Information Technology Institute

# ITI

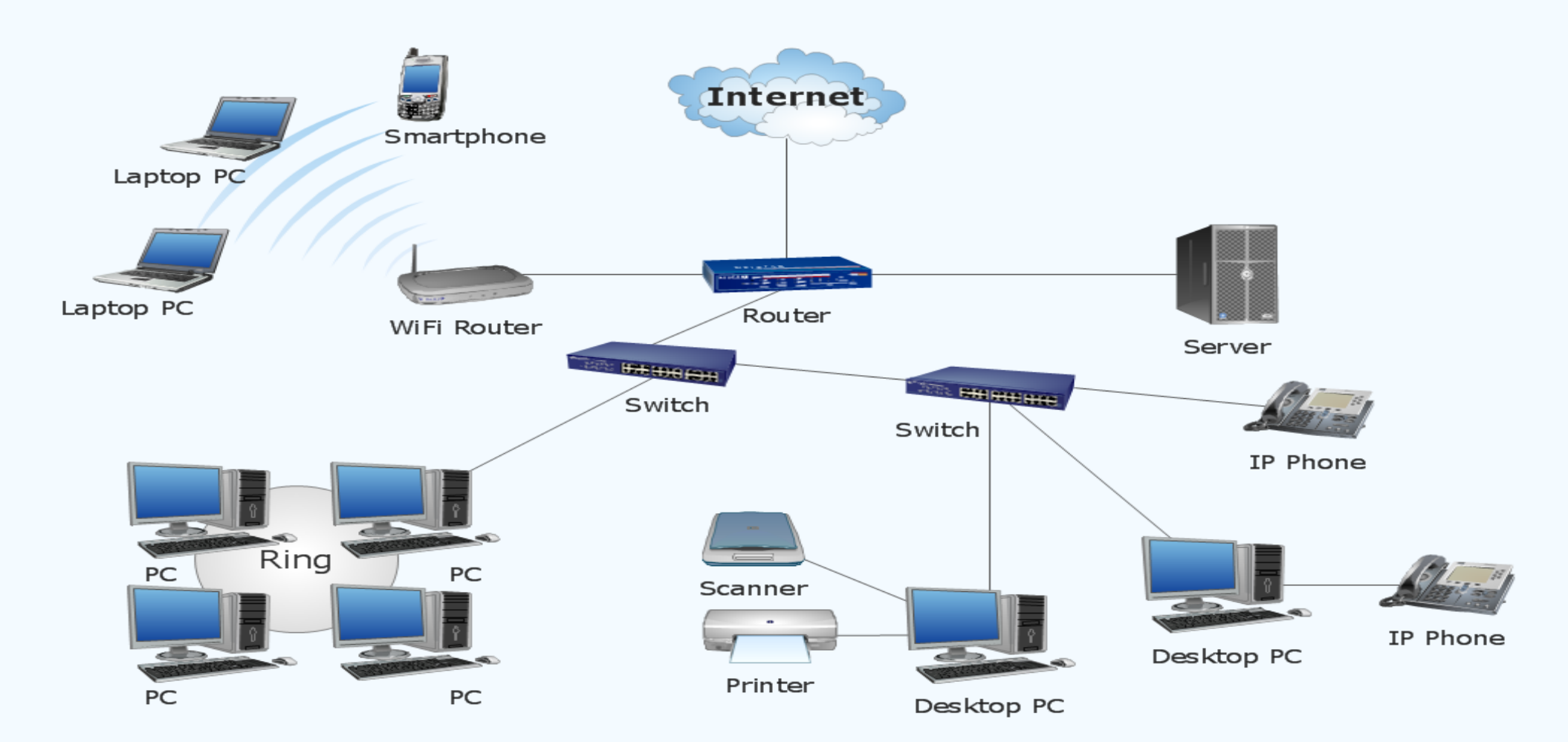
## Introduction to Computer Networks & Cyber Security

Prepared By : Mohamed AboSehly

# Building the network

**What do you need to build your network?**

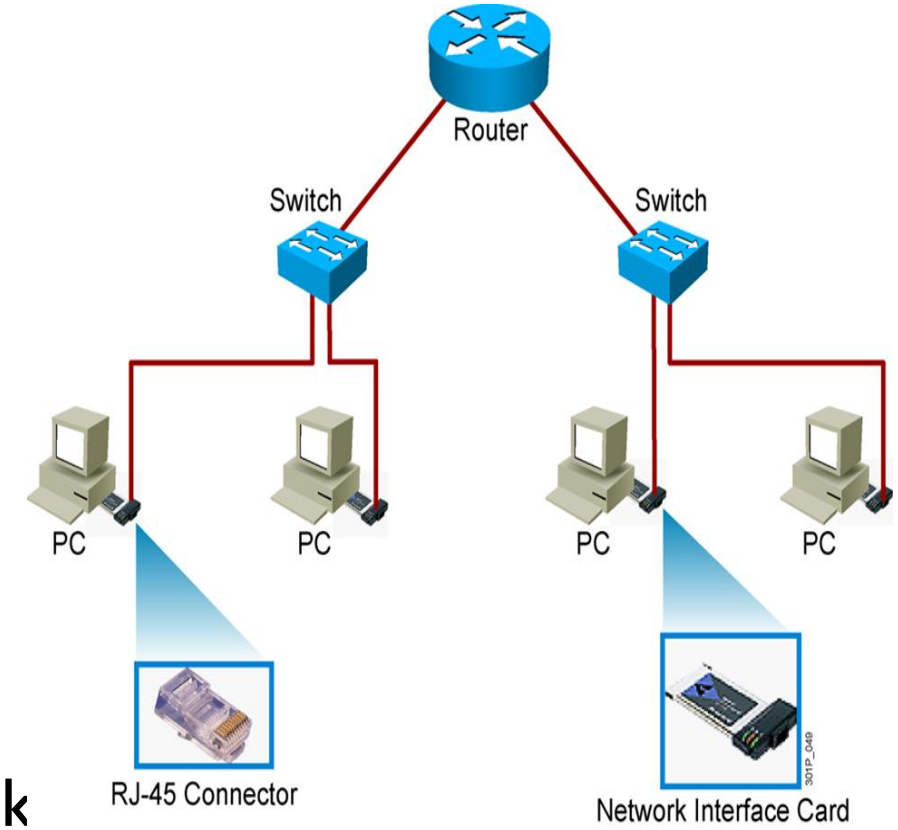
# Simple Network



# Basic Network Elements ( Hardware / Software )

- **Hardware**
  - **Devices**
    - Computers – Printers –Phone – Routers - Switches
  - **Medium**
    - Wired -Wireless –Satellites

- **Software**
  - **Messages**
    - Information that travels over the medium
    - Mails-WhatsApp….etc
  - **Protocols**
    - Governs how messages flow across network
    - http –https-FTP-RDP



# Basic Network Elements (Software)

## Software

Protocols

# Basic Network Elements (Software)

## What is Protocols ?

- Communication rules that all entity must agree on
- Method to connect internetworking elements

## Why we need Protocols ?

- To communicate **efficiently**
- Enable data to flow from one NIC to another
- **Control** the messages and the messages quantity in the network.

# Host to Host Communication

## Older Model

- Proprietary
- Application and combinations software controlled by one vendor

## Standard based Model

- Multivendor software
- Layered approach

# Open Systems Interconnection Reference Model
# OSI RM

# Part 1_Basic Network Elements

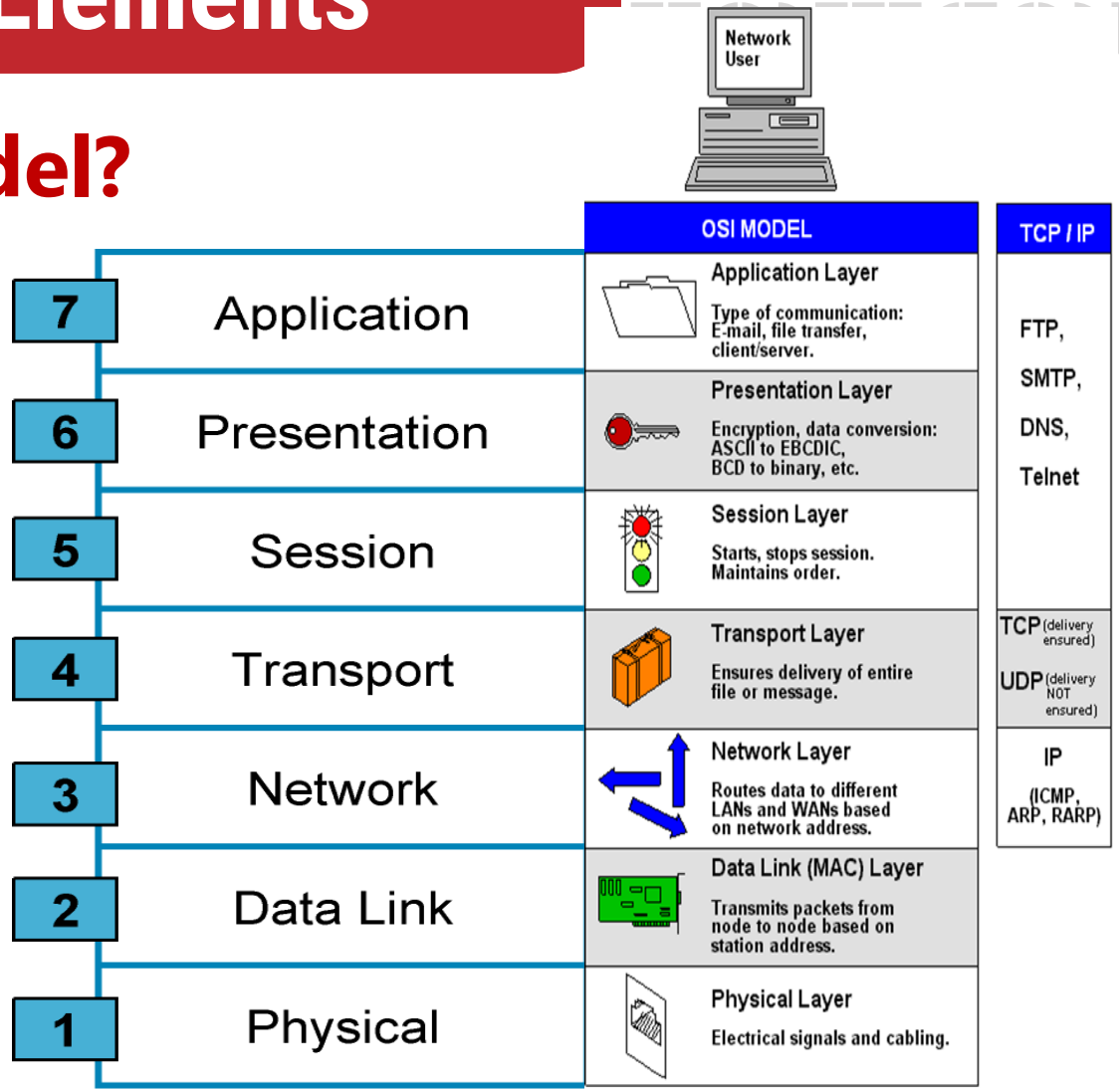
## OSI Reference Model

- 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

## Why a Layered Network Model?

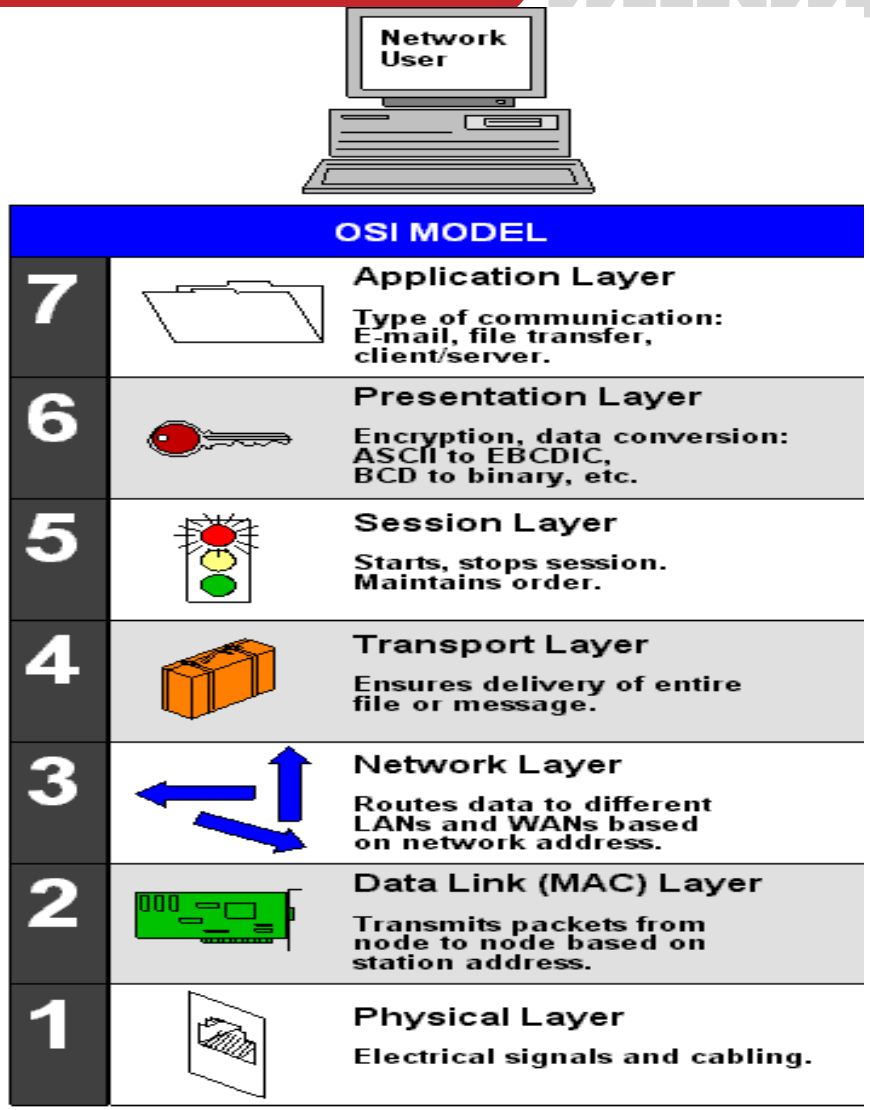
- Reduces complexity
  - Easier to troubleshooting
- Standardizes interfaces
  - Multiple-vendor
- Layer Separation
  - Changes in one layer do not affect other layers
- Simplifies teaching and learning



