Computer Communications and Networks

Topologies, Types, Switching

BECE401L

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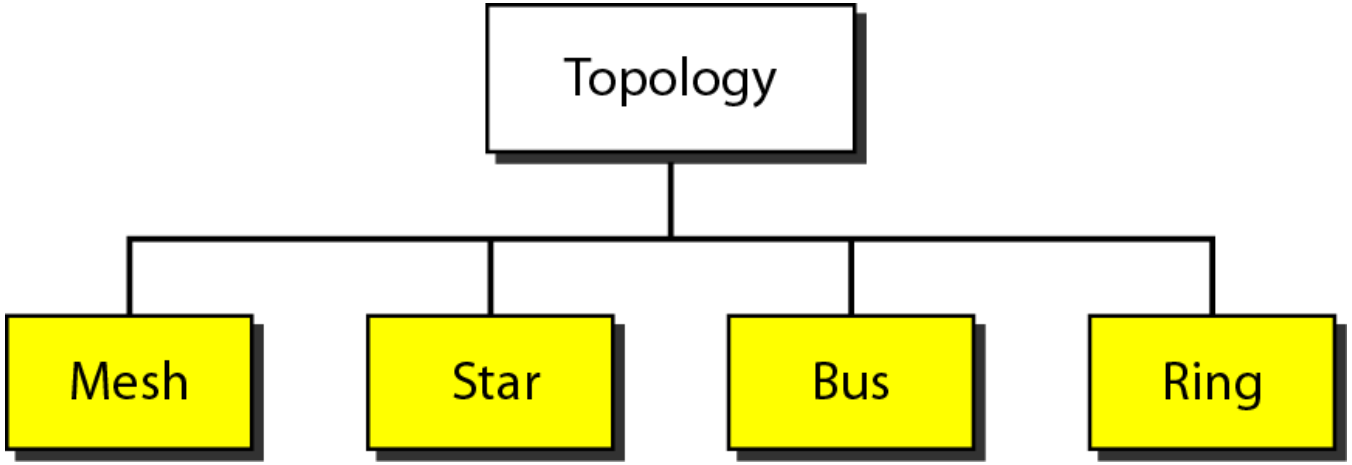
Networks : Topologies

Physical topology

- Refers to the way in which a network is laid out physically.
- Two or more devices connect to a ***link***;
- Two or more **links** form a ***topology***.
- The geometric representation of the relationship of all the links and linking devices (***nodes***) to one another.

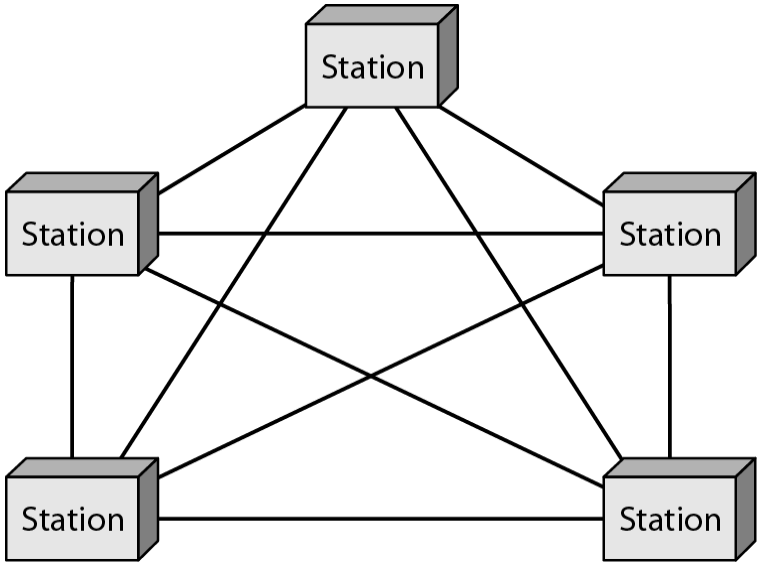


Networks : Topologies : **Mesh Topology**

Every device has a **dedicated point-to-point link** to **every other device**.

In a fully connected mesh network with *n* nodes

- Every Node must be connected to $n - 1$ nodes.
- We need $n(n - 1)$ physical links.
- We need $\frac{n(n-1)}{2}$ duplex-mode links.
- To accommodate that many links, every device on the network must have n – 1 input/output (I/O) ports



Advantages:

- *Dedicated links:* Guarantees that each connection can carry its own data load)
- *Robust:* If one link becomes unusable, it does not incapacitate the entire system
- *Secure: every message travels along a dedicated line*
- *Fault detection & diagnostics are easy*

Disadvantages:

Installation
Sheer bulk of wiring
Expensive

Networks : Topologies : **Star Topology**

Each device has a **dedicated point-to-point link only** to a **central controller**, usually called a ***hub***

