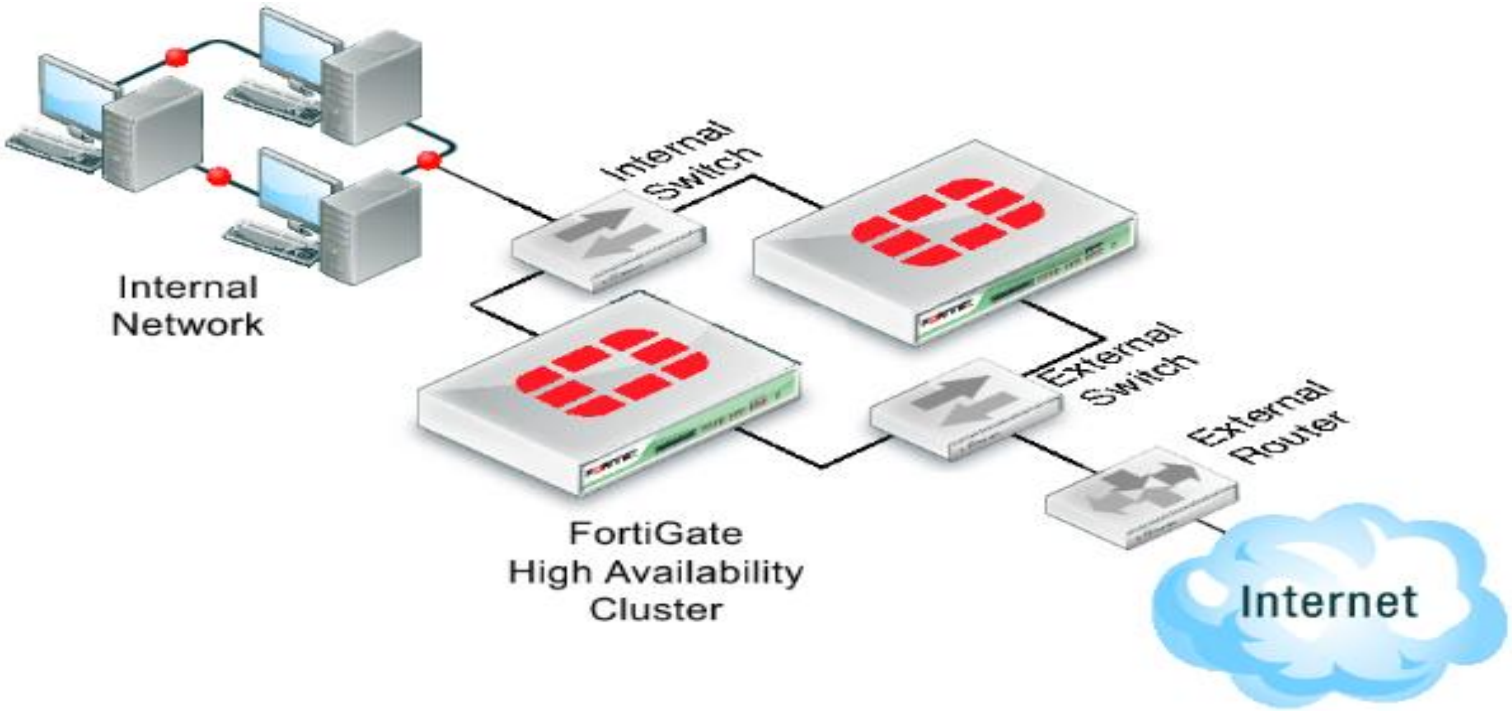
A Firewall is a network security device or a software that mon itors and filters incoming and outgoing network traffic based on an organization's previously established security policies.

At its most basic, a firewall is essentially the barrier that sits between a private internal network and the public Internet.



