Information Technology Institute

ITI

Introduction to
Computer Networks & Cyber Security

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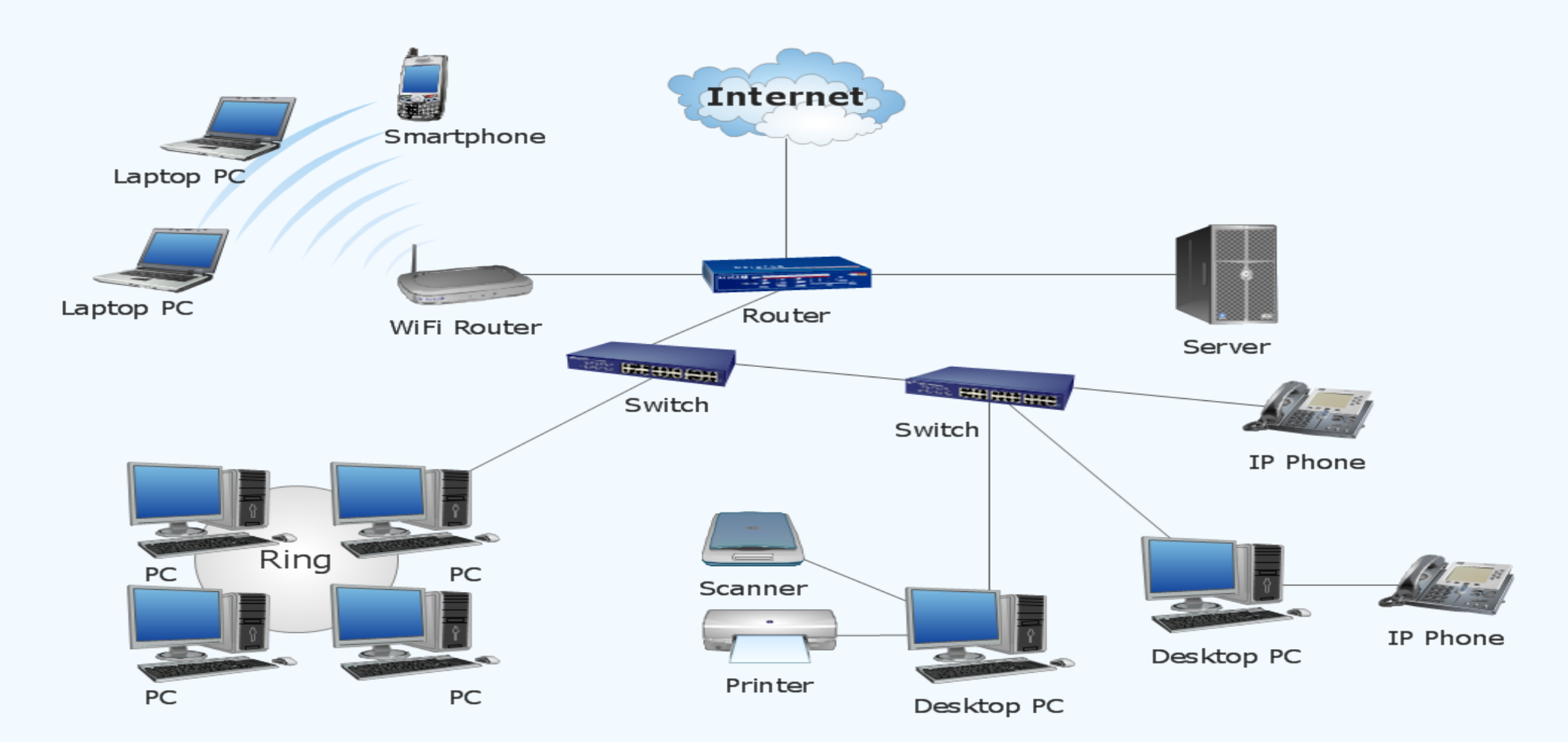
Building the network

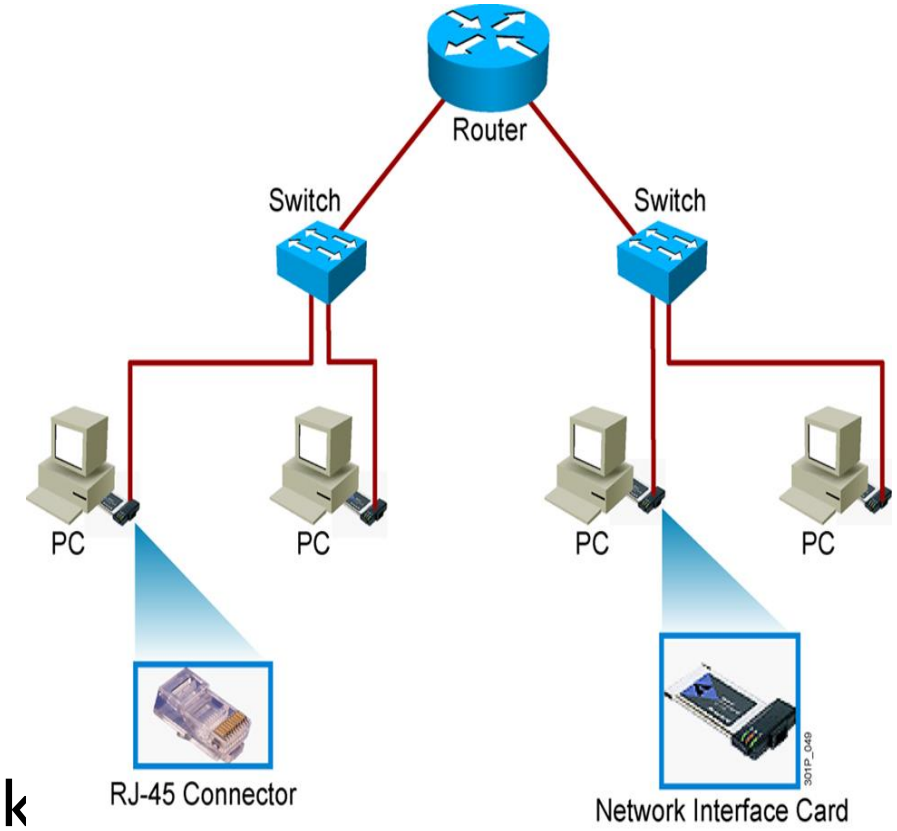
What do you need to build your network?

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

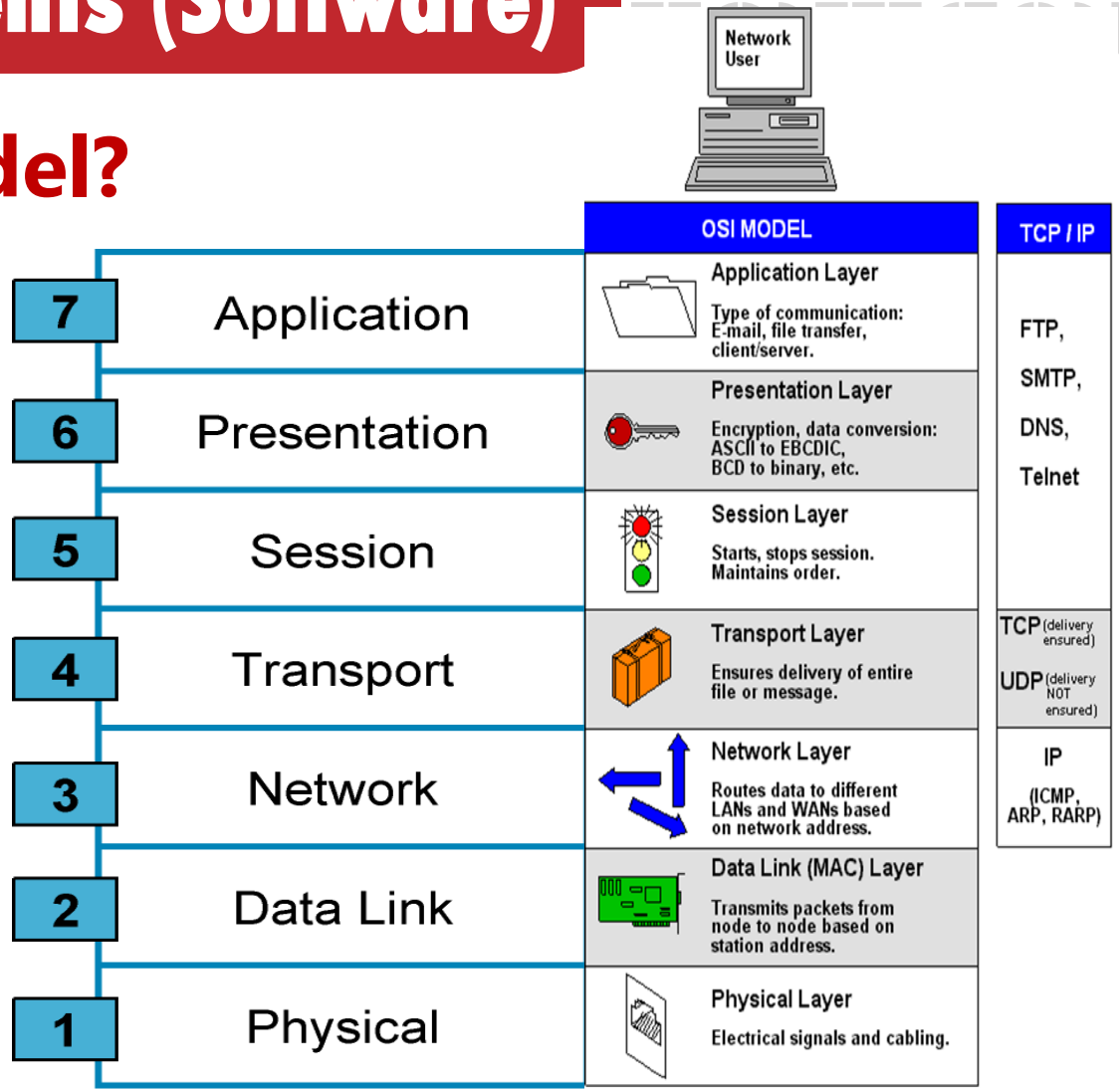
OSI Reference Model

- 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?

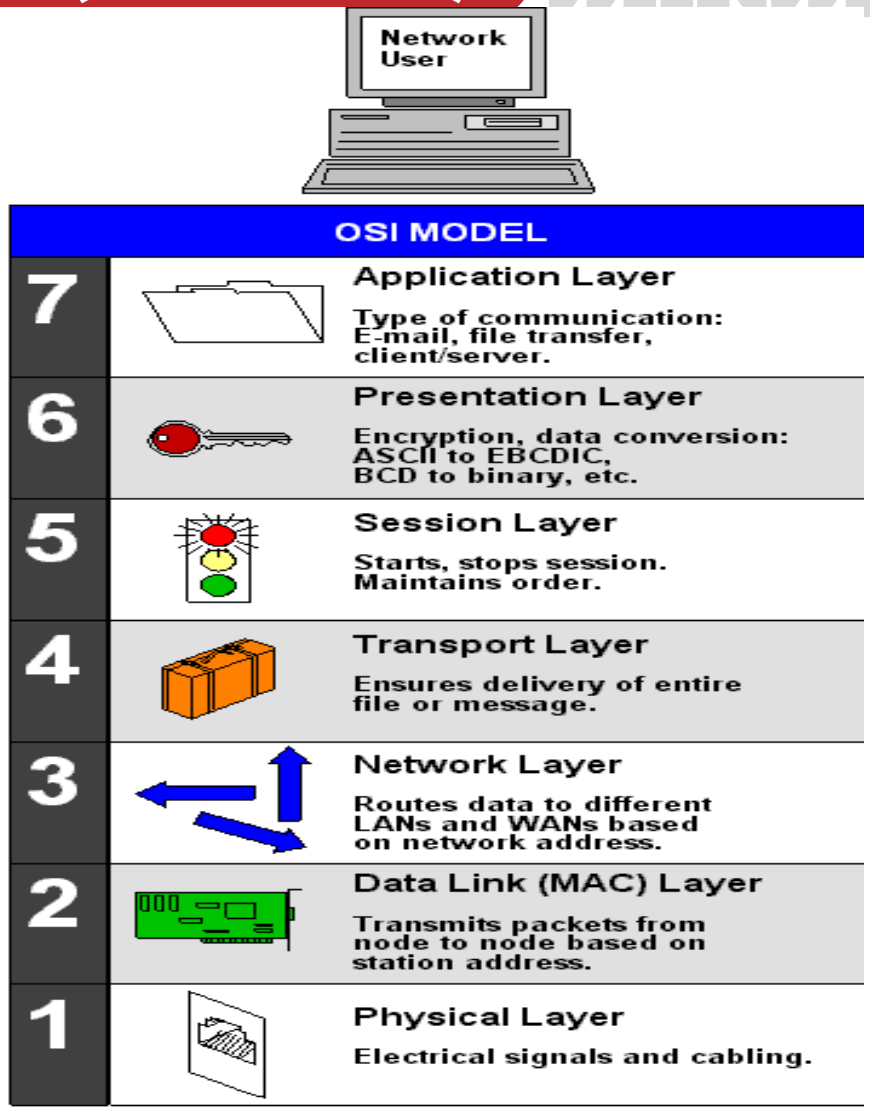
- Reduces complexity
  - Easier to troubleshooting
- Standardizes interfaces
  - Multiple-vendor
- Layer Separation
  - Changes in one layer do not affect other layers
- Simplifies teaching and learning



Part 1_Basic Network Elements (Software)

OSI (7-Seven Layers)

