



ITI

**Introduction to
Computer Networks & Cyber Security
Prepared By : Mohamed AboSehly**

Part 1_Basic Network Elements (Software)

**Open Systems Interconnection Reference Model
OSI RM**



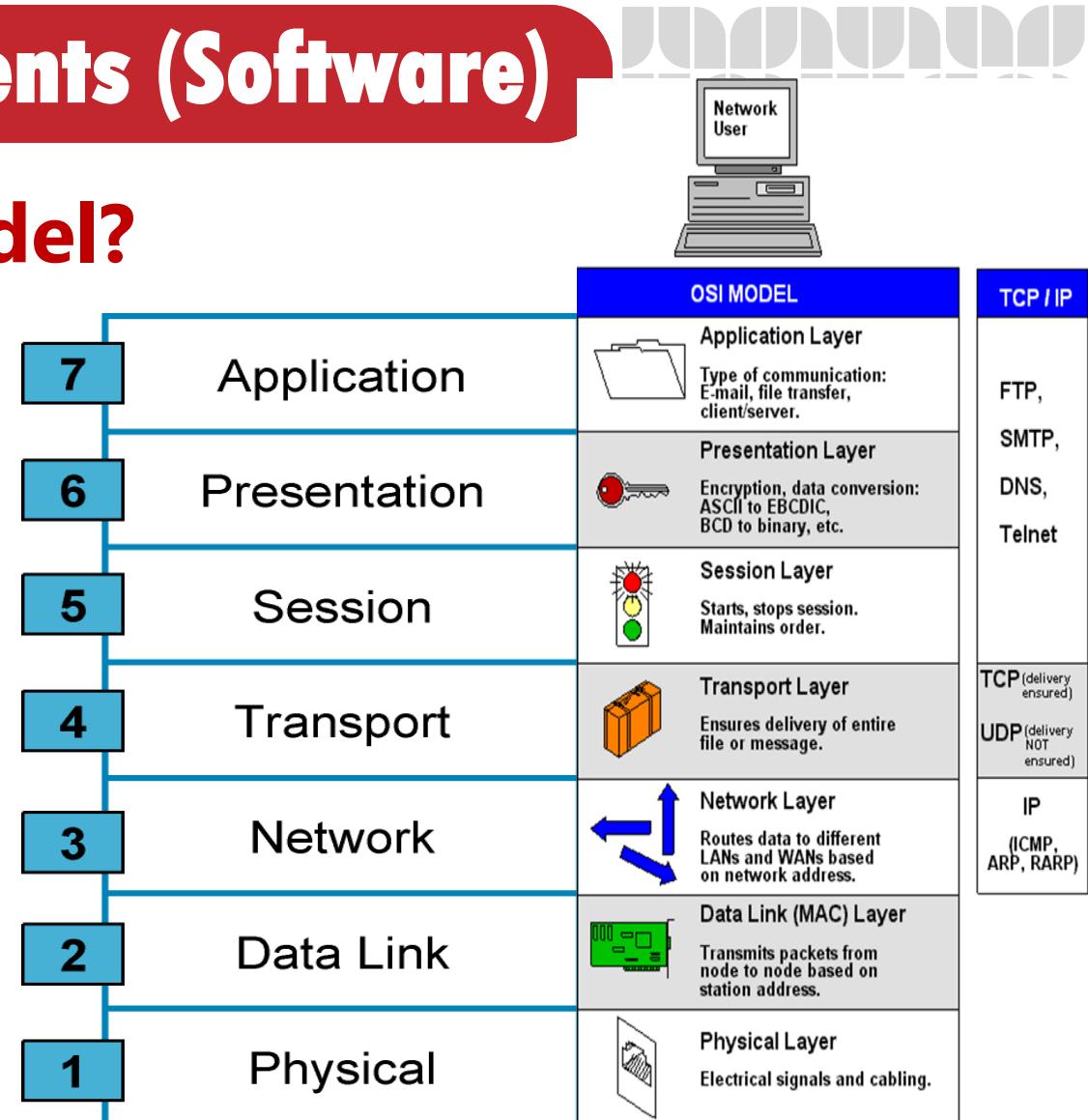
OSI Reference Model

- OSI: Open Systems Interconnect
- OSI/RM was defined by ISO in 1983
 - International Organization for Standardization
- OSI Three practical functions
 - Give developers universal concepts so they can develop protocols
 - Explain the framework used to connect heterogeneous systems
 - (Client/server can communicate even if they have different OS)
 - Describes the process of packet creation
- The OSI reference model breaks this approach into layers.

Part 1_Basic Network Elements (Software)

Why a Layered Network Model?

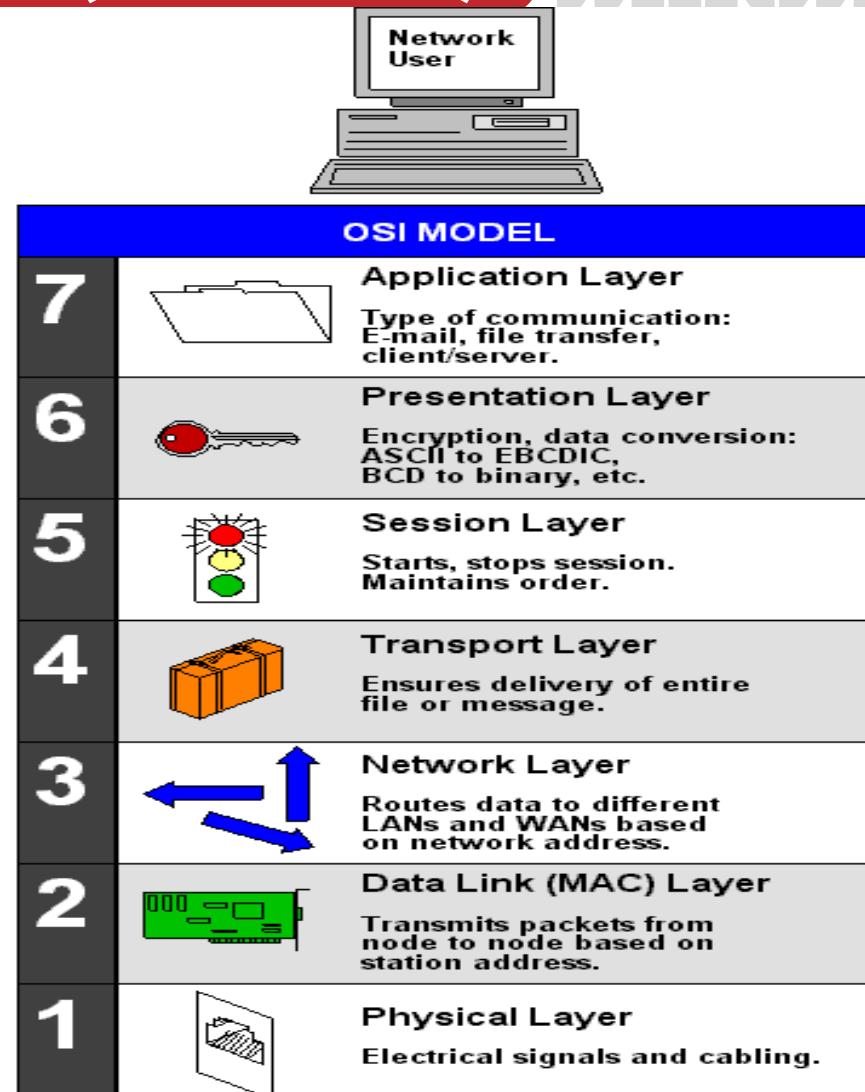
- Reduces complexity
 - Easier to troubleshooting
- Standardizes interfaces
 - Multiple-vendor
- Layer Separation
 - Changes in one layer do not affect other layers
- Simplifies teaching and learning



Part 1_Basic Network Elements (Software)

OSI (7-Seven Layers)

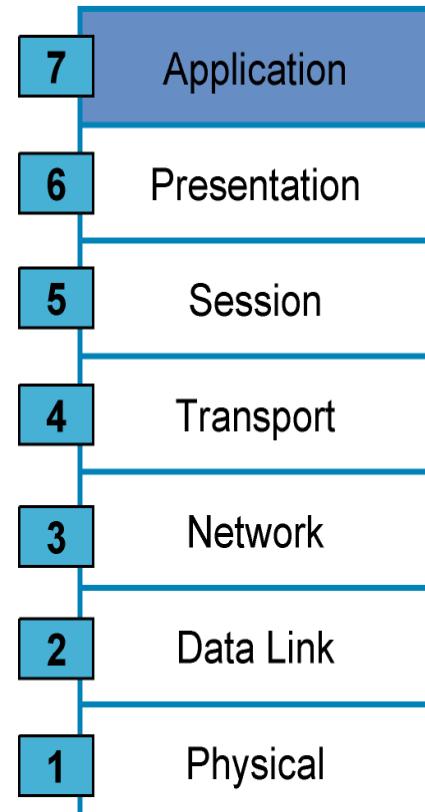
- Application
- Presentation
- Session
- Transport
- Network
- Data Link
- Physical





◊ Application Layer

- ◊ Interface to end users
- ◊ provides Many services
 - ◊ File transfer
 - ◊ Network management
 - ◊ Email
- ◊ Protocols
 - ◊ HTTP (Hyper Text Transfer Protocol)
 - ◊ FTP (File transfer Protocol)
 - ◊ SMTP (Simple Mail transfer Protocol)
 - ◊ POP3 (Post office transfers Protocol)
 - ◊ Telnet/SSH (secure Shell)
- ◊ Example : Web browser



Network Processes to Applications

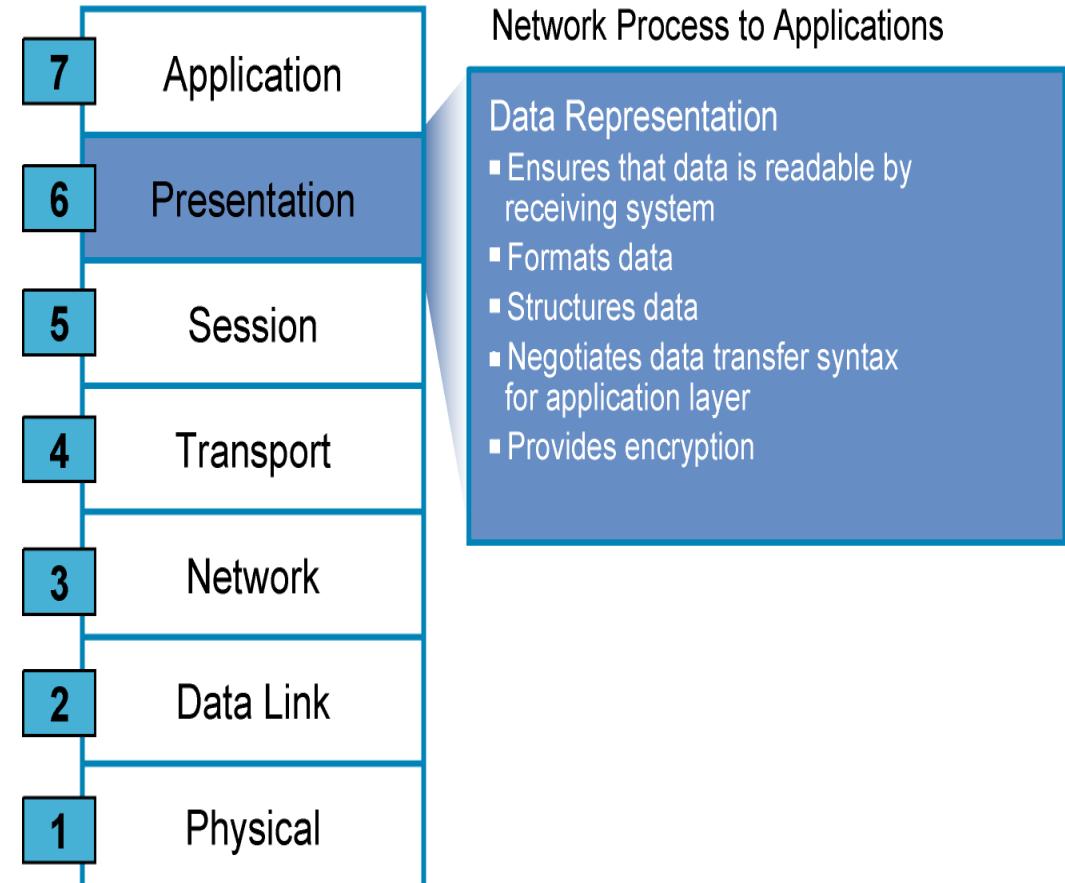
- Provides network services to application processes (such as electronic mail, file transfer, and terminal emulation)
- Provides user authentication



The Seven Layers Functions (Cont.)

◊ Presentation Layer

- ◊ Finding common presentation between source and Destination
- ◊ Ensures that is readable by receiving system
- ◊ **(support standardized application interface)**
- ◊ Formats data
- ◊ Structured data
- ◊ Negotiates data transfer syntax for application layer (Encoding and Decoding)
- ◊ Provides Encryption

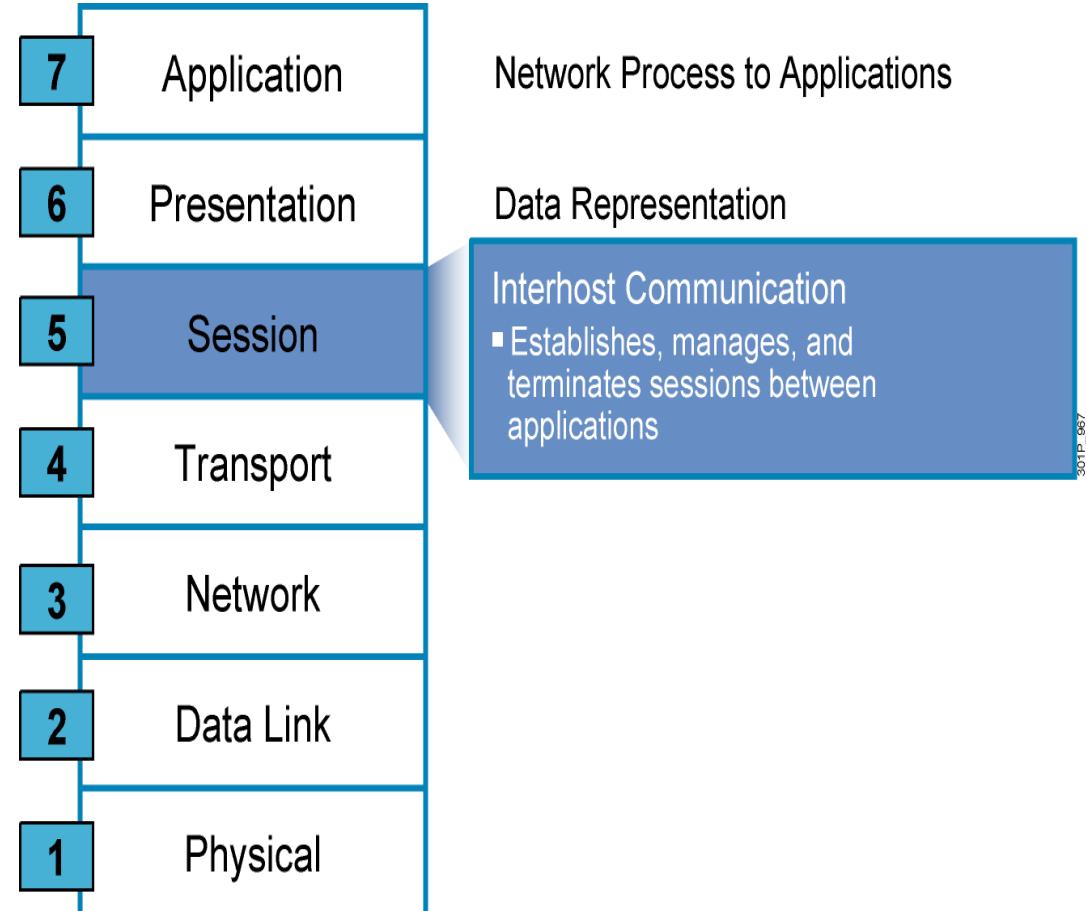




The Seven Layers Functions (Cont.)

