ITI

Introduction to
Computer Networks & Cyber Security

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References

- Essential Computer Science “ Paul D. Crutcher,Neeraj Kumar Singh,Peter Tiegs”
- Cisco Student Guide ICND1
- CompTIA Network
- Data and Computer Communications “ William Stallings 10th Edition”
- TCP/IP Protocol Suite “Behrouz A. Forouzan 4th Edition”
- Understanding IPv6 “Joseph Davies 2nd Edition”
- Distributed Systems ”van Steen, Maarten, Tanenbaum, Andrew S.”

Course Duration and Assessment

Duration

Lectures: 7

Labs: 2

❖ Assessment

- Final Exam : 70%
- Assignments : 10 %
- Labs : 20 %

Agenda

- **Part 1**
  Network Essentials
- **Part 2**
  Cyber Security Essentials
- **Part 3**
  Distributed Systems

Part 1 (Network Essentials)

- **Course Outlines**

  Computer Networks

  - Definition and Basic Terminologies
  - OSI Model

  – **TCP/IP Protocol Suite**

  - Network Access Layer (Physical Layer /Datalink Layer)
  - Internet layer
  - Transport layer
  - Application Layer

  – **Network Devices**

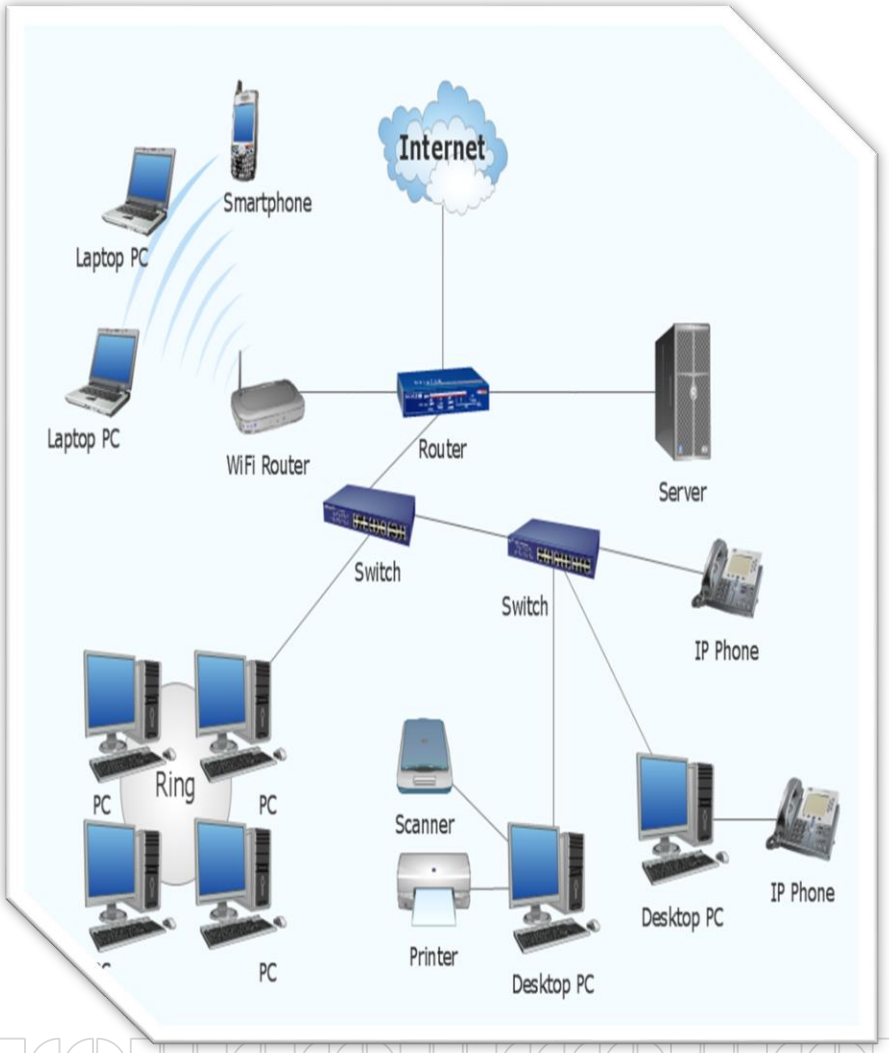
  – **Network Media**

Part 1 (Computer Networks Definition)

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

    Share Resources

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



Part1 (Network Elements)

- **Network Elements**

✓**Hardware**

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

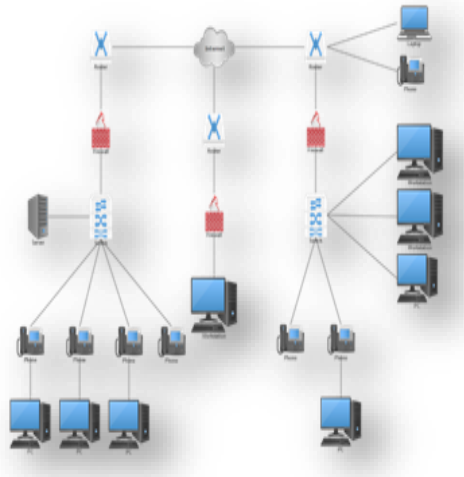
✓**Software**

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

Session 1 (Network Basic Terminologies)

- **NIC (Network Interface Card)/network adapter or LAN adapter.**
  - a hardware that enable the device to directly access the network
    - Internal NIC (plugs into the motherboard directly)
    - External NIC(Wireless and USB based)

- **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 http –https-FTP-RDP
- **Topology**
  - how devices are connected (shape) and how message flow from one device to another device



Session 1 (Network Basic 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

- **Access point (AP)**
  - allows other Wi-Fi devices to connect to a wired network. An AP is a physical location where Wi-Fi access is available.

- **Repeater**
  - Regenerate the signal over the same network before the signal becomes too weak or corrupted

How to apply networks ?

- **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?