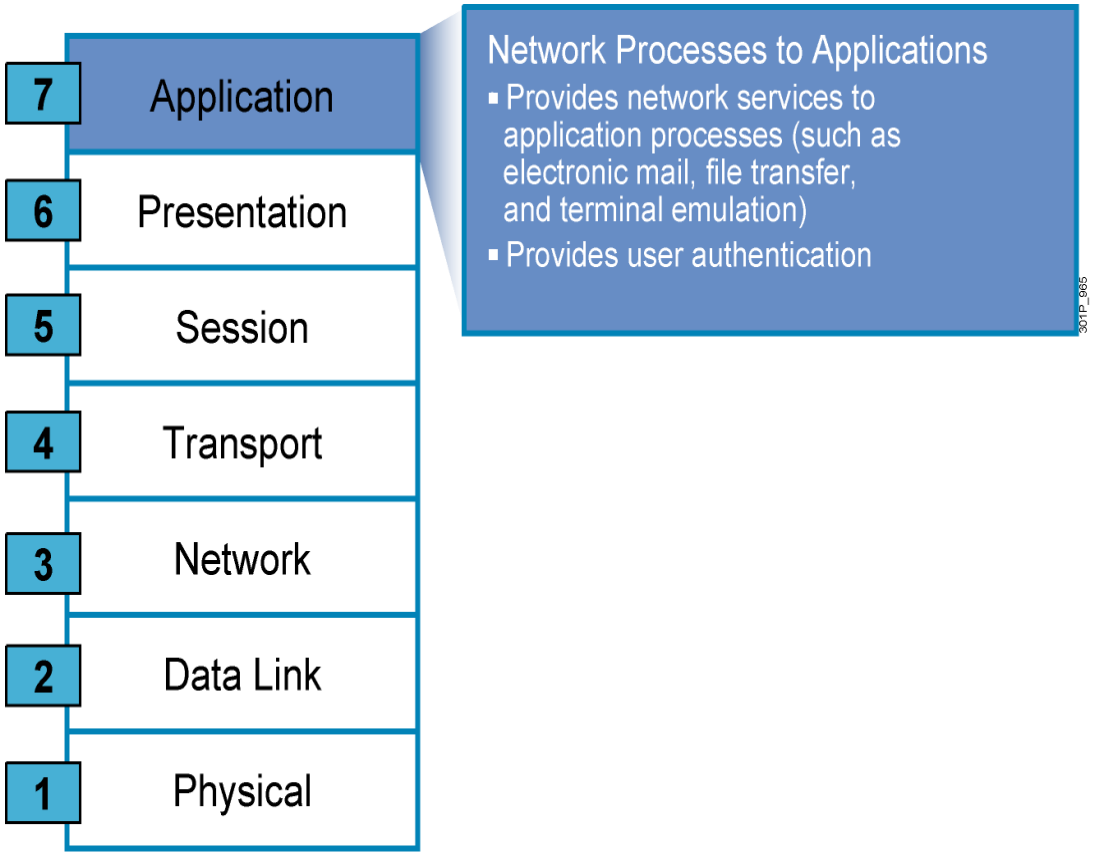
- Application
- Presentation
- Session
- Transport
- Network
- Data Link
- Physical



Part 1_Basic Network Elements (Software)_OSI

◊ Application Layer

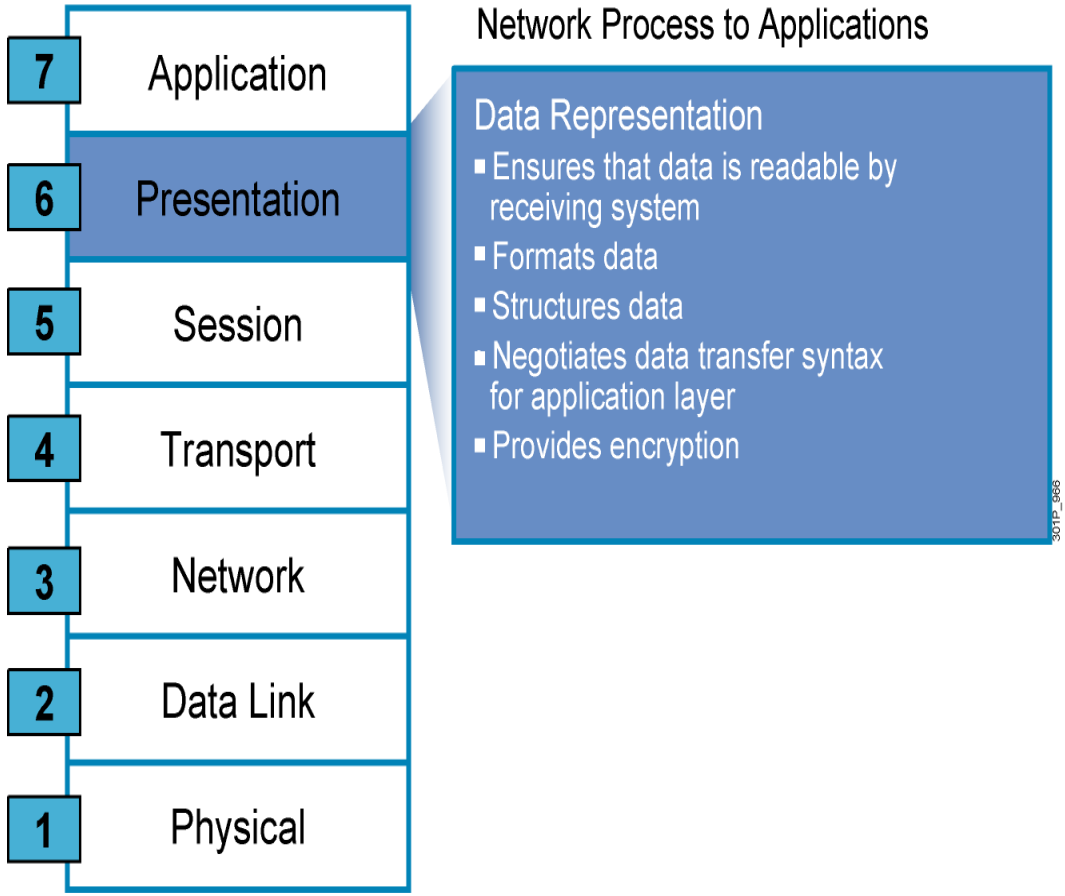
- ◊ Interface to end users
- ◊ provides Many services
  - ◊ File transfer
  - ◊ Network management
  - ◊ Email
- ◊ Protocols
  - ◊ HTTP (Hyper Text Transfer Protocol)
  - ◊ FTP (File transfer Protocol)
  - ◊ SMTP (Simple Mail transfer Protocol)
  - ◊ POP3 (Post office transfers Protocol)
  - ◊ Telnet/SSH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



The Seven Layers Functions (Cont.)

◊ Presentation Layer

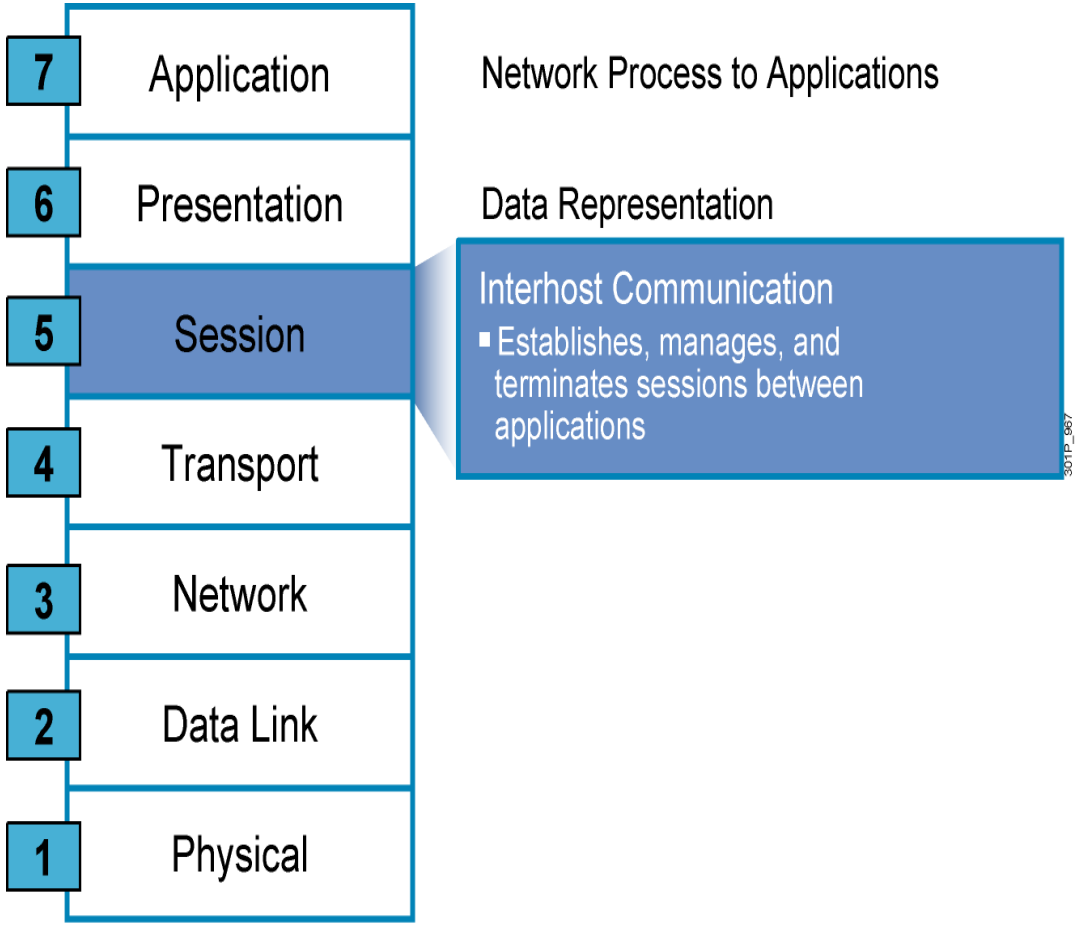
- ◊ Finding common presentation between source and Destination
- ◊ Ensures that is readable by receiving system
- ◊ (**support standardized application interface**)
- ◊ Formats data
- ◊ Structured data
- ◊ Negotiates data transfer syntax for application layer (Encoding and Decoding)
- ◊ Provides Encryption



The Seven Layers Functions (Cont.)

◊ Session Layer

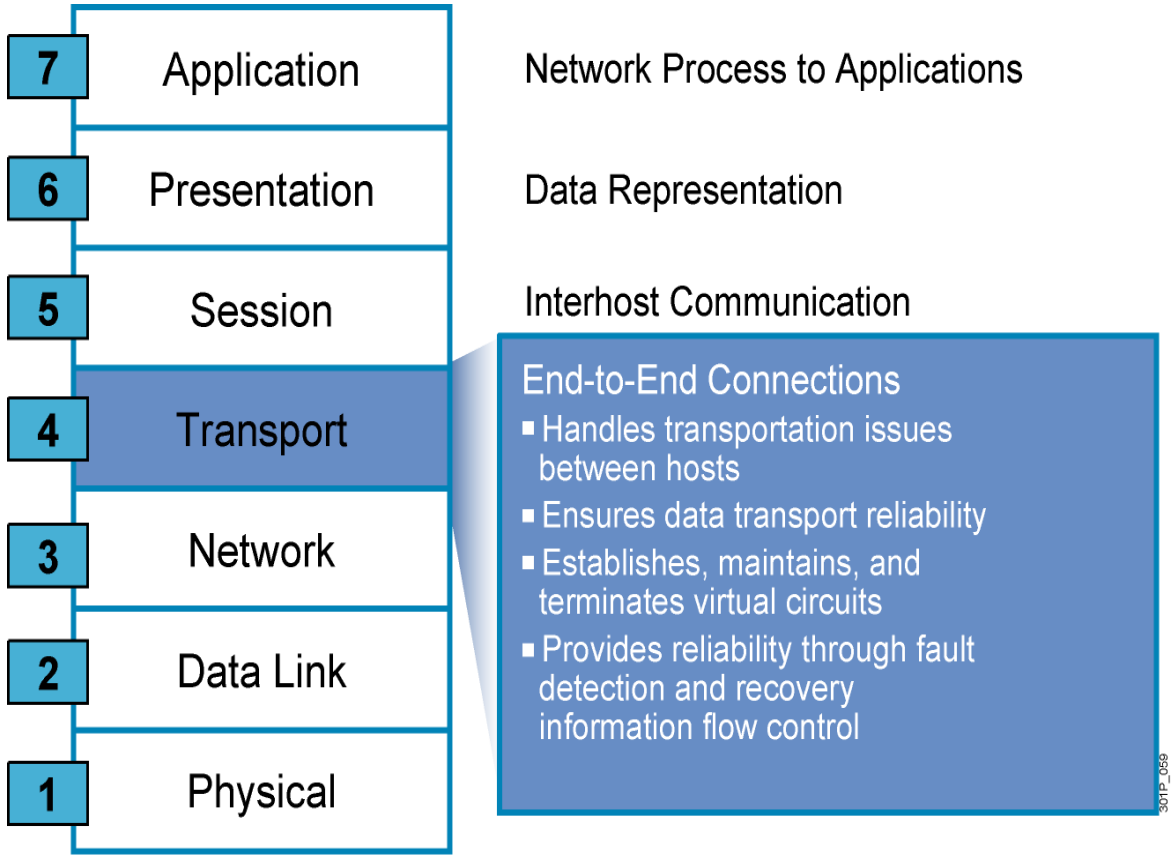
- ◊ **Establishes**, **manages** and **terminates** sessions (connections) between cooperating applications (Dialogues)
- ◊ **Synchronization** (add checkpoints into a stream of data)
- ◊ **Controls the sessions** between the local and remote applications



The Seven Layers Functions (Cont.)