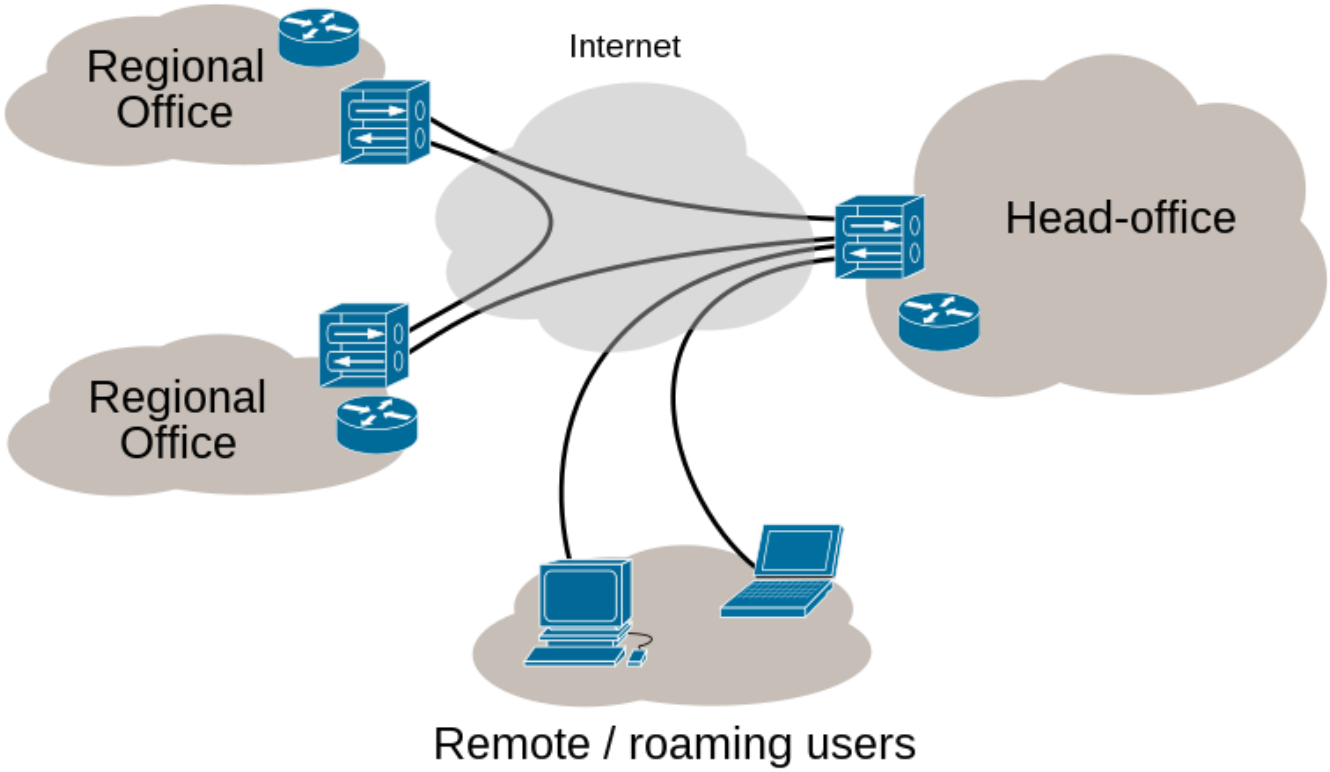
Firewall


FORTINET
FortiGate 200E
STATUS
ALARM
HA
POWER
CONSOLE
USB
HA
MGMT
WAN 1
WAN 2


Internal Switch
Internal Network
External Switch
External Router
FortiGate High Availability Cluster
Internet

Virtual Private Network

A VPN establishes a secure and encrypted connection between your computer and the Internet and provides a private tunnel f or your data and communications when using public networks.



