Computer Science Department

Computer Networks

Third Class

Second Course

By:

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COMPUTER NETWORKS

LAB1: Network Components

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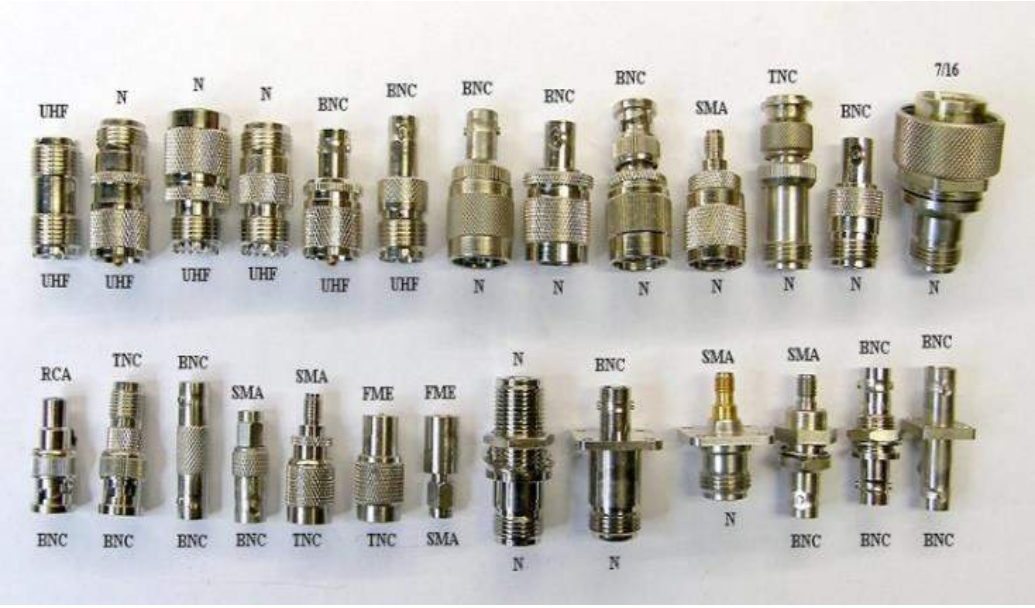
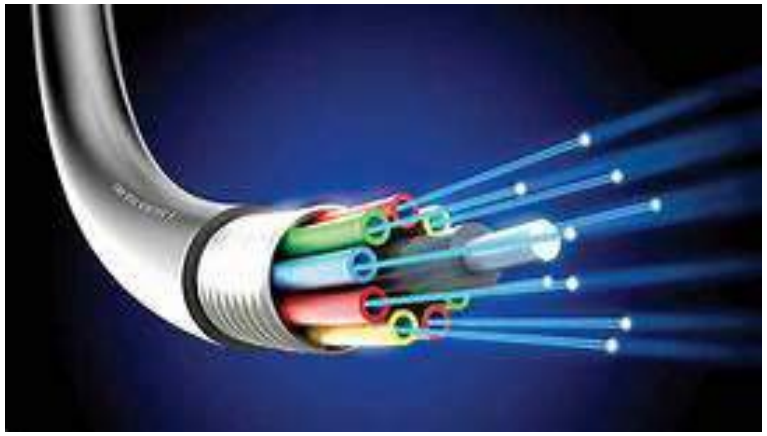
Network Components

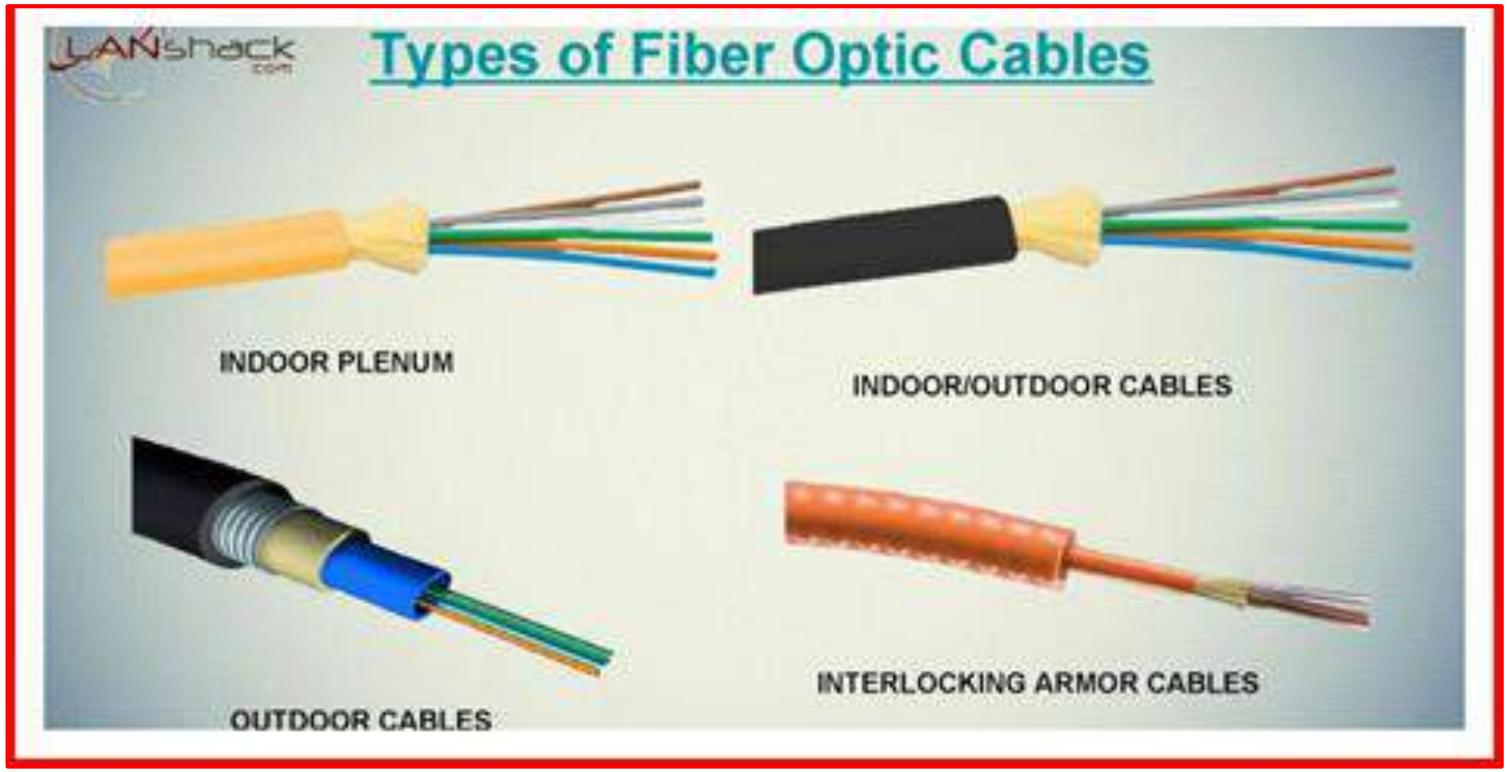
- **Devices**
  - PC, Router => Host
  - Hub, Switch
- **Medium**
  - Wire
    - Copper
    - Fiber optics
    - Twisted pair
      - STP (Shielded)
      - UTP (Unshielded)
  - Wireless

Copper wire

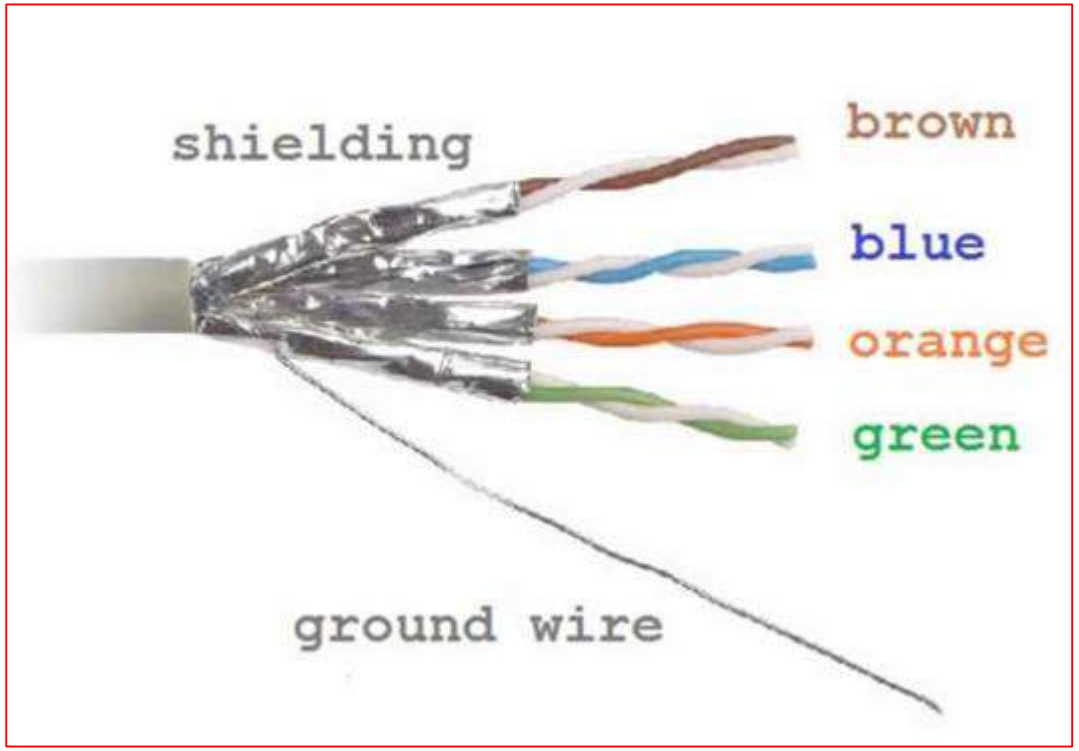


Fiber Optics

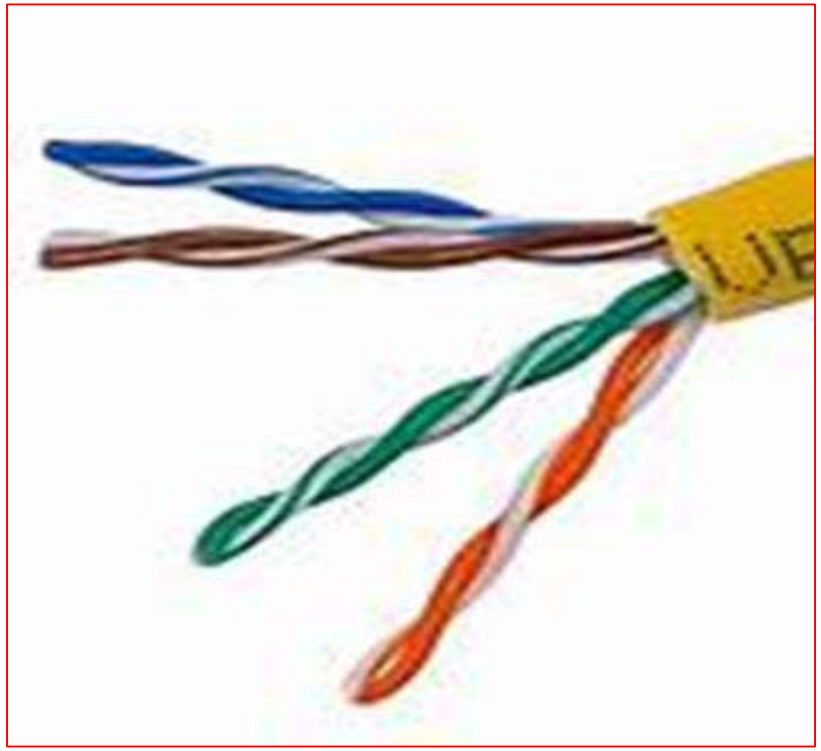




Twisted Pair Cable



Shielded Twisted Pair (STP)



Unshielded Twisted Pair (UTP)

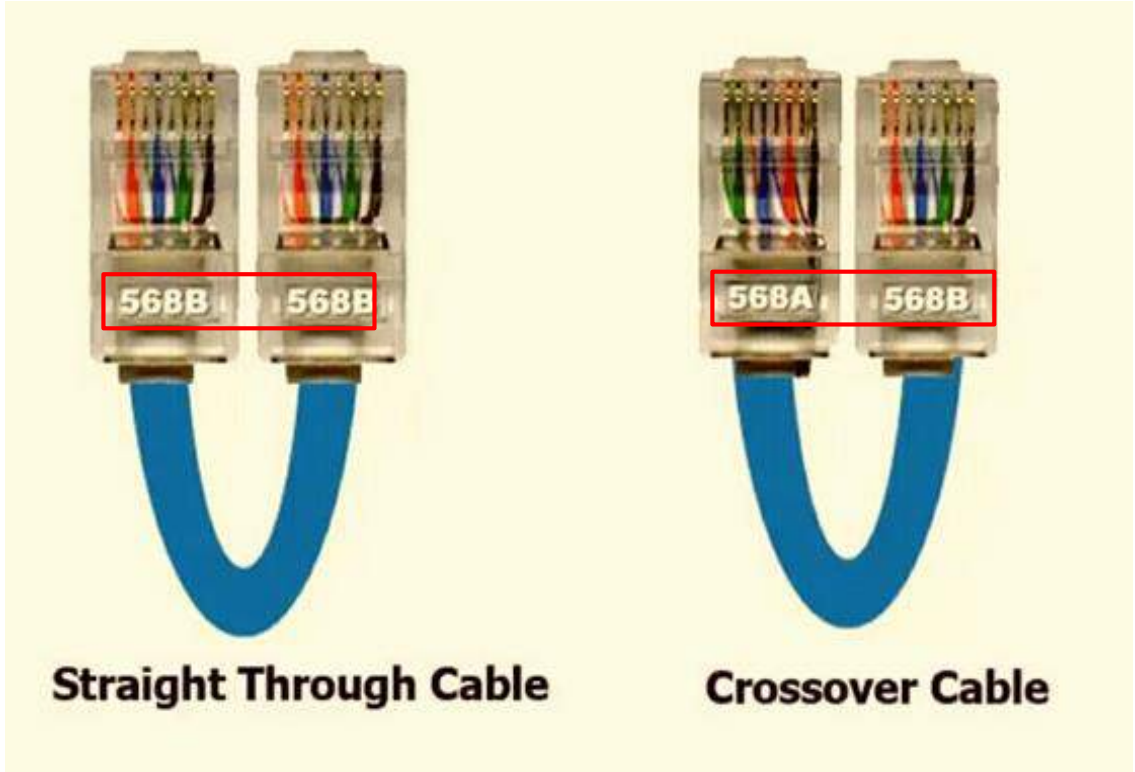
UTP Cables Connection Types

- **Straight forward** bet. dissimilar devices
  - PC , Hub
  - PC , Switch
  - Router , Switch
- **Crossover**
  - PC , PC
  - Router , Router
  - Switch , Switch

  } similar devices
  - Hub , Switch
  - PC , Router
- **Rollover**

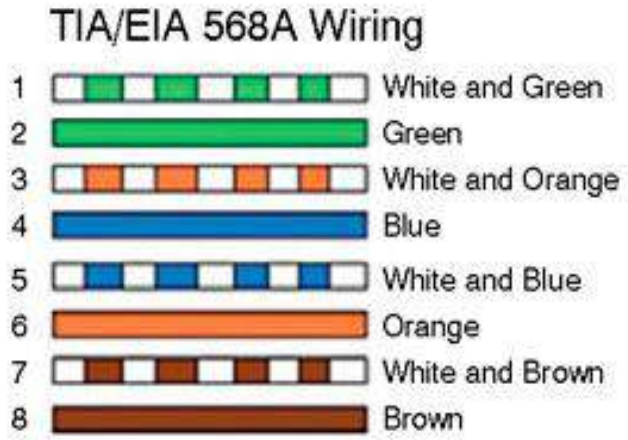
consists of RJ-45 on one end & DB-9 on the other end.

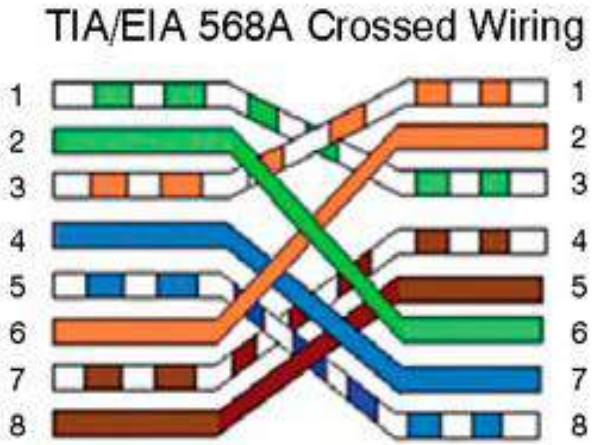
RJ45

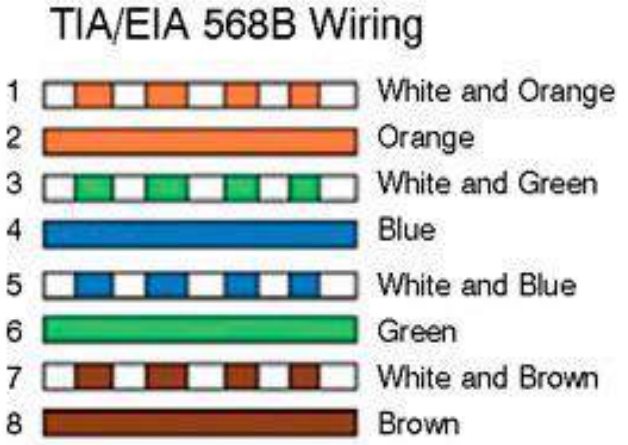


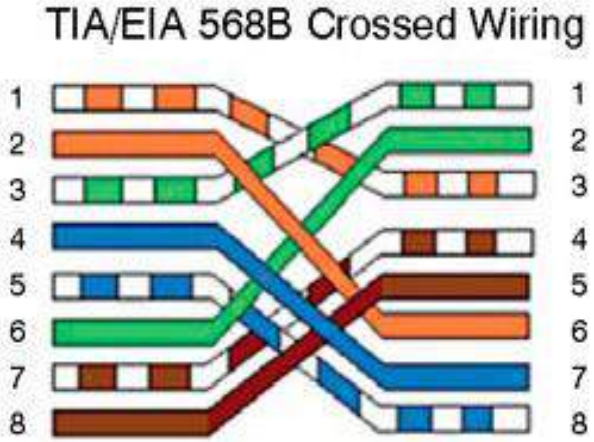
A - A
B - B

A - B
B - A



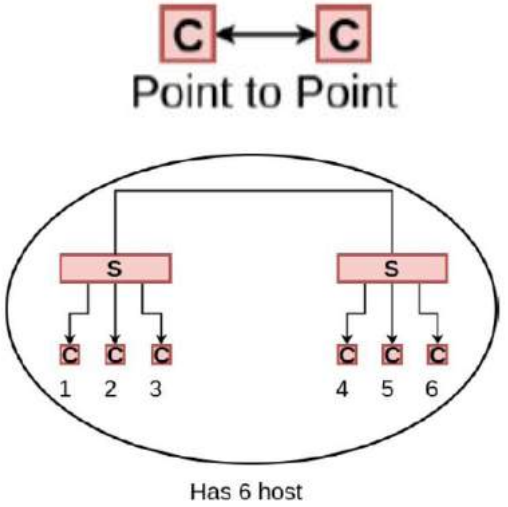






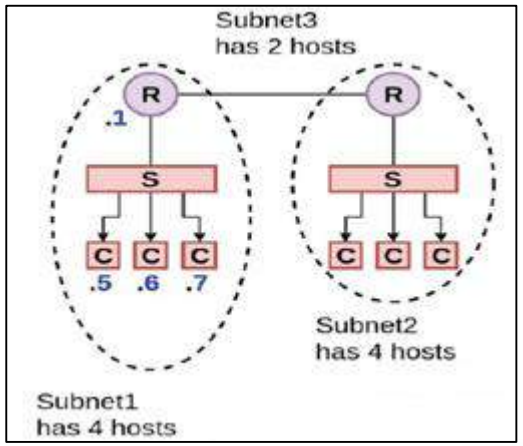
Network Devices

- **PC**
  - we can connect 2 devices directly and this type of connection is called Point to Point(**PtP**)
  - Considered **a host**



- **Switch** : level2
  - a distributor for connecting 3 or more devices
  - **NOT** considered **a host**

- **Router** : level3
  - Is a device used to separate devices into subnets
  - Considered **a host**



Addressing

- **Physical Address = MAC (Media Access Control)**

  MAC Address : **6** bytes (always unique) → in layer 2

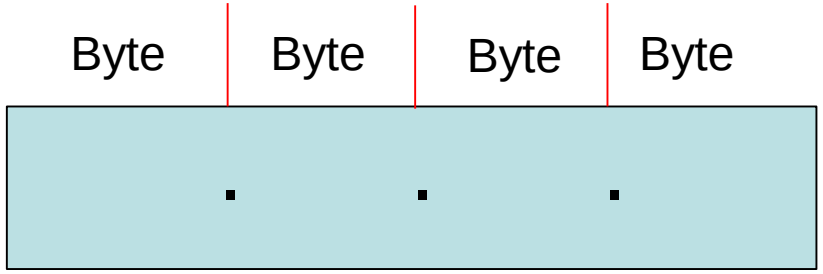
- **Logical Address = IP (Internet Protocol)**

  IP Address → in layer 3

  - IPv4
  - IPv6

IPv4

- 32 Bits => **4** bytes , separated by dot (.), unique during connection



- Byte = 8 bits => 8*4 =**32 bits**
- Each byte written in decimal
- Consist of 2 parts
  - **NetID** (subnet)
  - **HostID** (for host)

