

MOBILE COMPUTING

CHAPTER – FOUR **Wireless LAN**

Objective

- ▶ By the end of this chapter, you should be able to:
 - ✓ Understand wireless LAN, benefits and standards of WLAN
 - ✓ Differentiate Infrastructure based network and point – to – point network
 - ✓ Understand the Bluetooth technology
 - ✓ Explain the advantages and disadvantages of Bluetooth.
 - ✓ Understand the Bluetooth protocols.
 - ✓ Understand ad hoc networks

Recalling: IEEE 802 Standard

- ▶ The Institute of Electrical and Electronics Engineers (IEEE) has developed a **wide range of standards** covering various aspects of networking and communications.
- ▶ **IEEE 802** standards specifically pertain to **local** and **metropolitan** area networks (LANs and MANs).
- ▶ These standards address different aspects of **network design, architecture, and operation**.

Recalling: IEEE 802 Standard (Cont ...)

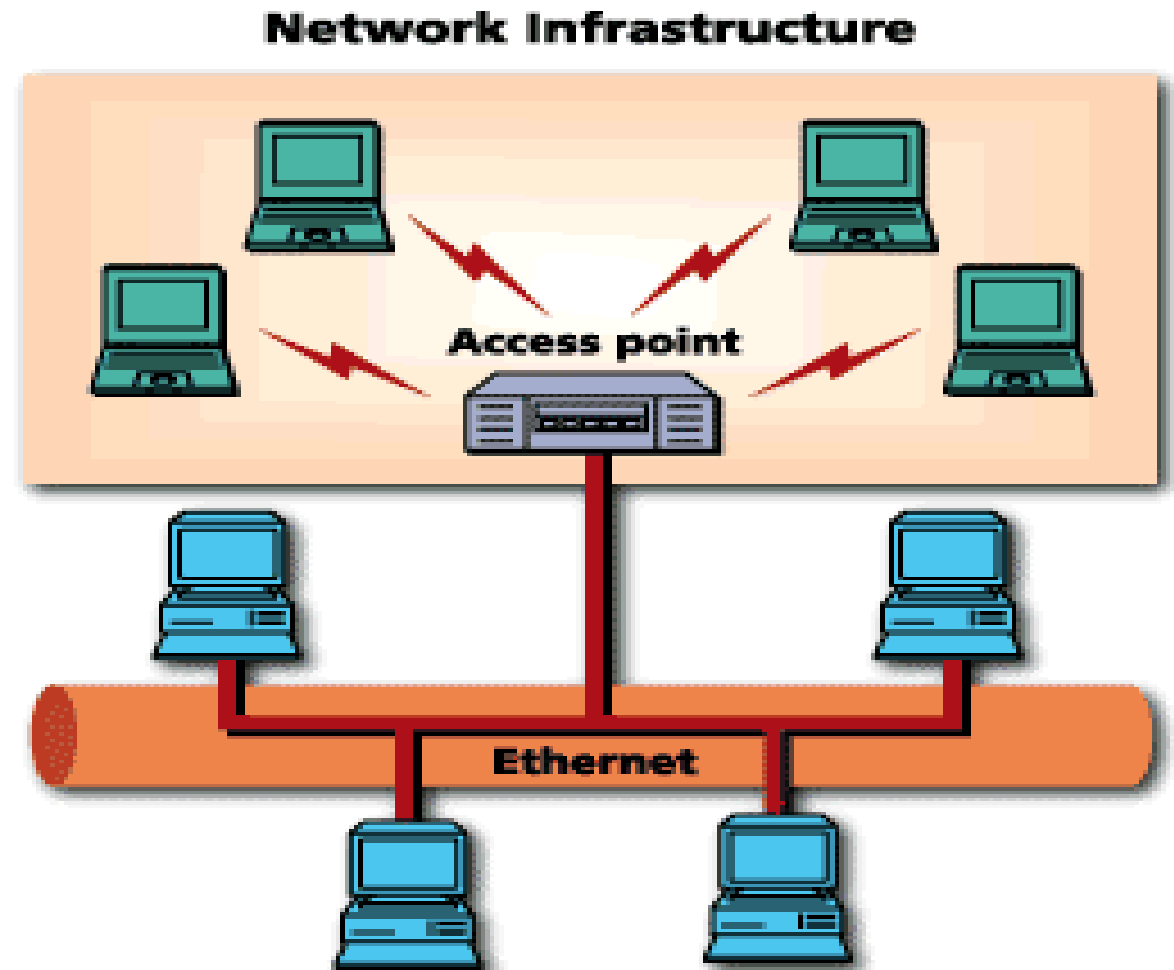
IEEE 802 Standard	Description
IEEE 802.1Q (VLANs)	Defines virtual LANs for network segmentation.
IEEE 802.1X (Port-Based Network Access Control)	Controls network access through authentication.
IEEE 802.3 (Ethernet)	Defines Ethernet standards for LANs.
IEEE 802.11 (Wi-Fi)	Family of standards for wireless LANs (Wi-Fi).
IEEE 802.15 (WPAN)	Standards for wireless personal area networks.
IEEE 802.16 (WiMAX)	Standards for wireless broadband access.
IEEE 802.22 (WRAN)	Standards for wireless regional area networks.

