Introduction to Computer Systems

Computer networks

IN CLASS TESTS ARE COMING

Lecture 10

Communicating over the Network

Lecture Outline

- Network Devices
- Broadcast Domain
- Collision Domain
- Transmission Media
  - Guided
  - Un-Guided

Data Communication Networks Need

Devices	• To communicate with one another
Medium	• Connects devices together
Messages	• Information over media
Rules	• Govern how messages flow across networks

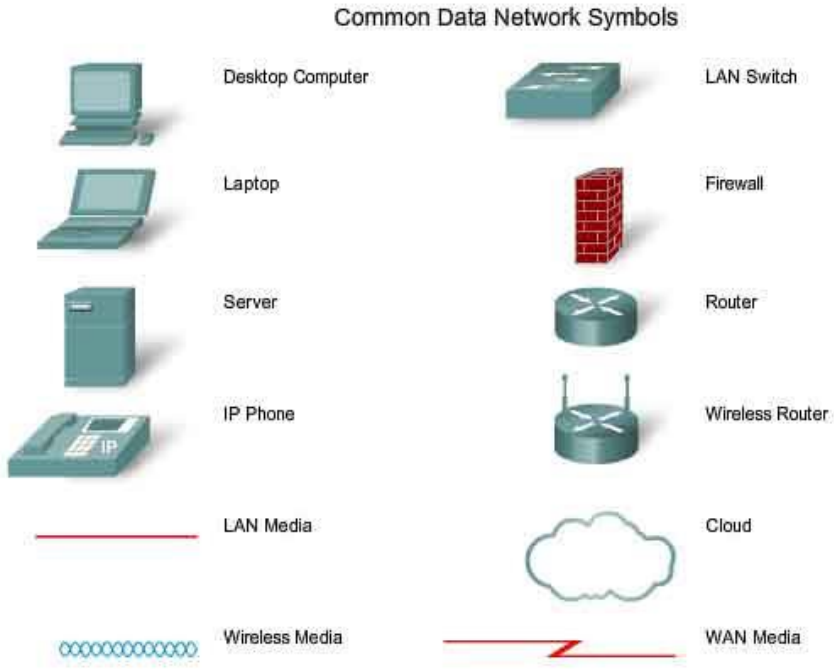
Network Devices

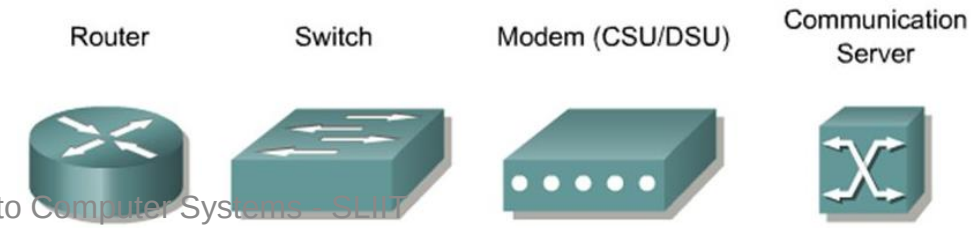
LAN
- Switch
- Hub
- Bridge
- Repeater

WAN
- Router
- Modem

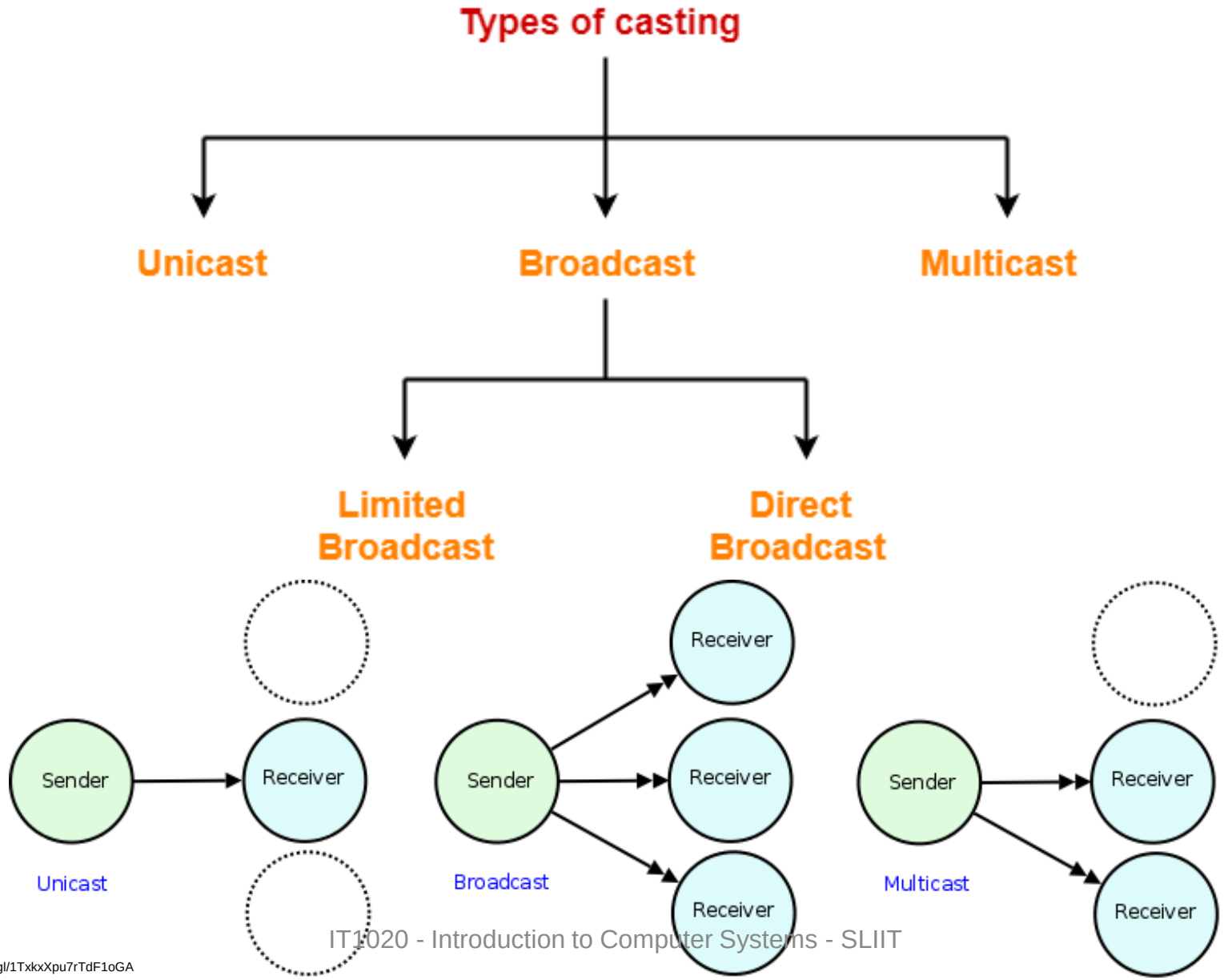
Utility
- Servers
- Firewall
- Gateway
- IPS/IDS

- The major devices used to create networks:





Message Delivery Modes



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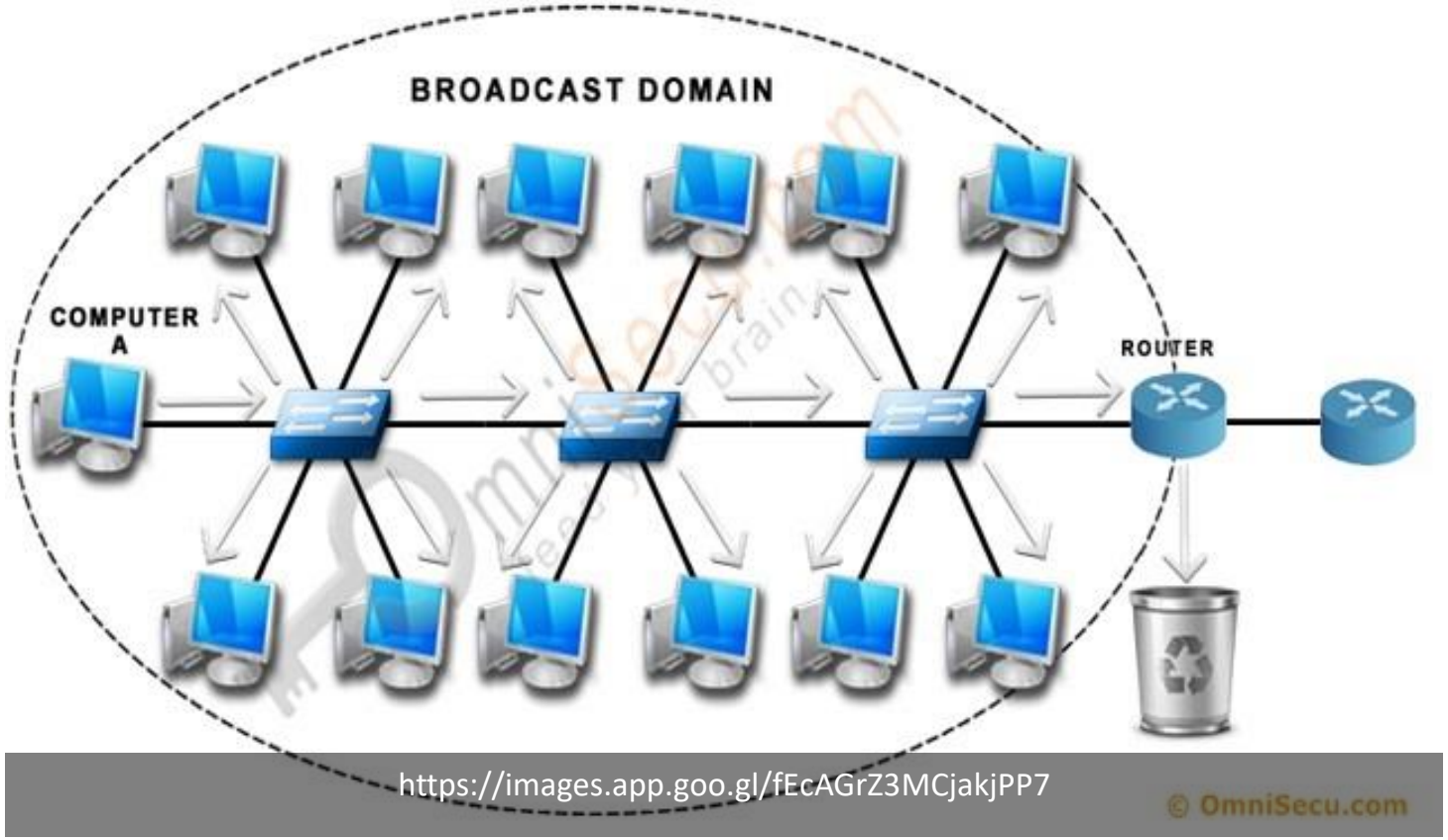
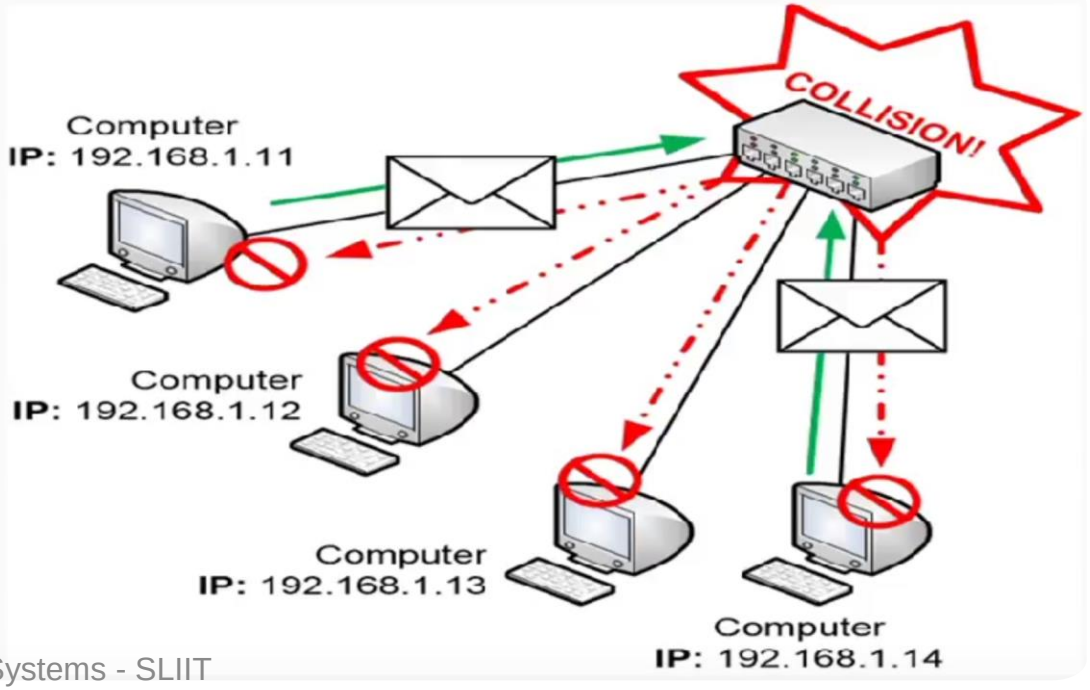
Broadcast Domain