Networks Classifications

According to Covered Area

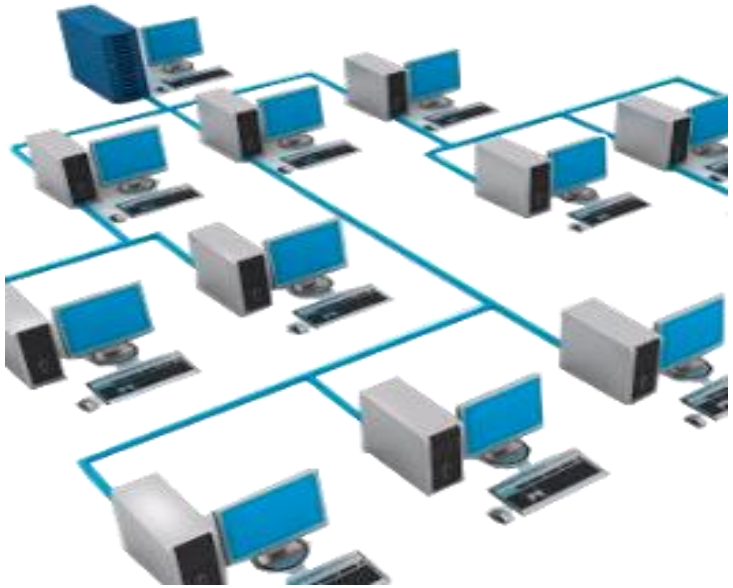
PAN – MAN- WAN-INTERNET

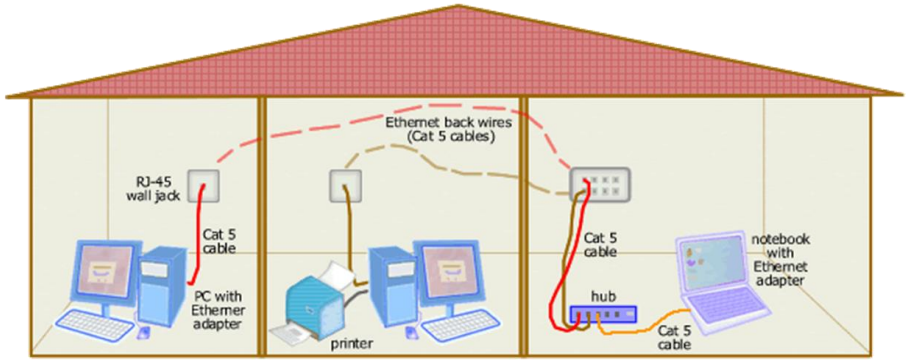
According to Covered Area

- 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

According to Covered Area

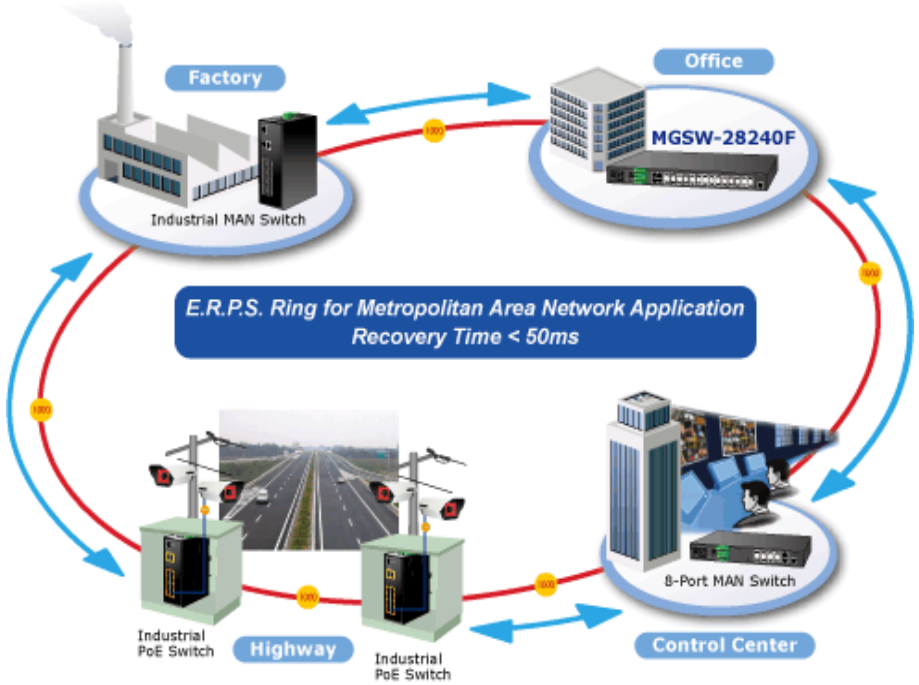
- Local Area Networks (**LAN**)
  - a **group** of computers connected in **small** geographical area
  - a limited area such as a residence, school, laboratory, university campus or office building (100 -1000 M)
  - Allow users to share files and services
  - **High speed** of communications
  - Under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