What's Wireless LAN?

- ▶ WLAN is a type of computer network that uses **wireless data connections** between devices to provide internet and network connectivity within a **limited geographic area**.
- ▶ WLANs are **flexible** data communication systems that can be used for applications in which **mobility** is required
- ▶ WLANs are commonly used in **homes, businesses, schools, airports, and public places** to enable wireless access to the internet and local network resources.

What's Wireless LAN? (Cont ...)

- ▶ WLAN is an extension of the Ethernet LAN.
- The function of the LAN has become **mobile**



Benefits of Wireless LAN

- ▶ Resolving the problems of **Hard-wired LAN** (Installation and Scalability)
- ▶ Providing user **mobility** and **flexibility** (from anywhere within the coverage area)
- ▶ Enabling to **extend the range** of an existing wired LAN
- ▶ Being **cheaper** to install than traditional wired LAN

Wireless LAN Standards

- ▶ WLAN standards define the **protocols** and **specifications** that govern wireless communication between devices and access points within a WLAN.
- ▶ Standards ensure **interoperability** between devices made by different manufacturers.
- ▶ These standards are developed by organizations such as the **Institute of Electrical and Electronics Engineers (IEEE)** and the **Wi-Fi Alliance**.

Wireless LAN Standards Summary

WLAN Standard	Frequency Band	Maximum Data Rate	Range (Indoor)	Year Standard ized
IEEE 802.11b	2.4 GHz	Up to 11 Mbps	Approx. 30 m	1999
IEEE 802.11a	5 GHz	Up to 54 Mbps	Approx. 30 m	1999
IEEE 802.11g	2.4 GHz	Up to 54 Mbps	Approx. 30 m	2003
IEEE 802.11n	2.4 and 5 GHz	Up to 600 Mbps	Approx. 70 m	2009

Types of Wireless LAN

► Two network categories are defined in the IEEE 802.11 standard:

