Information
Technology
Institute

Computer Networks Fundamentals

Course Objective

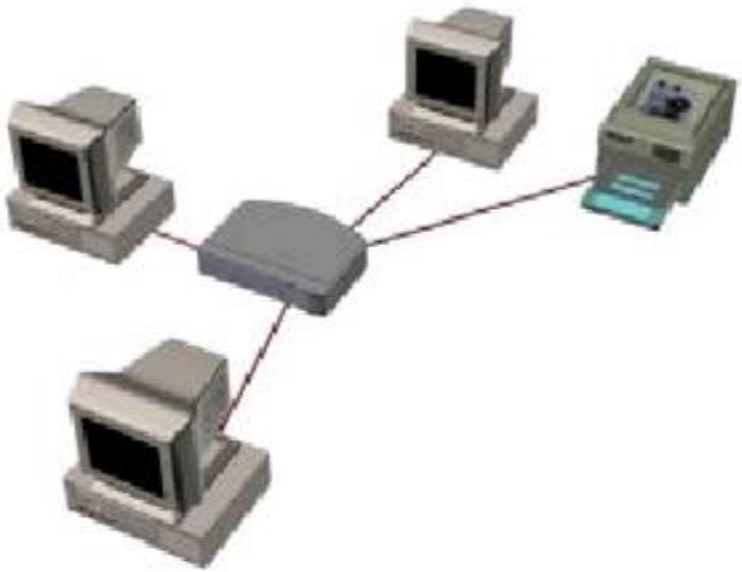
- Introduction to Computer Networks
- OSI Model
- TCP/IP Model
- Ethernet Protocol
- Network Devices
- Network Media
- Network Security Fundamentals
- Introduction to Distributed Systems

What is computer network (CN)

Computer Network :

a collection of computers, and other devices, or peripherals connected together through connecting media to perform certain task such as :

Share Resources



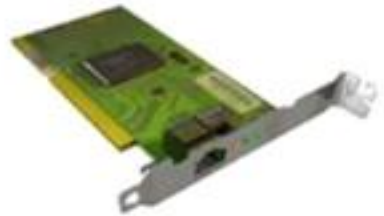
Benefits Of Computer Networks

- **Resources Sharing**
  - File Sharing
  - Devices Sharing
  - Software Sharing with multi-user licenses.
  - Voice and Video calls
- **Shared Internet Access**

BASIC NETWORK TERMINOLOGIES

Basic Network Terminologies

- **NIC (Network Interface Card)**



The hardware that plugs into the motherboard and directly access the network

- **Mac address:**

Physical Address, Unique address over the world burned on the NIC card

- **IP address :**

logical address, identify each device on an IP network layer. .

- **Protocols**

Communication rules that all entity must agree on

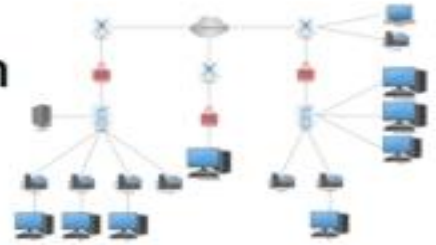
Basic Network Terminologies

- **Hub**
  Allow different nodes to communicate with each other at the same network(Slow the network)

- **Switch**
  Allow different nodes to communicate with each other at the same network and time without slowing each other

- **Router**
  Allow different networks to communicate with each other

- **Topology**
  how devices are connected (shape) and how message flow from one device to another device



HOW TO APPLY NETWORKS ?

Network Classification

- **According to Covered Area**
  - How large is the network?
- **According to network topology**
  - How the computer are connected?
- **According to network model**
  - What type of model?

Network Classification

According to Covered Area

PAN – MAN- WAN-INTERNET

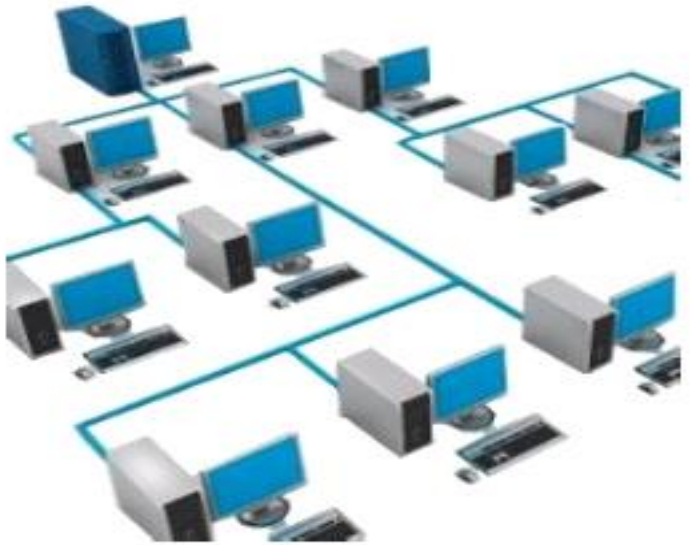
According To Coverd Area

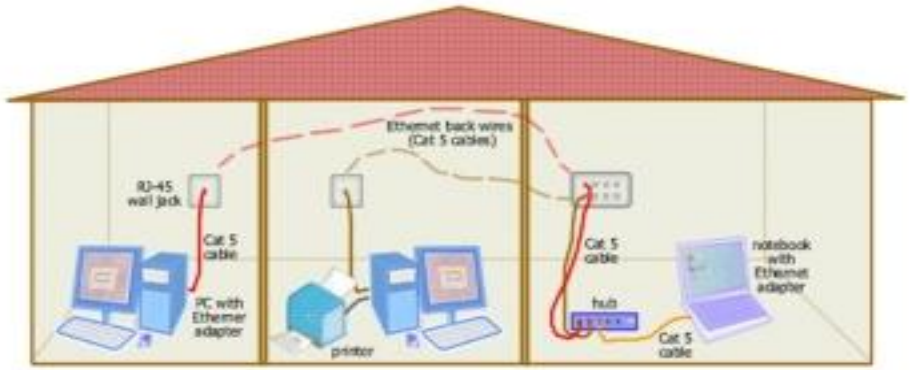
Personal Area Networks (**PAN**)

- a computer network for interconnecting devices centered on an **individual person's workspace.**
- A **PAN** provides data transmission among devices such as computers, smartphones, tablets and personal digital assistants

Local Area Networks (**LAN**)

- a **group** of computers connected in **small** geographical area
- a limited area such as a residence, school, laboratory, university campus or office building (100 -1000 M)
- Allow users to share files and services
- **High speed** of communications
- Under your **administrative Control**



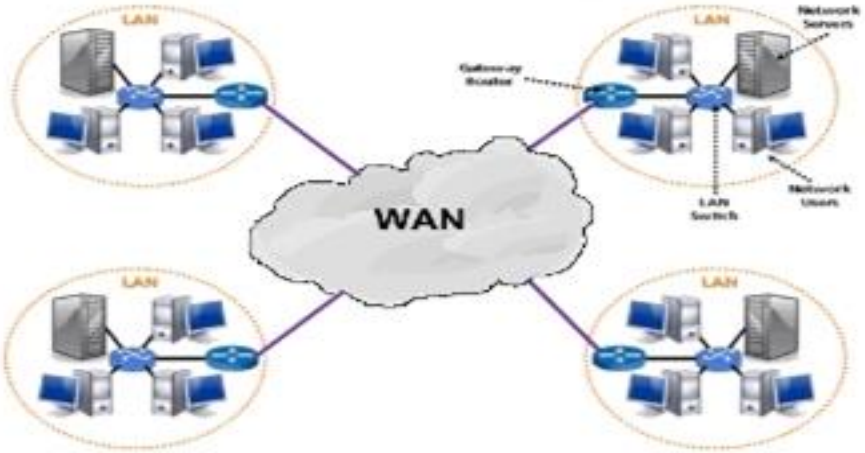


Metropolitan Area Networks (**MAN**)

- A MAN connects an **area larger than a LAN but smaller than a WAN** (Up to 100 km)
- such as a **city.**
- dedicated or high-performance hardware

Wide Area Networks (**WAN**)

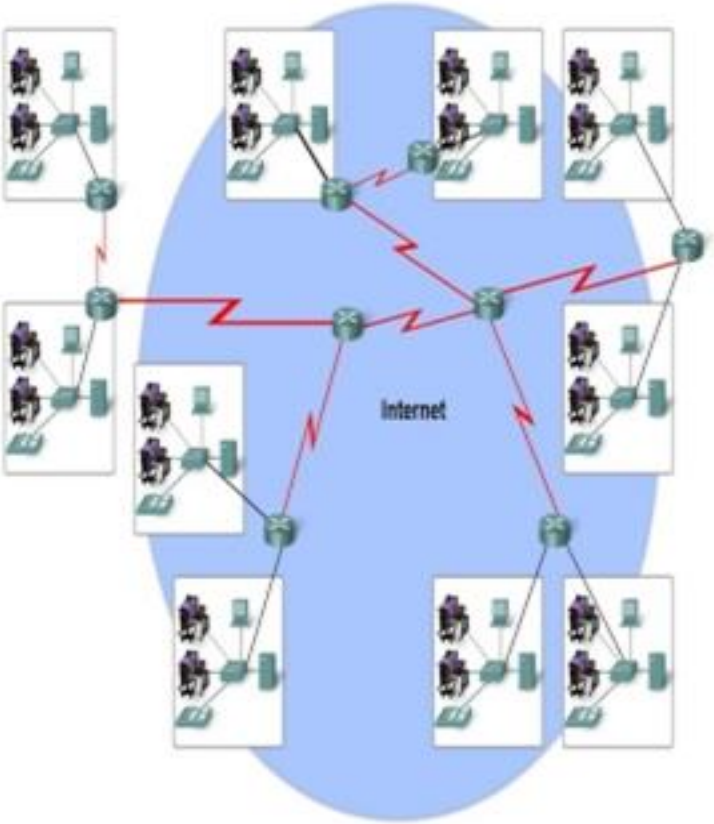
- A WAN is a group of computers connected in **Large geographical** area such as **country**
- A WAN often connects two LANs (WAN Link)
- WAN can <u>contain multiple smaller networks</u>, such as LANs or MANs.
- <u>Very low Speed</u>
- Under your **ISP** Administrative control example of WAN is **Internet**