IP Address Classes

Address Class	1st octet range (decimal)	1st octet bits (green bits do not change)	Network(N) and Host(H) parts of address	Default subnet mask (decimal and binary)	Number of possible networks and hosts per network
A	1-127**	00000001-01111111	N.H.H.H	255.0.0.0	128 nets (2^7) 16,777,214 hosts per net (2^24-2)
B	128-191	10000000-10111111	N.N.H.H	255.255.0.0	16,384 nets (2^14) 65,534 hosts per net (2^16-2)
C	192-223	11000000-11011111	N.N.N.H	255.255.255.0	2,097,150 nets (2^21) 254 hosts per net (2^8-2)
D	224-239	11100000-11101111	NA (multicast)		
E	240-255	11110000-11111111	NA (experimental)		

** All zeros (0) and all ones (1) are invalid hosts addresses.

Subnet Mask

is used to let devices differentiate between NetID and HostID

Class A

N.H.H.H /8

Subnet mask = 255.0.0.0

Class B

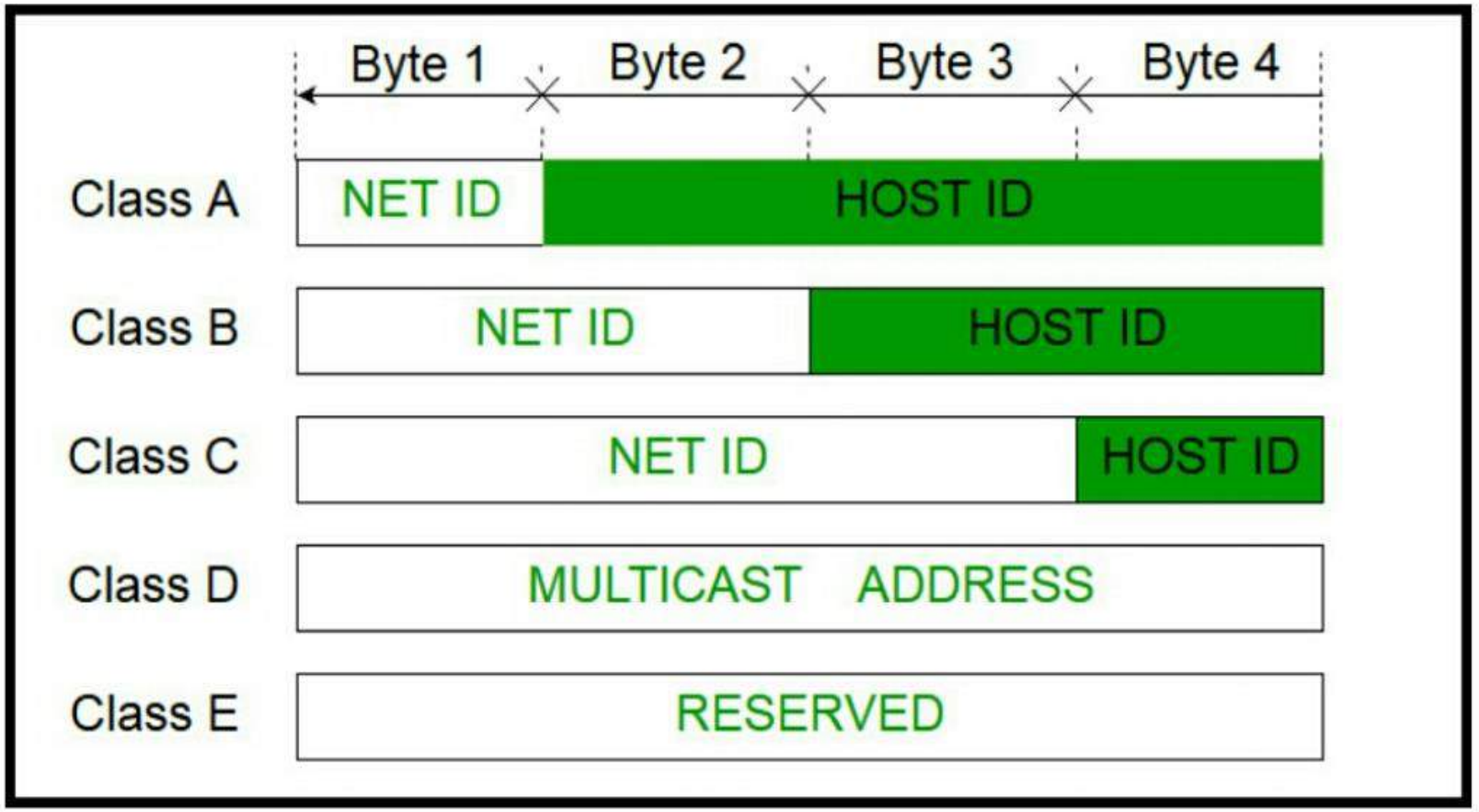
N.N.H.H /16

Subnet mask = 255.255.0.0

Class C

N.N.N.H /24

Subnet mask = 255.255.255.0



There are 2 IP addresses which can **NOT** be used in addressing a host

- Subnet IP (always 0)

  For example : **192 . 168 . 10 . 0**

- Broadcast IP (always 255)

  For example : **192 . 168 . 10 . 255**

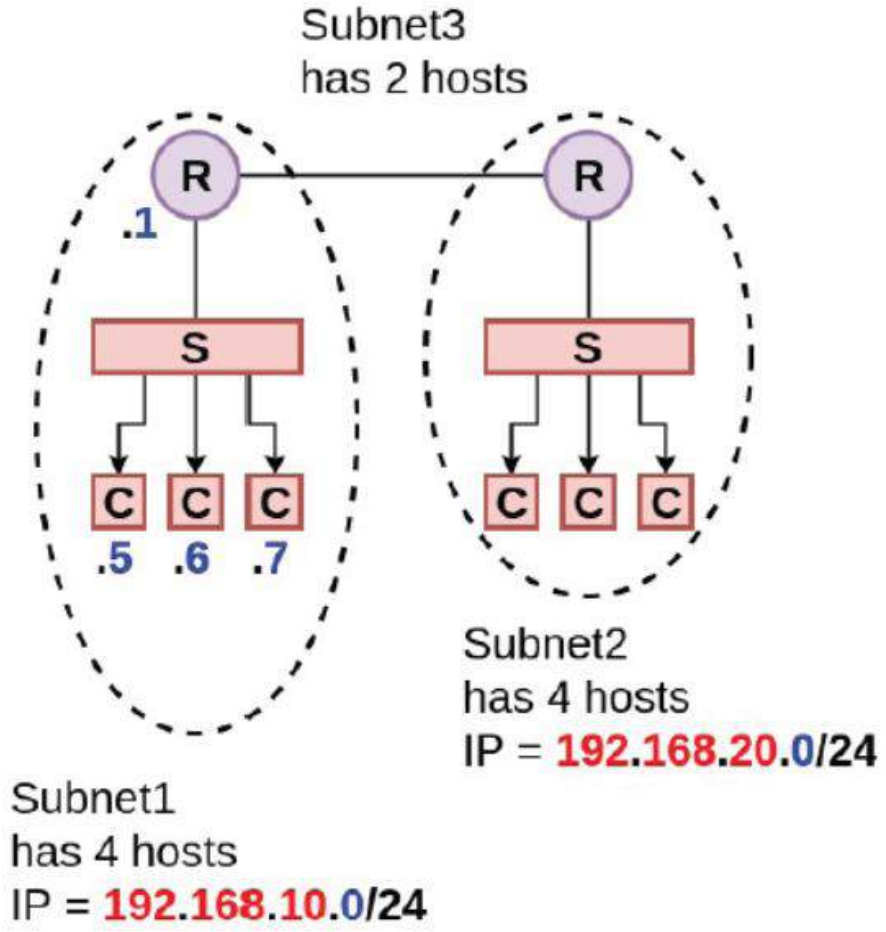
Default Gateway

is used to connect the subnet with the other networks

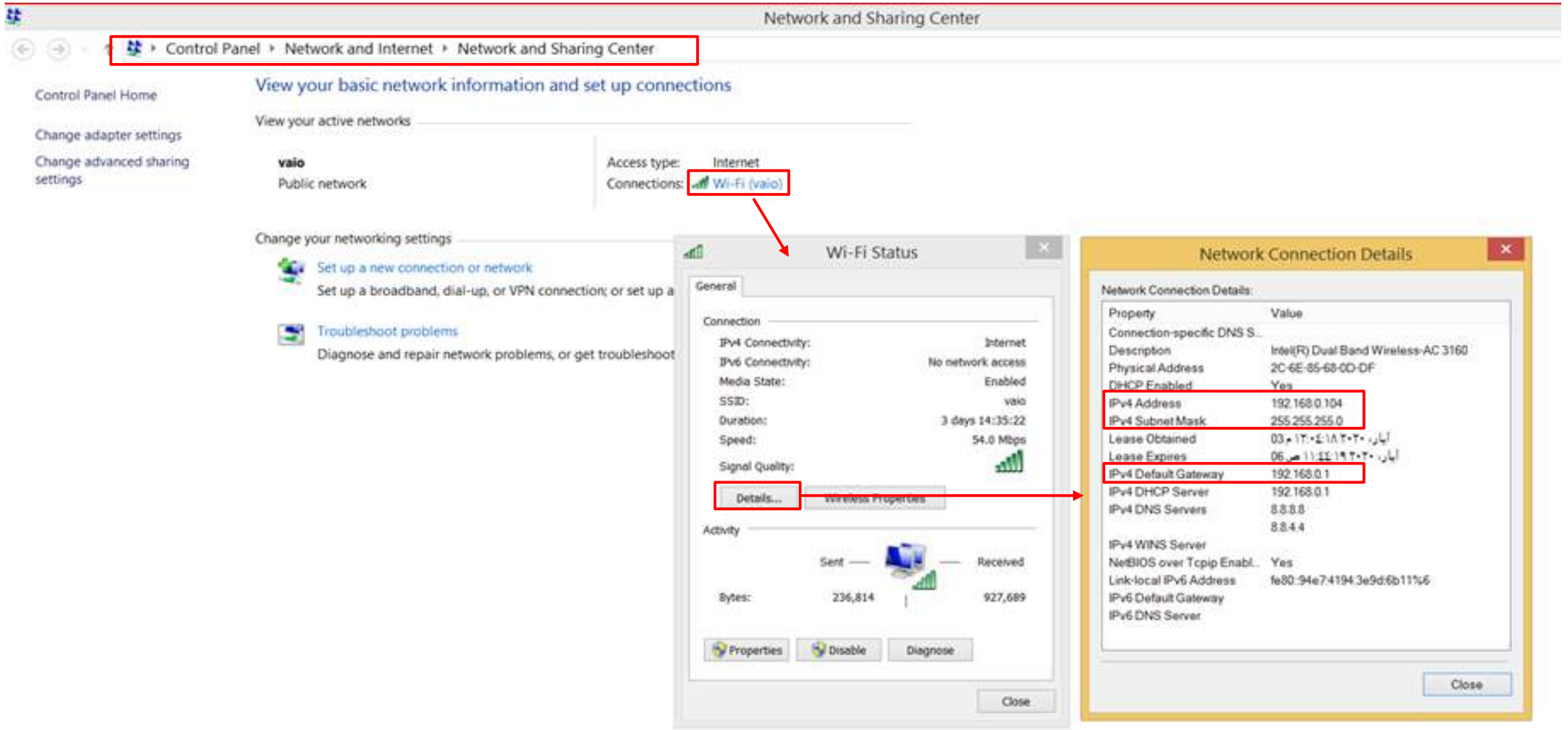
It is usually the IP of the router

Ex. we have the following configuration for subnet 1

- Subnet IP : **192.168.10.0**
- Subnet mask : **255.255.255.0**
- Default gateway : **192.168.10.1**



Check my Computer IP



Thank You

COMPUTER NETWORKS

LAB2: IP Configuration

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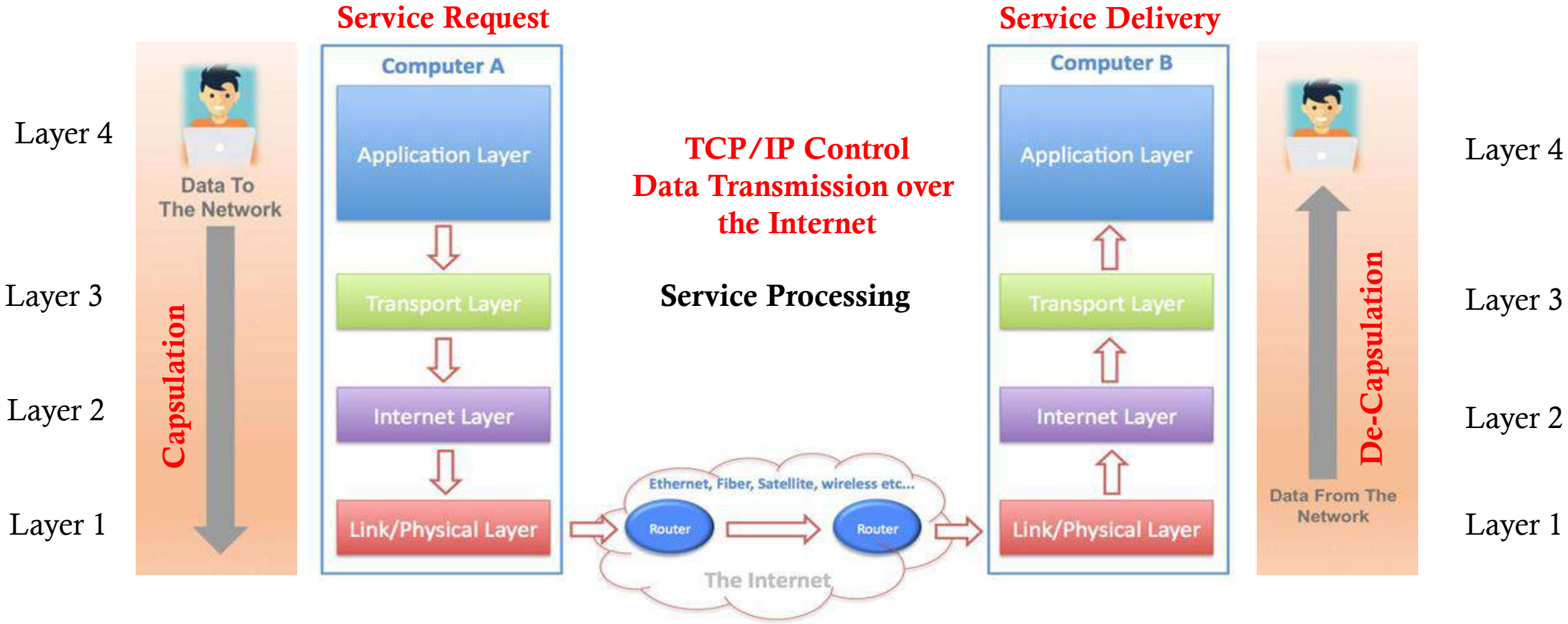
Third Class

TCP/IP
(Transmission Control Protocol/Internet Protocol)

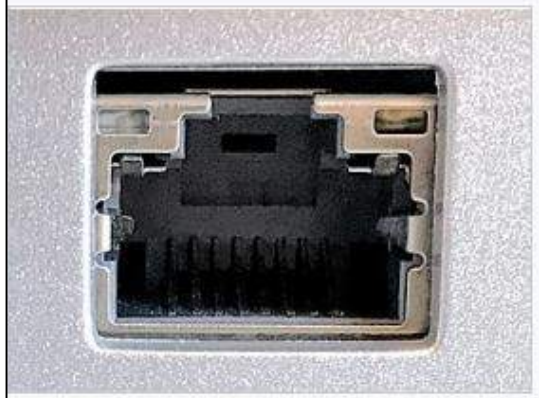


Ethernet

- is a technology used in **LAN (Local Area Network)**
- Related to Data link and physical layer (**wired connection**), throughput and Data transfer rate (speed) .
- **Throughput** : The amount of data that was successfully delivered over a specified period of time.
- **Data Transfer Rate** : The amount of data transmitted over a specified period of time.

Ex./10Mbps => Data Transfer Rate =10 Mega bit per second.

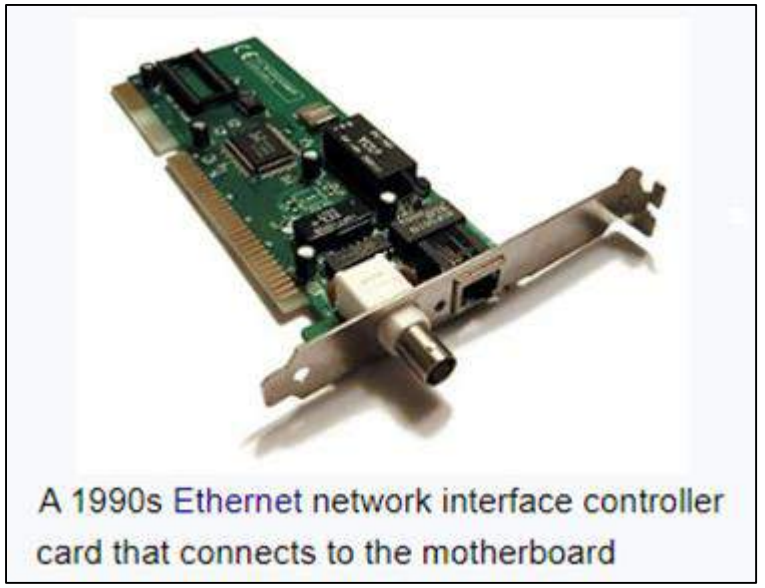
A twisted pair cable with an 8P8C modular connector attached to a laptop computer, used for Ethernet



An Ethernet over twisted pair port

Ethernet Types

- **Traditional Ethernet = Ethernet**
  - 10Base-**T** => (**T=** Twisted-pair)
  - 2 pair UTP
  - Half-Duplex
  - Uses Hub
  - Data Transfer Rate is 10 Mbps
- **Fast Ethernet**
  - 100Base-TX (2 pair UTP)
  - 100Base-T4 (4 pair UTP)
  - 100Base-FX (Fiber Optics)
  - Full-Duplex, Uses switch
  - Data Transfer Rate is 100 Mbps



A 1990s Ethernet network interface controller card that connects to the motherboard

- **Giga Ethernet**
  - 1000 Base-X (Fiber Optics)
  - 1000Base-T (Twisted Pair)
  - Data Transfer Rate is 1000 Mbps = 1Gbps

⇒ other (10,40,100) Giga Ethernet

– Each model is backward compatible

IP Configuration

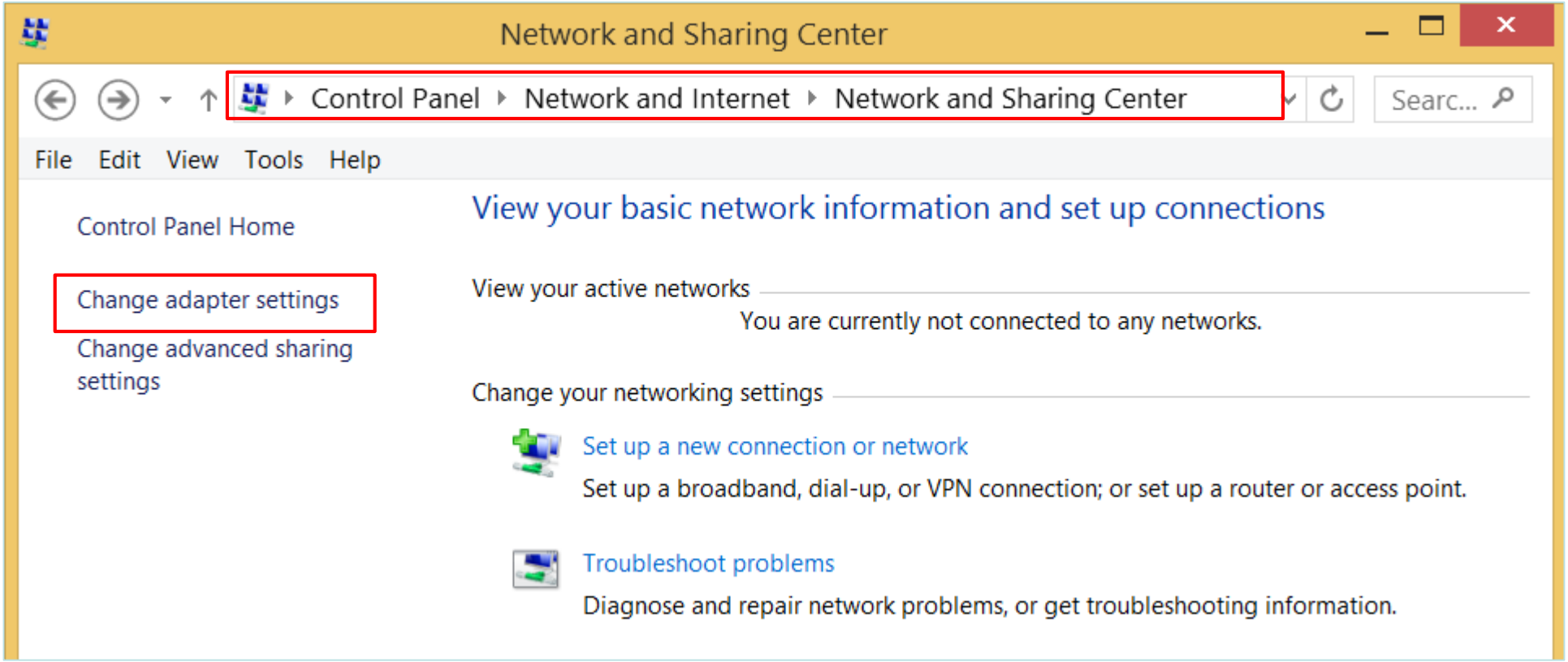
- **Assign IP Address to the Host =>** (GUI)
  - Static (manually)
  - Dynamic (automatically)
    - DHCP = Dynamic Host Configuration Protocol
- **Check IP**
  - GUI (windows)
  - CLI (cmd)