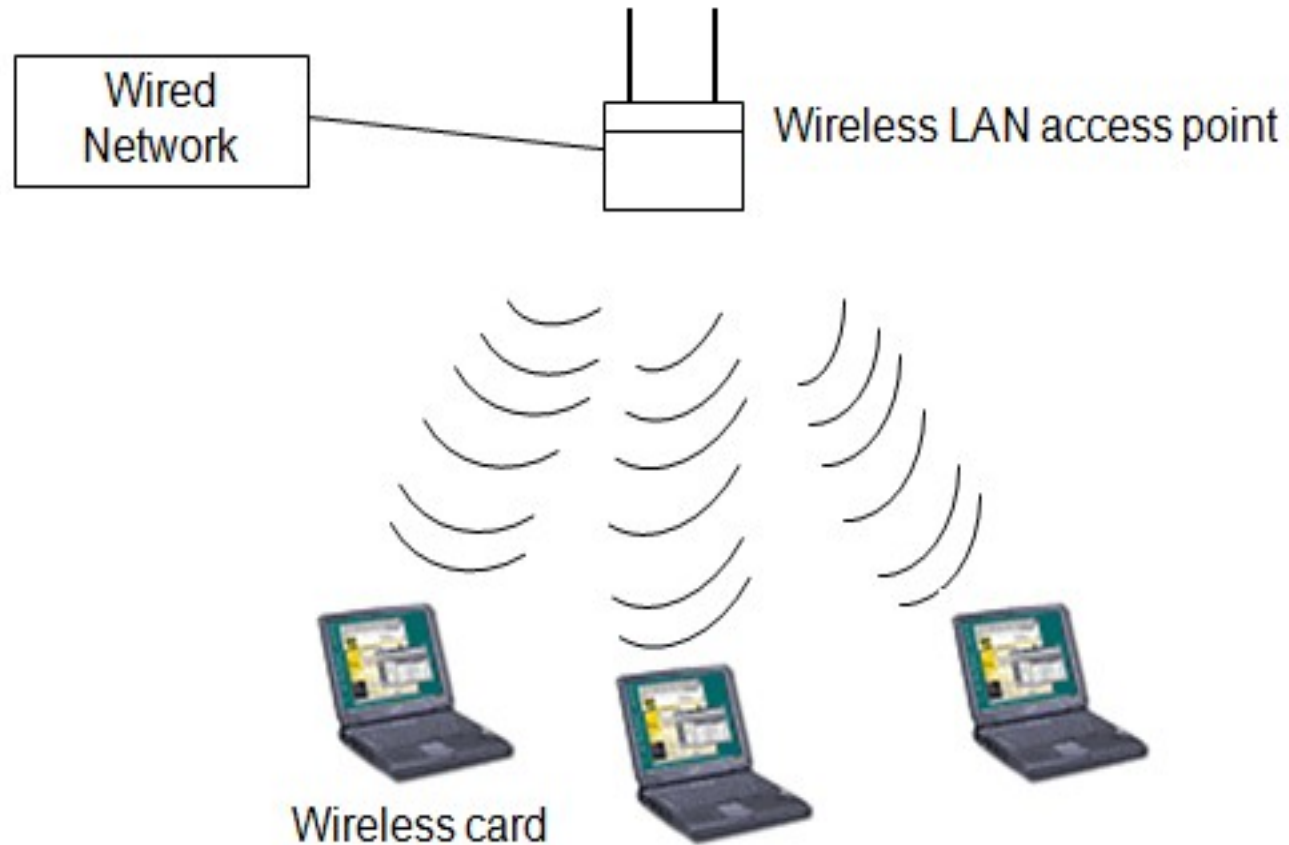
1. Infrastructure based network
2. Infrastructure less (ad hoc/point-to-point) network

1. Infrastructure Based Network:

- ✓ All the endpoints are connected to a **base station(AP)** and communicate through it
- ✓ The transition of data from the wireless to wired medium occurs via an AP

Types of Wireless LAN (Cont ...)

1. Infrastructure Based Network:



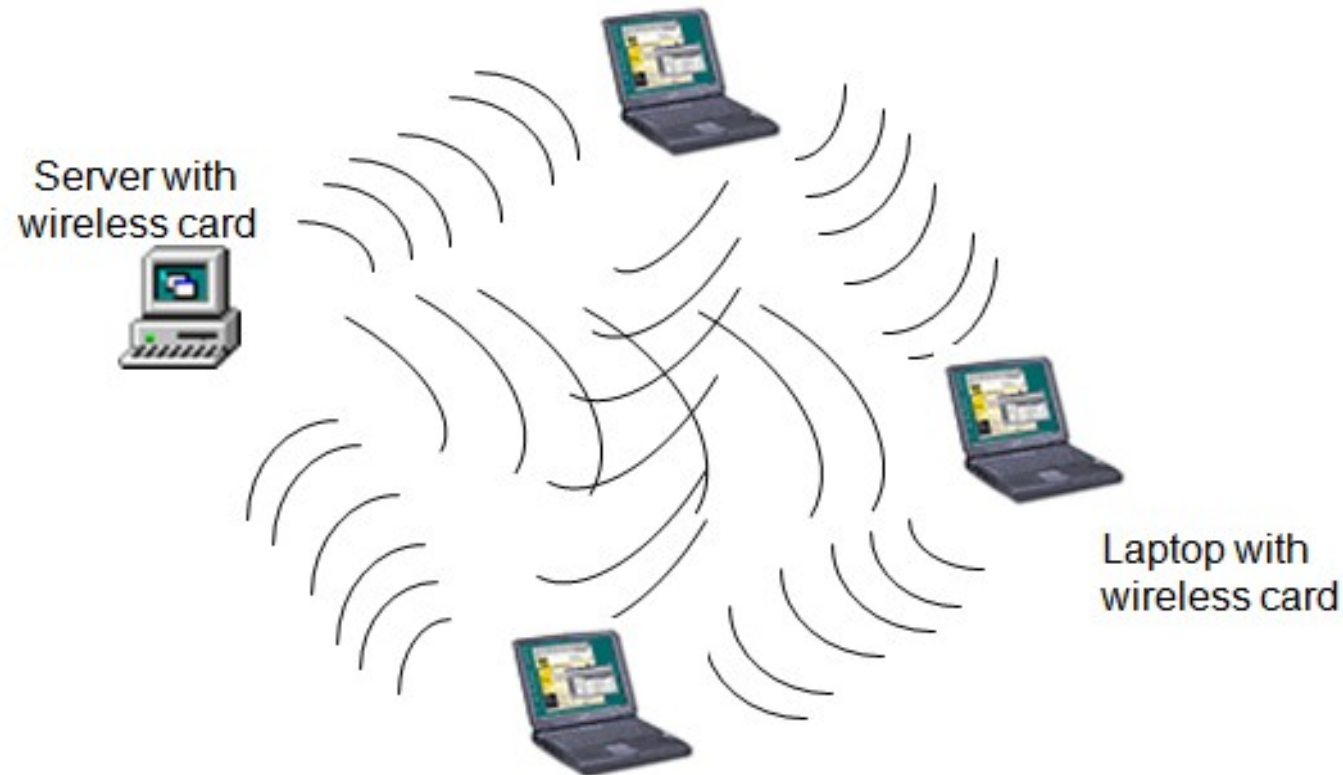
Types of Wireless LAN (Cont ...)