◊ Session Layer

- ◊ **Establishes, manages and terminates** sessions (connections) between cooperating applications (Dialogues)
- ◊ **Synchronization** (add checkpoints into a stream of data)
- ◊ **Controls the sessions** between the local and remote applications

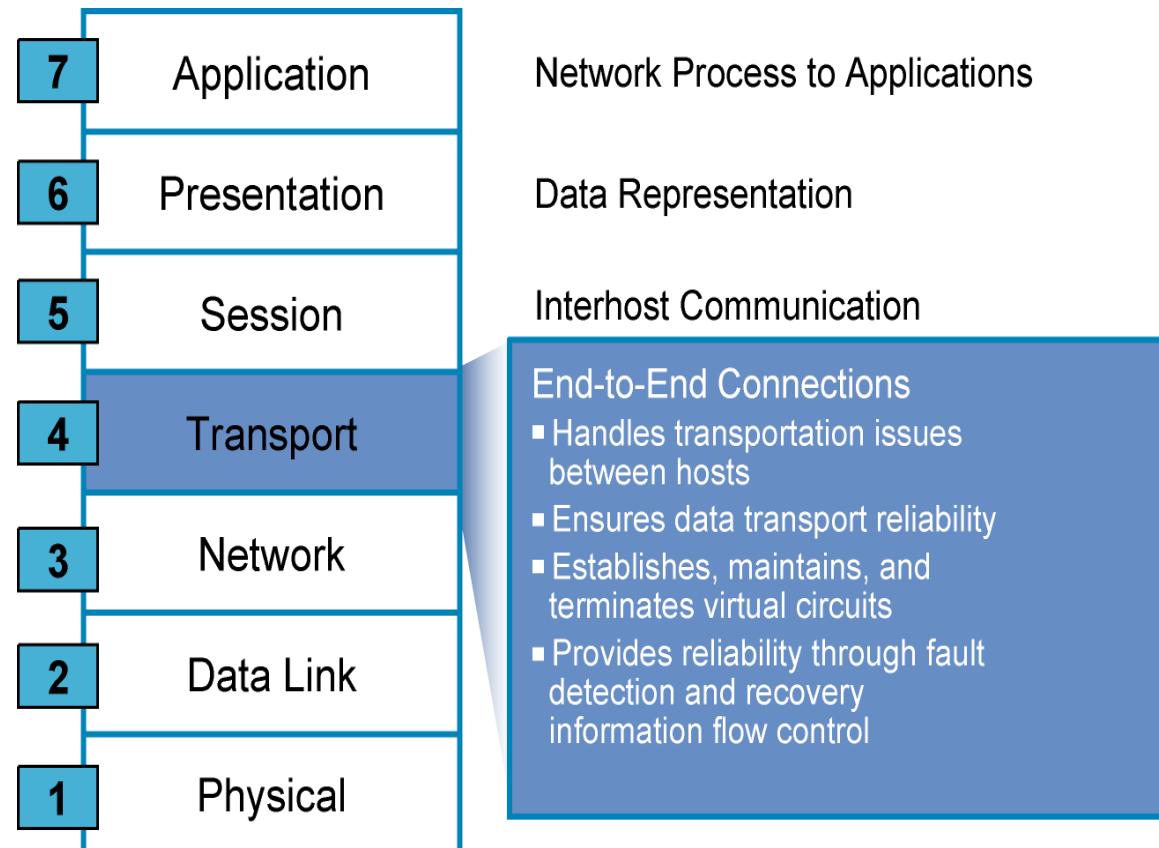




The Seven Layers Functions (Cont.)

◊ Transport Layer

- ◊ Organize data into **Segments**
- ◊ Provide **reliable** transport between end systems (source and destination hosts)
- ◊ End-to-end **error recovery**
- ◊ End-to-end **flow control**

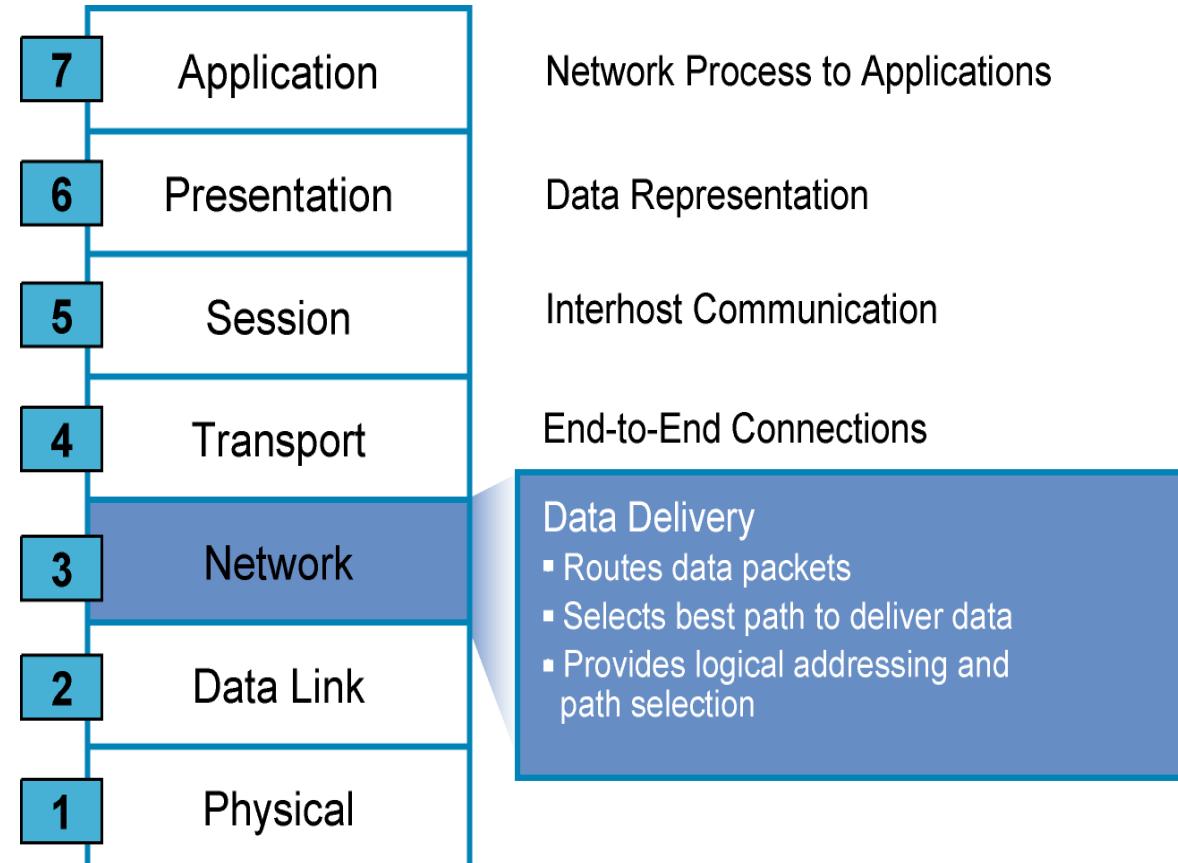




The Seven Layers Functions (Cont.)

◊ Network

- ◊ Organize data into **datagram** (**packets**)
- ◊ It is responsible for the Internet Protocol **Addressing (IP)** (**Addressing**)
- ◊ It know the **best path** for the destination (**Routing**)
- ◊ End-to-end Addressing



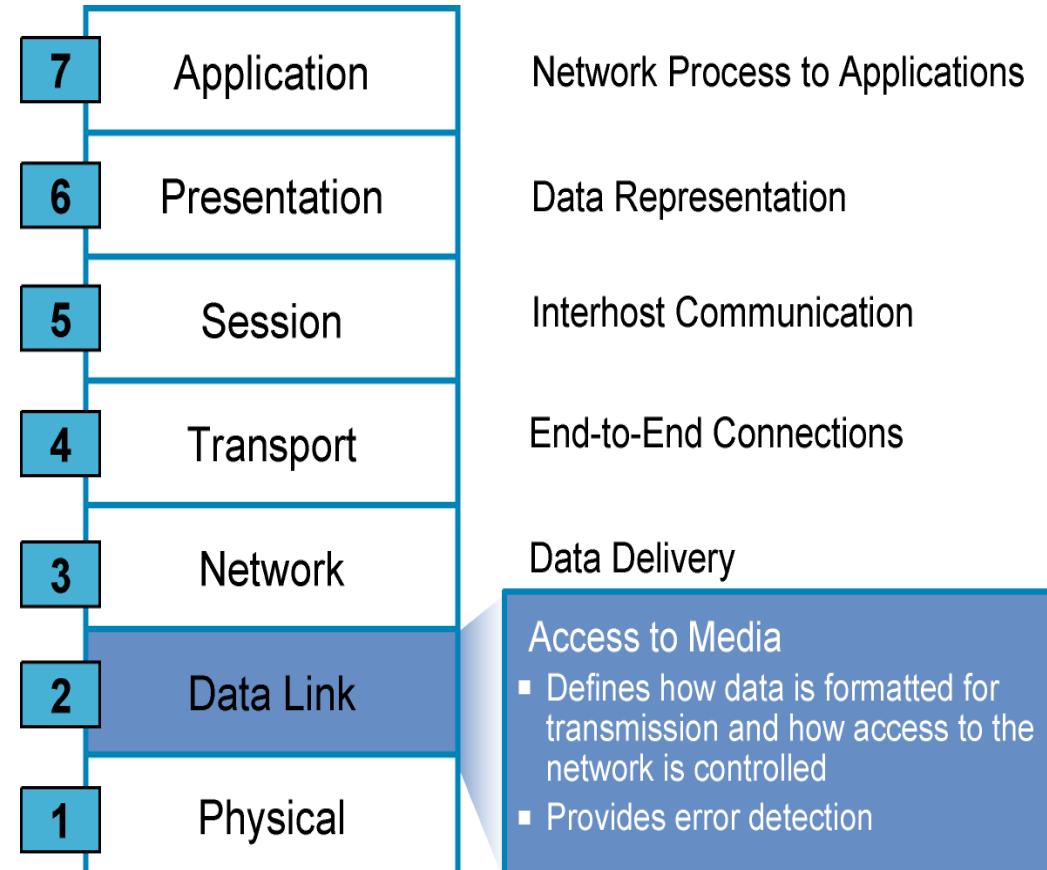
Part 1_Basic Network Elements (Software)



The Seven Layers Functions (Cont.)

◊ Data link

- ◊ Reliable data transfer across a **physical link** (Error Control)
- ◊ Organize the data into **Frames**, to be put on the physical medium
- ◊ Check the Frame For errors
- ◊ **Hop to hop** addressing

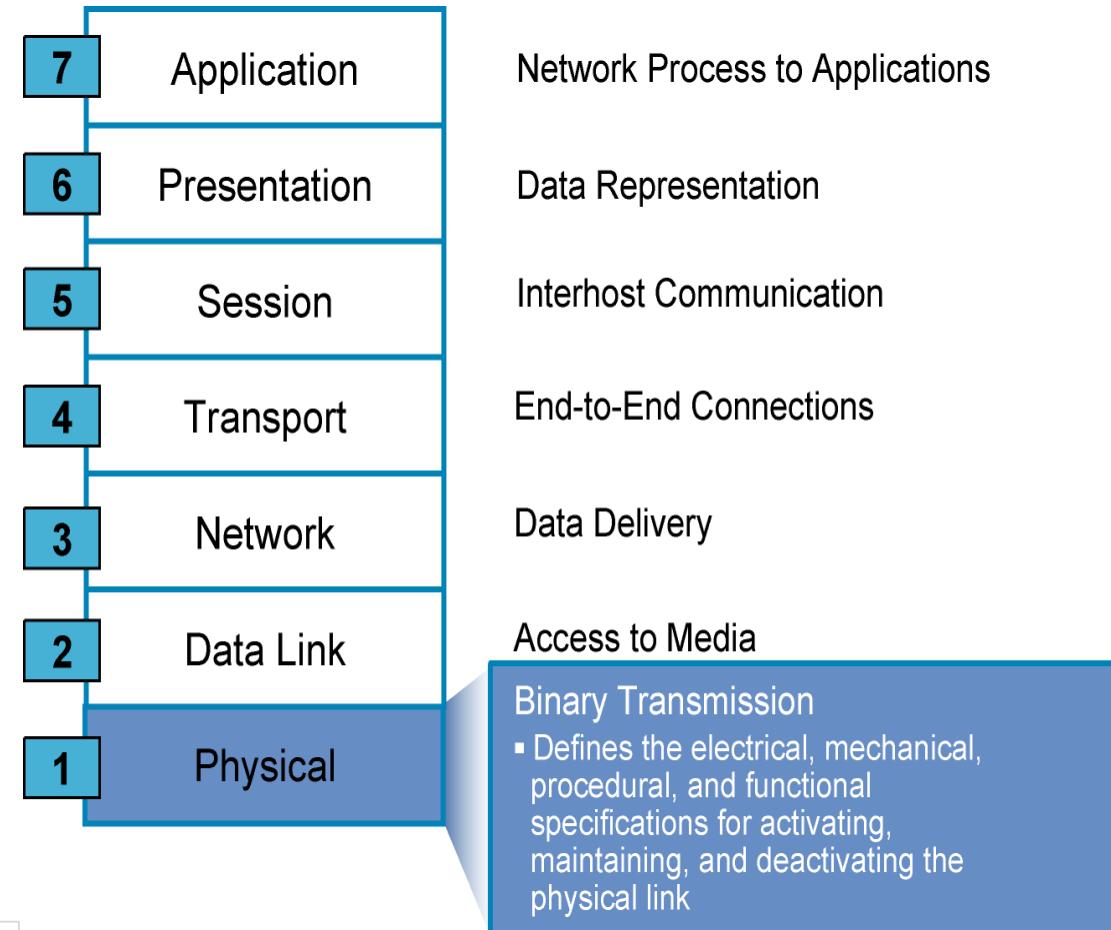




The Seven Layers Functions (Cont.)