# Part 1_Basic Network Elements

## OSI (7-Seven Layers)

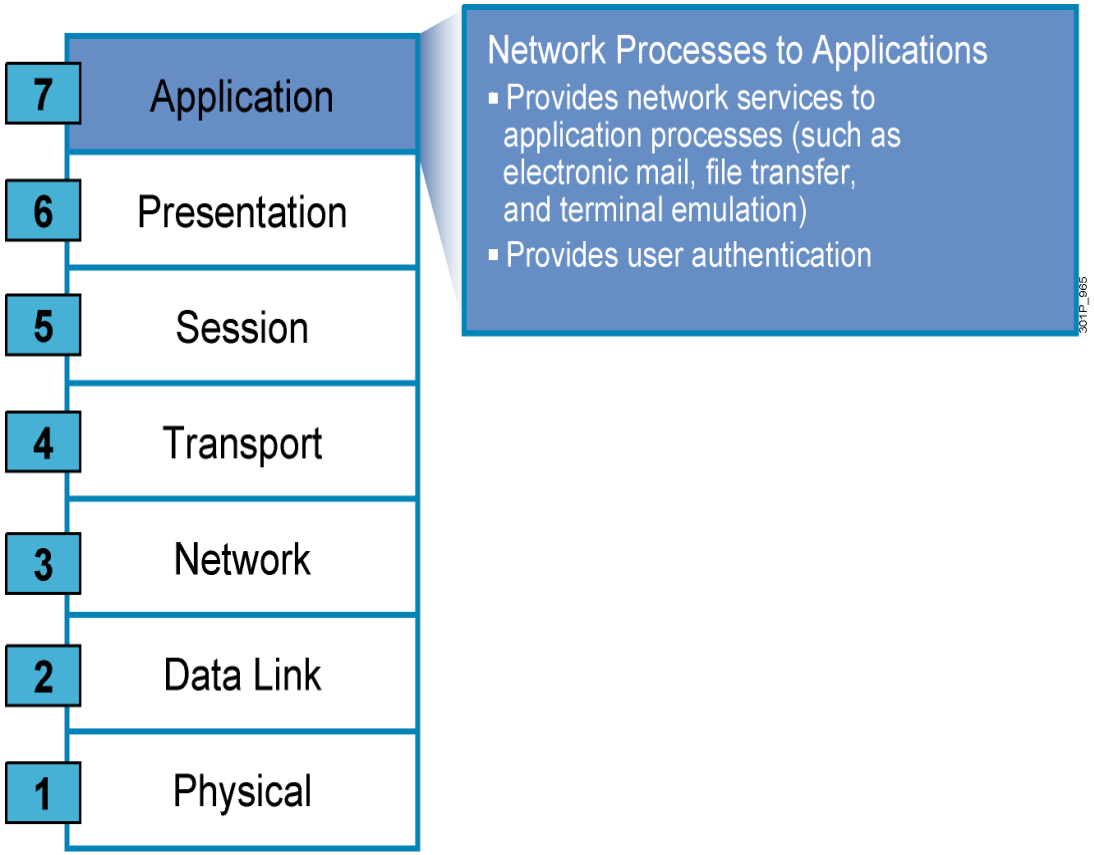
- Application
- Presentation
- Session
- Transport
- Network
- Data Link
- Physical



# Part 1_Basic Network Elements

## ◊ Application Layer

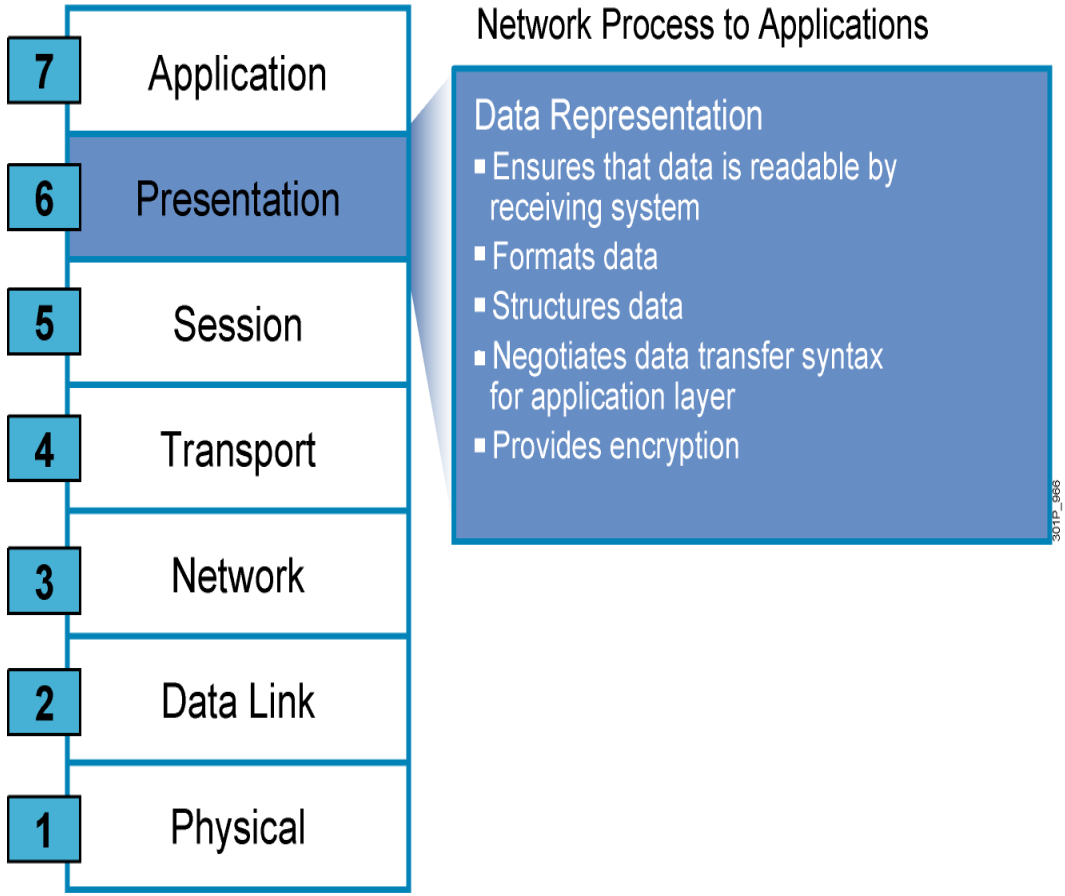
- ◊ Interface to end users
- ◊ provides Many services
  - ◊ File transfer
  - ◊ Network management
  - ◊ Email
- ◊ Protocols
  - ◊ HTTP (Hyper Text Transfer Protocol)
  - ◊ FTP (File transfer Protocol)
  - ◊ SMTP (Simple Mail transfer Protocol)
  - ◊ POP3 (Post office transfers Protocol)
  - ◊ Telnet/SSH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



# 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

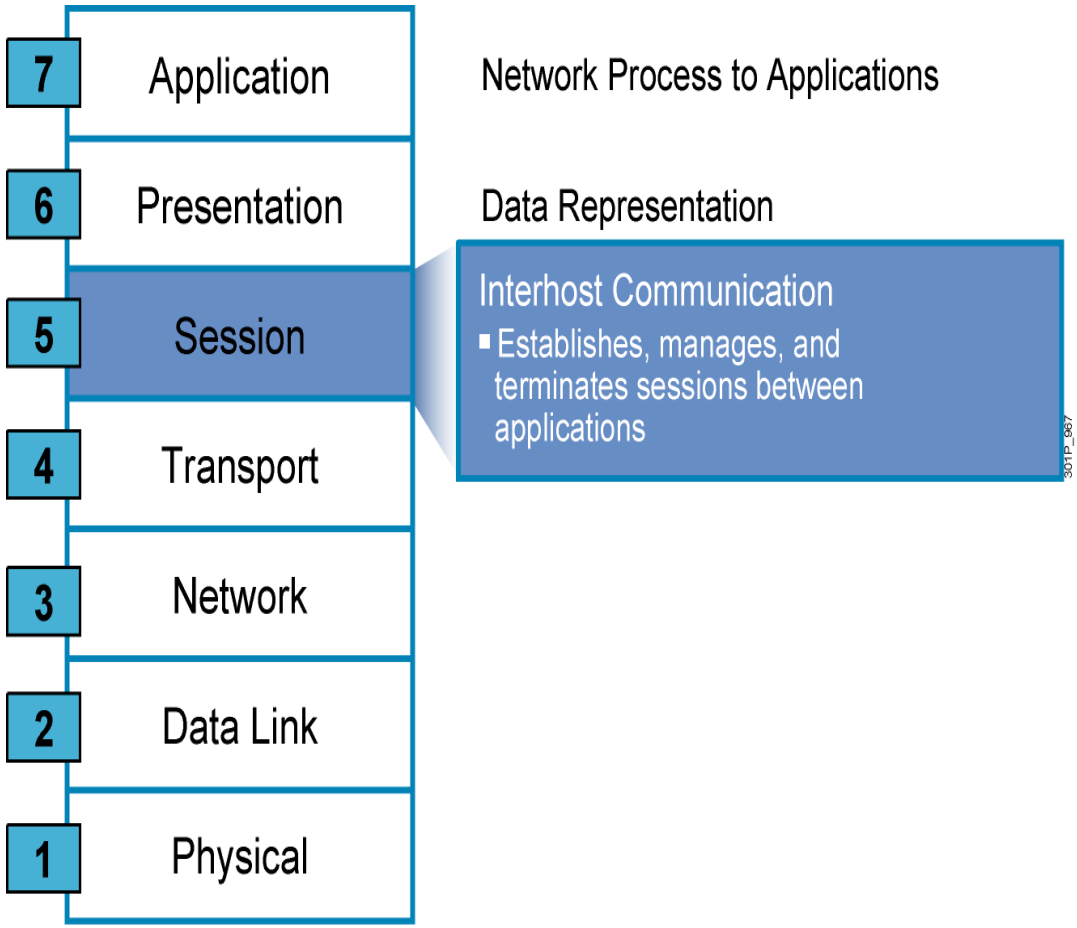


# Basic Network Elements (Software)_OSI

## The Seven Layers Functions (Cont.)

### ◊ Session Layer

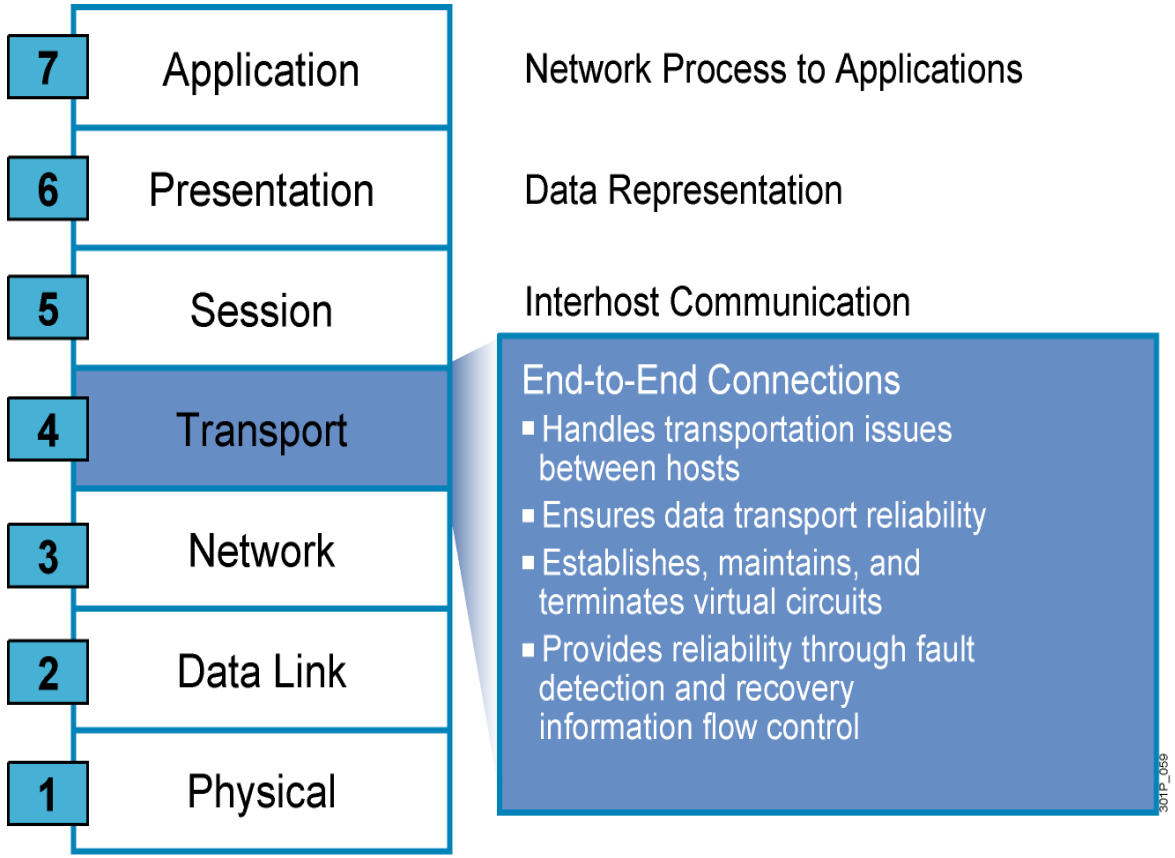
- ◊ **Establishes**, **manages** and **terminates** sessions (connections) between cooperating applications (Dialogues)
- ◊ **Synchronization** (add checkpoints into a stream of data)
- ◊ **Controls the sessions** between the local and remote applications