Virtual Private Network

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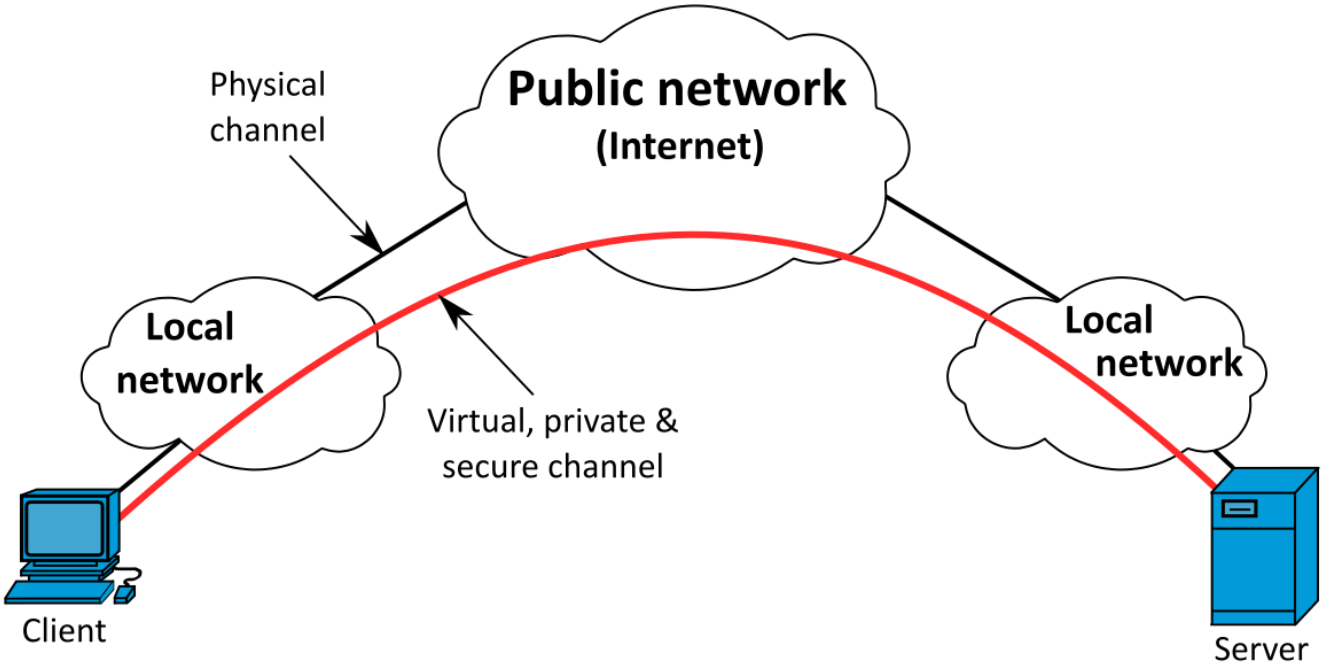


Wireless Networks

Wireless Networks

Wired vs Wireless Network

A wired network keeps devices connected to a network by wires.

In a Wireless network, the media (Air) is a shared resource.

This has several implications:

- Unlike a wired network, wireless can't both talk and listen at the same time, it is "half duplex"
- All users are sharing the same space must take turns to talk
- Everyone can 'hear' all traffic going on.

Wireless Networks

Types of Wireless Network Connections

- **WWAN**: A wide-area network covers a very large area, Such as m obile cellular networks (MCI net, MTN Irancell, …)
- **WMAN**: A metropolitan-area network is a computer network tha t spans across a city or small geographical area such as Wimax.
- **WLAN**: Wireless network that exists at a single site, such as an off ice building or in your home.
- **WPAN**: Bluetooth or IR Networks that work in 10 meters.