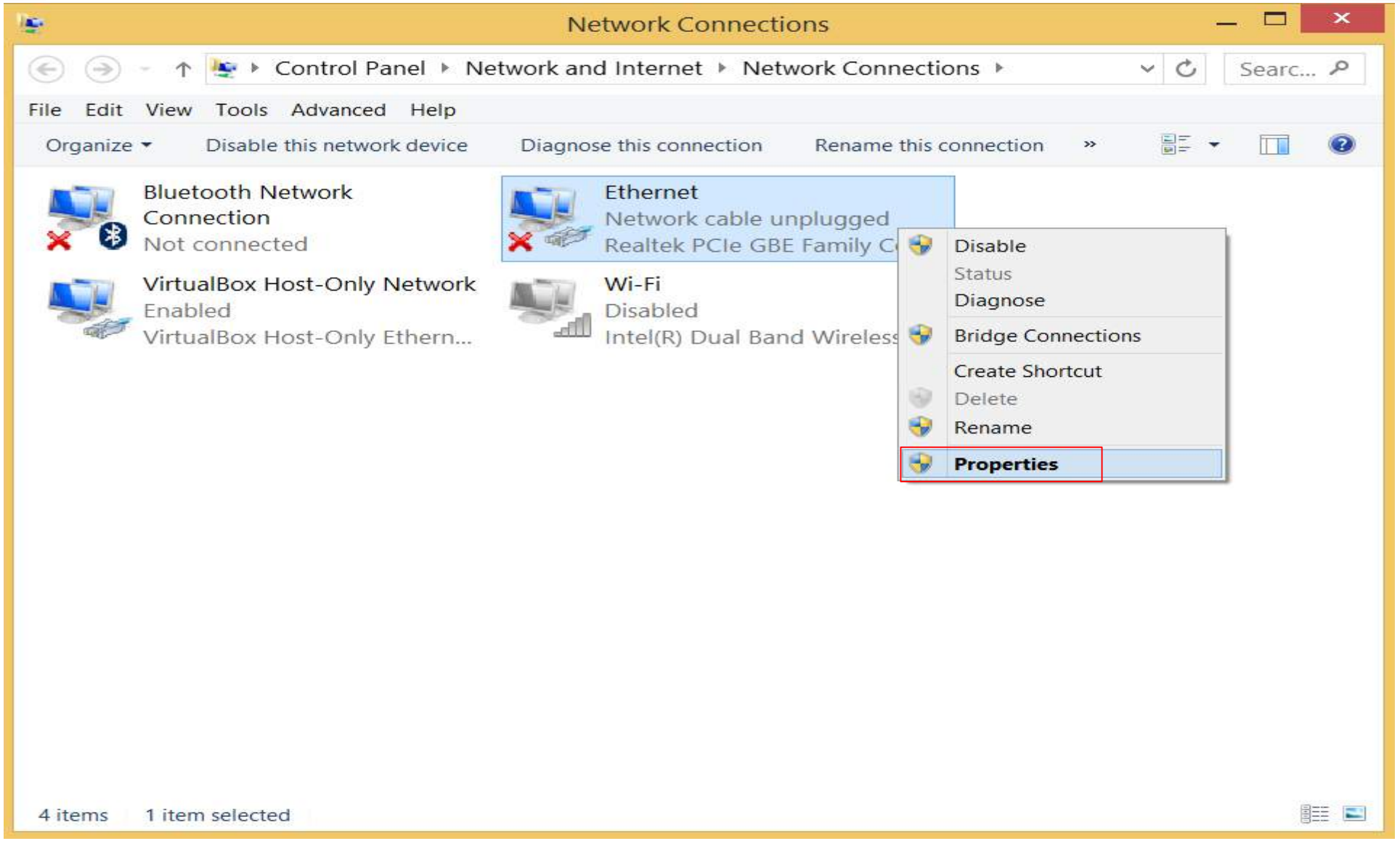
GUI

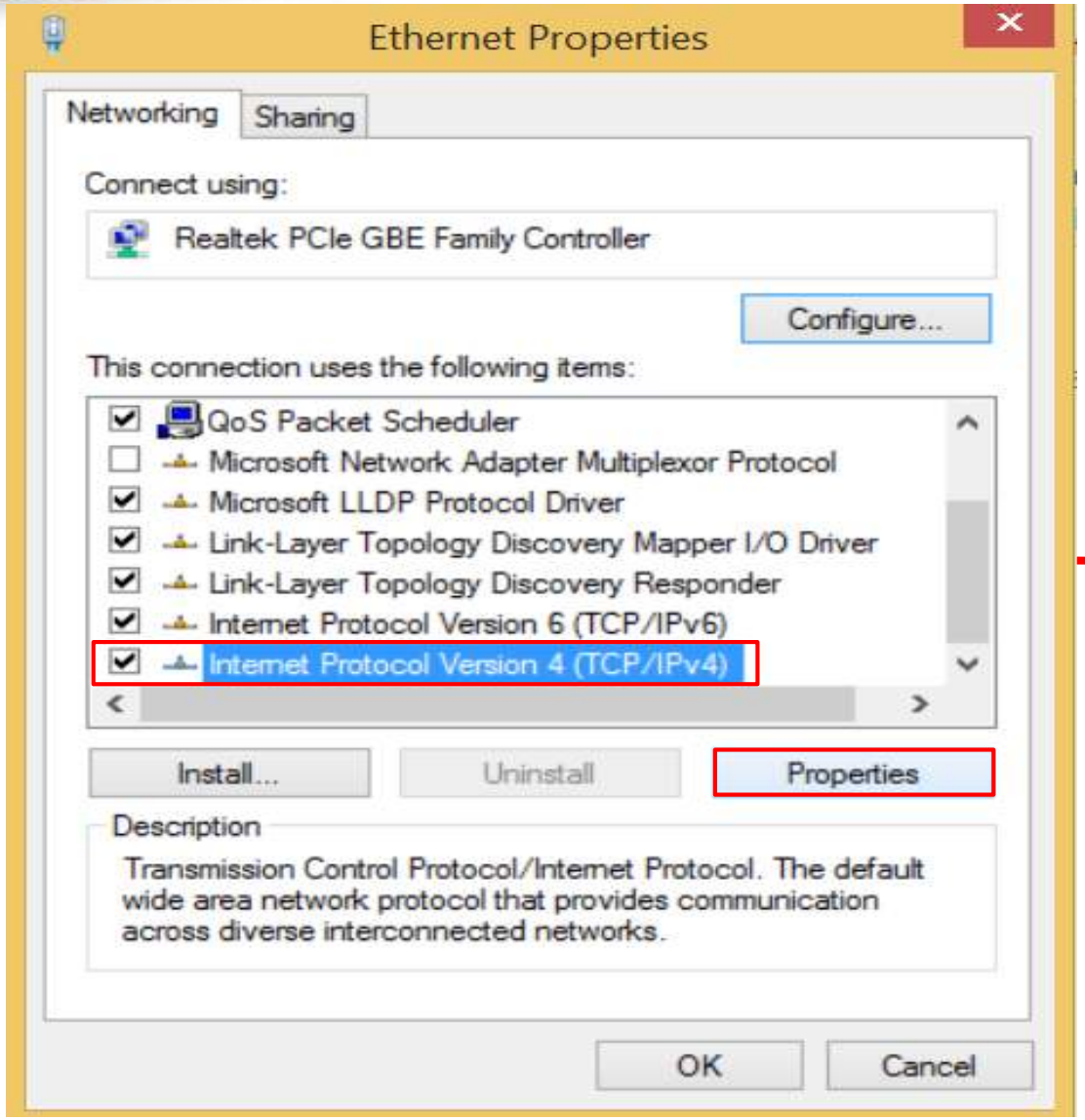
GUI => Graphical User Interface

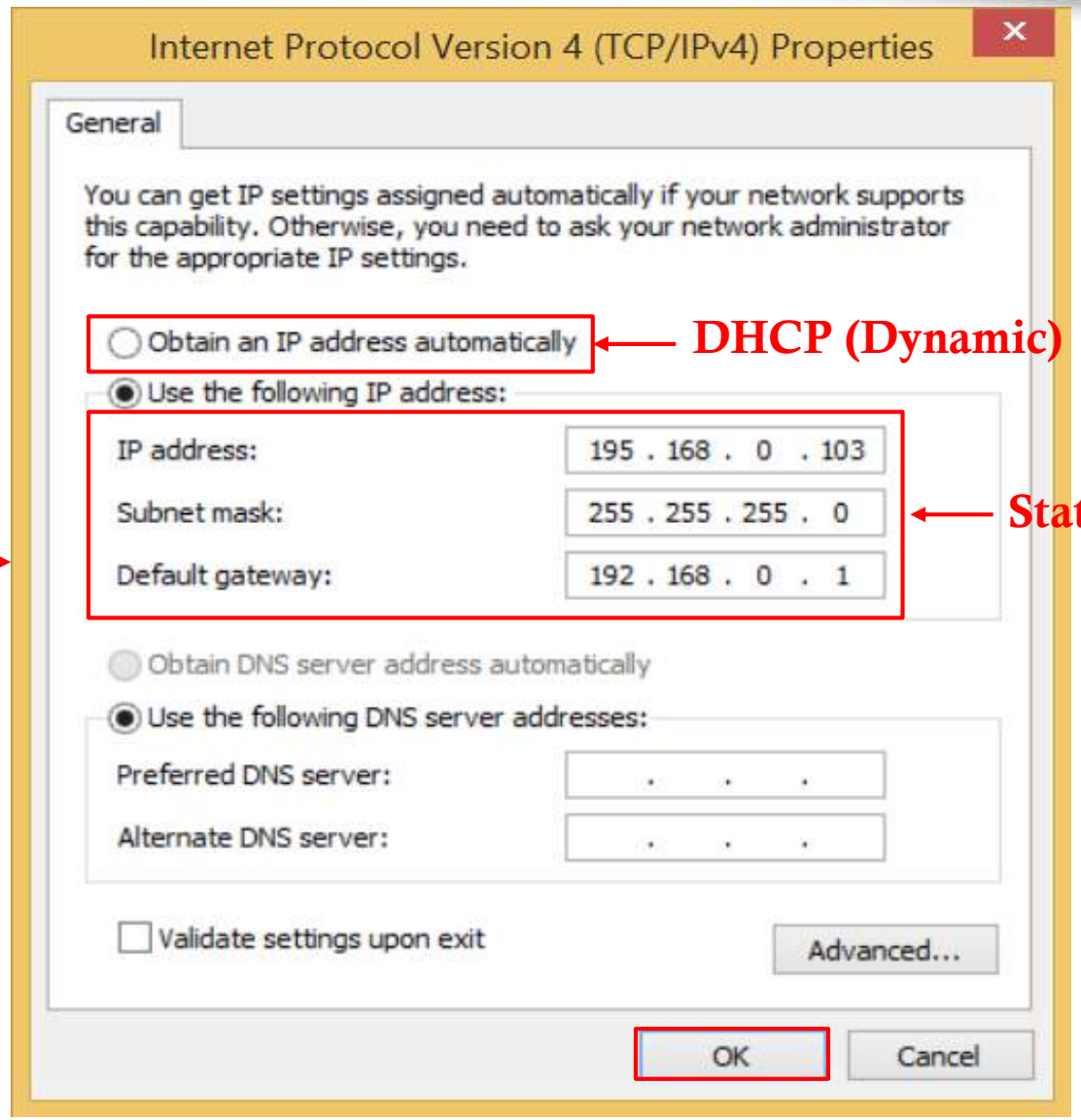
- Desktop => Network Connection
- Start => Network Connection
- Start => Search => Network Connection
- Start => control panel => Network and Internet =>

  Network and Sharing Center
- Click on  internet access icon => Open Network and Sharing Center


Network and Sharing Center
Control Panel ▸ Network and Internet ▸ Network and Sharing Center
Searc...
File Edit View Tools Help
Control Panel Home
Change adapter settings
Change advanced sharing settings
View your basic network information and set up connections
View your active networks
You are currently not connected to any networks.
Change your networking settings
Set up a new connection or network
Set up a broadband, dial-up, or VPN connection; or set up a router or access point.
Troubleshoot problems
Diagnose and repair network problems, or get troubleshooting information.


Network Connections
Control Panel ▸ Network and Internet ▸ Network Connections ▸
Searc...
File Edit View Tools Advanced Help
Organize
Disable this network device
Diagnose this connection
Rename this connection
Bluetooth Network Connection
Not connected
Ethernet
Network cable unplugged
Realtek PCIe GBE Family C
VirtualBox Host-Only Network
Enabled
VirtualBox Host-Only Ethern...
Wi-Fi
Disabled
Intel(R) Dual Band Wireless
Disable
Status
Diagnose
Bridge Connections
Create Shortcut
Delete
Rename
Properties
4 items
1 item selected

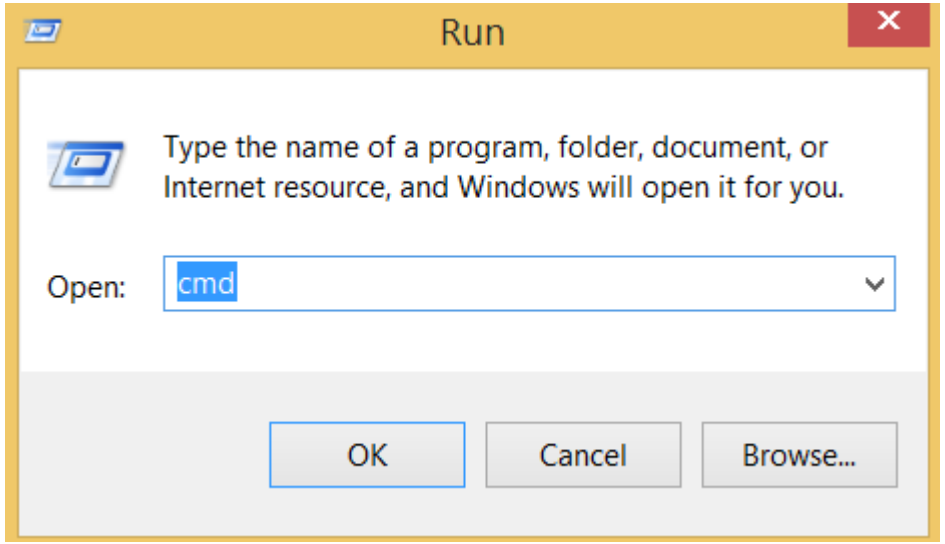

Ethernet Properties
Networking
Sharing
Connect using:
Realtek PCIe GBE Family Controller
Configure...
This connection uses the following items:
QoS Packet Scheduler
Microsoft Network Adapter Multiplexor Protocol
Microsoft LLDP Protocol Driver
Link-Layer Topology Discovery Mapper I/O Driver
Link-Layer Topology Discovery Responder
Internet Protocol Version 6 (TCP/IPv6)
Internet Protocol Version 4 (TCP/IPv4)
Install...
Uninstall
Properties
Description
Transmission Control Protocol/Internet Protocol. The default wide area network protocol that provides communication across diverse interconnected networks.
OK
Cancel

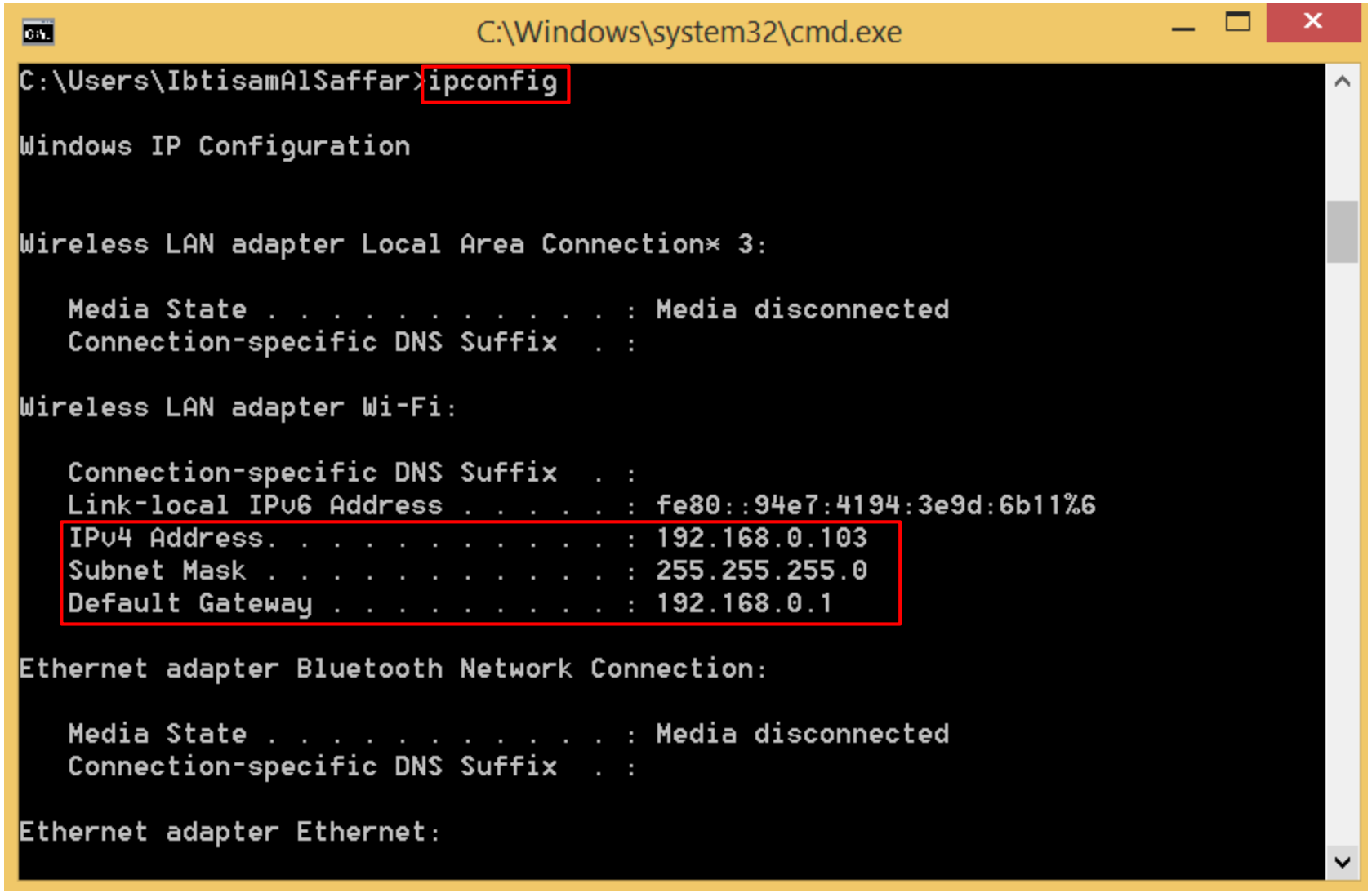

Internet Protocol Version 4 (TCP/IPv4) Properties
General
You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.
Obtain an IP address automatically
DHCP (Dynamic)
Use the following IP address:
IP address: 195 . 168 . 0 . 103
Subnet mask: 255 . 255 . 255 . 0
Default gateway: 192 . 168 . 0 . 1
Static
Obtain DNS server address automatically
Use the following DNS server addresses:
Preferred DNS server:
Alternate DNS server:
Validate settings upon exit
Advanced...
OK
Cancel

Check IP address

CLI => Command Line Interface

- using **ipconfig** command to check IP, subnet mask and gateway
- Start => Run => cmd => ipconfig
- **cmd** abbreviated to **command**

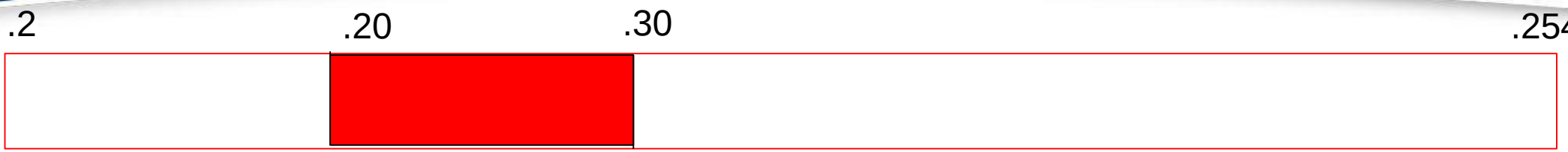



C:\Windows\system32\cmd.exe
C:\Users\IbtisamAlSaffar>ipconfig
Windows IP Configuration
Wireless LAN adapter Local Area Connection* 3:
Media State . . . . . : Media disconnected
Connection-specific DNS Suffix . :
Wireless LAN adapter Wi-Fi:
Connection-specific DNS Suffix . :
Link-local IPv6 Address . . . . . : fe80::94e7:4194:3e9d:6b11%6
IPv4 Address. . . . . : 192.168.0.103
Subnet Mask . . . . . : 255.255.255.0
Default Gateway . . . . . : 192.168.0.1
Ethernet adapter Bluetooth Network Connection:
Media State . . . . . : Media disconnected
Connection-specific DNS Suffix . :
Ethernet adapter Ethernet:

DHCP

Dynamic **H**ost **C**onfiguration **P**rotocol

- Assign IP automatically to PCs from the pool
- The DHCP server uses IP addresses that are available in the DHCP pool
- we can exclude some addresses from the whole range pool to aviod conflict
- We don’t need the whole range (2- 254) because we may need to assign static IP addresses to special devices (Printers, NAS, Servers etc)



- Lease time is the time given by DHCP server to a device to hold specific information
  - These information include : IP address, Subnet mask, default gateway
  - CISCO default time is 1 day
  - When lease expires, new information are assigned to that device

Thank You

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LAB3: Check PCs Connectivity

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IP Configuration

- **Assign IP Address to the Host =>** (GUI)
  - Static (manually)
  - Dynamic (automatically)
    - DHCP = Dynamic Host Configuration Protocol
- **Check IP**
  - GUI (start > Network Connections)
  - CLI (start > run > cmd > ipconfig)

IPs Types

- **Private (LAN)**
- **Public (WAN)**
  - Google.com
  - Yahoo.com
  - Youtube.com
  - Facebook.com
  - Uobaghdad.edu.iq
  - Host communicate direct with Internet : Server ,Router.