- A **broadcast domain** is a collection of computers in which, when **one sender sends** a message, the message is delivered to **all others** in the **same domain**.

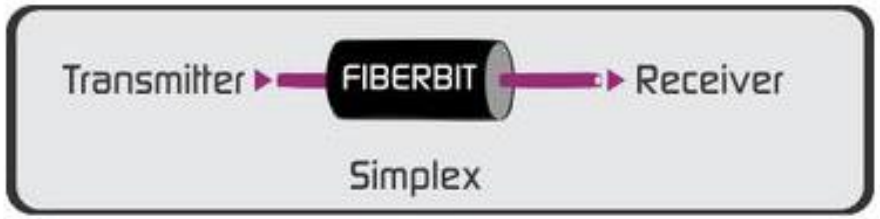


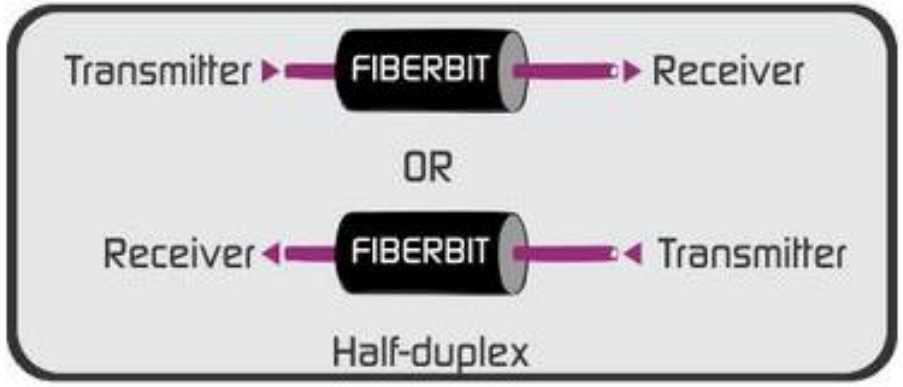
Collision Domain

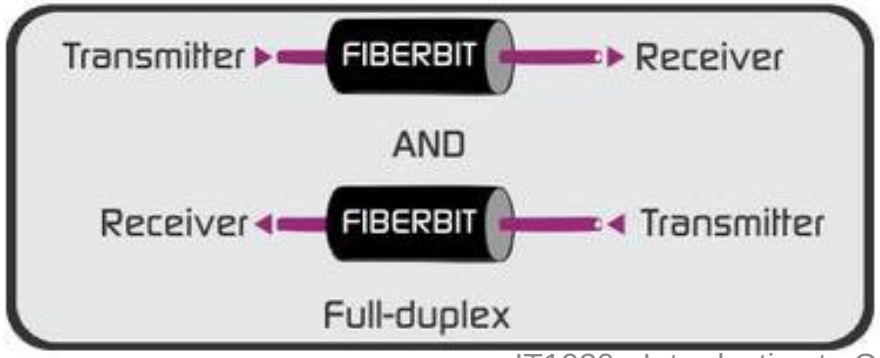
- A **collision domain** is a collection of **computers** in which, if **more than one sender** tries to **send** some **data simultaneously**, the **signal will collide** in the transmission media and make all the sent information unusable.



Full duplex vs Half duplex vs Simplex







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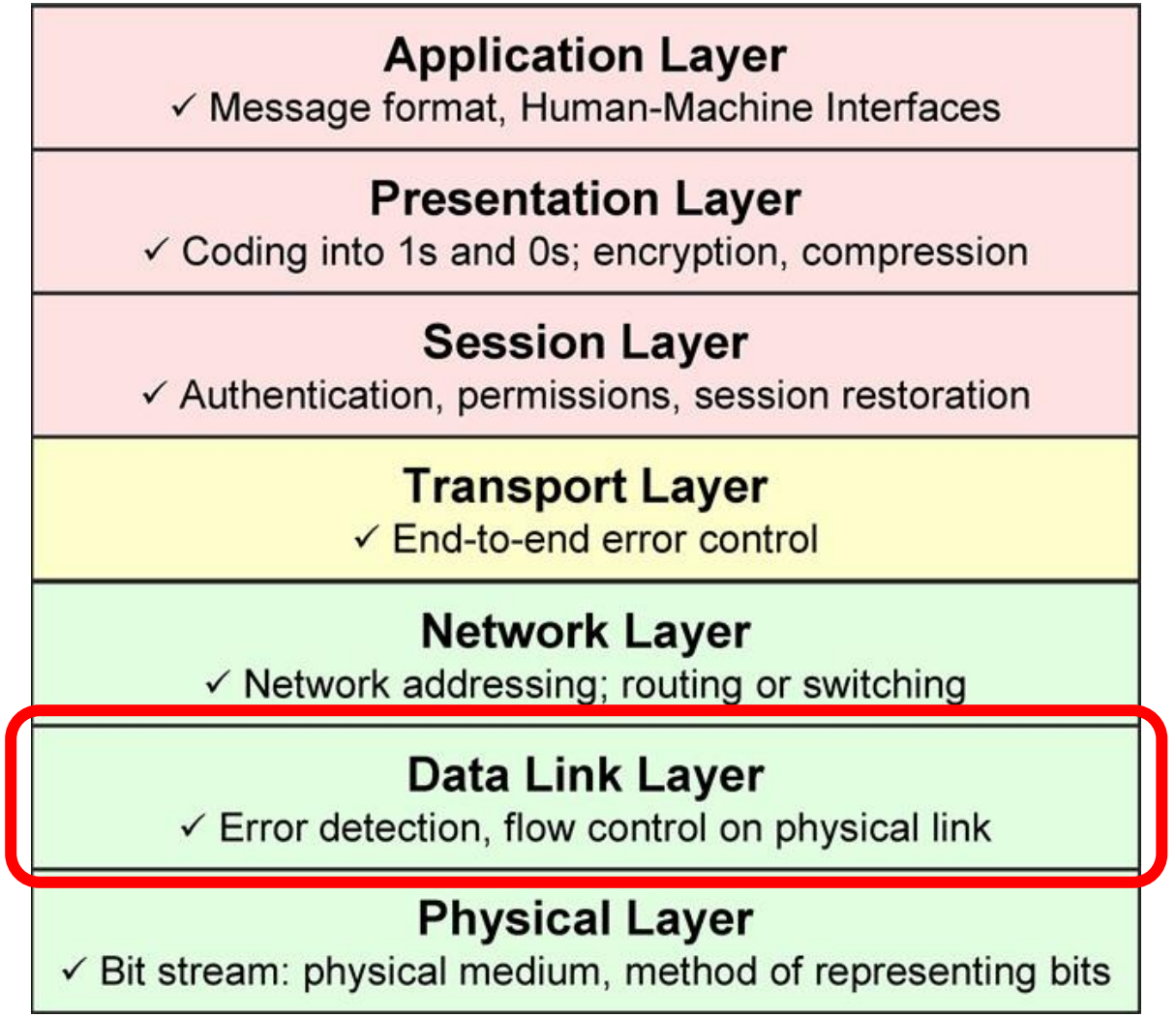
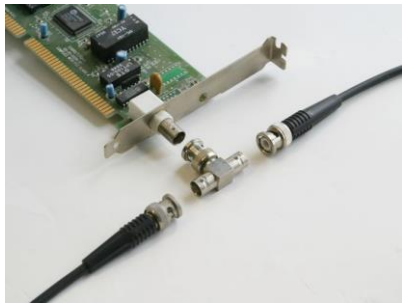
Network Interface Card (NIC) aka Network Interface Controller

- NIC is the **hardware interface** between a **computer and a network**
- NIC can operate in **half duplex or full duplex** modes

- NIC performs,
  - ✓ Carrier Sense
  - ✓ Converting the binary data into encoded signals and vice versa
  - ✓ Media Access Control

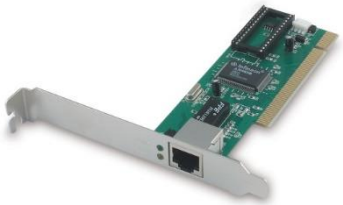


Types of NICs



Old NIC with BNC connection

A transitional NIC with BNC and RJ45 connections



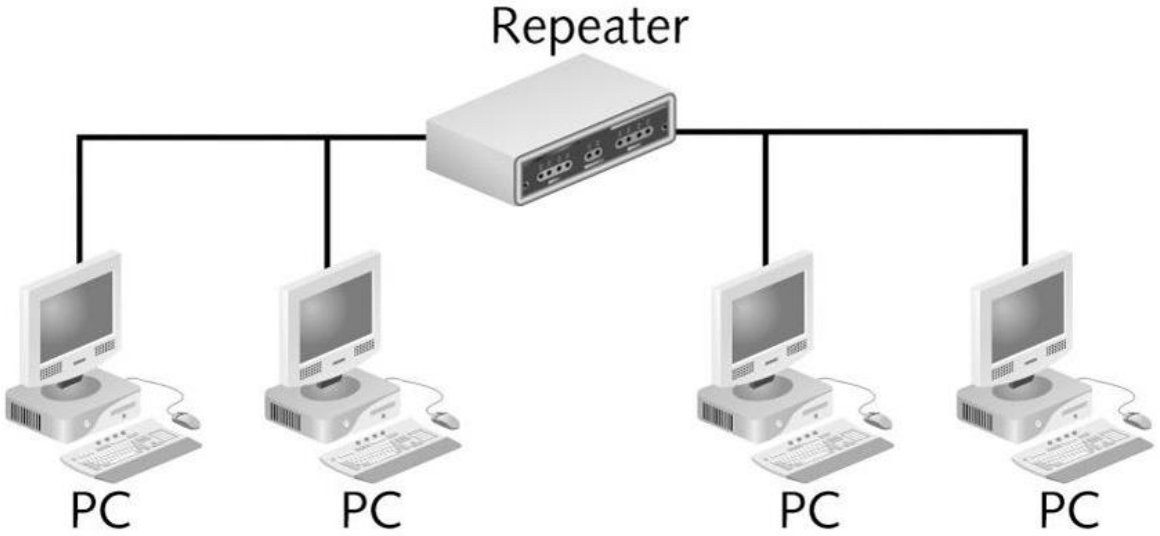
A typical modern NIC with RJ45 connection

