

Computer Network

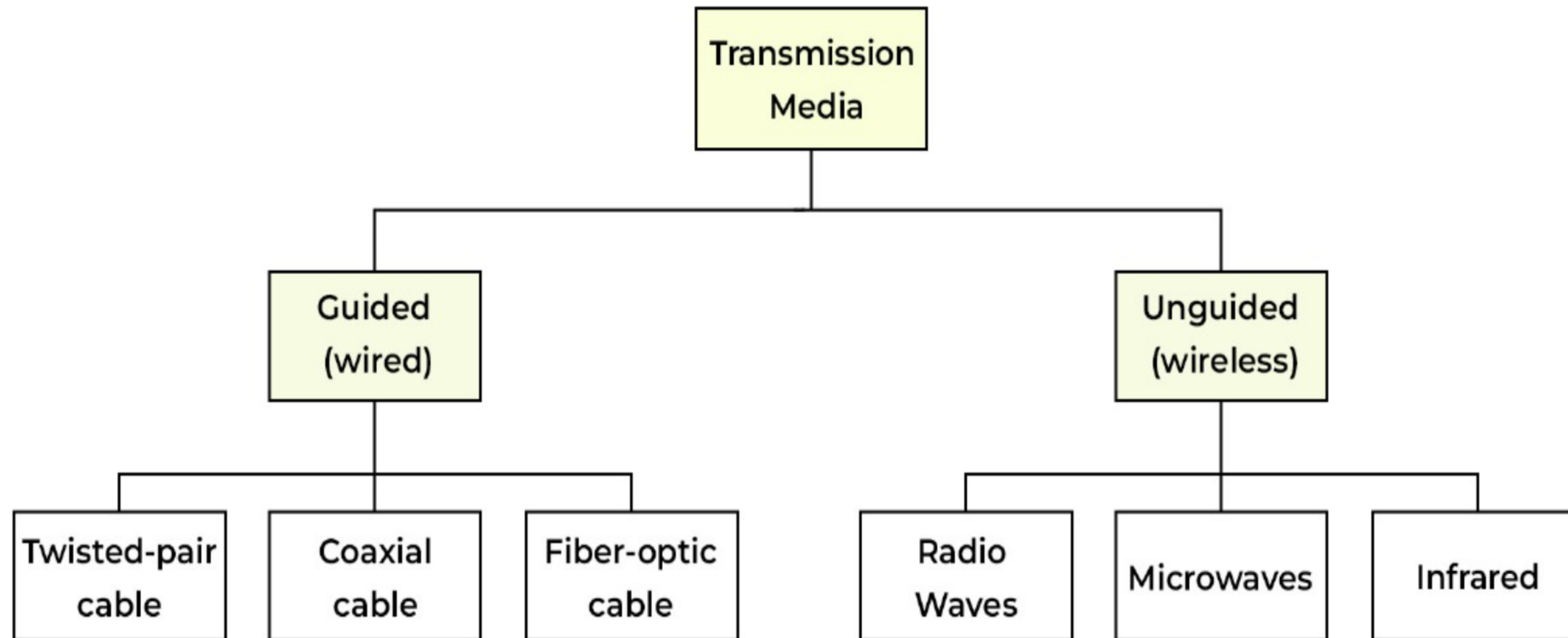
Physical Media/Network Devices

Lecture : 3

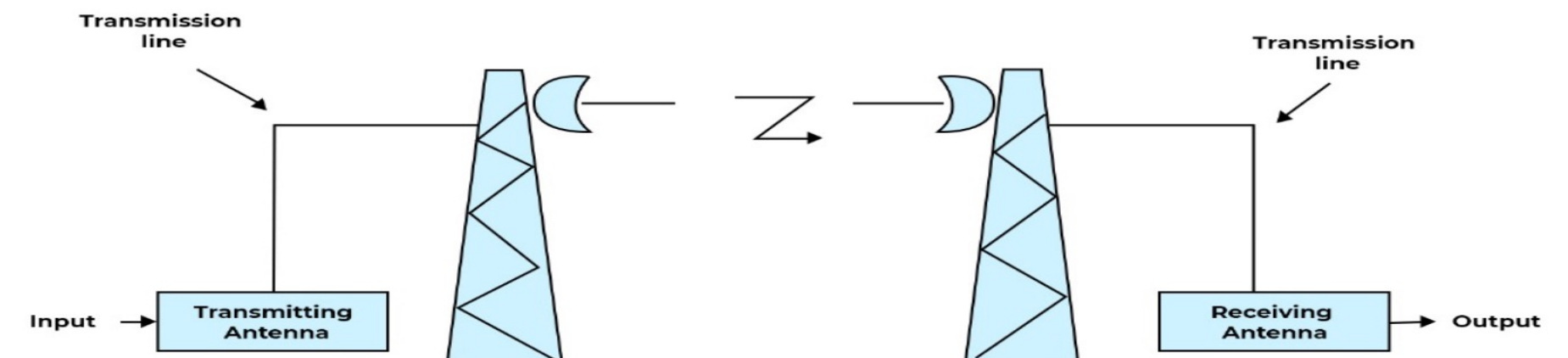
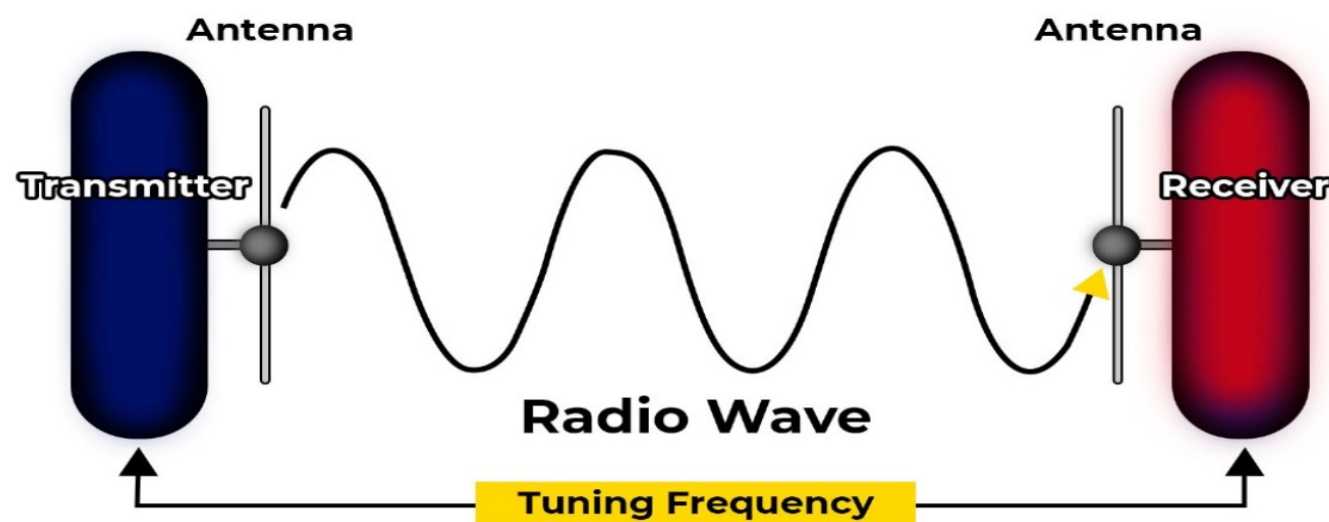