◊ Physical

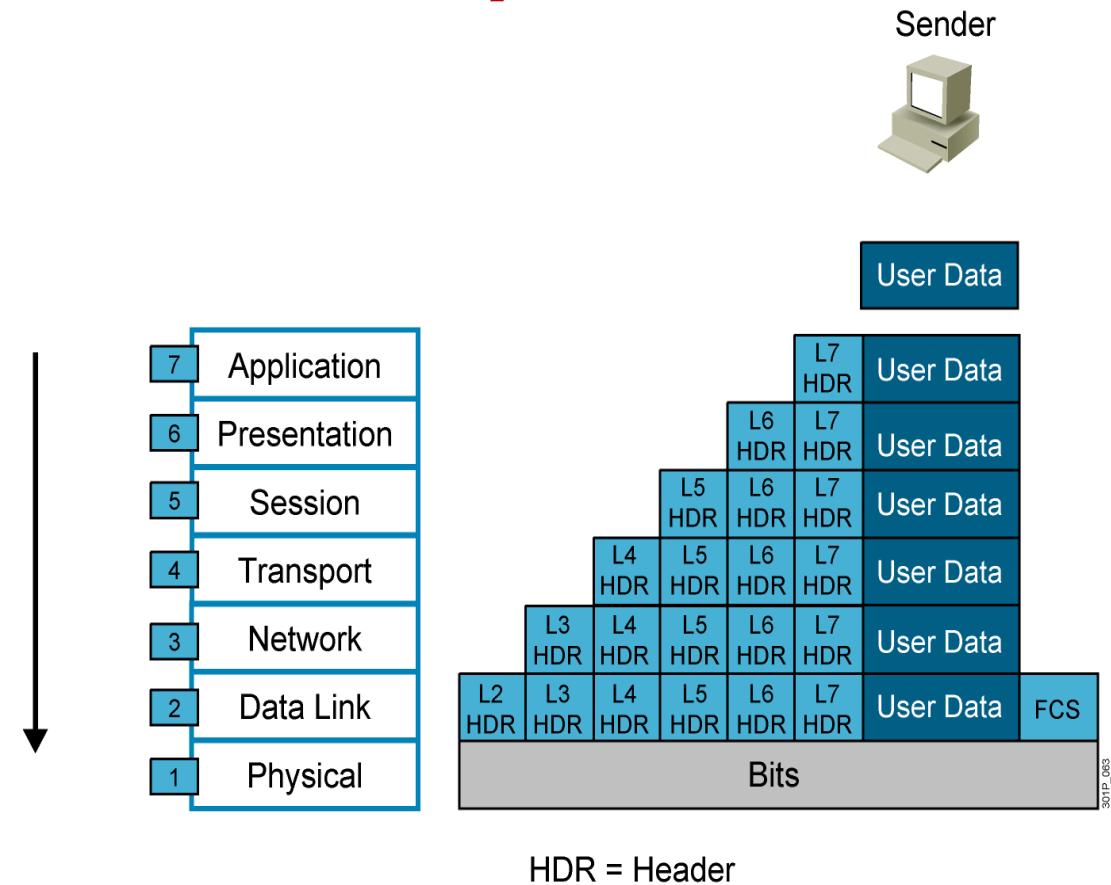
- ◊ Transmission of unstructured **bit stream** over the physical link
- ◊ Deals with the mechanical and electrical specifications of the interface and transmission media (cables and connectors)
- ◊ Representation of bits



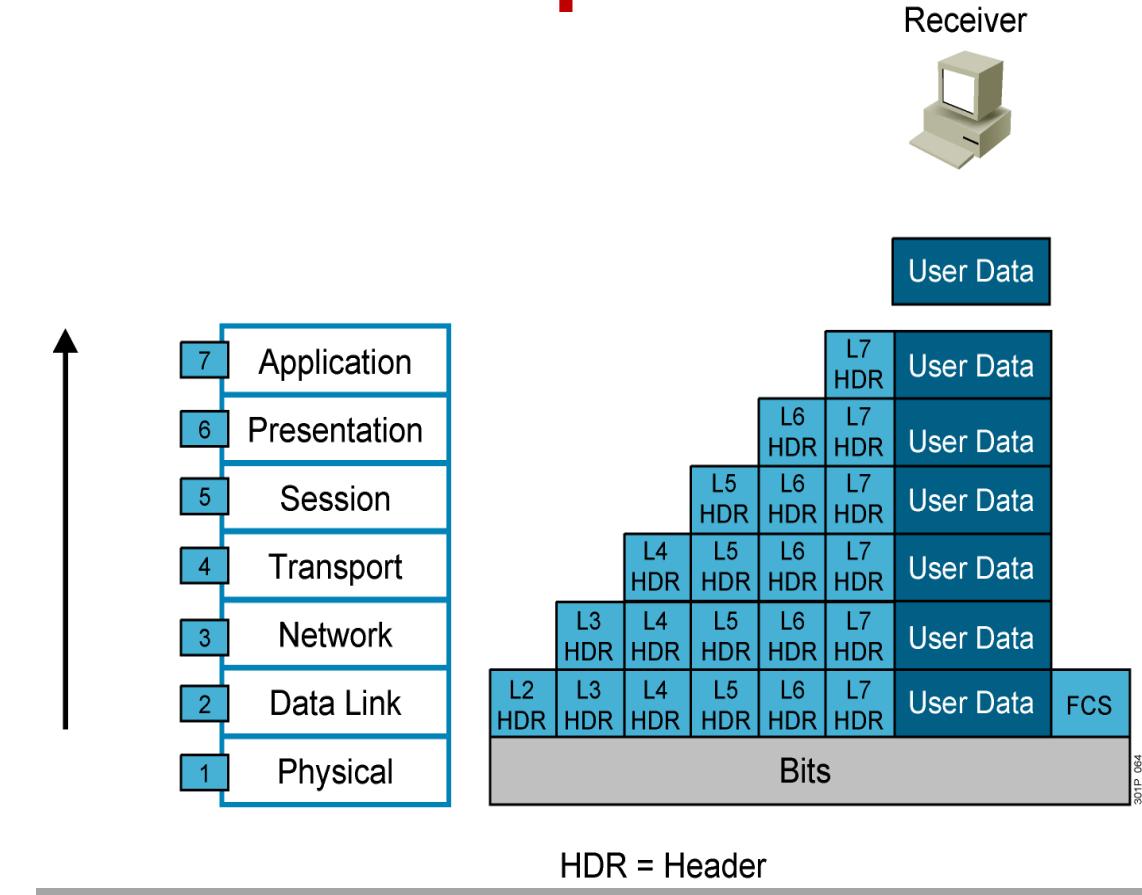
Part 1_Basic Network Elements (Software)



Data Encapsulation

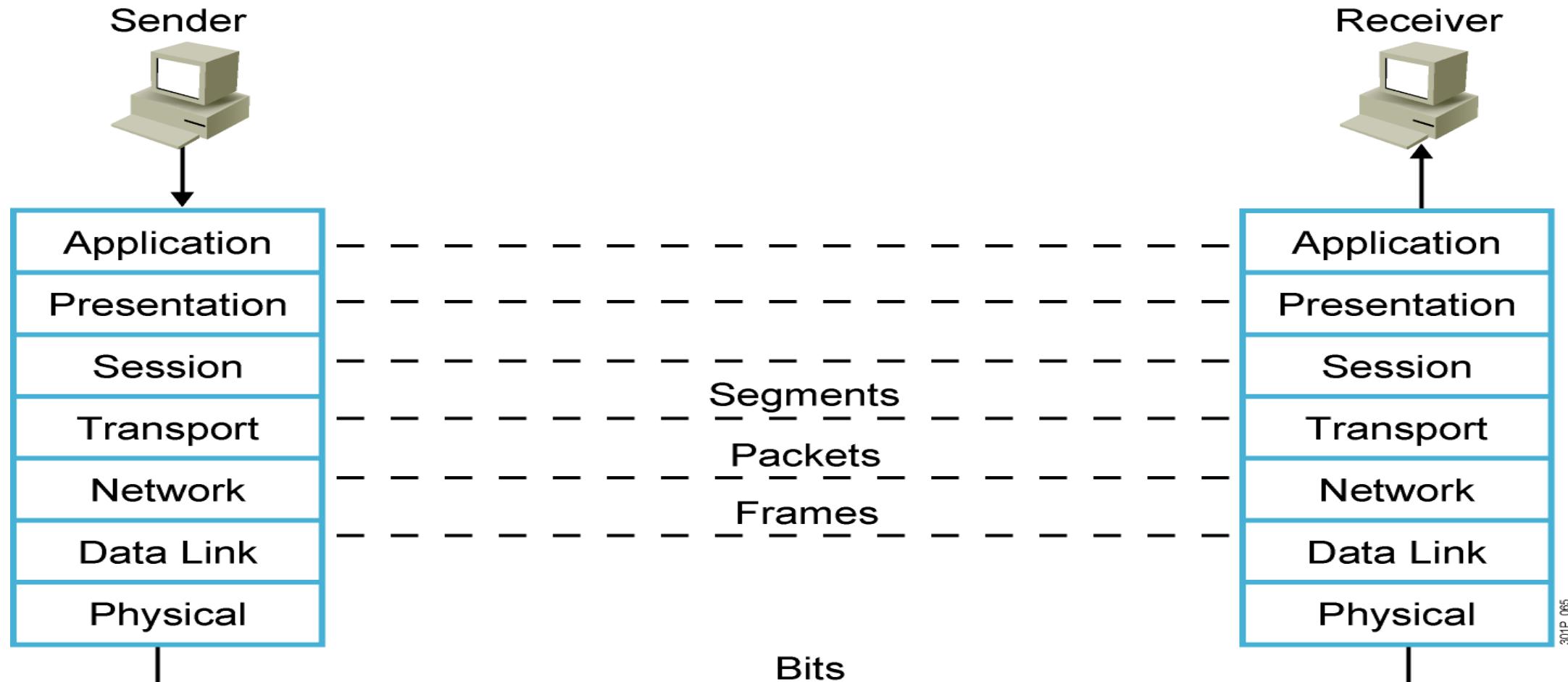


Data De-Encapsulation



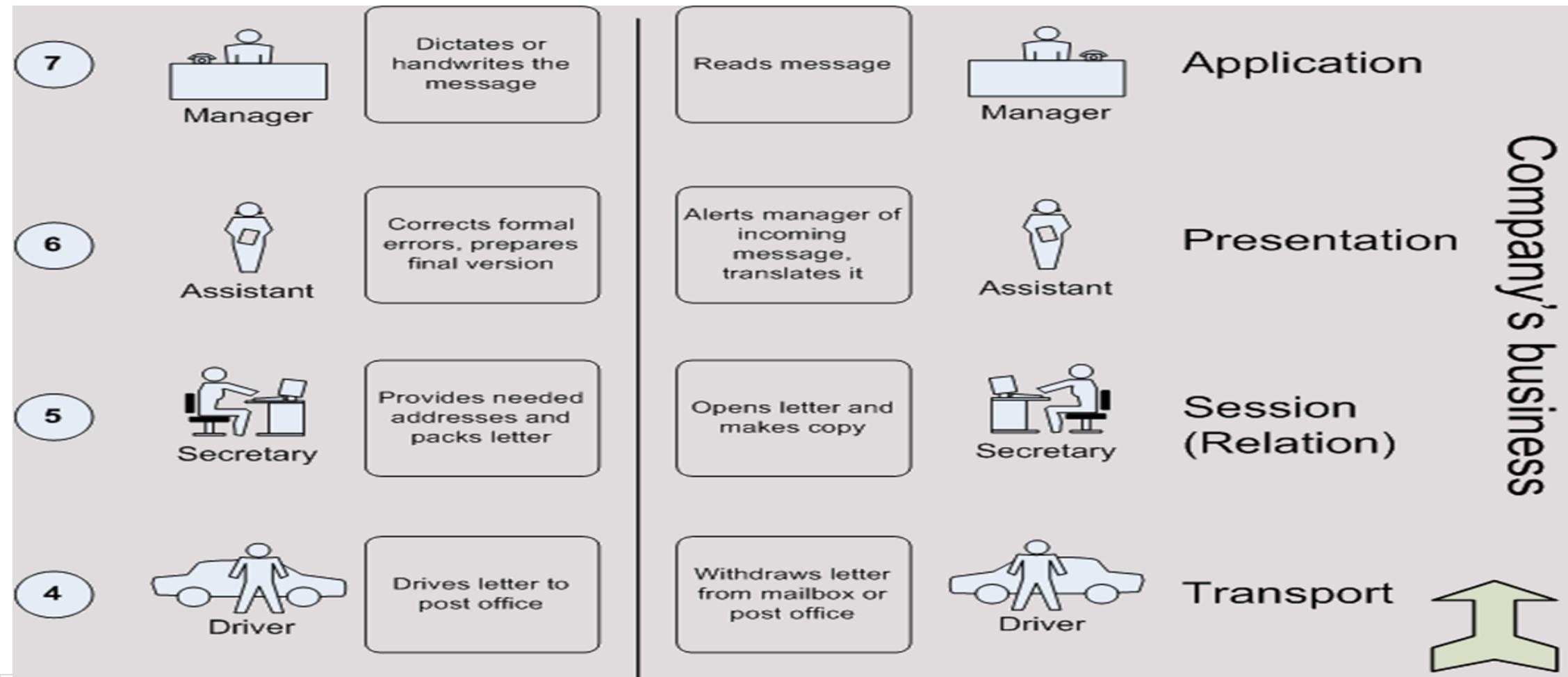
Part 1_Basic Network Elements (Software)