Wireless NIC

A multiport NIC typically used in servers

Repeater

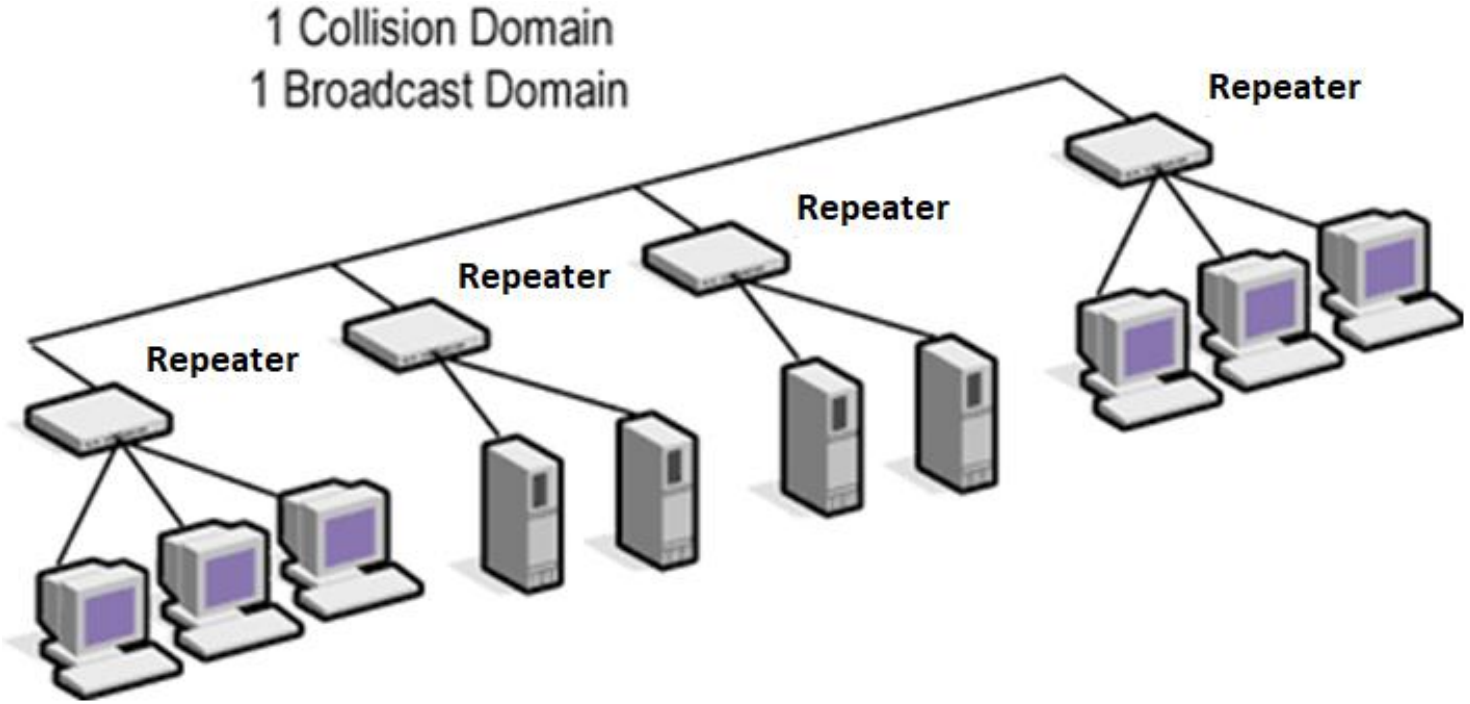
- Connects two network segments
- **Regenerates the signals** to **proper amplitudes** and sends them to the next segment



Application Layer ✓ Message format, Human-Machine Interfaces
Presentation Layer ✓ Coding into 1s and 0s; encryption, compression
Session Layer ✓ Authentication, permissions, session restoration
Transport Layer ✓ End-to-end error control
Network Layer ✓ Network addressing; routing or switching
Data Link Layer ✓ Error detection, flow control on physical link
Physical Layer ✓ Bit stream: physical medium, method of representing bits

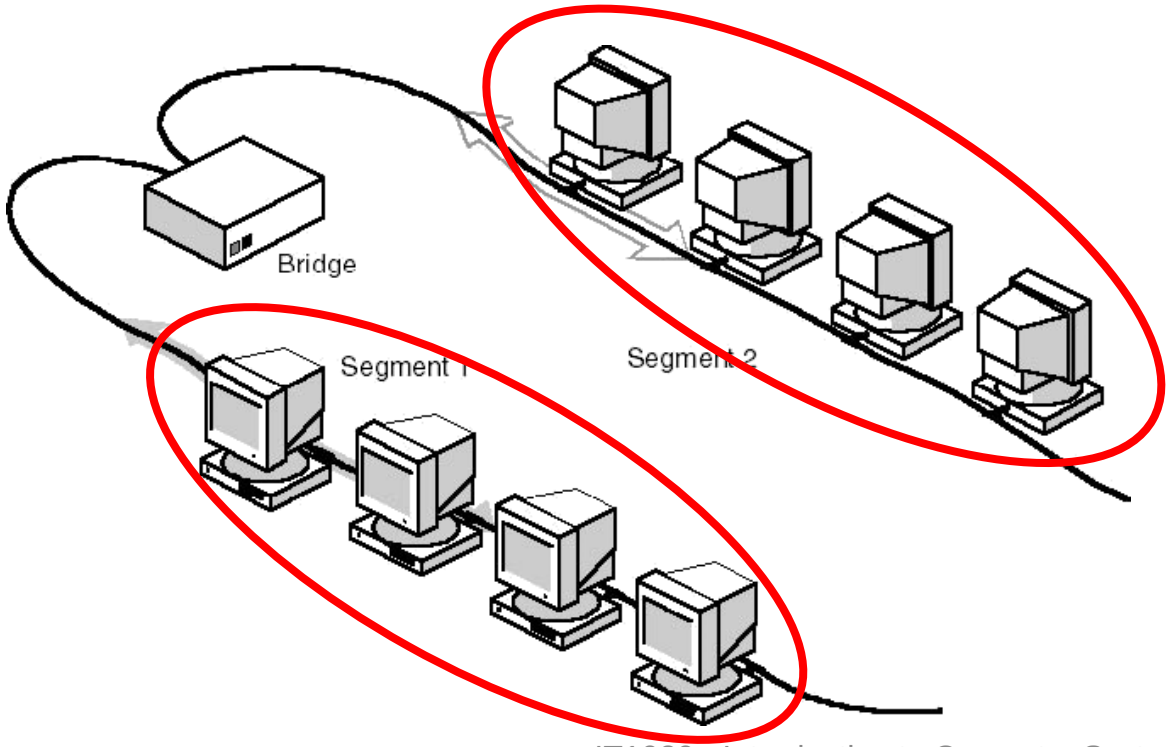
Repeater cont.

- One broadcast domain
- One collision domain



Bridge

- Used to connect **two or more** separate **LAN** segments



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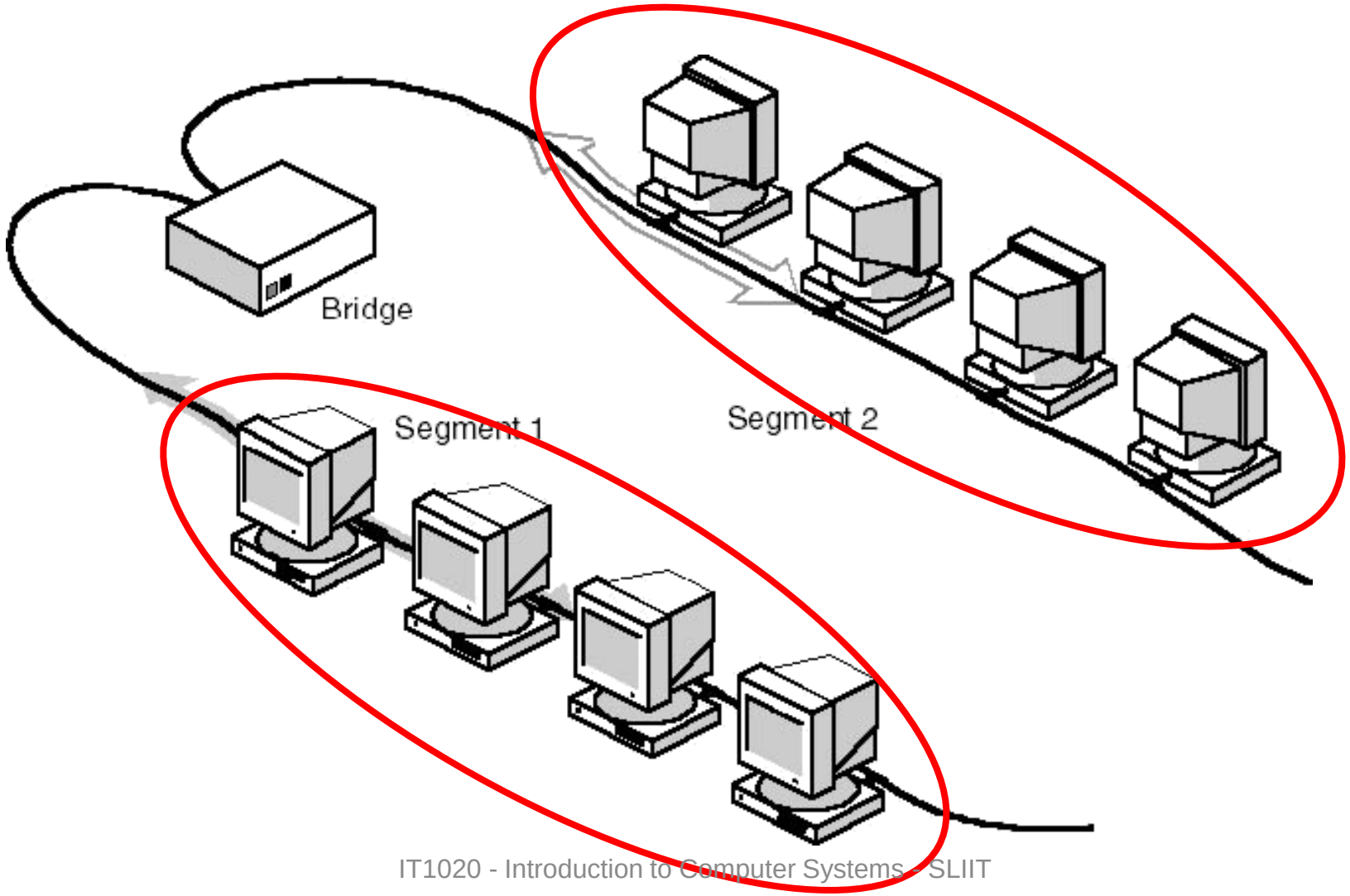
✓ Error detection, flow control on physical link

Physical Layer
✓ Bit stream: physical medium, method of representing bits

Bridge cont.