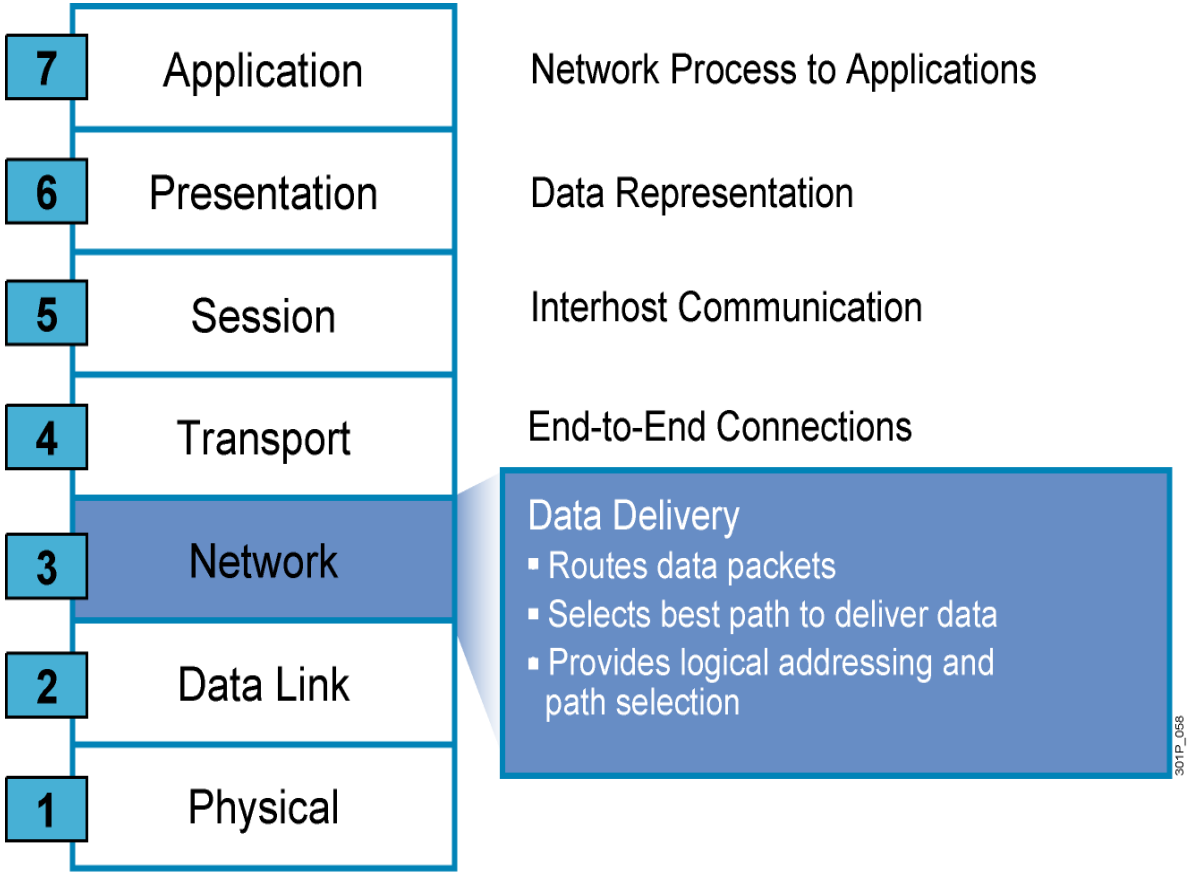
◊ Transport Layer

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



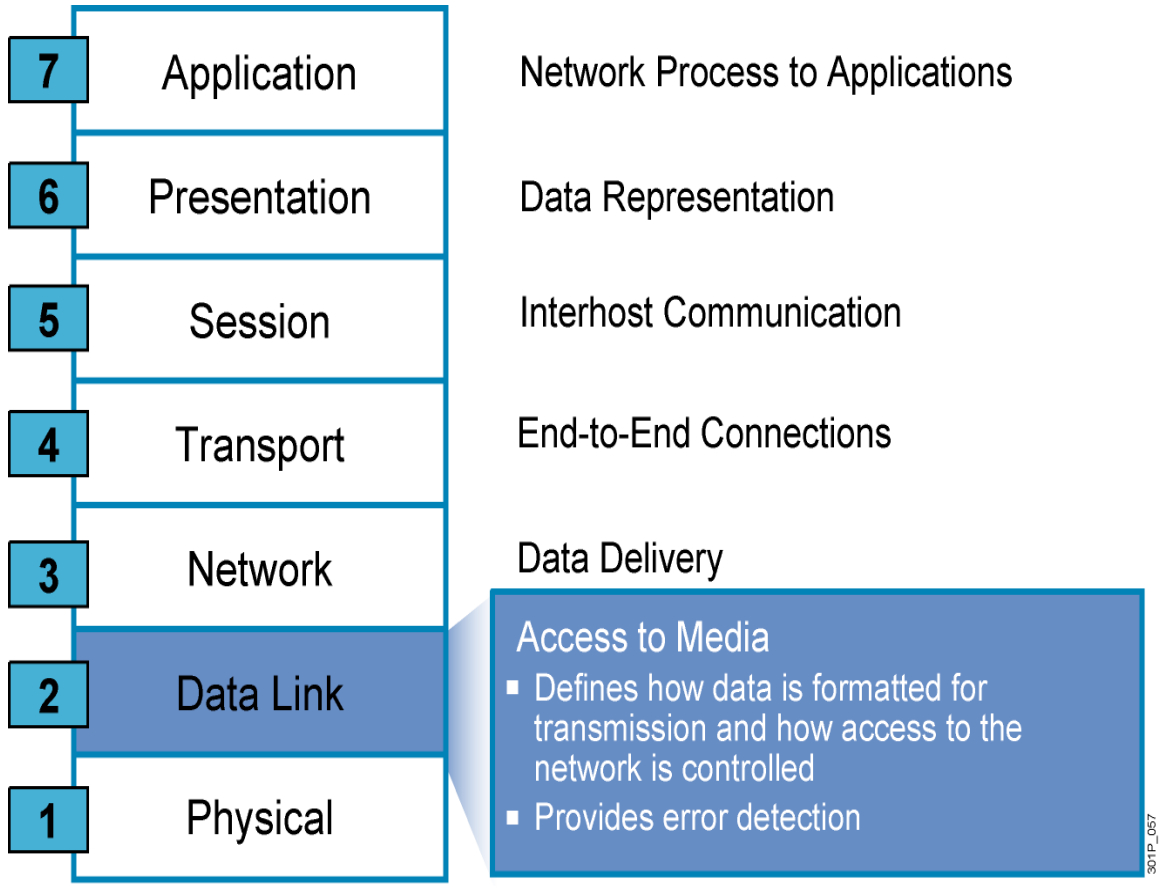
The Seven Layers Functions (Cont.)

- 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



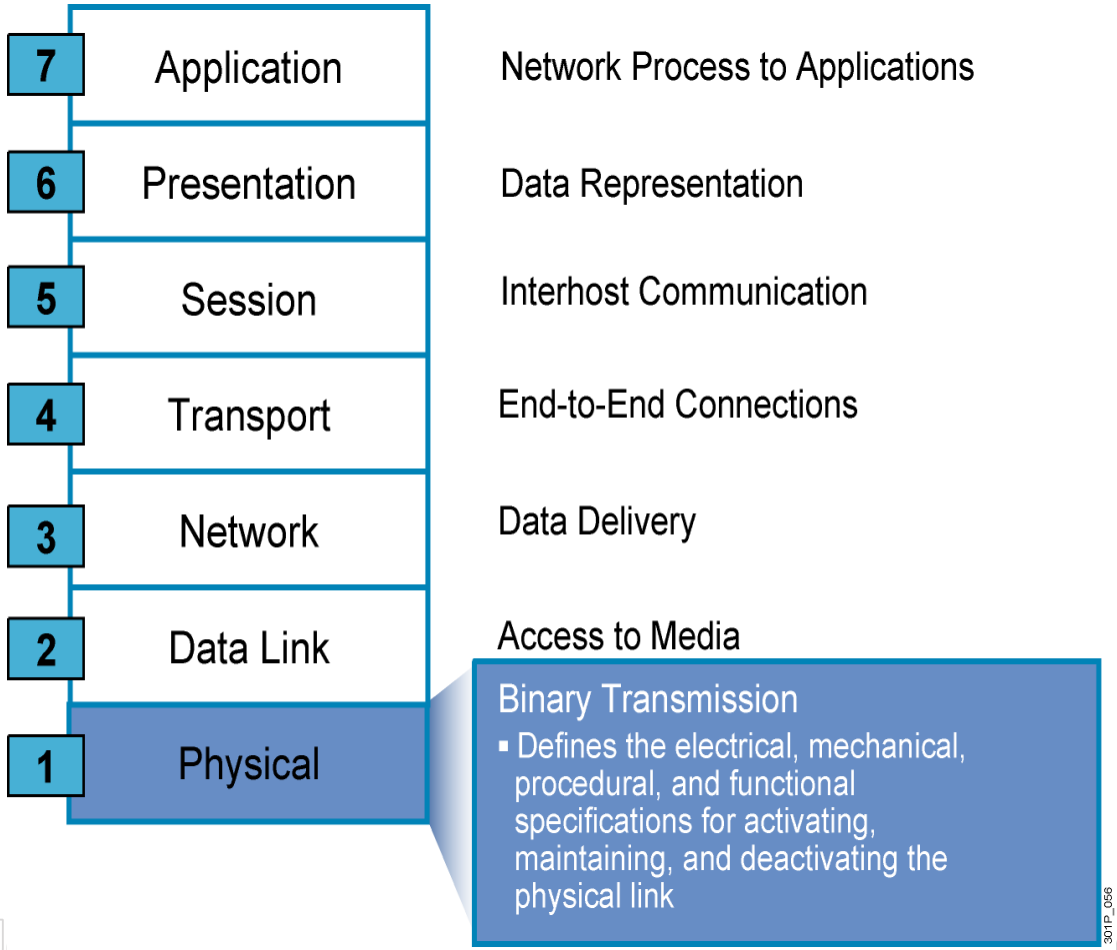
The Seven Layers Functions (Cont.)

- 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



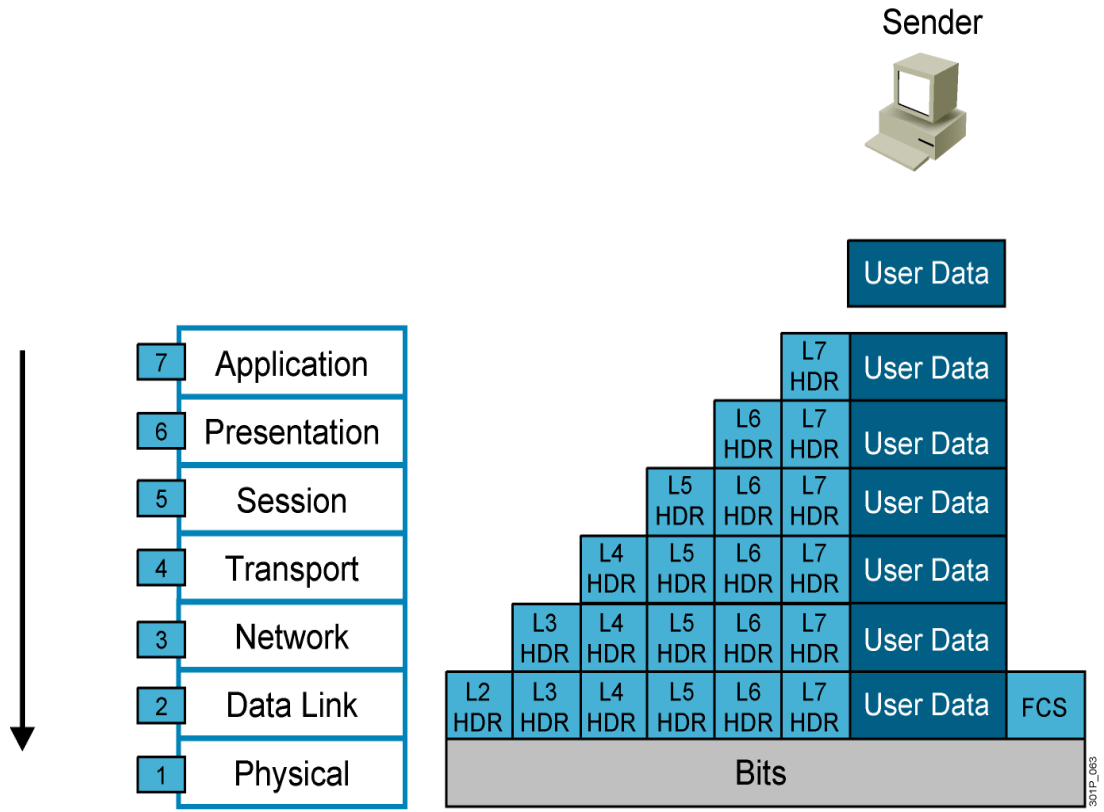
The Seven Layers Functions (Cont.)