2. Point-to-point (Ad Hoc) Network:

- ✓ An ad hoc network is the architecture that is used to support **mutual communication** between wireless clients.
- ✓ Typically, an ad hoc network is created spontaneously and does not support access to wired networks.
- ✓ An ad hoc network **does not require an AP.**

Types of Wireless LAN (Cont ...)

2. Point-to-point (Ad Hoc) Network:



Bluetooth Technology

- ▶ Bluetooth is a wireless technology standard used for **short-range** communication between devices.
- ▶ It allows devices to communicate with each other **without cables or wires**.
- ▶ Bluetooth relies on short-range **radio frequency**, and any device with that technology can communicate as long as it is within the required distance
- ▶ It is commonly used for connecting peripherals to computers

Bluetooth Technology

- ▶ Bluetooth is a Wireless Personal Area Network (**WPAN**) technology.
- ▶ Bluetooth defined under **IEEE 802.15** standard.
- ▶ Bluetooth eliminates the need for **physical cables** and **connectors**, enabling devices to communicate and exchange data wirelessly.
- ▶ This technology was invented by Ericson in 1994
- ▶ Bluetooth ranges up to **10 meters**.

Bluetooth Technology

- ▶ Bluetooth technology is governed by a series of standards, with each standard release identified by a version number (e.g., Bluetooth 1.0, Bluetooth 2.0, Bluetooth 4.0, Bluetooth 5.0, Bluetooth 5.1, and Bluetooth 5.2).
- ▶ Each new version introduces improvements in terms of **data speed, range, and power efficiency**.

Bluetooth Technology - Naming

- ▶ The name "Bluetooth" is often associated with a 10th-century Danish king, King Harald "Bluetooth" Gormsson, who united Denmark and parts of Norway during his reign.
- ▶ Jim Kardach, one of the engineers involved in the development of the technology, chose this historical name as a code name for the project.

Bluetooth Technology - Industry Collaboration

- ▶ The development of Bluetooth technology was **not limited to a single company** but involved collaboration among several major technology companies, including:
 - ✓ **Ericsson,**
 - ✓ **Nokia,**
 - ✓ **IBM,**
 - ✓ **Toshiba, and Intel.**
- ▶ They formed the Bluetooth Special Interest Group (SIG) in 1998 to develop and promote the technology