2 Collision Domains
1 Large Broadcast Domain



Switch

- A switch is **similar** in **functionality** to a **bridge**

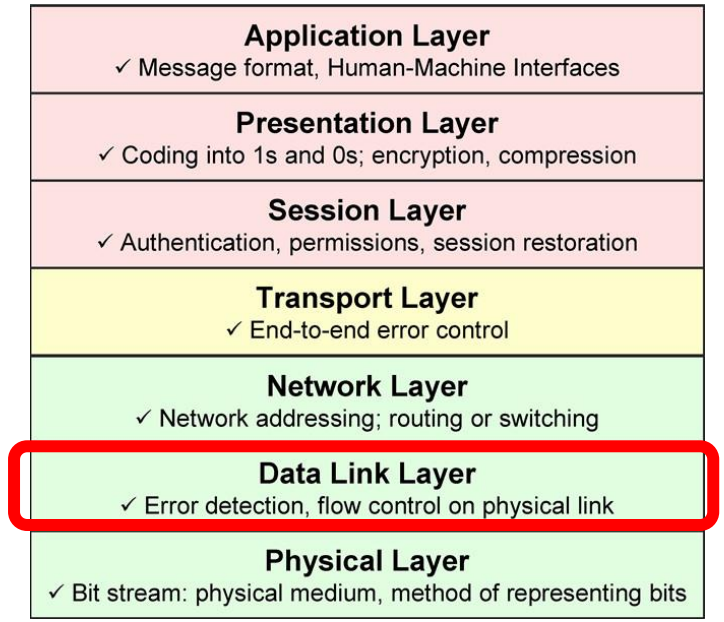
  (it is also used to connect multiple LAN segments together)

- However,
  - ✓ A switch has a **large number of ports** compared to a bridge

    (a switch is commonly referred to as a multiport bridge)
  - ✓ A switch **uses ASICs** for it's processing and **switches are faster**

    (bridges **use** software running, using a **normal processor**)
  - ✓ **Switches are widely used in todays' LANs**

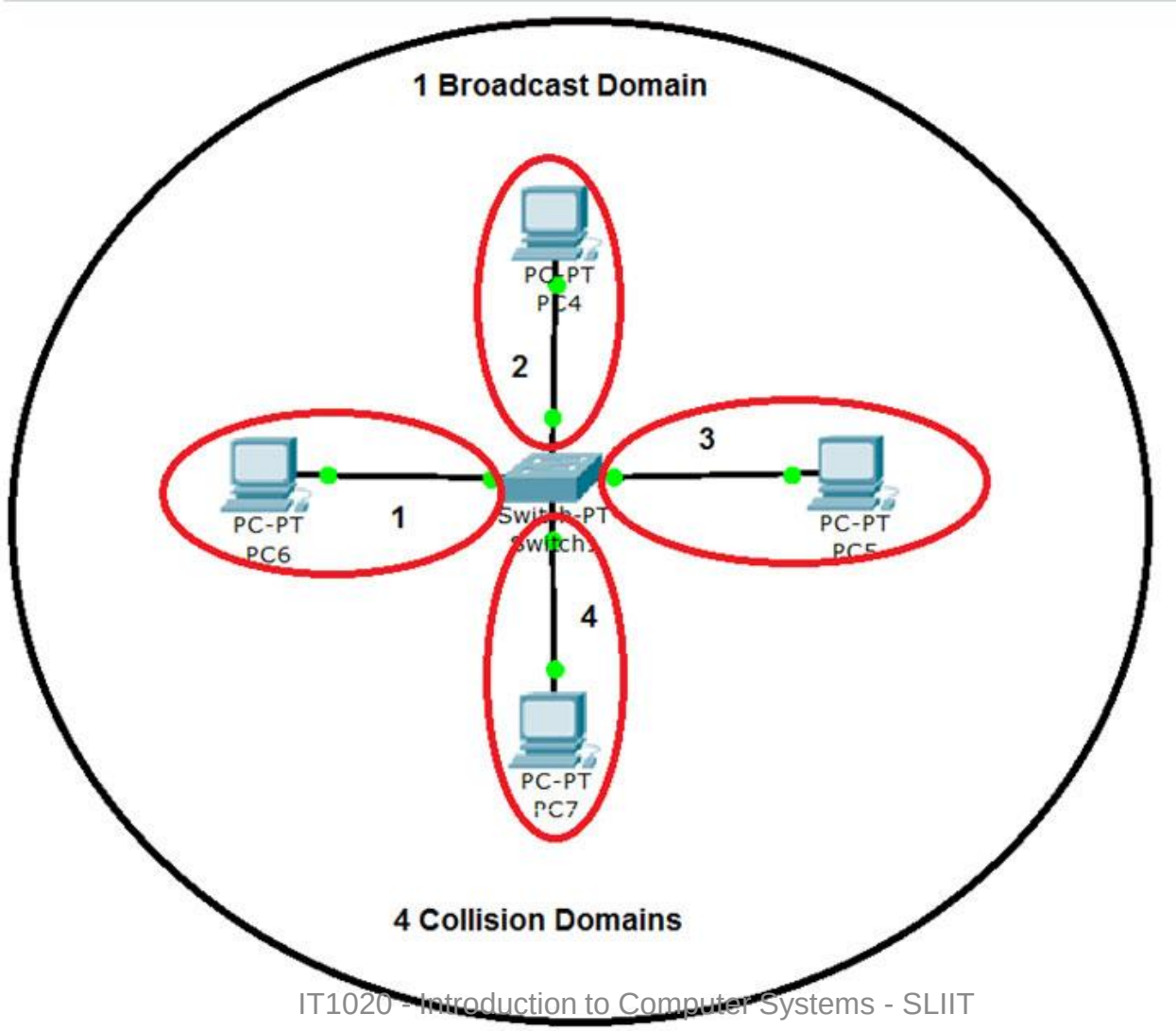
    (bridges are no longer used)



Note: Your home is mainly a WLAN built using a Wireless Switch commonly known as a Wireless Access Point

Switch cont.

4 Collision Domains
1 Large Broadcast Domain



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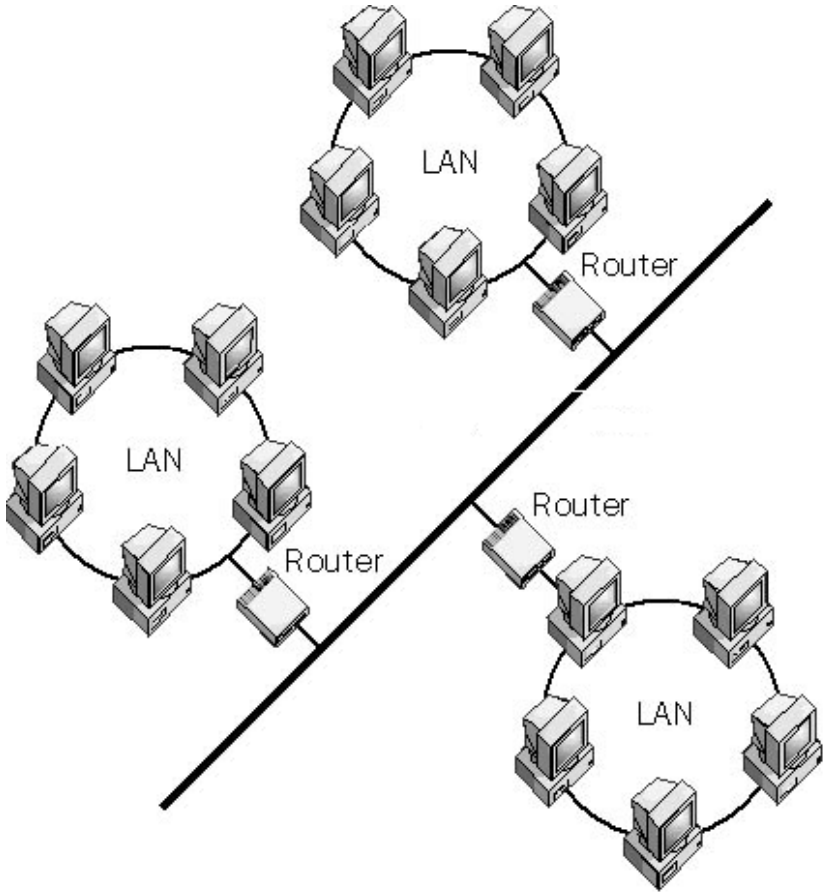
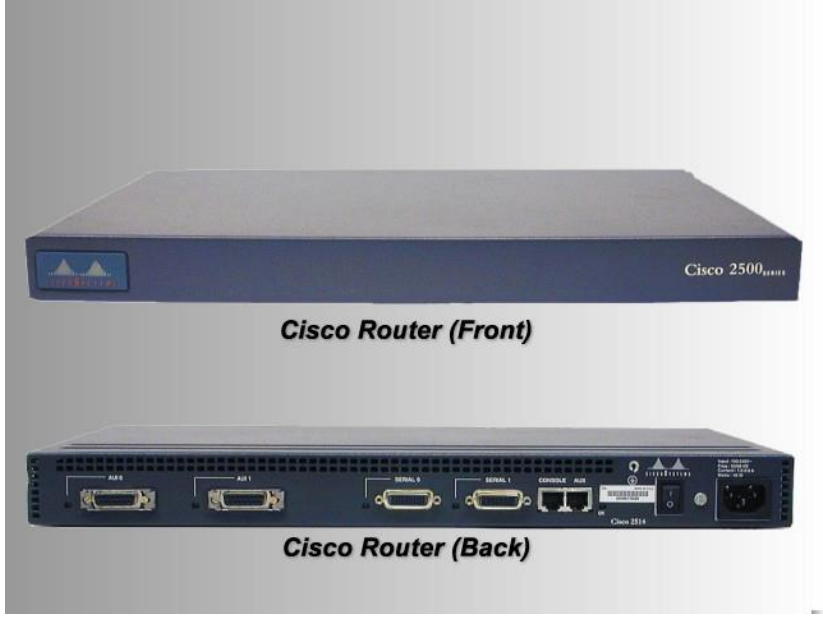
Router

- A router is used to **interconnect two or more LANs**





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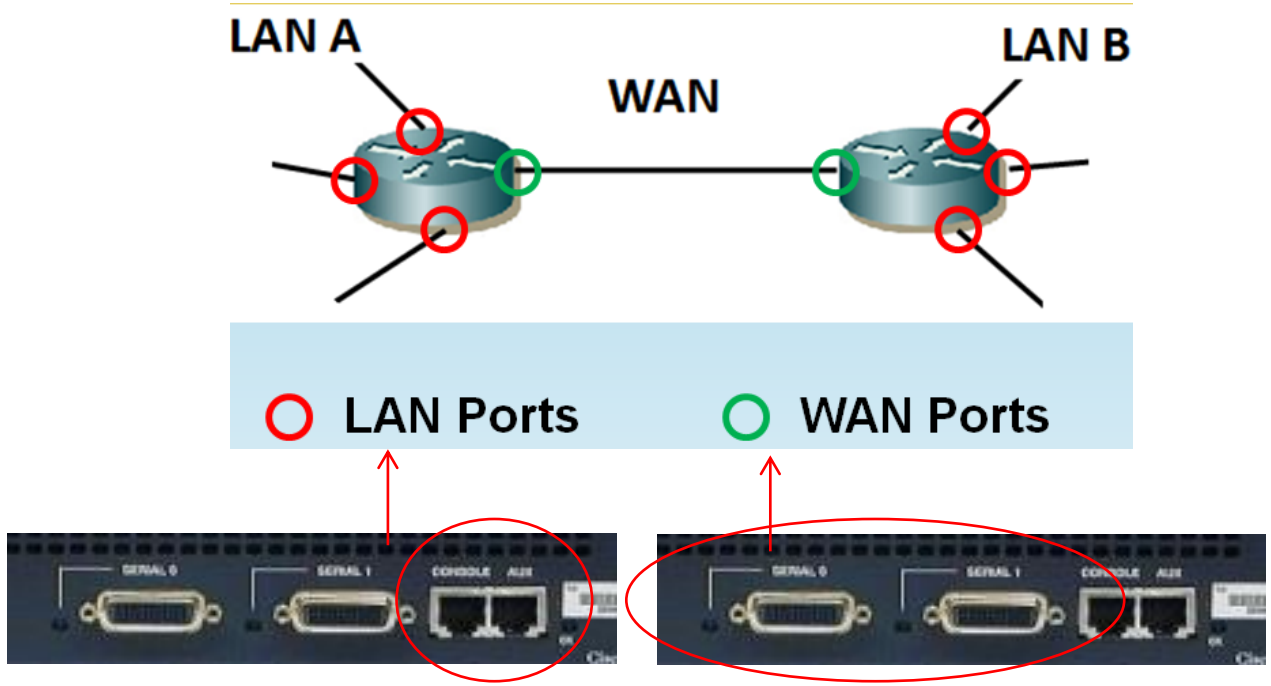
Router cont.