- **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



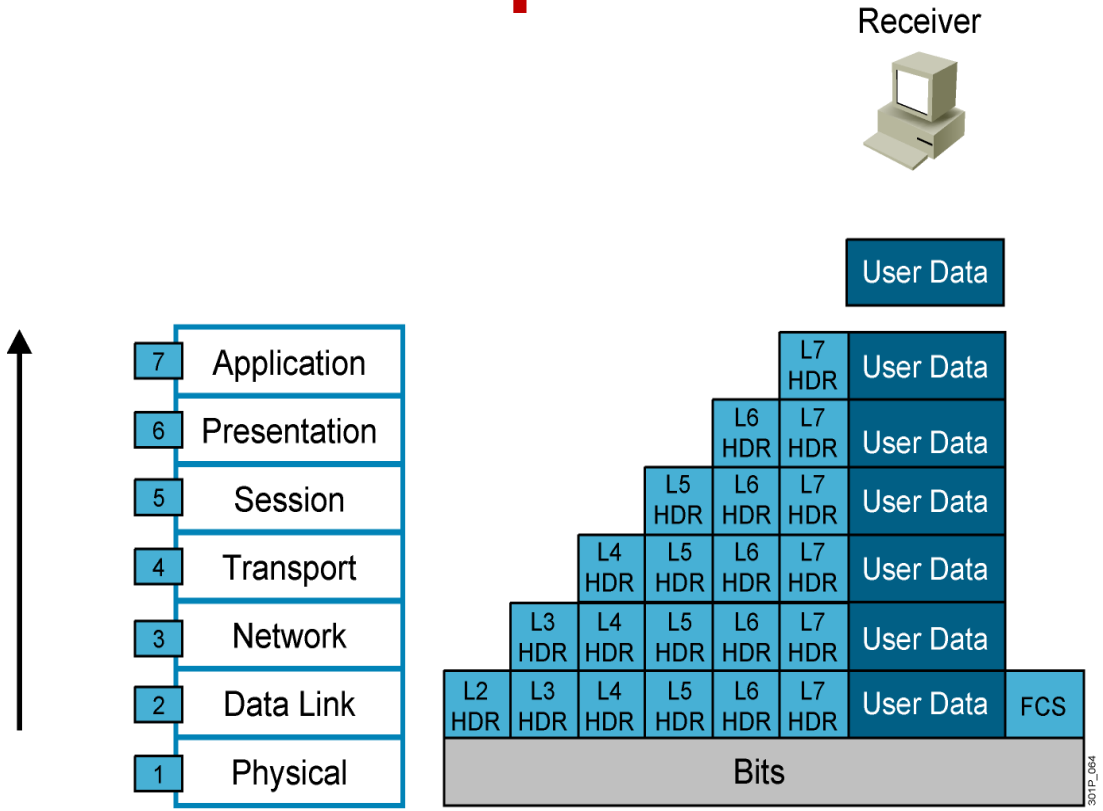
Part 1_Basic Network Elements (Software)

Data Encapsulation



HDR = Header

Data De-Encapsulation

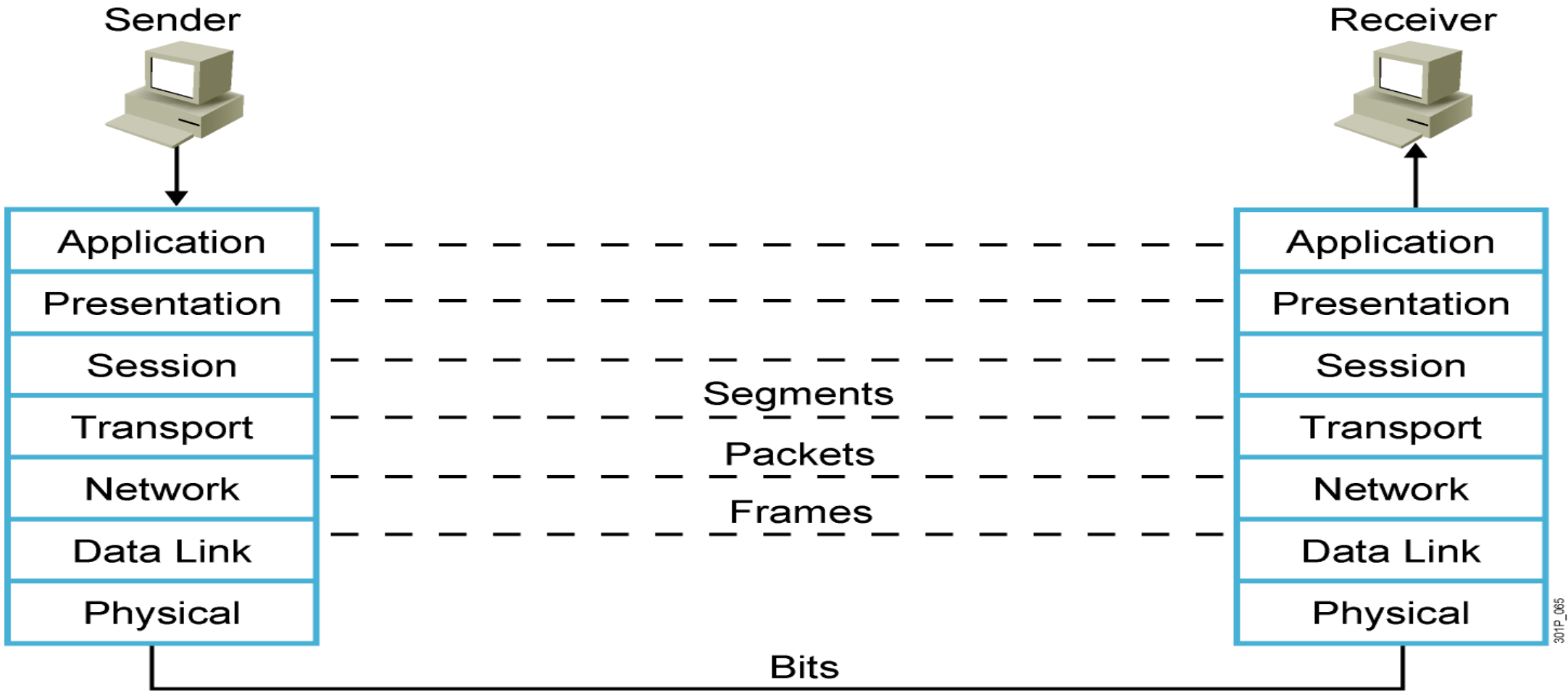


HDR = Header

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

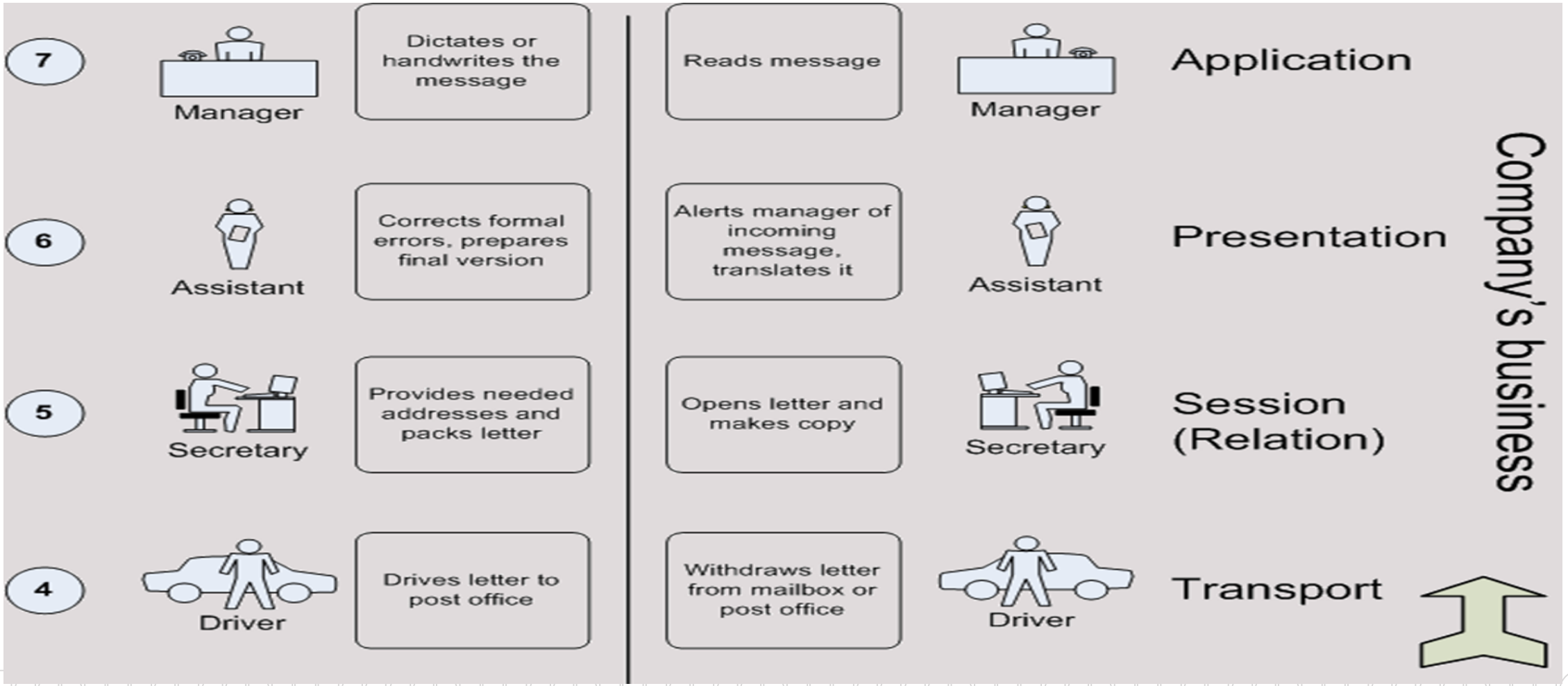
Part 1_Basic Network Elements (Software)

Peer-to-Peer Communication



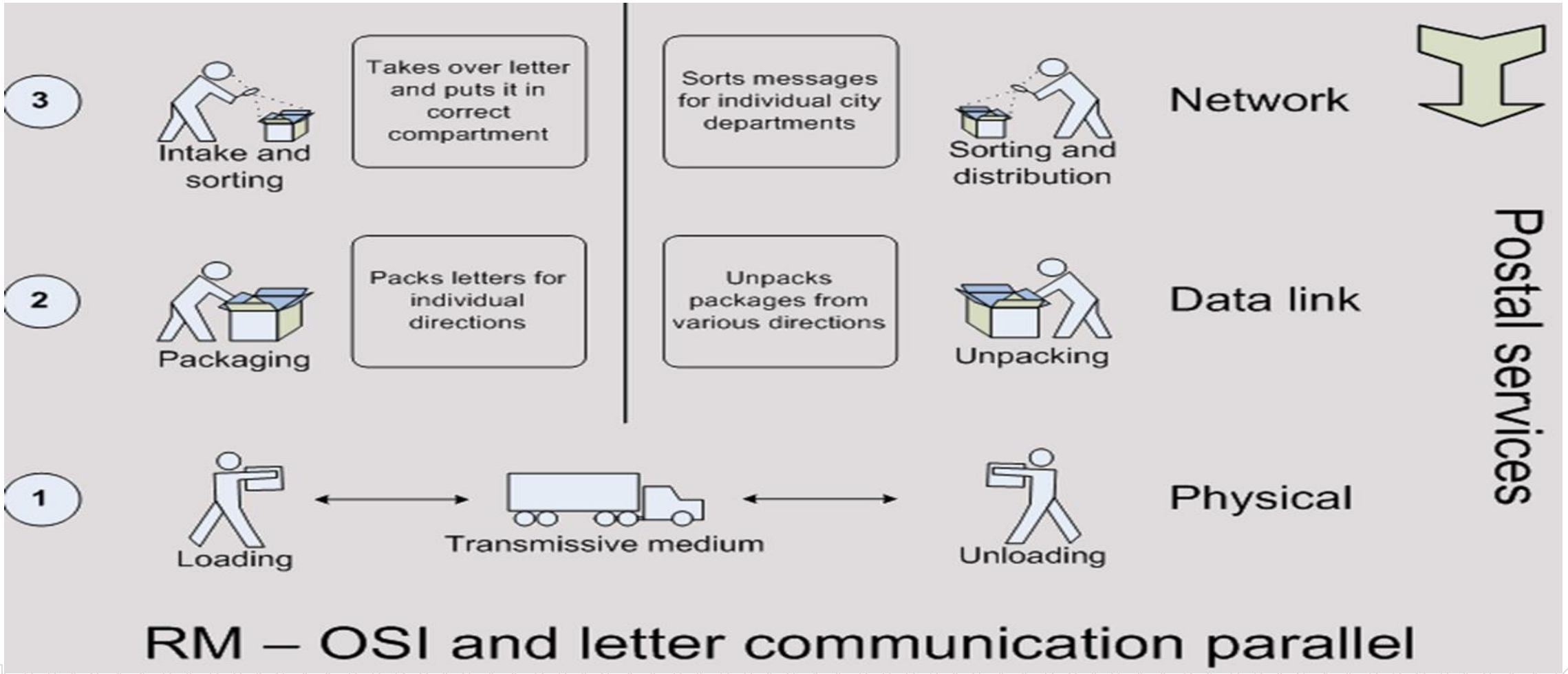
Part 1_Basic Network Elements (Software)

OSI Exercise



Part 1_Basic Network Elements (Software)