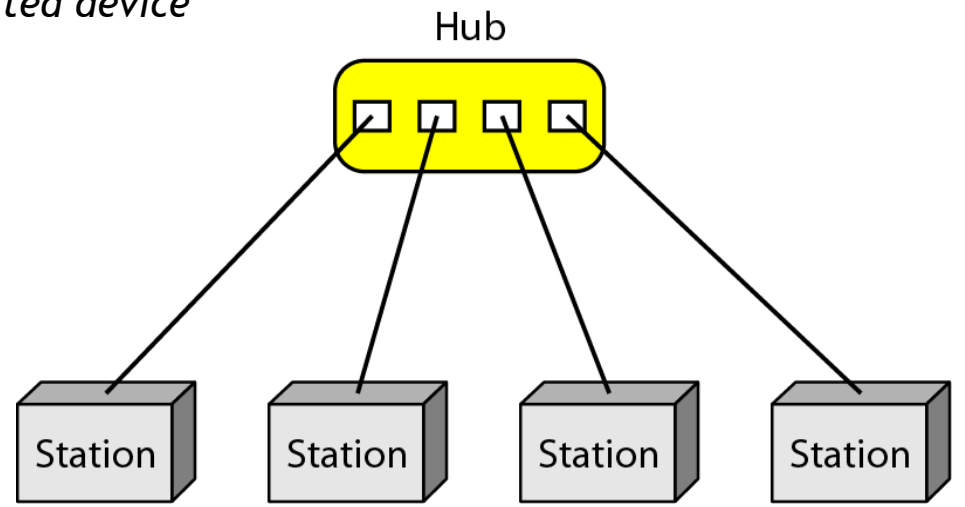
- *Unlike a mesh topology, a star topology **does not allow direct traffic between devices.***
- ***The controller acts as an exchange:***
  - *If one device wants to send data to another, it sends the data to the controller, which then relays the data to the other connected device*

Advantages:

- *Less expensive*
- *Less requirement of cabling*
- *Robust*

Disadvantages:

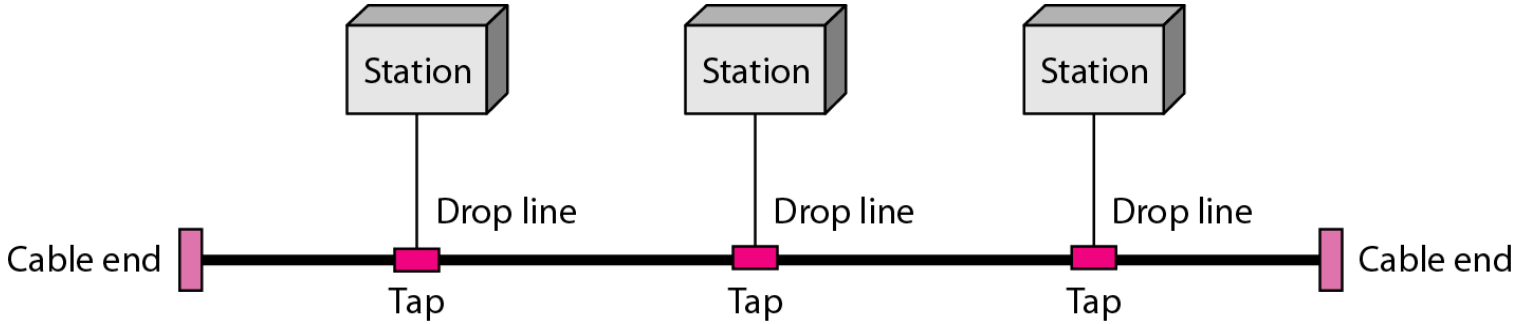
- *Dependency on Hub*



Networks : Topologies : **Bus Topology**

Multipoint Configuration

- **One long cable** acts as a **backbone** to **link all the devices** in a network
- Nodes are connected by **drop lines and taps**.
  - **Drop line:** Connection running between the device and the main cable.
  - **Tap:** is a connector to create a contact with the metallic core.



Advantages:

- *Ease of installation*
- *Backbone cable is laid along the most efficient path*
- *Then connected to the nodes by drop lines of various lengths.*
- *A bus uses less cabling than mesh or star topologies.*

Disadvantages:

Reconnection
Fault Identification & diagnosis
Usually designed to be optimally efficient at installation

Networks : Topologies : **Ring Topology**

Each device has a **dedicated point-to-point connection** with **only the two devices on either side of it.**

Each device in the ring incorporates a **repeater**

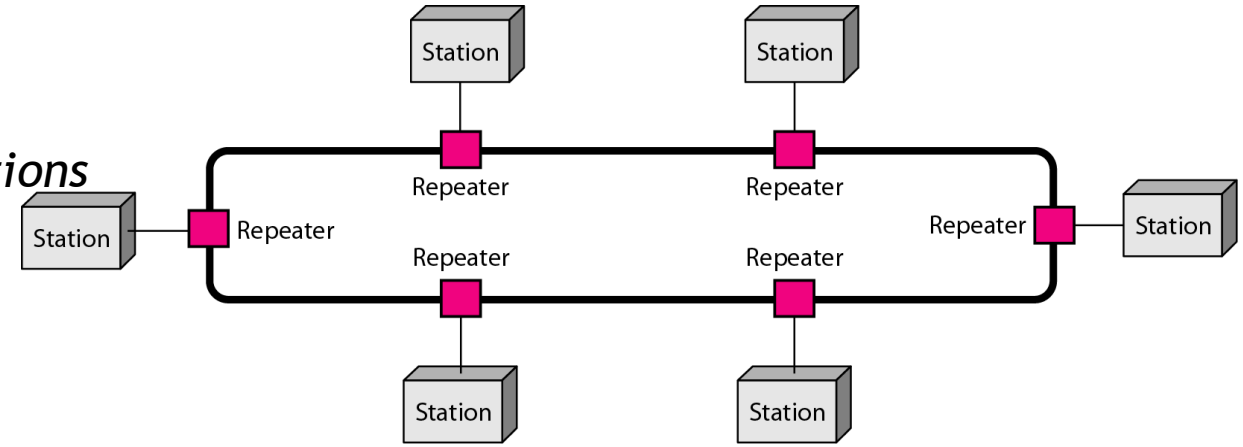
Each device is linked to only its immediate neighbors (either physically or logically).