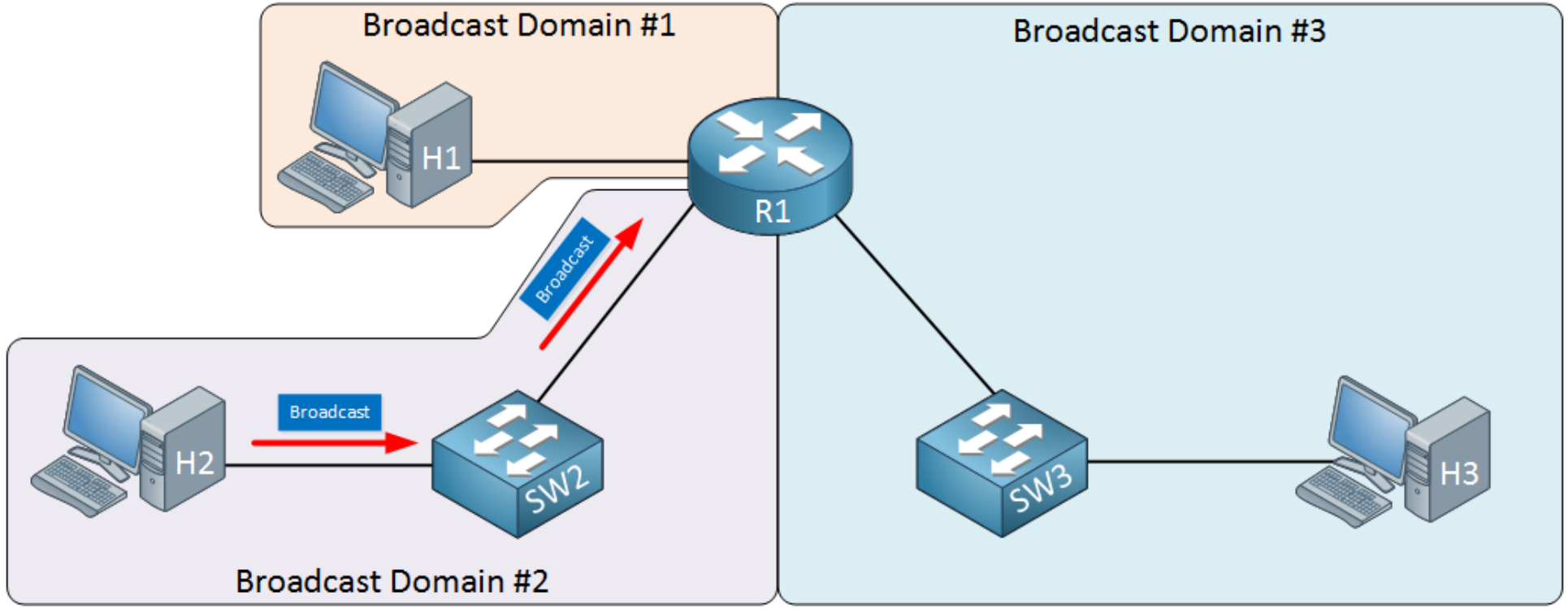
- **LAN ports are RJ45** connections while **WAN ports** are generally **serial connections**

Note:

*Your home Wireless Switch is a two-in-one device that also connects you to outside networks. That's why we usually call it a **wireless router**. In theory it's a Wireless Switch + Router.*

Router cont.

5 Collision Domains
3 Broadcast Domains



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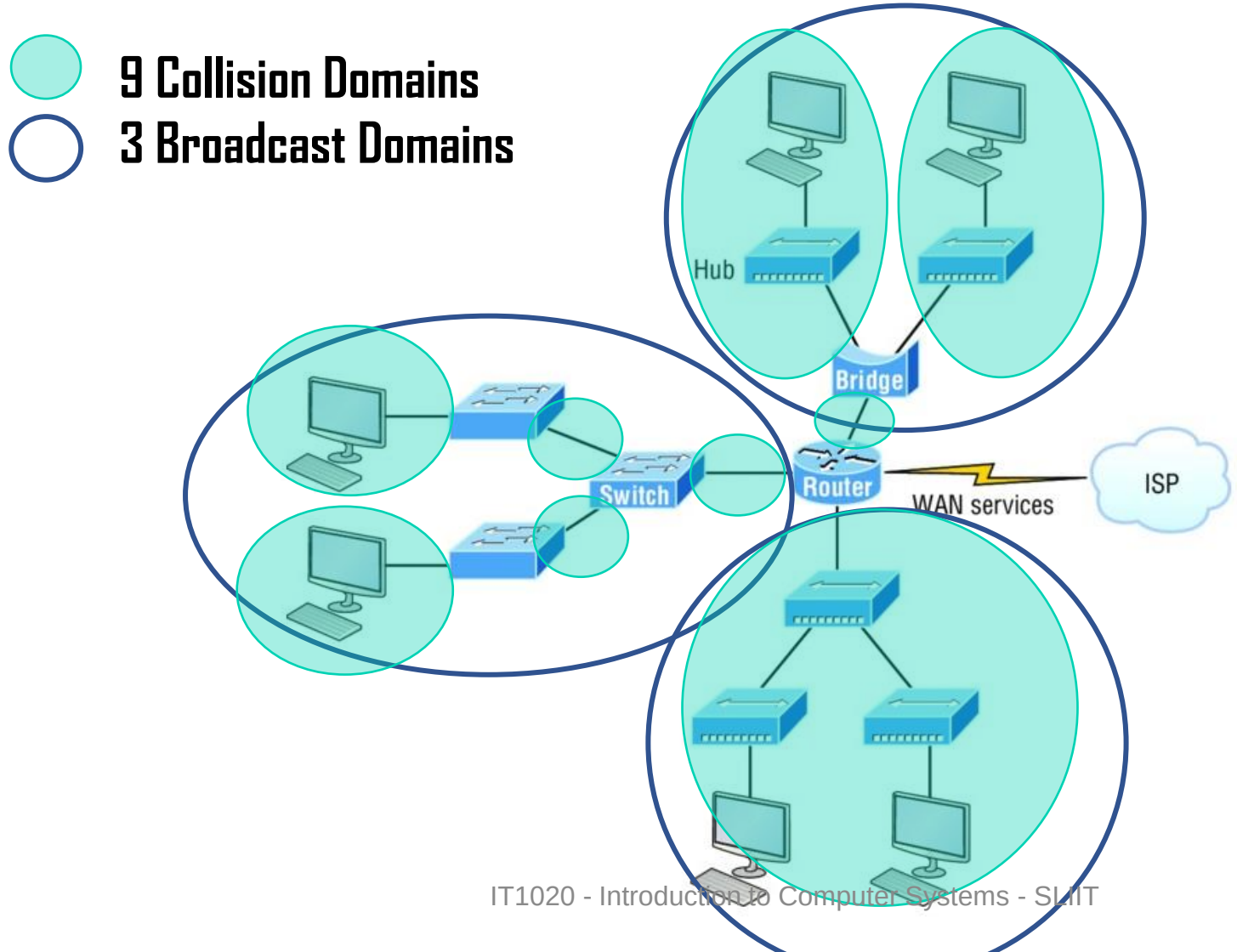
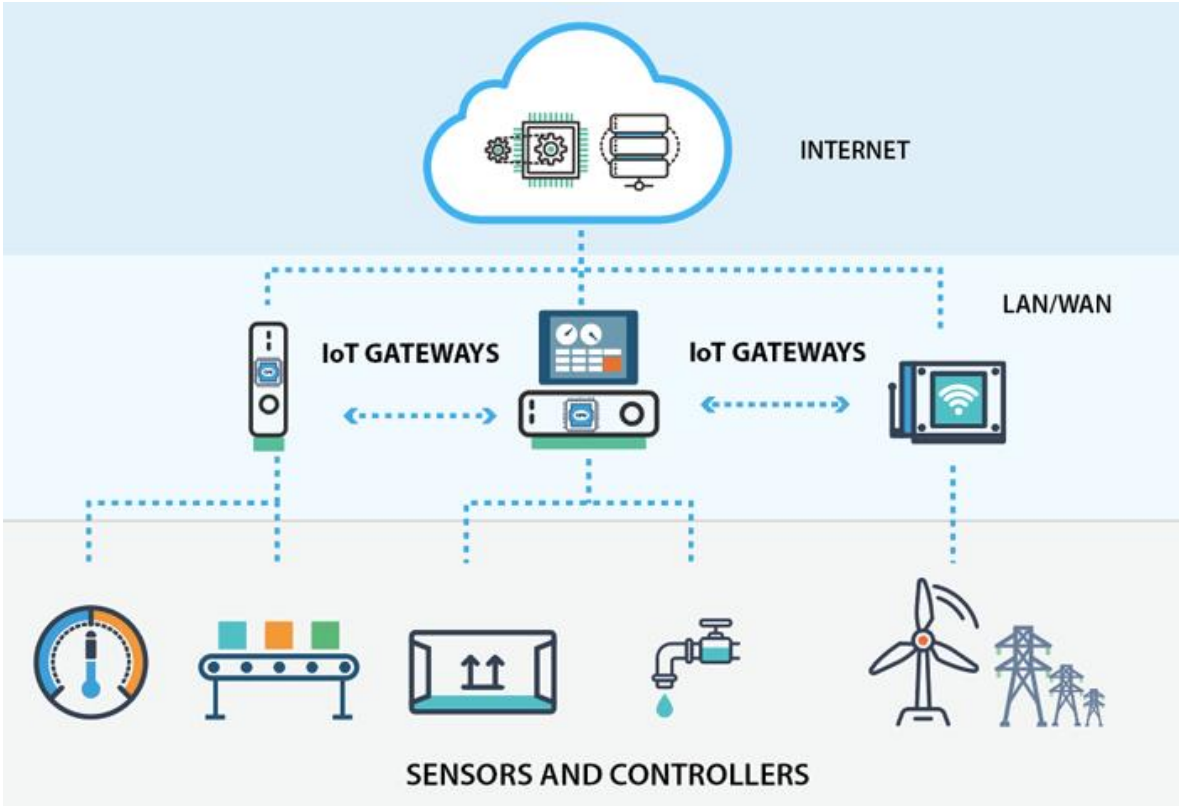
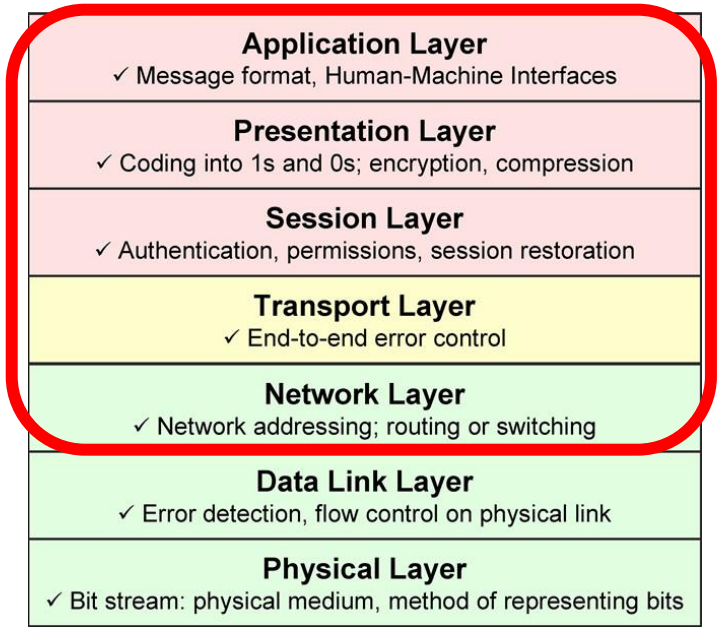
Let’s Find number of Broadcast Domains and Collisions domains