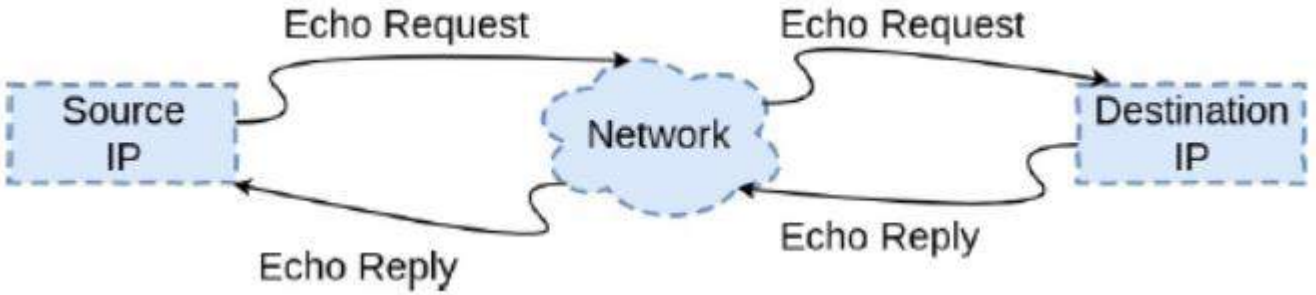
Private Addresses

CLASS	/?	IP	RANGE	MASK
A	/8	10.0.0.0	10.255.255.255	255.0.0.0
B	/12	172.16.0.0 – 172.31.0.0	172.16.255.255 – 172.31. 255.255	255.240.0.0
C	/16	192.168.0.0	192.168.255.255	255.255.0.0

Check PCs Connectivity

- The **ping** command is used to test the ability of the source computer to reach a specified destination computer. The ping command is usually used as a simple way verify that a computer can communicate over the network with another computer or network device.
- **Ping /? => Help**
- **ping** [**-n** *count*] [**-t**][**-l** *size*] [**-f**] destination

- IP
- Domain Name



Ping

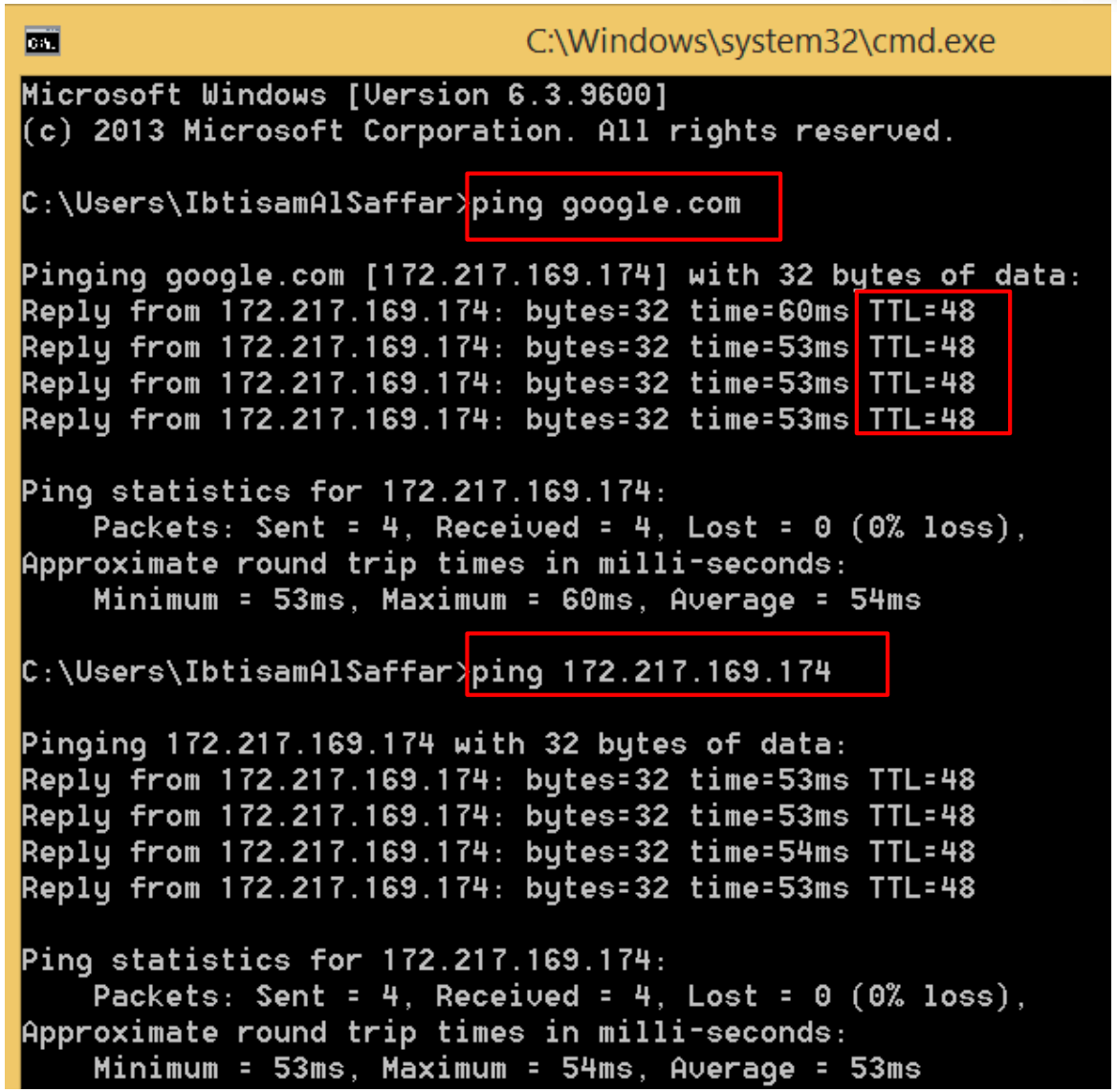
- ICMP (Internet Control Message Protocol) send messages to the destination to check connectivity.
- The default **number of packets** sent by ping differs depending on the system
- we are using
  - Windows is 4
  - Linux is infinite
  - CISCO is 5
- The echo **reply** represent the delay

Start => run => cmd => ping /? (Help)

Example:

Start => run => cmd

- Ping 172.217.169.174
- Ping www.google.com



TTL: **T**ime-**T**o-**L**ive is one of the information in the L3 header

- It is a counter with an initial value (that depends on the system)
- The default value in Windows is 128
- Each router that the packets goes through decreases the TTL by 1 and the packet(s) is dropped if TTL reaches zero.
- This is done to prevent an infinite loop in L3 layer
- For example: if a packet passes 2 routers then it will become 126

- **-n [number]** => number of requests(packets) to send.
- For example:

  ping -n 6 172.217.169.174 => send 6 packets to 172.217.169.174

```
C:\Users\IbtisamAlSaffar>ping -n 6 172.217.169.174

Pinging 172.217.169.174 with 32 bytes of data:
Reply from 172.217.169.174: bytes=32 time=52ms TTL=48
Reply from 172.217.169.174: bytes=32 time=52ms TTL=48
Reply from 172.217.169.174: bytes=32 time=54ms TTL=48
Reply from 172.217.169.174: bytes=32 time=52ms TTL=48
Reply from 172.217.169.174: bytes=32 time=52ms TTL=48
Reply from 172.217.169.174: bytes=32 time=55ms TTL=48

Ping statistics for 172.217.169.174:
    Packets: Sent = 6, Received = 6, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 52ms, Maximum = 55ms, Average = 52ms
```

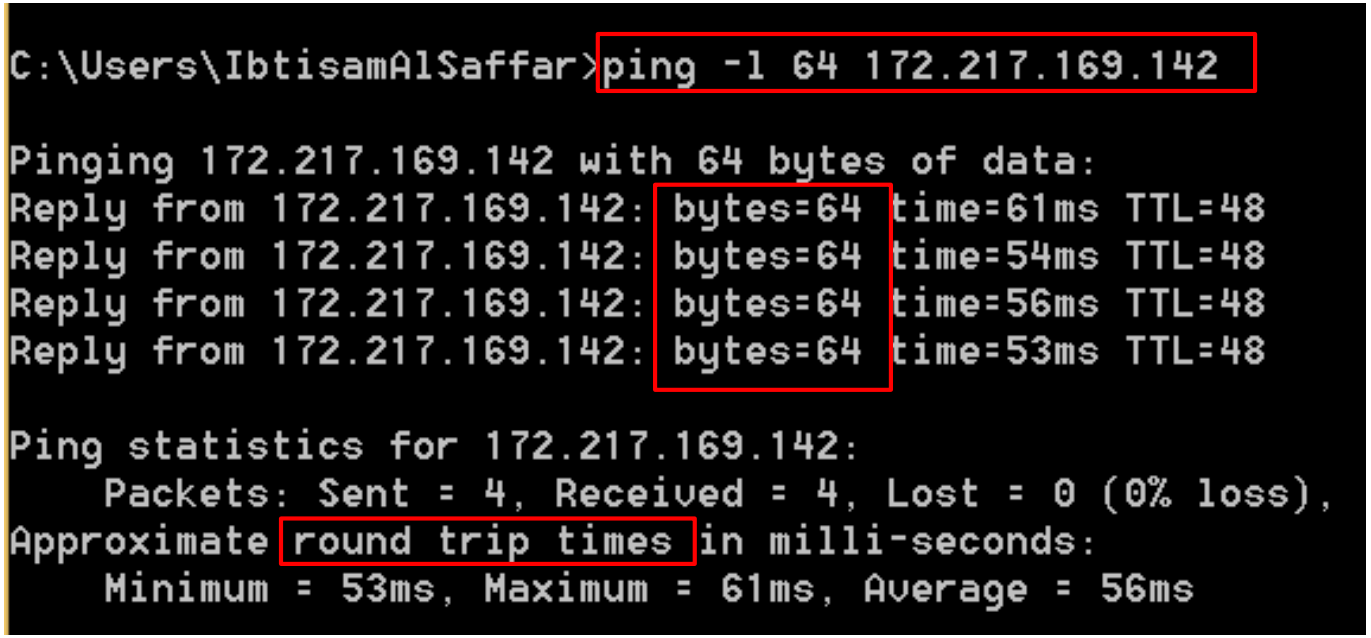
- **-t** to send an infinite number of packets
  - CTRL-C to stop
  - We can't use -n with it

```
C:\Users\IbtisamAlSaffar>ping google.com -t

Pinging google.com [172.217.169.142] with 32 bytes of data:
Reply from 172.217.169.142: bytes=32 time=54ms TTL=48
Reply from 172.217.169.142: bytes=32 time=57ms TTL=48
Reply from 172.217.169.142: bytes=32 time=53ms TTL=48
Reply from 172.217.169.142: bytes=32 time=54ms TTL=48
Reply from 172.217.169.142: bytes=32 time=53ms TTL=48
Reply from 172.217.169.142: bytes=32 time=54ms TTL=48
Reply from 172.217.169.142: bytes=32 time=55ms TTL=48
Reply from 172.217.169.142: bytes=32 time=55ms TTL=48
Reply from 172.217.169.142: bytes=32 time=53ms TTL=48
Reply from 172.217.169.142: bytes=32 time=53ms TTL=48
Reply from 172.217.169.142: bytes=32 time=53ms TTL=48
Reply from 172.217.169.142: bytes=32 time=60ms TTL=48
Reply from 172.217.169.142: bytes=32 time=374ms TTL=48

Ping statistics for 172.217.169.142:
    Packets: Sent = 13, Received = 13, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 53ms, Maximum = 374ms, Average = 79ms
Control-C
^C
```

- **-l** => change the size of the send packets
  - The default size is 32 bytes (without using this option)
  - This also increase the time required to send and receive packets



- **MTU** = **M**aximum **T**ransmission **U**nit which defines the maximum size of bytes that can be send without fragmentation, MTU depends on the physical network. In **Ethernet MTU is 1500** byte
- Ping www.yahoo.com –l 1500

```
C:\Users\IbtisamAlSaffar>ping www.yahoo.com -l 1500

Pinging new-fp-shed.wg1.b.yahoo.com [87.248.98.7] with 1500 bytes of data:
Reply from 87.248.98.7: bytes=1500 time=118ms TTL=46
Reply from 87.248.98.7: bytes=1500 time=111ms TTL=46
Reply from 87.248.98.7: bytes=1500 time=119ms TTL=46
Reply from 87.248.98.7: bytes=1500 time=111ms TTL=46

Ping statistics for 87.248.98.7:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 111ms, Maximum = 119ms, Average = 114ms
```

- **Fragmentation** is the process in which we broke the information into smaller pieces and the combining them at the destination.
- Ping www.yahoo.com –l 1500 -f => don't fragment

```
C:\Users\IbtisamAlSaffar>ping www.yahoo.com -l 1500 -f

Pinging new-fp-shed.wg1.b.yahoo.com [87.248.98.8] with 1500 bytes of data:
Packet needs to be fragmented but DF set.
Packet needs to be fragmented but DF set.
Packet needs to be fragmented but DF set.
Packet needs to be fragmented but DF set.

Ping statistics for 87.248.98.8:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Trace Route

- **Tracert destination-IP**
- Follows the route from source to destination
- This form is slow because it register the hostname and IP, to make it faster we can **-d** (ignore hostname and print only the IP)

And suppose we are working at the device which has the IP (192.168.10.2)
If we use the following command **tracert -d 192.168.20.5** then we will get the following output:

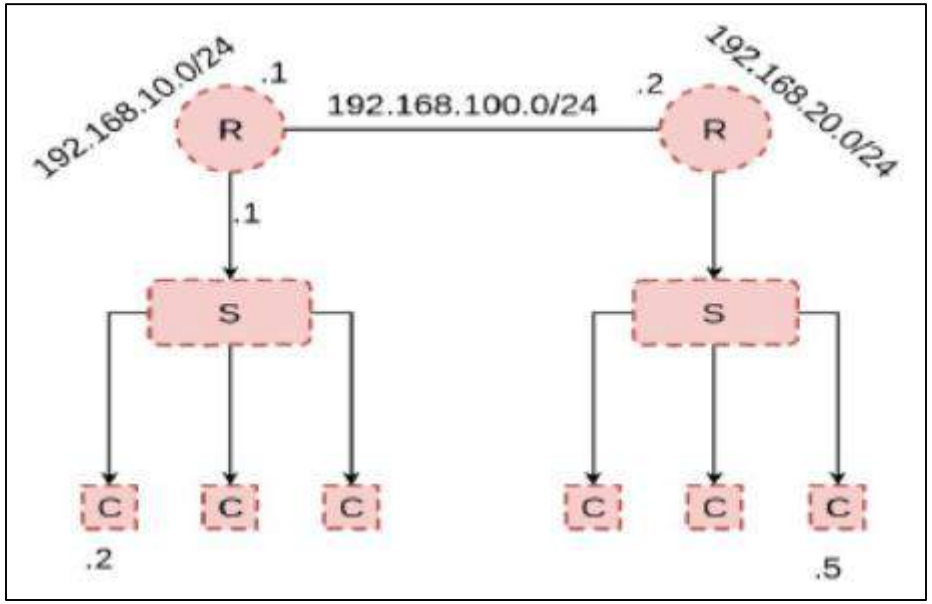
```
Tracing route to 192.168.20.5 over a maximum of 30 hops