# The Seven Layers Functions (Cont.)

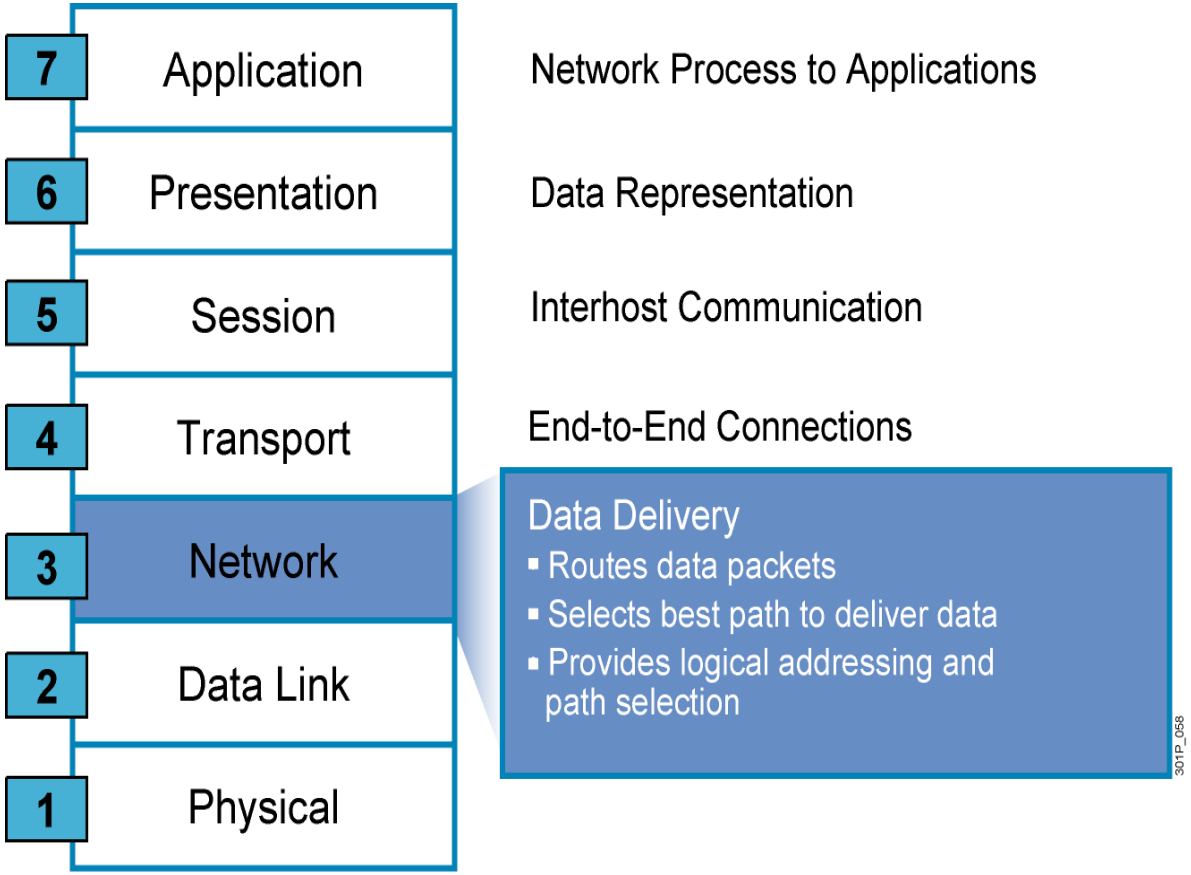
## ◊ Transport Layer

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



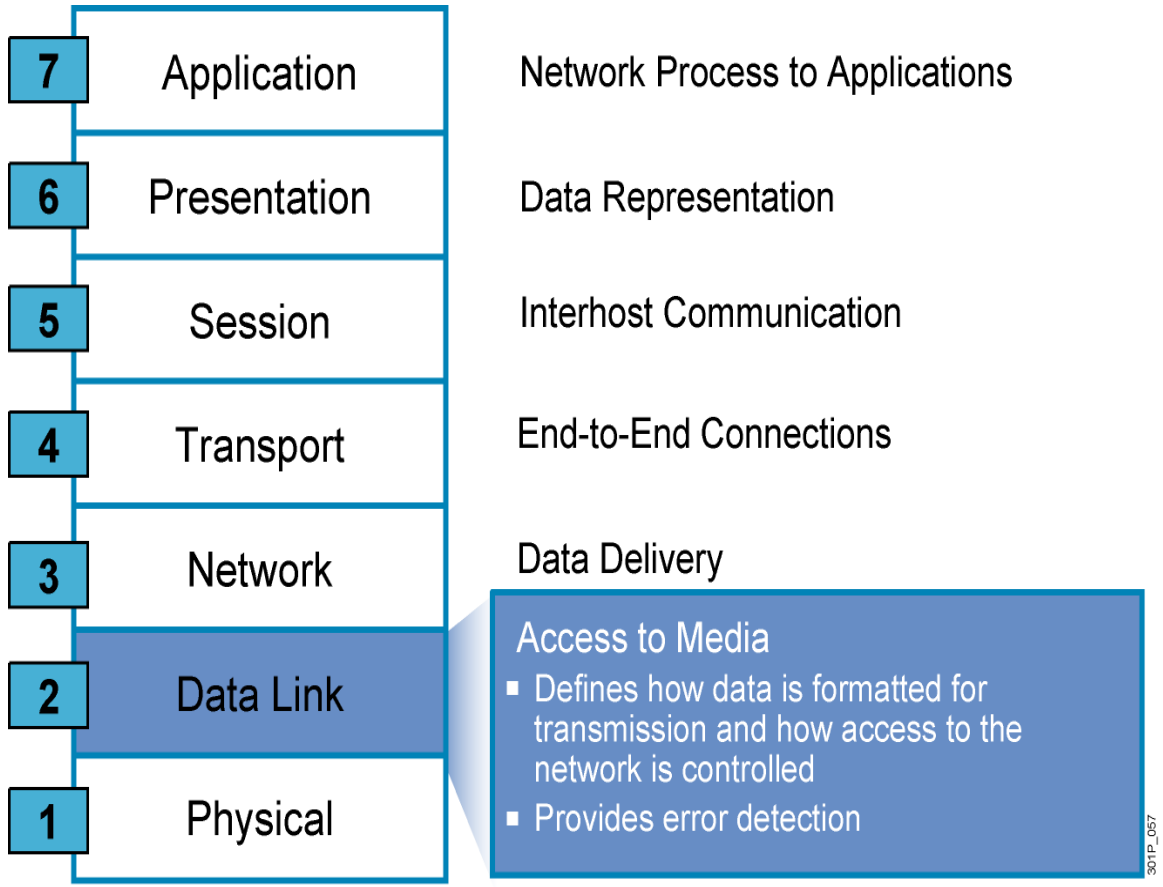
# The Seven Layers Functions (Cont.)

- 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



# The Seven Layers Functions (Cont.)

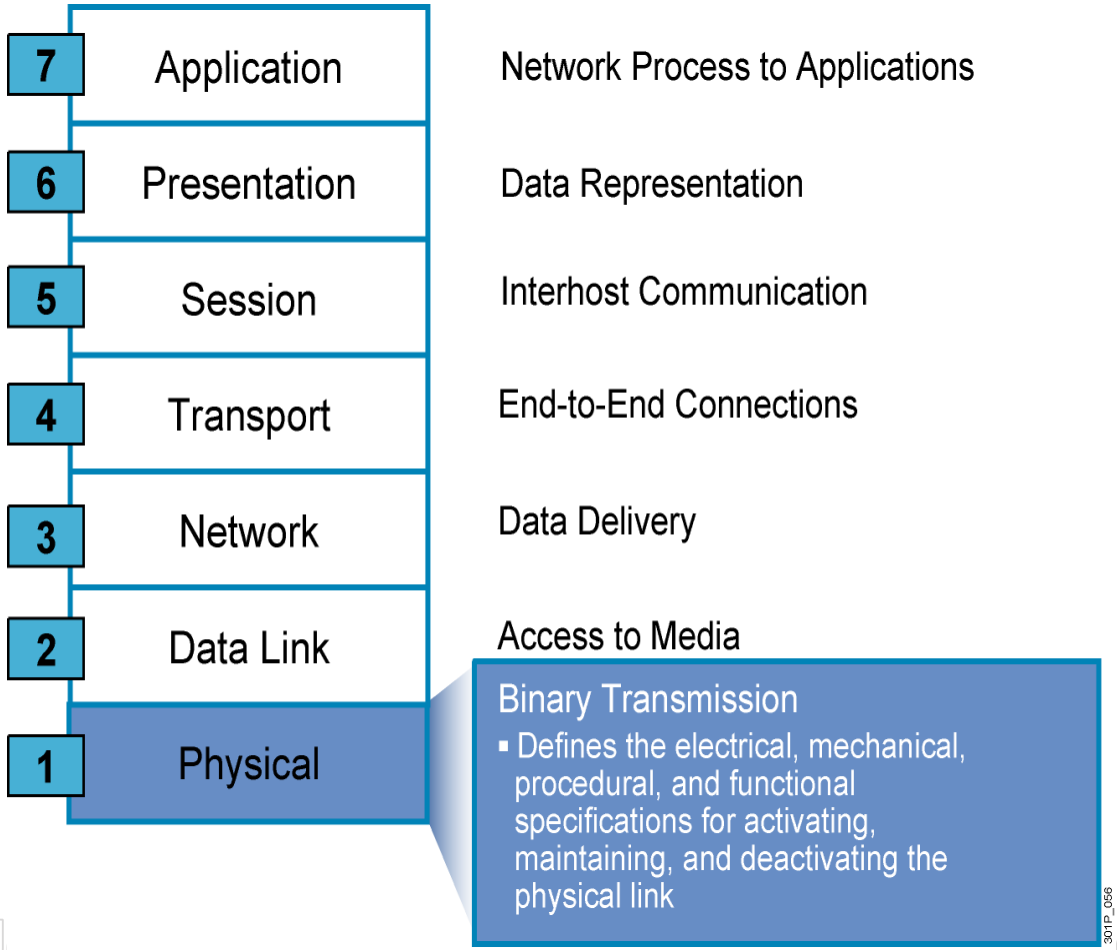
- Data link
  - Reliable data transfer across a **physical link** (Error Control)
  - Organize the data into **Frames**, to be put on the physical medium
  - Check the Frame For errors
  - **Hop to hop** addressing



# Part 1_Basic Network Elements

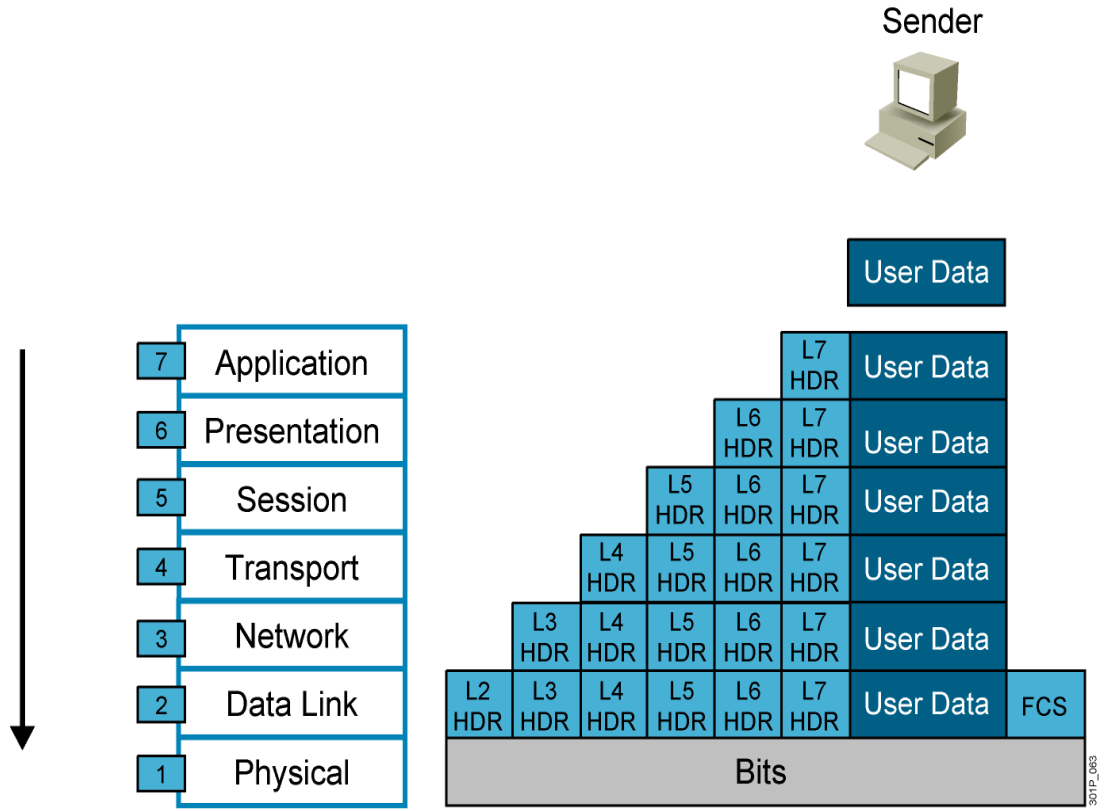
## The Seven Layers Functions (Cont.)