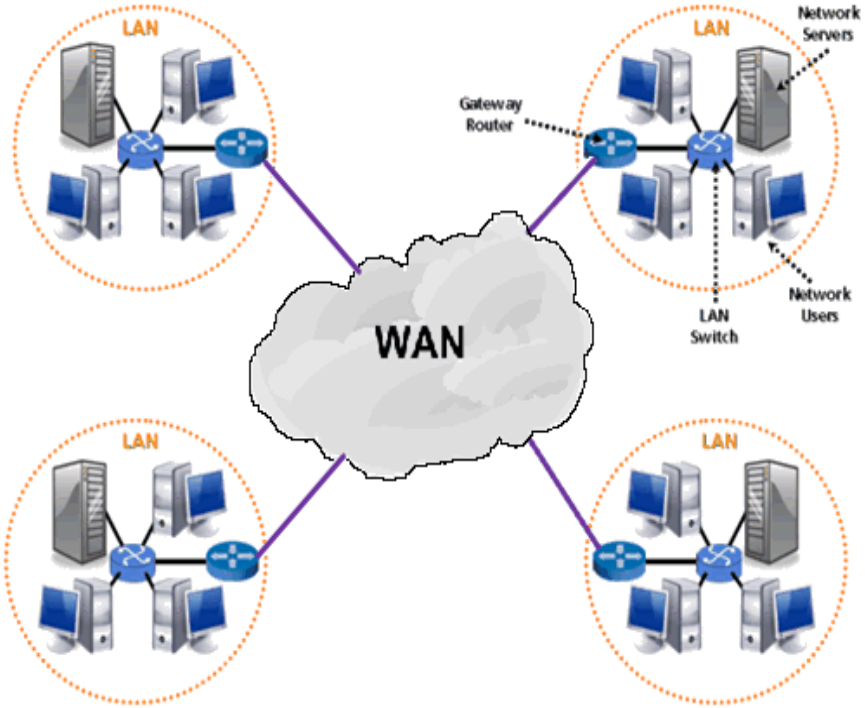
According to Covered Area

- 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



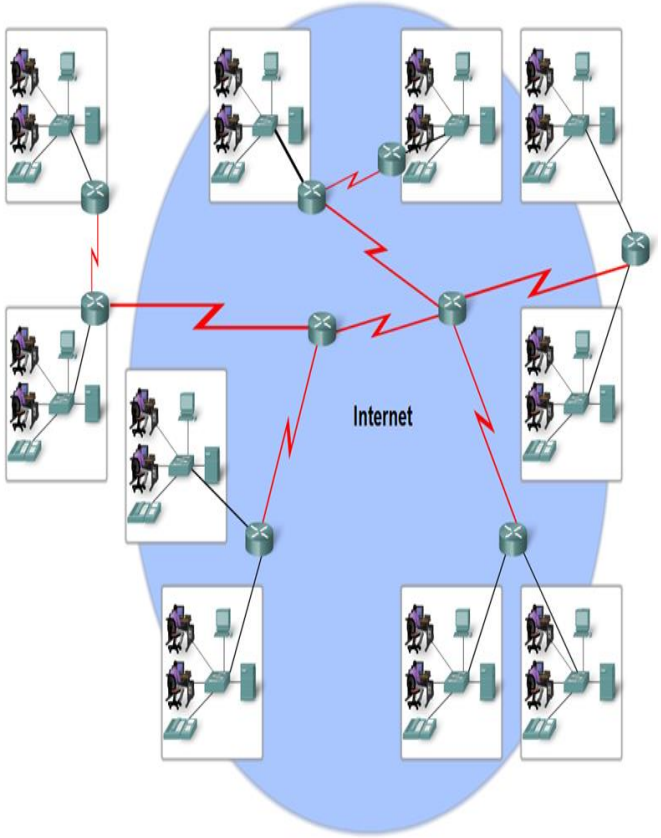
According to Covered Area

- 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**

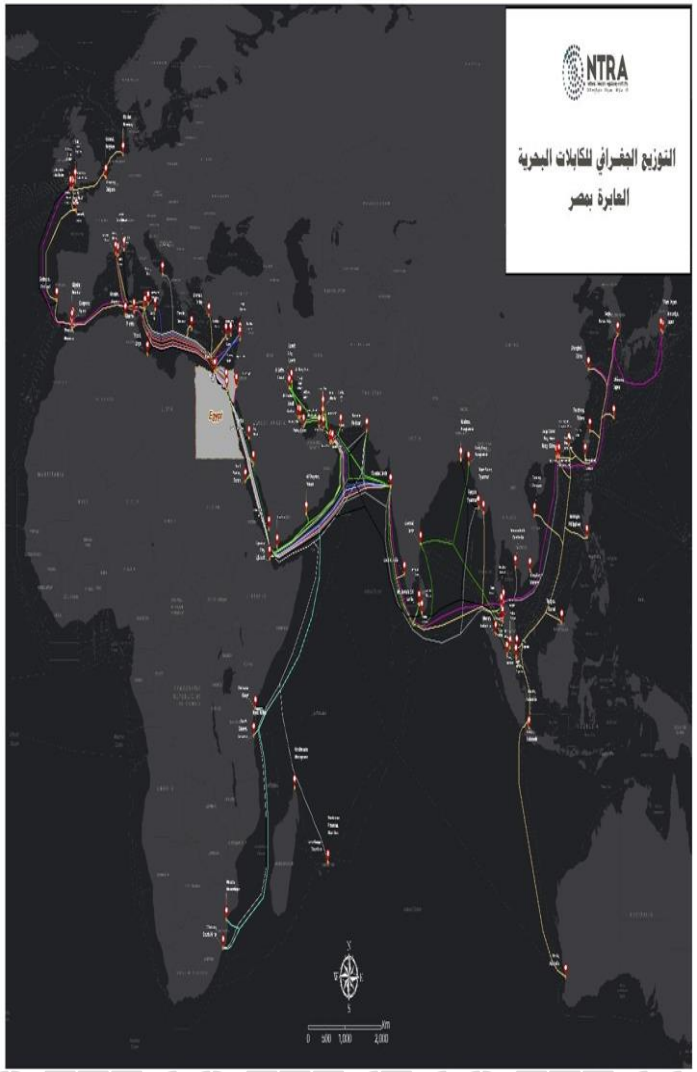


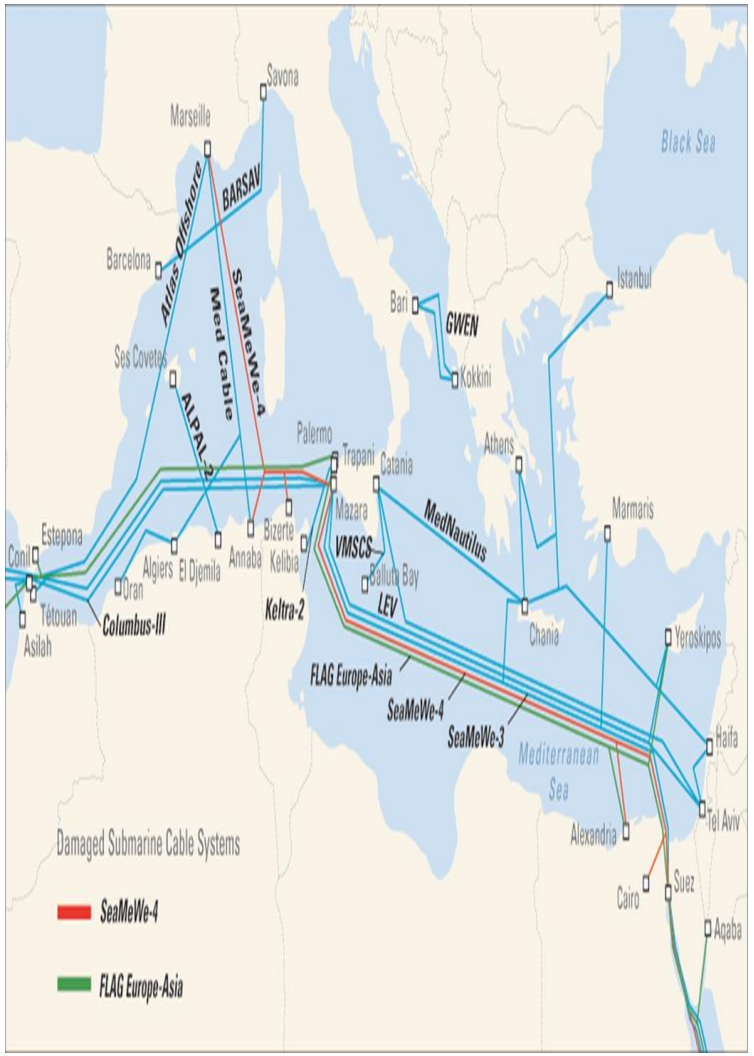
What is Internet ?

- **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**



Internet Gateway in Egypt_ Submarine Cable





According to Network Topology

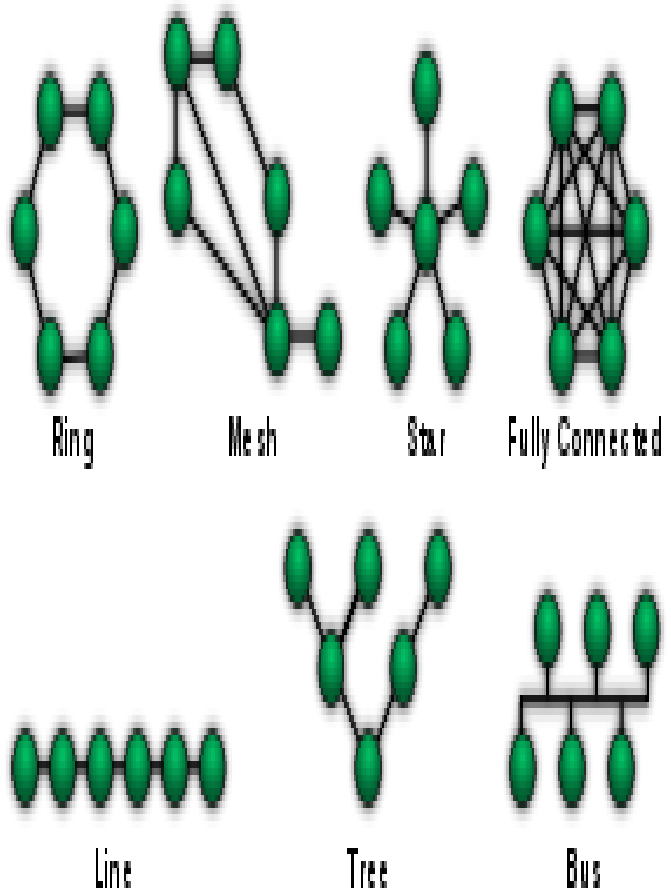
Bus – Star- Ring- Mesh-Hybrid

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**

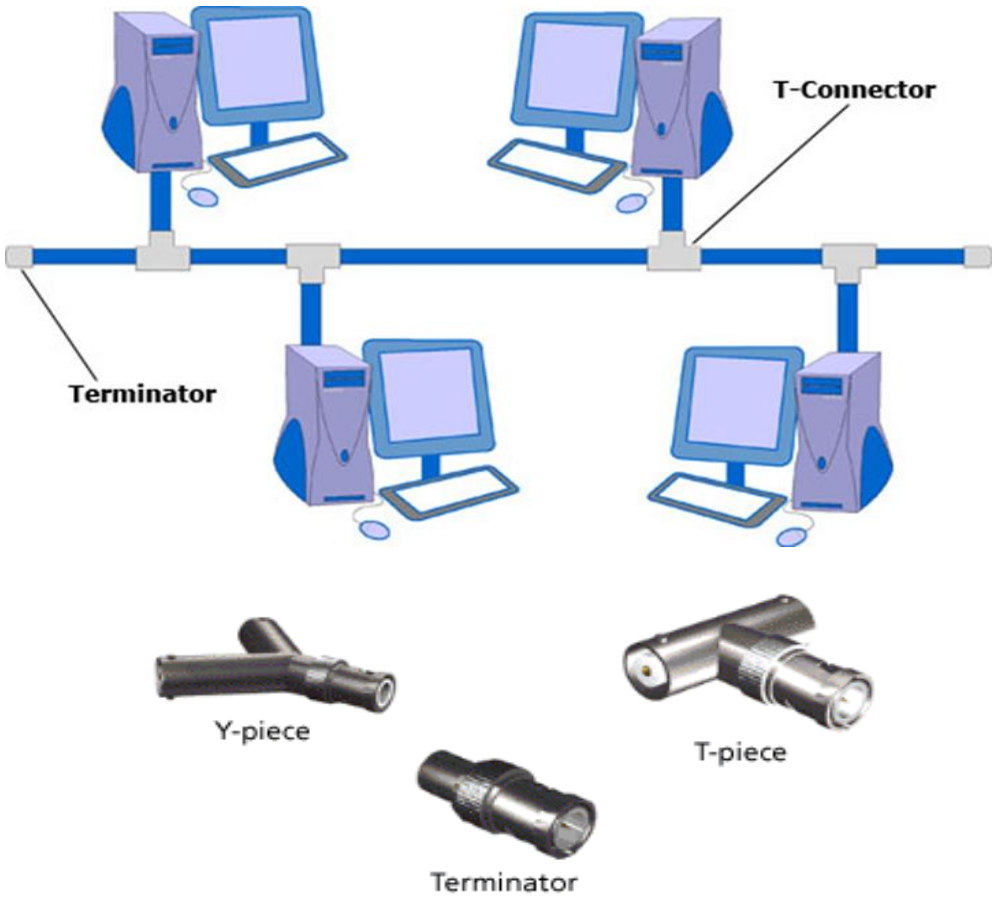
Each topology has its own **advantages and disadvantages**.