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

  1      2 ms       3 ms       2 ms       192.168.10.1

  2     75 ms      83 ms      88 ms       192.168.100.2

  3     73 ms      79 ms      93 ms       192.168.20.5
```



Thank You

COMPUTER NETWORKS

LAB4: Network Services

By:

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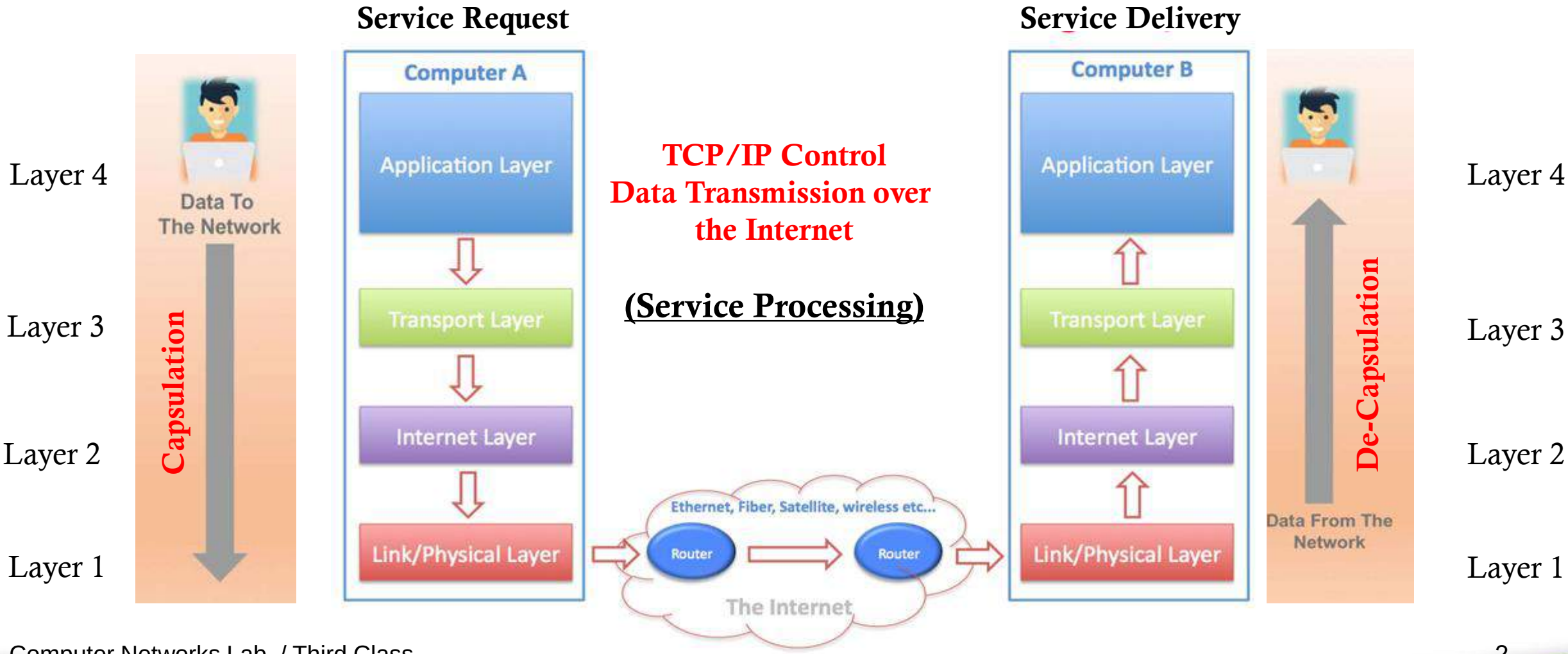
Third Class

TCP/IP Model
(Transmission Control Protocol/Internet Protocol)



Network Services

- Web Browser
- E-Mail
- File sharing
- Instant messaging
- Online game
- Printing
- DNS
- Voice over IP
- Video on demand
- Video telephony , etc….

Port no.

⇒ Port no. are used to identify which service the server provide to the requesting client

⇒ **For each service => port number**

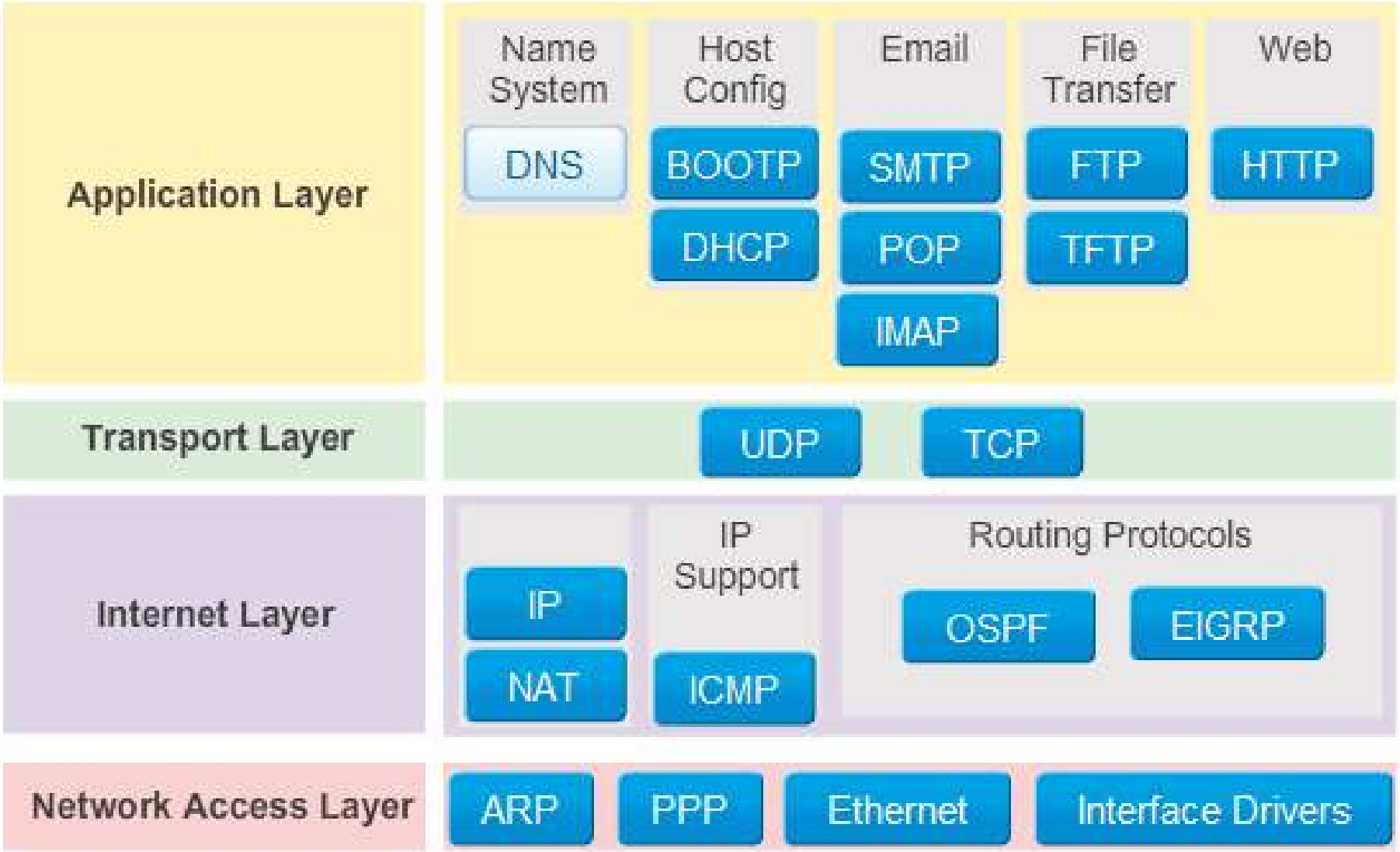
⇒ In transport layer

⇒ The port number uses **16** bits => **(2^16)** => The range = (**0 - 65,535**)

Port no. Range	Port Types
0 - 1023	well known applications
1024 - 49151	registered ports
49152 - 65,535	Dynamic or private ports

Well Known Applications

Service	Port no.	Protocol
Files : Transfer Files over the Internet	20/21	**F**ile **T**ransfer **P**rotocol (**FTP**)
Remotely access : Establish a secure connection bet. a remote server and computer (encryption), create/delete/browse/ transfer files-folders, start/stop service.	22	**S**ecure **Sh**ell (**SSH**)
Remotely access : Establish a connection between a remote server and computer (manage device remotely by CLI)	23	**T**erminal **net**work (**Telnet**)
Email : Deliver email messages successfully and securely	25	**S**imple **M**ail **T**ransfer **P**rotocol (**SMTP**)
Name System : Link the host names to their respective IP Addresses	53	**D**omain **N**ame **S**ystem (**DNS**)
Host Configuration : assign IP Address to the Hosts automatically	67/68	**D**ynamic **H**ost **C**onfiguration **P**rotocol (**DHCP**)
Web : Establish a connection between the webpages and the browser	80	**H**ypertext **T**ransfer **P**rotocol (**HTTP**)
Web : Establish a secure connection between webpages and browser (encryption)	443	**H**ypertext **T**ransfer **P**rotocol **S**ecure (**HTTPS** => HTTP+SSL)


Application Layer
Name System
DNS
Host Config
BOOTP
DHCP
Email
SMTP
POP
IMAP
File Transfer
FTP
TFTP
Web
HTTP
Transport Layer
UDP
TCP
Internet Layer
IP
NAT
IP Support
ICMP
Routing Protocols
OSPF
EIGRP
Network Access Layer
ARP
PPP
Ethernet
Interface Drivers

DNS

- **D**omain **N**ame **S**ystem
- **It's a service allowed to use Domain Name or Hostname instead of IP address**
- **more than 1 DNS server =>**
  - Balance the load of the network
  - Speed
  - Prevent the halt of the network if one DNS server crashes

  Ex./ Primary DNS server address : 8.8.8.8

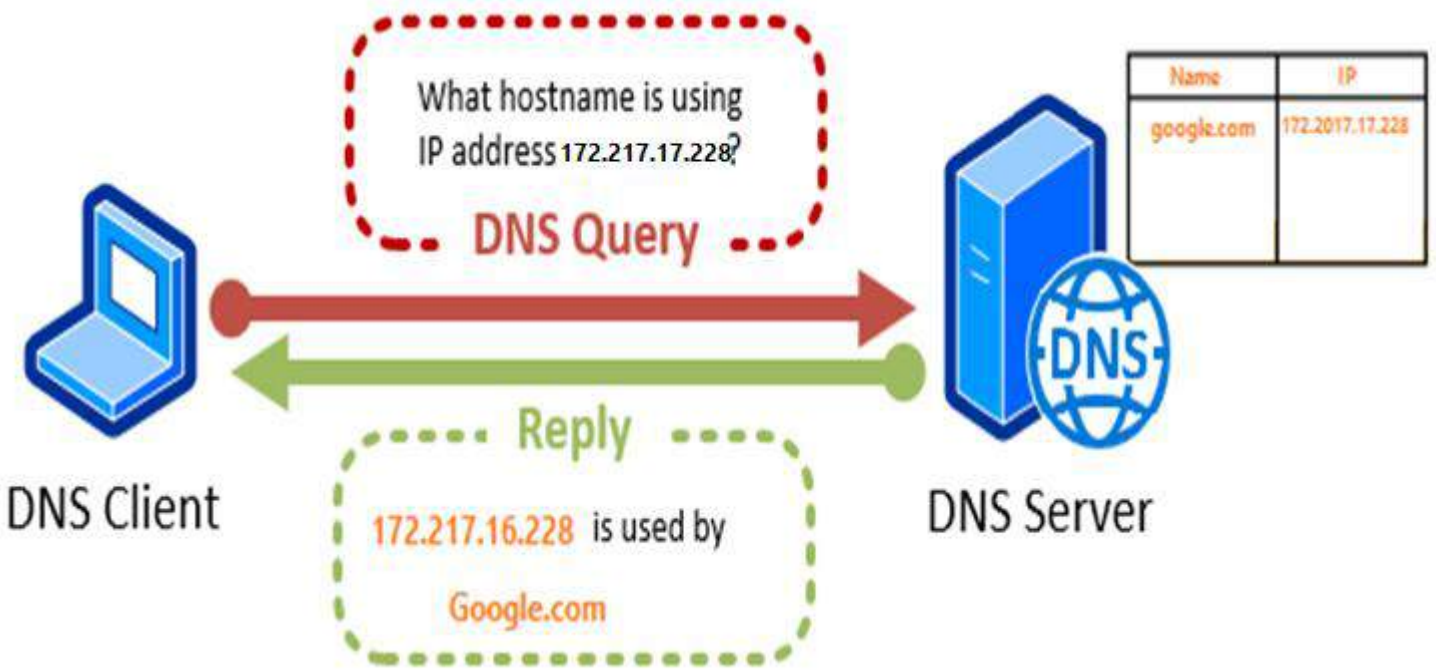
  Alternate DNS server address : 8.8.4.4

DNS

– **Ex./ Ping www.Google.com or Ping 172.217.17.228**

Domain	Stand for
com	commercial
edu	education
org	organization
gov	government
info	information
net	network

DNS service => DNS server => DNS protocol



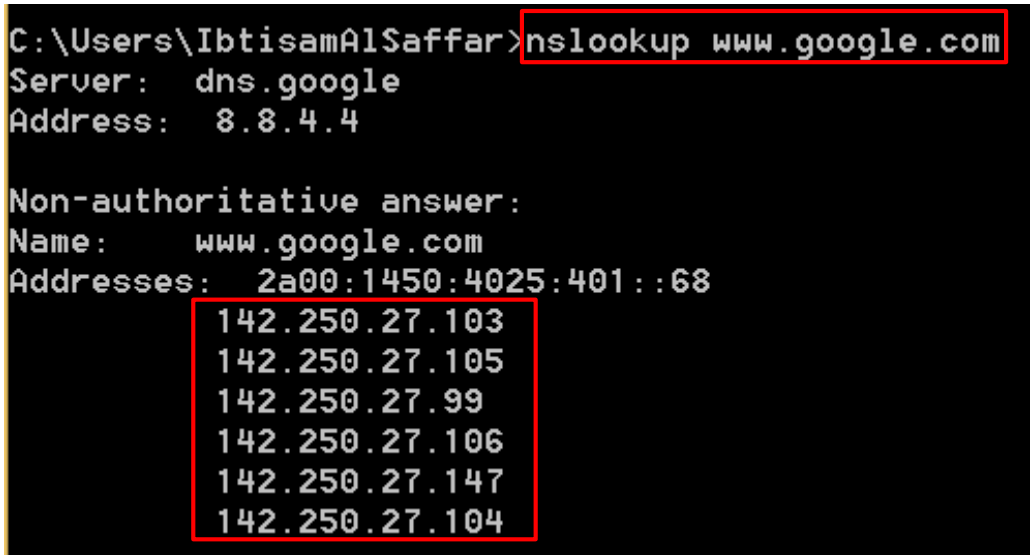
DNS Record Types	
Record	**Description**
NS:	Nameserver record
A:	Address record
HINFO:	Host Information record
MX:	Mail Exchange record
TXT:	Text record
CNAME:	Canonical Name record
SOA:	Start of Authority record
RP:	Responsible Person record
PTR:	Point of inverse lookups record
SRV:	Service location record

NSLOOKUP

- Domain Name (Host name) => IPs
- nslookup <hostname> <server>

  Ex./ nslookup www.google.com

  DNS Server address : 8.8.8.8 or 8.8.4.4



```
C:\Users\IbtisamAlSaffar>nslookup yahoo.com
Server:  dns.google
Address:  8.8.8.8

Non-authoritative answer:
Name:    yahoo.com
Addresses:  2001:4998:c:1023::5
          2001:4998:58:1836::11
          2001:4998:58:1836::10
          2001:4998:44:41d::4
          2001:4998:c:1023::4
          2001:4998:44:41d::3
          98.138.219.232
          98.137.246.7
          72.30.35.10
          98.138.219.231
          72.30.35.9
          98.137.246.8
```

```
C:\Users\IbtisamAlSaffar>nslookup www.facebook.com
Server:  dns.google
Address:  8.8.4.4

Non-authoritative answer:
Name:    star-mini.c10r.facebook.com
Addresses:  2a03:2880:f11c:8083:face:b00c:0:25de
          31.13.92.36
Aliases:  www.facebook.com
```

```
C:\Users\IbtisamAlSaffar>nslookup uobaghdad.edu.iq
Server:  dns.google
Address:  8.8.4.4

Non-authoritative answer:
Name:    uobaghdad.edu.iq
Addresses:  2606:4700:3034::ac43:bba8
          2606:4700:3033::681b:a698
          2606:4700:3036::681b:a798
          104.27.167.152
          104.27.166.152
          172.67.187.168
```

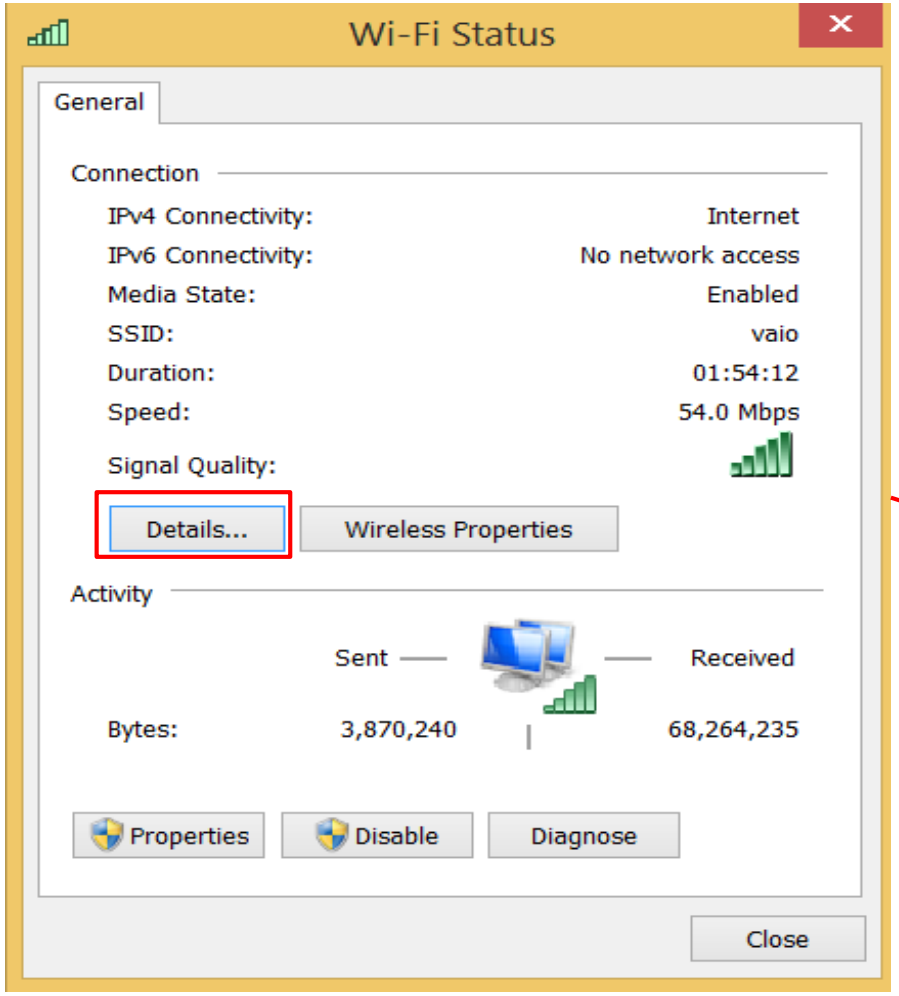
Display DNS Server IP

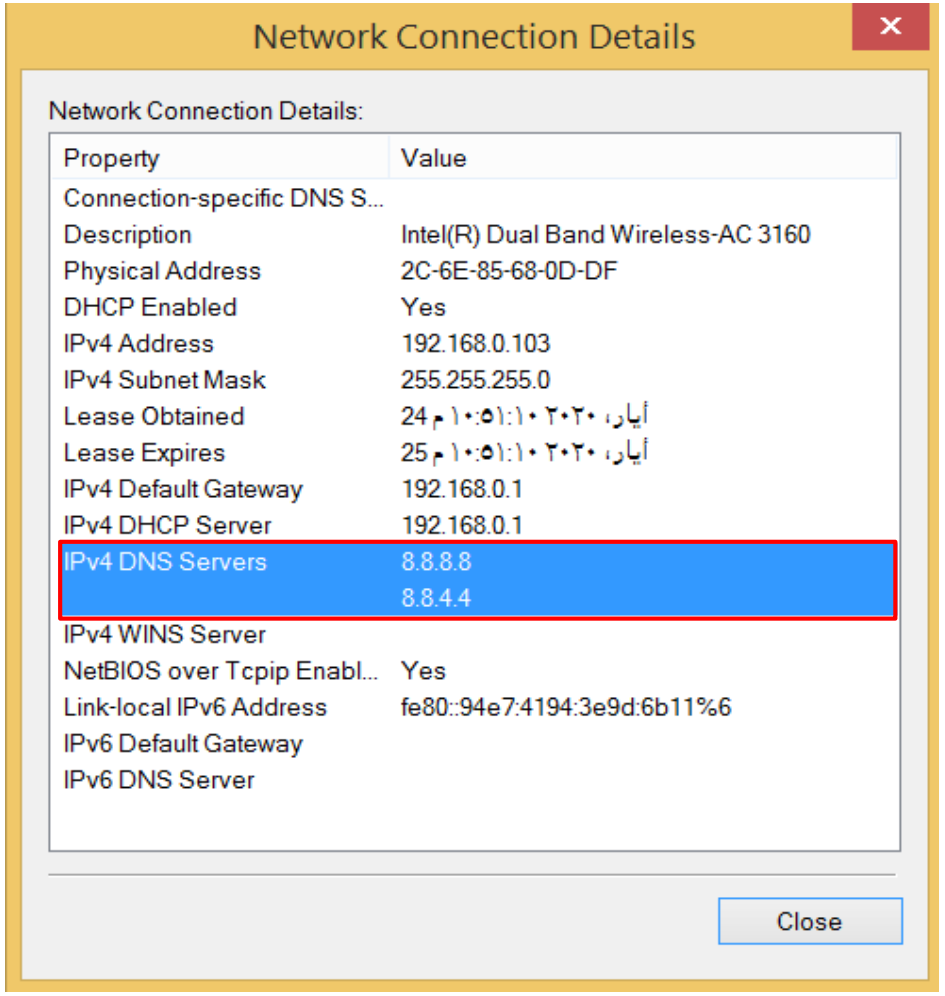
1. **GUI**

   ⇒ Network connection (Windows)

2. **CLI**

   ⇒ Start => Run => cmd => ipconfig





IPCONFIG

- Display information about your PC during connect to the net like ip, mask, default gateway and **DNS** ,etc..
- **ipconfig /? => Help**
- **ipconfig**
- **ipconfig /all**
- **ipconfig /release**
  - To release the IP address back to DHCP pool
- **ipconfig /renew**
  - To get a new IP address from the DHCP pool

- **ipconfig /all**

```
Wireless LAN adapter Wi-Fi:

   Connection-specific DNS Suffix  . :
   Description . . . . . . . . . . . : Intel(R) Dual Band Wireless-AC 3160
   Physical Address. . . . . . . . . : 2C-6E-85-68-0D-DF
   DHCP Enabled. . . . . . . . . . . : Yes
   Autoconfiguration Enabled . . . . : Yes
   Link-local IPv6 Address . . . . . : fe80::94e7:4194:3e9d:6b11%6(Preferred)
   IPv4 Address. . . . . . . . . . . : 192.168.0.104(Preferred)
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Lease Obtained. . . . . . . . . . : 21 ÜñƒÑ, 2020 11:06:47 ¡
   Lease Expires . . . . . . . . . . : 22 ÜñƒÑ, 2020 11:06:47 ¡
   Default Gateway . . . . . . . . . : 192.168.0.1
   DHCP Server . . . . . . . . . . . : 192.168.0.1
   DHCPv6 IAID . . . . . . . . . . . : 103575173
   DHCPv6 Client DUID. . . . . . . . : 00-01-00-01-22-20-00-B5-1C-39-47-B6-9B-ED