Wireless Networks

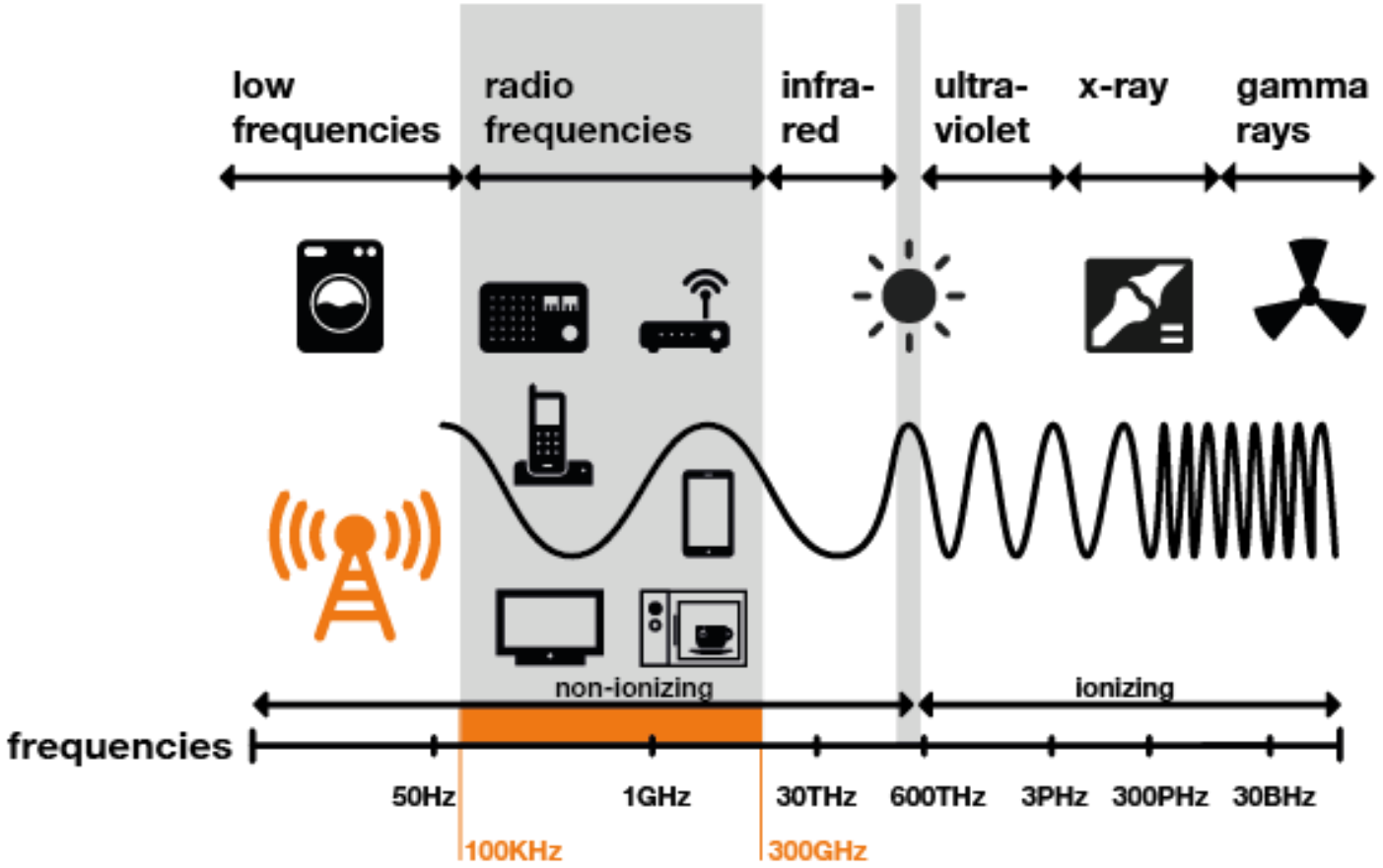
Wi-Fi Network Connection Modes

- **Infrastructure**: With infrastructure mode, you need an access point that serves as the primary connection device for clients.

- **Ad hoc**: Ad hoc mode is also referred to as peer-to-peer mode because it does not involve an access point, but is instead made up of multiple client devices. The devices, acting as “peers” with in the network, connect to each other directly.
  Such as ‘Wireless Sensor Networks (WSNs)’