Network Topology

Bus Topology

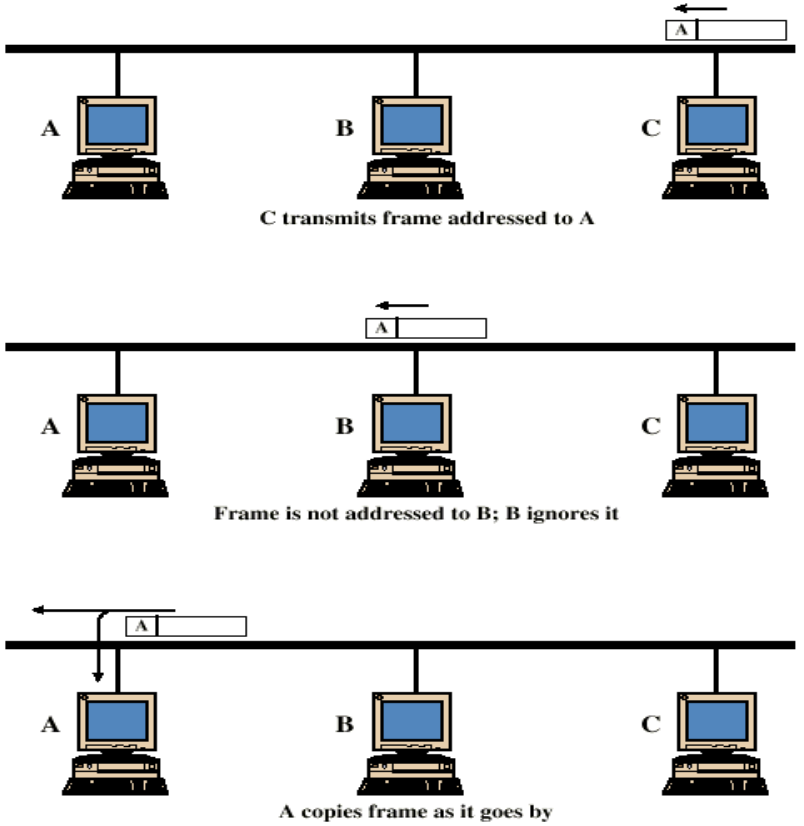
- All devices are connected to a central cable, called the bus or backbone
- Both ends of the network must be terminated with a terminator.
- A barrel connector can be used to extend the network.



Network Topology

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

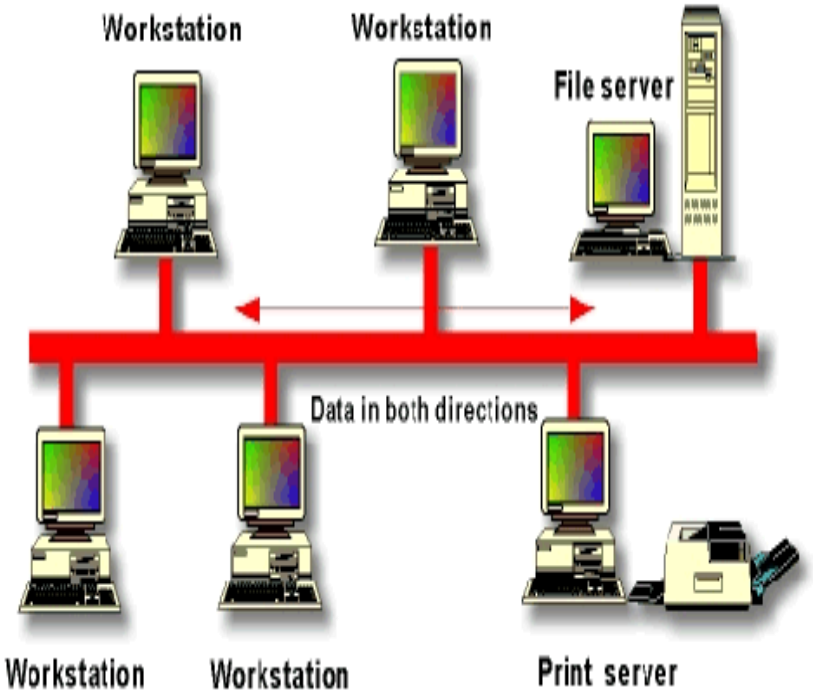


Station C want to transmit a frame of data to station A.

Network Topology

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

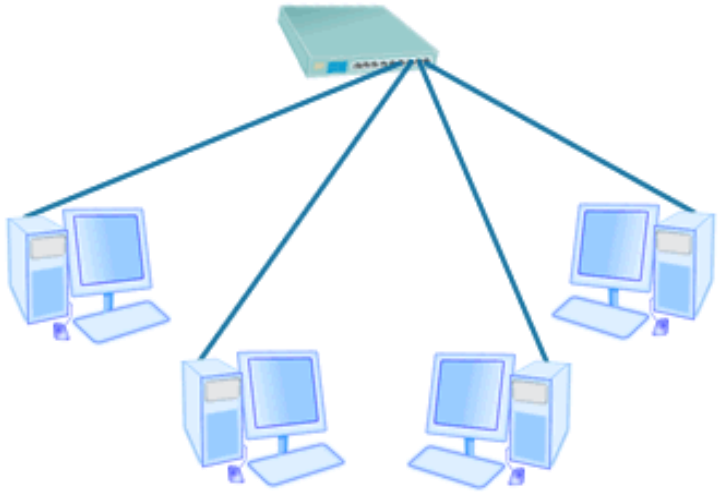


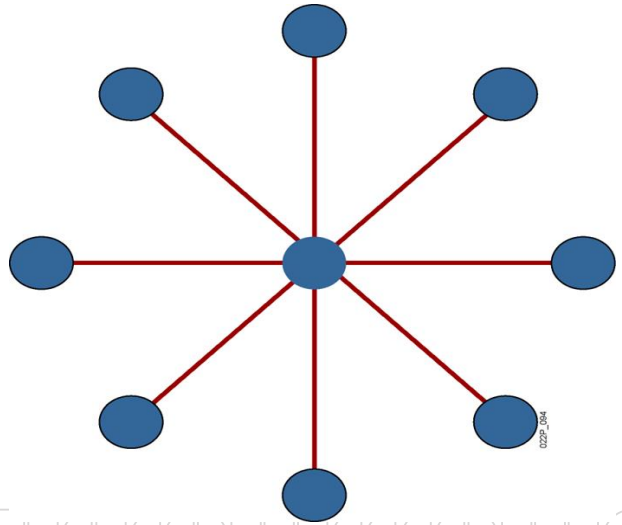
Network Topology

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.