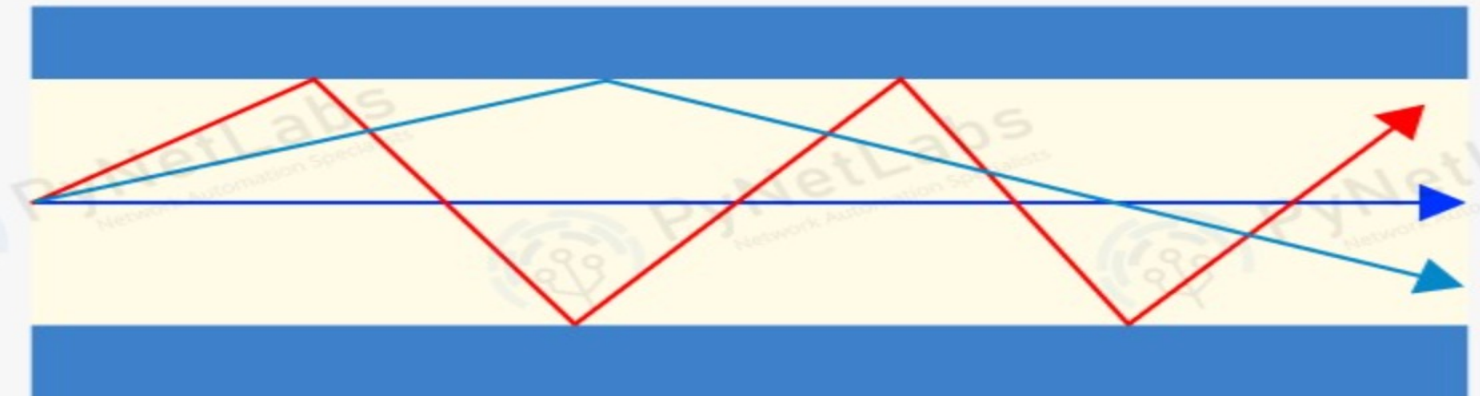
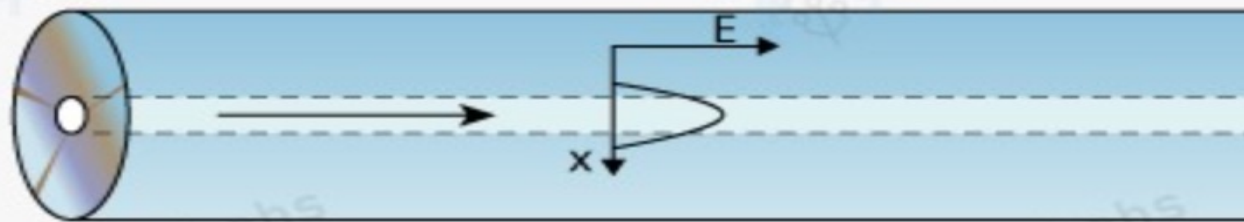
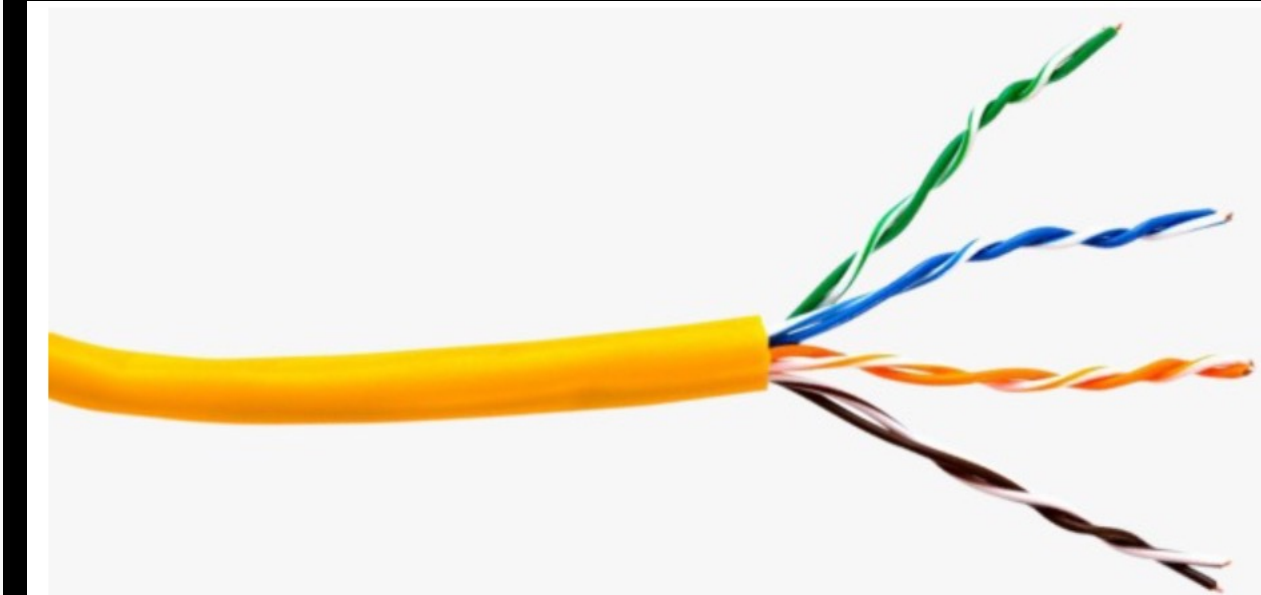
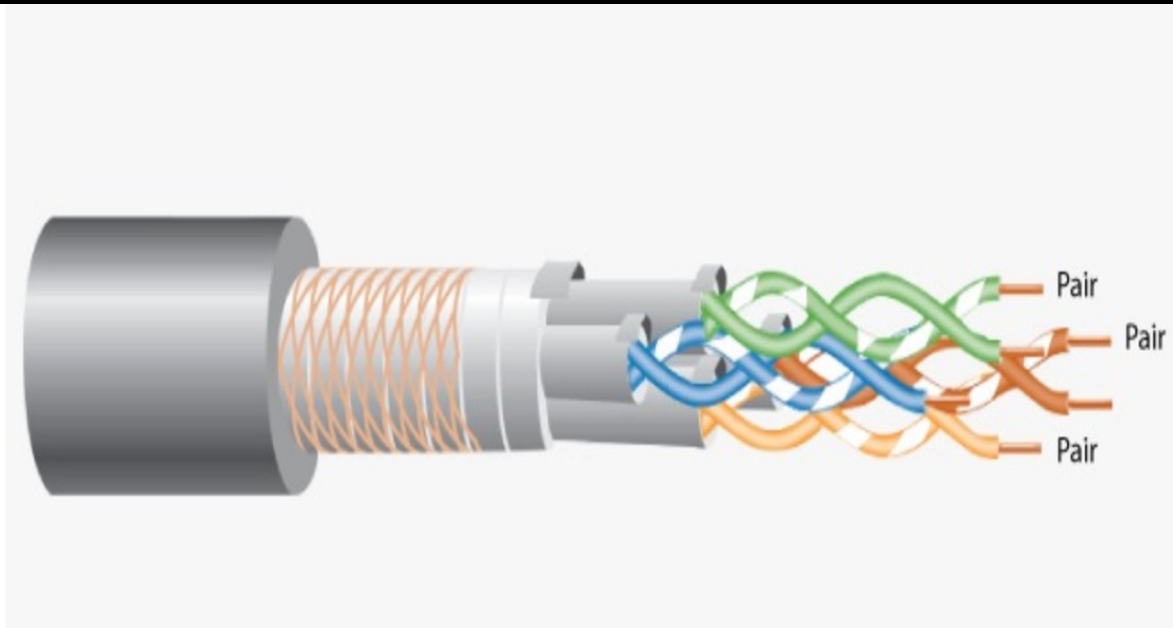
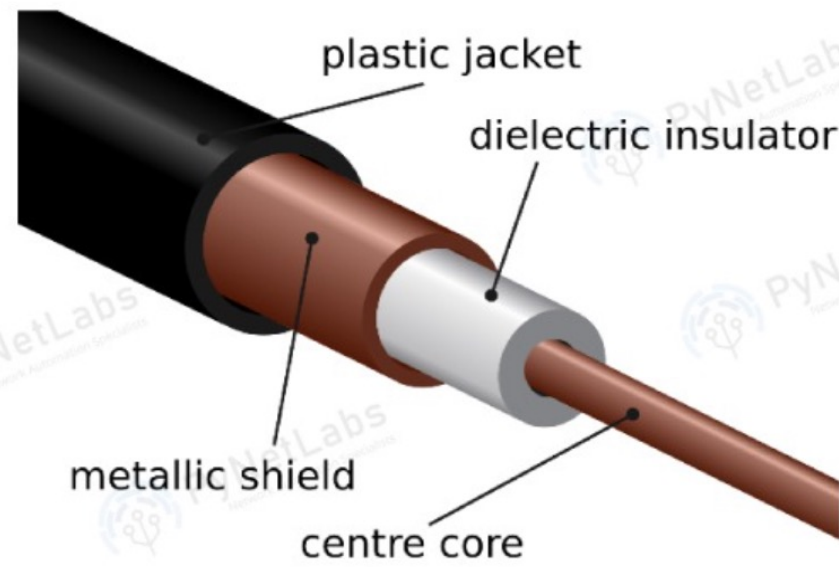
Gaurav Raj