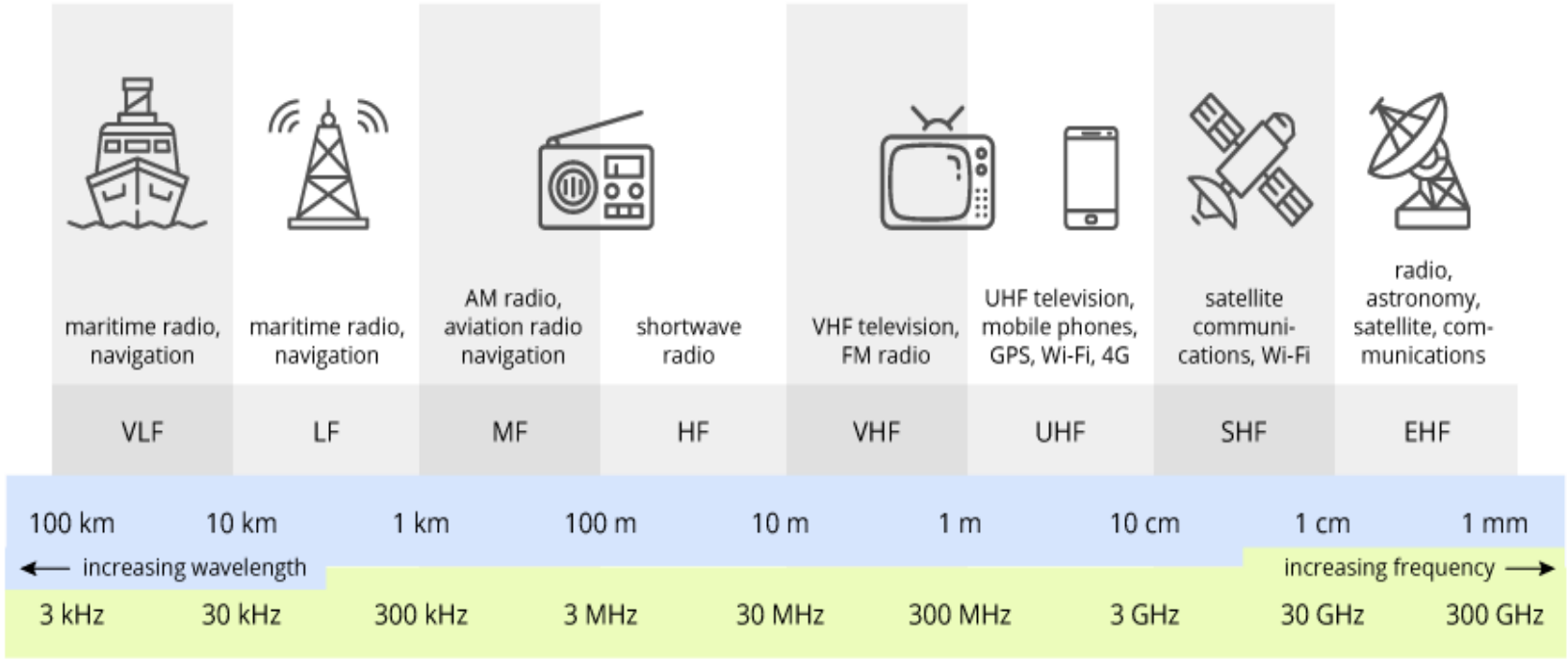
Wireless Networks

Waves Frequency and Radio Range



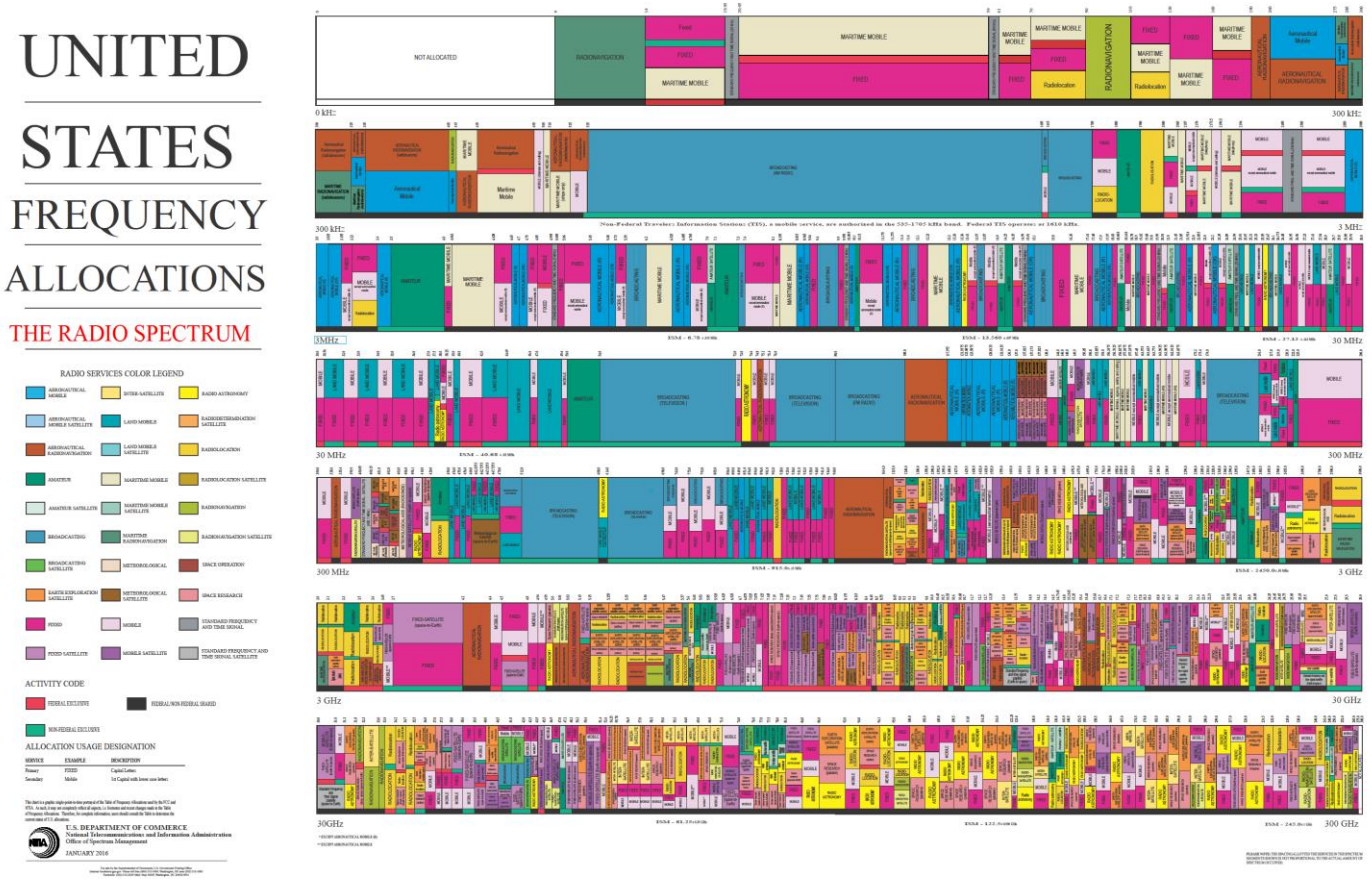
Wireless Networks

Waves Frequency and Radio Range



Wireless Networks

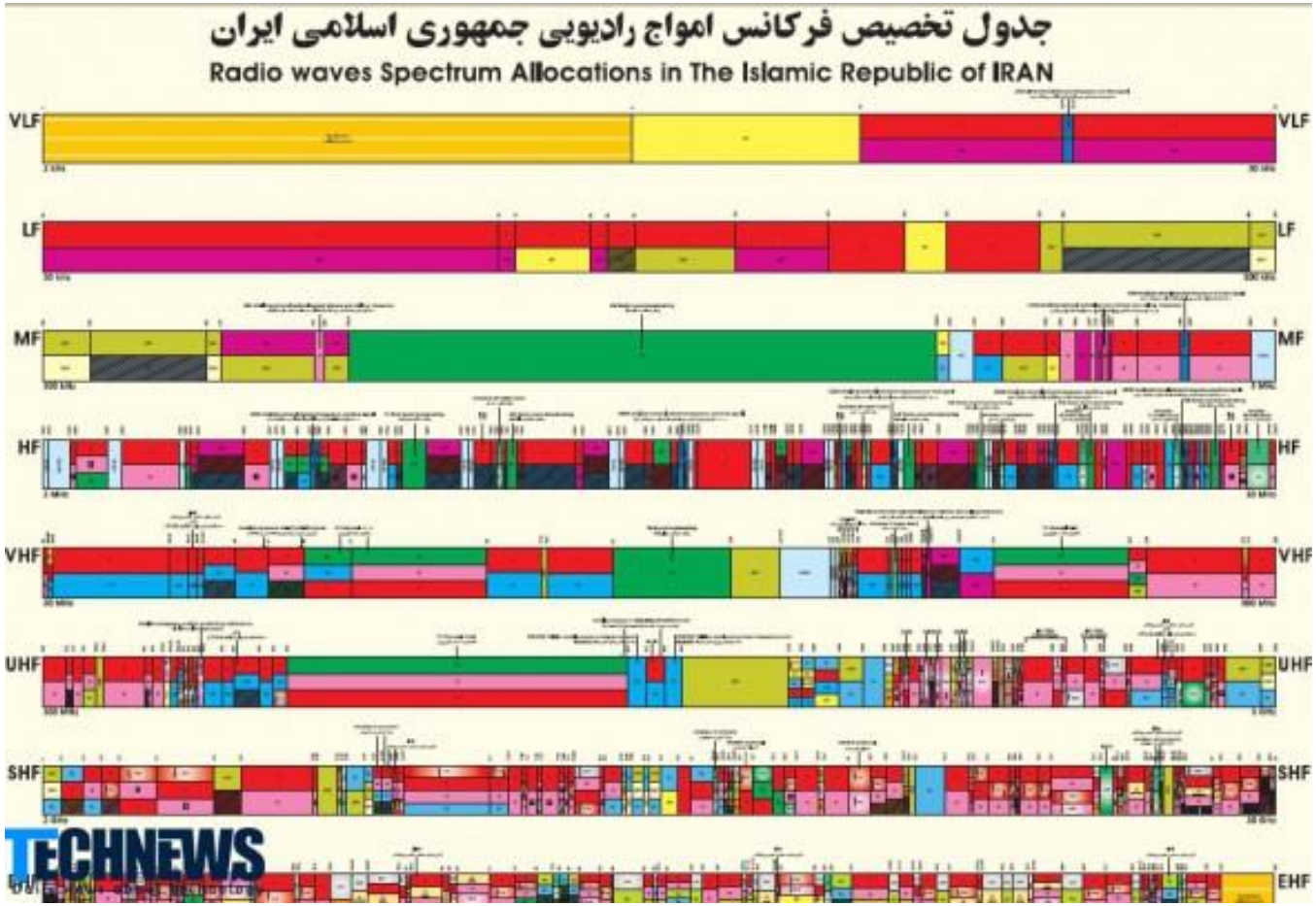
National Table of Frequency Allocation



T. Mehri (Ardabil University of Medical Sciences)

Wireless Networks

National Table of Frequency Allocation



Wireless Networks

Wireless IEEE Standards

Name of the Standard	Went Live	Bands	Max Network Bandwidth	Remarks
802.11be (WiFi 7) Extremely High Throughput (EHT)	Currently in works	2.4 GHz, 5 GHz, and new 6 GHz band	30 Gbps (Theoretically)	• Based on draft 802.11be standard drafted in 2021. • The WiFi 7 standard is backward compatible with 2.4 