Advantages:

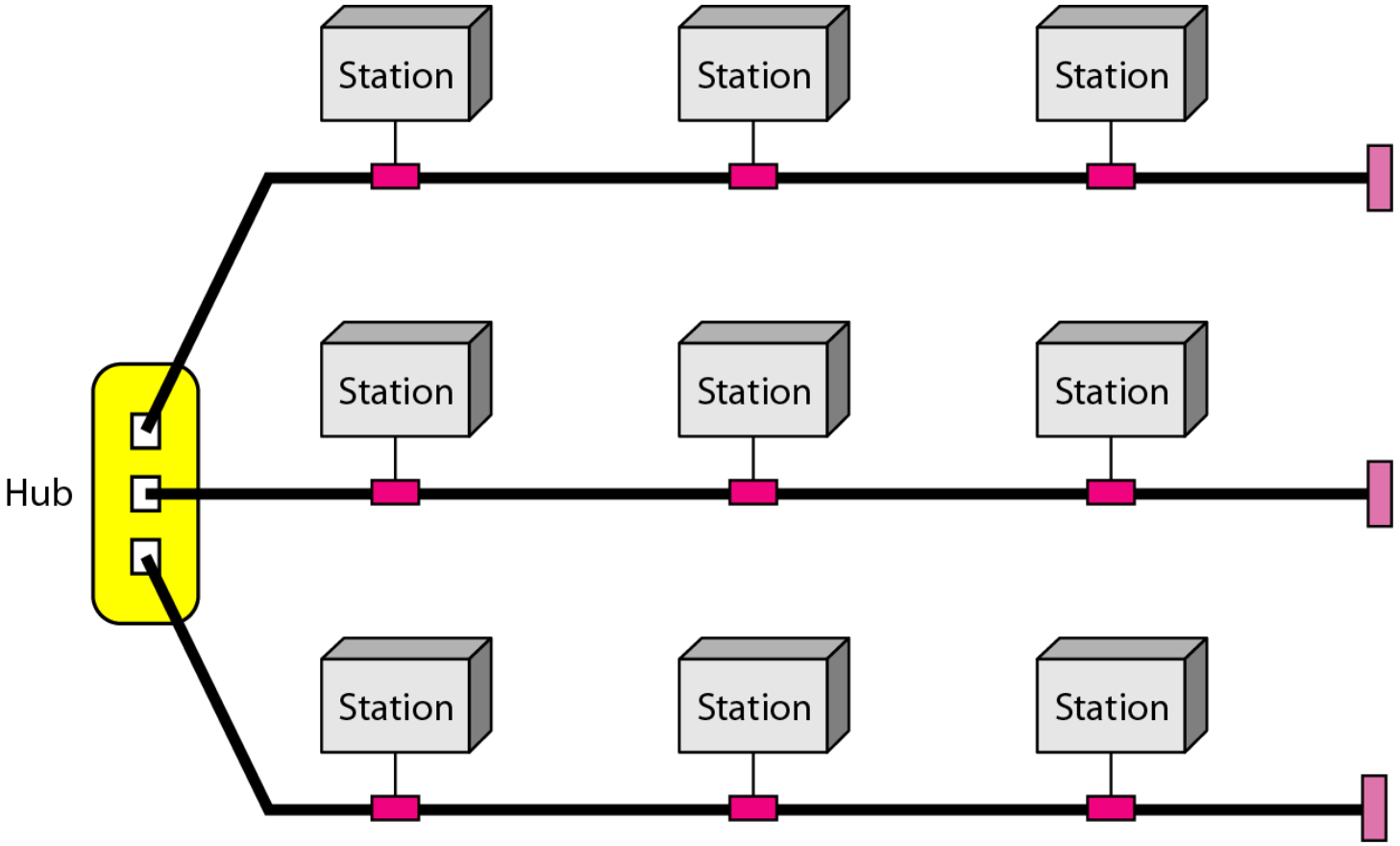
- *Ease of installation, fault Identification & diagnosis*

Disadvantages:

- *Unidirectional Traffic*
  - *A break in the ring can disable the entire network.*
  - *Can be solved using dual rings or self healing rings*
- *Constraints are media and traffic considerations*
  - *Maximum ring length and number of devices*



Networks : Topologies : **Hybrid Topology**



Networks : **Types**

Local Area Networks (LANs)