Application Examples of Bluetooth

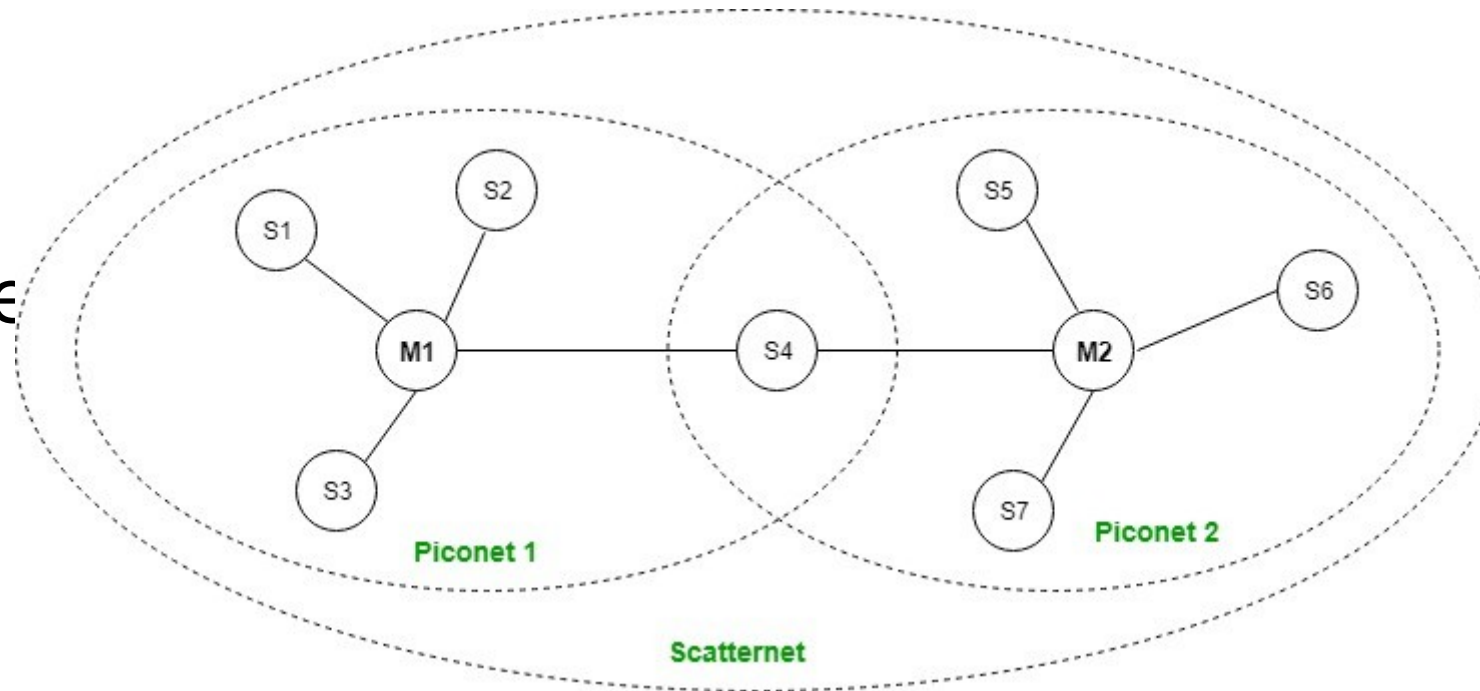
- ▶ **Wireless Audio Streaming**: to transmit music and phone calls without the need for cables.
- ▶ **Wireless Keyboards and Mice**: used to connect keyboard and mouse to computer without USB cables.
- ▶ **Wireless Printers**: allow users to print documents directly from their mobile devices without the need for physical connections.
- ▶ **IoT and Home Automation**: used in smart home

Types of Bluetooth Network

► The architecture of Bluetooth defines two types of networks:

✓ Piconet

✓ Scatternet



Types of Bluetooth Network - Piconet

- ▶ It is a type of Bluetooth network that contains one primary node called the **master** node and seven active secondary nodes called **slave** nodes.
- ▶ The communication between the primary and secondary nodes can be **one-to-one** or **one-to-many**.
- ▶ The master device **initiates** and **controls** communication within the piconet.
- ▶ Possible communication is only between the master and slave;
- ▶ Slave-slave communication is not possible.

Types of Bluetooth Network - Scatternet

- ▶ It is a more complex Bluetooth network that consists of multiple interconnected piconets.
- ▶ A slave that is present in one piconet can act as master or primary in another piconet.
- ▶ This kind of node can receive a message from a master in one piconet and deliver the message to its slave in the other piconet where it is acting as a master.
- ▶ A station cannot be mastered in two piconets.
- ▶ **Application:** used in a home automation system where multiple

Advantage of Bluetooth Technology

- ▶ It is a low-cost and easy-to-use device.
- ▶ It can also penetrate through walls.
- ▶ It creates an Ad-hoc connection immediately without any wires.
- ▶ It is used for voice and data transfer.