Peer-to-Peer Communication



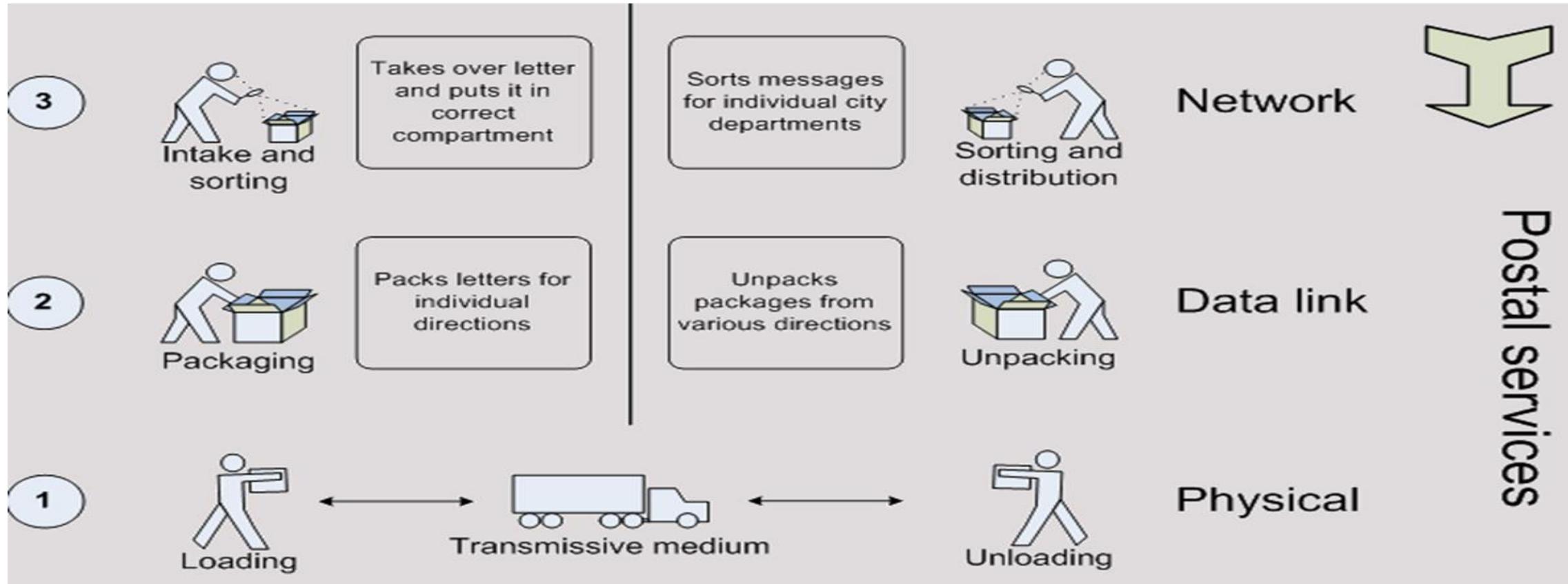
Part 1_Basic Network Elements (Software)

OSI Exercise



Part 1_Basic Network Elements (Software)

OSI Exercise



RM – OSI and letter communication parallel

Part 1_Basic Network Elements (Software)

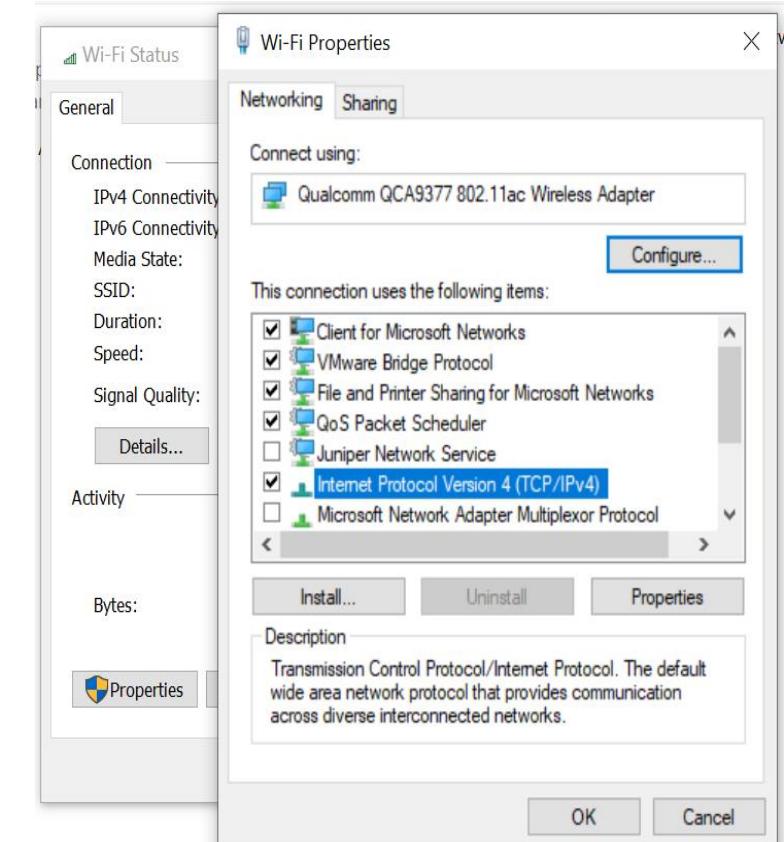
Transmission Control Protocol/Internet Protocol TCP /IP

Part 1_ (TCP/IP Protocol Suite)

- **TCP/IP**

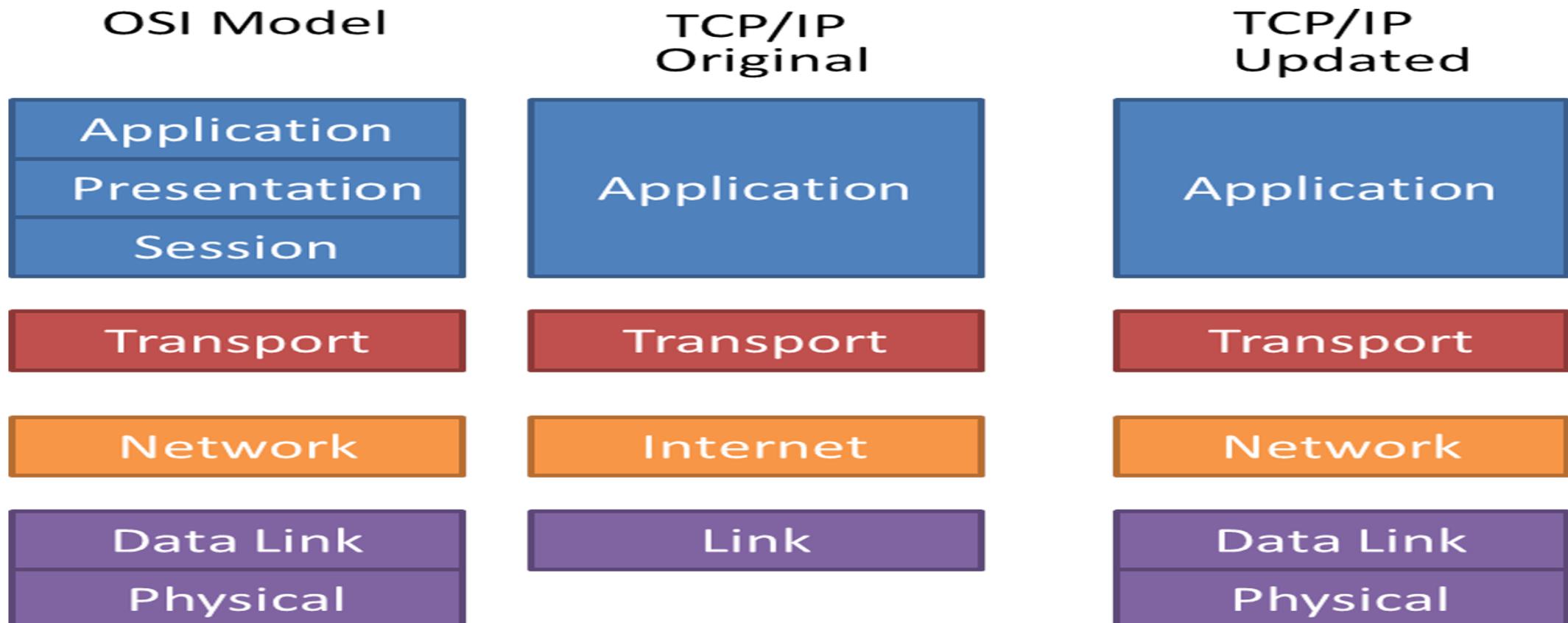
- **Transmission Control Protocol/Internet Protocol.**

- **Open standard protocol**
 - **Cross Platform** (default protocol for all modern operating systems)
 - Microsoft Operating Systems
 - LINUX Operating Systems
 - **Not tied to one vendor**
 - **Direct access to the Internet**
(TCP/IP is the internet protocol)
 - Now internet use TCP/IP v4
 - Next version TCP/IP v6
 - **Routable**



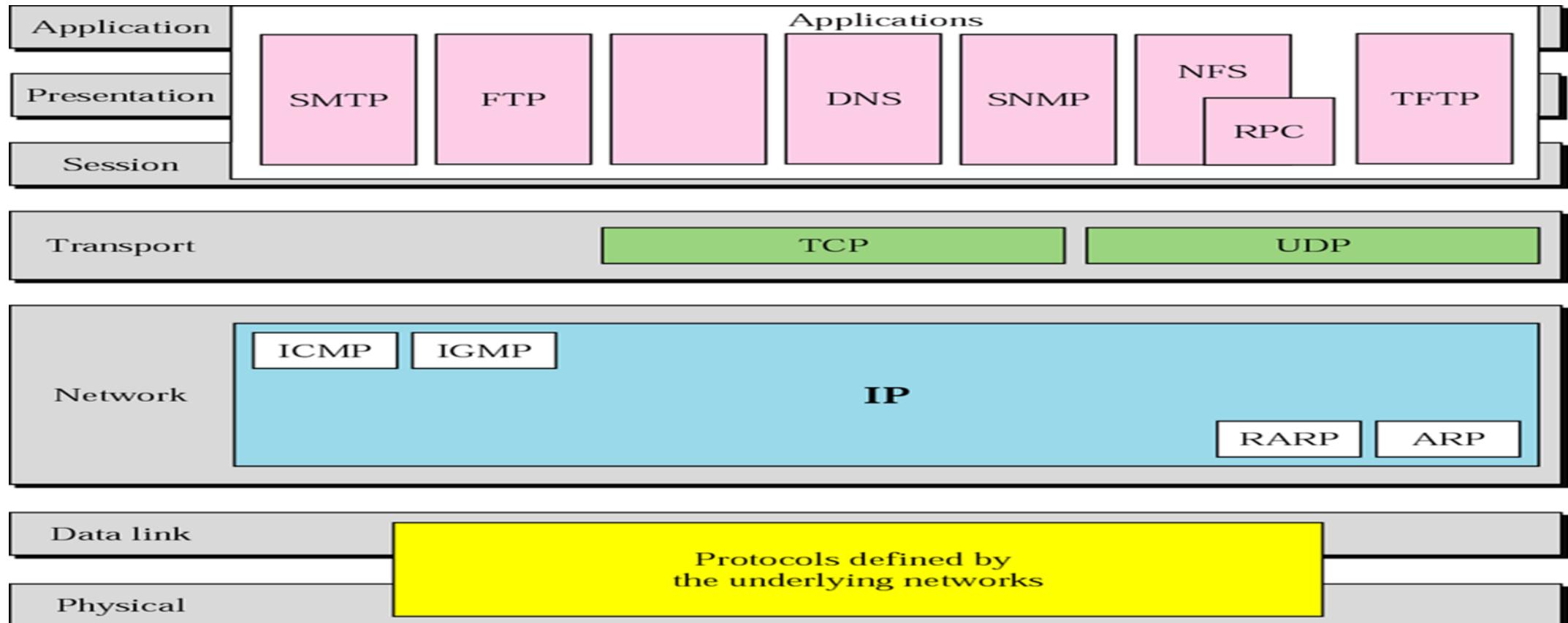
Part 1_(TCP/IP Protocol Suite)

- **TCP/IP VS. OSI Model**



Part 1_(TCP/IP Protocol Architecture)

- Some Protocols in TCP/IP Suite



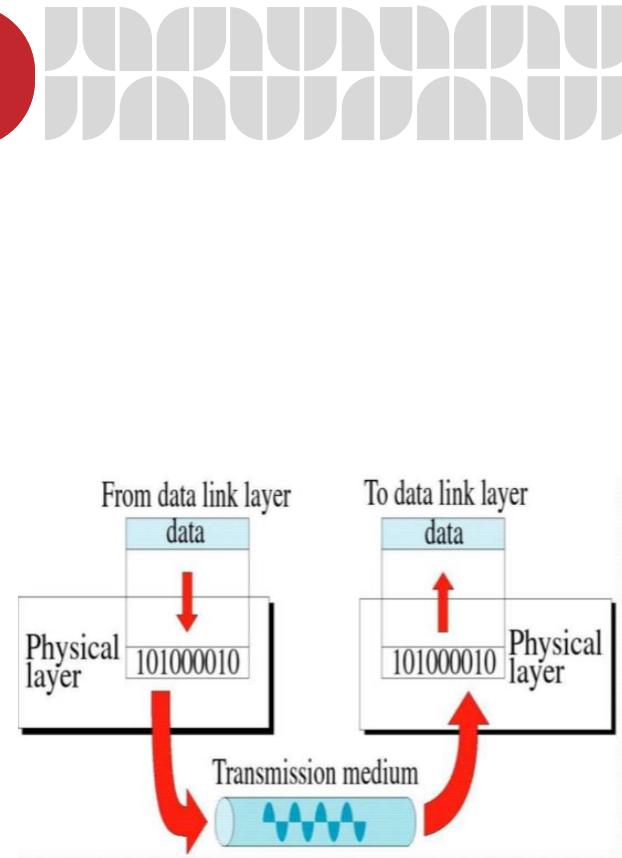
Part 1_(TCP/IP Protocol Architecture)

- **Physical Layer**

- defines the electrical, mechanical, Transmission medium
- movements of individual **Bits** from one node to next