- **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



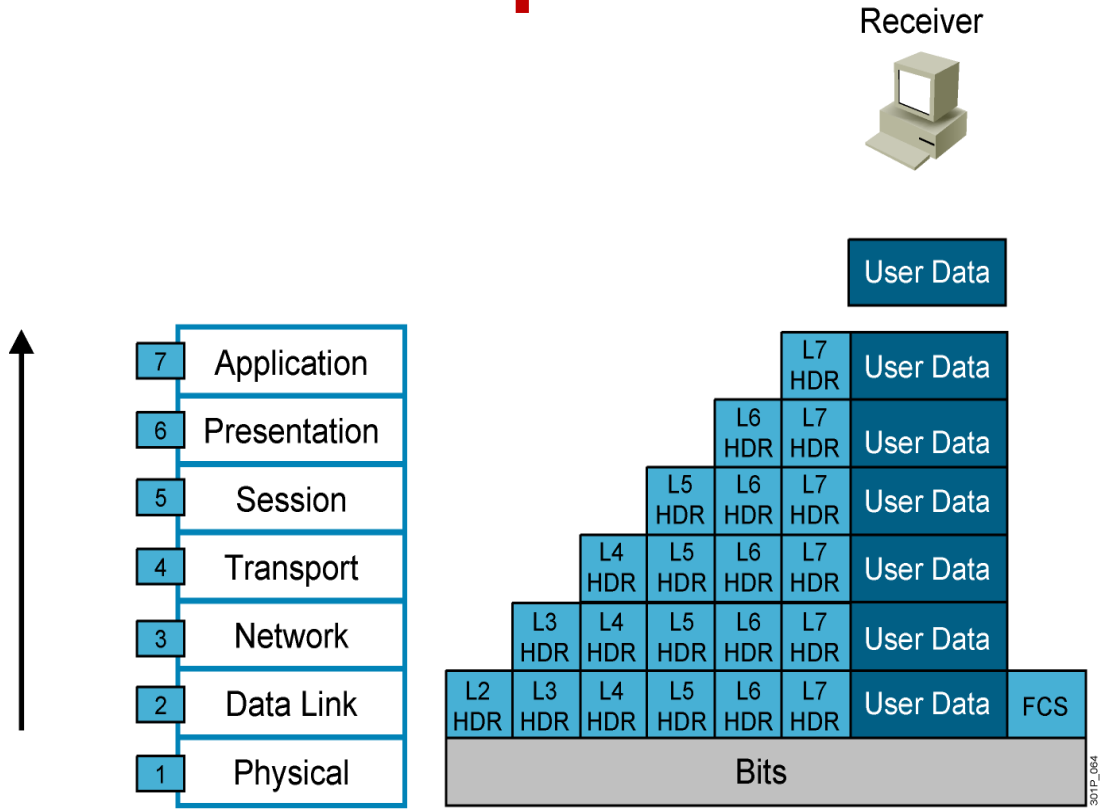
# Part 1_Basic Network Elements

## Data Encapsulation




HDR = Header

## Data De-Encapsulation

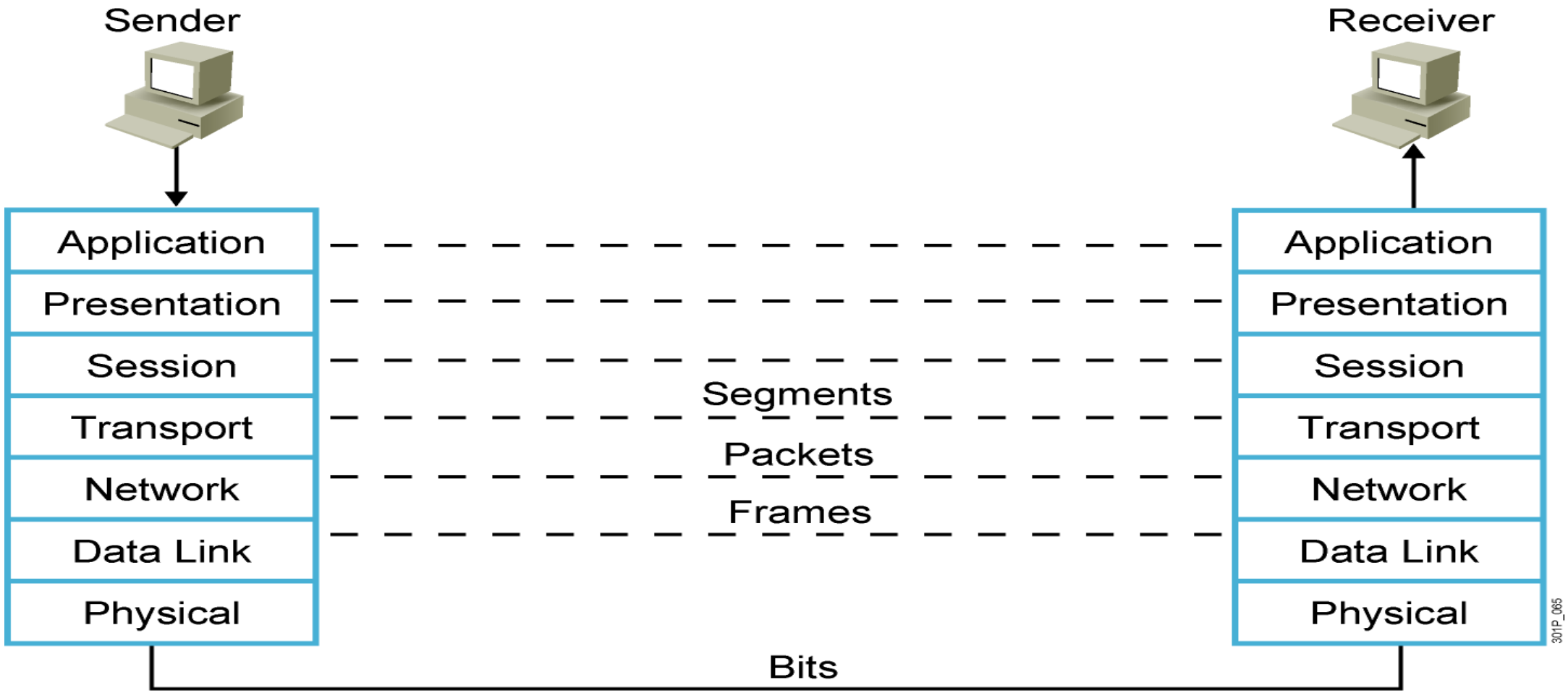



HDR = Header

(FCS) frame check sequence used for error-detecting/Hash

# Part 1_Basic Network Elements

## Peer-to-Peer Communication

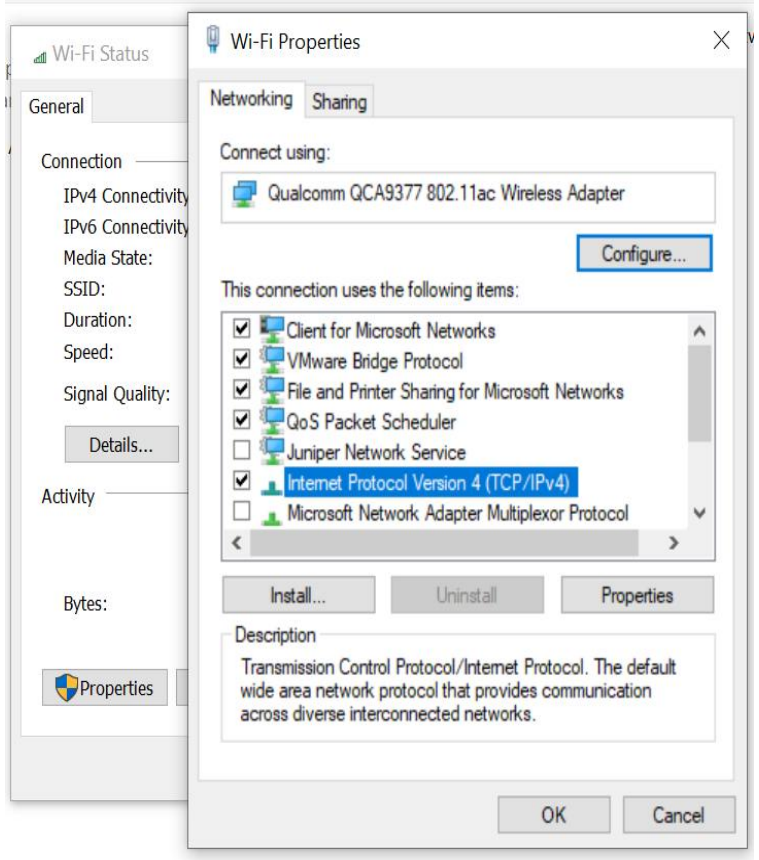


# Part 1_Basic Network Elements

## Transmission Control Protocol/Internet Protocol
## TCP /IP

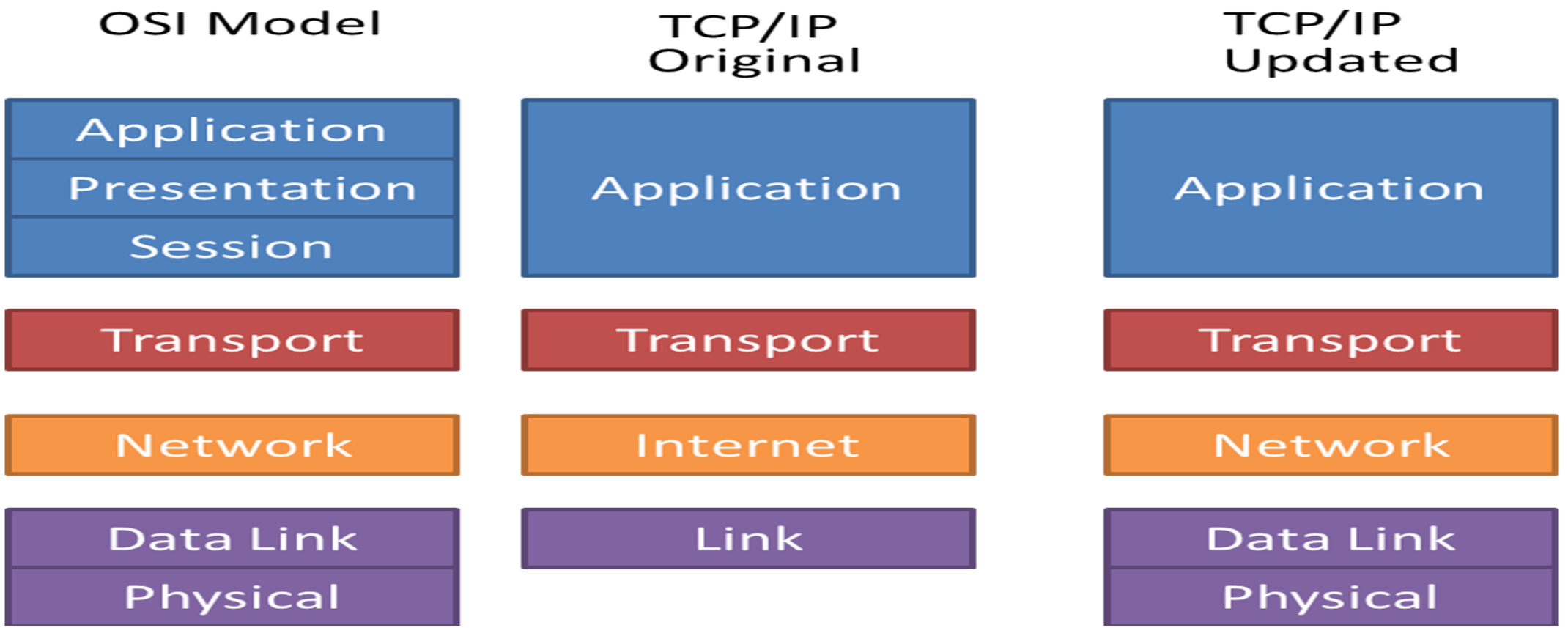
# Part 1_ (TCP/IP Protocol Suite)