Gateway

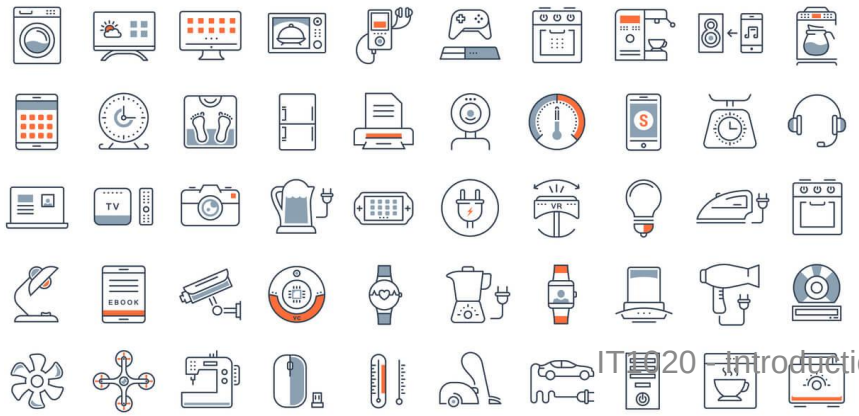
- A network device which can interconnect two networks that are using different protocols to communicate

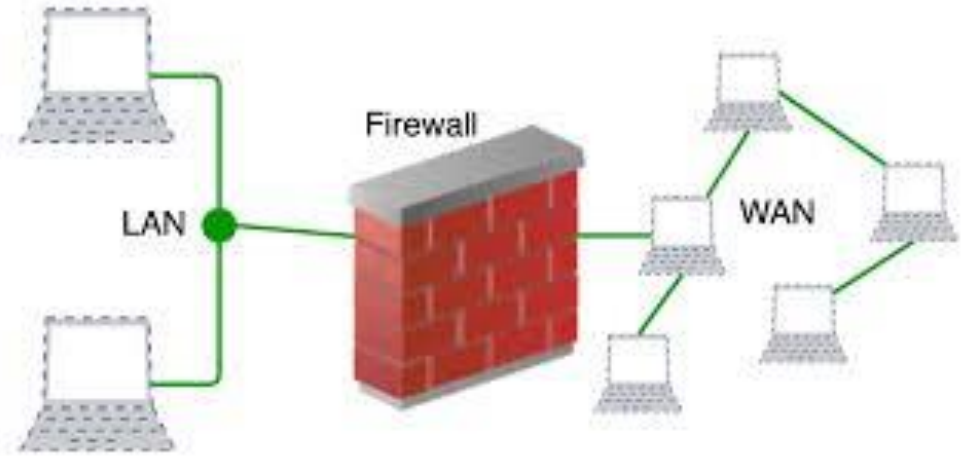




Other Devices

- Firewalls
- Servers
- IoT devices





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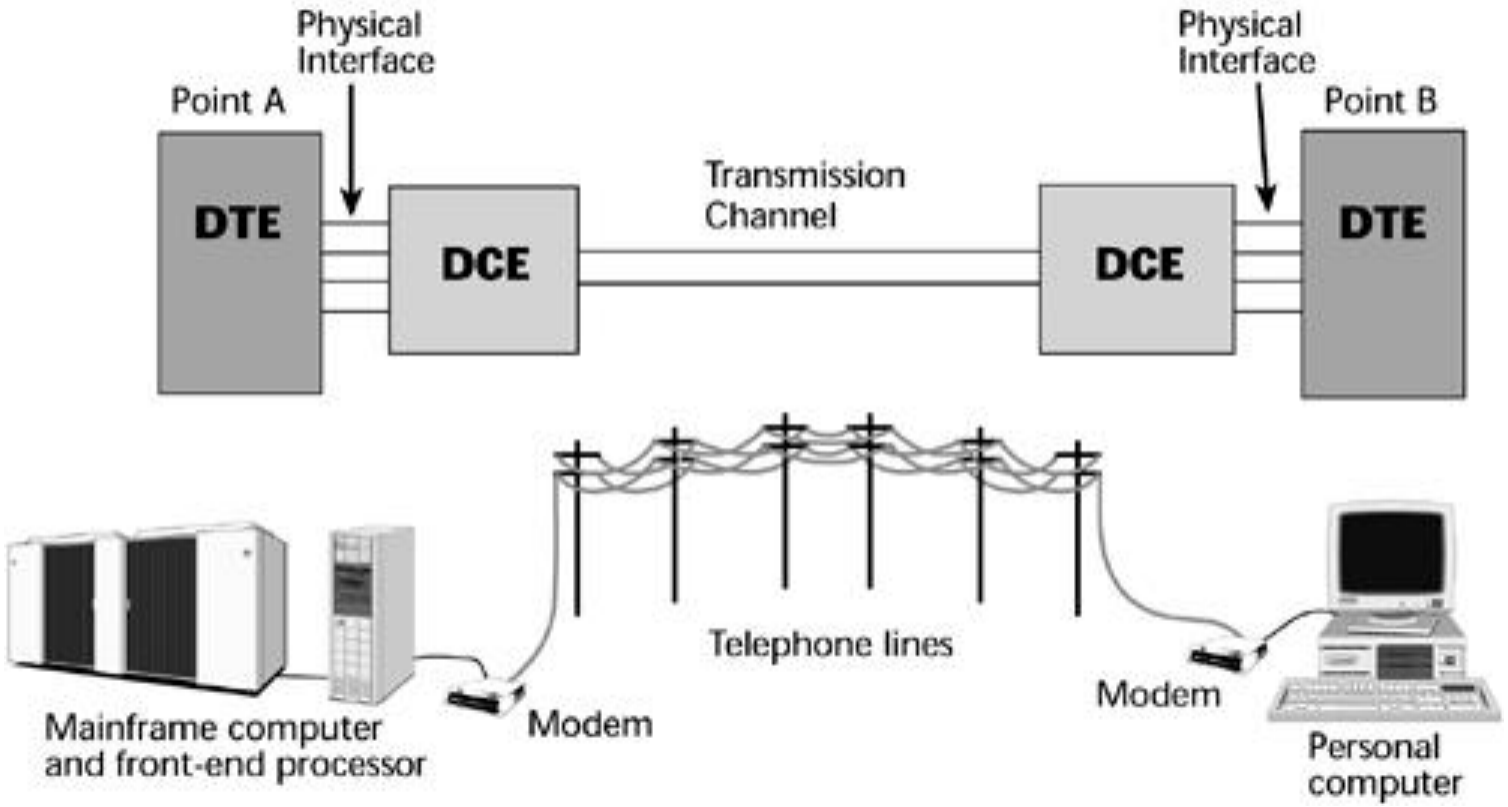
Data Communication Model

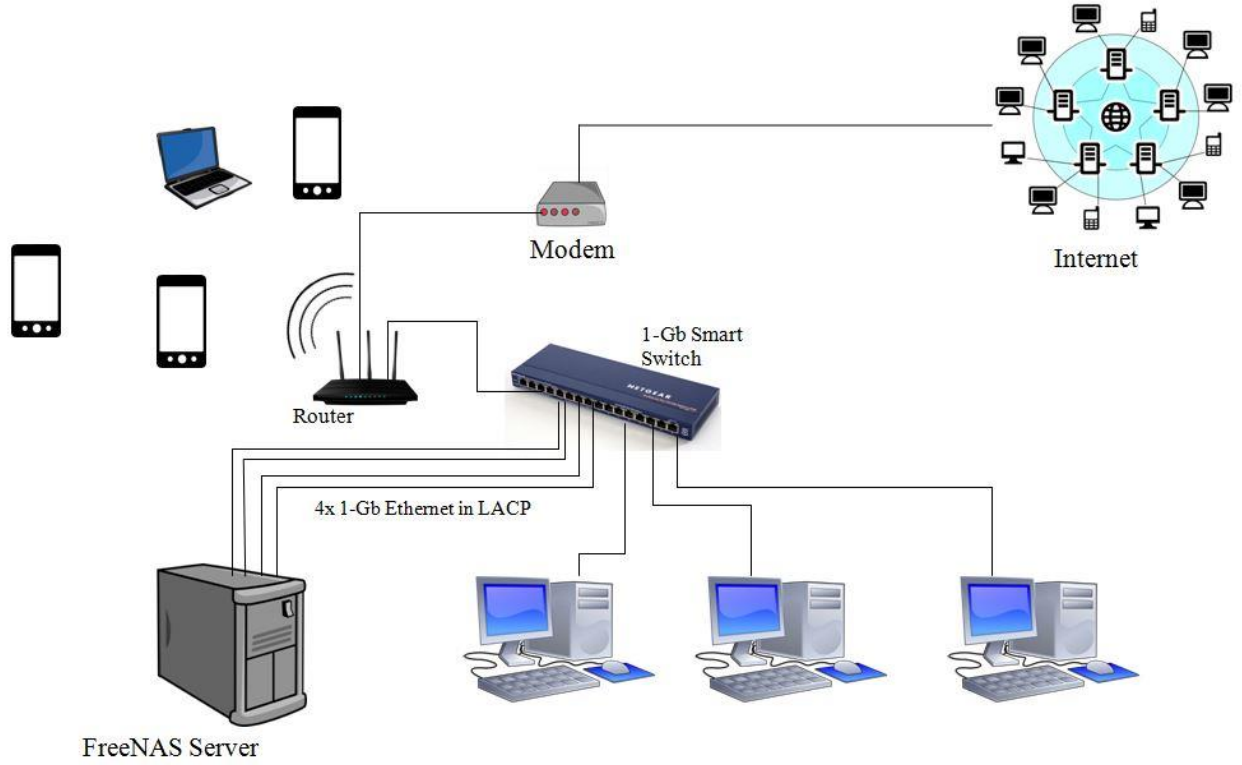


- DTE – Data Terminal Equipment (Ex: Computer, Printer, Fax machine)
- DCE – Data Circuit-Terminating Equipment (Ex: Modem)

Data Communication Networks Need

Devices	• To communicate with one another
Medium	• Connects devices together
Messages	• Information over media
Rules	• Govern how messages flow across networks