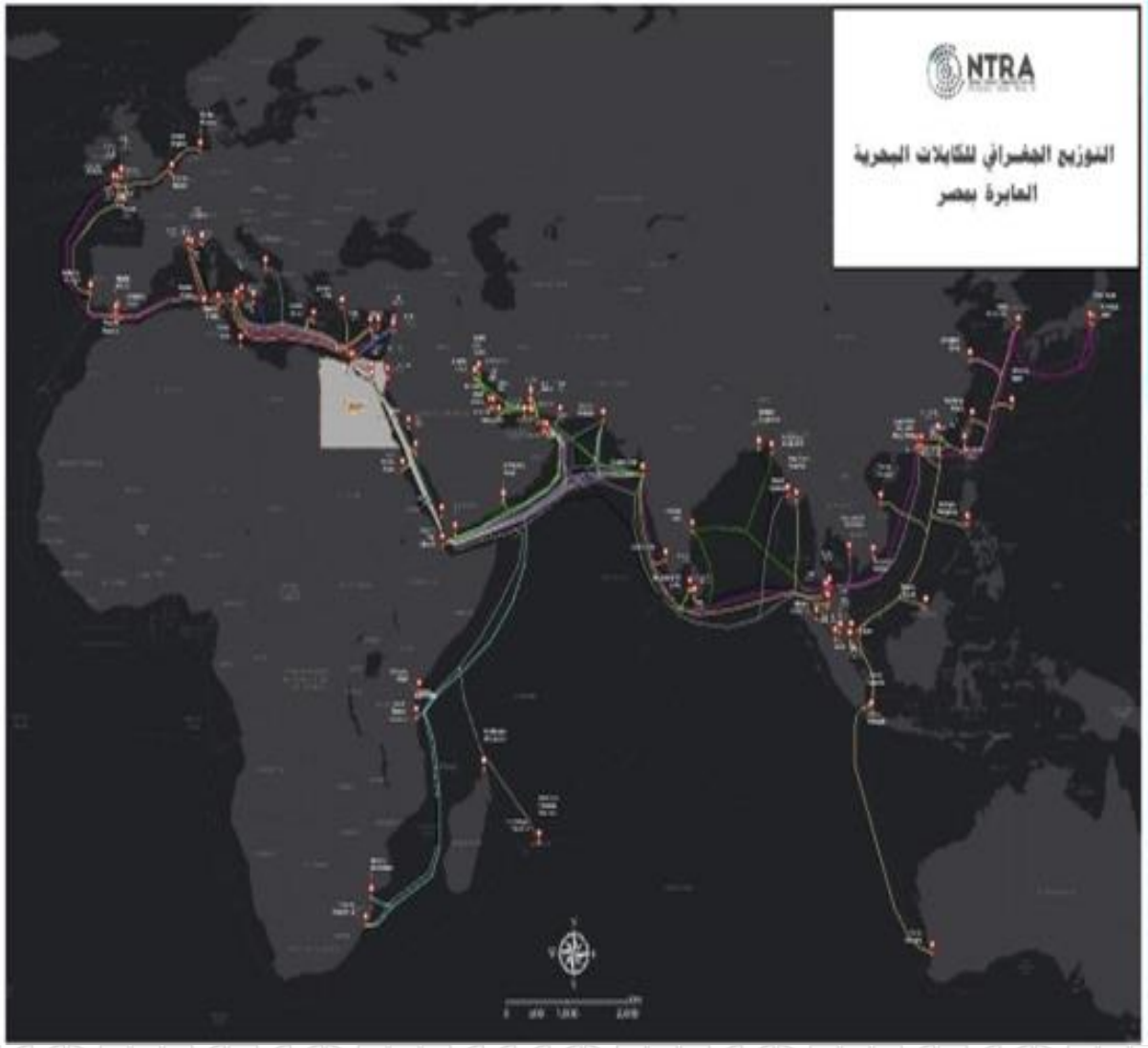


Internet

Internet (WWW)

- The internet is defined as a **global mesh** of interconnected networks
- the most used service on the Internet is the **World Wide Web**
- No one actually owns the Internet
- Many Orgs, ISPs, Companies, Govs own pieces of Internet Infrastructure.
  - ISOC: Internet Society
  - IETF: Internet Engineering Task Forum
  - **ICANN:** Internet Corporation for Assigned **Names** and **Numbers**

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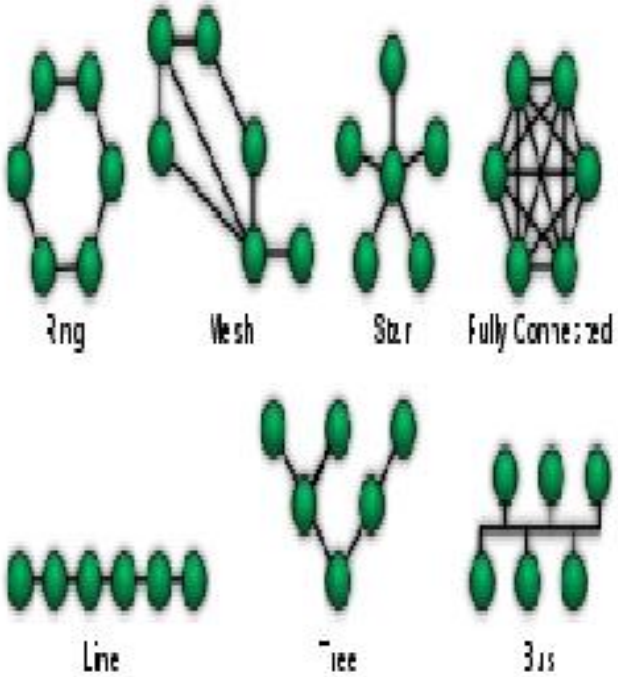
Network Topology

Topology

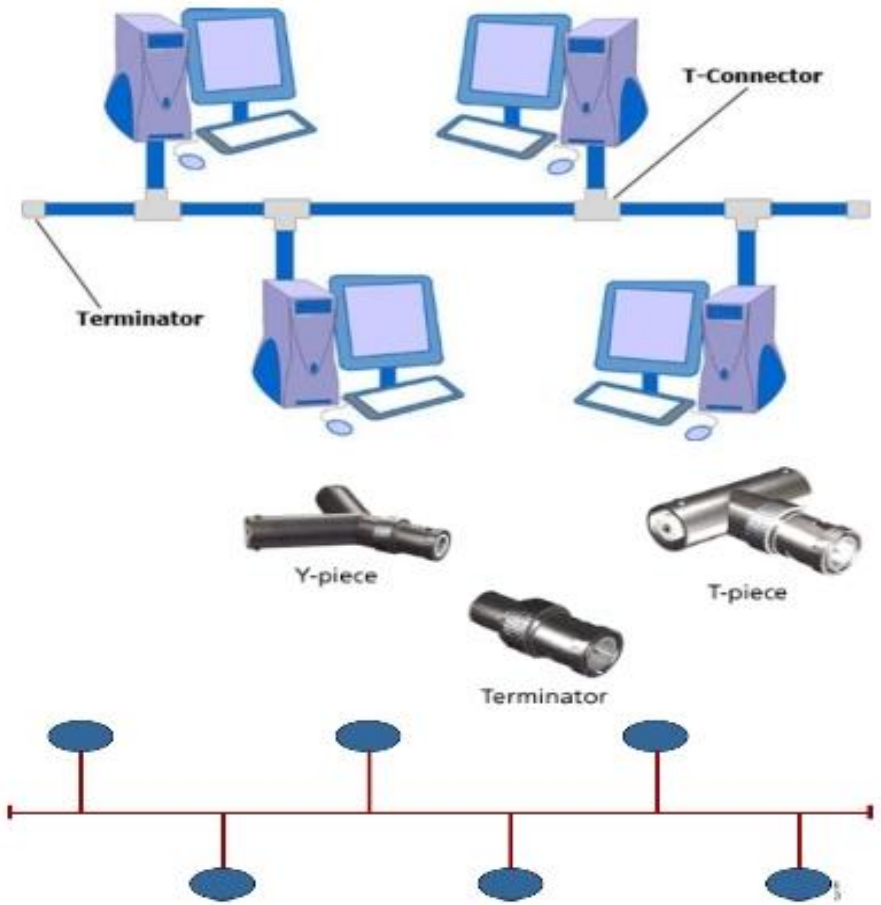
- Refers to the **shape of a network,** or the **network's layout.**
- **Types**
  - **Physical Topology:** how computers connected to each other physically (wired)
  - **Logical Topology:** how to send message from device to other, (the way in which to the generated signal actual path across the network).
- **Dependent on :**
  - ❑ **Type and number of equipment being used**
  - ❑ **Cost**

Each topology has its own **advantages and disadvantages.**



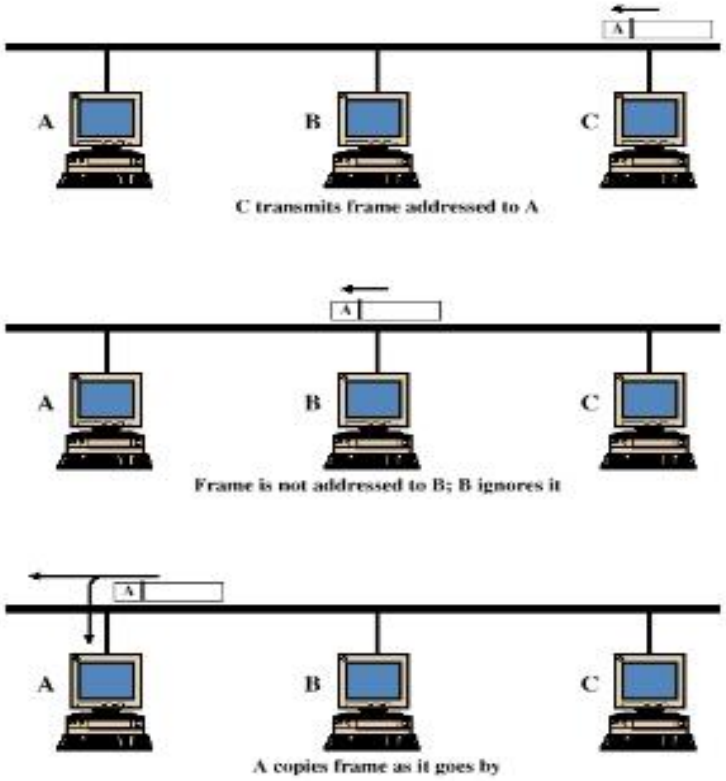
Bus Topology

- All devices are connected to a central cable, called the bus or backbone
- Both ends of the network must be terminated with a terminator.
- A barrel connector can be used to extend the network.



Frame Transmission - Bus LAN

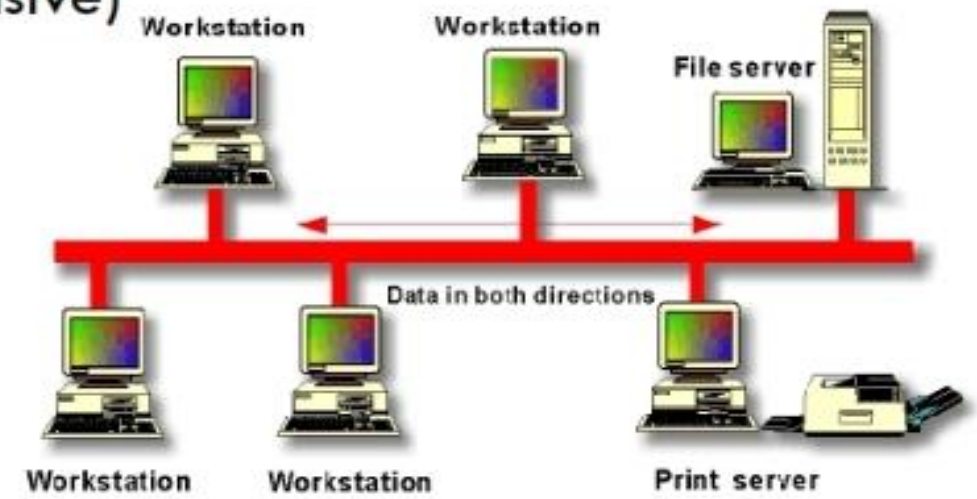
- The backbone functions as a shared communication medium
- Device wanting to communicate with another device on the network sends a message onto the backbone
- The message is **heard by all stations,** but only the intended recipient actually accepts and processes the message.
- Terminator absorbs frames at end of medium



Station C want to transmit a frame of data to station A.