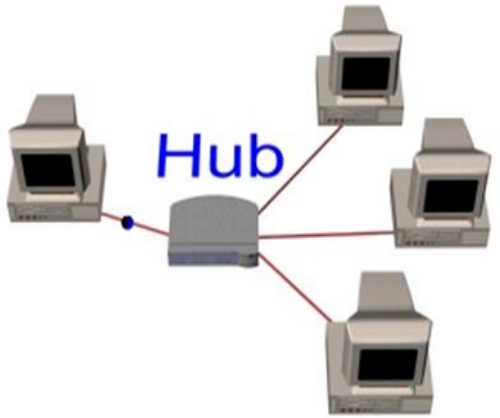




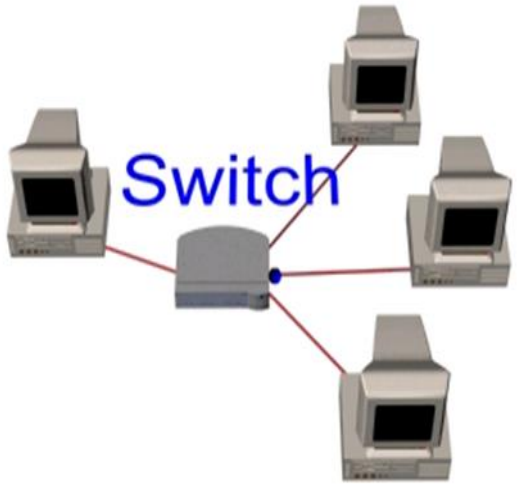
Network Topology

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**



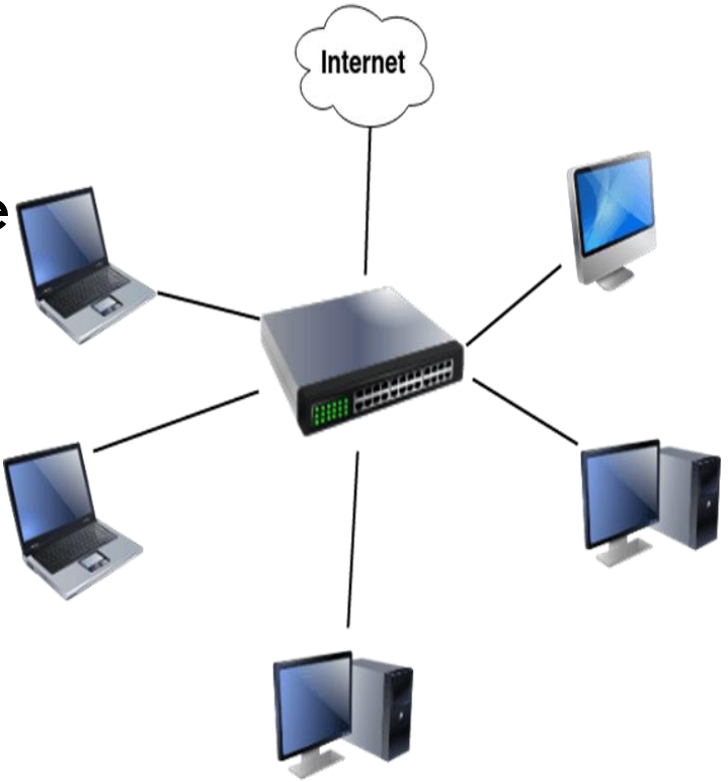
- **Switched Star**
  - Central node can act as frame switch
    - Retransmits only to destination



Network Topology

Star Advantages and Disadvantages

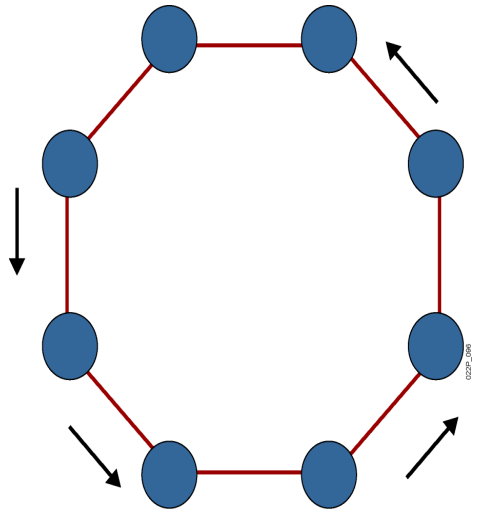
- **Advantages:**
  - Network not affected if one PC fails
  - Network expansion and reconfiguration is simple
  - Network management and monitoring can be centralized
  - Troubleshooting is easy
- **Disadvantages**
  - If the central device fails, all the network fails



Network Topology

Ring Topology

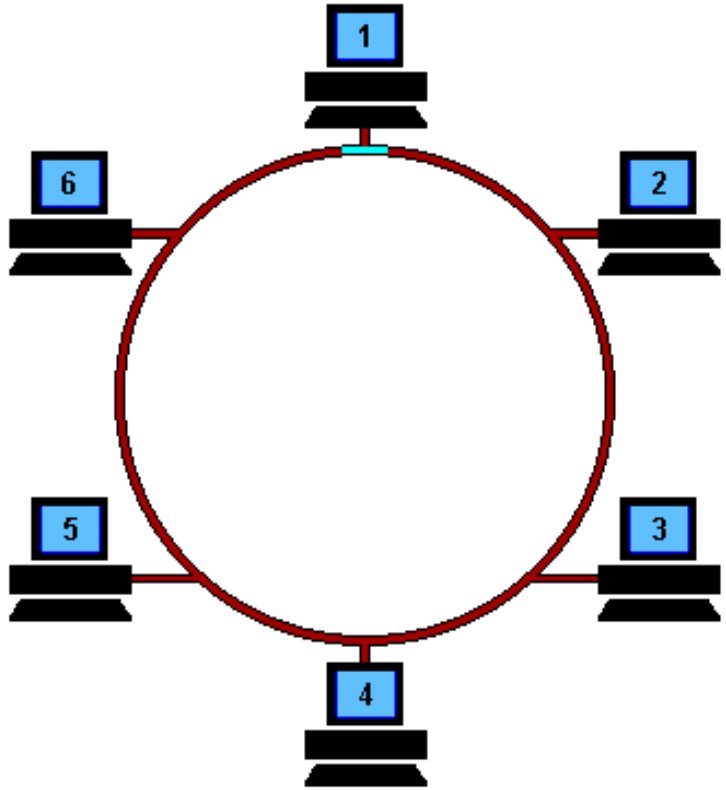
- A cable connects one node to another to form a ring (shape of a closed loop)
- each device is connected directly to two other devices, one on either side of it.
- All messages travel through a ring in **the same direction**
- **token** is used to transmit data and pass over each station
- **Medium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



Frame Transmission - Ring LAN

Data transmitted in frames (token)

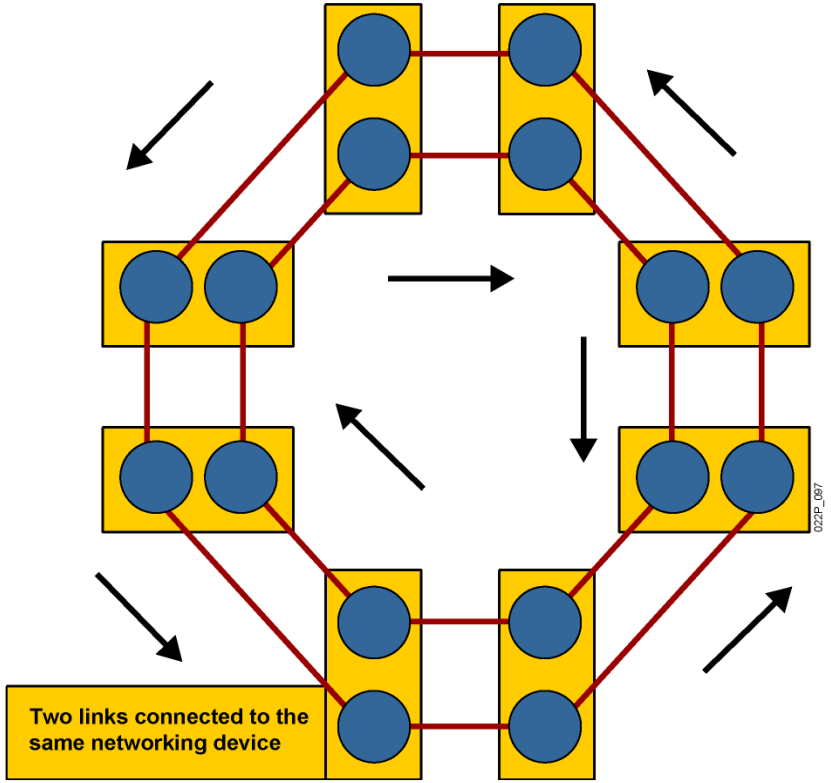
- Circulate past all stations
- Destination recognizes address and copies frame
- Data is passed one way from device to device.
- Frame circulates back to source where it is removed
- **Medium access control** determines when station can insert frame