- Concept of layering: OSI and TCP/IP Protocol Stacks;
- Basics of packet, circuit and virtual circuit-switching;
- Data link layer: framing, error detection, Medium Access Control, Ethernet bridging;
- Routing protocols: shortest path, flooding, distance vector and link state routing; Fragmentation and IP addressing, IPv4, CIDR notation, Basics of IP support protocols (ARP, DHCP, ICMP), Network Address Translation (NAT);
- Transport layer: flow control and congestion control, UDP, TCP, sockets;
- Application layer protocols: DNS, SMTP, HTTP, FTP, Email.

Transmission Media

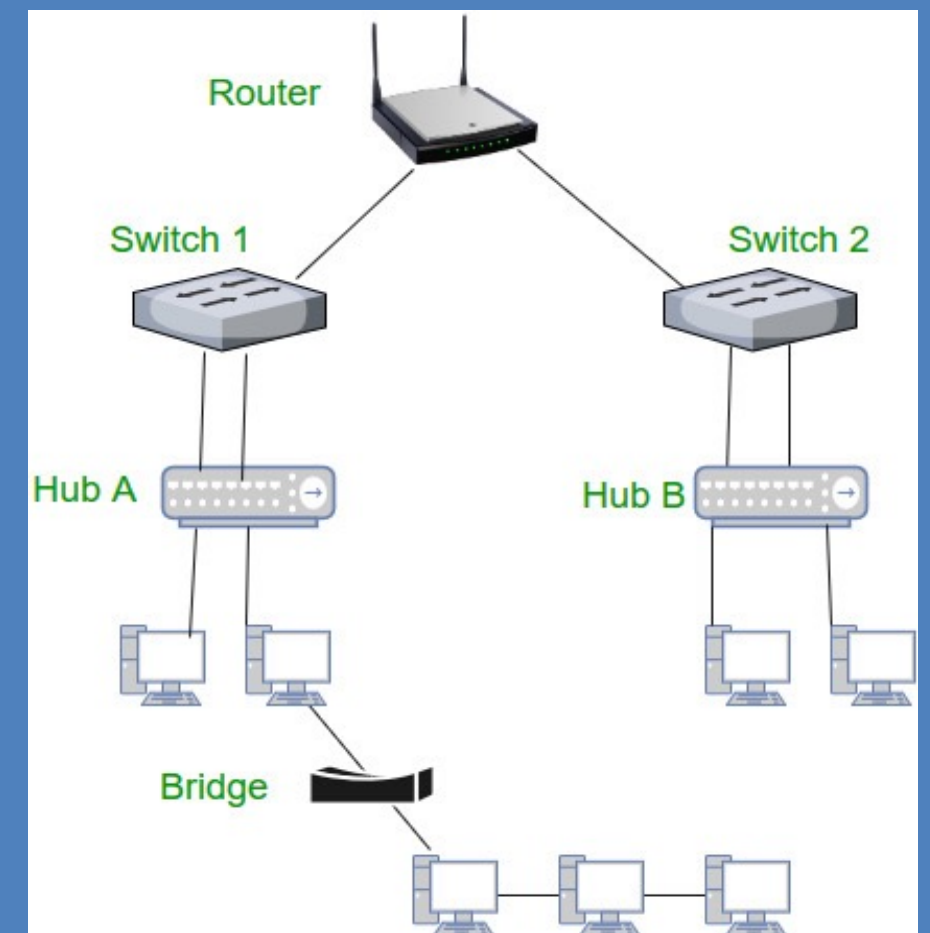