Bus Advantages and Disadvantages

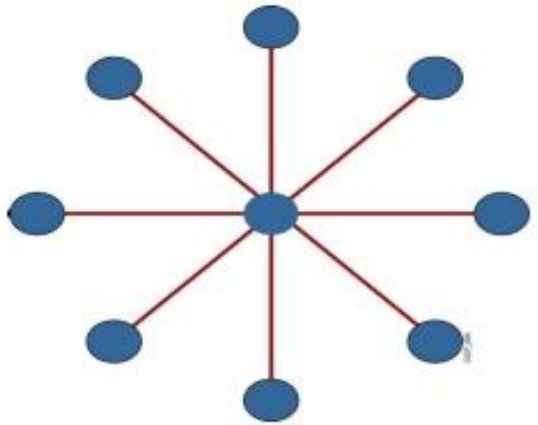
- **Advantages**
  - Simple, easy to use and construct
  - Requires least amount of cable (less expensive)
  - Reliable
- **Disadvantages**
  - A faulty cable take the entire LAN down
  - Difficult to troubleshoot
  - No security
  - Slow during peak traffic period



Star Topology

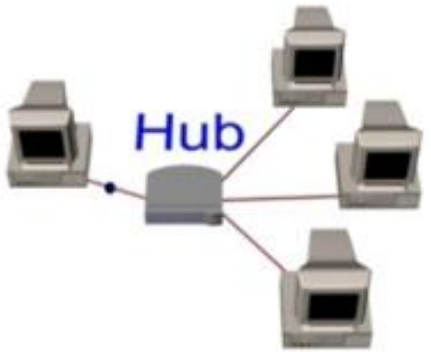
- All the devices are connected to a **centralized unit** such as a Hub or Switch.

- Nodes communicate across the network by passing data through the central device.

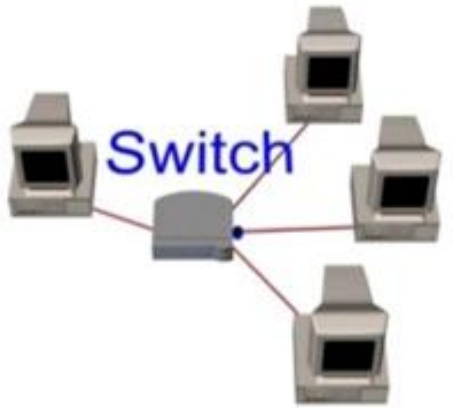


Star Topology types

- **Hubbed Star** (Broadcasted Star Topology)
  - Central node can broadcast (Hub)
    - Physical star, logically bus
    - **Only one station can transmit at a time**



- **Switched Star**
  - Central node can act as frame switch
    - Retransmits only to destination

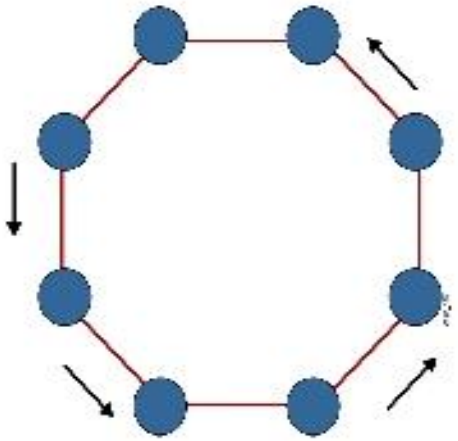


Star Advantages and Disadvantages

- **Advantages:**
  - Network not affected if one PC fails
  - Network expansion and reconfiguration is simple
  - Network management and monitoring can be centralized
  - Troubleshooting is easy
- **Disadvantages**
  - If the central device fails, all the network fails

Ring Topology

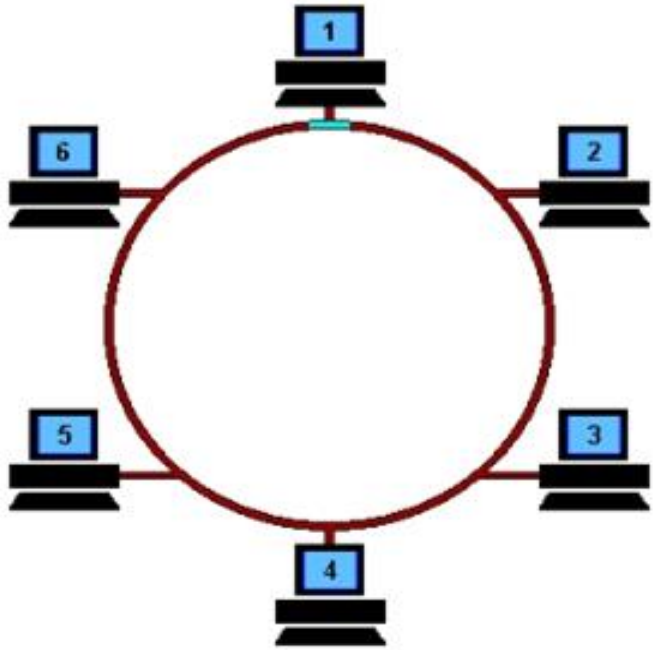
- A cable connects one node to another to form a ring (shape of a closed loop)
- each device is connected directly to two other devices, one on either side of it.
- All messages travel through a ring in **the same direction**
- **token** is used to transmit data and pass over each station
- **Medium access control** determines when station can insert frame



Frame Transmission - Ring LAN

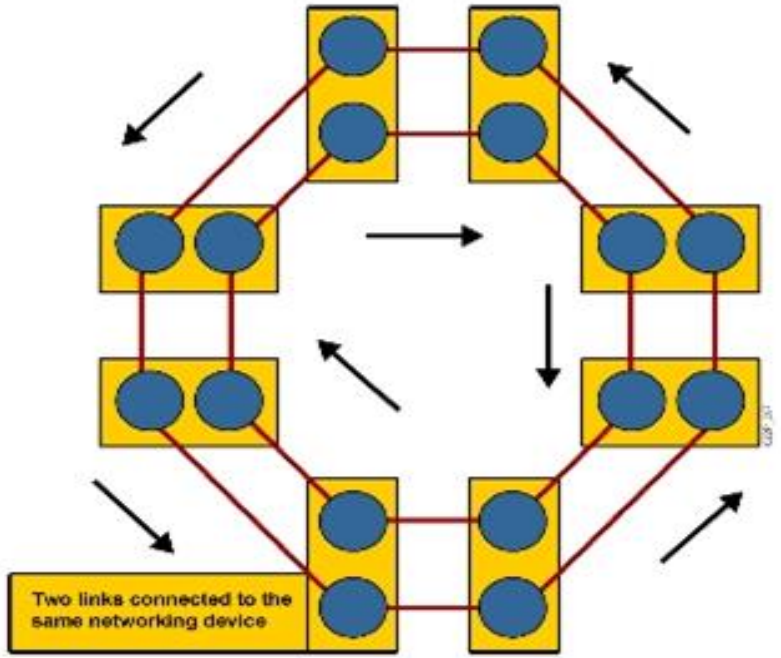
Data transmitted in frames (token)

- Circulate past all stations
- Destination recognizes address and copies frame
- Data is passed one way from device to device.
- Frame circulates back to source where it is removed
- **Medium access control** determines when station can insert frame



Dual Ring Topology

- Signals travel in opposite directions.
- More resilient than single ring.



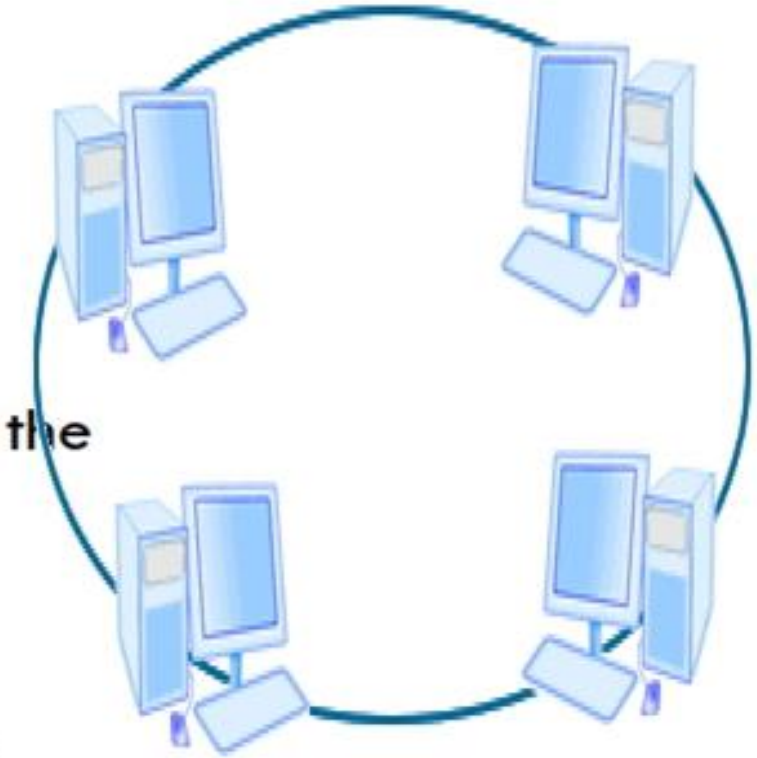
Ring Advantages and Disadvantages

❑ Advantages:

- **Fair** (Equal access for all users)
- Perform **well** under heavy traffic

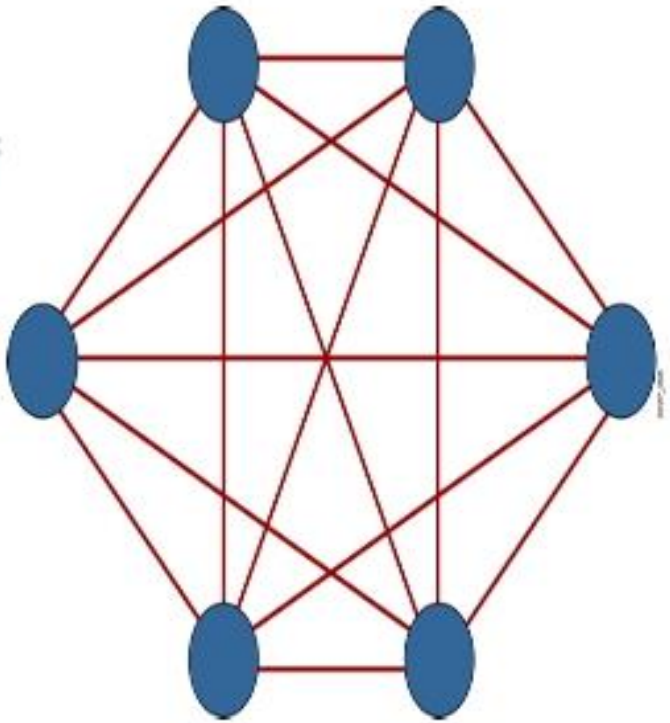
❑ Disadvantages

- Network expansion or reconfiguration will affect the network operation
- If **one node** fails, the entire network fails
- Difficult to troubleshoot
- very bad if we have about **60** pc, Slow Network