- **Datalink Layer**

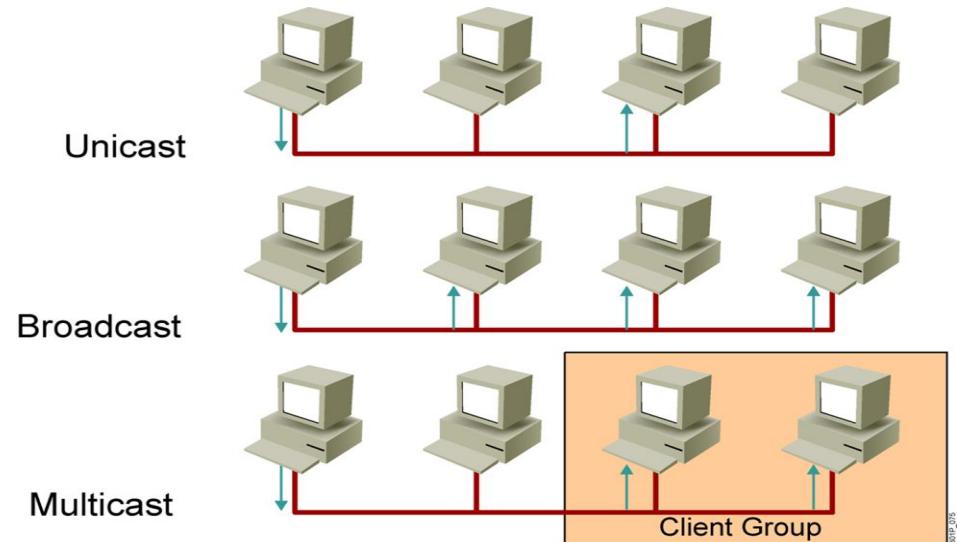
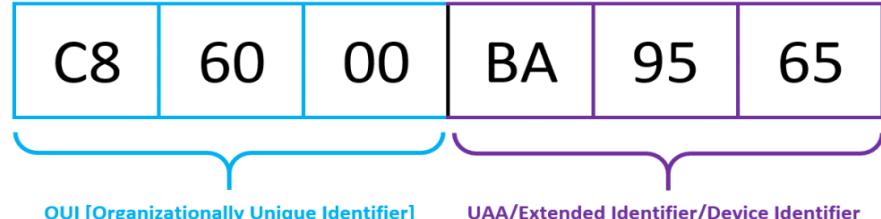
- Logical interface between end system and network
- **Error notification.**
- (FRAMES, MEDIA ACCESS CONTROL)
- Hop to Hop addressing
- Error detection Mechanism (detects damaged or lost frames)



Part 1_(TCP/IP Protocol Architecture)

• Physical Addresses (Mac)

- Physical Address burned on the card
- Unique address over the world
- 48-bit (6-byte) written as 12 hexadecimal digits;
- every byte (2 hexadecimal digits) is separated by a colon
- Physical addresses can be either
 - **Unicast**
 - **Multicast**
 - **Broadcast**
- To check your physical address: -
 - **Ipconfig /all**
 - **GetMac**



Part 1_ Lab (Practices)

- In your lab
 - To check your physical address: -
 - **Ipconfig /all**
 - **GetMac**
 - **GetMac /v**

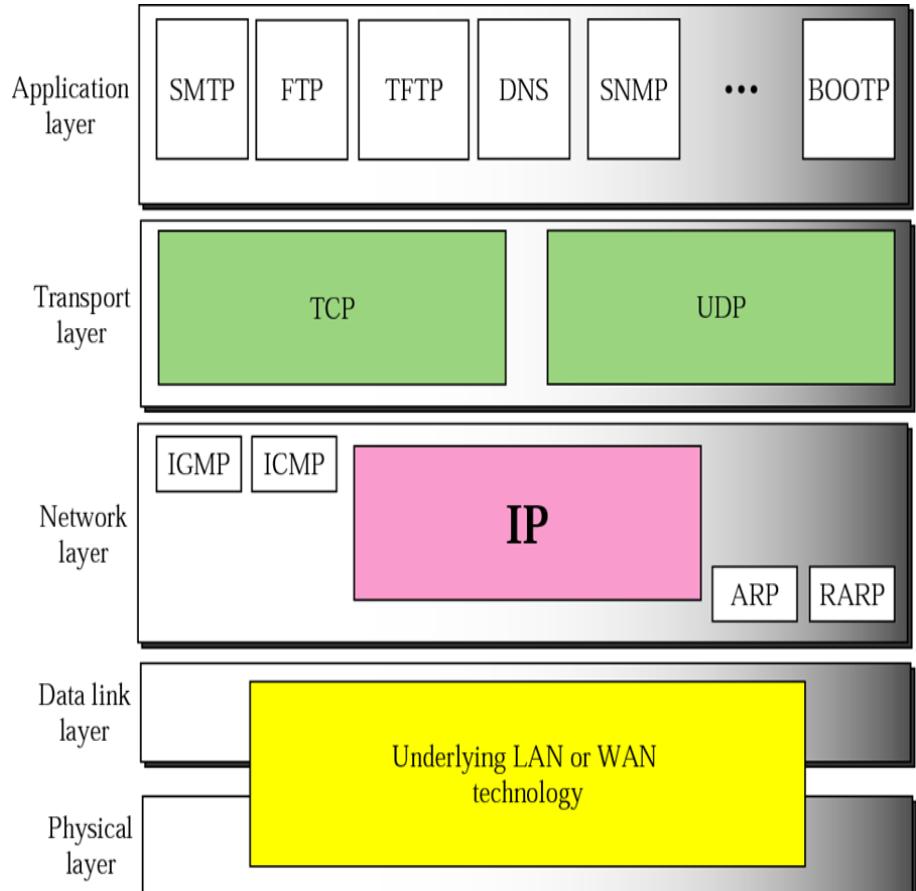
```
Connection-specific DNS Suffix . :  
Description . . . . . : Qualcomm QCA61x4A 802.11ac Wireless Adapter  
Physical Address. . . . . : 74-40-BB-80-37-3D  
DHCP Enabled. . . . . : Yes  
Autoconfiguration Enabled . . . . . : Yes  
IPv6 Address. . . . . : fd9c:c172:b05a:8700:bc38:bbc1:e959:4f54(Preferred)  
Temporary IPv6 Address. . . . . : fd9c:c172:b05a:8700:e597:12c5:be0:3a7c(Preferred)  
Link-local IPv6 Address . . . . . : fe80::bc38:bbc1:e959:4f54%18(Preferred)  
IPv4 Address. . . . . : 192.168.1.2(Preferred)  
Subnet Mask . . . . . : 255.255.255.0  
Lease Obtained. . . . . : Saturday, September 28, 2019 9:12:55 AM  
Lease Expires . . . . . : Sunday, September 29, 2019 9:12:53 PM  
Default Gateway . . . . . : 192.168.1.1  
DHCP Server . . . . . : 192.168.1.1  
DHCPv6 IAID . . . . . : 108282043  
DHCPv6 Client DUID. . . . . : 00-01-00-01-22-DA-1F-5D-54-BF-64-2B-09-81  
DNS Servers . . . . . : 192.168.1.1  
192.168.1.1  
NetBIOS over Tcpip. . . . . : Enabled  
  
Tunnel adapter Teredo Tunneling Pseudo-Interface:
```

```
C:\Users\ITD-mabdsalam>getmac  
  
Physical Address Transport Name  
===== =====  
74-40-BB-80-37-3D \Device\Tcpip_{AF590558-C7CC-40B4-95A4-9F4476D1DDEC}  
54-BF-64-2B-09-81 Media disconnected  
N/A Hardware not present  
00-50-56-C0-00-01 \Device\Tcpip_{D37FF6B5-F7BA-498B-979F-AE0B4A6B42E1}  
00-50-56-C0-00-08 \Device\Tcpip_{AA96FF0D-8253-4B8C-9233-DD61B6501B22}  
  
C:\Users\ITD-mabdsalam>
```

Part 1 (TCP/IP Protocol Architecture)

- **Internet / Network protocol Layer (IP Layer)**

- Provides **connectivity** and **path selection** between two hosts (Source to Destination)
- Routing of data (Provide mechanism to transmit data over independent networks that are linked together)
- Logical addressing IPV4 , IPV6



Part 1 (TCP/IP Protocol Architecture)



• Internet Protocol (IP V4)

- **Uniquely** identify each device on an IP network layer.
- Some times we called it **the logical address**
- Every host (computer, networking device, peripheral) must have **a unique address at the same network**
- The IP address **32 bit divided into 4 octets** each octet 8 bit

1 octet = 8 bit each represents from 0 to 255 separated with dots

	Example			
An IP address is a 32-bit binary number	10101100 00010000 10000000 00010001			
For readability, the 32-bit binary number can be divided into four 8-bit octets	10101100 00010000 10000000 00010001			
Each octet (or byte) can be converted to decimal	172 16 128 17			
The address can be written in dotted decimal notation	172. 16. 128. 17			

•The address space of IPv4 is 2^{32} or 4,294,967,296

Part 1 (TCP/IP Protocol Architecture)



IP ADDRESS RANGES The First Octet

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.

A B C ... Easy as 1 2 3

Class **A** ... First **1** bit fixed



Class **B** ... First **2** bits fixed



Class **C** ... First **3** bits fixed



Part 1 (TCP/IP Protocol Architecture)



PUBLIC IP ADDRESSES (Real IP) Private IP Addresses (Local IP)

Class	Public IP Ranges
A	1.0.0.0 to 9.255.255.255 11.0.0.0 to 126.255.255.255
B	128.0.0.0 to 172.15.255.255 172.32.0.0 to 191.255.255.255
C	192.0.0.0 to 192.167.255.255 192.168.0.0 to 223.255.255.255

Class	Private Address Range
A	10.0.0.0 to 10.255.255.255
B	172.16.0.0 to 172.31.255.255
C	192.168.0.0 to 192.168.255.255

- **Nat** is used to Translate the private IP address to public IP addresses.

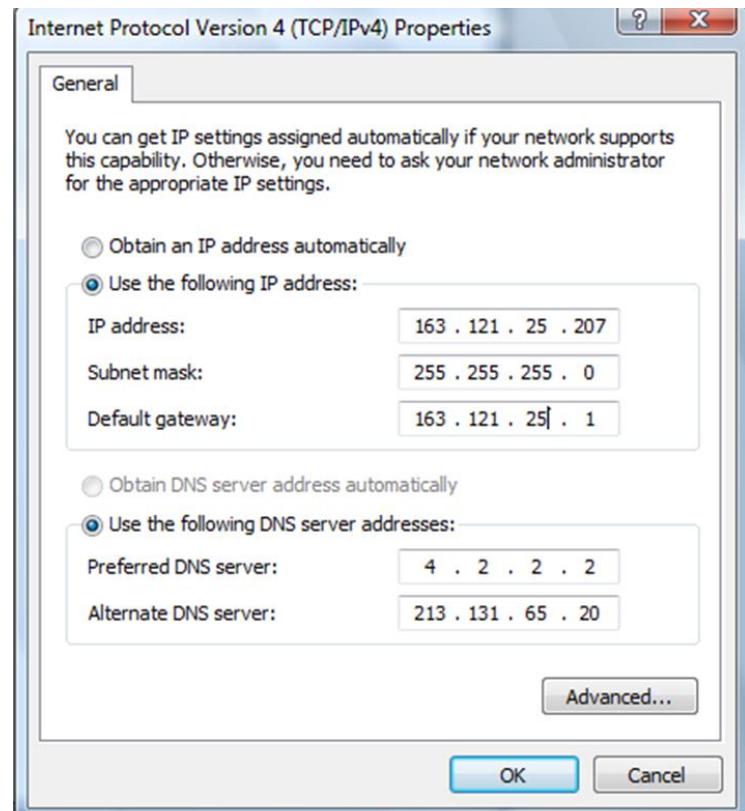
Part 1 (TCP/IP Protocol Architecture)_lab

❖ How to assign IP address to device

- Manually
- Automatic
- APIPA

- Set IP address
- Set Subnet mask
- Set IP default-Gateway
- Set DNS server

■ Manually

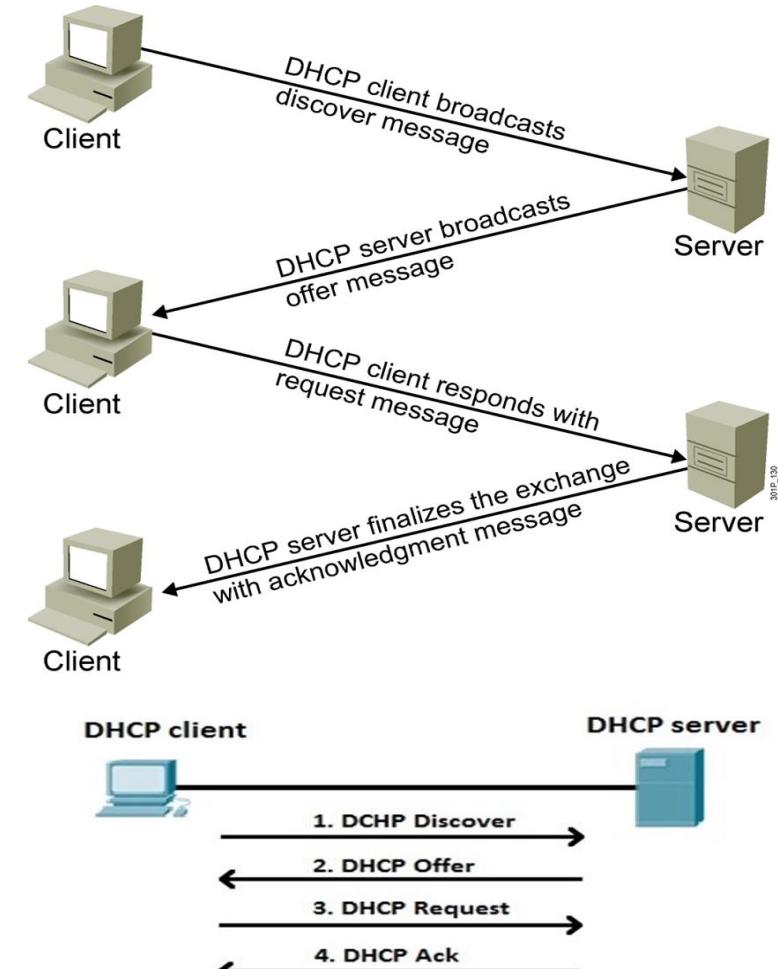


Part 1 (TCP/IP Protocol Architecture)- LAB

❖ Assign IP address Automatic

■ DHCP Server

- used to assign **dynamically** the IP Configuration including
 - Host IP
 - Subnet mask
 - Default Gateway
 - DNS server IP
 - Lease Time
- **Dora** (Discover –Offer-Request-Acknowledgment)



Part 1 (TCP/IP Protocol Architecture)- LAB



❖ Assign IP address Automatic

■ APIPA

- If **no DHCP server** is available the APIPA is used
- Auto configuration IP address
- let LAN users talk to Each other if the DHCP fails
- Can **not** be Routed
- **Rang : 169.254.X.X**

■ APIPA

```
Link-local IPv6 Address . . . . . : fe80::3428:a83b:6e6b:24b2%3
Autoconfiguration IPv4 Address . . . : 169.254.36.178
Subnet Mask . . . . . . . . . . . : 255.255.0.0
Default Gateway . . . . . . . . . . : 
```

Part 1 (TCP/IP Protocol Architecture)- LAB

❖ Ipconfig

Ipconfig is a command line utility in Microsoft Windows.