   DNS Servers . . . . . . . . . . . : 8.8.4.4
                                       8.8.8.8
                                       192.168.100.1
   NetBIOS over Tcpip. . . . . . . . : Enabled
```

- Windows caches the DNS servers information
  - **ipconfig /displaydns => display the contents of DNS cache**
  - **ipconfig /flushdns => delete the contents of DNS cache**
- **Socket** is the name given to the [IP + port no.]
  - IP : port
  - Ex./ 192.168.10.10:**80** => web browser service (http)

Thank You

COMPUTER NETWORKS

LAB5: MAC Address

By:

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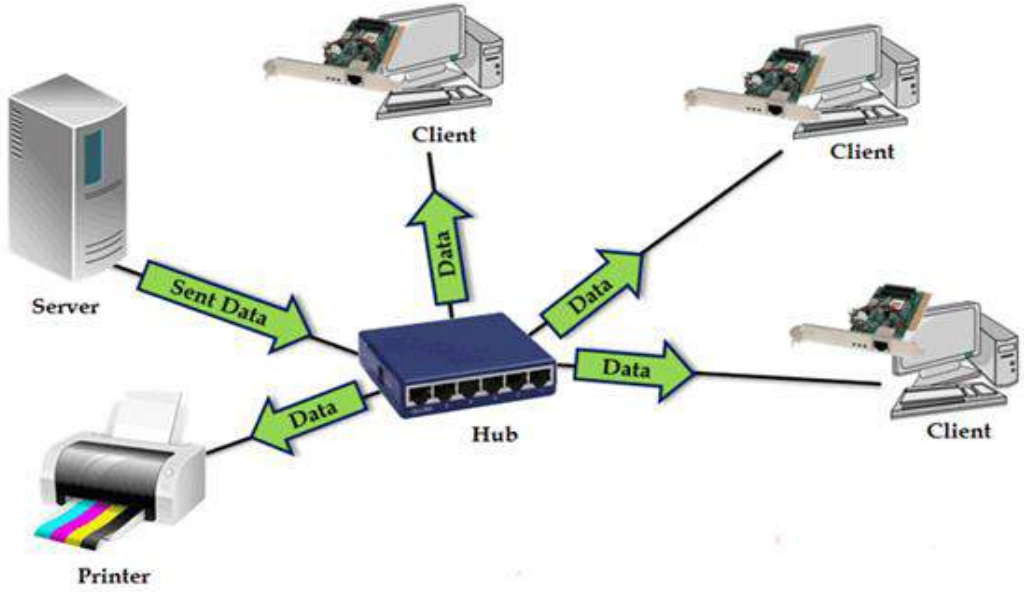
Third Class

Hub

- plug and play
- 4 ,8,16 ports
- Layer 1 device => Physical Layer (OSI model)
- Not intelligent device : Direct Data to all Hosts

  not to a specific destination

- **Hub Types:**
  - Passive
  - Active : Repeater



Switch

- Layer 2 device => Data Link Layer **or** multilayer => router and switch at the same time
- Smart device : Direct message to the dest. Host (MAC Table)
- **Ethernet Switch (LAN Switch) Categories :**
  - **Fixed** : fixed number of ports (not flexible , cheap)
    - Unmanaged => plug and play
    - Managed => Partially M. (smart switch) and Fully M. (enterprise switch)

    Ex./ 5,8,10,16, 24,28, 48 ,52 ports
  - **Modular** : add expansion modules (flexible ,expensive)

    Ex./ expansion modules are application-specific (such as firewall, wireless or network analysis) and modules for additional interfaces, power supplies, or cooling fans

Standalone Switch

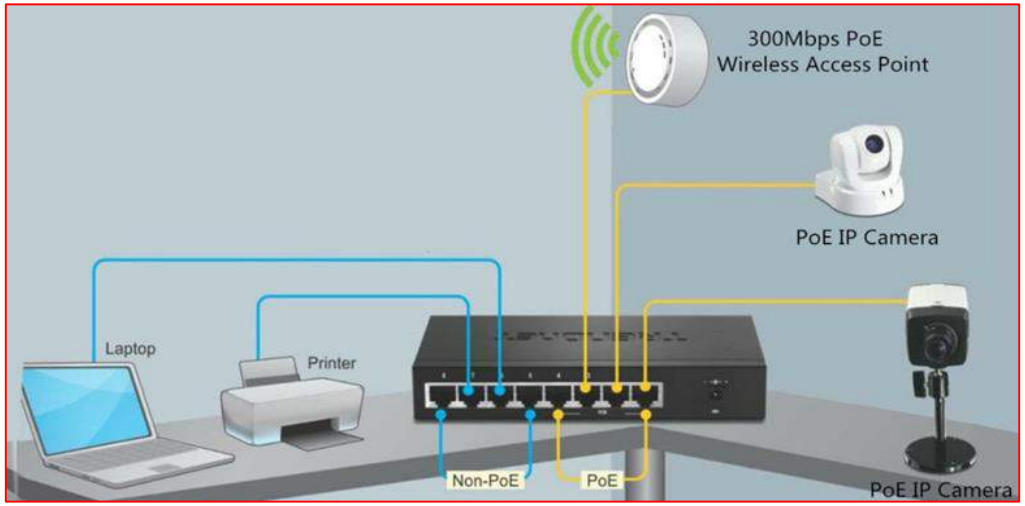
Stackable Switch

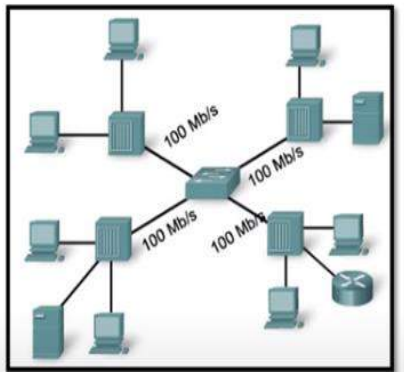
Multiple standalone => as one switch

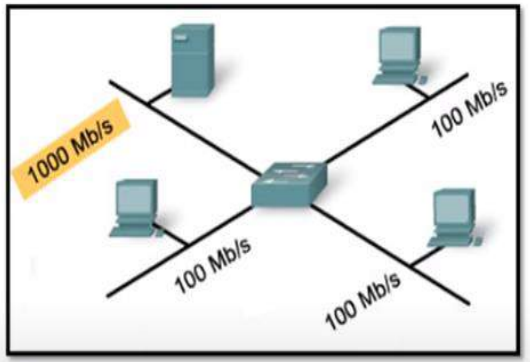
- **Switching Methods**
  - **Store and forward : S. & F.** frame after checking error (CRC)
  - **Cut through** (direct frame forward without check error)

- **Symmetric and Asymmetric switching ports** **(**same or different Data transfer Rate)
- **PoE and not PoE** **(Power over Ethernet)**
  - **not POE** => port => transfer Data only ex./printer
  - **POE** => port => transfer Data + Power to the device

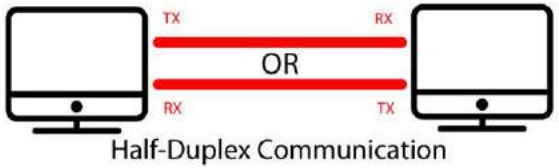
ex./camera







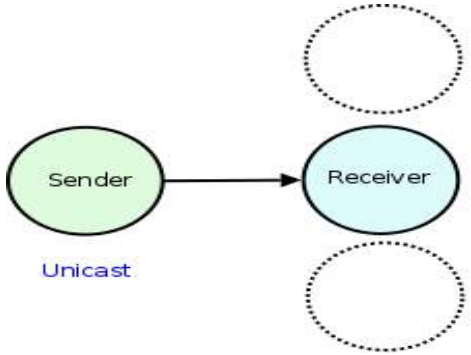
- **Transmission Types**
  - **Half Duplex** (port => send **or** receive data at a time)
  - **Full Duplex** (port => send **and** receive at the same time)

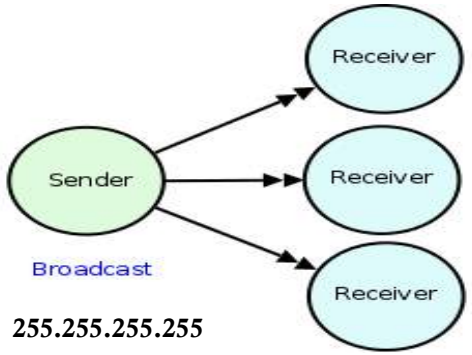


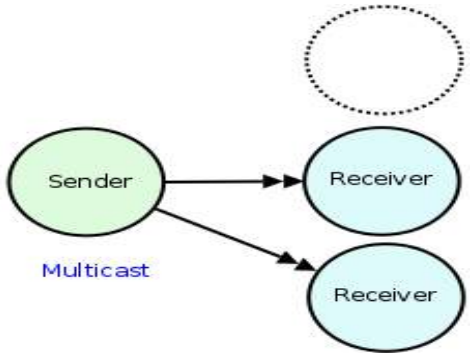
Half-Duplex Communication

Full-Duplex Communication

- **Communication Types**
  - **UniCast** => 1:1 => 1 sender : 1 receiver
  - **BroadCast** => 1:All => 1 sender : All receivers
  - **MultiCast** => 1:M => 1 sender : many receivers







MAC Address

- Physical address (Hardware Address)
- Stands for **M**edia **A**ccess **C**ontrol
  - Used in layer 2 (Data Link Layer) in OSI model
  - **6 bytes = 48 bits**, each byte 2 digit, digit = 4 bit , Hexadecimal
  - separated by a hyphen(**-**) or a colon(**:**) or a dot(**.**)
- For Example: Broadcast MAC Add.
  - FF:FF:FF:FF:FF:FF or FF-FF-FF-FF-FF-FF or FFFF.FFFF.FFFF

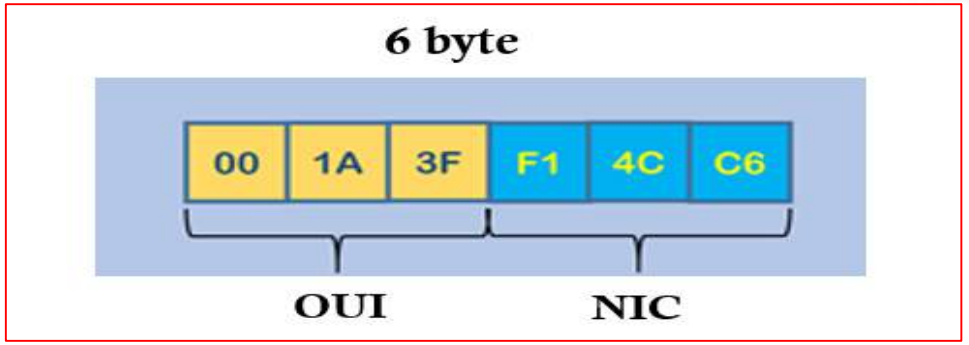
    or FFFFFF.FFFFFF or FFFFFF-FFFFFF or FFFFFFFFFFFF

- **MAC Address**

  is a Network Card number

  consist of 2 parts as :

  - **OUI** : **O**rganization **U**nique **I**dentifier
  - **NIC** : **N**etwork **I**nterface **C**ard (**C**ontroller)
    - LAN Card = Ethernet NIC
    - Wireless NIC (Wireless Connection ex./ Wi-Fi)



- **Display Mac Address**
  - **GUI (windows) => Network Connection**
  - **CLI => Start => Run => cmd => ipconfig /all**

MAC Table

- **Switch => Switch Table** or **MAC Table** or

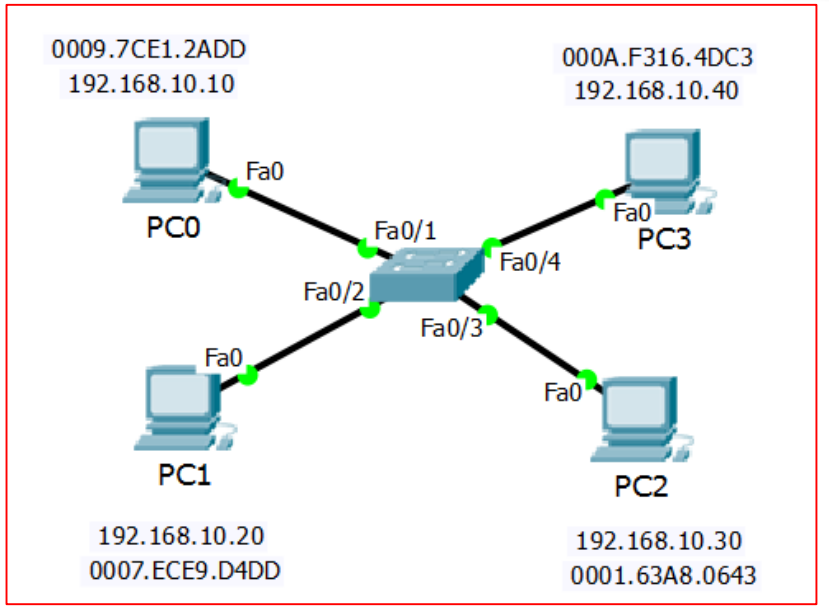
  CAM (Content Addressable Memory) **Table**

- **CAM Table** : **Mac** address for each device **+ port no.**

- **Fa**= **Fa**stethernet 0/1 .. Fastethernet 0/24

  Data Transfer Rate for the port=10/100 Mbps

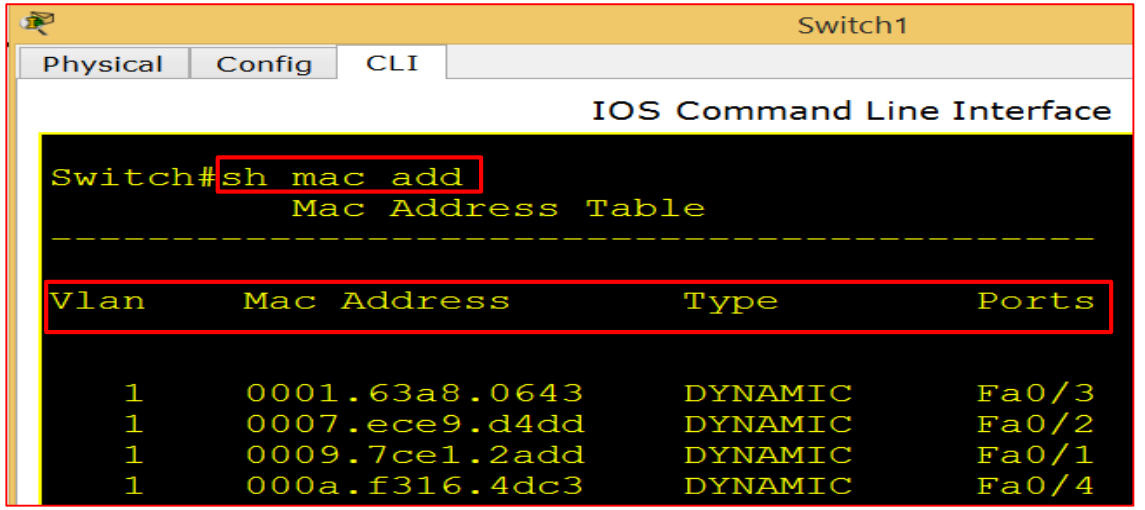
  Slot no. **Port no.**



- **Display Switch MAC Address Table**

  Click on Switch1=> CLI

  sh mac add = **sh**ow **mac add**ress-table



ARP

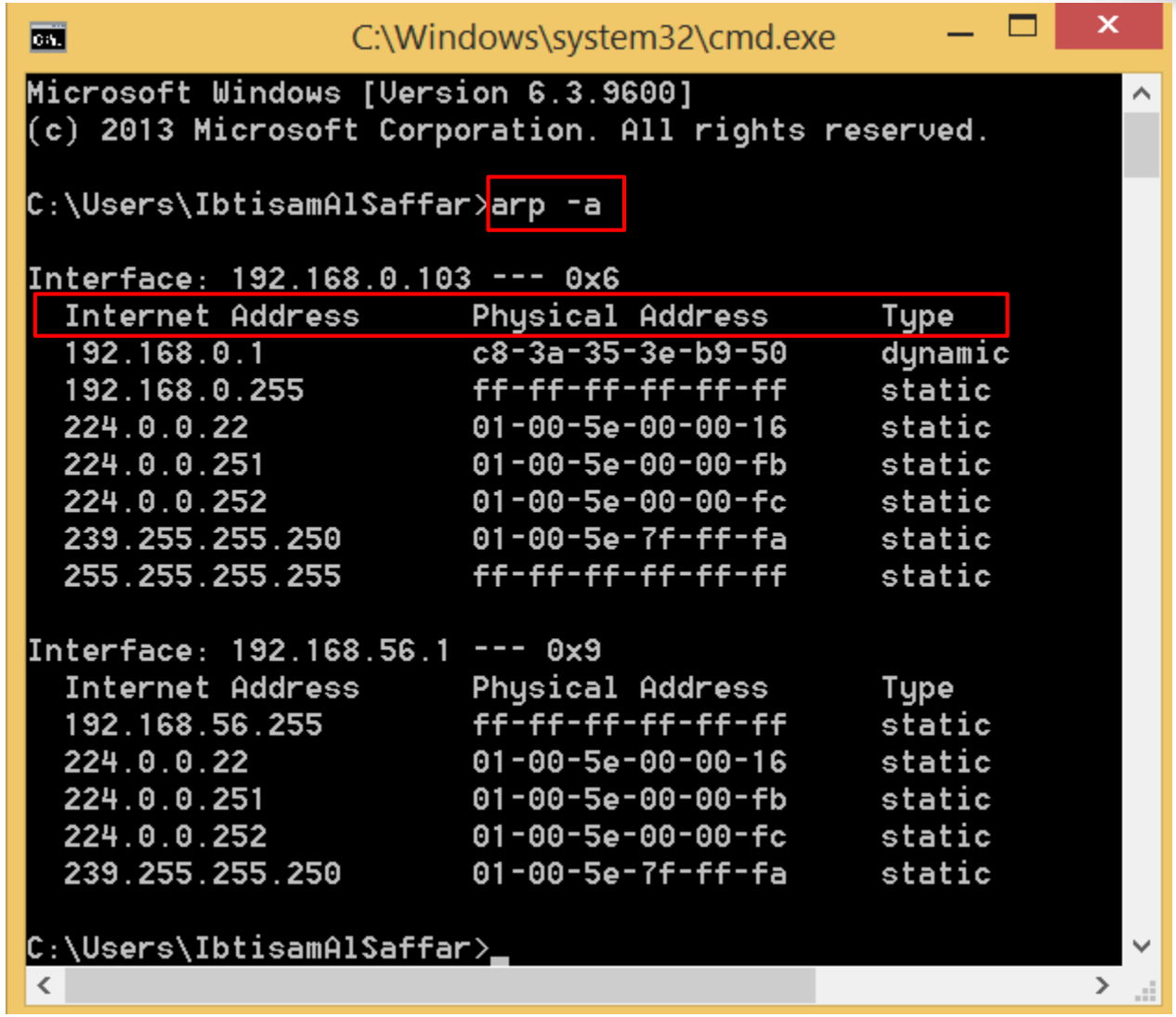
- **Address Resolution Protocol (Layer 2 protocol)**
- It has an ARP cache (Table) which contains the MACs of all devices in a subnet
- The cache can be either filled
  - Statically (manually)
  - Dynamically (by the ARP)
- The source sends an ARP Request **Broadcast MAC Add. FFFF.FFFF.FFFF** (it is picked by all the devices) with specific dest. IP
- The device which has that IP replies with an ARP reply (Unicast, because it is one device which replies) to return it's MAC add.

- **arp -a =>** display the ARP table
- **arp -d =>** deletes the ARP table
- **arp -s <IP address> <MAC address>**

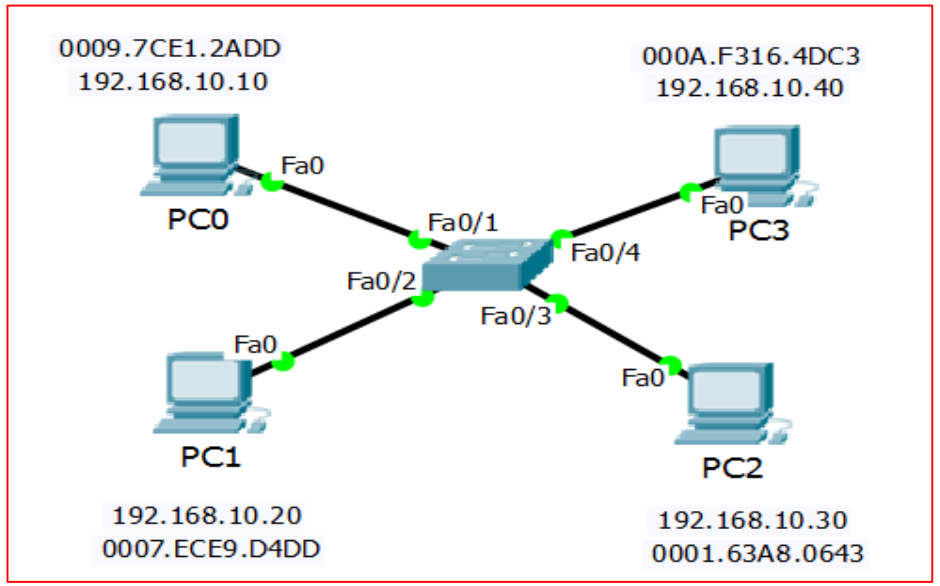
=> To set a MAC address manually for a device

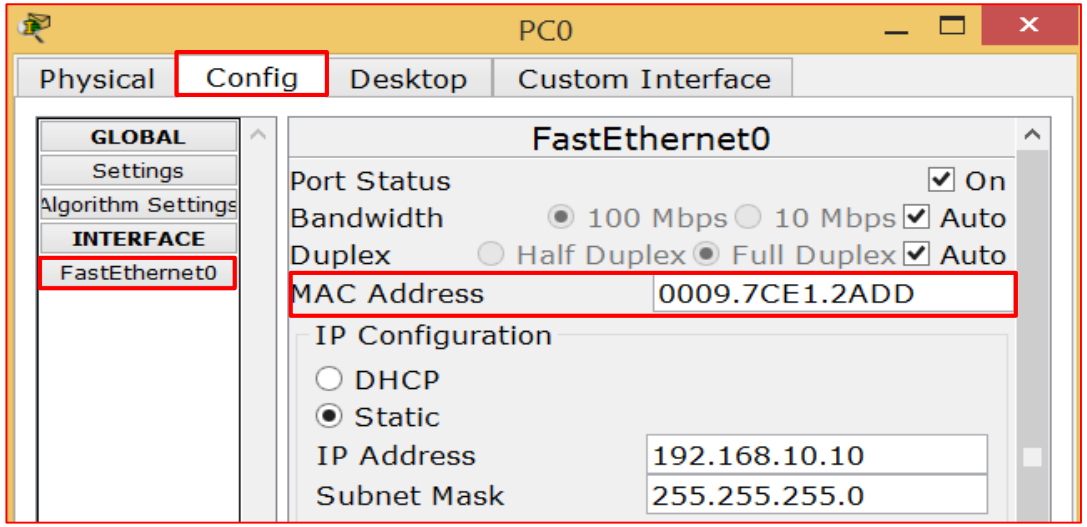
Ex:/ arp -s 192.168.10.12 B2-FD-0F-11-A2-C3

=> Add the Host IP add. 192.168.10.12 with it's MAC Add. B2-FD-0F-11-A2-C3 to the ARP cache statically (manually)



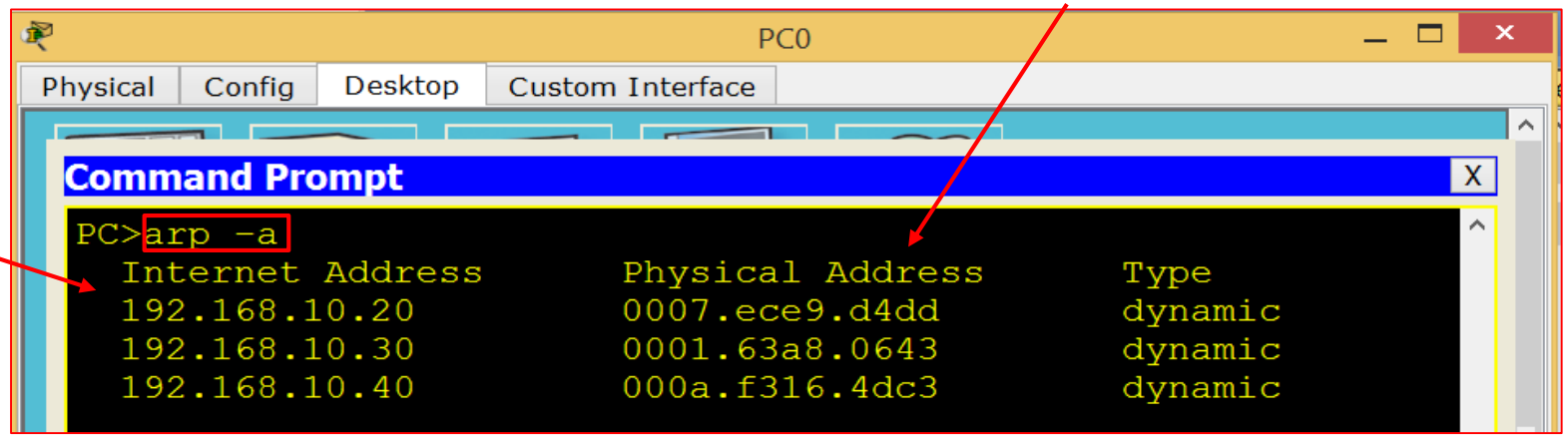
- PC0 => **ping** PC1,PC2,PC3
- PC0 => **arp -a**





MAC Add.

Dest. IP Add.



Thank You

COMPUTER NETWORKS

LAB6: Netstat (Network Statistics)

By:

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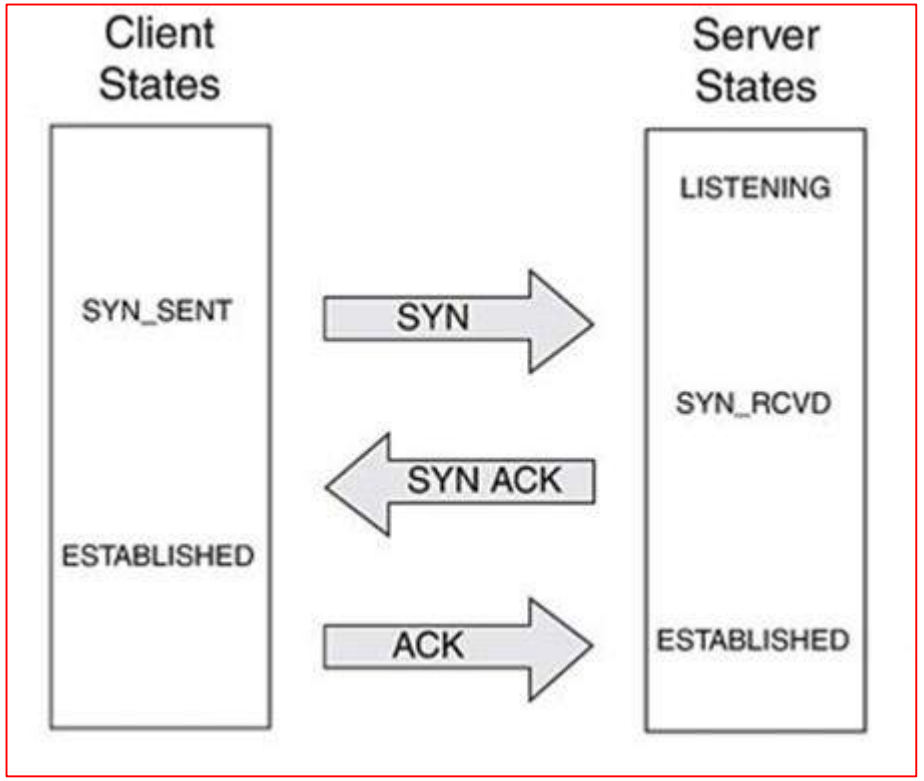
Computer Department

Third Class

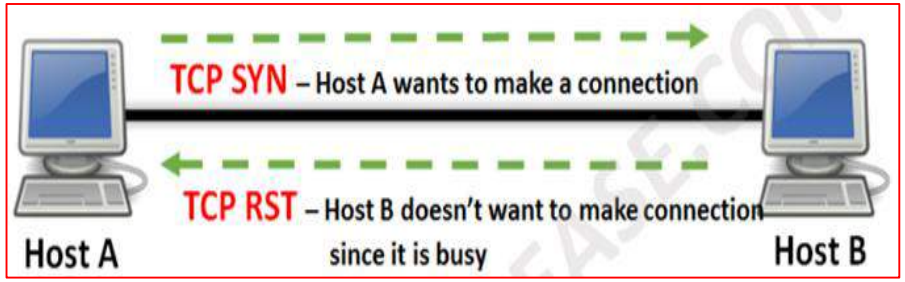
Transport Layer

- **is end-to-end** connection between the sender and receiver before transmitting any data
- The major protocols are:
  - **TCP** : **T**ransmission **C**ontrol **P**rotocol
  - **UDP** : **U**ser **D**atagram **P**rotocol
- **TCP Connection**
  - Open Connection => Established (**3 way handshake)**
    - SYN (Synchronize)
    - SYN + ACK (Acknowledgment)
    - ACK
  - Transfer Data
  - End Connection => Closed

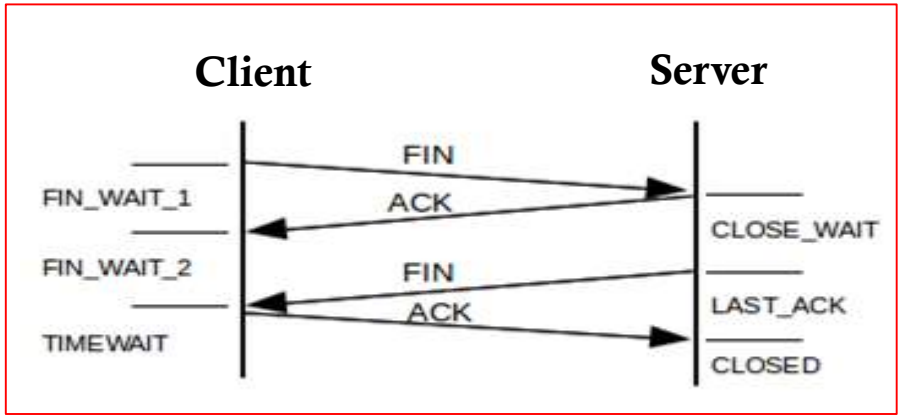
Open Connection



Reset Connection



Close Connection



TCP	UDP
Reliable	Unreliable
Connection oriented (3 way handshake)	Connectionless
Slower (Delay)	Speed
Acknowledgment	-
Sequence no. (reorder : sort segments in the right order)	-
Windowing (Flow Control) => Dest. Window size	-
Error Handling (resend if lost)	-
High Overhead	Low Overhead
Text	VoIP, Video

Netstat

Netstat = **Net**work **Stat**istics

=> display *very* detailed information about network active connections, protocol-specific statistics

=> help troubleshoot certain kinds of networking issues.

- **Proto =>** protocol that is used to establish the connection (either **TCP** or **UDP**)

Socket => IP : Port no

- **Local Address =>** The IP address and port number of the **source** computer try to establish a connection.
- **Foreign Address =>** The IP address and port number of the **destination** (remote) computer .
- **State =>** connection state :
  - **Established =>** The session is established between the source and destination
  - **Close_wait =>** The remote end has shut down, waiting for the socket to close.
  - **Time_wait =>** The socket is waiting after close to handle packets still in the network.

- **Netstat /?**
- **Netstat**
- **Netstat -a** => Displays **a**ll active connections (protocol, local add., foreign add., state)
- **Netstat -e** => Displays **e**thernet statistics

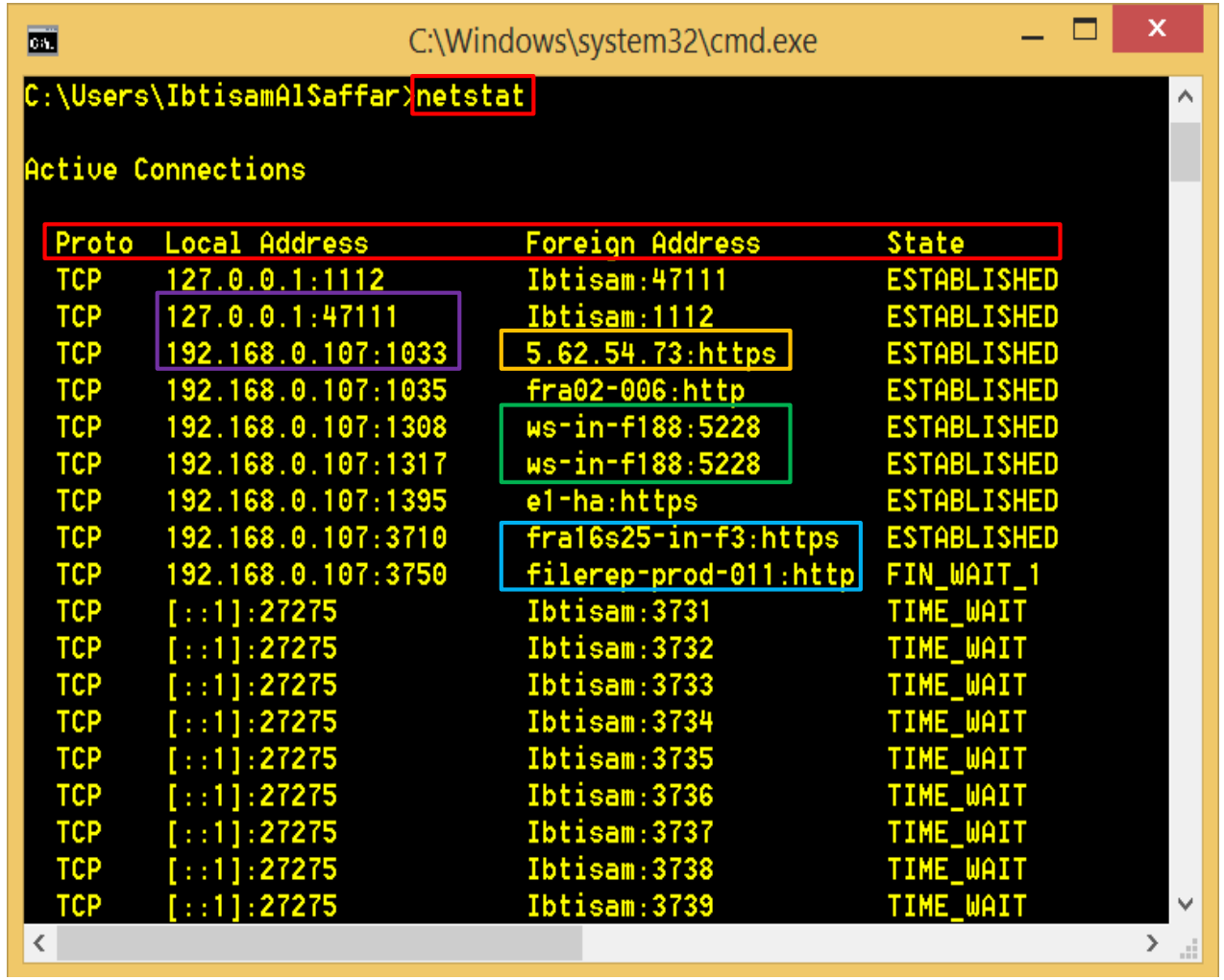
Socket => IP : Port no

Socket => Domain name : Protocol name

Socket => Domain name : Port no

Socket => IP : Protocol name

Loopback Address : 127.0.0.1



- **Netstat –n**

Socket => IP : Port no

⇒ Displays addresses and port numbers in numerical form .

⇒ **ex./ http => 80 , https => 443**