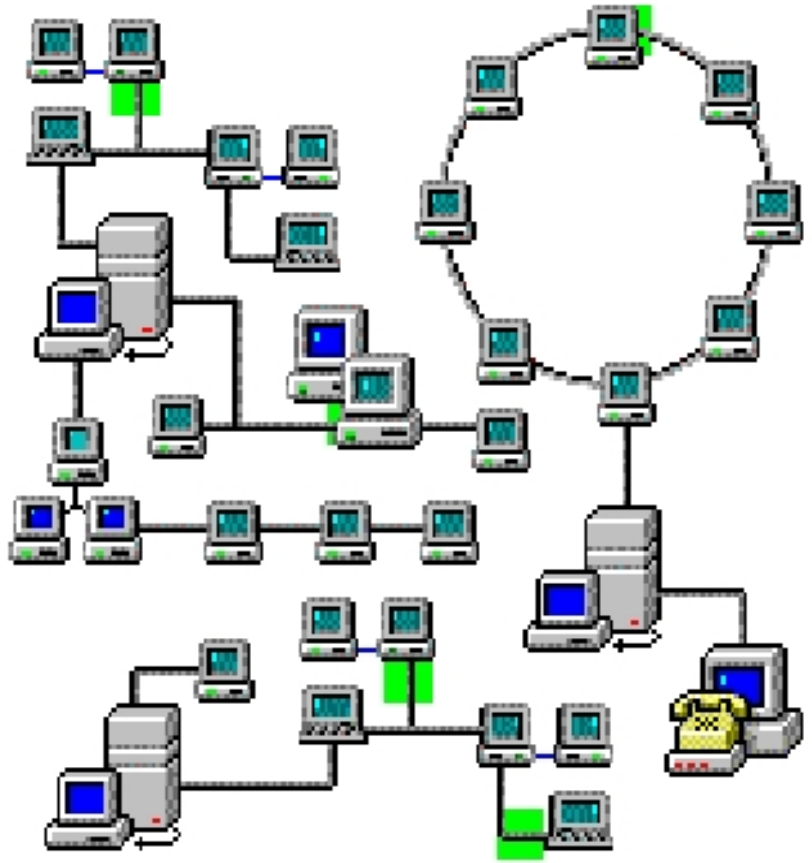
Mesh Advantages and Disadvantages

- Advantages:
  - Mesh topology boasts the highest fault tolerance of all of the network topologies
  - **Redundancy** exist
  - **Secure**
- Disadvantages
  - Because each connection needs its own cable a Mesh topology can get **very expensive**



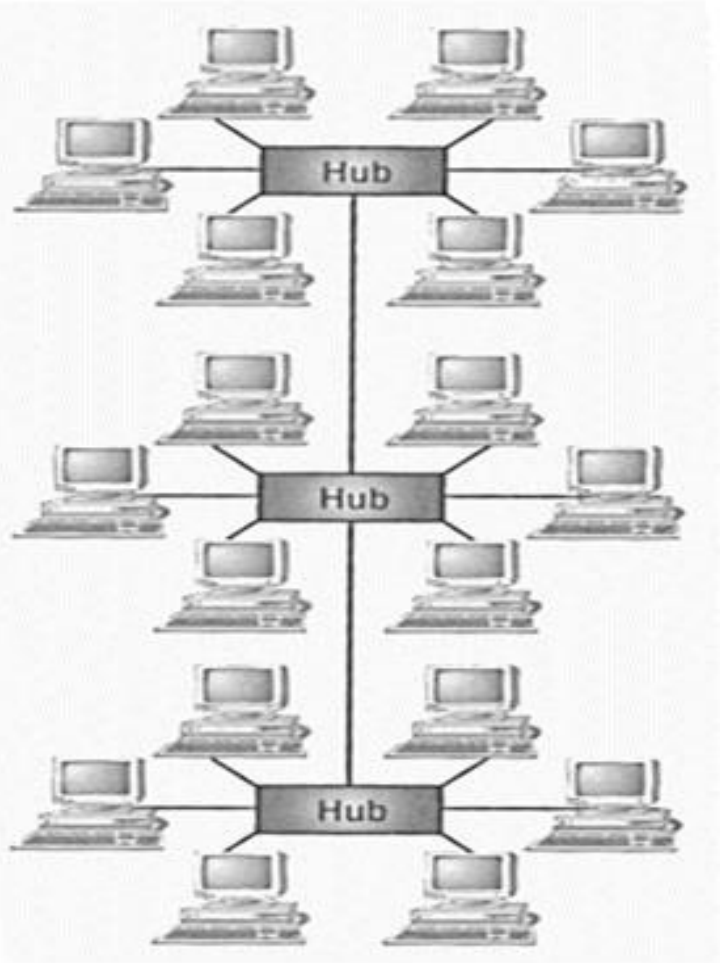
Hybrid Topology

- Hybrid means that there is more than one topology exist
- Combine bus ,star and ring topologies
- Allow network expansion
- Flexible



Hybrid Advantages and Disadvantages

- Advantages:
  - Network **expansion is simple**
- Disadvantages
  - If hub fails connections between failed hub and other hubs will fail

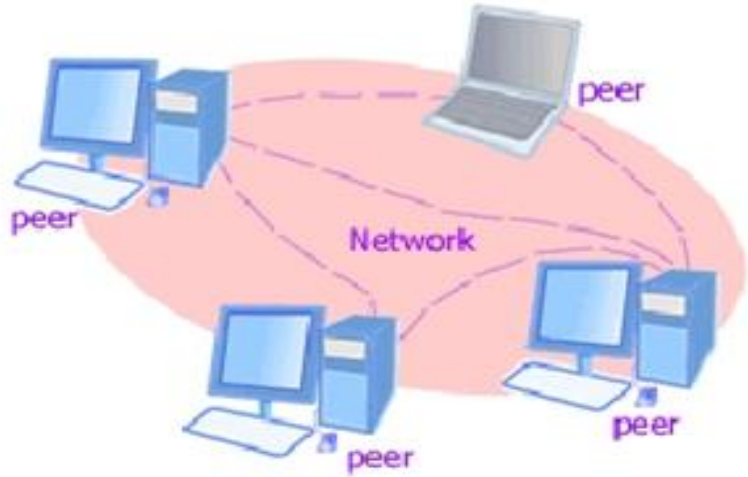


Network Model

Peer-to-Peer Networks

- **No** dedicated resources to present specific service
- **Easy** to work with
- **All nodes are the same** (equal to use the resources)

Example : Windows Workgroup

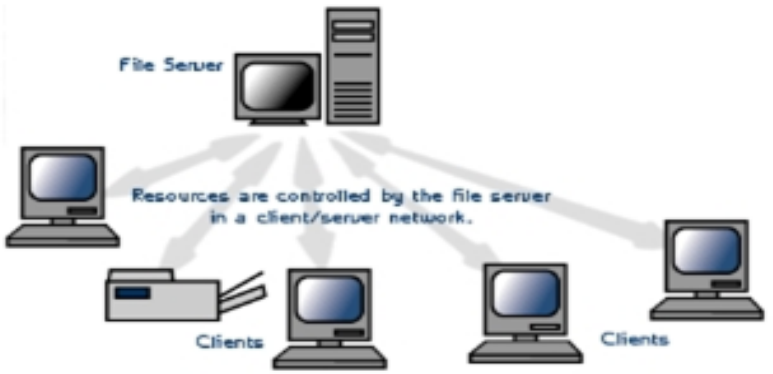


Client/Server Networks

- Some nodes (**SERVER**) are dedicated to **present services** to other nodes (**CLIENTS**)
- Server is **more powerful**

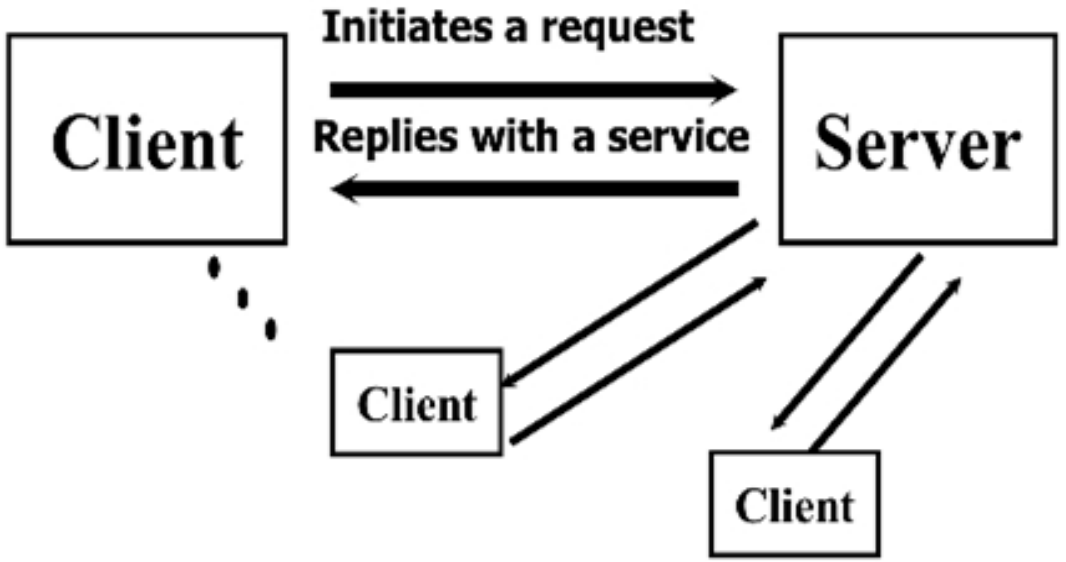
Examples:

- Mail Server
- Web Server
- File Server
- Print Server



Client/Server Networks

- computers providing the service are called **Servers**
- computers that request and use the service are called **Client** computers.
- number of servers is very small compared with the number of clients