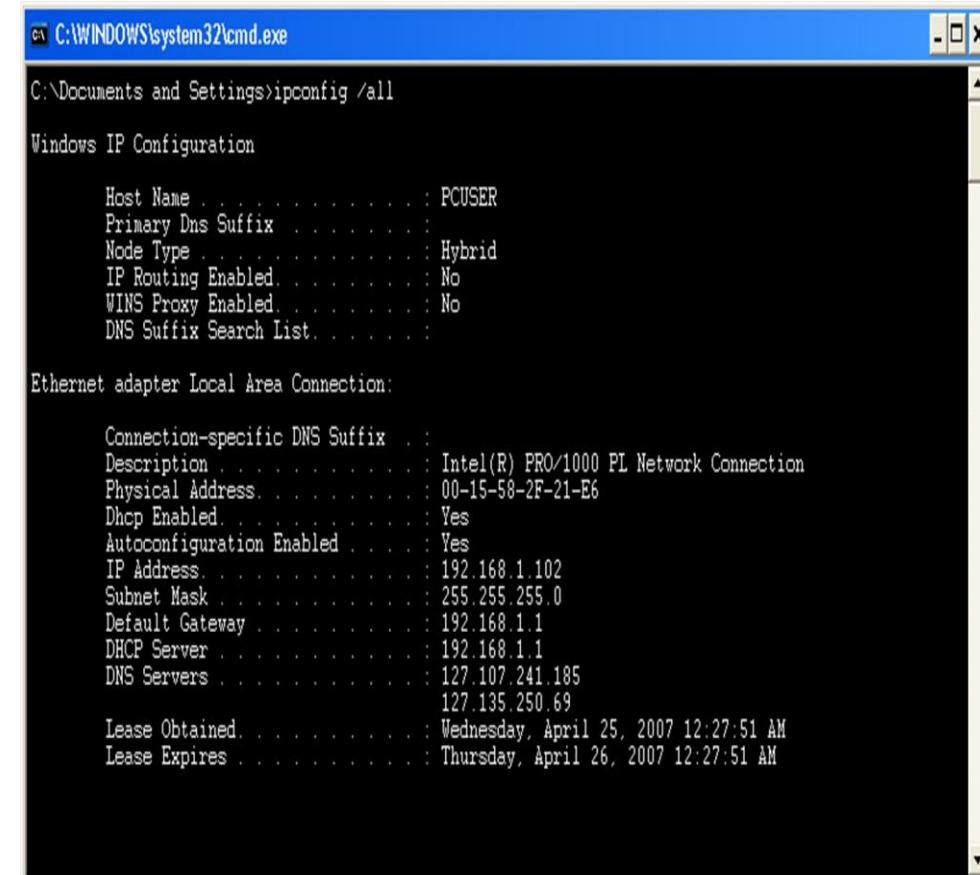
ipconfig allows you to get the IP address

information of a Windows computer such as :

- Physical Address (MAC)
- IP address
- Subnet mask
- Default gateway
- DNS server

❖ To know your Private IP addresses

- Ipconfig
- Ipconfig /all
- Ipconfig /release
- Ipconfig /renew



```
C:\WINDOWS\system32\cmd.exe
C:\Documents and Settings>ipconfig /all

Windows IP Configuration

Host Name . . . . . : PCUSER
Primary Dns Suffix . . . . . : Hybrid
Node Type . . . . . : Hybrid
IP Routing Enabled . . . . . : No
WINS Proxy Enabled . . . . . : No
DNS Suffix Search List . . . . . :

Ethernet adapter Local Area Connection:

Connection-specific DNS Suffix . . . . . : Intel(R) PRO/1000 MT Desktop Connection
Description . . . . . : Intel(R) PRO/1000 MT Desktop Connection
Physical Address . . . . . : 00-15-58-2F-21-E6
Dhcp Enabled . . . . . : Yes
Autoconfiguration Enabled . . . . . : Yes
IP Address . . . . . : 192.168.1.102
Subnet Mask . . . . . : 255.255.255.0
Default Gateway . . . . . : 192.168.1.1
DHCP Server . . . . . : 192.168.1.1
DNS Servers . . . . . : 127.107.241.185
                                         127.135.250.69
Lease Obtained . . . . . : Wednesday, April 25, 2007 12:27:51 AM
Lease Expires . . . . . : Thursday, April 26, 2007 12:27:51 AM
```

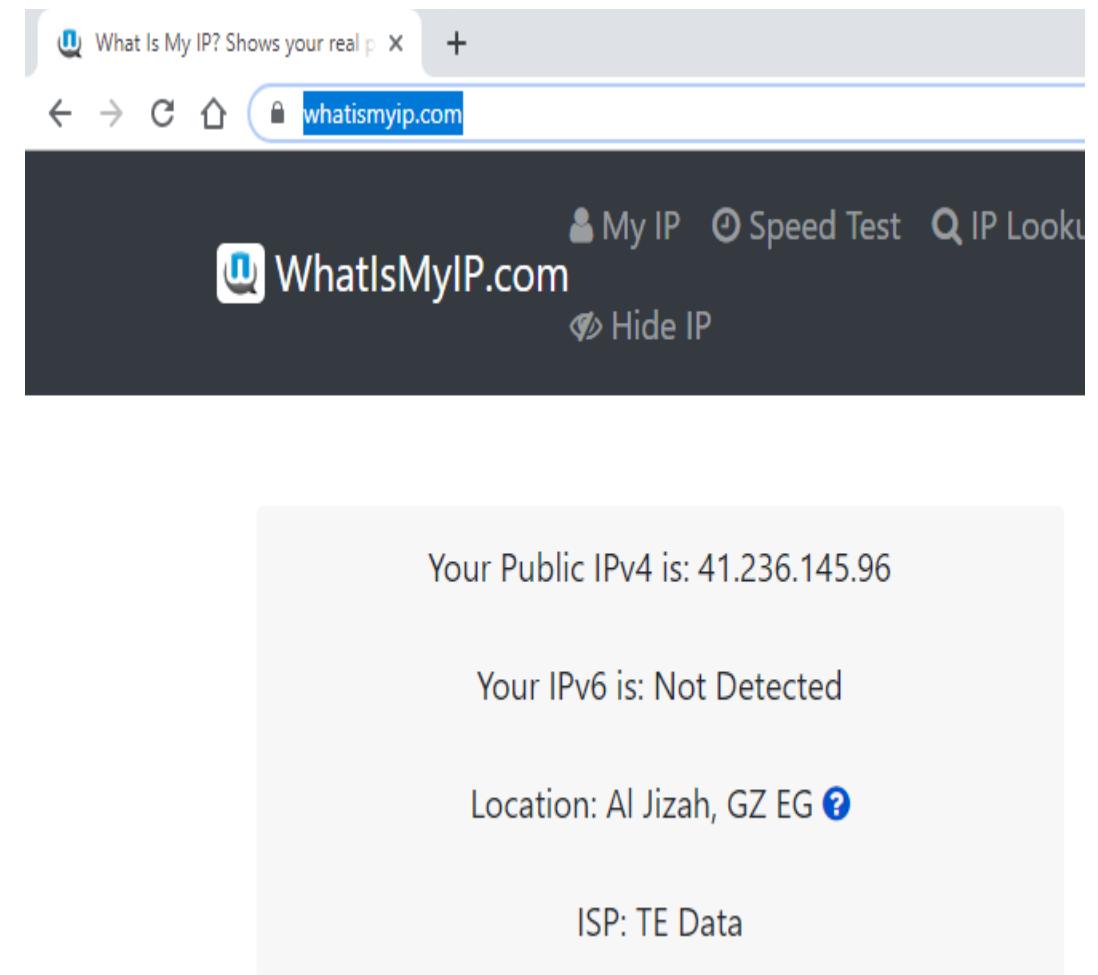
Part 1 (TCP/IP Protocol Architecture)- LAB

- To know your real IP addresses

<https://www.whatismyip.com/>

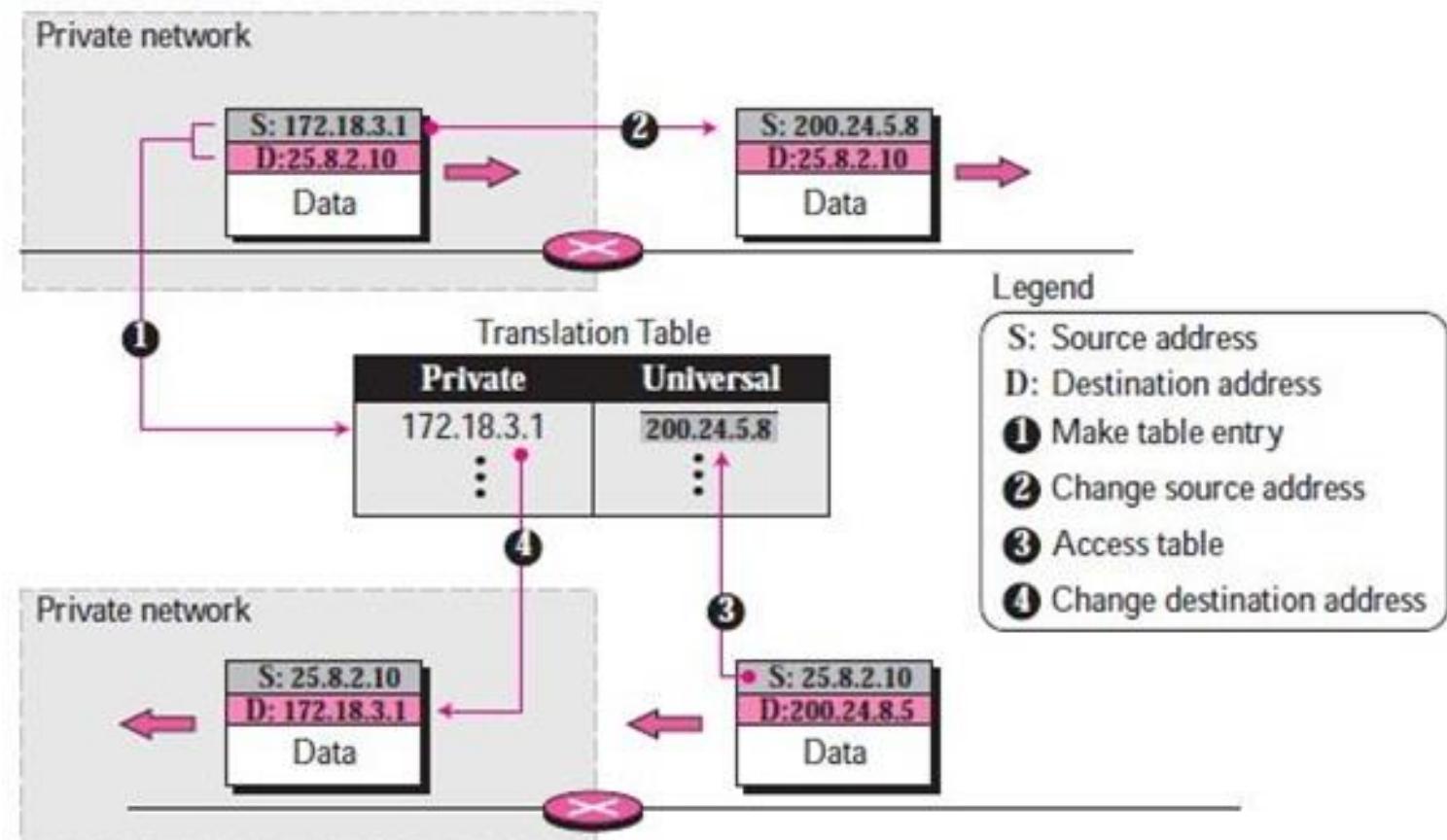
- To get bulk of the Public IP address you get it from your Internet service provider

- With the grow the of the public IP address we used **NAT** and **IPv6**



Network Address Translation(NAT)

The technology allows a site to use a set of private addresses for internal communication and a set of global Internet addresses (at least one) for communication with the rest of the world

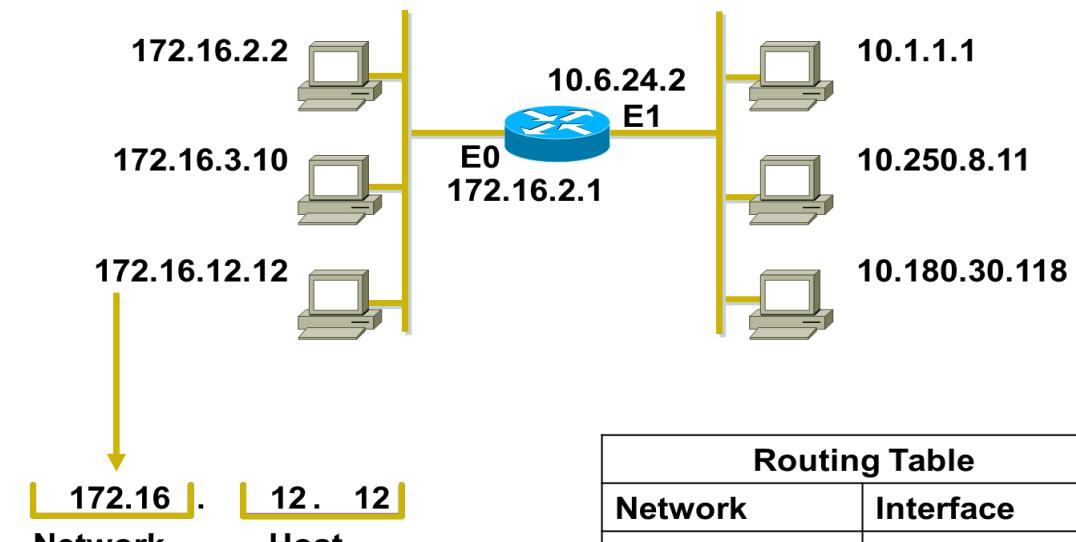
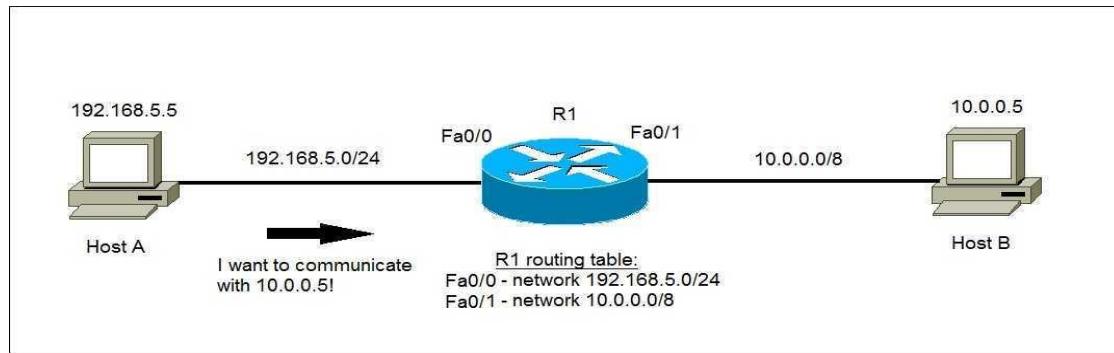