```
C:\Users\IbtisamAlSaffar>netstat -n

Active Connections

  Proto  Local Address          Foreign Address        State
  TCP    127.0.0.1:2735         127.0.0.1:3285         ESTABLISHED
  TCP    127.0.0.1:3285         127.0.0.1:2735         ESTABLISHED
  TCP    192.168.0.105:3310     5.62.54.89:80          ESTABLISHED
  TCP    192.168.0.105:3329     77.234.45.60:80        ESTABLISHED
```

- **Netstat –p** proto => display information about a specific protocol

```
C:\Users\IbtisamAlSaffar>netstat -p tcp

Active Connections

  Proto  Local Address          Foreign Address        State
  TCP    127.0.0.1:1096         Ibtisam:7824           ESTABLISHED
  TCP    127.0.0.1:7824         Ibtisam:1096           ESTABLISHED
  TCP    192.168.0.105:1032     5.62.54.42:https       ESTABLISHED
  TCP    192.168.0.105:1174     prg16-007:http         ESTABLISHED
```

- **Netstat –s**

  => Displays **s**tatistics for :

  - IP ,IPv6 (Packet)
  - ICMP, ICMPv6 (Message)
  - TCP, TCPv6, UDP, and UDPv6 (Segment)

  Ex./ send, received (discard, delivered),error

- **Netstat –f** => display **f**ully Qualified domain name for foreign addresses

```
C:\Users\IbtisamAlSaffar>netstat -f

Active Connections

  Proto  Local Address          Foreign Address        State
  TCP    127.0.0.1:1096         Ibtisam:7824           ESTABLISHED
  TCP    127.0.0.1:7824         Ibtisam:1096           ESTABLISHED
  TCP    192.168.0.105:1032     5.62.54.42:https       ESTABLISHED
  TCP    192.168.0.105:1174     prg16-007.ff.avast.com:http  ESTABLISHED
```

⇒ **Netstat –s –p tcp** => statistic about TCP protocol

⇒ **Netstat –s –p tcp –f** => same as above with fully domain name for foreign addresses

```
C:\Users\IbtisamAlSaffar>netstat -s -p tcp

TCP Statistics for IPv4

  Active Opens                            = 1721
  Passive Opens                           = 9
  Failed Connection Attempts              = 178
  Reset Connections                       = 604
  Current Connections                     = 4
  Segments Received                       = 177476
  Segments Sent                           = 177285
  Segments Retransmitted                  = 3810

Active Connections

  Proto  Local Address          Foreign Address        State
  TCP    127.0.0.1:2735         Ibtisam:3285           ESTABLISHED
  TCP    127.0.0.1:3285         Ibtisam:2735           ESTABLISHED
  TCP    192.168.0.105:3310     5.62.54.89:http        ESTABLISHED
  TCP    192.168.0.105:3329     fra02-002:http         ESTABLISHED
```

```
C:\Users\IbtisamAlSaffar>netstat -s -p tcp -f

TCP Statistics for IPv4

  Active Opens                            = 1721
  Passive Opens                           = 9
  Failed Connection Attempts              = 178
  Reset Connections                       = 604
  Current Connections                     = 4
  Segments Received                       = 177486
  Segments Sent                           = 177292
  Segments Retransmitted                  = 3812