OSI Exercise

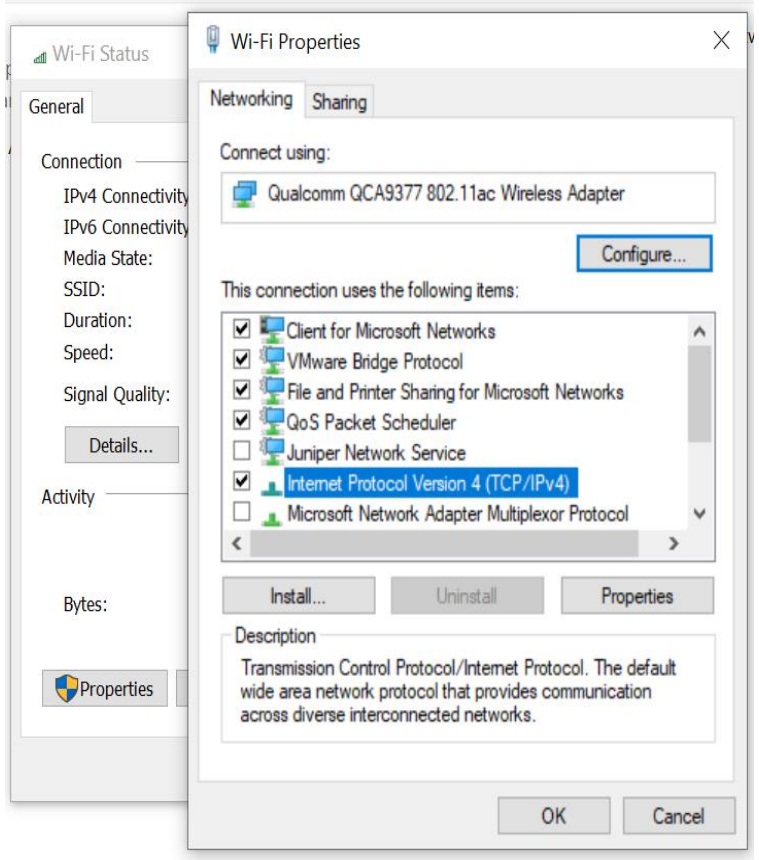


RM – OSI and letter communication parallel

Transmission Control Protocol/Internet Protocol
TCP /IP

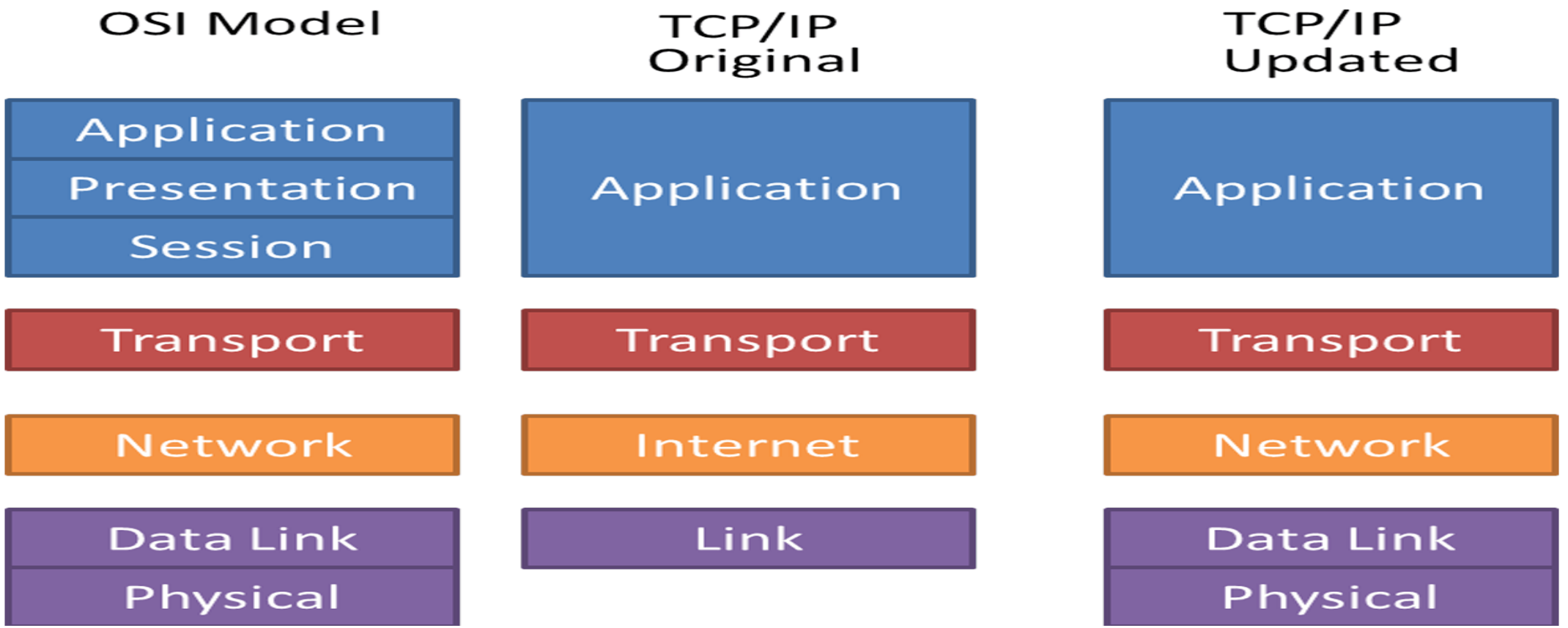
Part 1_ (TCP/IP Protocol Suite)

- **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**



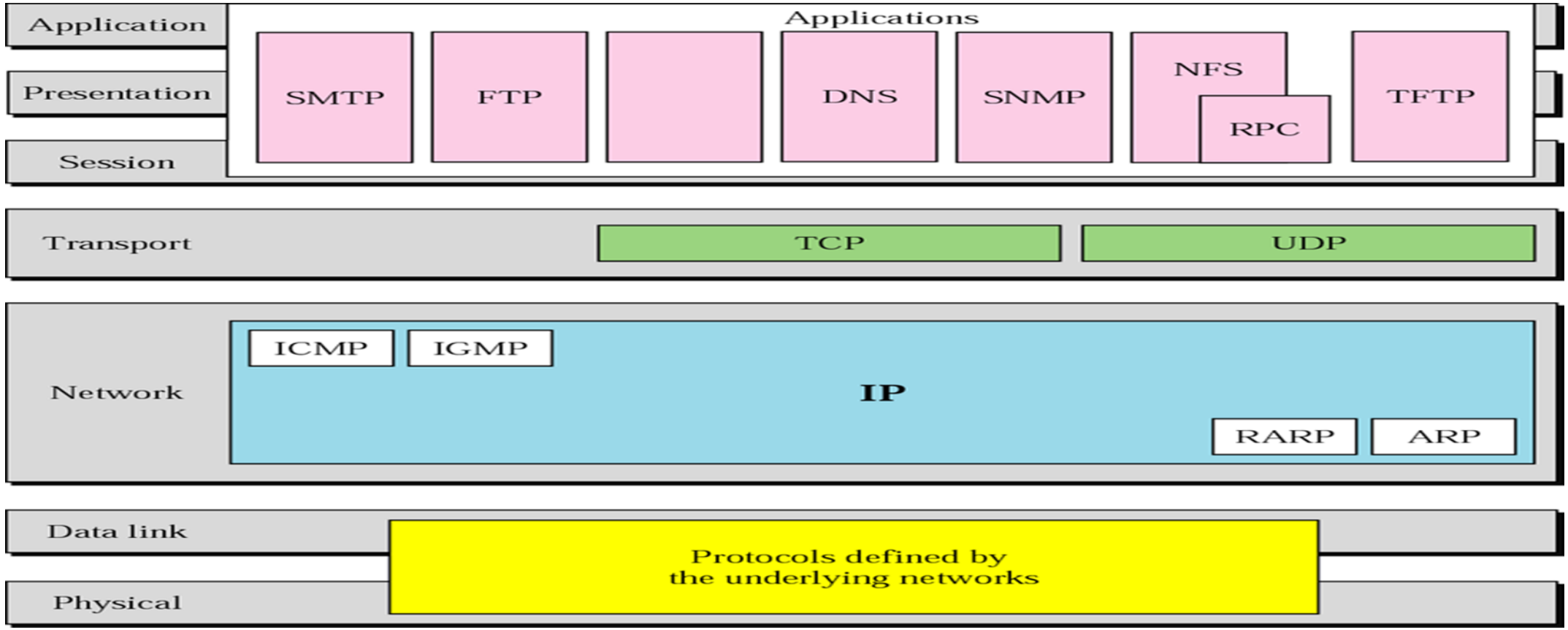
Part 1_(TCP/IP Protocol Suite)

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



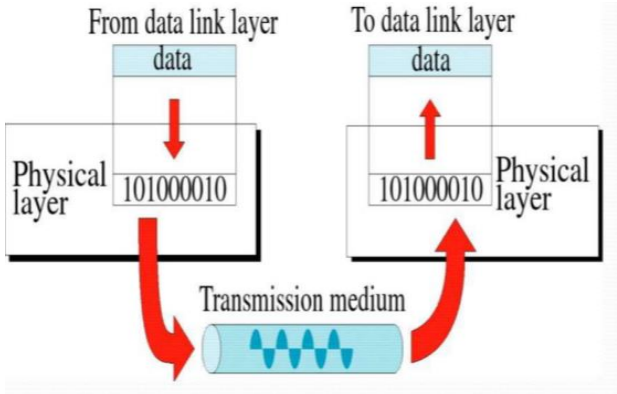
Part 1_(TCP/IP Protocol Architecture)

- Some Protocols in TCP/IP Suite



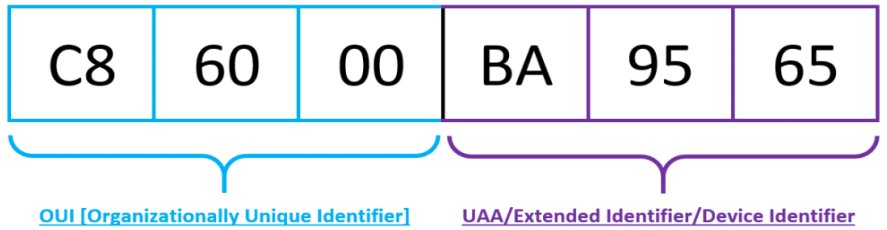
Part 1_(TCP/IP Protocol Architecture)

- **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)

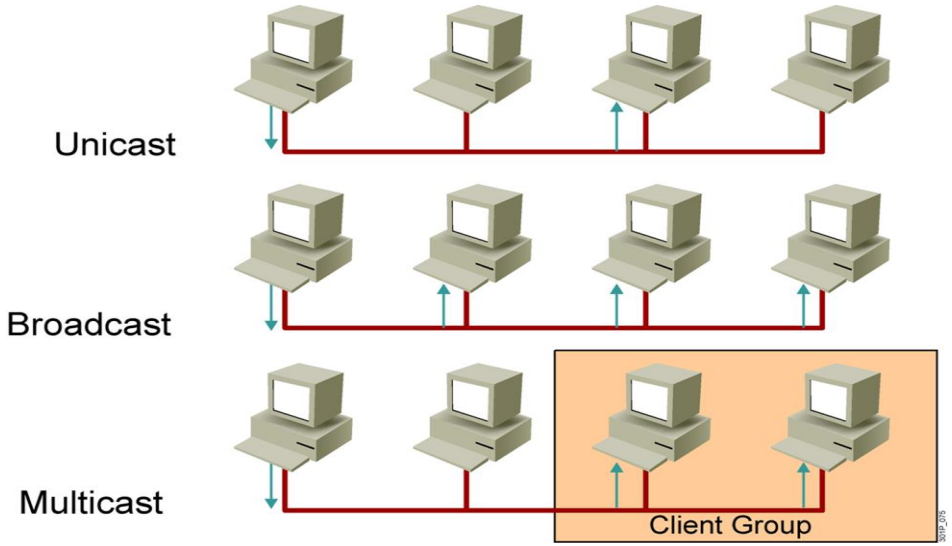


Part 1_(TCP/IP Protocol Architecture)

- **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:
```

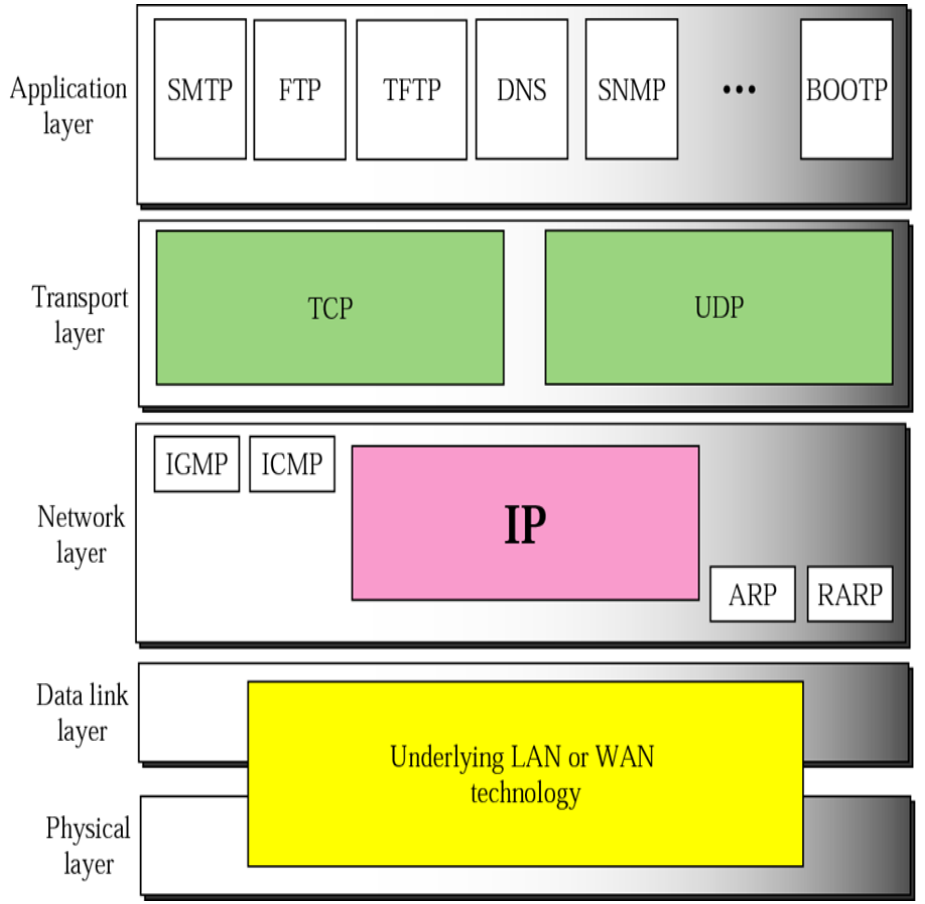
```
C:\Users\ITD-mabdsalam>getmac

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

Class A ... First 1 bit fixed — 0 x x x x x x x . Host . Host . Host

Class B ... First 2 bits fixed — 1 0 x x x x x x . Network . Host . Host

Class C ... First 3 bits fixed — 1 1 0 x x x x x . Network . Network . Host

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 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 192.167.255.255 192.169.0.0 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

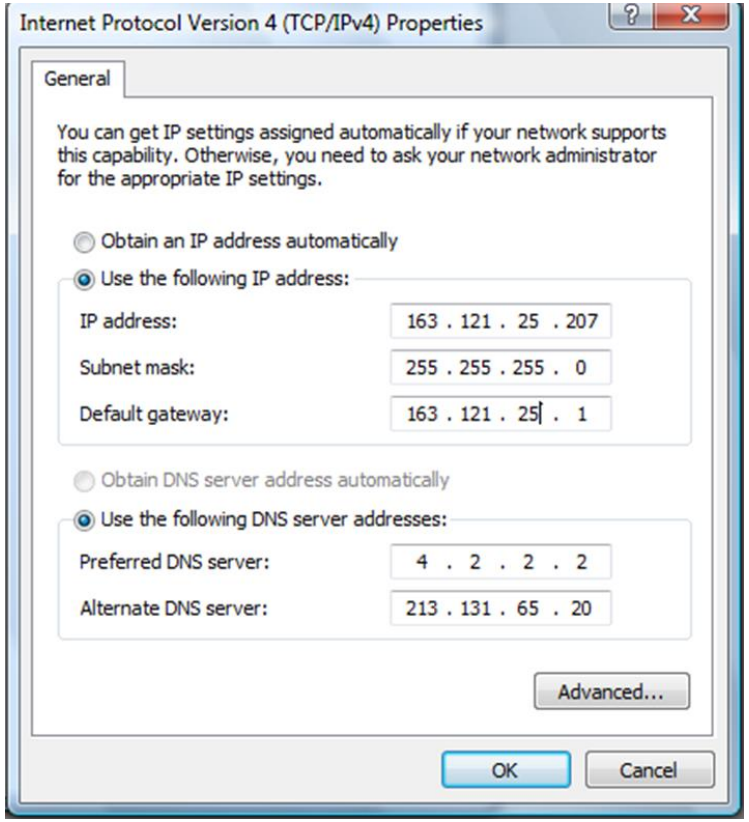
- **Nat** is used to Translate the private IP address to public IP addresses.