- **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**



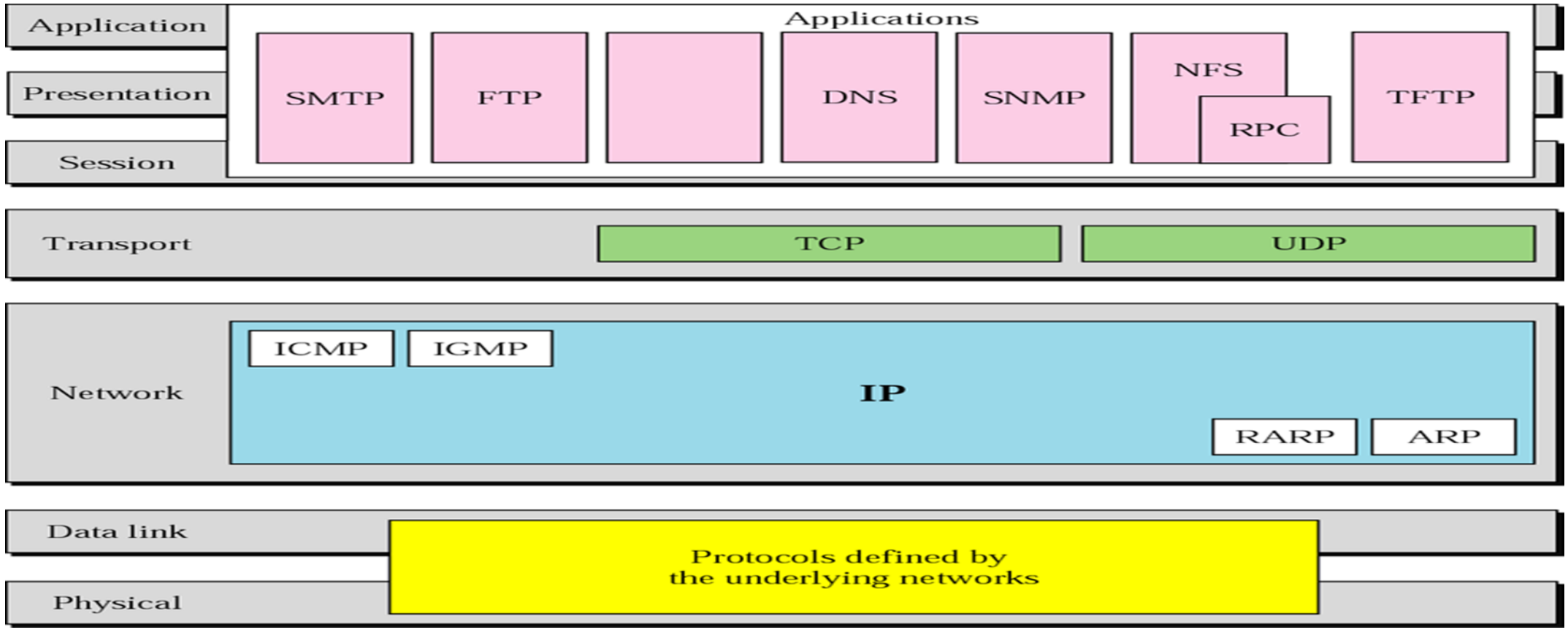
# Part 1_(TCP/IP Protocol Suite)

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



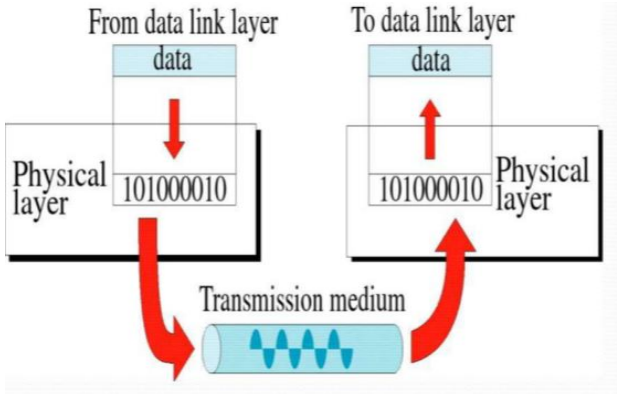
# Part 1_(TCP/IP Protocol Architecture)

- Some Protocols in TCP/IP Suite



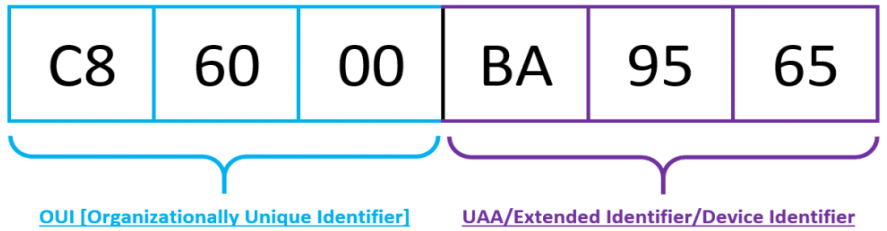
# Part 1_(TCP/IP Protocol Architecture)

- **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)

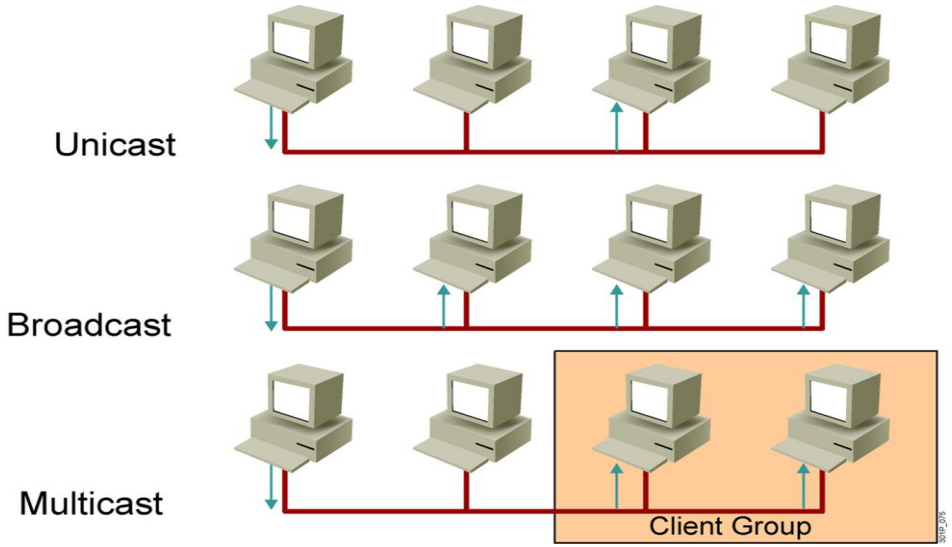



# Part 1_(TCP/IP Protocol Architecture)

- **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:
```

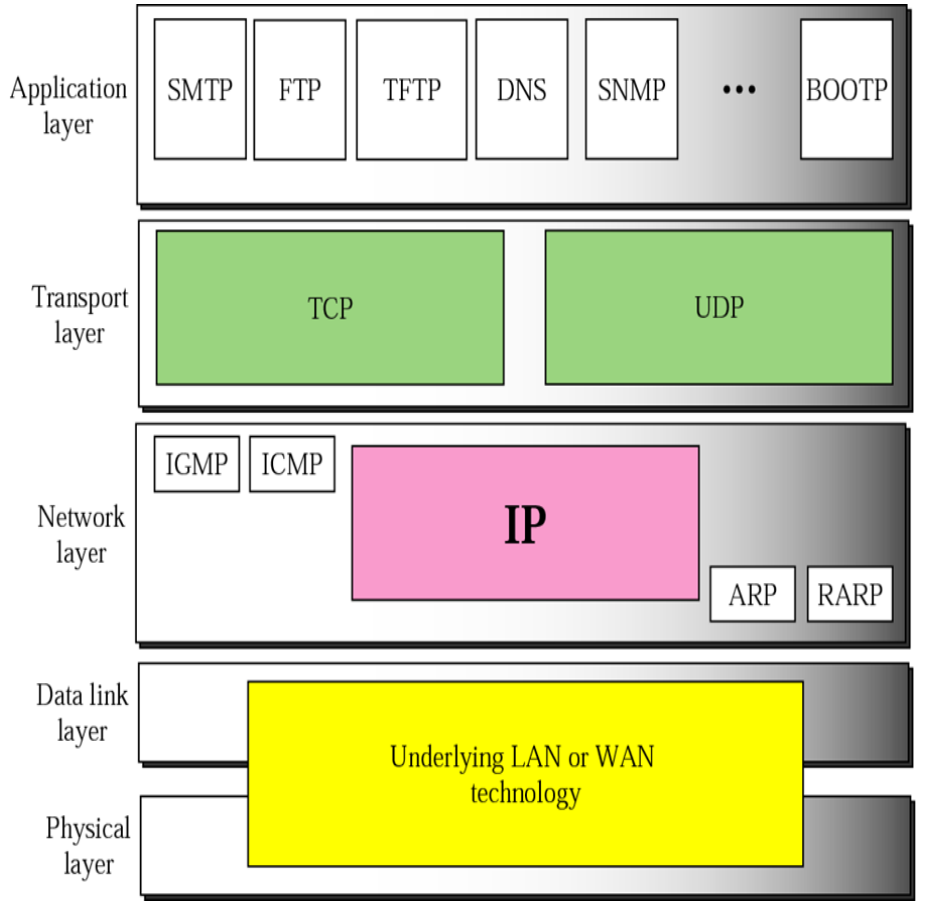
```
C:\Users\ITD-mabdsalam>getmac

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 232 or 4,294,967,296**

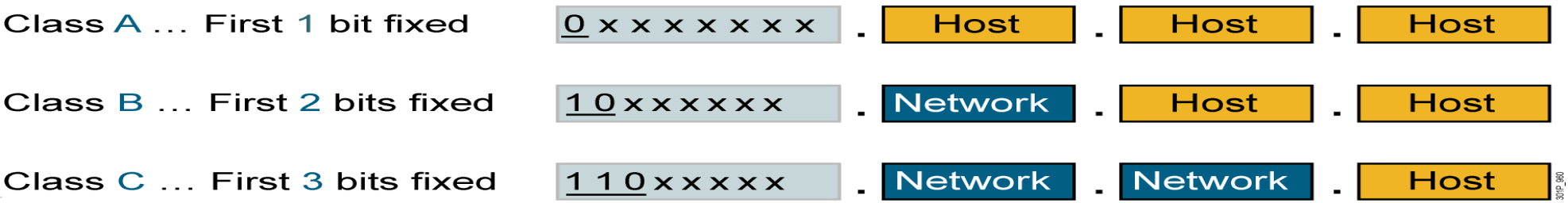
# Part 1 (TCP/IP Protocol Architecture)

## 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



# Part 1 (TCP/IP Protocol Architecture)

## PUBLIC IP ADDRESSES (Real IP)

| Class | Public IP Ranges |
|---|---|
| A | 1.0.0.0 to 9.255.255.255<br>11.0.0.0 to 126.255.255.255 |
| B | 128.0.0.0 to 172.15.255.255<br>172.32.0.0 to 191.255.255.255 |
| C | 192.0.0.0 to 192.167.255.255<br>192.169.0.0 to 223.255.255.255 |

## Private IP Addresses (Local IP)

| 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.

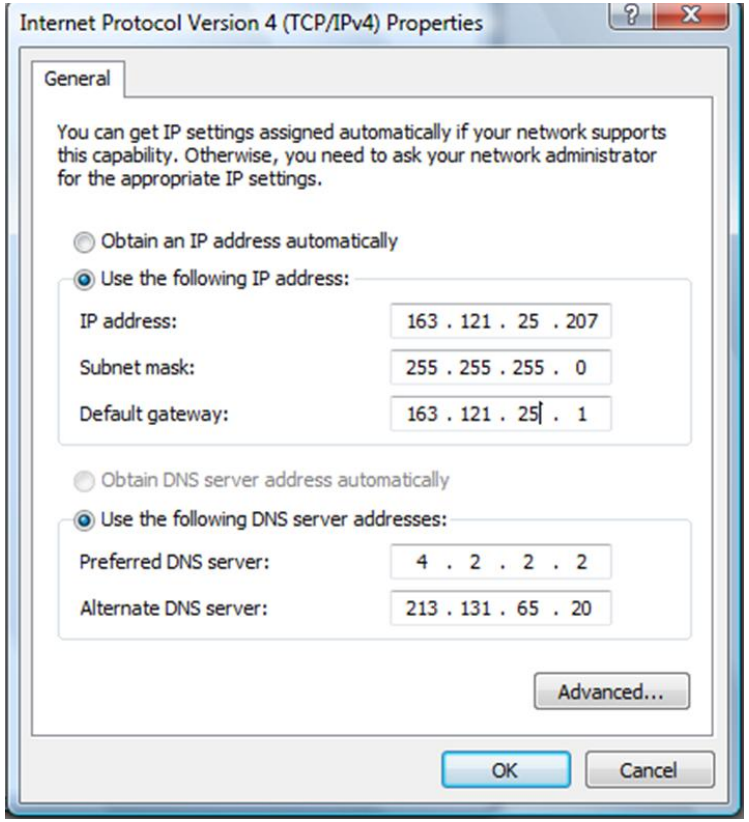
# Part 1 (TCP/IP Protocol

## ❖ How to assign IP address to device

- Manually
- Automatic
- APIPA

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

- Manually

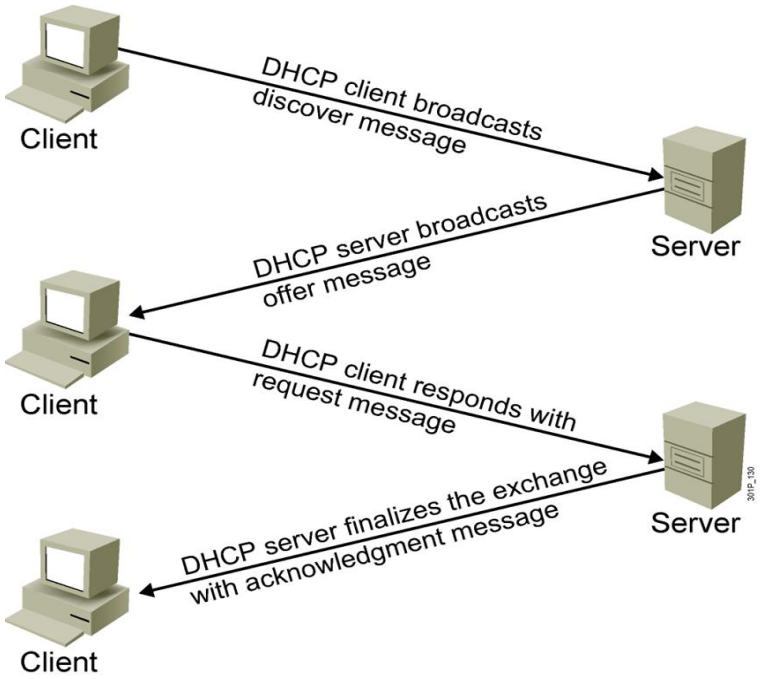


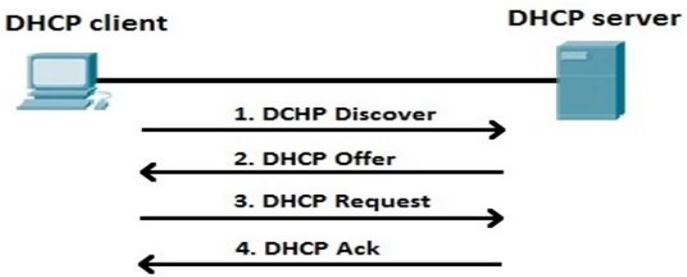
# Part 1 (TCP/IP Protocol Architecture)-