Transmission Media

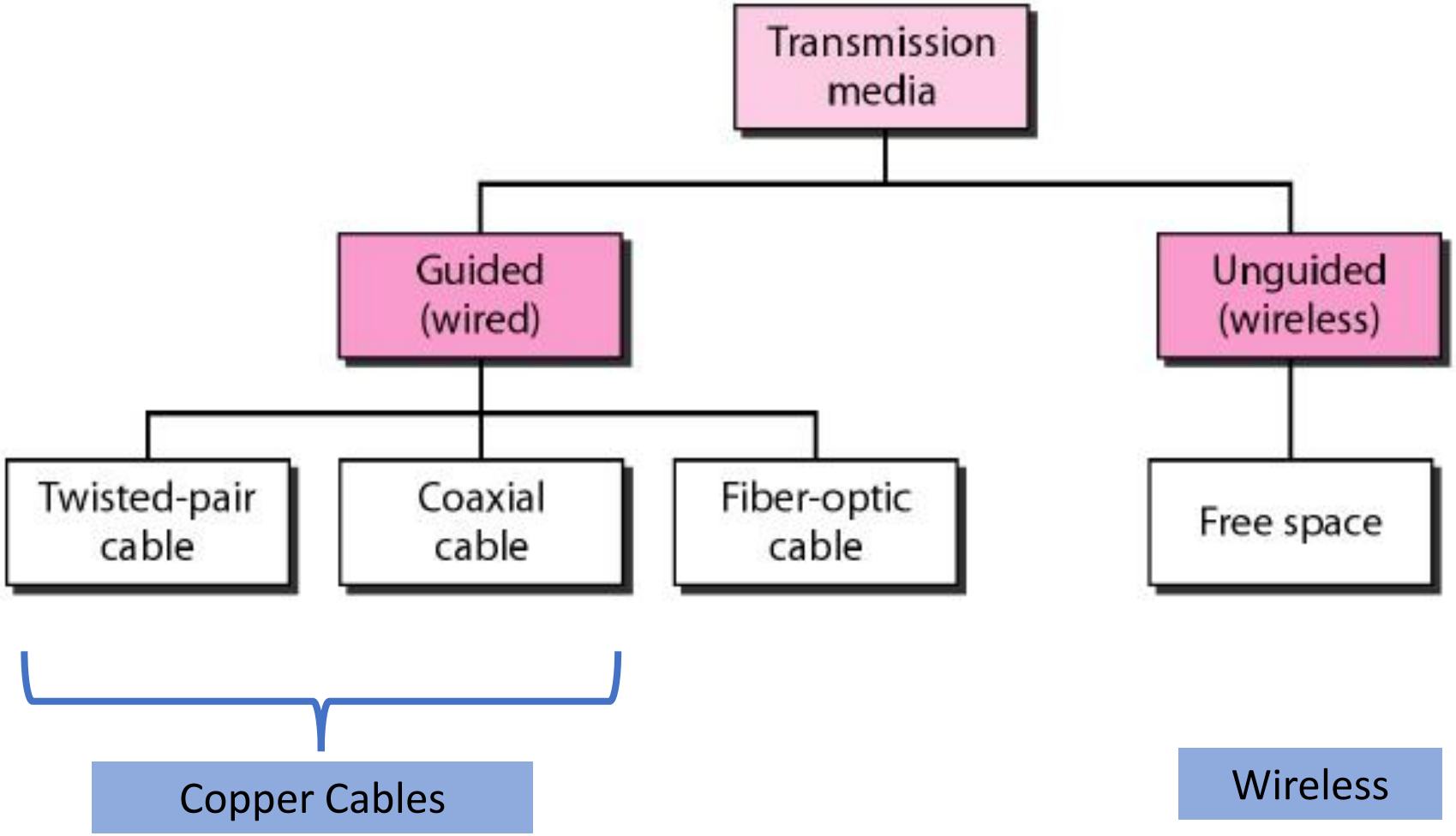


- A **transmission medium** (plural transmission media) is a **material substance** (solid, liquid, gas, or plasma) **that can propagate energy waves**

  – *from Wikipedia*.

- We use transmission media to propagate the signals carrying some information (data) from a sender to a receiver

Transmission Media cont.



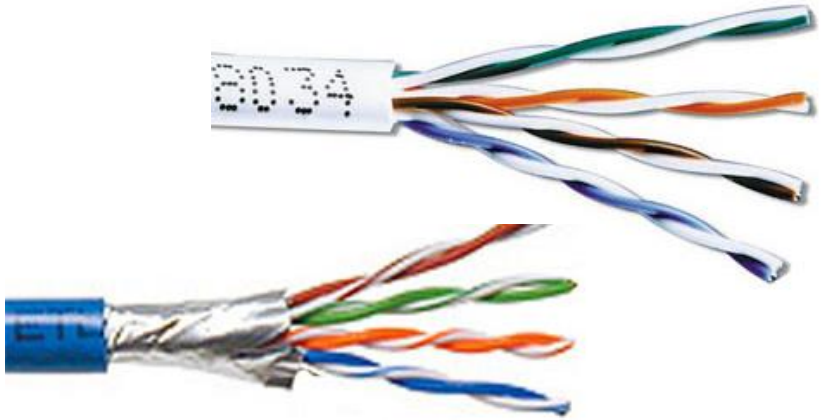
Twisted-pair Cables

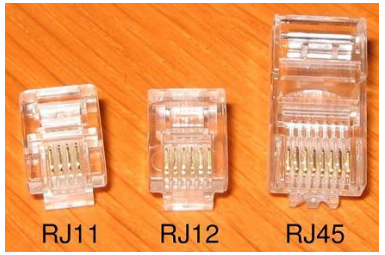
The **least expensive** and **most widely used** copper based guided media

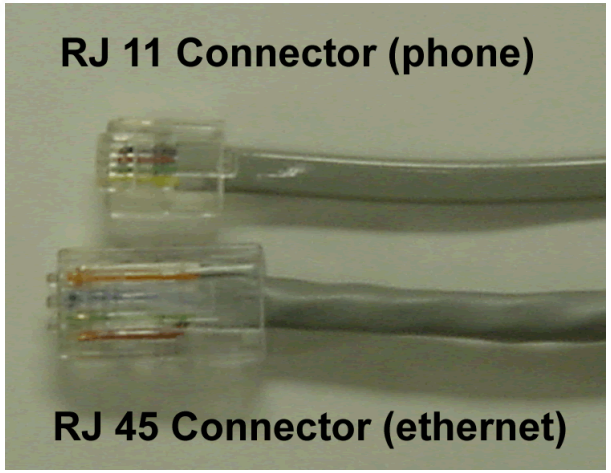
A twisted-pair consist of two insulated copper wires arranged in a regular spiral pattern

Twisted-pair cables come in **two variants**

- Unshielded Twisted Pair (UTP)
- Shielded Twisted Pair (STP)





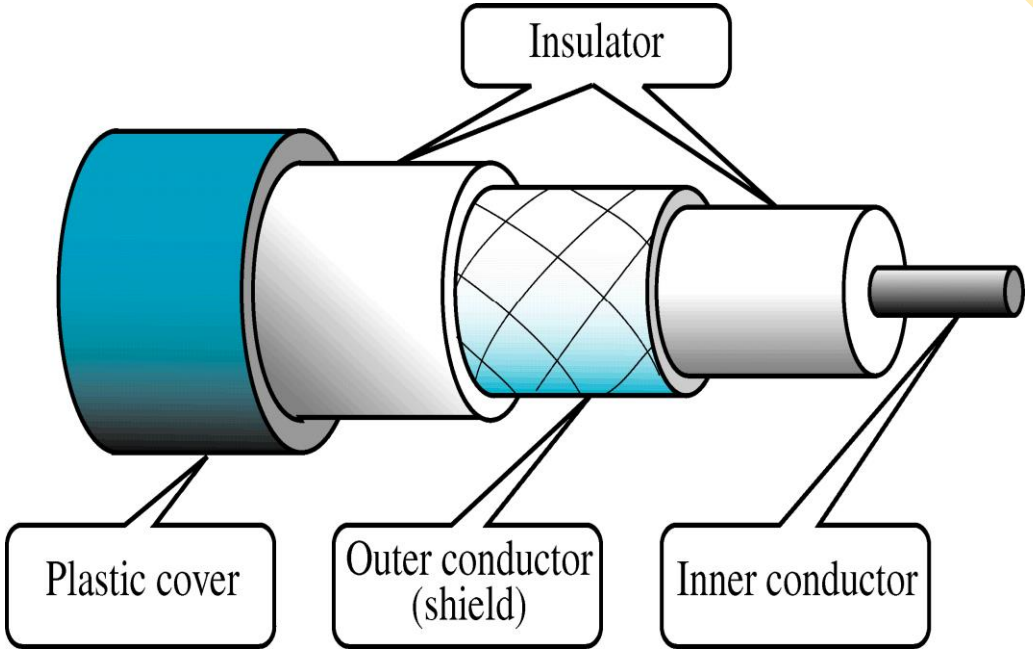


- Most widely used connectors for twisted-pair cables are Registered Jack (RJ) connectors

Coaxial Cables

- Coaxial cables were **widely used in past**, but **now obsolete**, to bus topology local area networks

- A coaxial cable consist of :
  - two conductors as same as twisted-pair
  - but these two conductors are arranged in a different manner

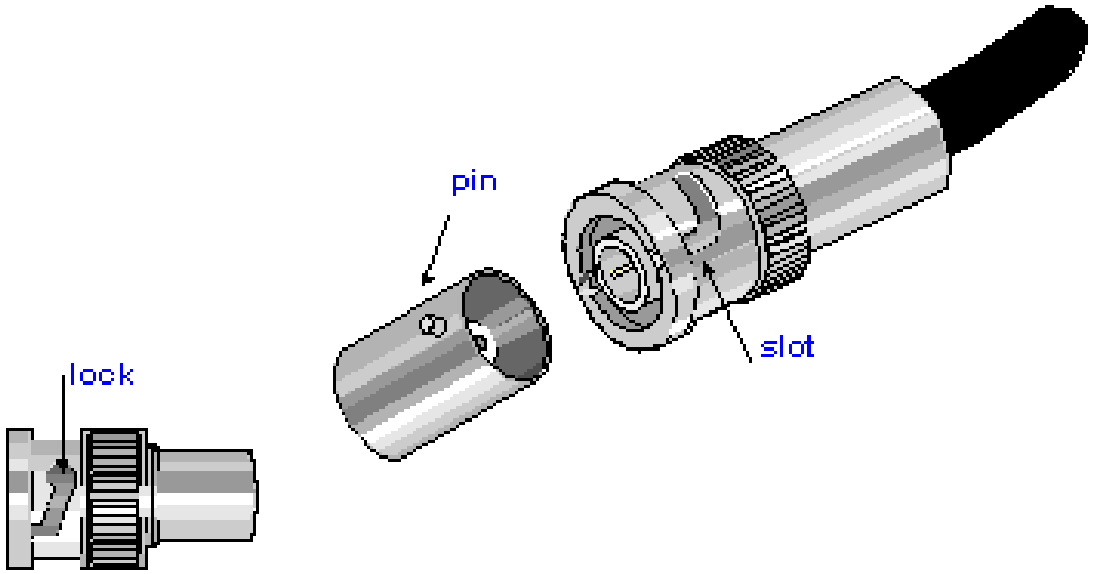


Coaxial Cables cont.