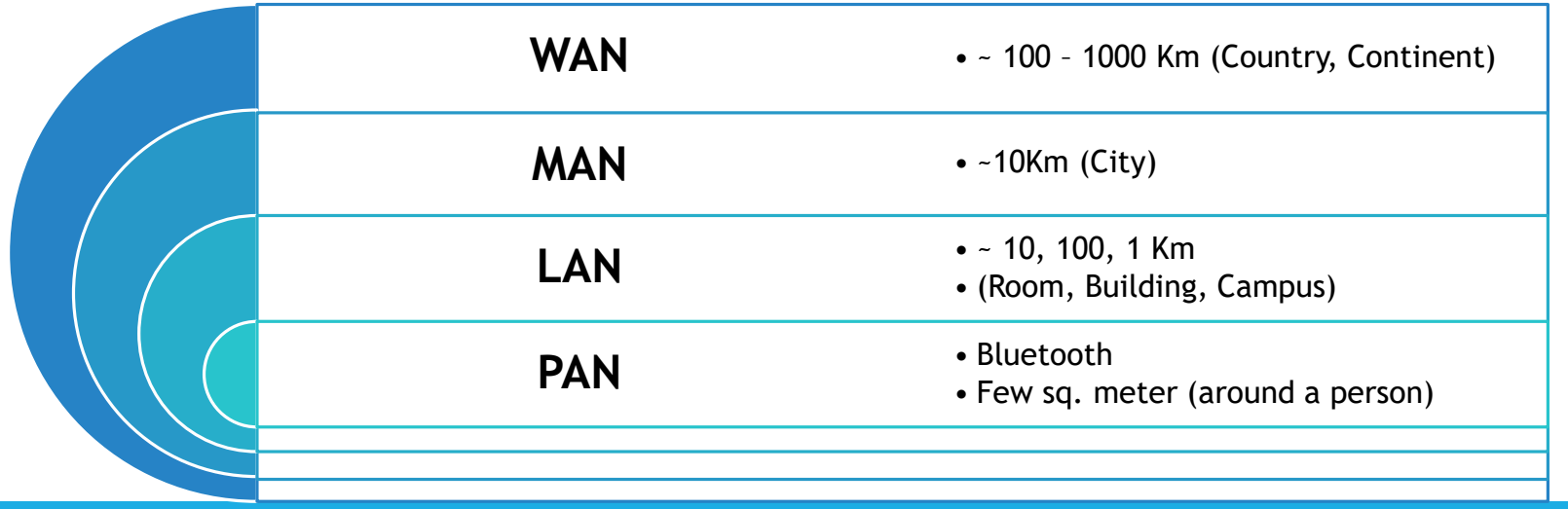
- Short distances
- Designed to provide local interconnectivity

Wide Area Networks (WANs)

- Long distances
- Provide connectivity over large areas

Metropolitan Area Networks (MANs)

- Provide connectivity over areas such as a city etc.



Local Area Networks (LANs)

LAN is usually ***privately owned*** and ***connects some hosts*** in a single office, building, or campus.

Depending on the needs of an organization,

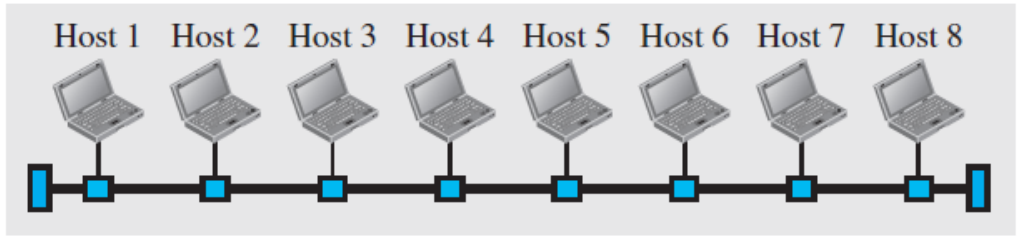
- Can be as simple as two PCs and a printer in someone's home office, or
- it can extend throughout a company and include audio and video devices.

Each host in a LAN has an **identifier**,

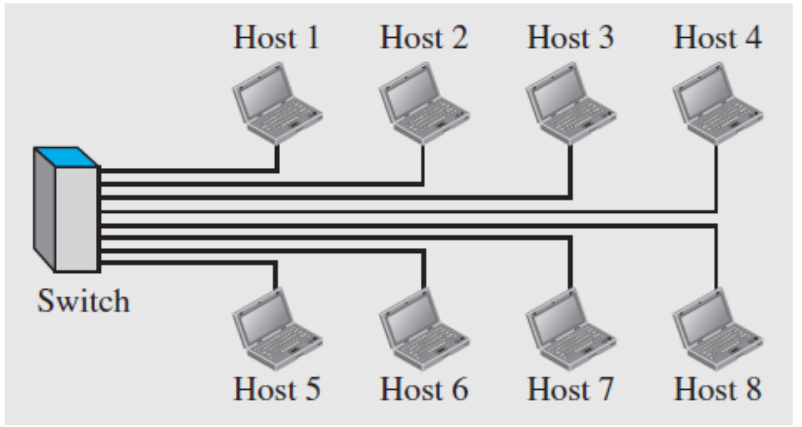
- an address, that uniquely defines the host in the LAN.

A **packet sent** by a **host** to **another host** *carries both the source host's and the destination host's addresses*.

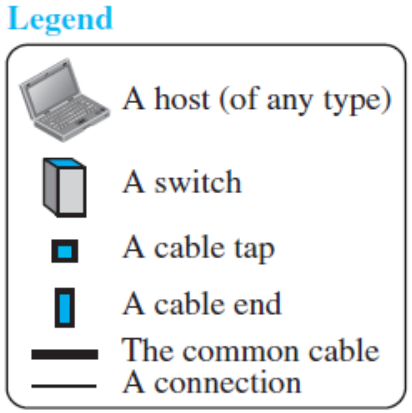
Most LANs use a smart connecting **switch**



a. LAN with a common cable (past)



b. LAN with a switch (today)



Wide Area Networks (WANs)

A **wide area network (WAN)** is also an interconnection of devices capable of communication.

- A **LAN** is *normally limited in size*, spanning an office, a building, or a campus;
- a **WAN** has a *wider geographical span*, spanning a *town*, a *state*, a *country*, or even the world.

- A **LAN** *interconnects hosts*;
- a **WAN** *interconnects connecting devices* such as *switches, routers*, or *modems*.