## ❖ 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)



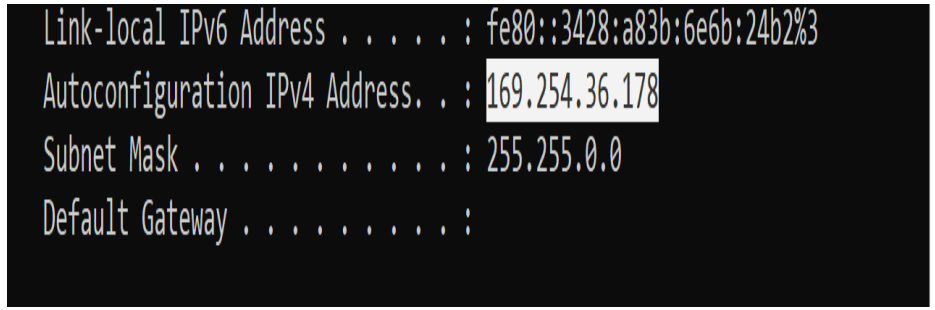
# Part 1 (TCP/IP Protocol Architecture)-

## ❖ 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

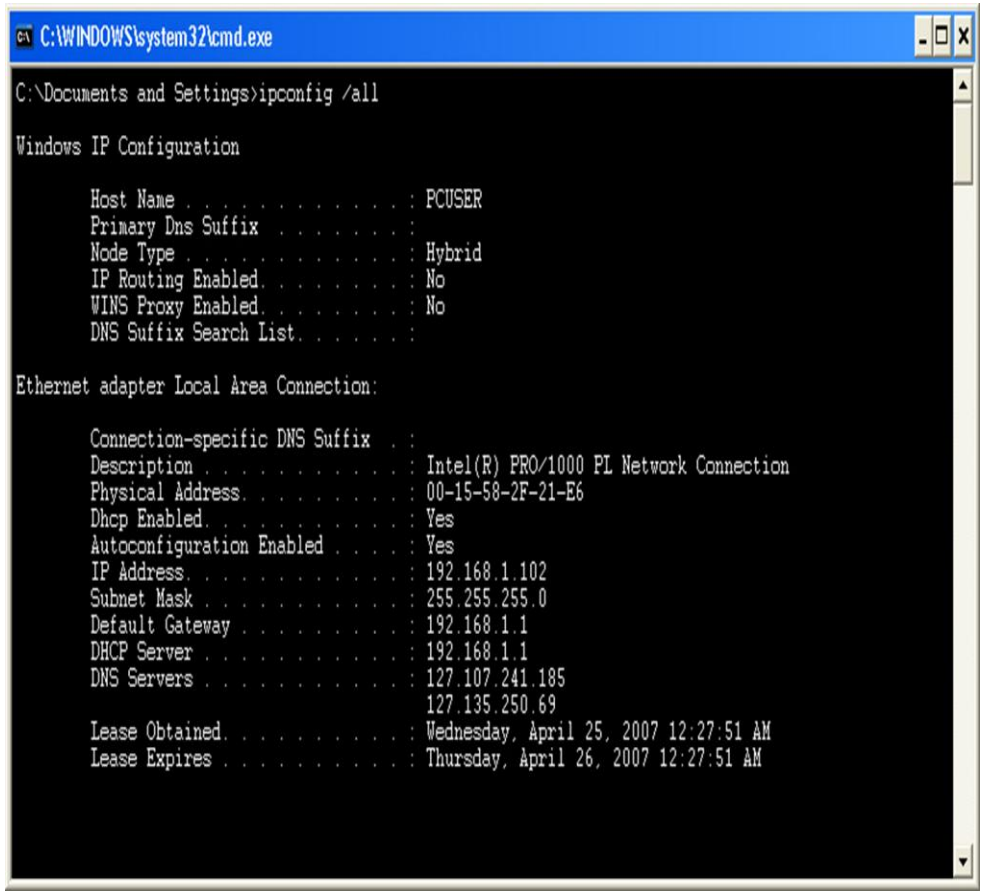


# Part 1 (TCP/IP Protocol Architecture)-

## ❖ 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

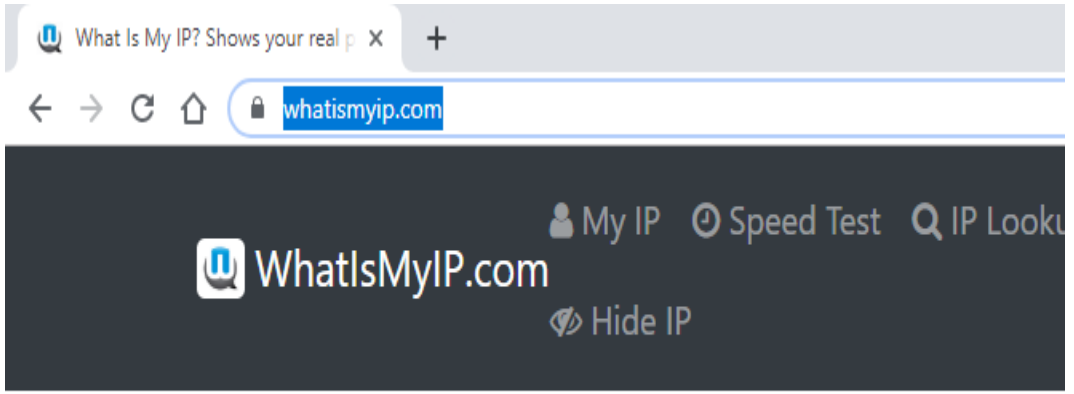
- Ipconfig
- Ipconfig /all
- Ipconfig /release
- Ipconfig /renew

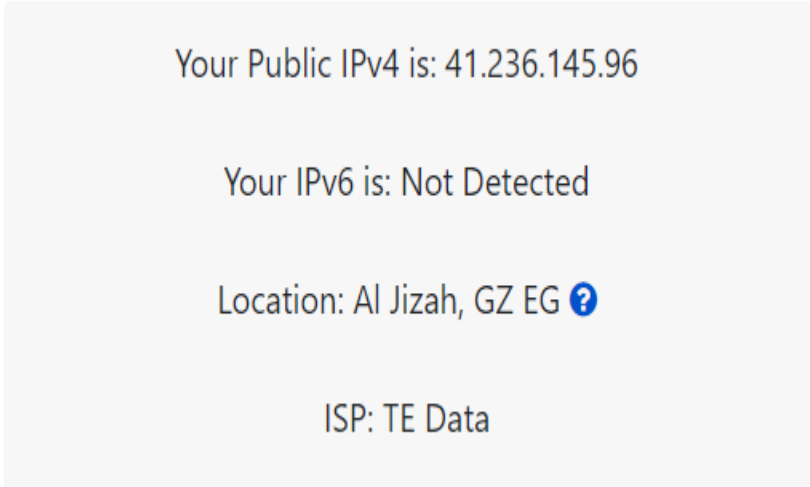
# Part 1 (TCP/IP Protocol Architecture)-

- 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

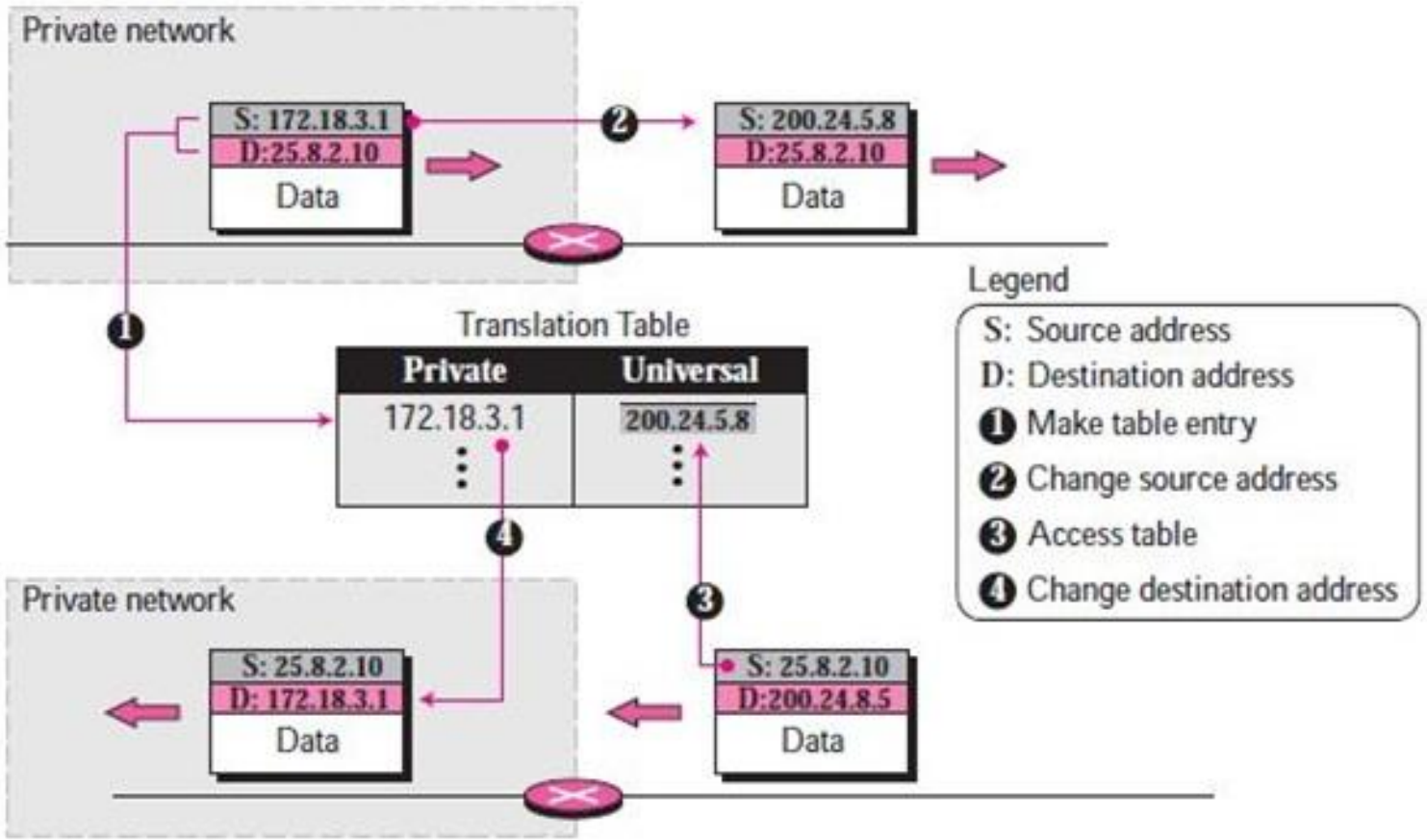
- With the  grow the of the pubic IP address we used **NAT** and **IPV6**



## Network Address Translation(NAT)

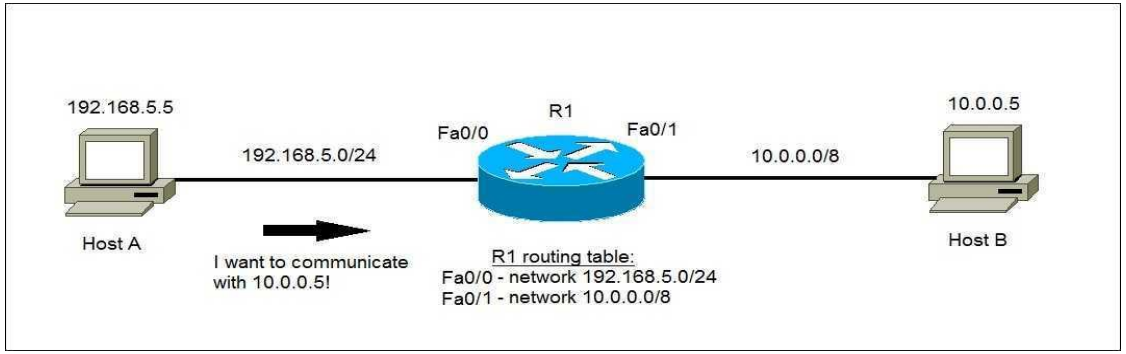
The technology allows a site to use a set of private addresses for internal communication and a set of global Internet addresses (at least one) for communication with the rest of the world