Active Connections

  Proto  Local Address          Foreign Address        State
  TCP    127.0.0.1:2735         Ibtisam:3285           ESTABLISHED
  TCP    127.0.0.1:3285         Ibtisam:2735           ESTABLISHED
  TCP    192.168.0.105:3310     5.62.54.89:http        ESTABLISHED
  TCP    192.168.0.105:3329     fra02-002.ff.avast.com:http  ESTABLISHED
```

Thank You

COMPUTER NETWORKS

LAB7: Wireshark

By:

Asst.Lec. Ibtisam A. Taqi

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Third Class

Wireshark

=> used for packet capture (PCAP) with detailed information about the connection and protocols

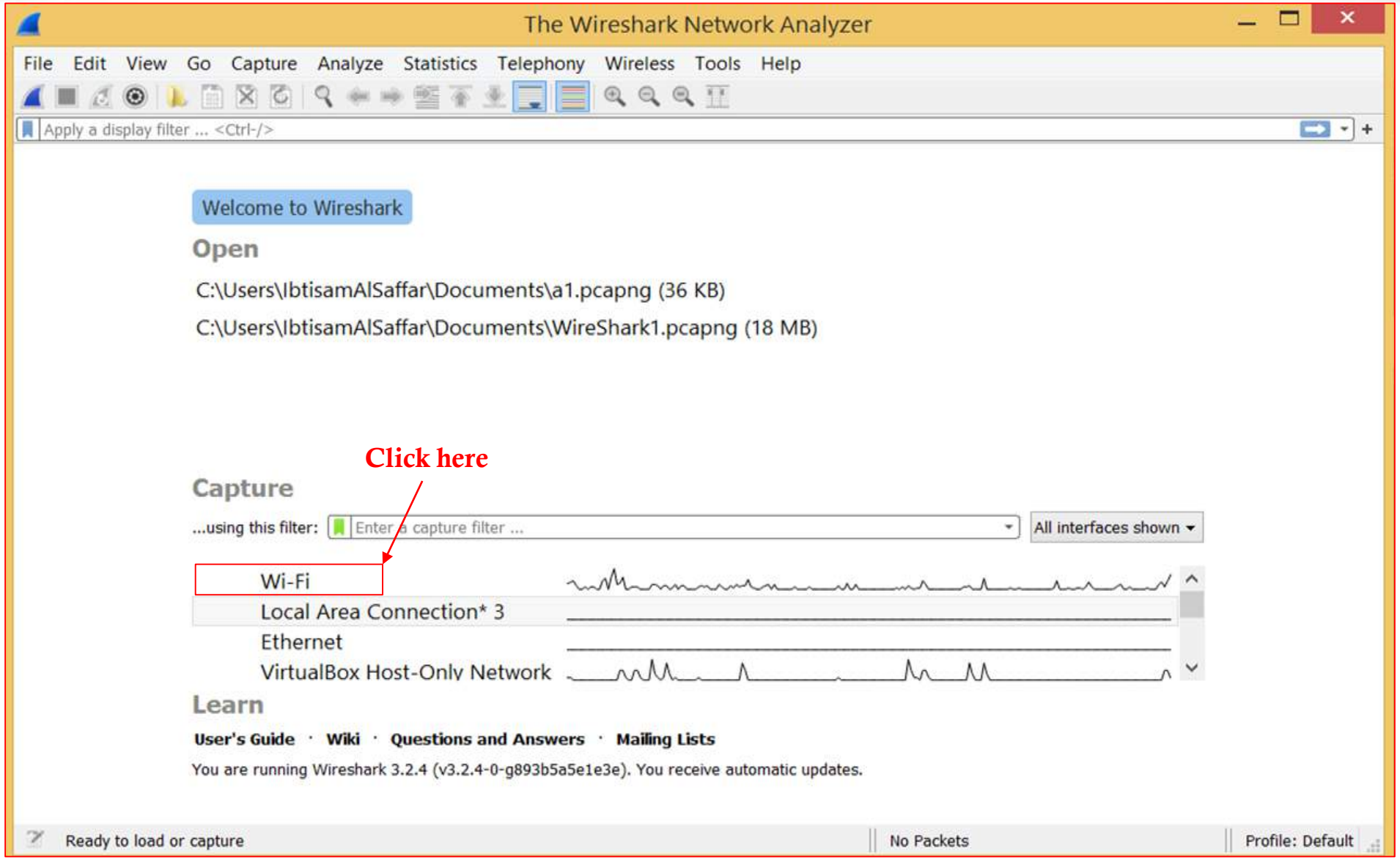
- Reading headers contents

=> It used by

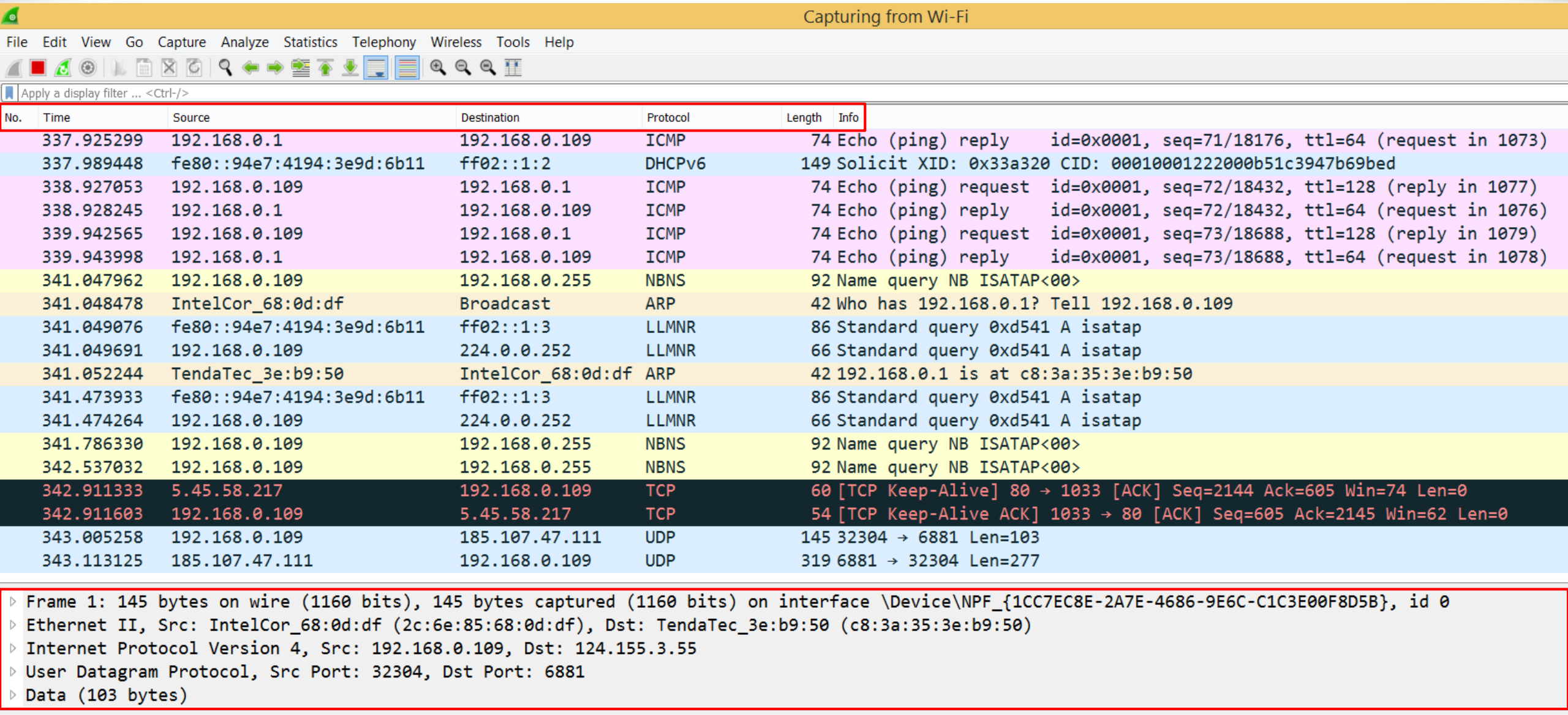
- Attackers
- Network Admins
- Educational Purposes

=> To protect data we can use

- Encryption
- Hashing (to prevent changing the data)

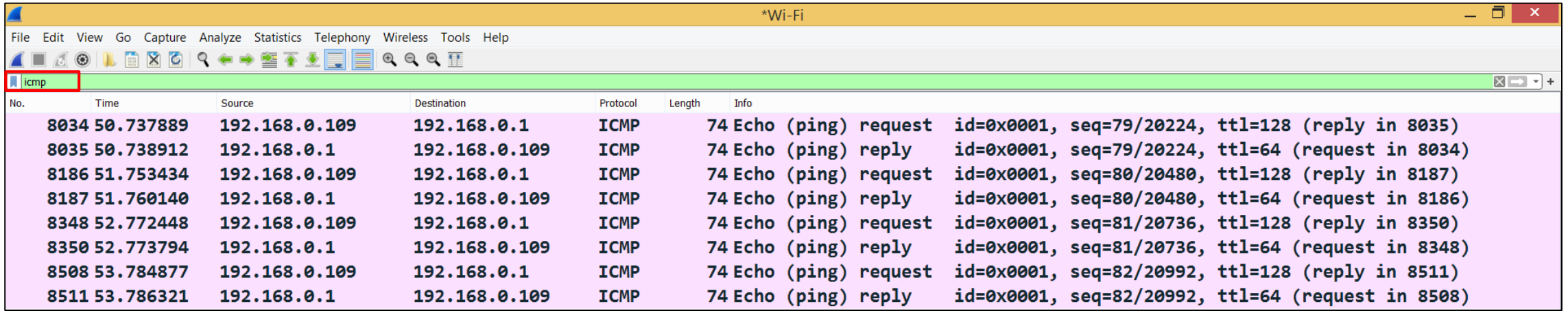

The Wireshark Network Analyzer
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Apply a display filter ... <Ctrl-/>
Welcome to Wireshark
Open
C:\Users\IbtisamAlSaffar\Documents\a1.pcapng (36 KB)
C:\Users\IbtisamAlSaffar\Documents\WireShark1.pcapng (18 MB)
Click here
Capture
...using this filter: Enter a capture filter ...
All interfaces shown
Wi-Fi
Local Area Connection* 3
Ethernet
VirtualBox Host-Only Network
Learn
User's Guide · Wiki · Questions and Answers · Mailing Lists
You are running Wireshark 3.2.4 (v3.2.4-0-g893b5a5e1e3e). You receive automatic updates.
Ready to load or capture
No Packets
Profile: Default

Wireshark.org => download

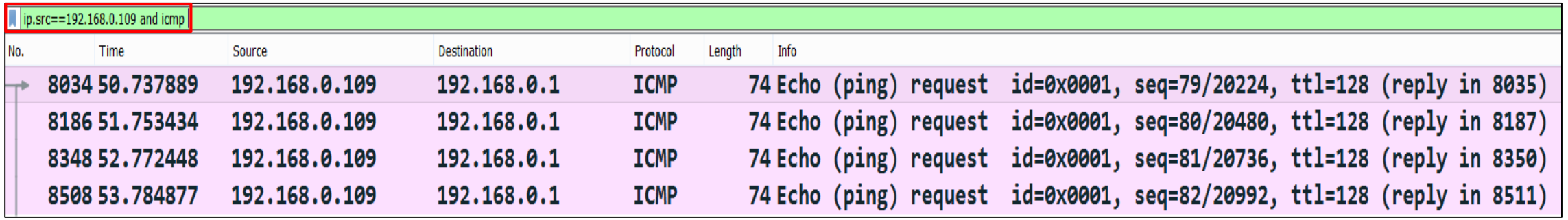


- **Filter** => The filter bar can be used to filter results depending on a certain criteria
  - **Protocol**
    - tcp, udp, arp, icmp, dns , http
    - **!**dns => **!** : Display all protocol information except DNS
    - http **or** icmp
    - tcp.port==80 , tcp.port==80 **||** udp.port==80 => **||**: or
    - **!**(tcp.port == 53)
  - **IP Address**
    - Source & destination => ip.addr == 192.168.0.109
    - Source => ip.src == 192.168.0.109
    - Destination => ip.dst == 192.168.0.109
  - **IP Address and Protocol**
    - ip.src == 192.168.0.109 **and** icmp

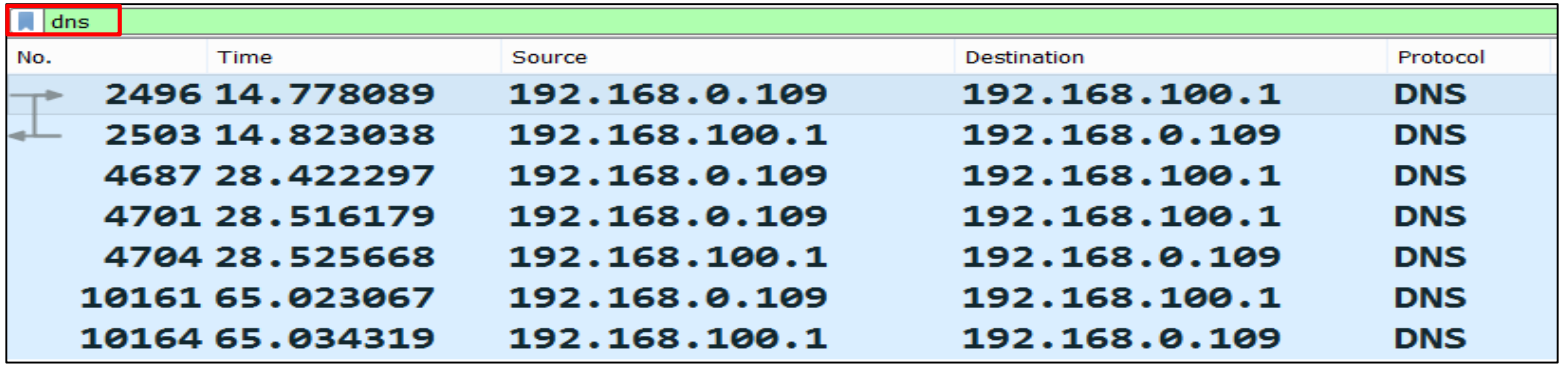
- Ex./ Filter by ICMP protocol : Display All Information about ICMP protocol
  - From My - PC => Ping 192.168.0.1
- We can follow the stream of a specific packet by right clicking on it and choosing (follow stream)



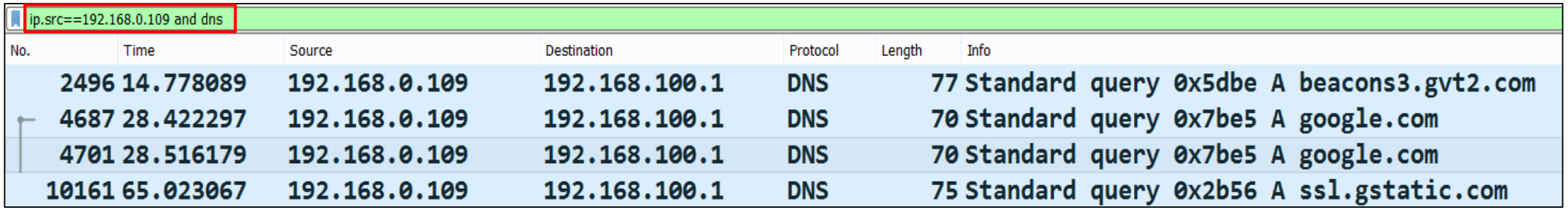
Ex./ Display All Information about ICMP protocol for the source ip (My - PC) = 192.168.0.109



Ex./ Filter by DNS protocol : Display All Information about DNS protocol



Ex./Display All Information about DNS protocol for the source ip (MY – PC) =192.168.0.109



Thank You

COMPUTER NETWORKS

LAB8

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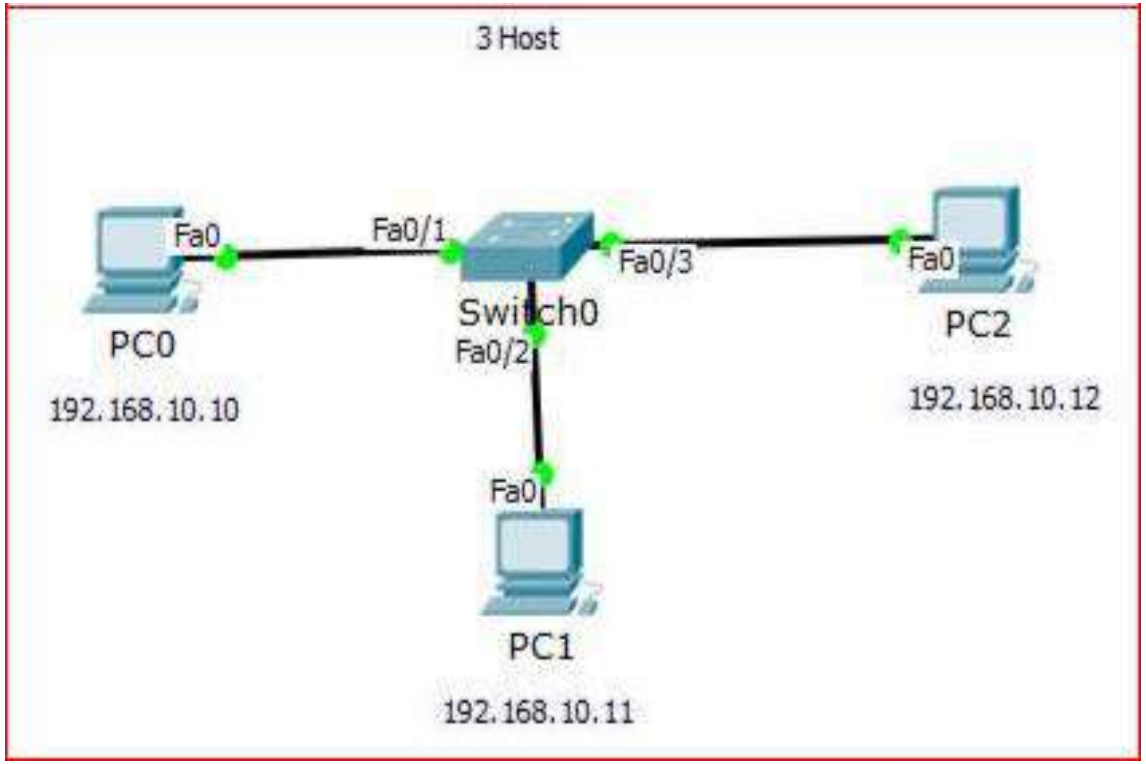
Third Class

Q1\ Draw the net. and then do the following:

1. Assign IPs to the Host **statically**.
2. Display the IP address for PC1 using **ipconfig** command
3. Check connectivity between PC0 and PC2 by using **ping** command bidirectional



Q2/ using (**Ping**) command to check your PC connectivity with the following website:

- **Telegram.com** with (5) echo messages.
- **Youtube.com** with (6) echo requests , (64) byte of data (message length)
- **Facebook.com** with infinity messages until stopped by using CTRL+C

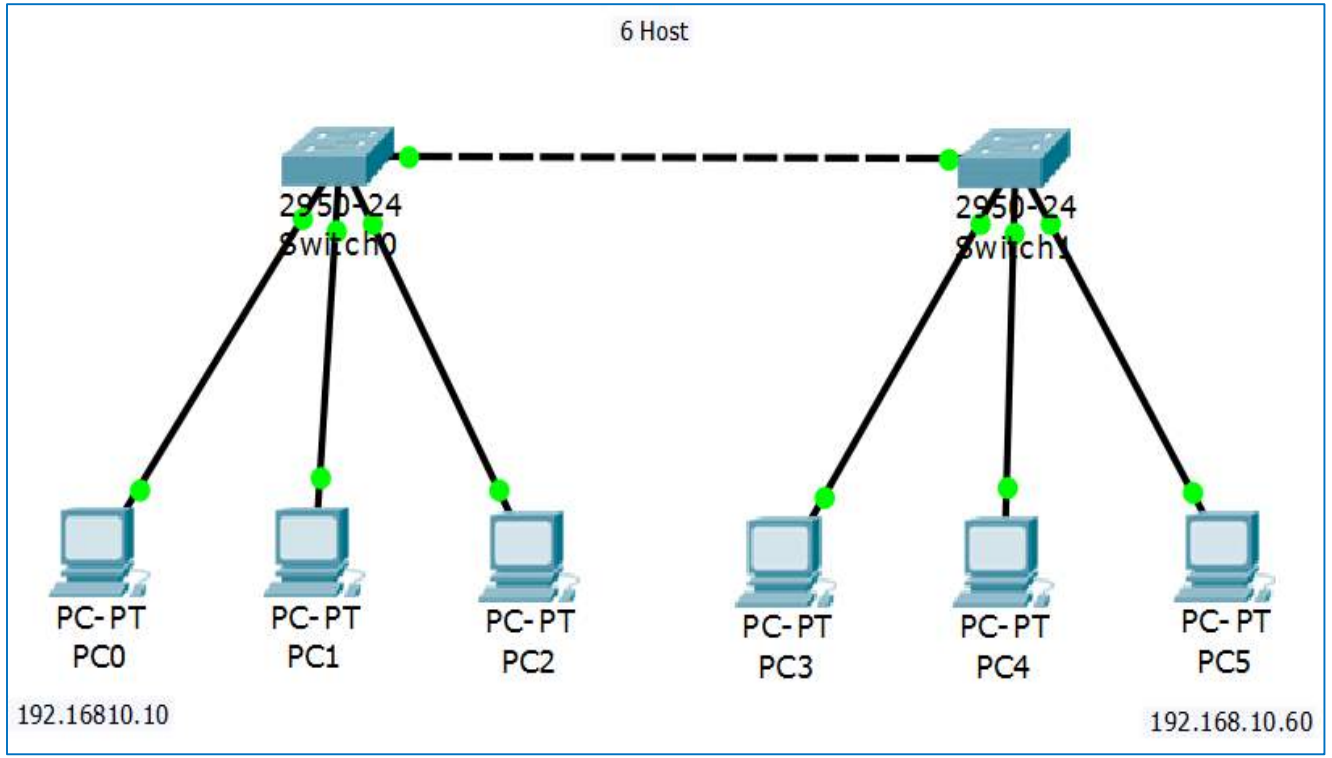
Q3/ using (**Tracert**) command to check route from your PC to

- **Uobaghdad.edu.iq**
- **Google.com**
- **Twitter.com**

Note: Using Ctrl+C to stop

Q4/By using **Packet Tracer** design the Topology below then check connectivity between **PC0 & PC5** using (**ping**) command as follows:

- Send 6 echo request.
- Send infinity echo request.



Thank you

COMPUTER NETWORKS

LAB9

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Third Class

Q1/ Display IPs allocated for the following websites by using (**nslookup**) command:

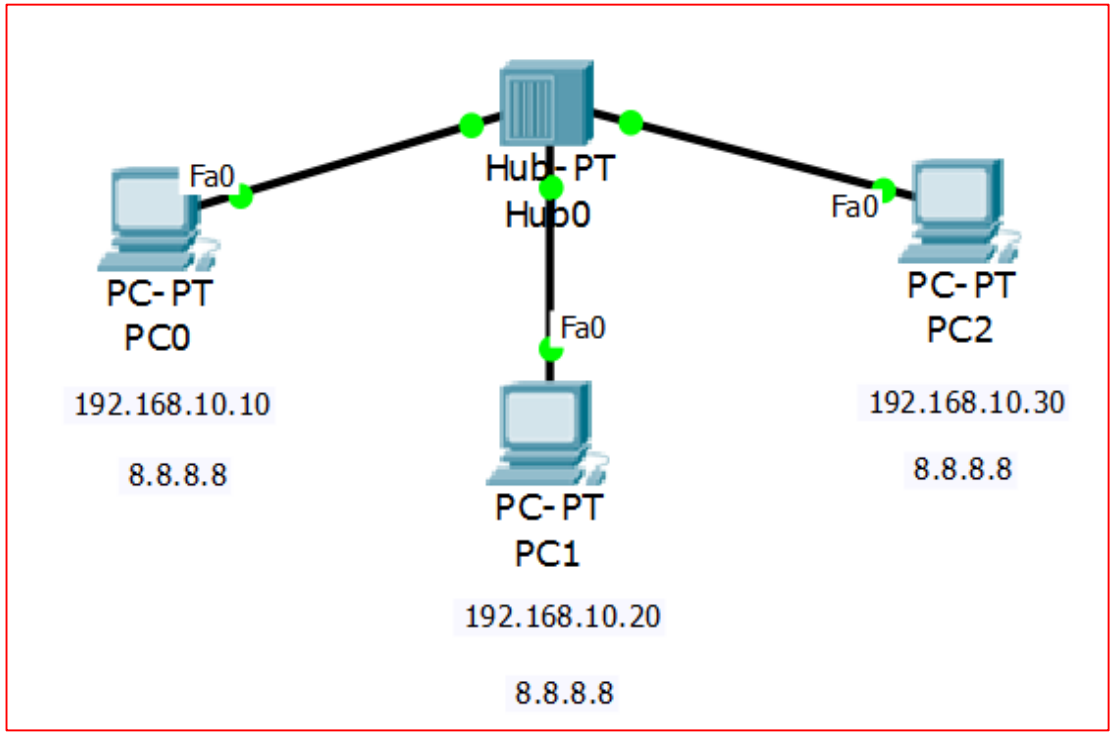
- **Uobaghdad.edu.iq**
- **Yahoo.com**

Q2/ Display the DNS servers addresses by using **CLI** after do the following steps :-

- **ipconfig /release**
- **ipconfig /renew**
- **ipconfig /all**

Q3/Using **Packet Tracer** to Design the topology below and then

- assign IPs to the Hosts
- assign DNS server address for each Host
- show DNS server address for PC1 by using **ipconfig /all**



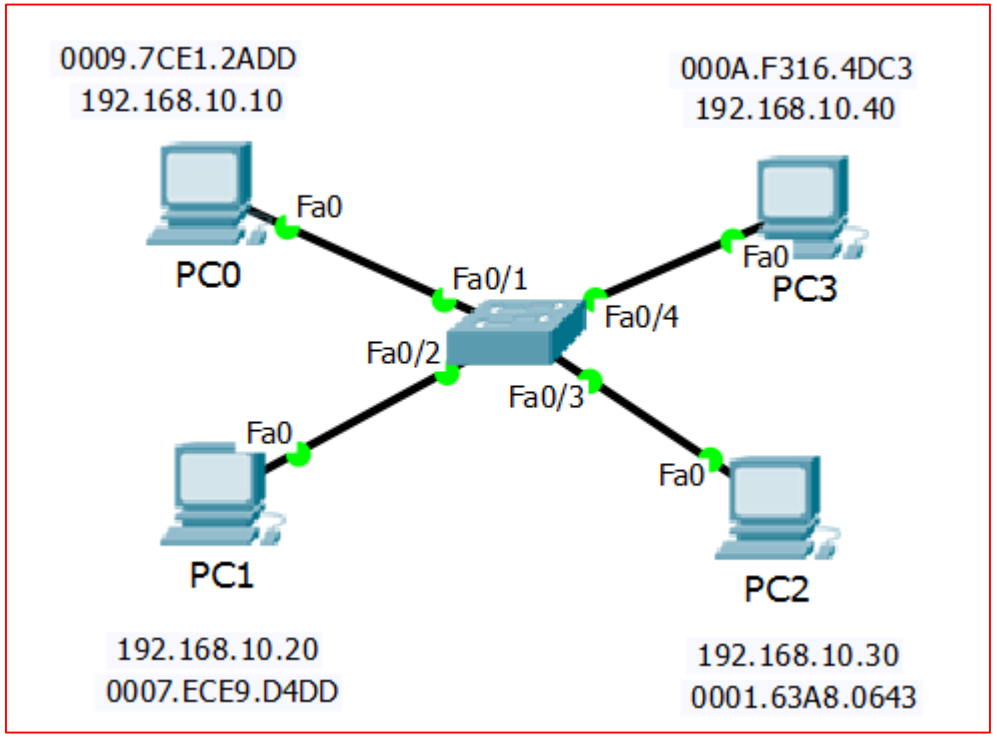
Q4/ Use CMD of your PC to answer the following:

- How to display the **options of arp** command
- Display the **ARP table** for your PC using **arp –a**

Q5/ Design the topology below using Packet Tracer and then answer the following:

1- **Ping** from PC1 to PC0, PC2, PC3

2- **Display** PC1-MAC address using **ipconfig /all**



3- Show PC1-ARP table using **arp –a. Explain** the arp table briefly

4- Delete PC1-ARP table using **arp –d**

5- Enter to the switch (by one click), then **Display** switch-MAC address using **sh mac add**

Note That:

If you want to run **arp –d** to delete the arp table for your PC, you must do the following steps:

Start > Search > cmd > ***Right click on***

Command Prompt > Run as administrator

Thank you

COMPUTER NETWORKS

LAB10

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Third Class

Q1/ Use CMD of your PC to Run and explain the following commands:

- **Netstat /?**
- **Netstat –a**
- **Netstat –n**
- **Netstat –f**

Q2/ Run and explain the main differences between the following commands:

- **Netstat –s and Netstat –p TCP**
- **Netstat –s –p ICMP and Netstat –s –p IP**
- **Netstat –s –p TCP and Netstat –s –p TCP -f**

Q3/Use Wireshark to capture your network traffic and answer the following:

Display all information about:

- **All websites that your PC browse**
- **All your PC requests**
- **All responses reached to your PC**
- **All your PC request messages**
- **All reply messages to your PC**
- **All services request by your PC except domain name service**

Q4/ What are the differences between :

- **TCP and UDP header**
- **TCP.port==443 and !(TCP.port==443)**
- **(ip.src==your PC-IP and dns or http) and**
- **(ip.dst== your PC-IP and !(dns or http))**

Thank you