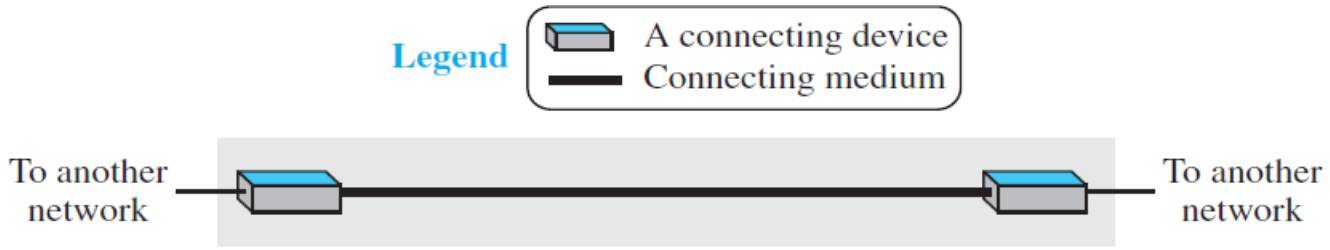
- A **LAN** is *normally privately* owned by the *organization* that uses it;
- a **WAN** is normally created and run by communication companies and leased by an organization that uses it.

Networks : **WANs**

Wide Area Networks (WANs)

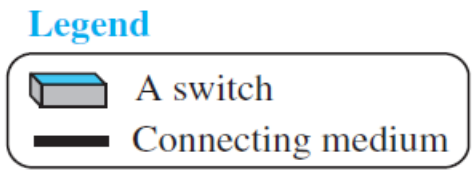
Point-to-Point WAN

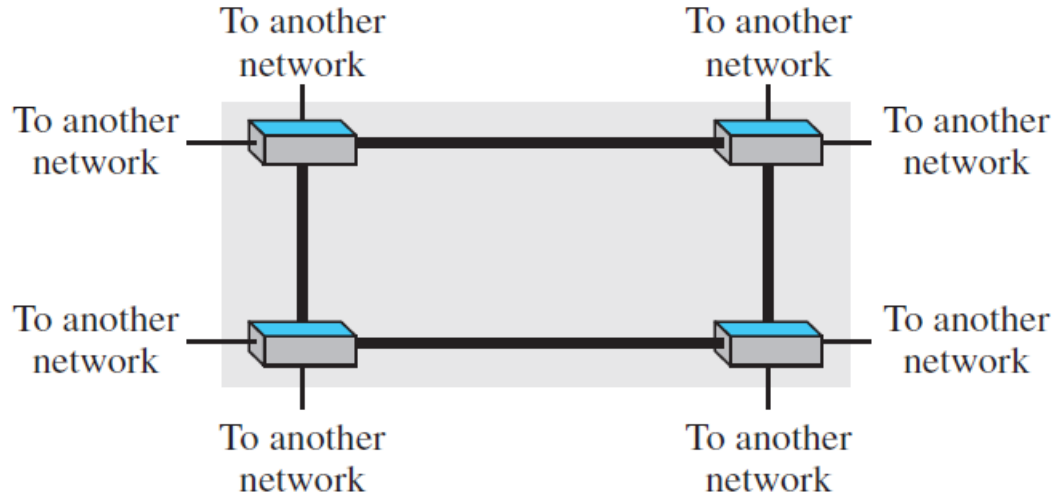
- A point-to-point WAN is a network that connects two communicating devices through a transmission media (cable or air).



Switched WAN

- A switched WAN is a network with more than two ends.
- A switched WAN, is used in the **backbone of global communication** today.
- Switched WAN is a combination of several point-to-point WANs that are connected by switches.