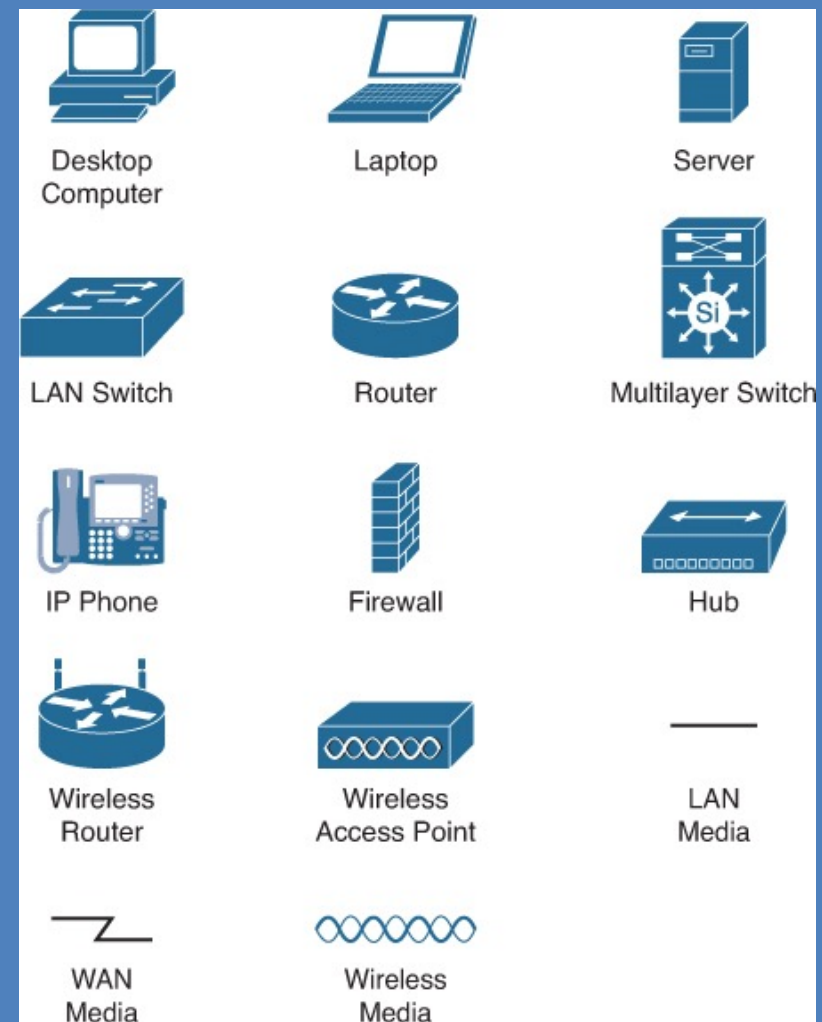
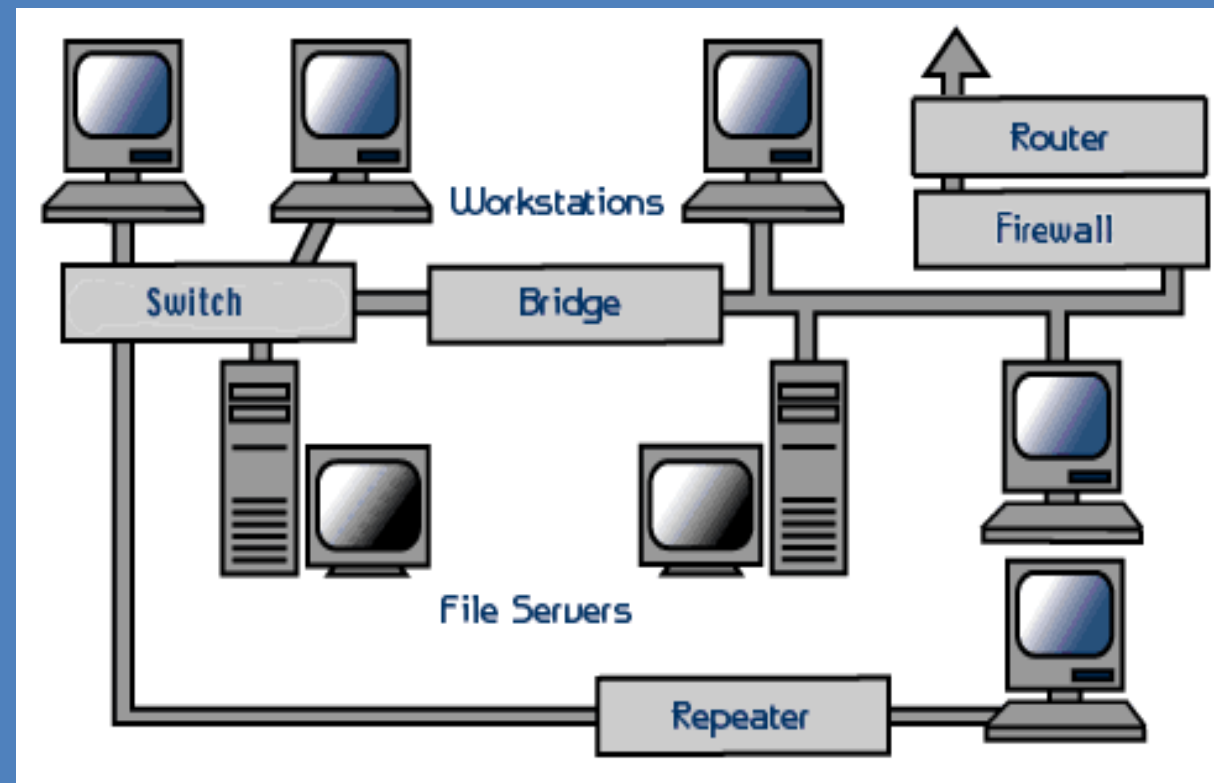


Transmission Media



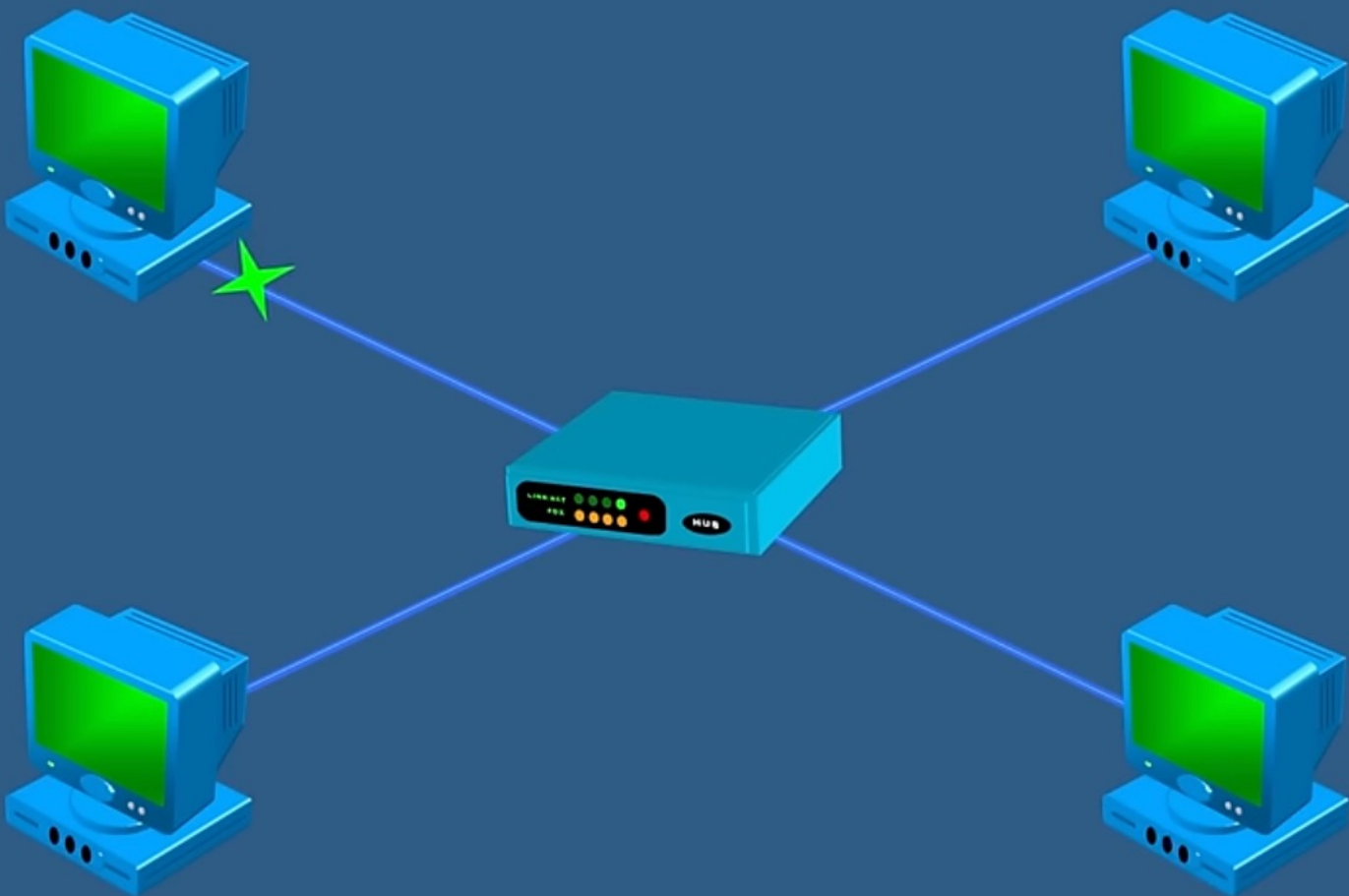
The diagram illustrates five types of network devices arranged in two rows. The top row contains a Repeater (a rectangular device with a circular arrow icon), a Hub (a square device with multiple ports), and a Bridge (a rectangular device with two ports). The bottom row contains a Switch (a rectangular device with multiple ports and four arrows indicating switching) and a Router (a cylindrical device with two antennas and four arrows indicating routing). Each device is labeled with its name below it.