GHz and 5 GHz devices. • The 6 GHz band yields drastically less interference as compared to the 2.4 and 5 GHz bands.
802.11ax (WiFi 6) High-Efficiency Wireless (HEW)	2019		10 Gbps	• Will replace 802.11ac as a de-facto wireless standard. • Uses less power more reliable in congested environments. • Supports better security.
802.11ac (WiFi 5)	2014	5 GHz band	1300 Mbps (5 GHz Band) 450 Mbps (2.4 GHz Band)	• Uses dual-band wireless technology, supporting simultaneous connections on both 2.4 GHz and 5 GHz WiFi devices. • Most wireless routers are compliant with this standard. • Most expensive to implement.
802.11n (WiFi 4)	2009	2.4 GHz, and 5 GHz bands	600 Mbps	• Uses MIMO technology. • Supports a better range over WiFi standards due to its increased signal intensity. • Significant bandwidth improvement over earlier standards. • More expensive to implement over 802.11g (WiFi 3)
802.11g (WiFi 3)	2002-2003	2.4 GHz bands	Up to 54 Mbps	• Uses the 2.4 GHz range. • Combines best of 802.11a and 802.11b. • 802.11g access points work with 802.11b wireless network adaptors and vice versa. • Least expensive. • Supported by all wireless devices.
802.11a (WiFi 2)	1999	5 GHz band	upto 54 Mbps (5 GHz Band)	• 802.11a and 802.11b use different frequencies and hence are incompatible.
802.11b (WiFi 1)	July 1999	2.4 GHz band	2 Mbps (TCP) 3 Mbps (UDP)	• Unregulated. • An issue with interference from microwave ovens and other appliances using the 2.4 GHz range.

Configuration an ADSL Modem-Router

Thank you