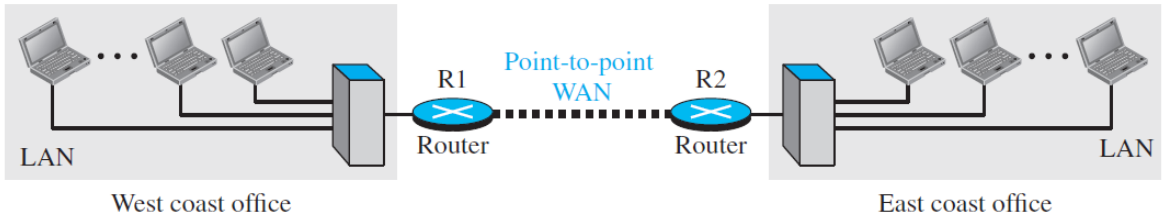




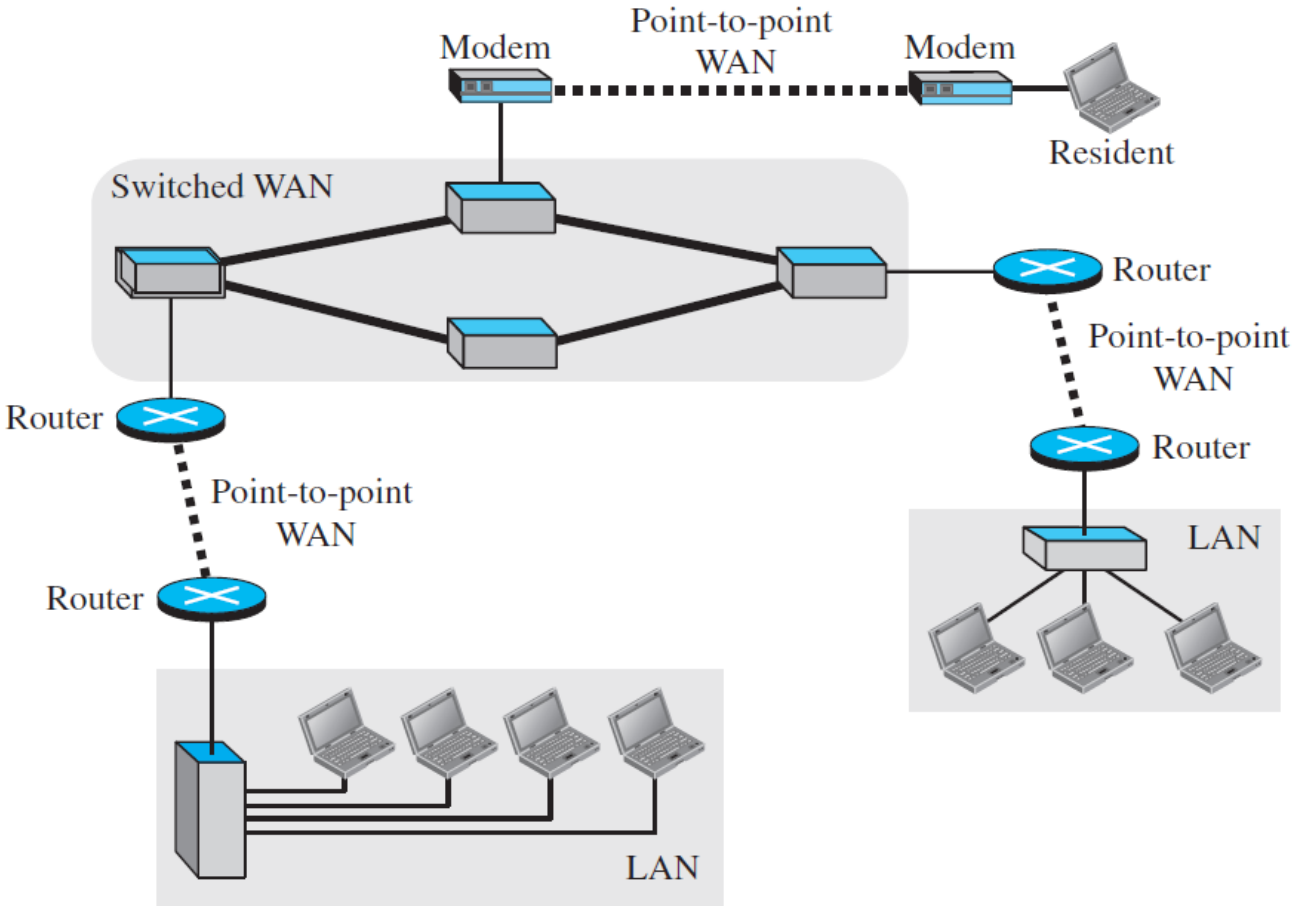
Networks : Internetwork

When two or more networks are connected, they make an **internetwork,** or **internet.**

Internetwork



Example, assume that an organization has two offices, one on the east coast and the other on the west coast

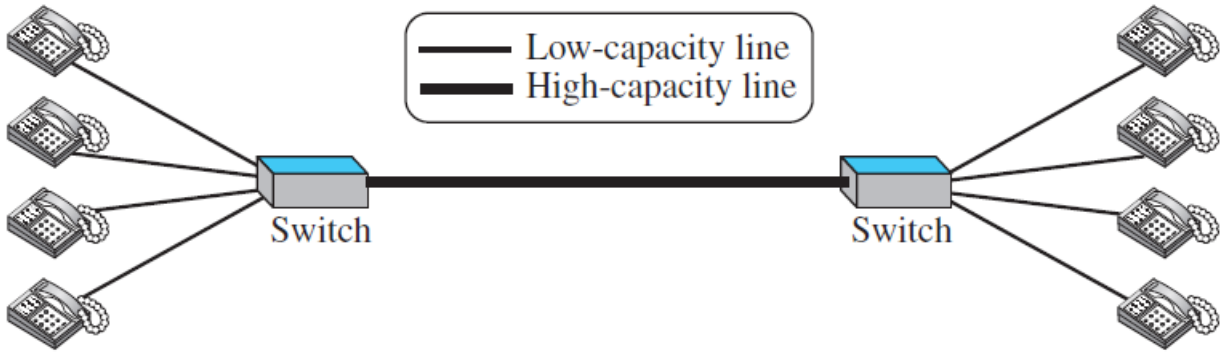


Networks : **Switching**

- An internet is a **switched network** in which a switch connects at least two links together.
- **Switch** needs **to forward data** from a **network to another network when required**

Circuit Switched Network

- A **dedicated connection**, called a **circuit**, is always available between the two end systems;
- The switch can only make it active or inactive.
- Figure *shows a very simple switched network that connects four telephones to each end.*

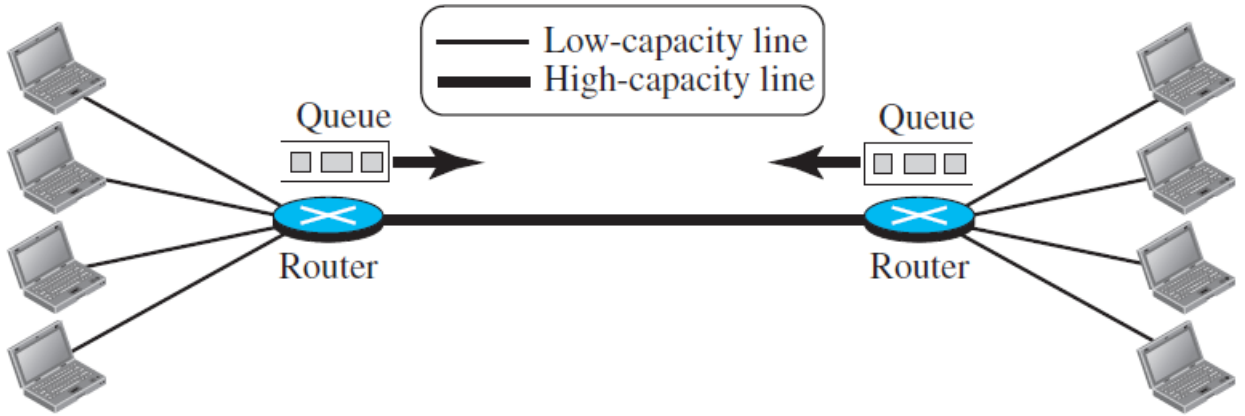


- Circuit-switched network is **efficient only when it is working at its full capacity**;
- Most of the time, it is inefficient because it is working at partial capacity.