Part 1 (TCP/IP Protocol Architecture)_lab

❖ How to assign IP address to device

- Manually
- Automatic
- APIPA

- Manually



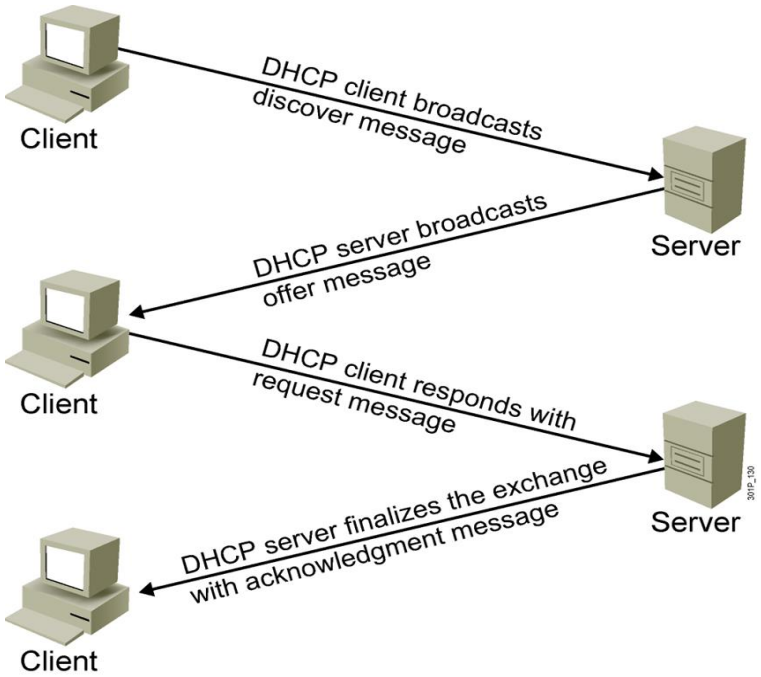
- Set IP address
- Set Subnet mask
- Set IP default-Gateway
- Set DNS server

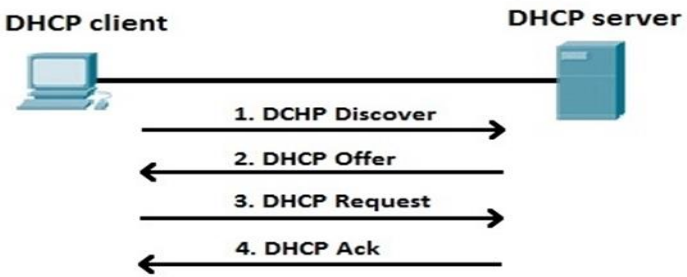
Part 1 (TCP/IP Protocol Architecture)- LAB

❖ 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)





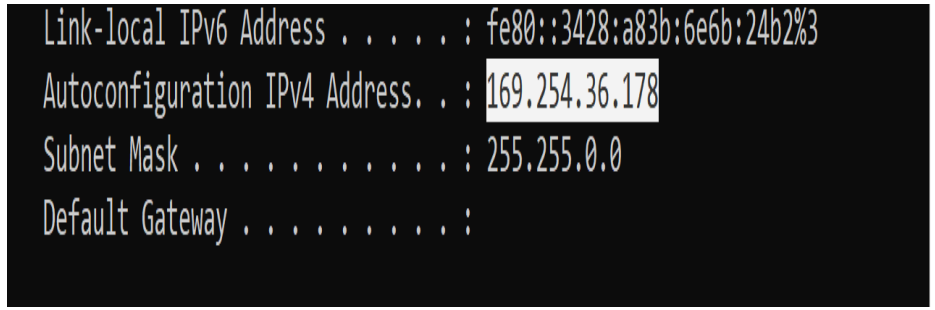
Part 1 (TCP/IP Protocol Architecture)- LAB

❖ 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

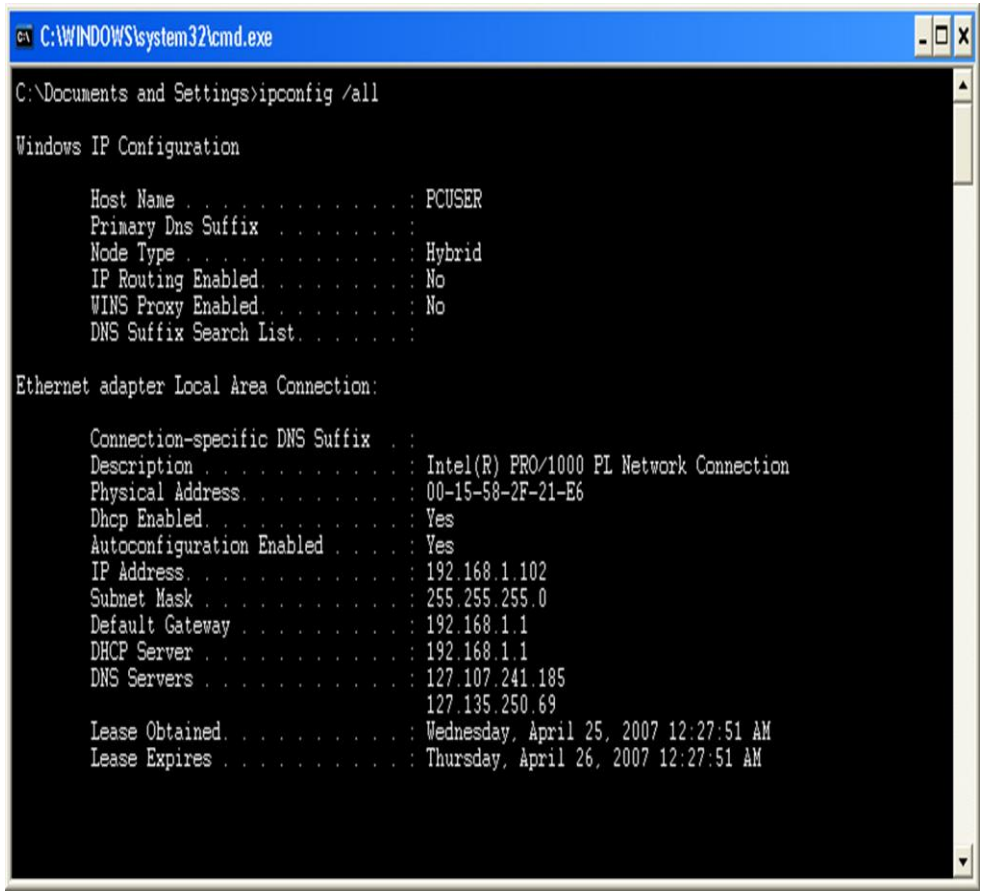


Part 1 (TCP/IP Protocol Architecture)- LAB

❖ 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

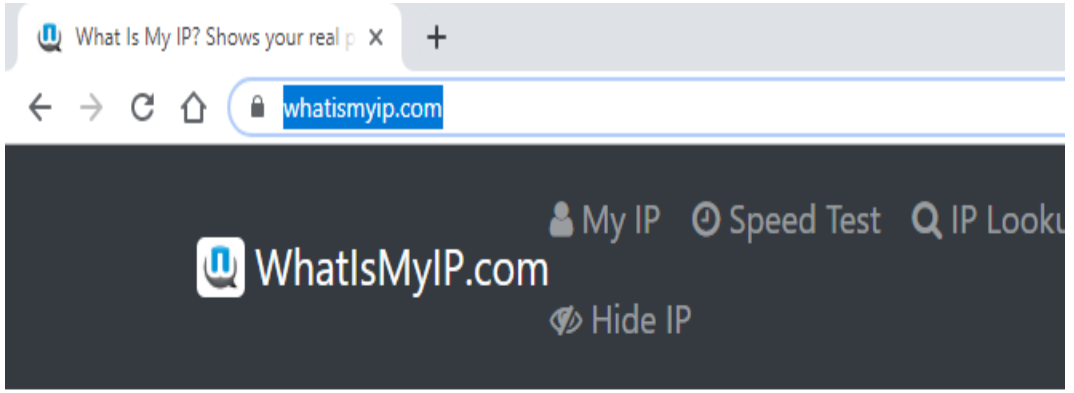
- Ipconfig
- Ipconfig /all
- Ipconfig /release
- Ipconfig /renew

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 pubic IP address we used **NAT** and **IPV6**



Your Public IPv4 is: 41.236.145.96

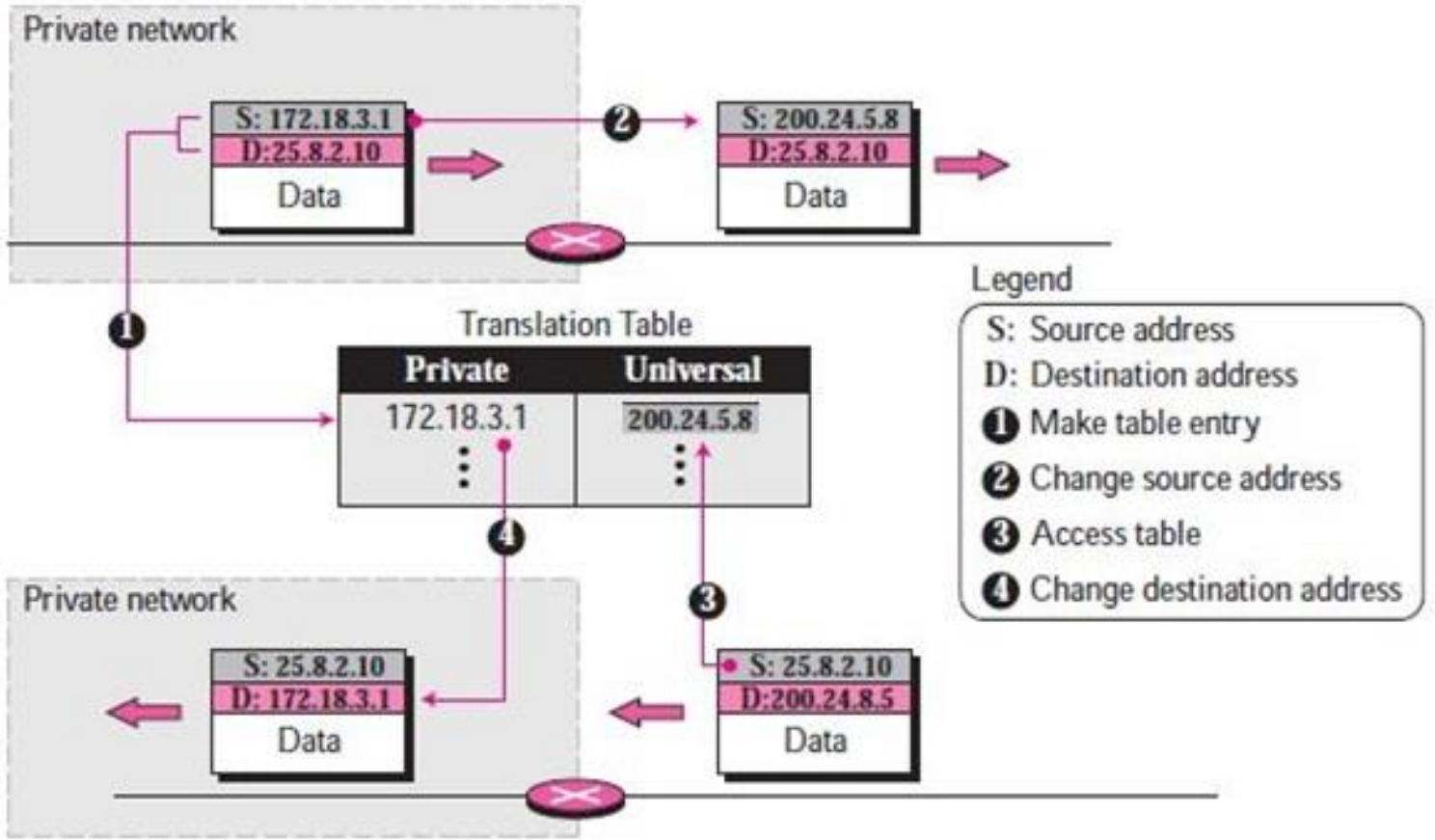
Your IPv6 is: Not Detected

Location: Al Jizah, GZ EG

ISP: TE Data

Network Address Translation(NAT)