Network Topology

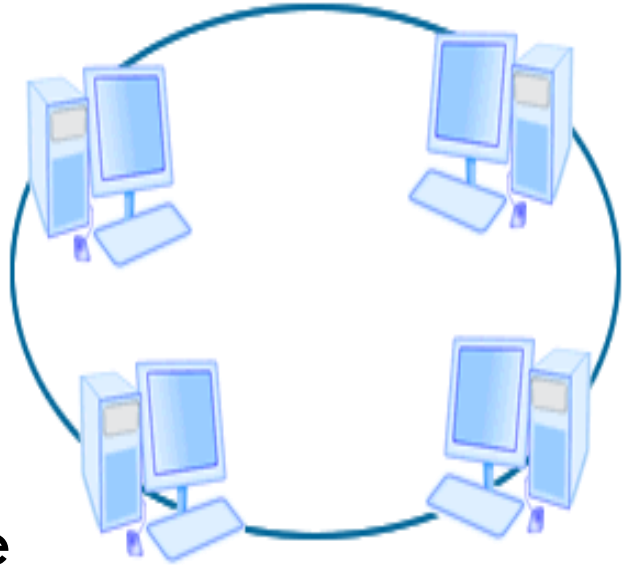
Dual Ring Topology

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



Network Topology

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

Network Topology

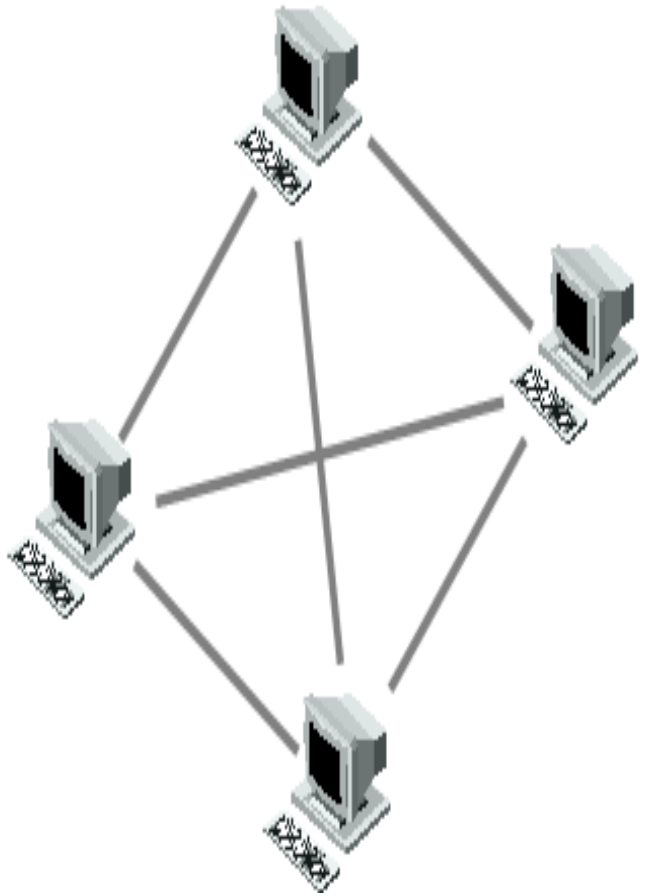
Mesh Topology

- Each device/PC is connected to **every** other device/PC in the network by its own cable
- Amount of cables needed can be calculated by

CN = (D * (D-1)) / 2

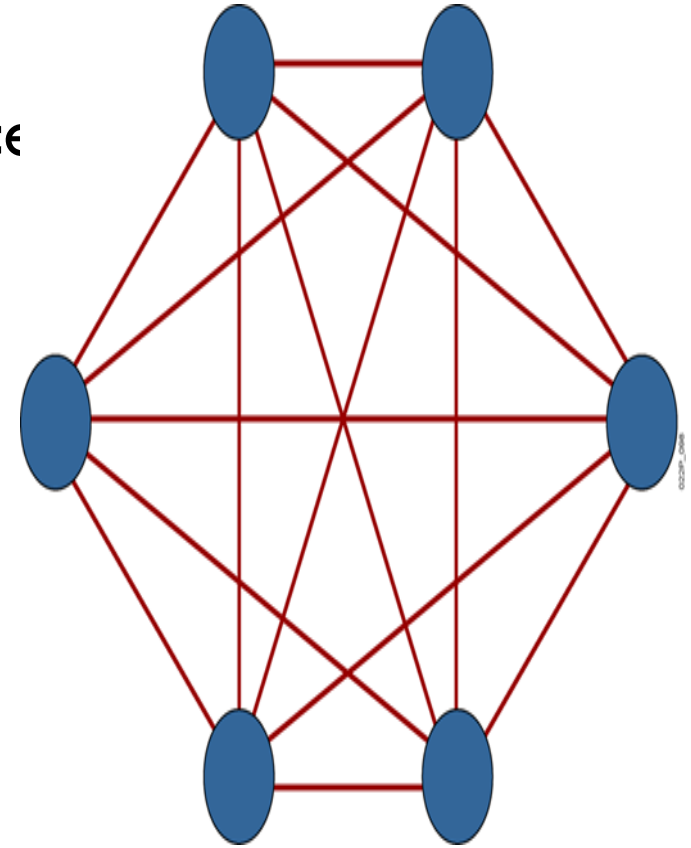
(where CN is Cables Needed, and **D** is the amoun of devices on the network)

- Mesh Types:
  - Full Mesh
  - Partial Mesh



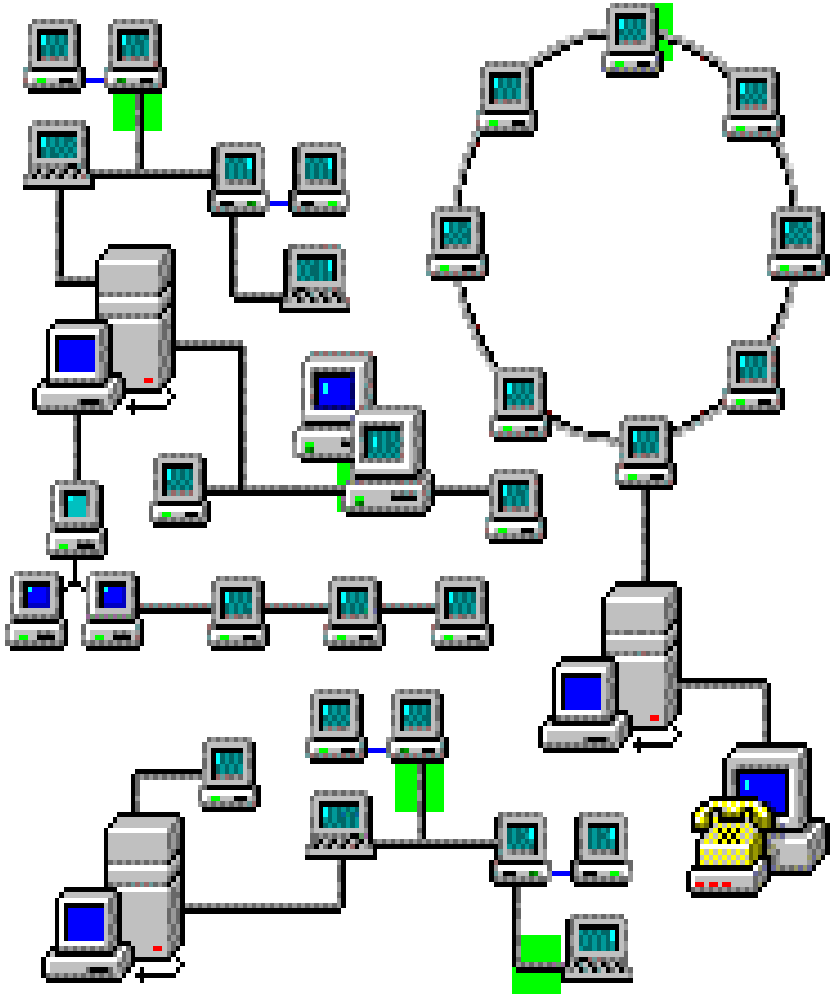
Mesh Advantages and Disadvantages

- Advantages:
  - Mesh topology boasts the highest fault tolerance 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