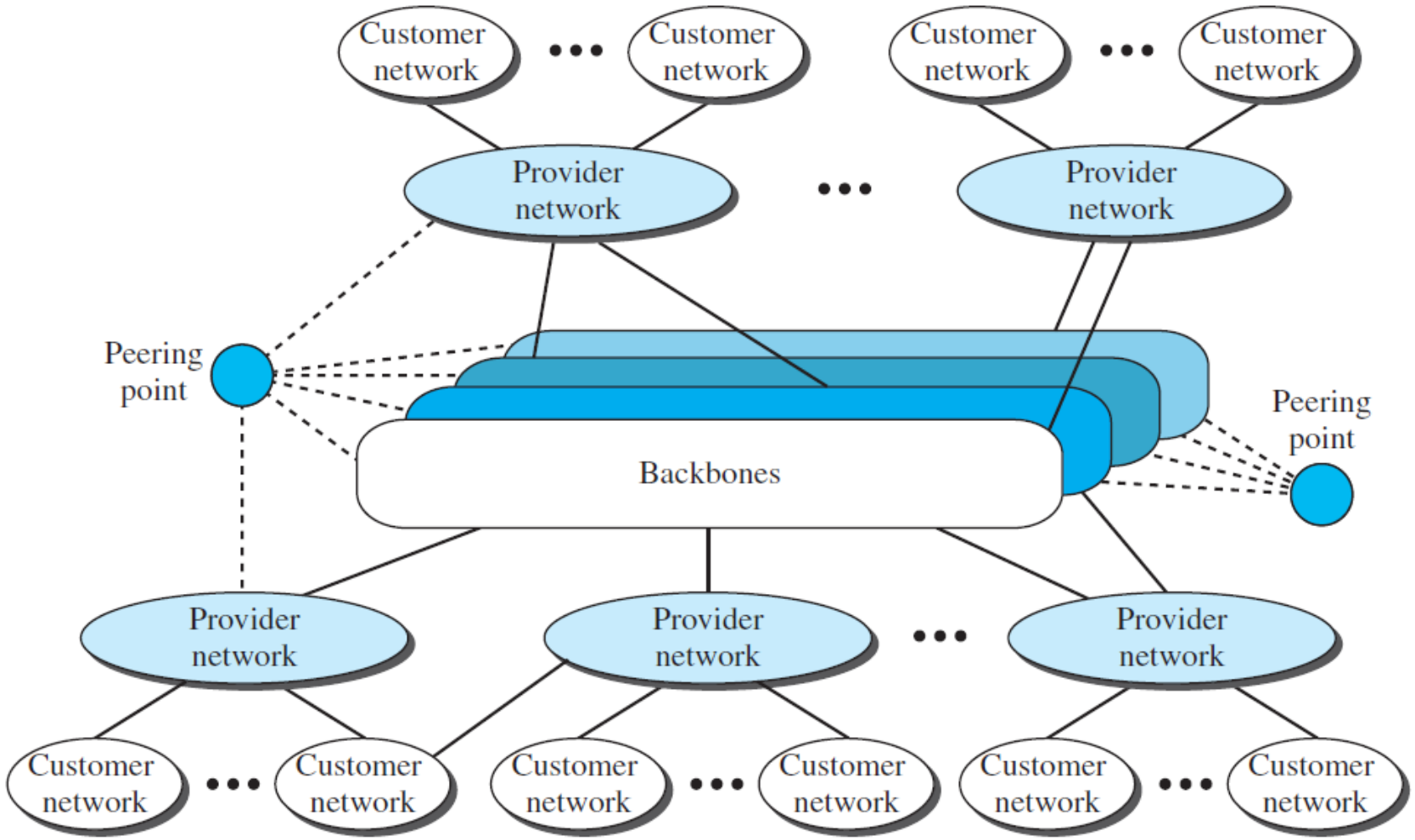
Networks : **Switching**

Packet Switched Network

- In a **computer network**, the communication between the two ends is done in blocks of data called **packets**.
  - Instead of the continuous communication, here the exchange of individual data packets between the two computers.
  - This allows to make the switches function for both storing and forwarding
    - A a packet is an independent entity that can be stored and sent later.
- A **router** in a packet-switched network has a queue that can store and forward the packet.