Part 1 (TCP/IP Protocol Architecture)- LAB



HOST ADDRESSES & ROUTING

- Identifies the individual host
 - Assigned by organizations to individual devices
 - Router maintain network information to route the data



Routing Table	
Network	Interface
172.16.0.0	E0
10.0.0.0	E1

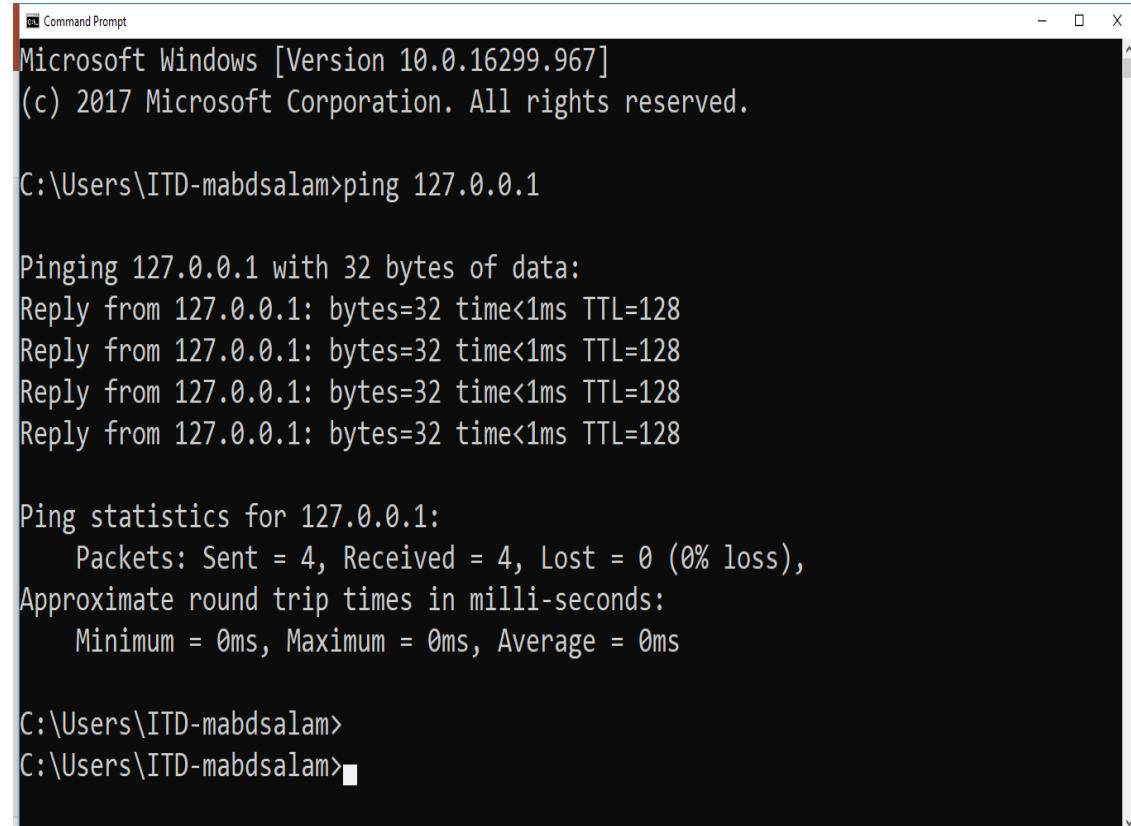
Part 1 (TCP/IP Protocol Architecture)- LAB

❖ ICMP → Ping

- Ping is a command line utility in Microsoft Windows.
- Ping allows you to check connectivity with other devices
- Ping is a tool of DOS attack

❖ Tray in your lab

- Ping IP
- Ping URL
- Ping IP -l
- Ping IP -n
- Ping IP -t



```
Microsoft Windows [Version 10.0.16299.967]
(c) 2017 Microsoft Corporation. All rights reserved.

C:\Users\ITD-mabdsalam>ping 127.0.0.1

Pinging 127.0.0.1 with 32 bytes of data:
Reply from 127.0.0.1: bytes=32 time<1ms TTL=128

Ping statistics for 127.0.0.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\Users\ITD-mabdsalam>
C:\Users\ITD-mabdsalam>
```

Part 1 (TCP/IP Protocol Architecture)

RESERVED ADDRESS

❖ Network address:

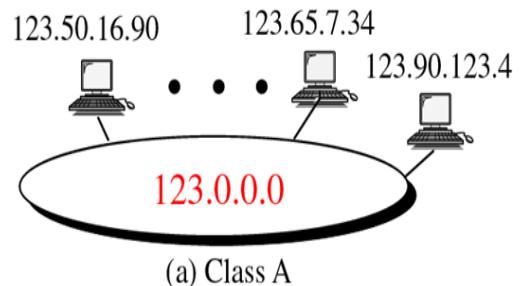
- reserved
- can not be assigned to any device
- used for routing by the router

Class A: 10.0.0.0

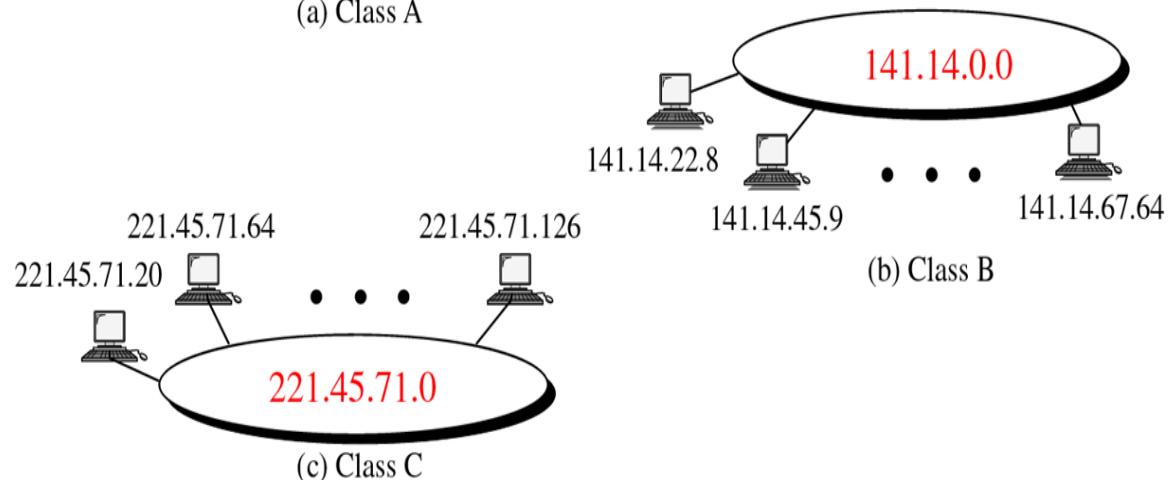
Class B: 172.16.0.0

Class C: 192.168.1.0

Netid	Hostid
Specific	All 0s



(a) Class A

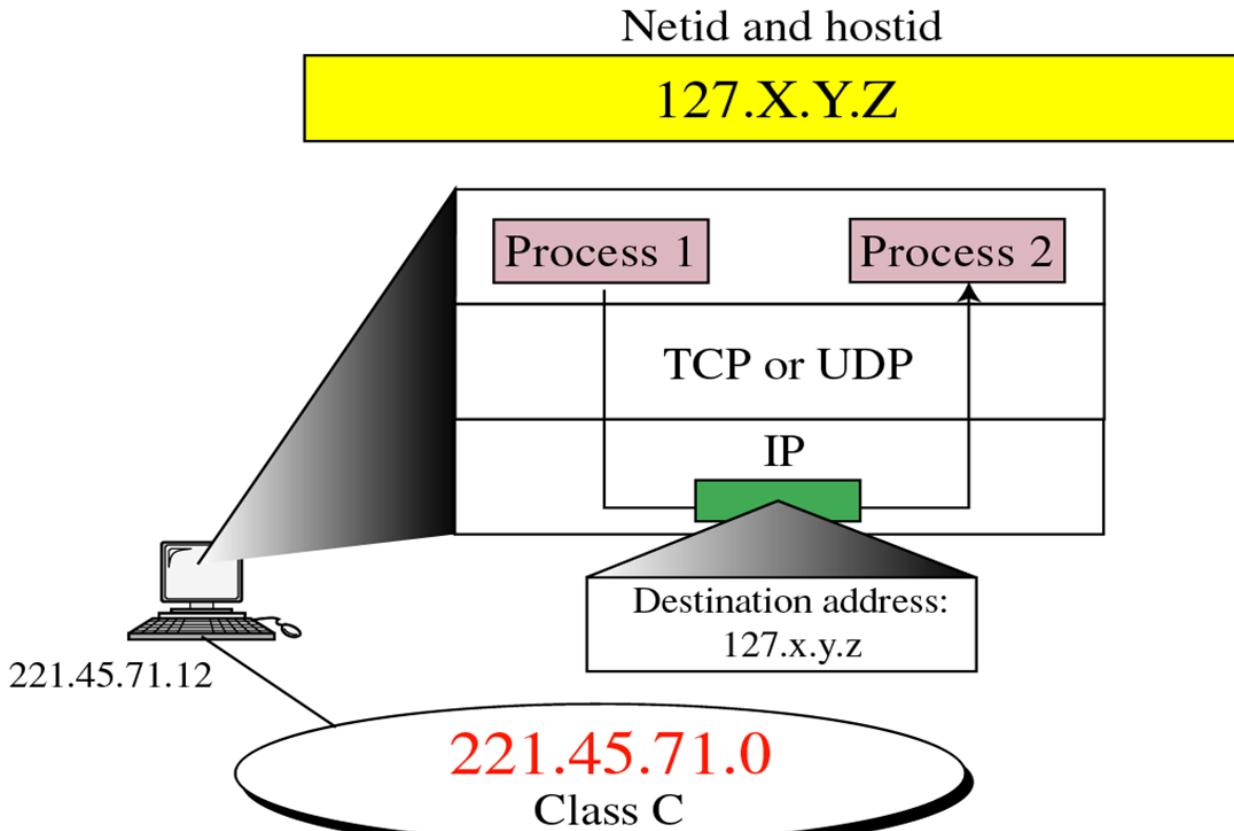


Part 1 (TCP/IP Protocol Architecture)

RESERVED ADDRESS

Loop back Address

- Loopback address: It is used just for testing
- the TCP/IP Protocol Suit 127.0.0.1 example test NIC

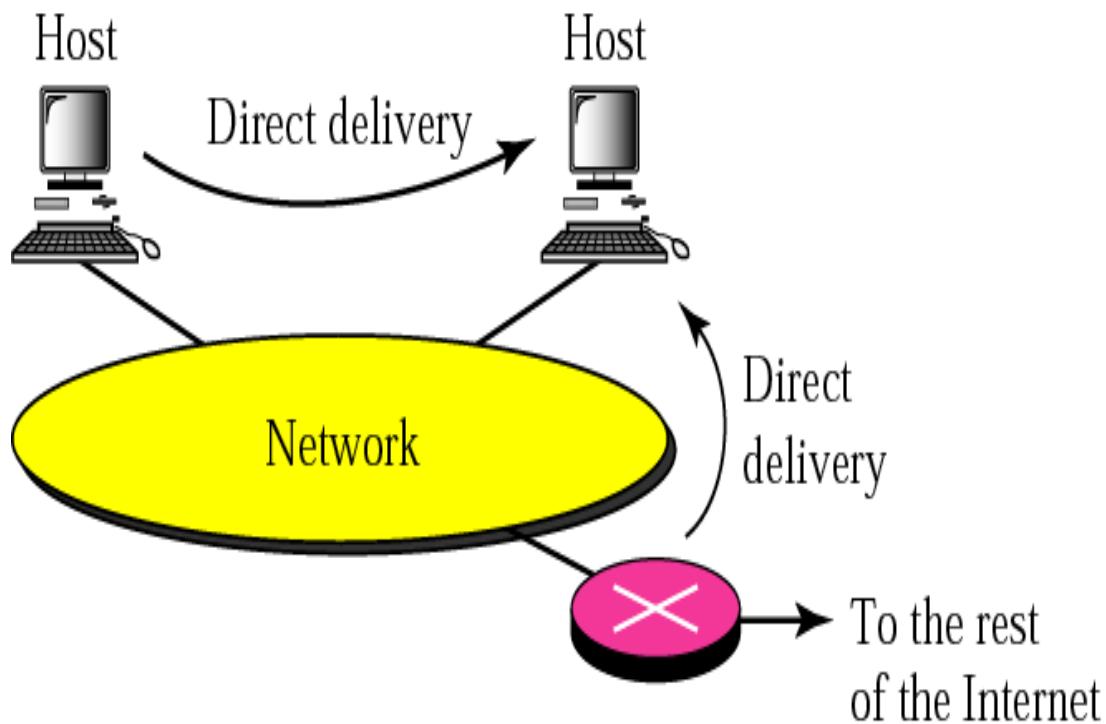


A packet with a loopback address
will not reach the network.