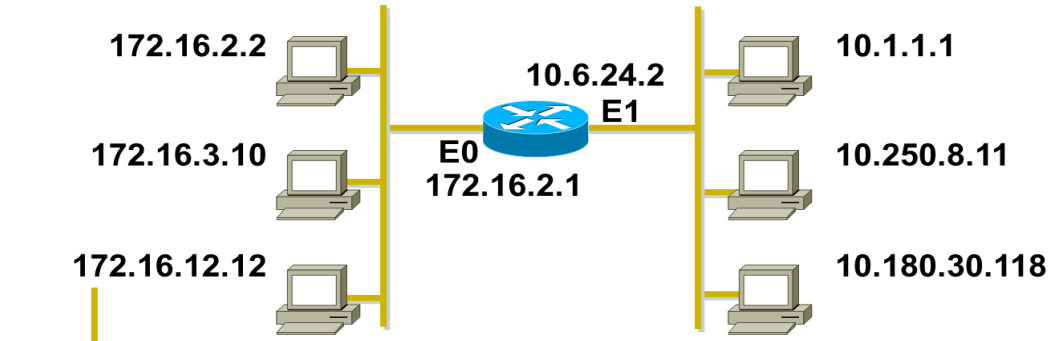


# Part 1 (TCP/IP Protocol Architecture)-

## HOST ADDRESSES & ROUTING

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



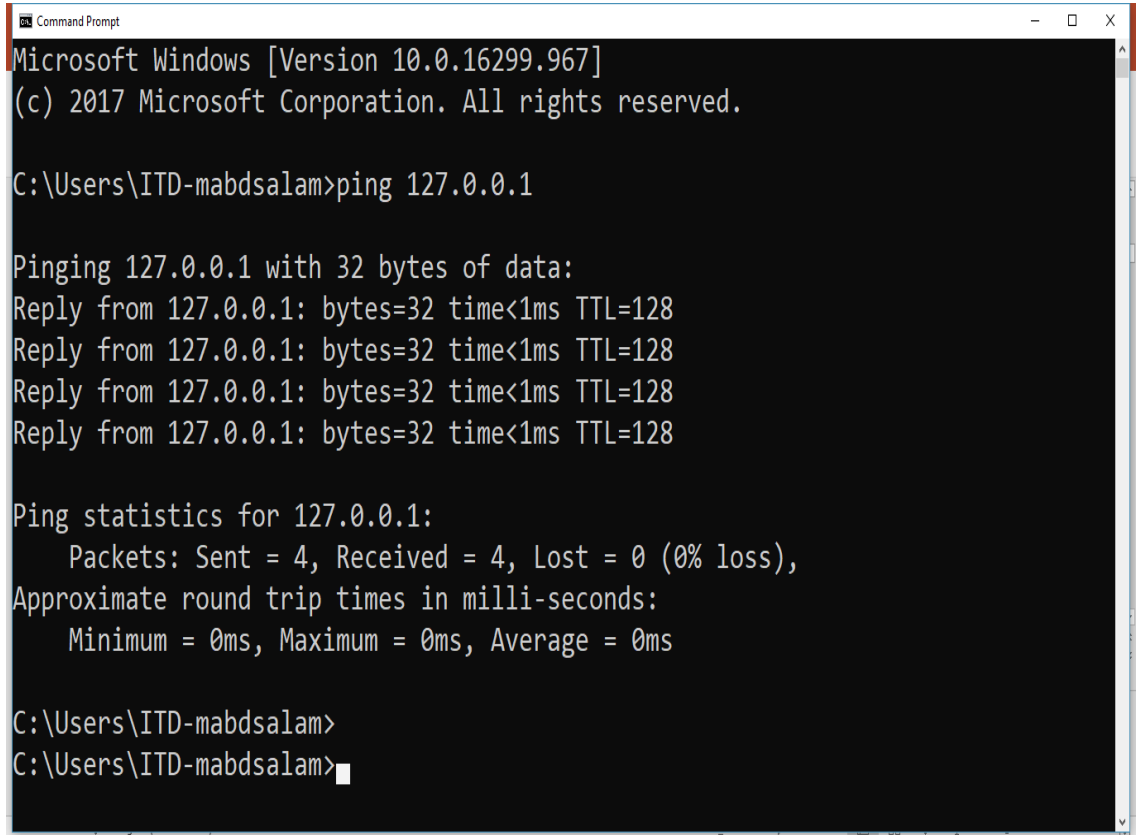


| Routing Table | |
|---|---|
| Network | Interface |
| 172.16.0.0 | E0 |
| 10.0.0.0 | E1 |

# Part 1 (TCP/IP Protocol Architecture)-

## ❖ 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

# Part 1 (TCP/IP Protocol Architecture)

## RESERVED ADDRESS

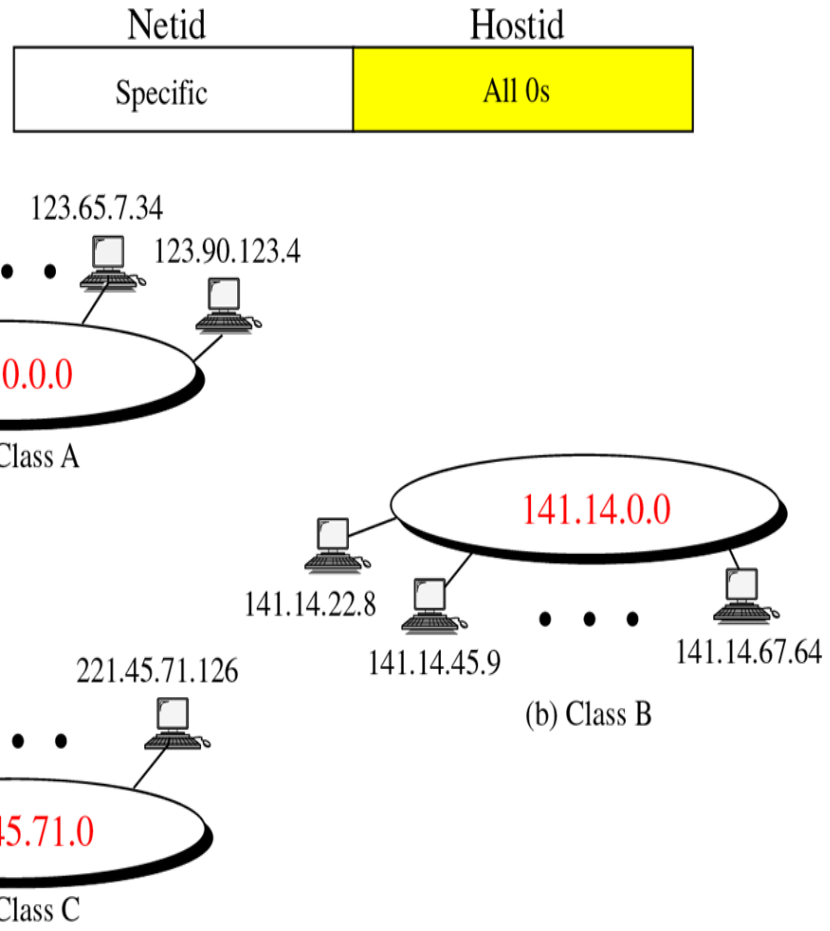
❖ **Network address:**

- 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

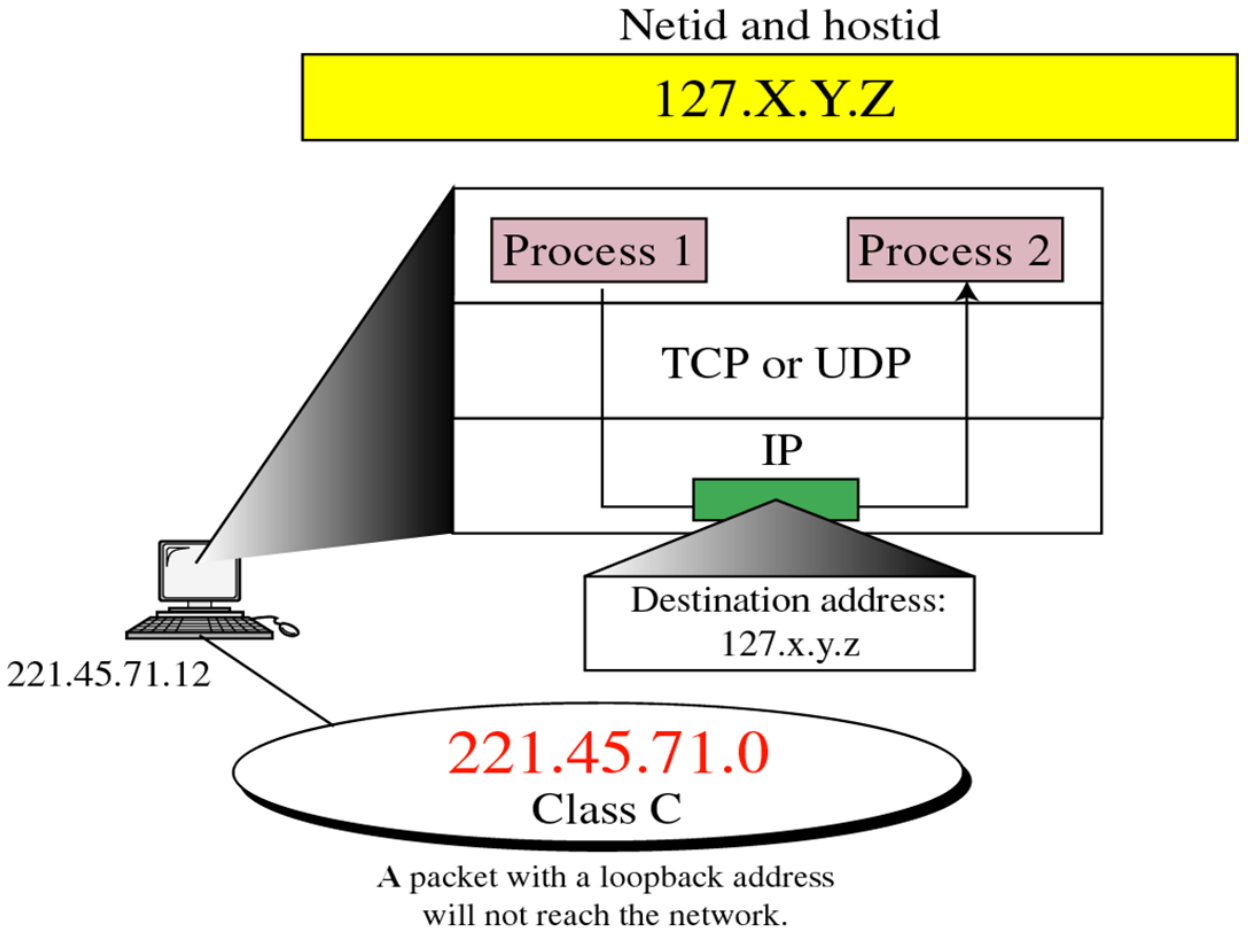


# Part 1 (TCP/IP Protocol Architecture)

## 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

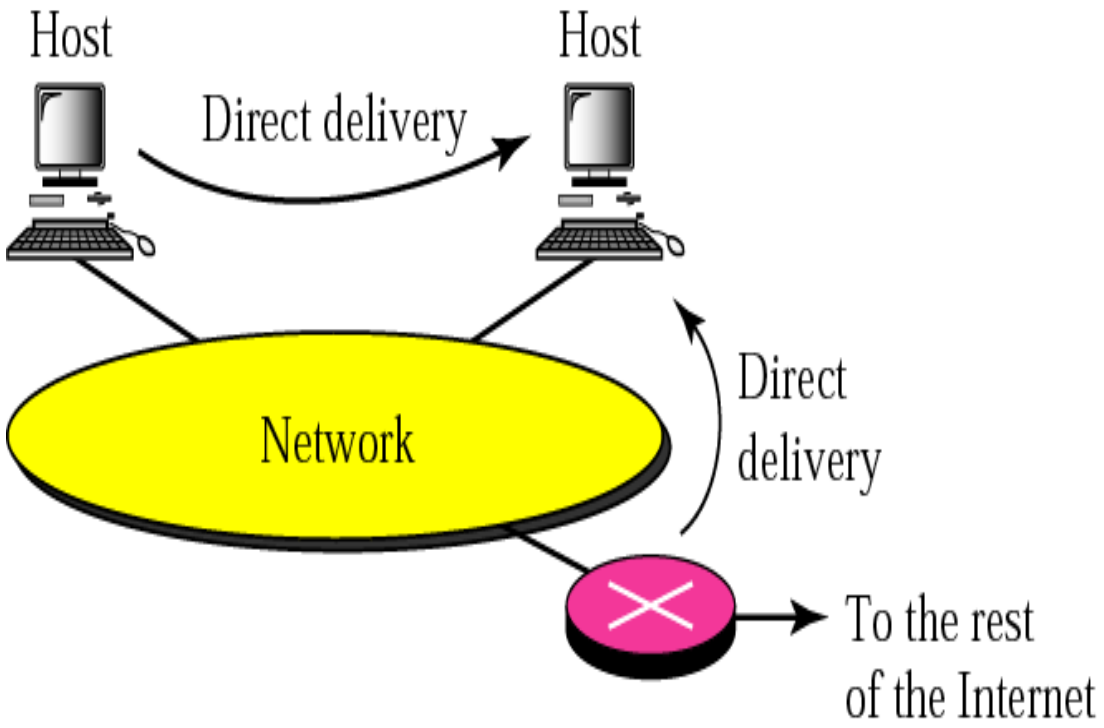


A packet with a loopback address will not reach the network.