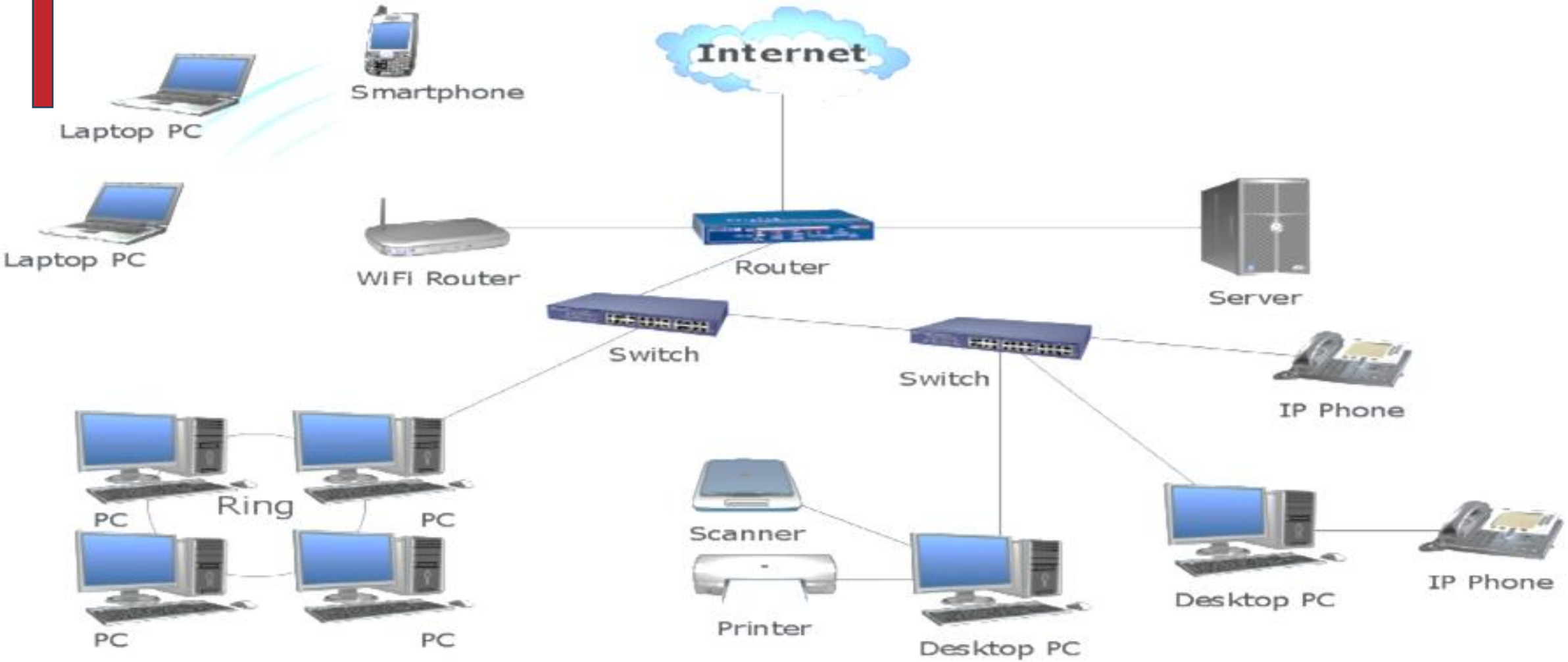


Peer To Peer VS Client / Server Model

	Peer to peer	Client/server
Centralization	Local machine no central server	All client machines connect to central server to get service
Storage	Each machine share its files equally with the others	All files and folders are on dedicated storage on the server and client access their files based on database on the server
Cost	inexpensive	Expensive because of server OS license
scalable	In home or small office	Medium/large enterprise
Operating system	Client operating system	Server operating system to handle multiple requests

What do you need to build your network?

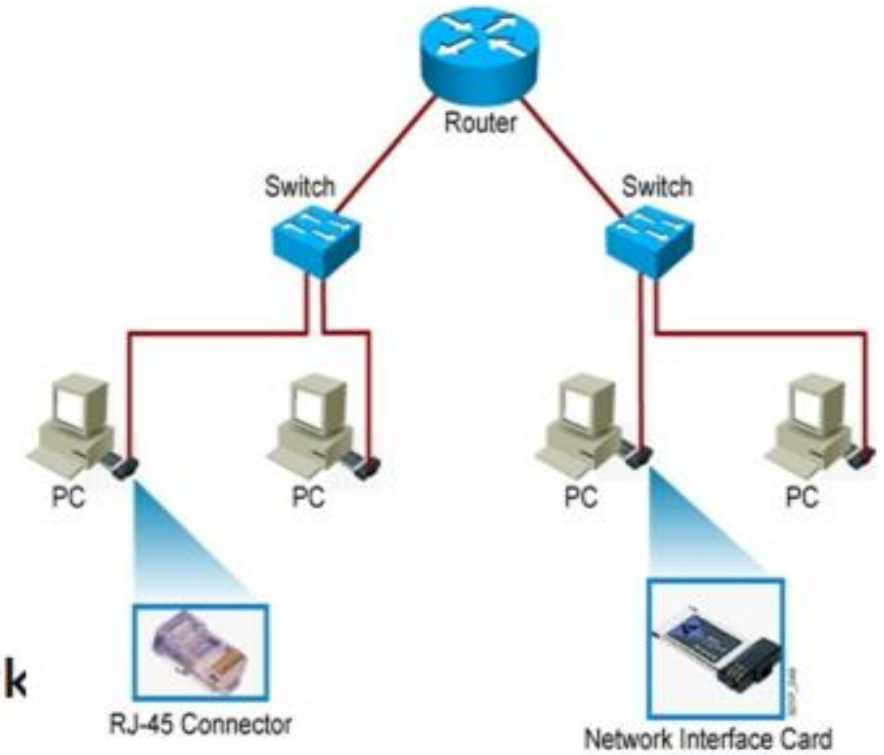
Simple Network



Basic Network Elements

- Hardware
  - Computers / Peripherals
  - NICs
  - Connecting Media
  - Networking Device(s)
    - Routers
    - Switches
    - Hubs
- Software
  - Protocols
    - Communication rules that all entity must agree on

- **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



Software

Protocols

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

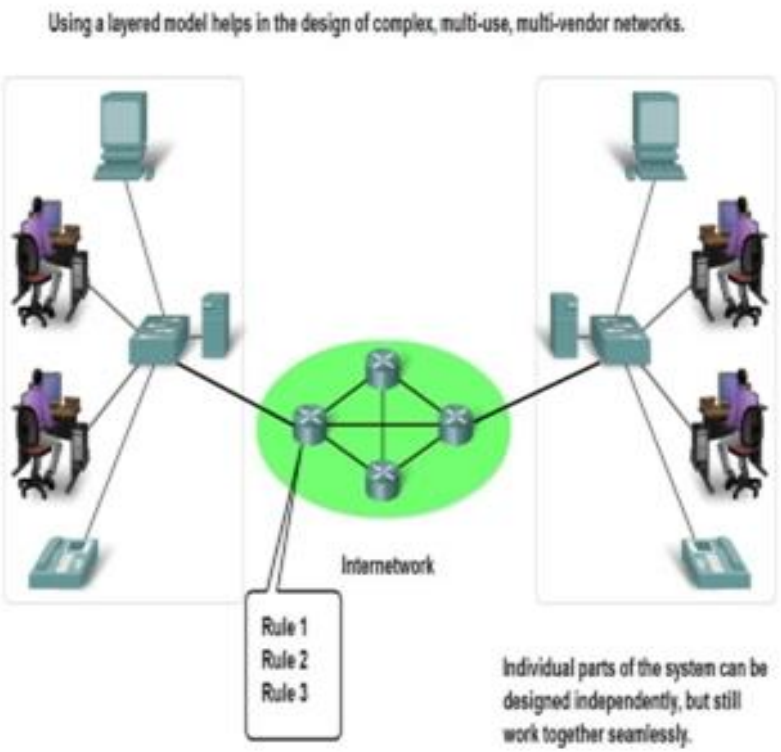
Basic Network Elements (Software)

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.

Benefits Of Using A Layered Model

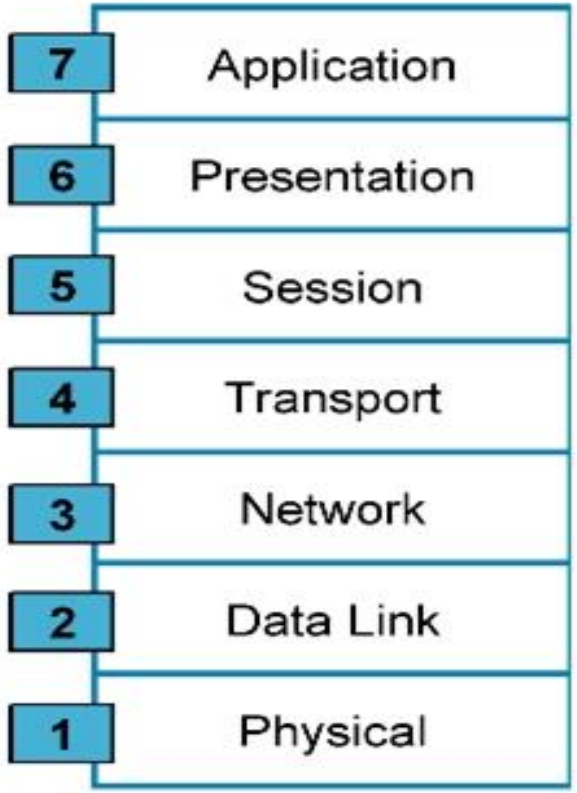
- It divides the network communication process into Layers, so easier to troubleshooting.
- It allows multiple-vendor development through standardization of network components.
- It allows various types of network hardware and software to communicate.
- Changes in one layer do not affect other layers because of layer separation
- Layers interact with each other.



Basic Network Element Software

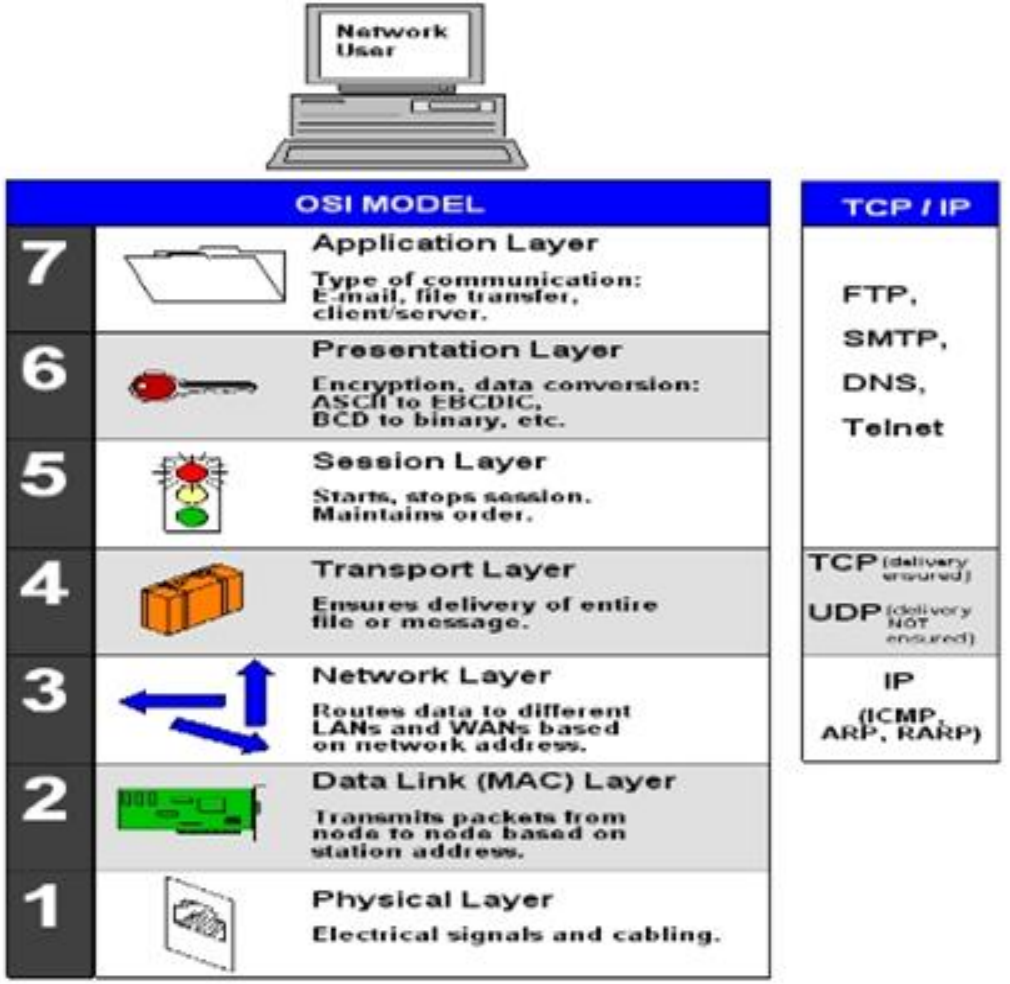
Why a Layered Network Model?