- Repeater**: A rectangular device with a circular arrow icon, indicating signal amplification.
- Hub**: A square device with multiple ports, indicating a central connection point.
- Bridge**: A rectangular device with two ports, indicating a device that connects two network segments.
- Switch**: A rectangular device with multiple ports and four arrows indicating switching between ports.
- Router**: A cylindrical device with two antennas and four arrows indicating routing between different networks.



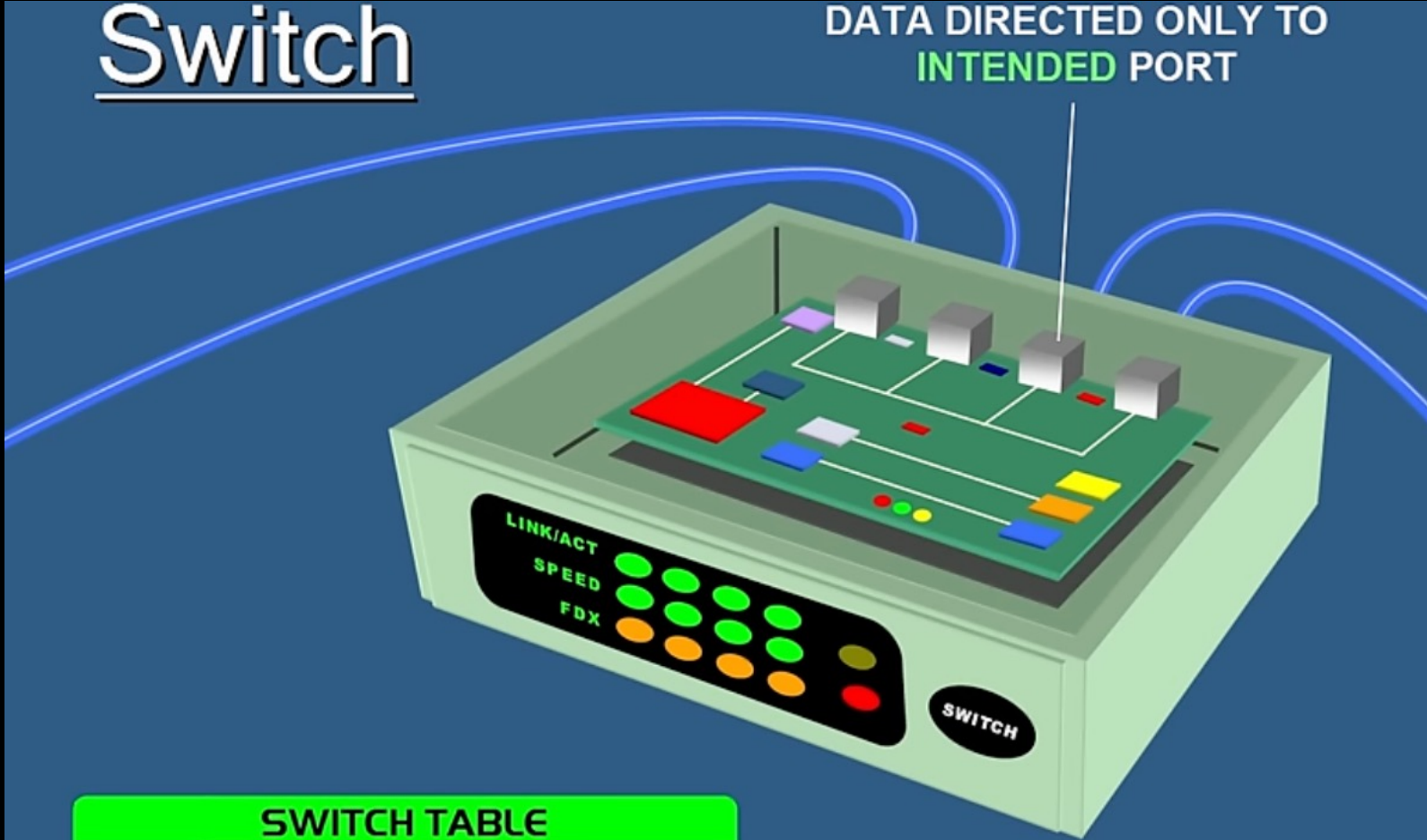
Network Devices

Hub



Switch

DATA DIRECTED ONLY TO
INTENDED PORT

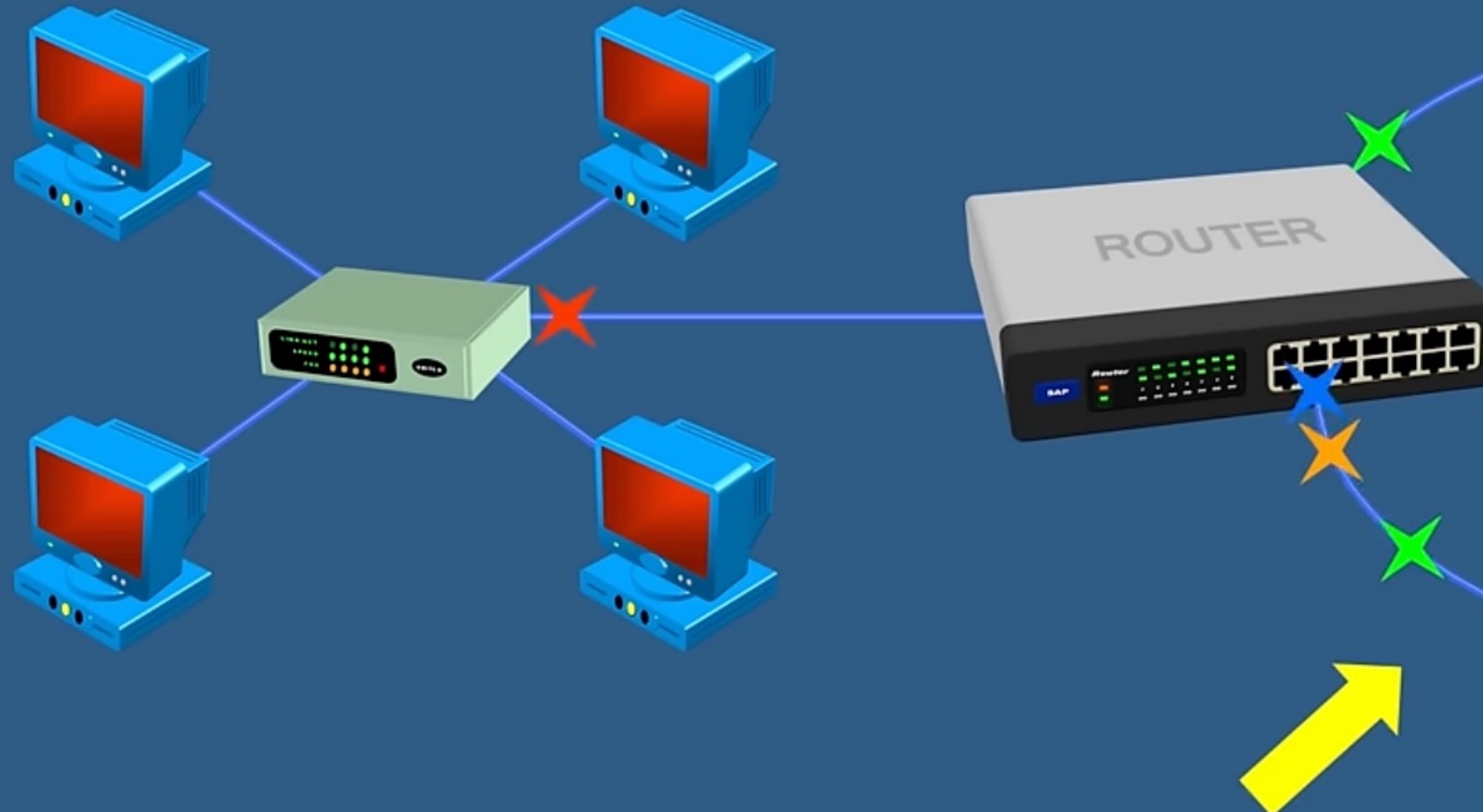


SWITCH TABLE		
PORT	DEVICE	MAC ADDRESS
1	DETECTED	00-04-5A-63-A1-66
2	DETECTED	90-02-7B-C2-C0-67
3	DETECTED	32-07-9A-92-A2-00
4	DETECTED	72-00-FA-63-A9-66

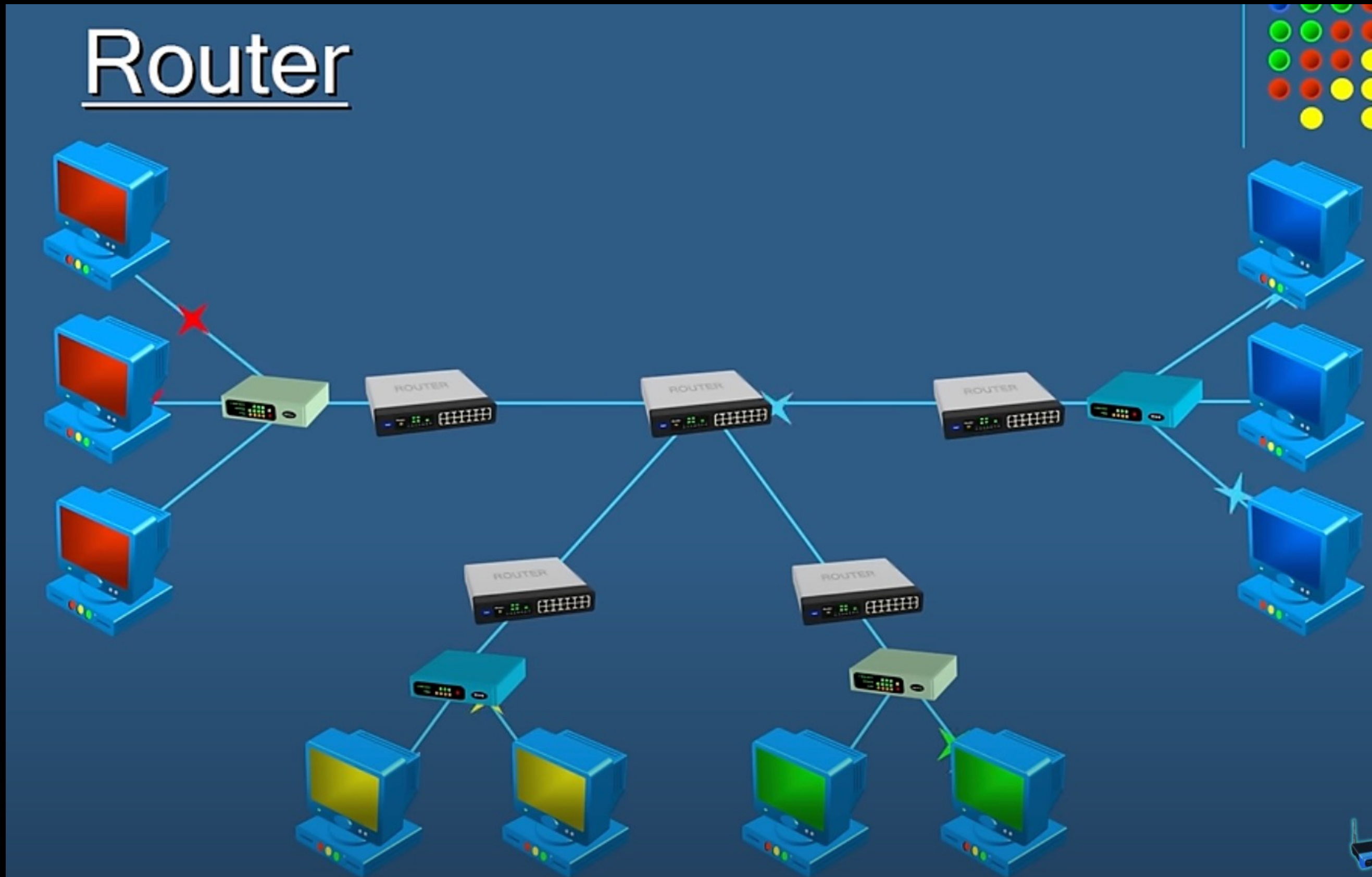
Network Devices: Router

Router

The *RED* network



Network Devices: Home Router



Network Devices: Modem



Modem **demodulates** incoming analog signals into a digital signal.