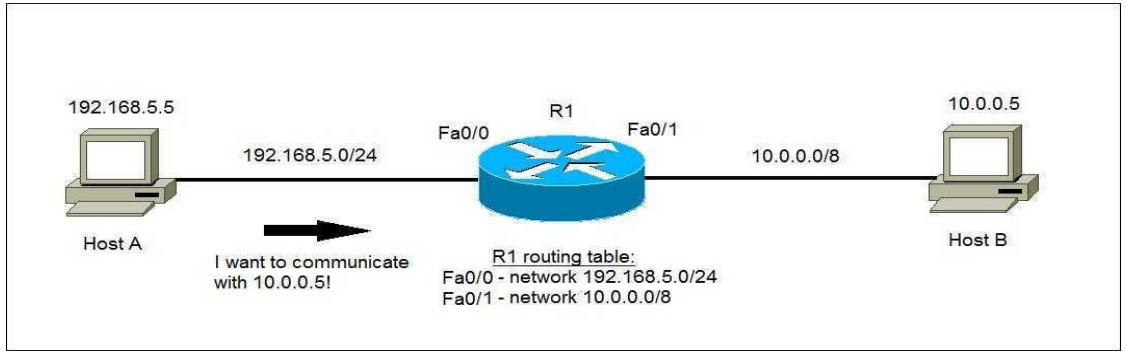
The technology allows a site to use a set of private addresses for internal communication and a set of global Internet addresses (at least one) for communication with the rest of the world

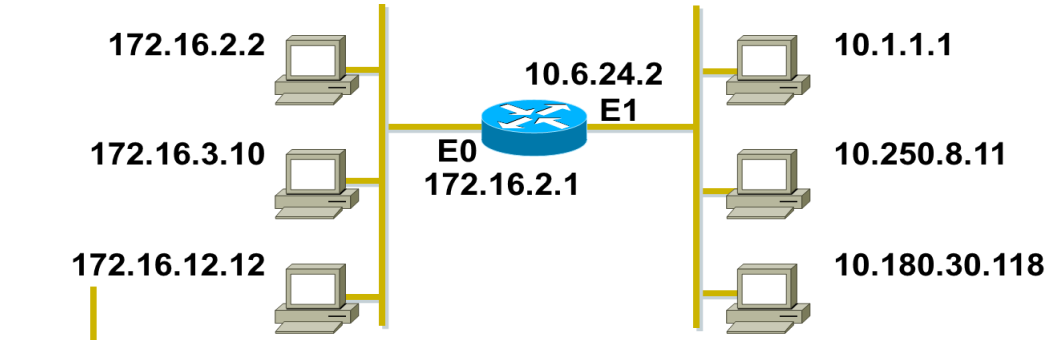


Part 1 (TCP/IP Protocol Architecture)- LAB

HOST ADDRESSES & ROUTING

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



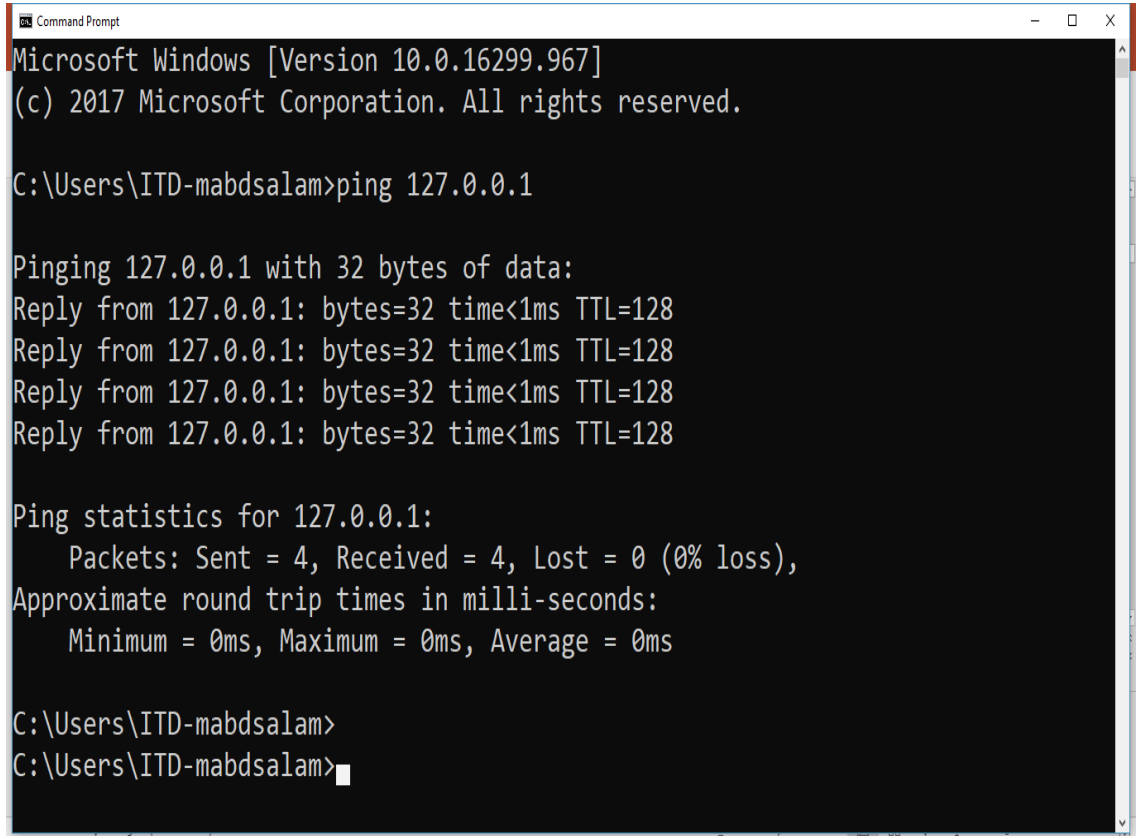


Routing Table	
Network	Interface
172.16.0.0	E0
10.0.0.0	E1

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

Part 1 (TCP/IP Protocol Architecture)

RESERVED ADDRESS

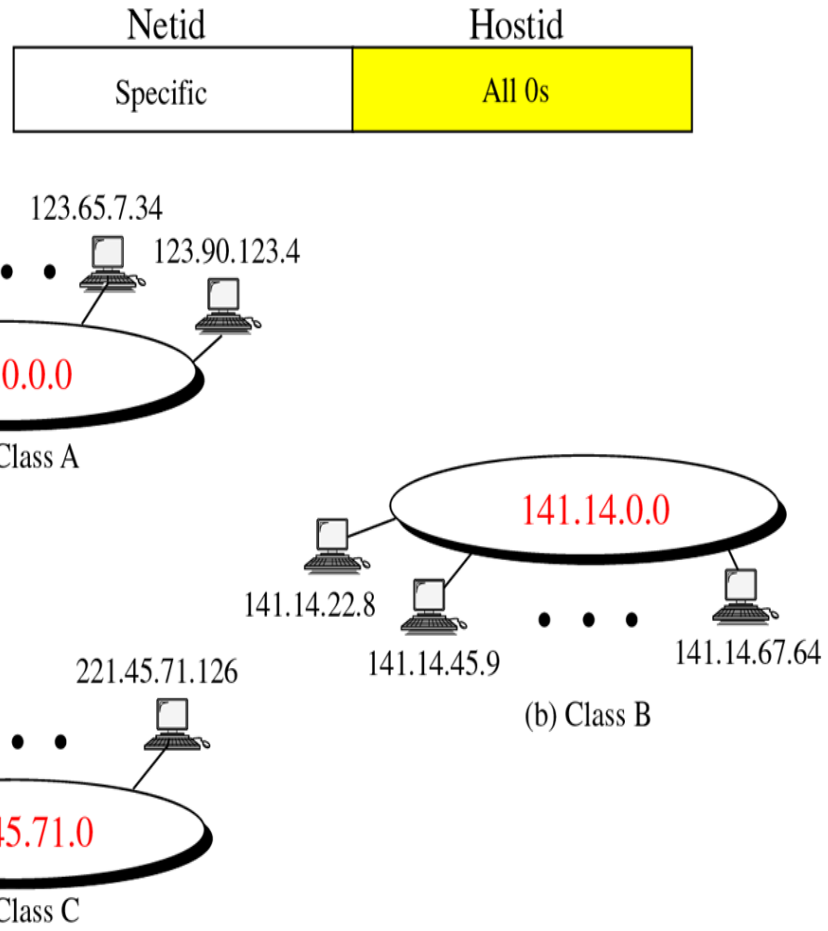
❖ **Network address:**

- 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

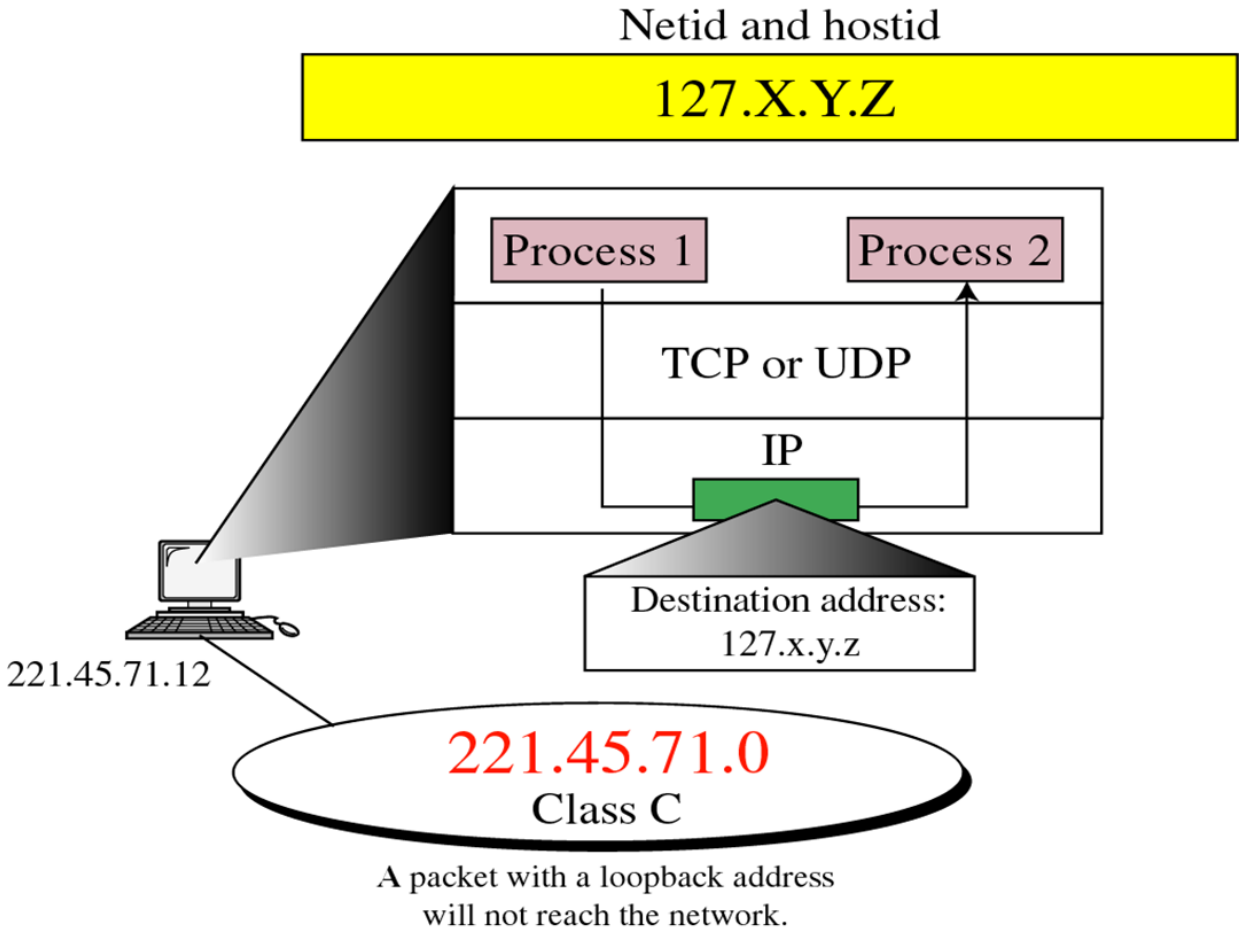


Part 1 (TCP/IP Protocol Architecture)

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

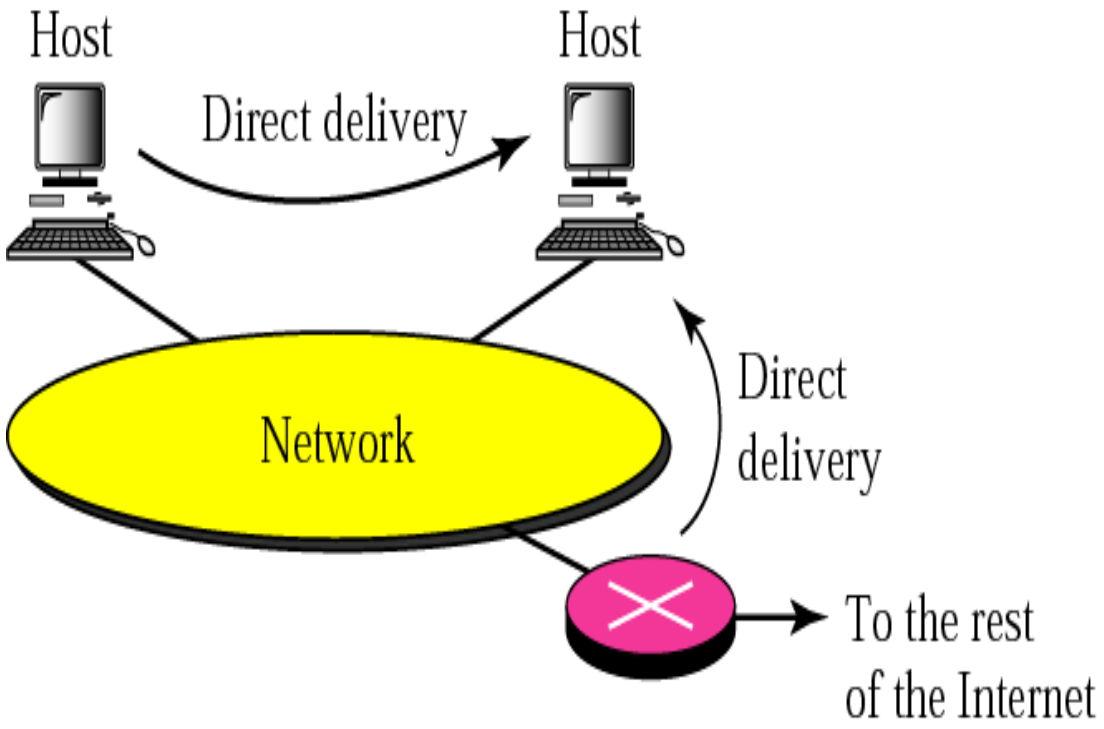


A packet with a loopback address will not reach the network.