- Reduces complexity
- Standardizes interfaces
- Facilitates modular engineering
- Simplifies teaching and learning



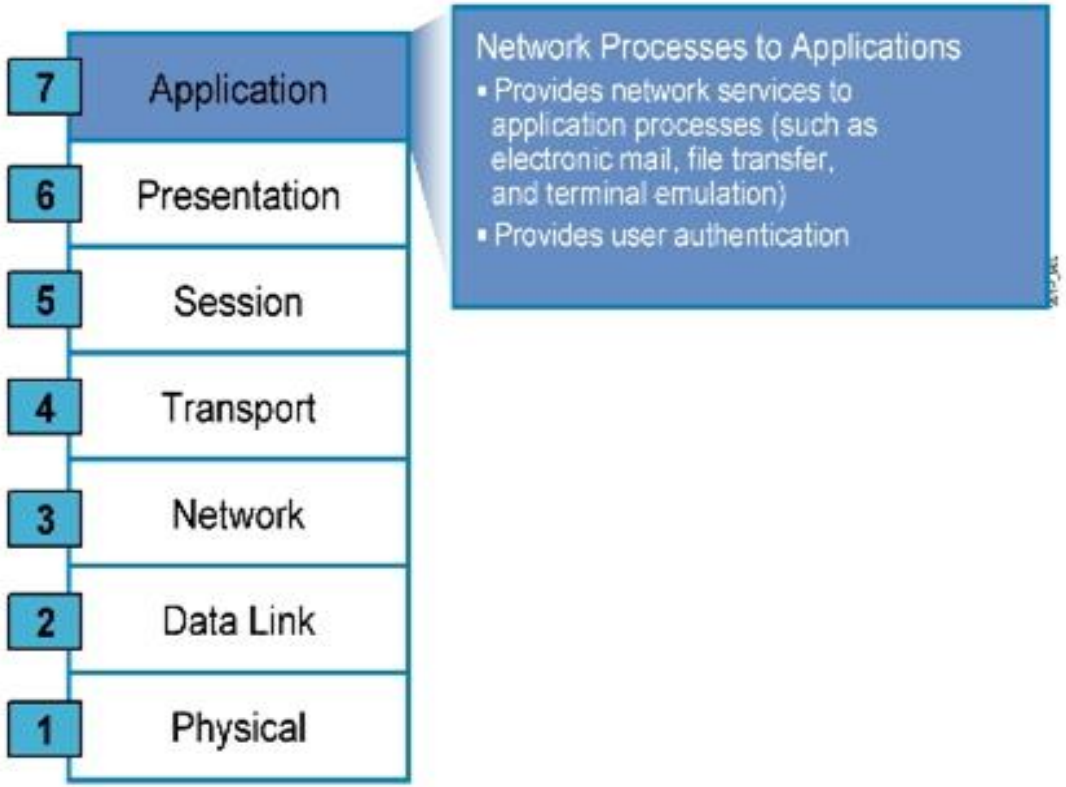
OSI (7-Seven Layers)

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



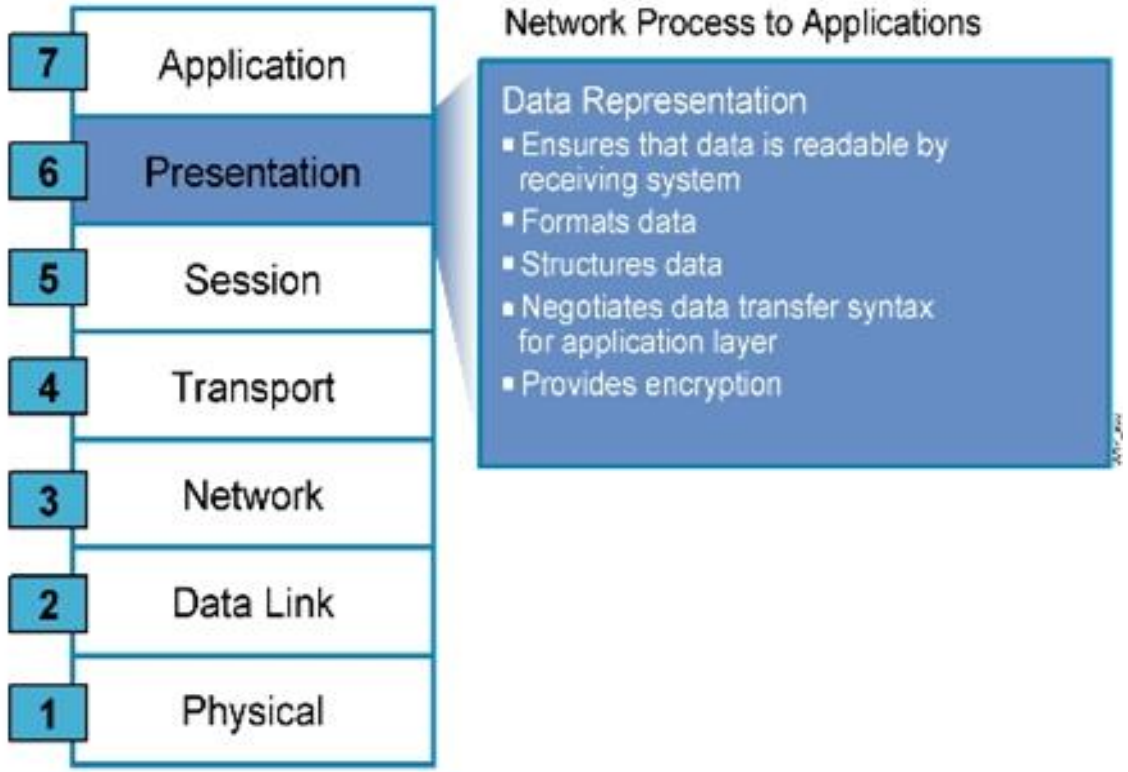
The Seven Layers Functions (Cont.)

- **Application Layer**
  - Interface to end users
  - File transfer
  - Network management
  - Email
  - Many other services
  - 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



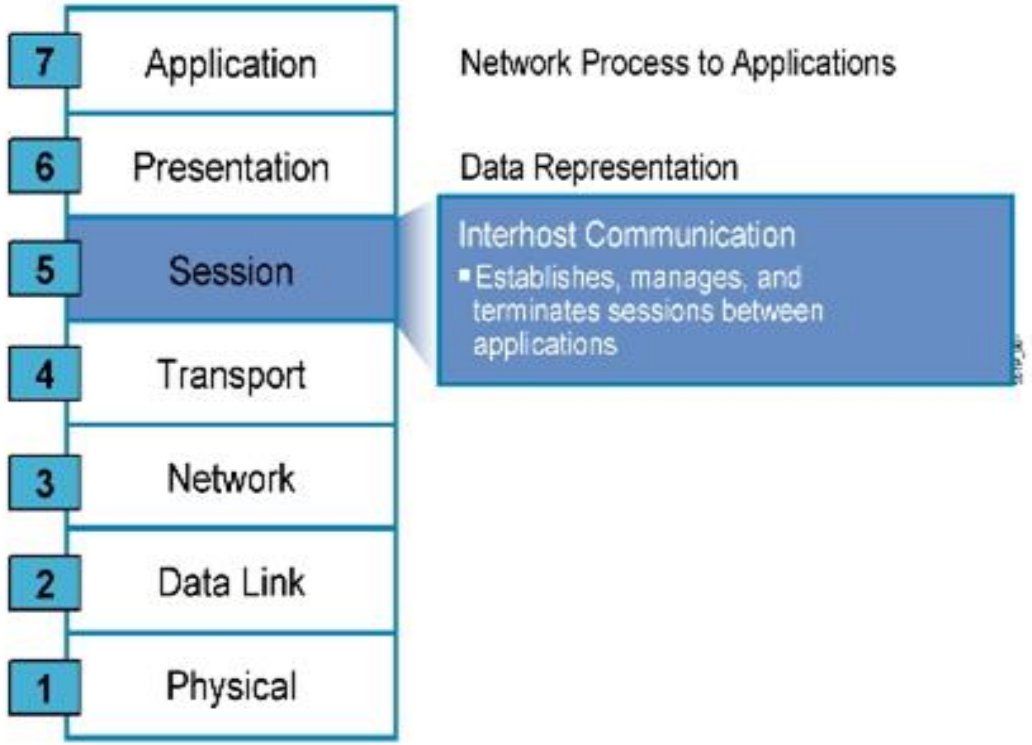
The Seven Layers Functions (Cont.)

- **Presentation Layer**
  - Finding common presentation between source and Destination
  - ensures that the information that the application layer of one system sends out is readable by the application layer of another system. (support standardized application interface)
  - Provide transformation of data (Encoding and Decoding Sender to Common format on Sending)
  - ex: EBCDIC to ASCII



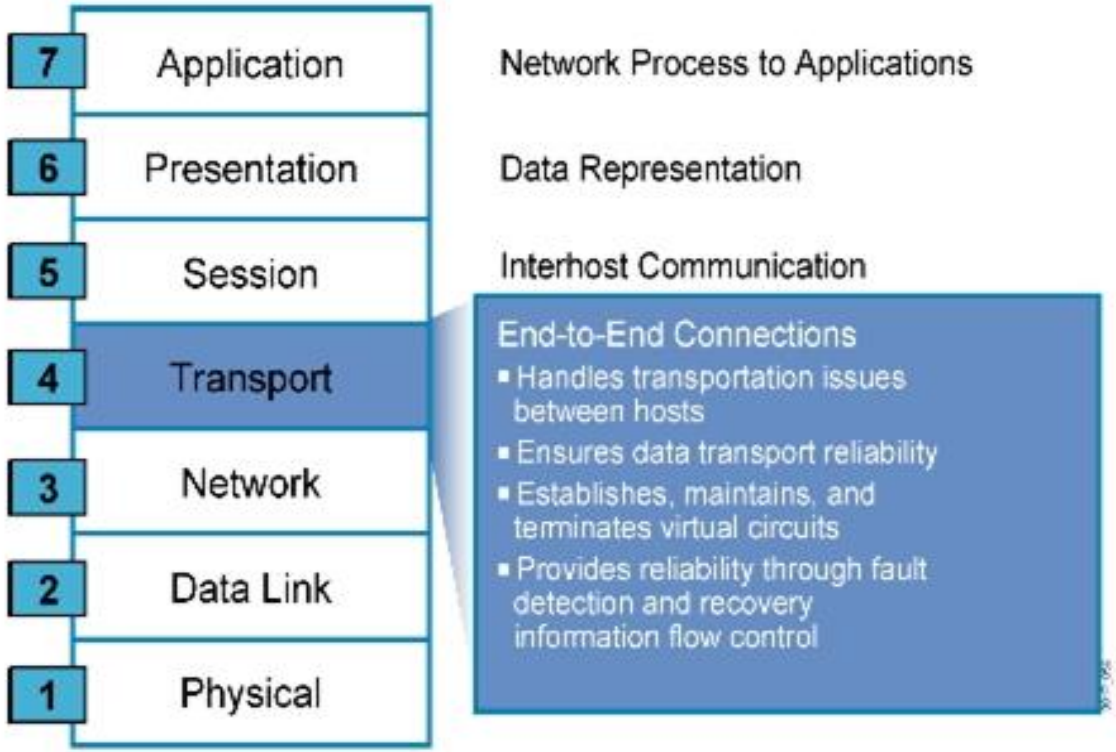
The Seven Layers Functions (Cont.)