WAP vs Wi-Fi Router



Wireless Access Point

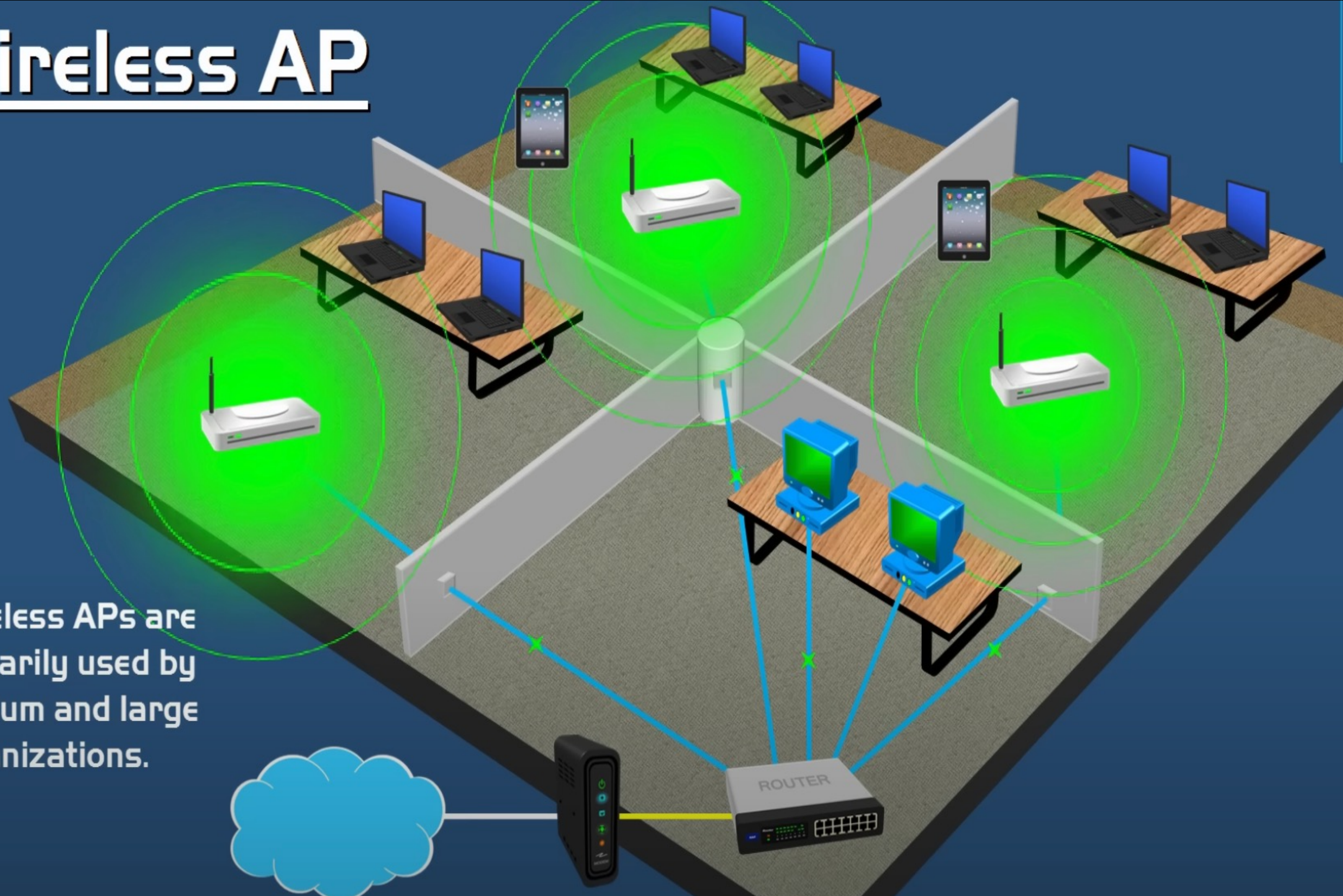


Wi-Fi Router

Router vs Access-Point

Wireless AP

Wireless APs are primarily used by medium and large organizations.



Network Devices



Business router



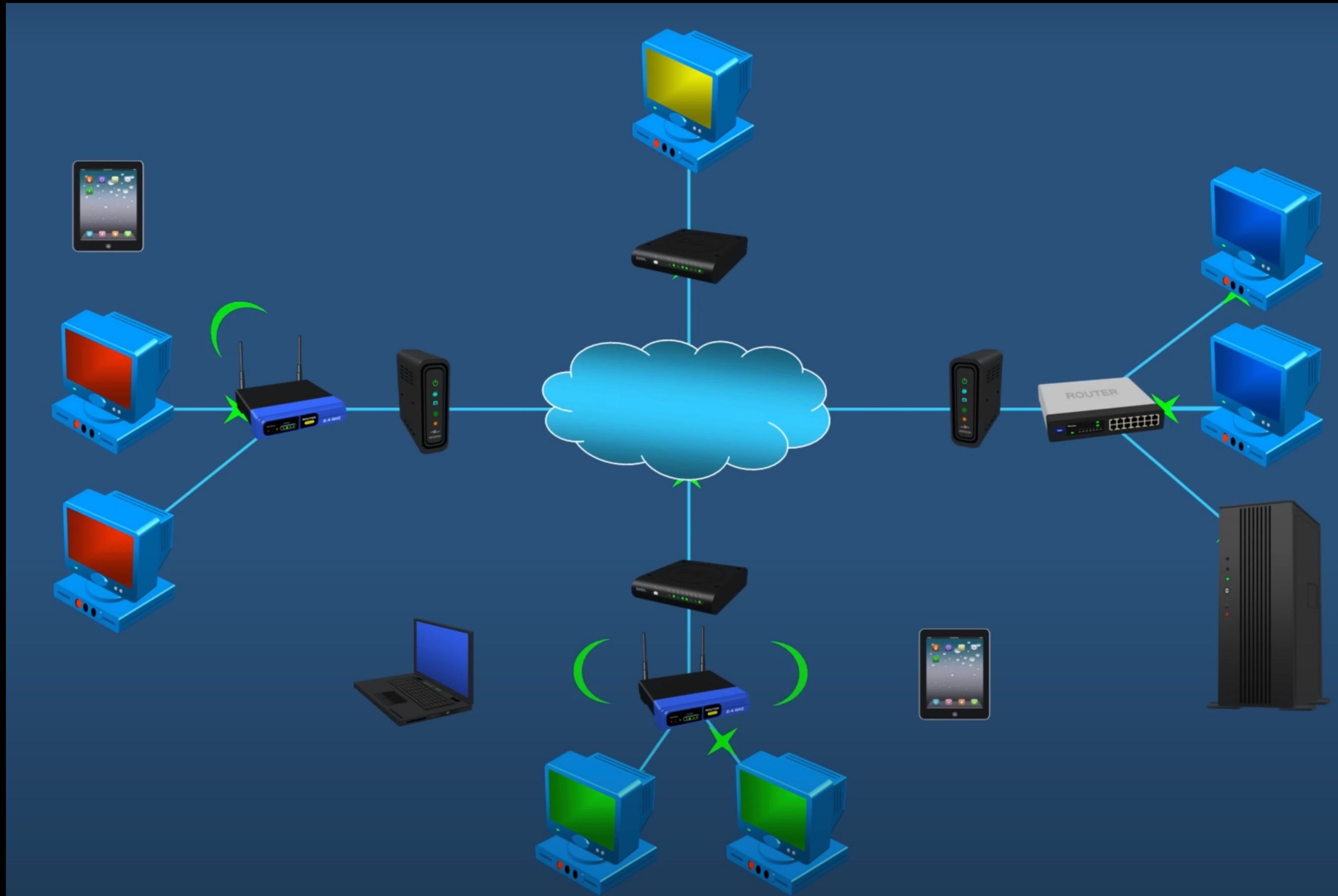
Small office / home office router

All in One: Home Router

1. Access point
2. Switch
3. Router



Small Network



Ethernet Port vs Ethernet Cable

Ethernet supports **baseband signals**.