The Internet



Internet: Standards, Administration & Protocols

Syntax

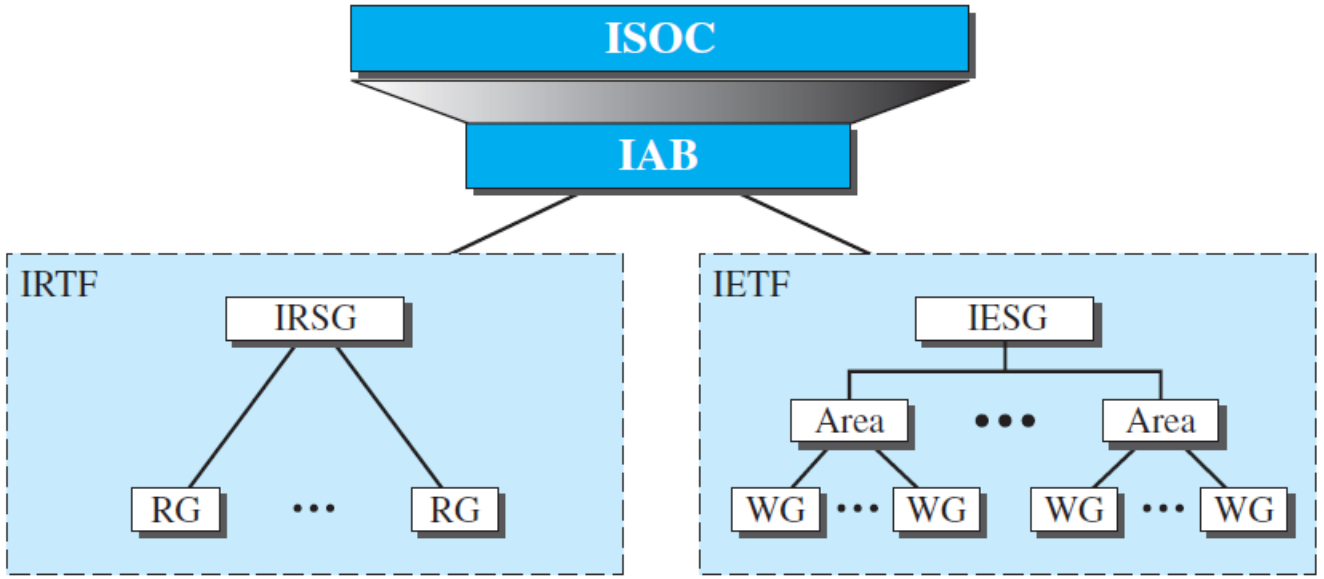
- Structure or format of the data
- Indicates how to read the bits - field delineation

Semantics

- Interprets the meaning of the bits
- Knows which fields define what action

Timing

- When data should be sent and what
- Speed at which data should be sent or speed at which it is being received.



Internet:
Standards, Administration & Protocols

Internet Society (ISOC)

- is an international, nonprofit organization to provide support for the Internet standards process.
- Maintaining and supporting other Internet administrative bodies such as IAB, IETF, IRTF, and IANA
- Promotes research activities relating to the Internet.

Internet Architecture Board (IAB)

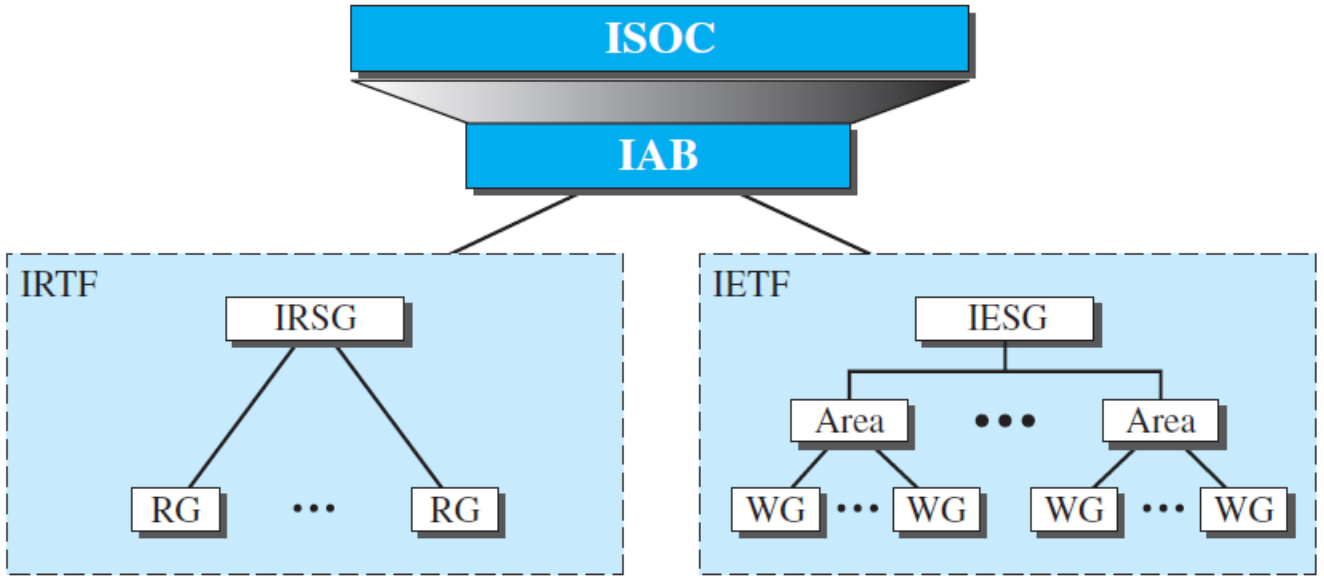
- Is the technical advisor to the ISOC.
- Main purposes of the IAB are to oversee the **continuing development of the TCP/IP Protocol Suite**.

Internet Engineering Task Force (IETF)

- IETF is responsible for **identifying operational problems and proposing solutions** to these problems.
- IETF also develops and reviews specifications intended as Internet standards.

Internet Research Task Force (IRTF)

- IRTF focuses **on long-term research topics** related to Internet protocols, applications, architecture, and technology.



Reference

Forouzan, A. Behrouz. *Data Communications & Networking*. 5th Edition. Tata McGraw-Hill Education.

Chapter 1

Topics: 1.1 – 1.3