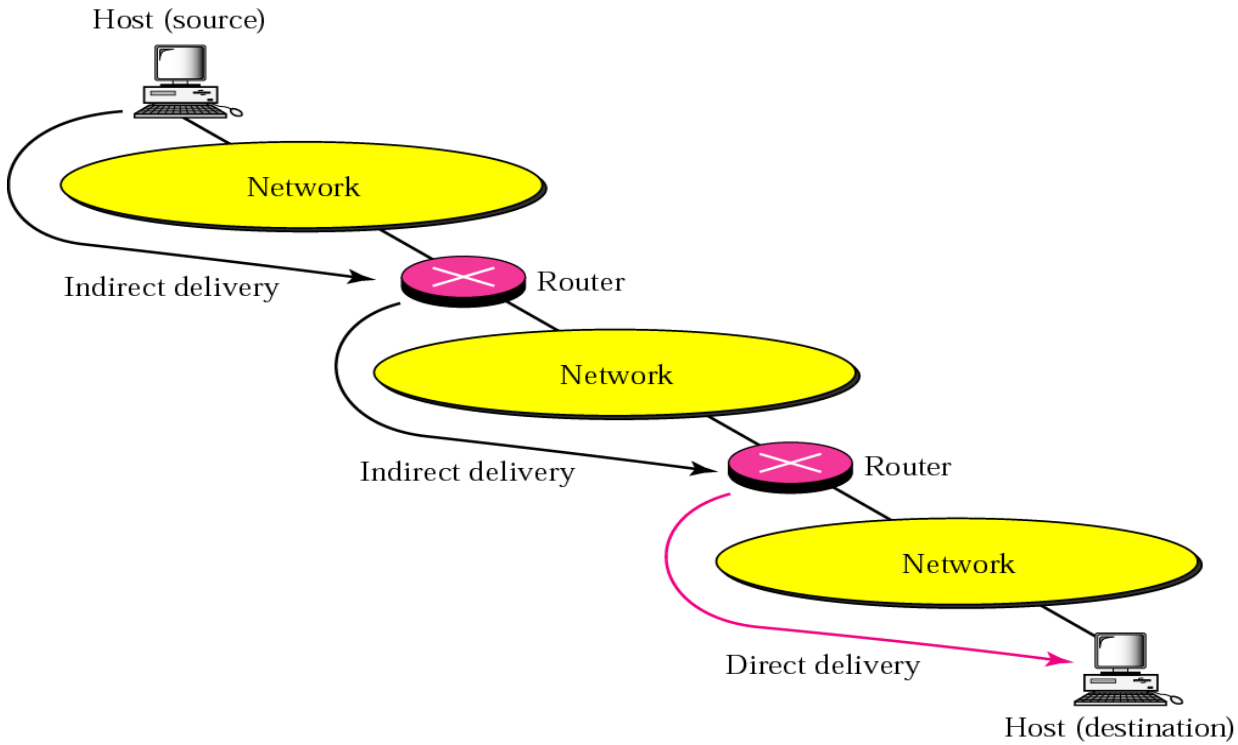
# Part 1 (TCP/IP Protocol Architecture)

## DELIVERY OF IP PACKETS

### Direct delivery



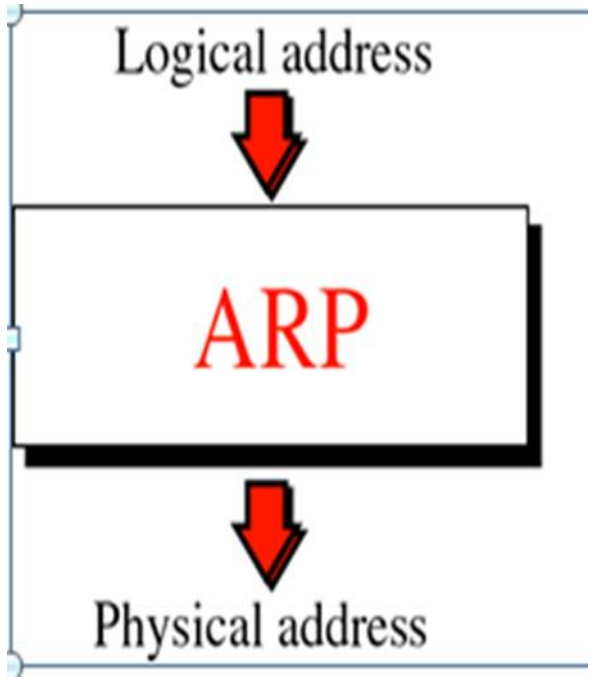

### Indirect delivery



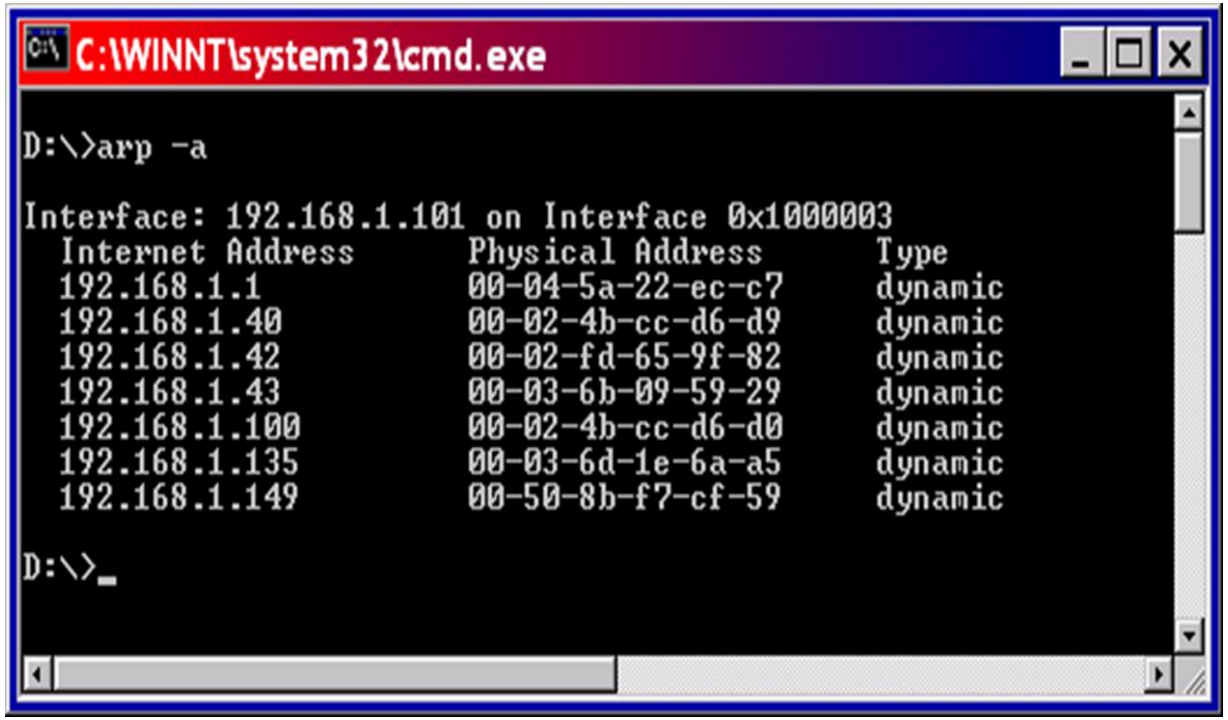
# Part 1 (TCP/IP Protocol Architecture)-

❖ ARP (ADDRESS RESOLUTION PROTOCOL)

## Arp -a

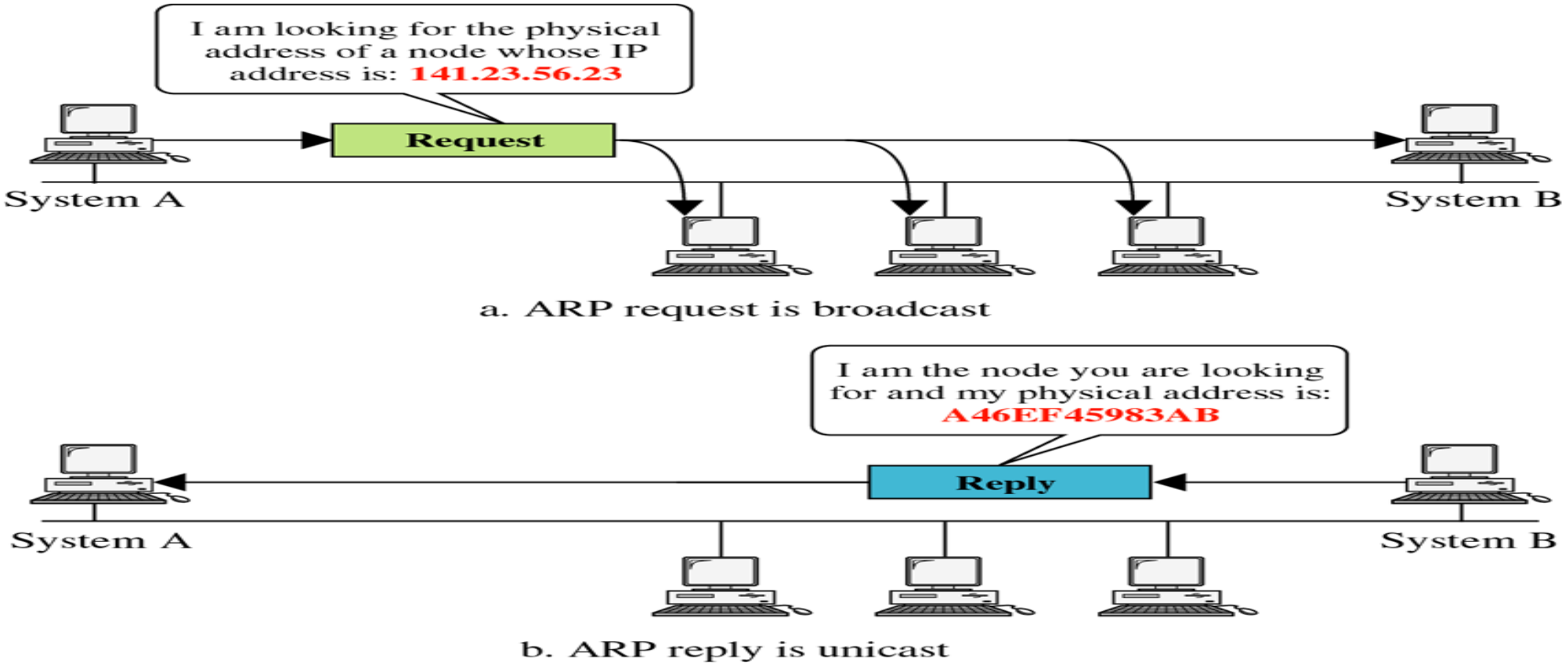



ARP TABLE



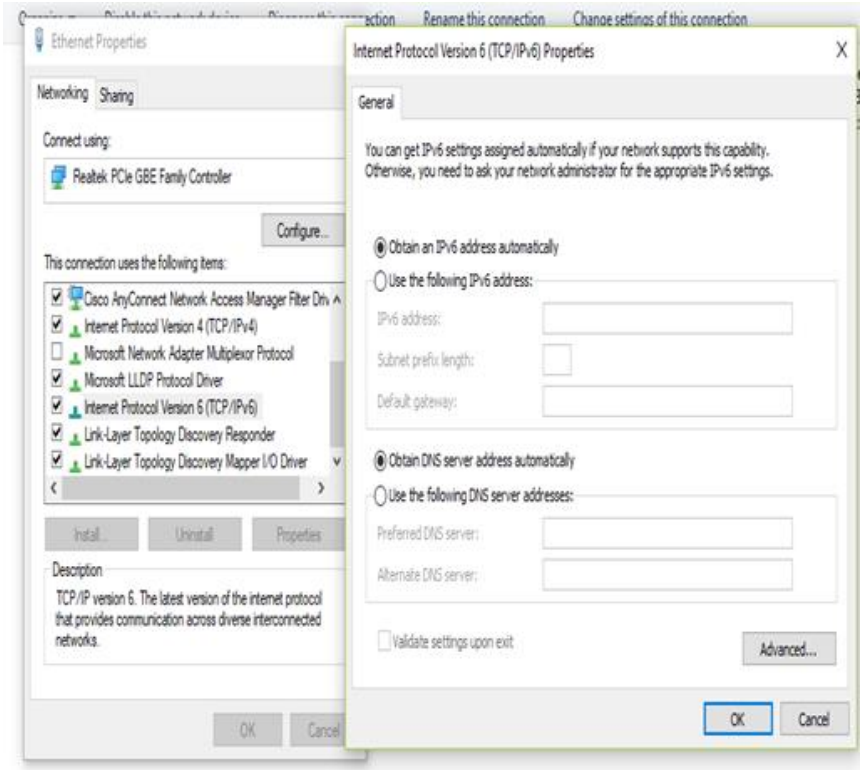
# Part 1 (TCP/IP Protocol Architecture)

## ❖ ARP OPERATION



# Session 1 (TCP/IP Protocol

- **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 billion, addresses)
  - Represented as eight groups, separated by colons, of four hexadecimal digits. The full representation may be simplified by several methods of notation;




**2001:0db8:0000:0000:0000:8a2e:0370:7334**

**= 2001:db8::8a2e:370:7334**

# Session 1 (TCP/IP Protocol

- **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