- **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



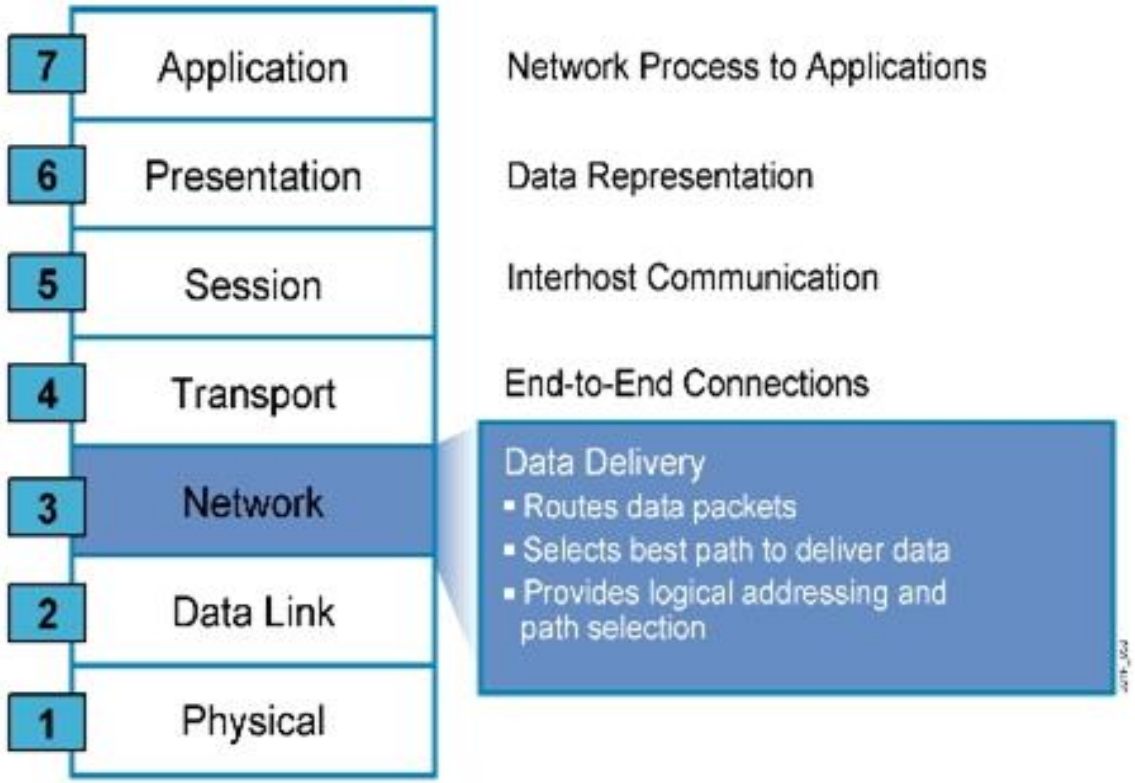
The Seven Layers Functions (Cont.)

- **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**



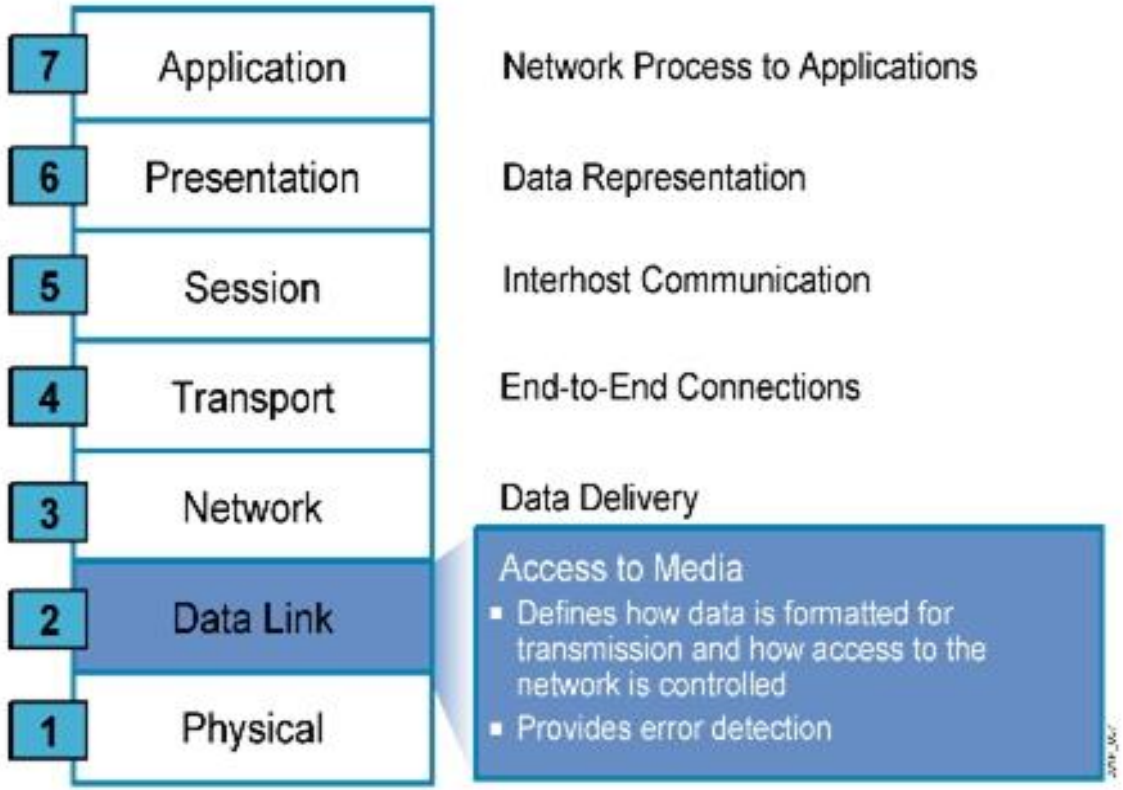
The Seven Layers Functions (Cont.)

- 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



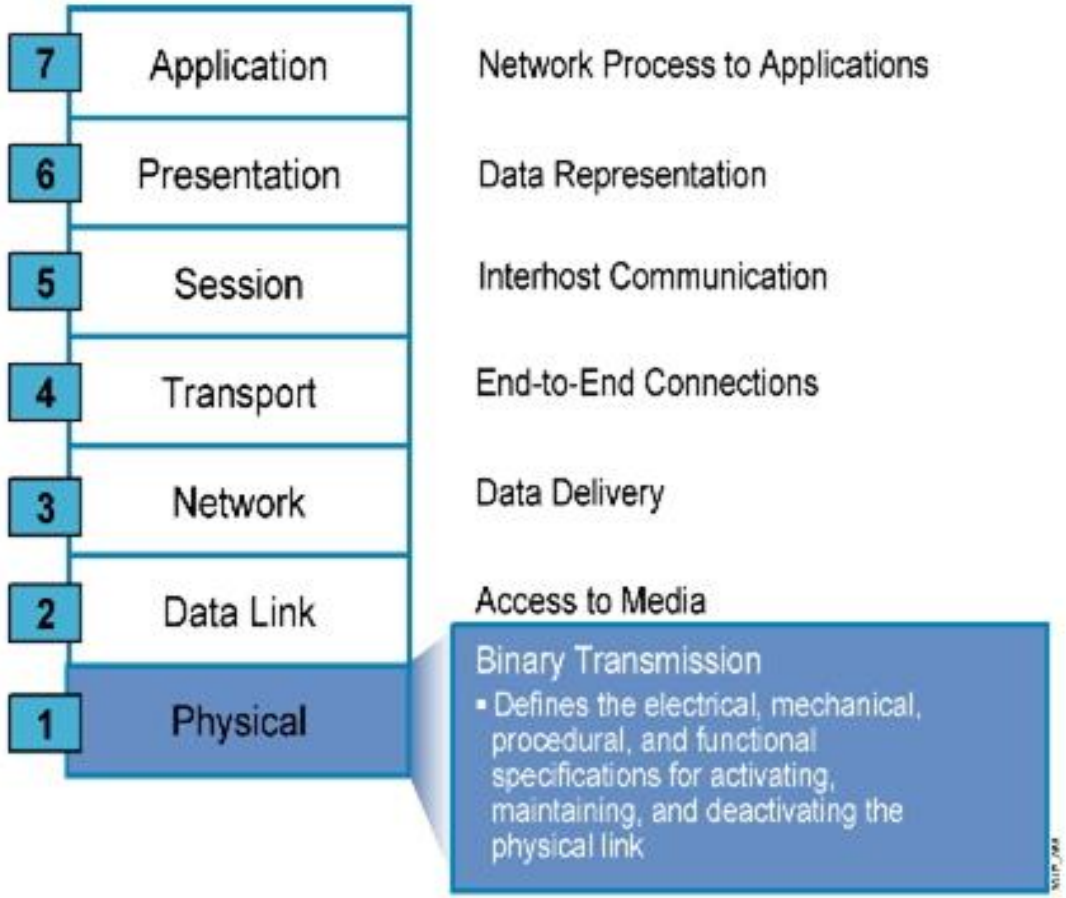
The Seven Layers Functions (Cont.)