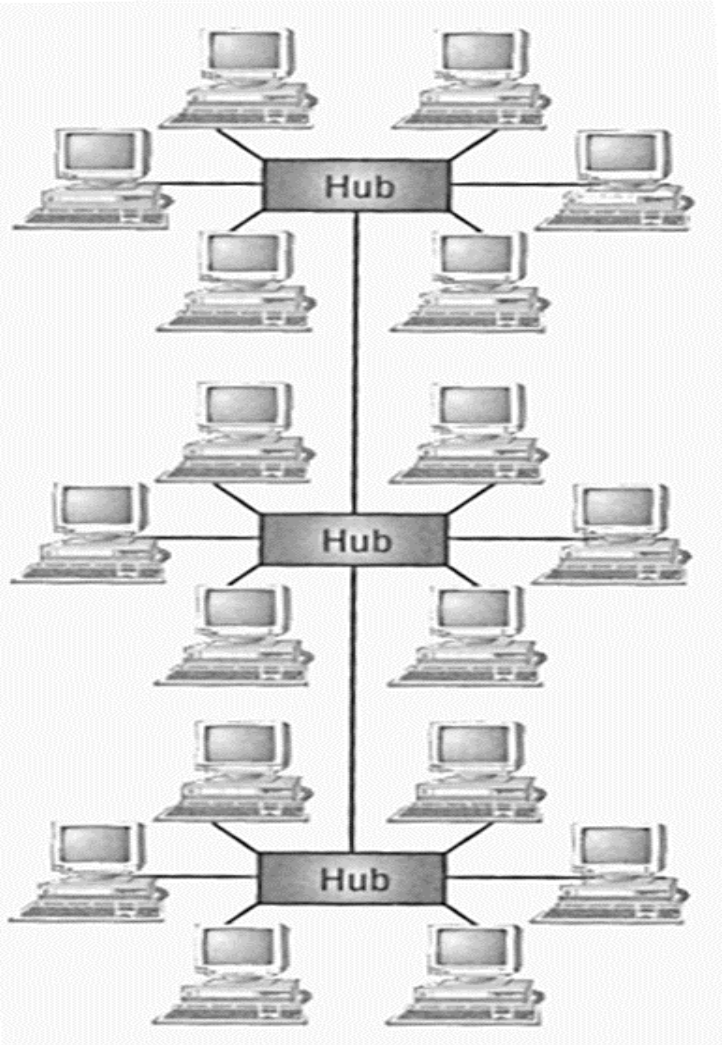
- Hybrid means that there is more than one topology exist
- Combine bus ,star and ring topologies
- Allow network expansion
- Flexible



Network Topology

Hybrid Advantages and Disadvantages

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



Networks Classifications

According to Network Model

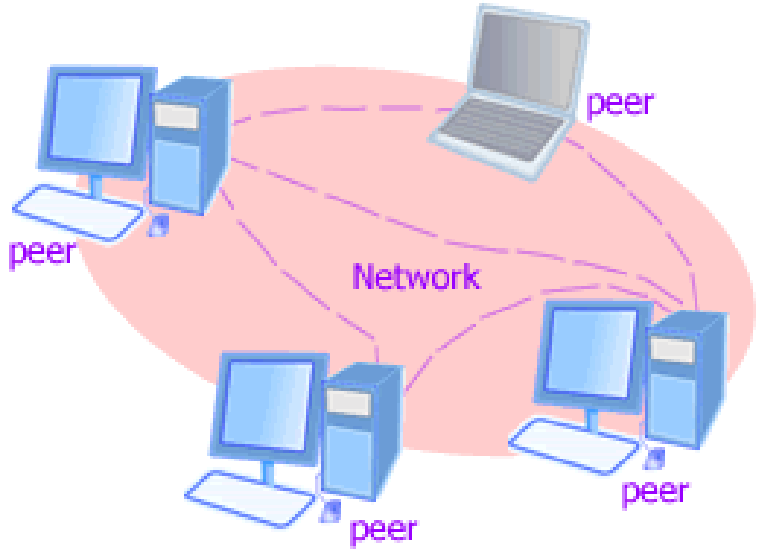
- Peer to Peer Networks
- Client/Server Networks

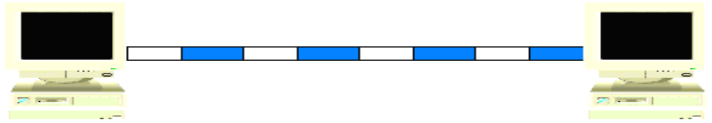
Network Model

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)

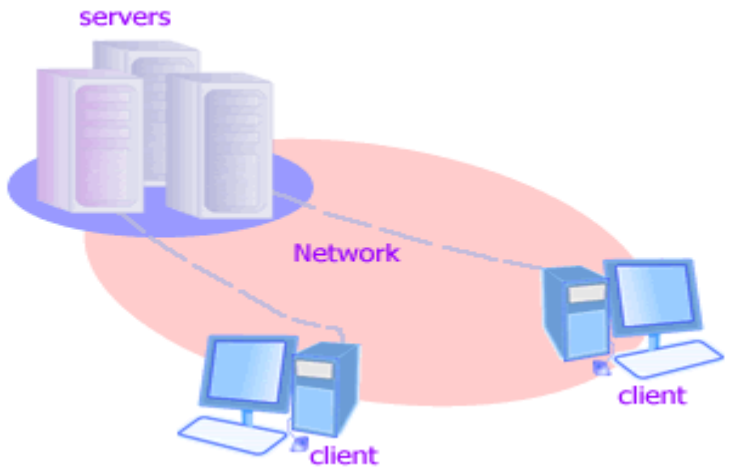
Example : Windows Workgroup





Network Model

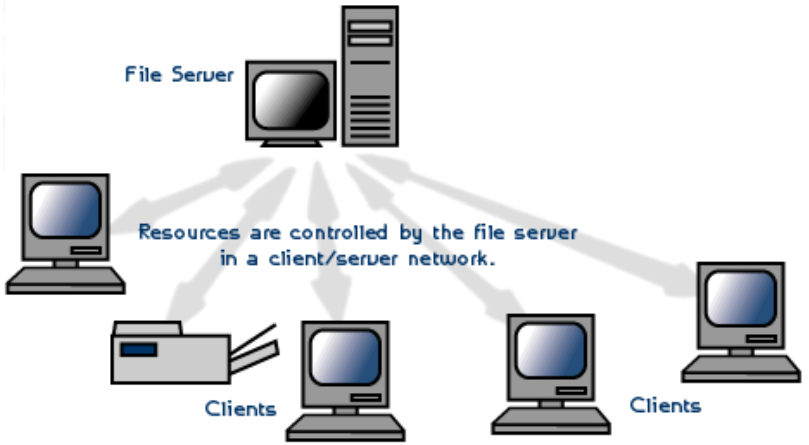
Client/Server Networks



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

Examples:

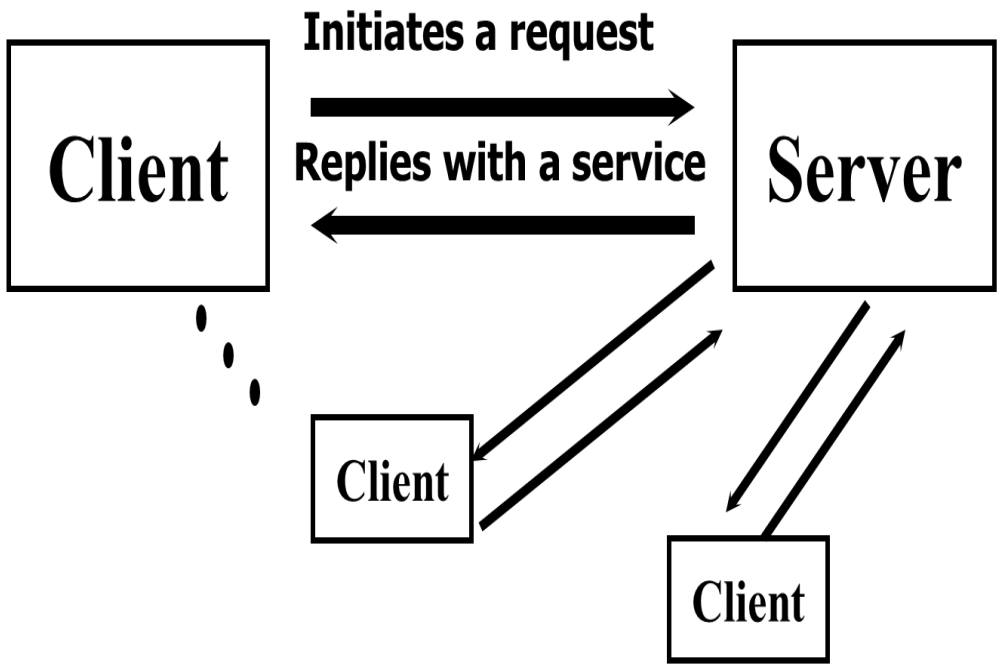
- Mail Server
- Web Server
- File Server
- Print Server



Network Model

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



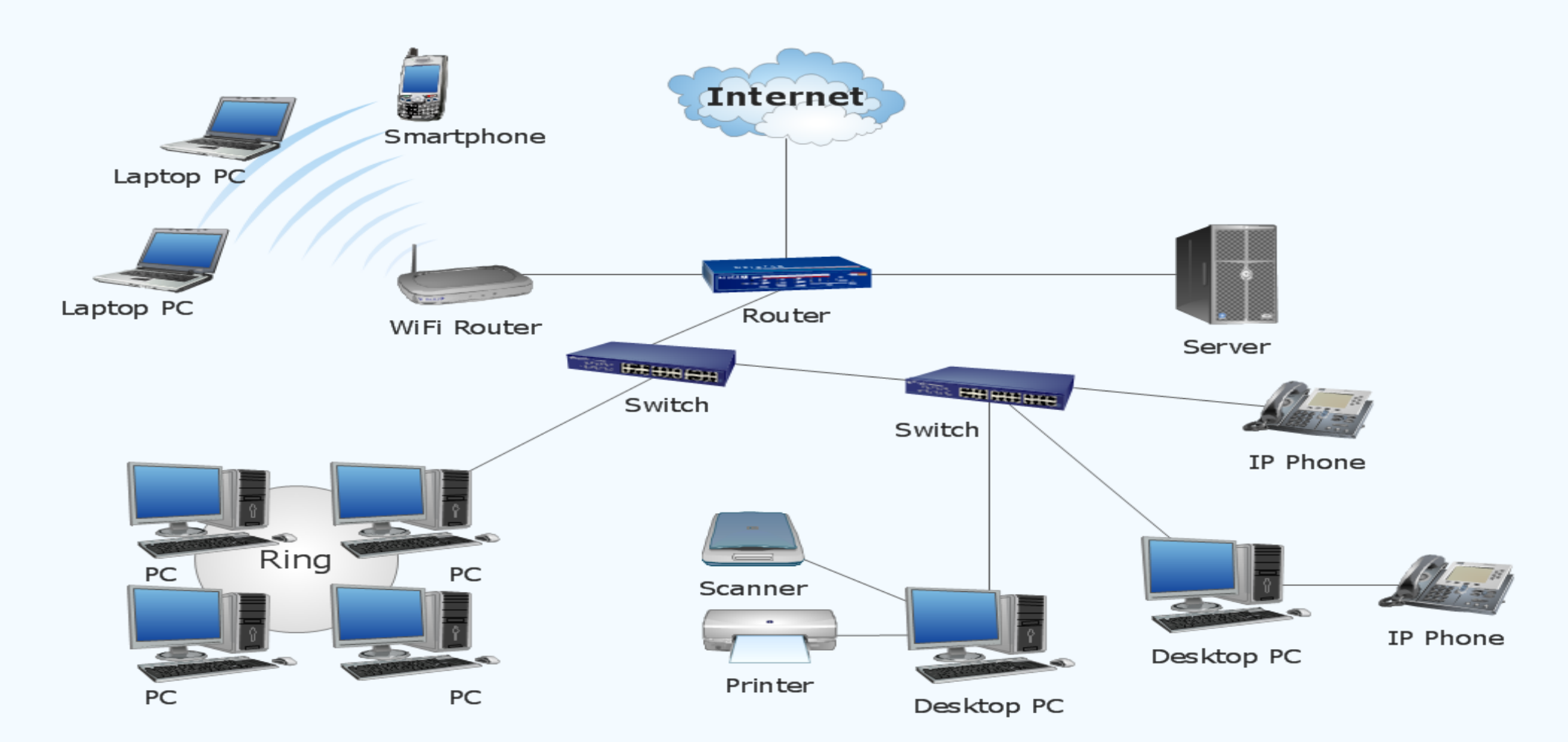
Peer to peer vs client/server model

	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

Building the network

What do you need to build your network?

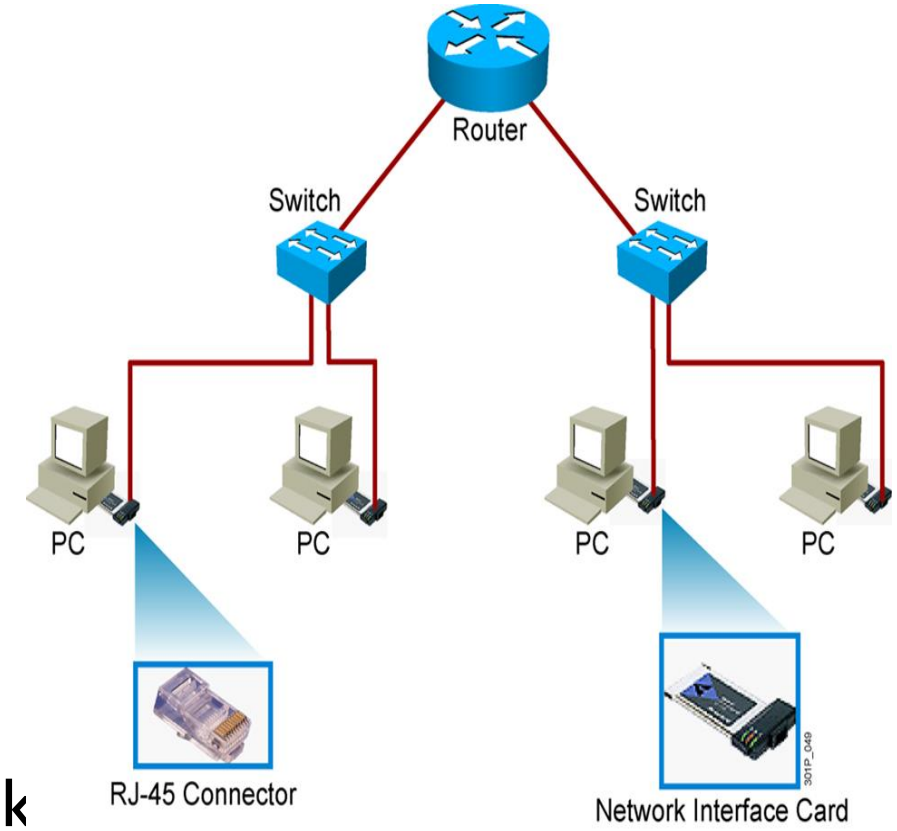
Simple Network



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

Thank You