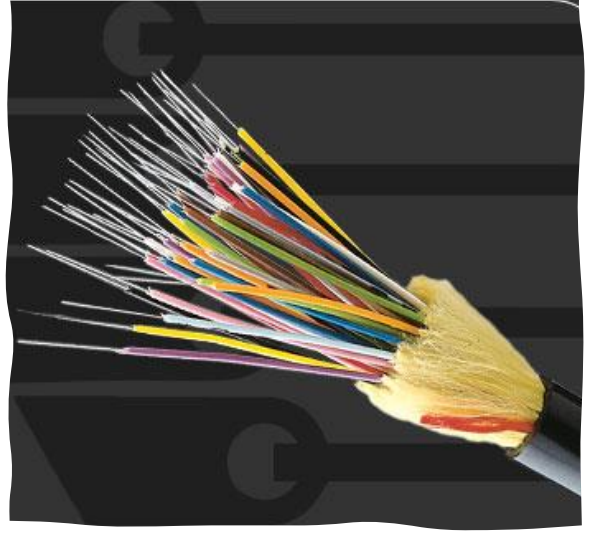
- Coaxial cables are widely used in other applications as well,
  - ✓ Television distribution (i.e. cable TV)
  - ✓ Long-distance telephone transmission
  - ✓ Antenna cables used with Televisions

Coaxial Cables cont.

Most widely used connectors for coaxial cables were Bayonet Network Connectors (BNC)

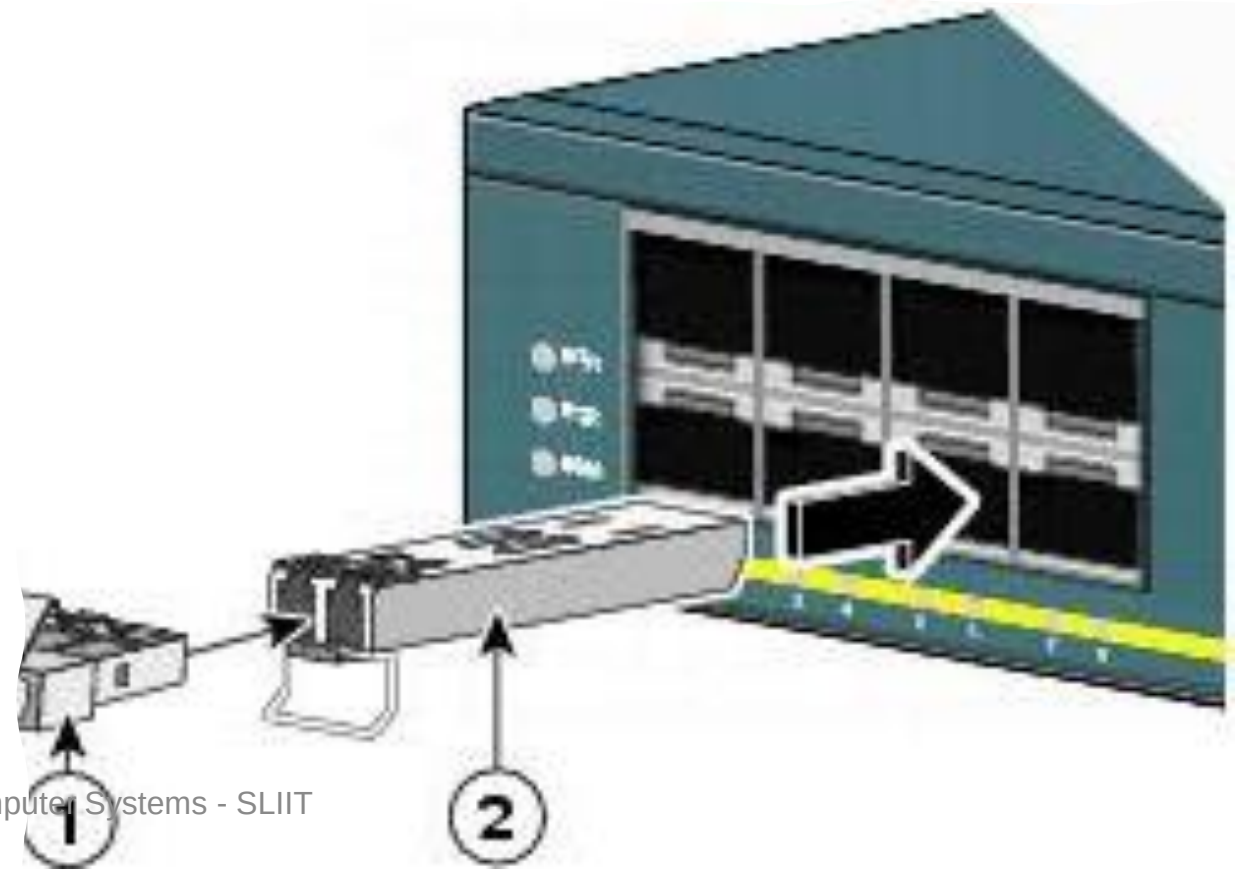


Fiber Optic Cables



- Optical fibers are made of glass or plastic material and the signals are transmitted as light rays

- **Optical fibers operate** based on an optical phenomena known as **total internal reflection**

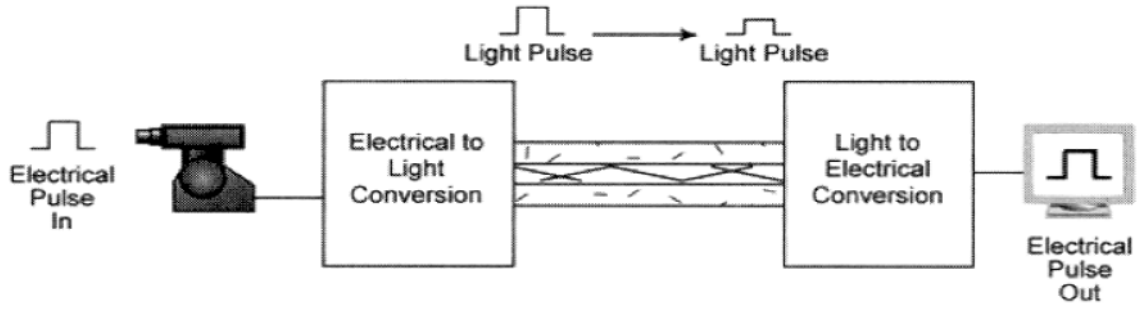


Optical Transmission of Data

Optical Transmission of Data

- Electrical signal generated by the transmitter is converted to a light pulse and this light pulse is transmitted through the optical fiber

- At the receiver, the light pulse is converted back to an electrical signal



Summary of Guided Media

- Three Types of Guided Media
  - 1. ----------
    - Advantages
    - ----------
    - Disadvantages
    - ----------
  - 2. ----------
    - Advantages
    - ----------
    - Disadvantages
    - ----------
  - 3. ----------
    - Advantages
    - ----------
    - Disadvantages
    - ----------

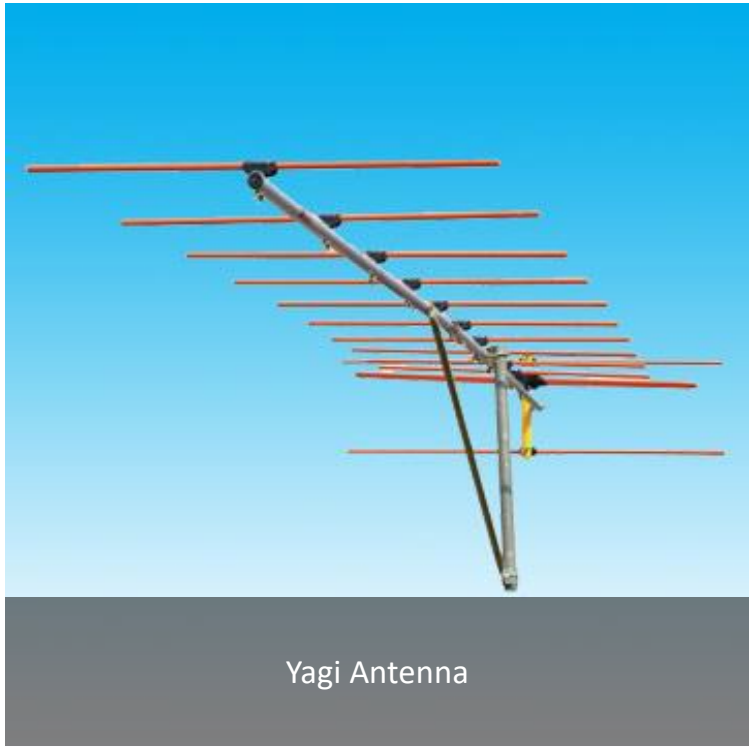
Unguided Media

- **Unguided media**, or more commonly referred to as wireless communication, requires **transportation of electromagnetic waves** without the usage of a physical conductor
- The signals are **transmitted** into **free space**
- In order to transmit signals into free space a special equipment called **antenna is required**

Antenna Types

Parabolic Antenna

Omnidirectional Antenna



Yagi Antenna

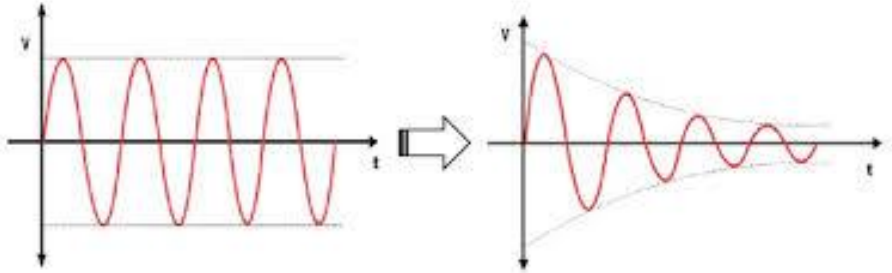
Note: *Your laptop or your smart device has an omnidirectional antenna fitted inside.*

Types of Wireless Communication

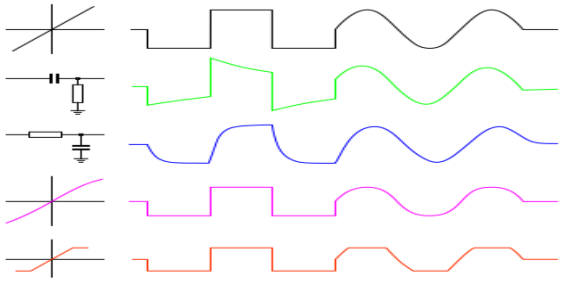
- Wireless transmission of signals can be divided into several categories based on the range of frequencies used by each type,
  - ✓ Broadcast radio
  - ✓ E.g. _____
  - ✓ Terrestrial microwave
  - ✓ E.g. _____
  - ✓ Satellite microwave
  - ✓ E.g. _____

Transmission Impairments

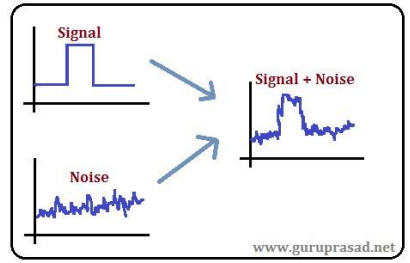
- Attenuation: **Attenuation or**, in some contexts, **extinction** is the **gradual loss** of **flux intensity through a medium** (Wiki)



- Distortion: **Distortion**, in acoustics and electronics, **any change in a signal** that **alters the basic waveform** or the relationship between various frequency components (Britanica)



- Noise: **Noise** is an **unwanted disturbance** in an electrical signal.



THANK YOU!