- 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

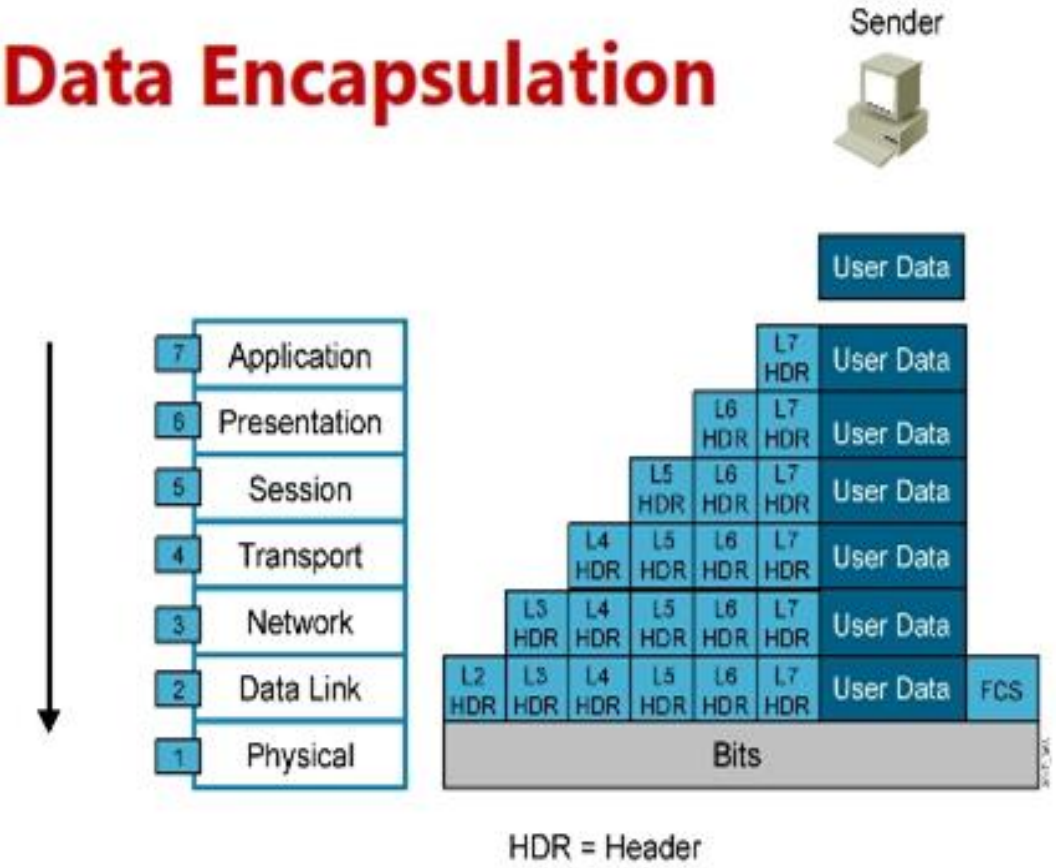


The Seven Layers Functions (Cont.)

- 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

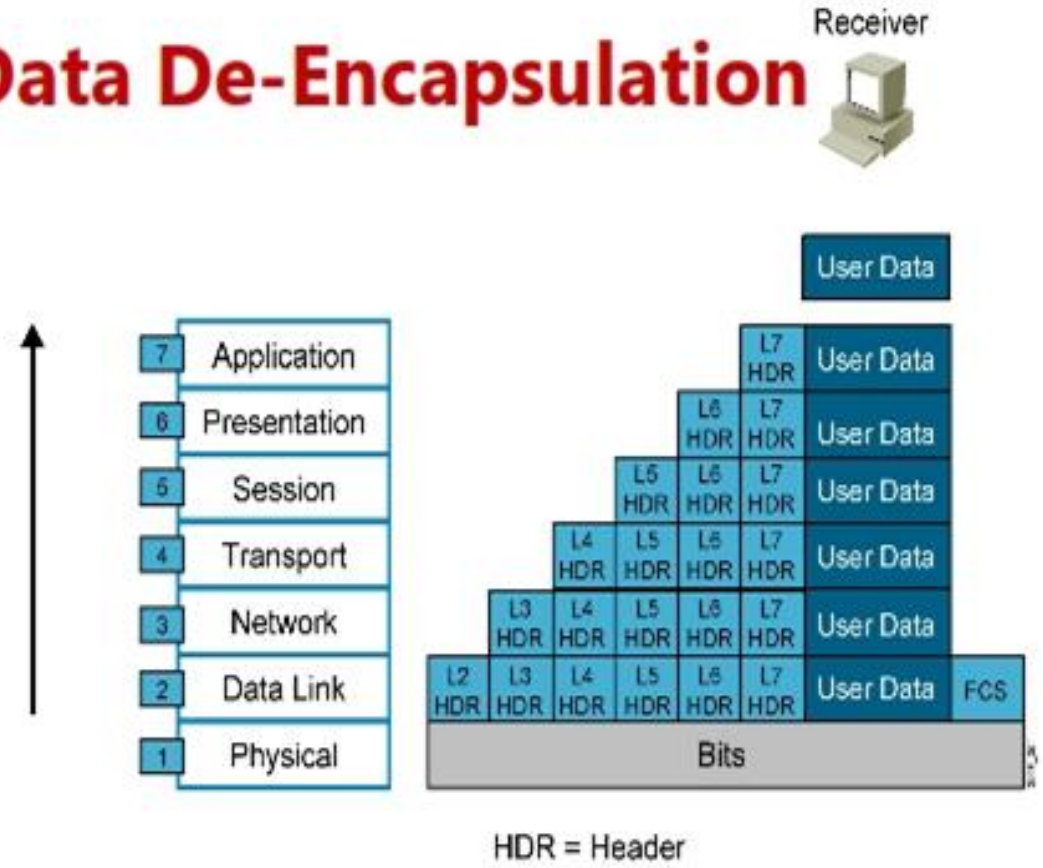


Data Encapsulation



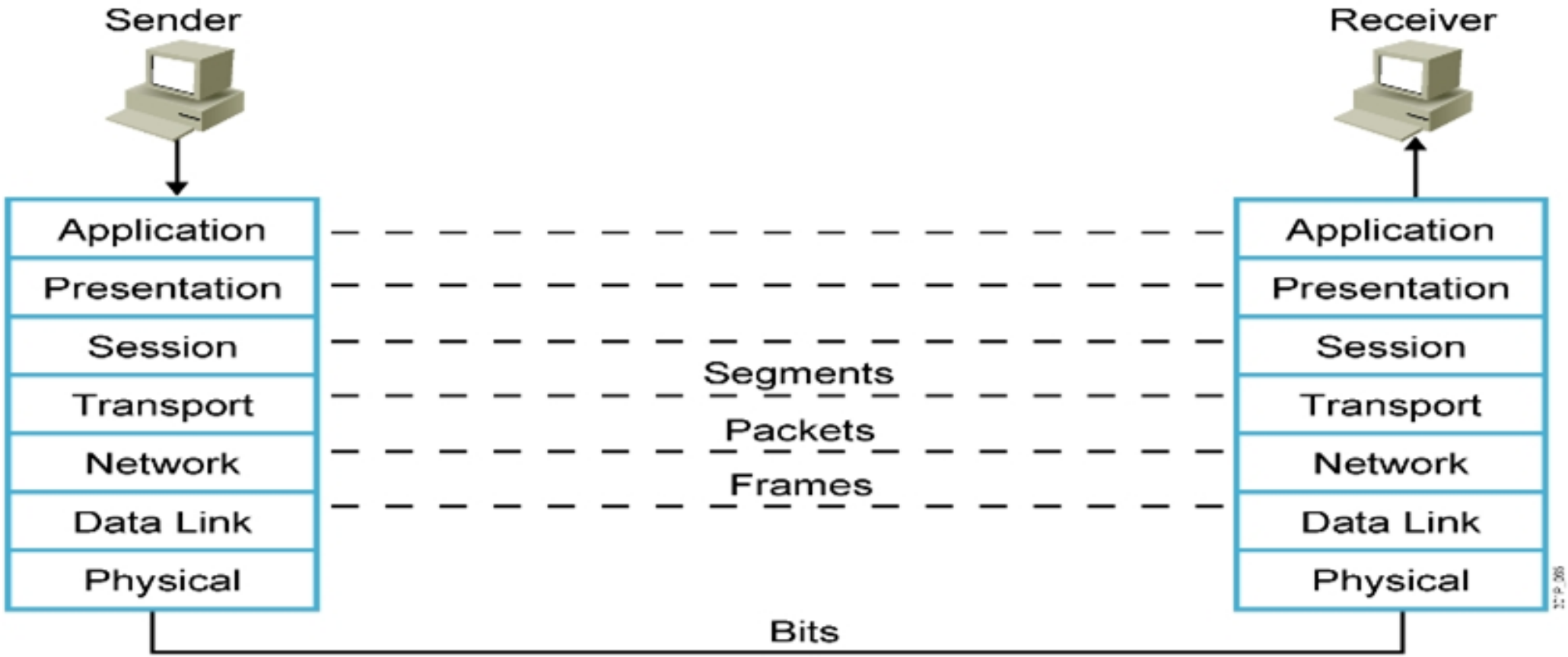
HDR = Header

Data De-Encapsulation



HDR = Header

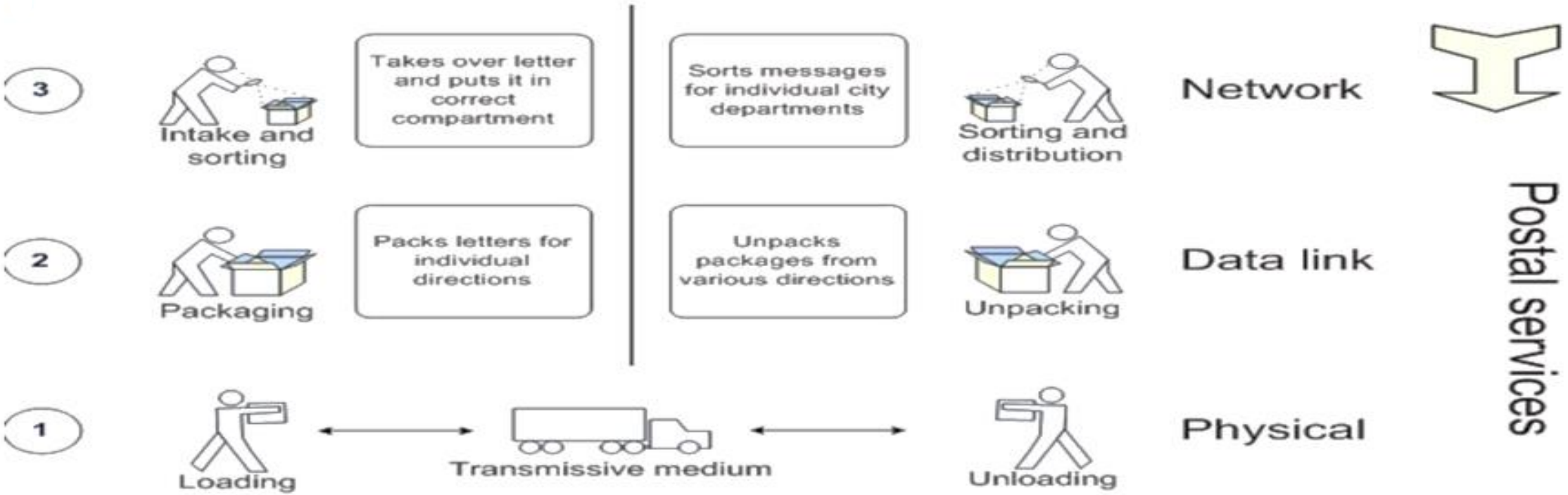
Peer-to-Peer Communication



OSI Exercise

7	Manager	Dictates or handwrites the message	Reads message	Manager	Application	Company's business
6	Assistant	Corrects formal errors, prepares final version	Alerts manager of incoming message, translates it	Assistant	Presentation	
5	Secretary	Provides needed addresses and packs letter	Opens letter and makes copy	Secretary	Session (Relation)	
4	Driver	Drives letter to post office	Withdraws letter from mailbox or post office	Driver	Transport	

OSI Exercise



RM – OSI and letter communication parallel

Thank You