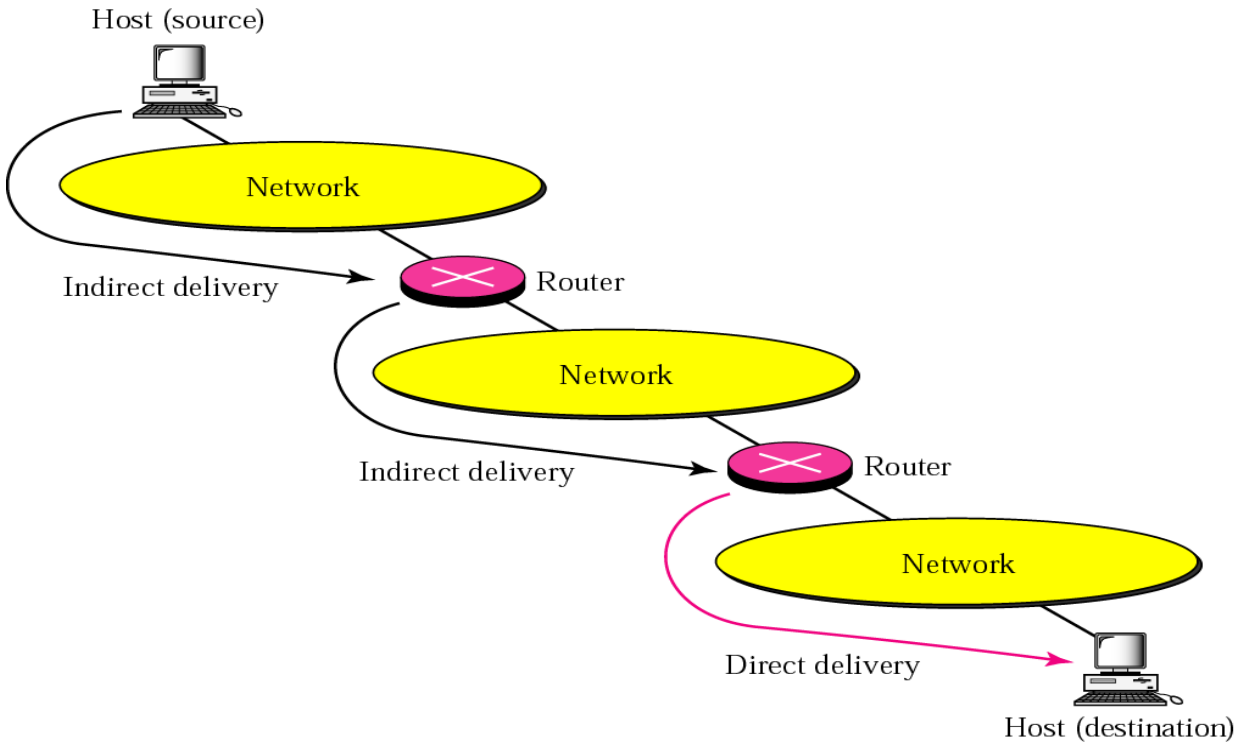
Part 1 (TCP/IP Protocol Architecture)

DELIVERY OF IP PACKETS

Direct delivery



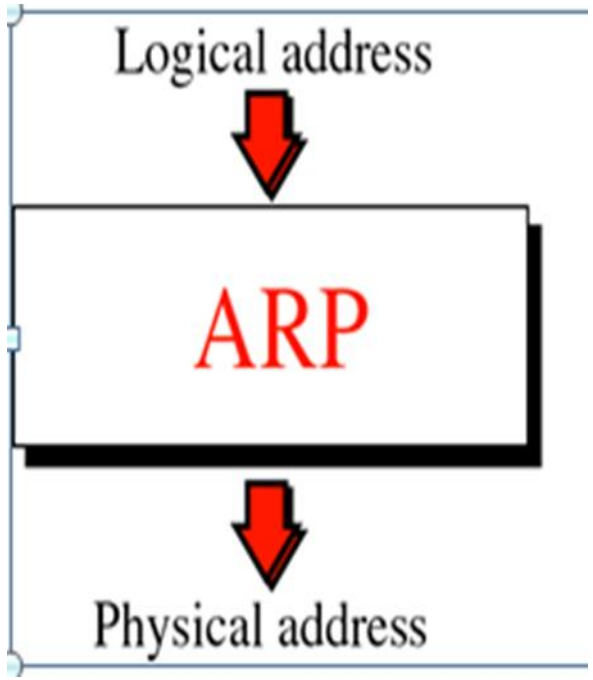
Indirect delivery



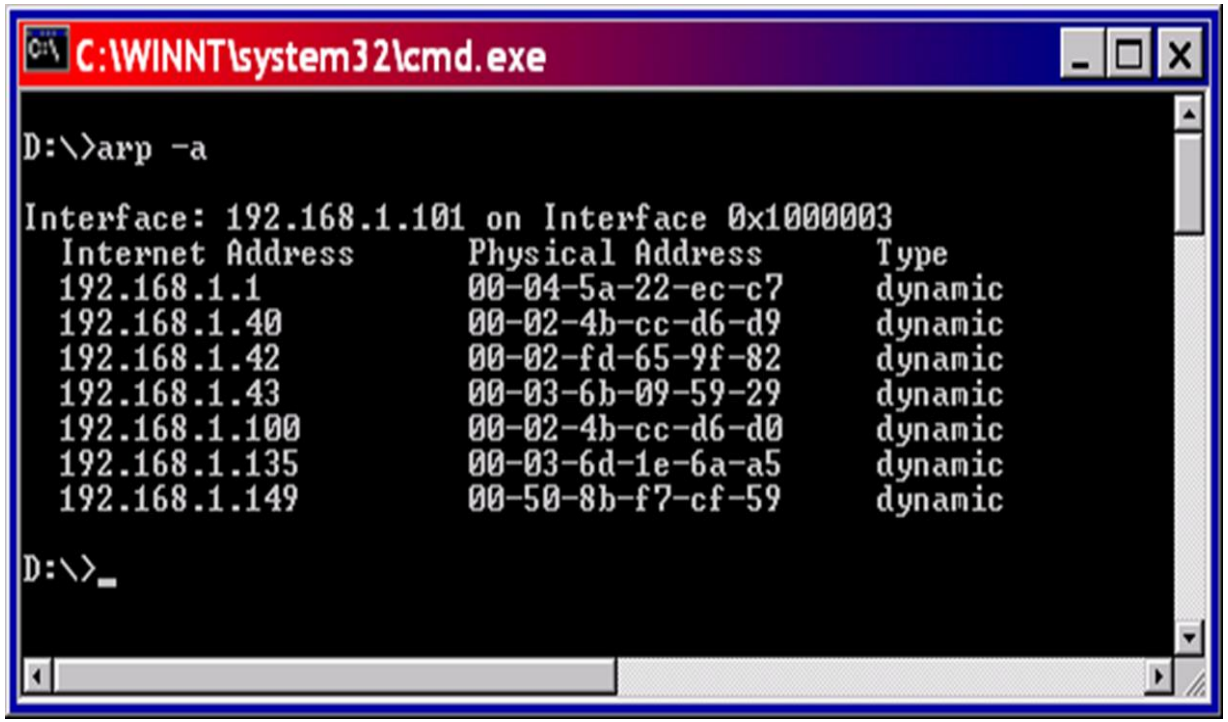
Part 1 (TCP/IP Protocol Architecture)- LAB

❖ ARP (ADDRESS RESOLUTION PROTOCOL)

Arp -a

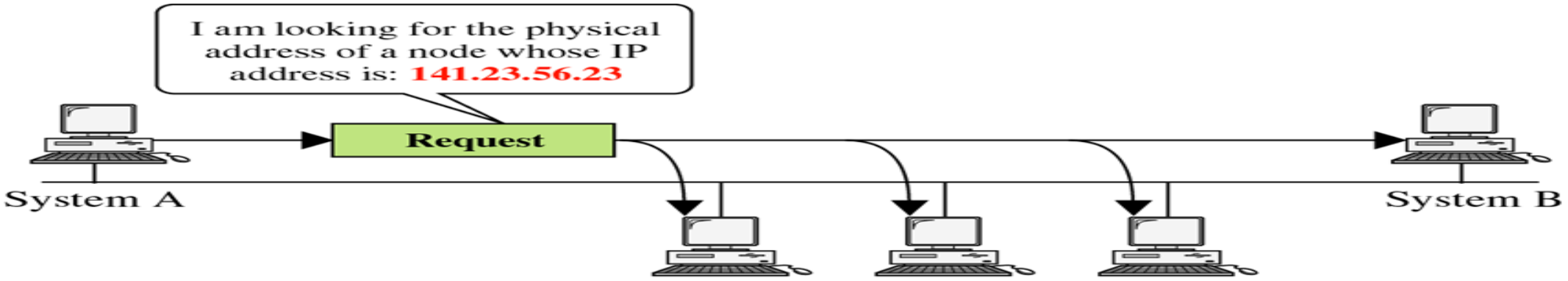


ARP TABLE

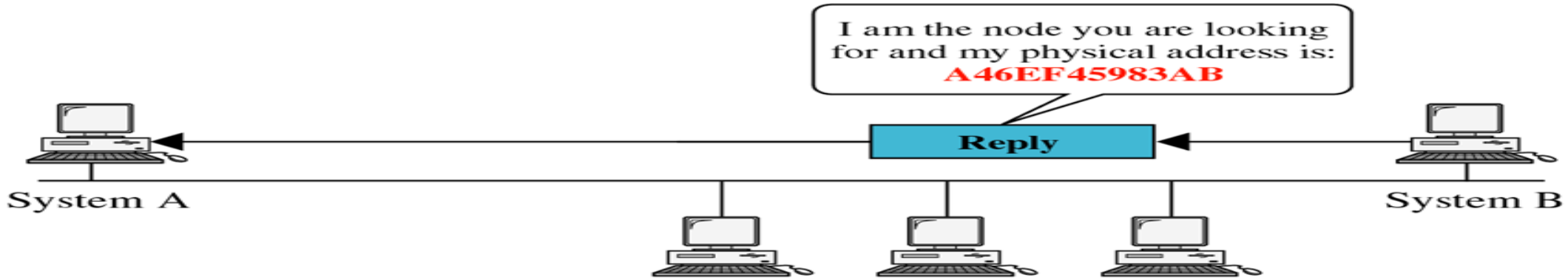


Part 1 (TCP/IP Protocol Architecture)

❖ ARP OPERATION



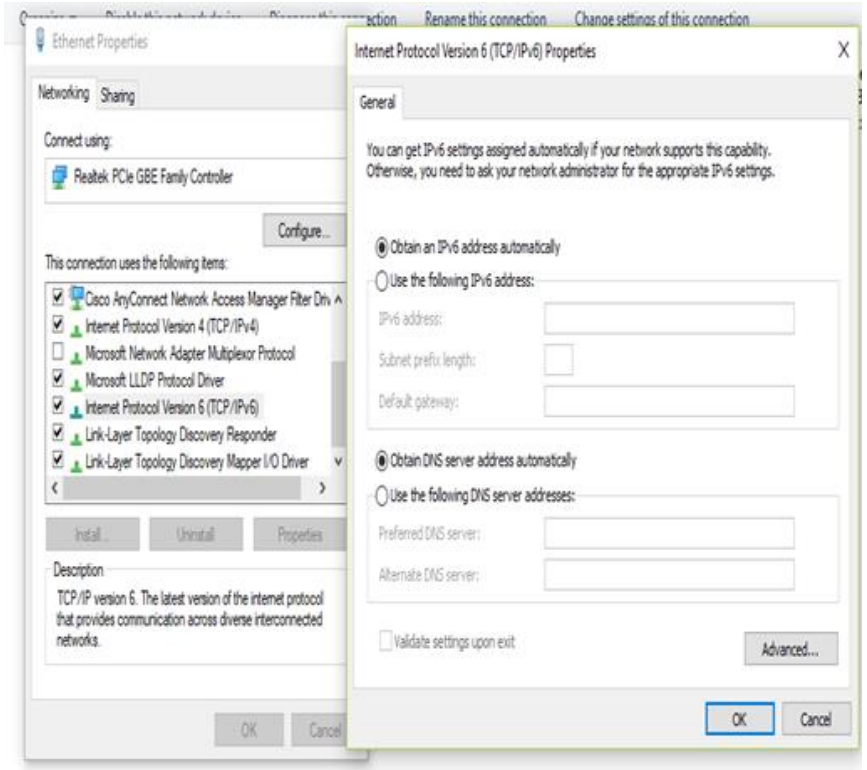
a. ARP request is broadcast



b. ARP reply is unicast

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 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 Architecture)

- **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