Baseband signaling means the entire bandwidth of the medium is used to transmit a single data signal at a time.

In Ethernet, digital signals are sent directly over the medium (like twisted-pair cables or fiber optics) without modulation.

Type of Signal	Description	Used in
Baseband	Digital signal, uses full bandwidth	Ethernet
Broadband	Analog signal, divided into channels	Cable TV, DSL

digital signals can be transmitted over fiber optic cables, but they are converted into light pulses first.

How it works:

- **In fiber optics, digital data (1s and 0s) is converted into light signals using LEDs or lasers.**
- **A "1" is represented by a light pulse, and a "0" by the absence of light.**
- **At the receiving end, a photodetector converts the light back into digital electrical signals.**

Medium	Signal Type	Transmission Form
Copper cables	Electrical signals	Baseband (digital)
Fiber optics	Optical signals	Light pulses (digital-encoded)

Modem (Modulator-Demodulator)

- **Used in:** Analog phone lines (e.g., DSL)
- **Function:**
 - **Modulation:** Converts digital signals to analog (for transmission)
 - **Demodulation:** Converts analog signals back to digital (at the receiver)

Network Interface Card (NIC)

- Used in:** Ethernet (copper cables)
- Function:**
 - Converts digital data from the computer into electrical signals for transmission over LAN**
 - And vice versa**

Media Converter •Used in: Fiber optic to copper conversion •Function: <ul style="list-style-type: none">• Converts electrical signals to optical (light) signals and back	Transceiver (Transmitter + Receiver) Used in: Fiber optics, wireless, etc. Function: Converts electrical digital signals into light (optical) or radio waves And receives those signals back into electrical form	Wi-Fi Adapter: Converts digital → radio waves
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Today's laptops are multi-capable devices

1. Wi-Fi Adapter (Built-in)

- **Yes – Always Present**
- **Supports wireless communication (IEEE 802.11 standards like Wi-Fi 5, 6, 6E).**
- **Converts digital data ↔ radio waves**
- **Used for: Wireless LAN (Wi-Fi)**

2. Ethernet Port / LAN Port

- **Sometimes Present (common in business or gaming laptops, not in slim models)**
- **If present, supports twisted pair cable using RJ-45**
- **Works with the internal Ethernet controller/NIC to send digital electrical signals**
- **Used for: Wired LAN**

Note: Many ultra-thin laptops skip this and offer a USB-to-Ethernet adapter instead.

3. Bluetooth Adapter

- **Yes – Usually Present**
- **For short-range wireless communication (not networking in the traditional internet sense)**

4. Modem

- **No – Not Present**
- **Laptops do not have modems anymore. Dial-up modems were used in older laptops for analog phone lines.**
- **Today, modems are separate devices (like DSL or cable modems provided by ISPs).**

5. Cellular Modem (4G/5G SIM slot)

- **Rare, but Available in some business-class laptops (e.g., Dell Latitude, Lenovo ThinkPad X series)**
- **Uses eSIM or physical SIM to connect to mobile networks**
- **Works like your phone's modem to access the internet**

Computer → Ethernet Port → Ethernet Cable (Twisted Pair) → Home Router → Modem → Internet (ISP)

Step	Device	Signal Type	Role
1	Computer (NIC)	Digital	Your computer generates digital data . The Network Interface Card (NIC) inside the computer converts this data into digital electrical signals .
2	Ethernet Cable (Twisted Pair)	Digital Electrical	The digital signal travels as electrical pulses through the Ethernet cable to the router.
3	Home Router	Digital Electrical	The router processes the digital signals, assigns IP addresses, routes packets, etc. Still working with digital data.
4	Ethernet Cable (to Modem)	Digital Electrical	The router sends the digital signal to the modem via Ethernet (again, twisted pair).
5	Modem (Modulator-Demodulator)	Converts Digital → Analog	This is the key conversion point . The modem modulates the digital data into an analog signal , suitable for transmission over traditional telephone lines (DSL) or coaxial cables (cable internet) .
6	ISP Infrastructure	Analog or Encoded Light (Fiber)	The analog signal goes to your ISP, where it may be converted again depending on the medium (DSL = analog; fiber = optical digital).

Computer → Ethernet Port → Ethernet Cable (Twisted Pair) → Home Router → Modem → Internet (ISP)

Device	Input	Output	Conversion
Computer (NIC)	Digital data	Digital electrical	Digital → Electrical
Ethernet Cable	Digital electrical	Digital electrical	Transmission only
Router	Digital electrical	Digital electrical	Routing & processing
Modem	Digital electrical	Analog	Digital → Analog
ISP	Analog	Depends	Further transmission

Laptop (Wi-Fi) → Access Point → Ethernet Cable → Office Router → Modem → ISP

Step	Device	Signal Type	Role
1	Laptop (Wi-Fi Adapter)	Digital → Radio Waves (Wireless Signal)	Your laptop generates digital data . The Wi-Fi adapter converts it into radio waves for wireless transmission.
2	Wi-Fi Access Point	Radio Waves → Digital Electrical	The access point receives the radio signal and converts it back to digital electrical signals .
3	Ethernet Cable (to Router)	Digital Electrical	The access point sends the digital signal over an Ethernet cable to the office router .
4	Office Router	Digital Electrical	The router handles IP management, packet routing, firewalling, etc., all still in digital .
5	Ethernet Cable (to Modem)	Digital Electrical	Router sends the data over twisted pair to the modem.
6	Modem	Digital → Analog	The modem converts the digital signal into an analog signal suitable for the ISP line (DSL/coax).
7	ISP	Analog	The ISP receives and further transmits this data, possibly converting to optical in backbone networks.

Laptop (Wi-Fi) → Access Point → Ethernet Cable → Office Router → Modem → ISP

Laptop Wi-Fi Adapter: Converts digital → radio waves

Access Point: Converts radio waves → digital electrical

Modem: Converts digital electrical → analog

Laptop (Wi-Fi) → Access Point → Ethernet Cable → Office Router → Modem → ISP

Device	Input	Output	Conversion
Laptop (Wi-Fi)	Digital	Radio Waves	Digital → Wireless RF
Access Point	RF (Radio)	Digital Electrical	RF → Digital
Ethernet Cable	Digital Electrical	Digital Electrical	Just transmits
Router	Digital Electrical	Digital Electrical	Routing, NAT
Modem	Digital Electrical	Analog	Digital → Analog
ISP	Analog	Depends	Further transmission



Thank You