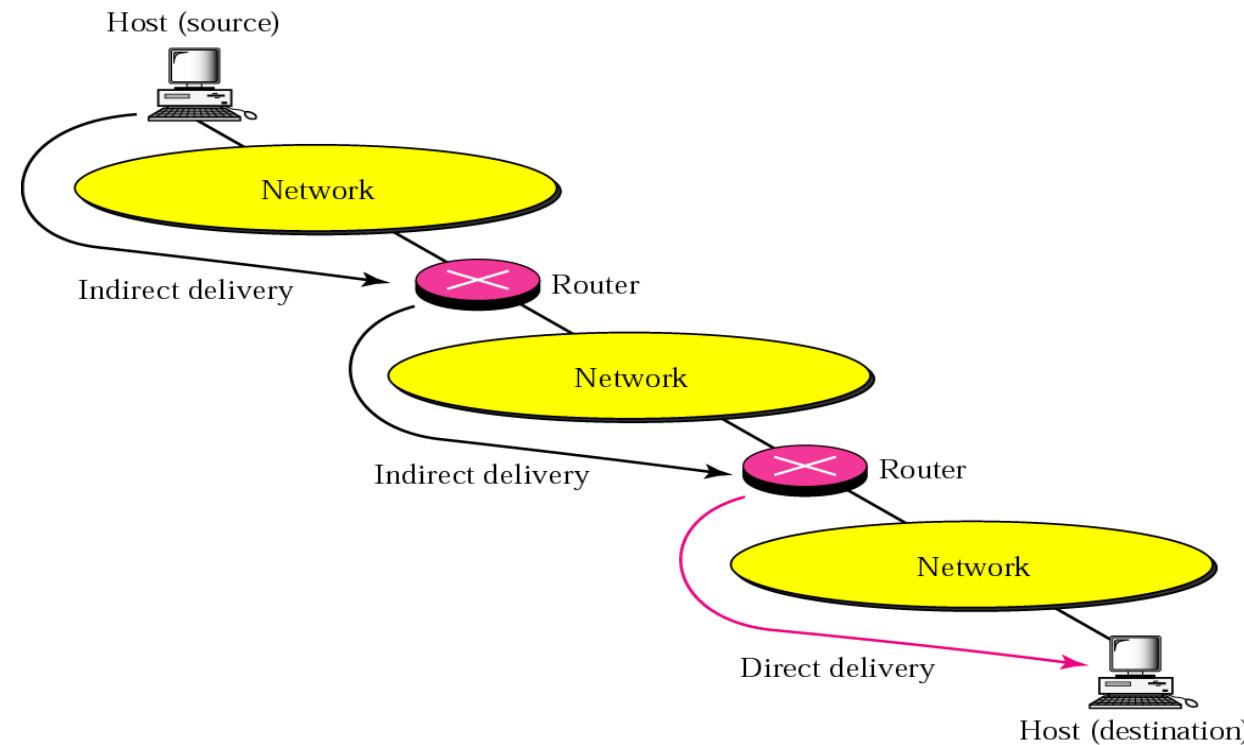
Part 1 (TCP/IP Protocol Architecture)

DELIVERY OF IP PACKETS

Direct delivery



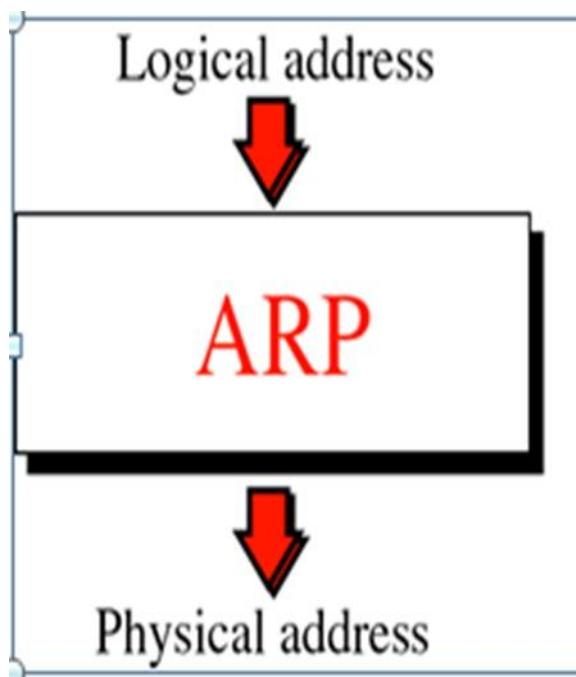
Indirect delivery



Part 1 (TCP/IP Protocol Architecture)- LAB

❖ ARP (ADDRESS RESOLUTION PROTOCOL)

Arp -a



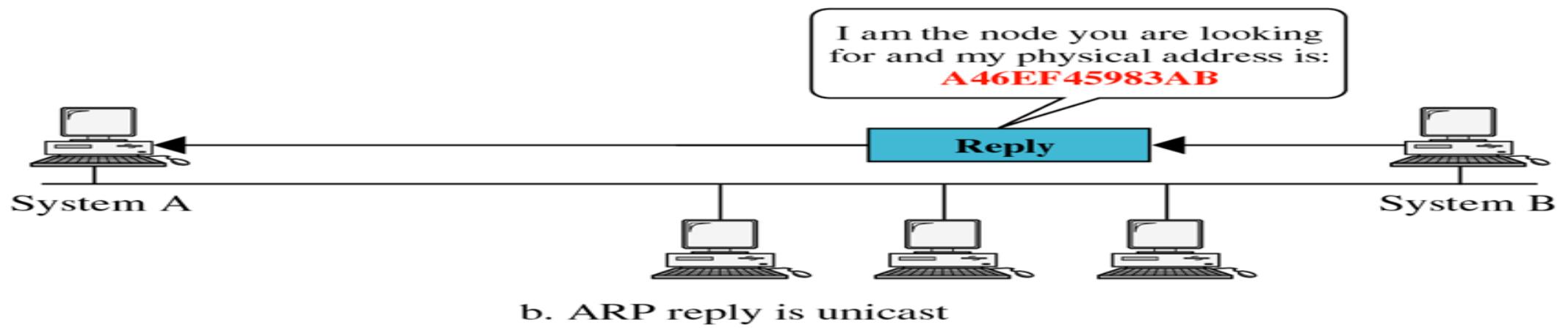
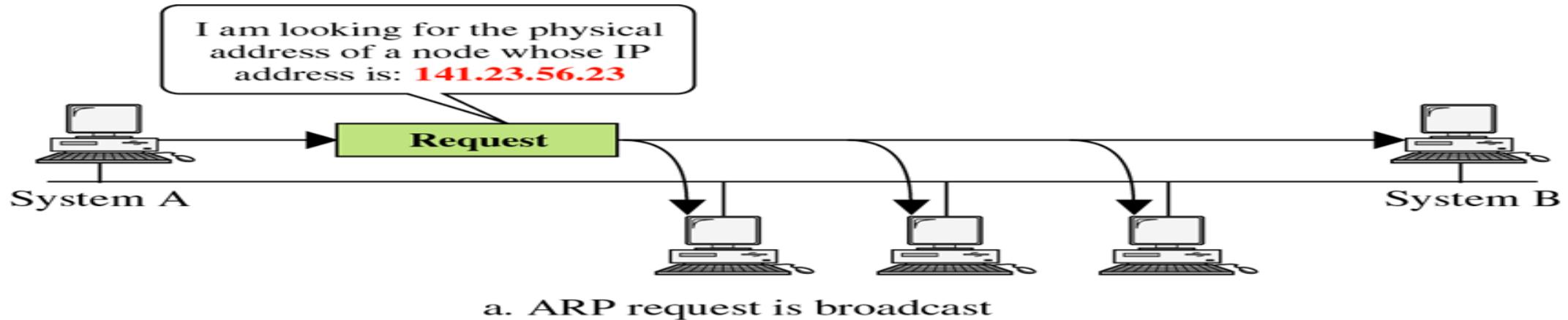
ARP TABLE

A screenshot of a Windows command prompt window titled 'C:\WINNT\system32\cmd.exe'. The window shows the command 'D:\>arp -a' followed by a table of ARP entries. The table has columns for Interface, Internet Address, Physical Address, and Type. The data is as follows:

Interface	Internet Address	Physical Address	Type
192.168.1.101 on Interface 0x1000003	192.168.1.1	00-04-5a-22-ec-c7	dynamic
	192.168.1.40	00-02-4b-cc-d6-d9	dynamic
	192.168.1.42	00-02-fd-65-9f-82	dynamic
	192.168.1.43	00-03-6b-09-59-29	dynamic
	192.168.1.100	00-02-4b-cc-d6-d0	dynamic
	192.168.1.135	00-03-6d-1e-6a-a5	dynamic
	192.168.1.149	00-50-8b-f7-cf-59	dynamic

Part 1 (TCP/IP Protocol Architecture)

❖ ARP OPERATION



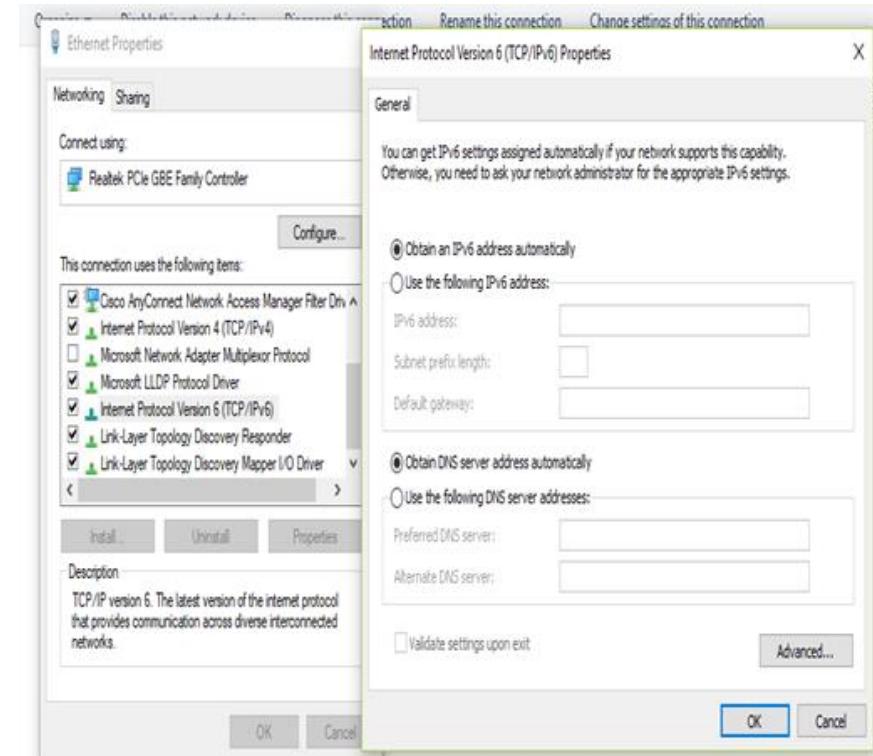
Session 1 (TCP/IP Protocol Architecture)



• Internet Protocol (IP V6)

- 128-bit address, provides approximately $(340,282,366,920,938,463,463,374,607,431,768,211,456) =$ approximately 340 undecillion, or 340 billion billion billion, addresses)
- Represented as eight groups, separated by colons, of four hexadecimal digits. The full representation may be simplified by several methods of notation;

2001:0db8:0000:0000:8a2e:0370:7334
= 2001:db8::8a2e:370:7334



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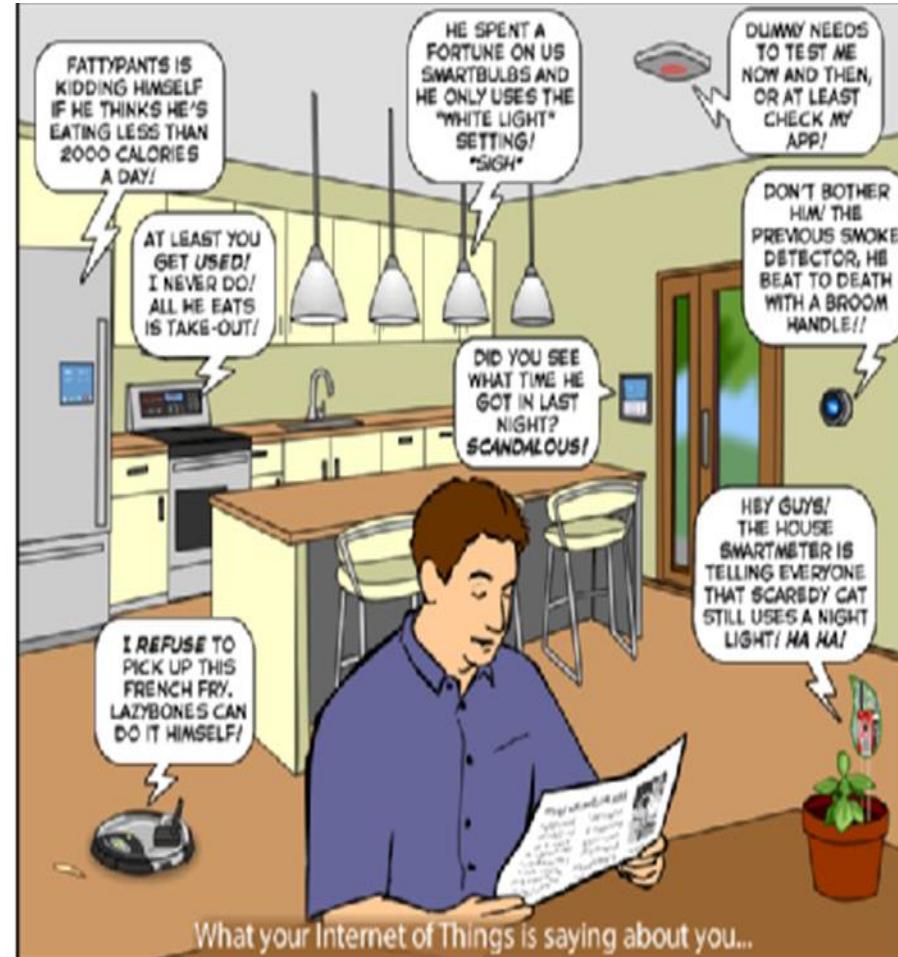


• Internet Of Things (IOT)

- Aims connect all devices to the existing Internet infrastructure.
- "things" that sense and collect data and send it to the internet.
- (Eg:- coffee maker, A.C, Washing Machine, Ceiling Fan, lights , any thing) having sensors can be connected with internet.

• PRACTICAL APPLICATIONS:-

- Smart Homes -Smart Cities-Energy - Environment monitoring- healthcare- Management



Thank You