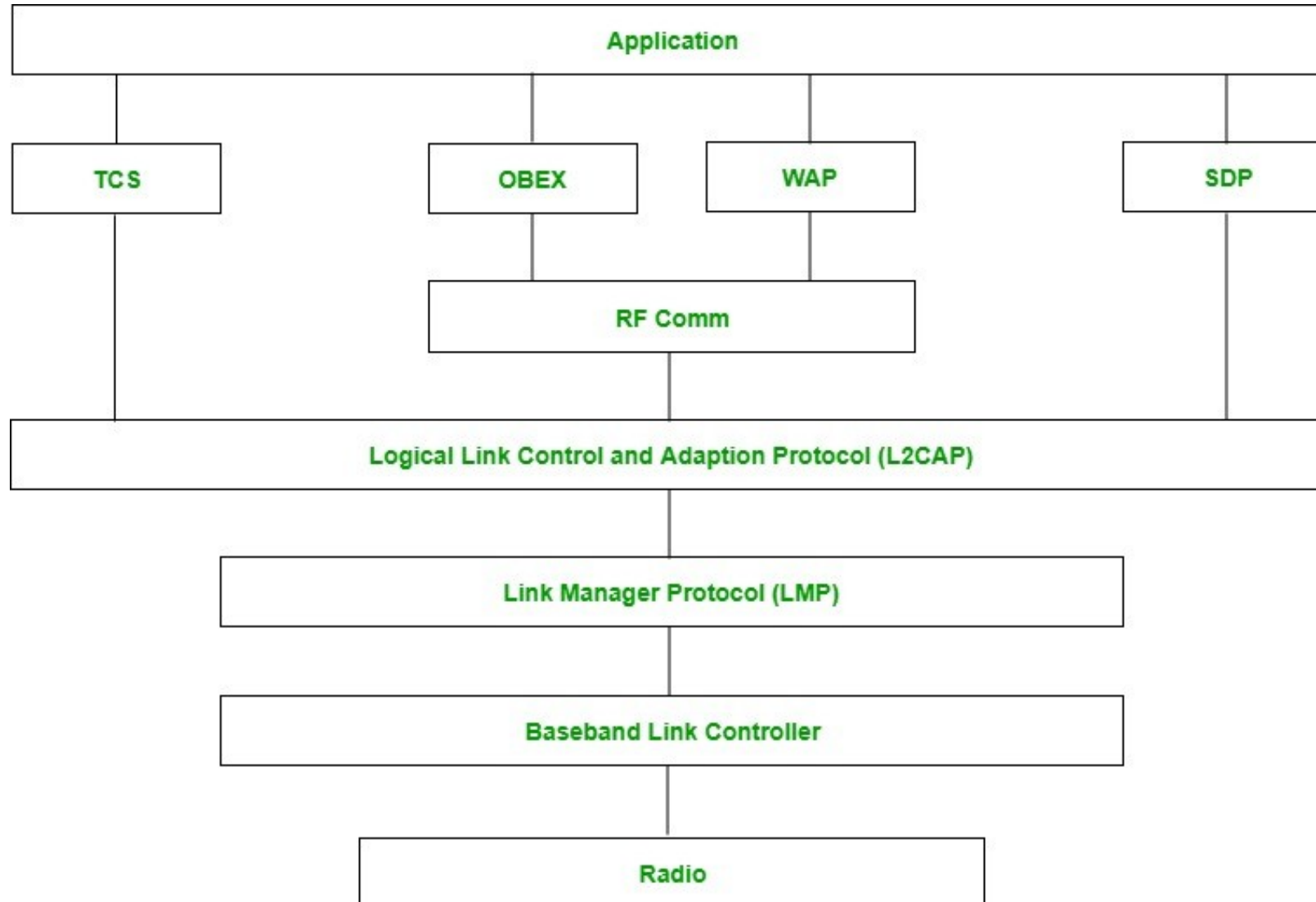
Disadvantage of Bluetooth Technology

- ▶ It can be hacked and hence, less secure.
- ▶ It has a slow data transfer rate: of 3 Mbps.
- ▶ It has a small range: 10 meters.
- ▶ Bluetooth communication does not support routing.
- ▶ The issues of handoffs have not been addressed.

Bluetooth Protocols

- ▶ Bluetooth is not a single protocol but is made of different protocols
- ▶ Each of these protocols **work at different part of Bluetooth** completing the Bluetooth configuration.

Bluetooth Protocols



Bluetooth Protocols

► Radio (RF) Layer:

- ✓ This layer is responsible for **transmitting** and **receiving** radio signals over the airwaves.
- ✓ It performs **modulation/demodulation** of the data into RF signals.
- ✓ Bluetooth operates in the **2.4 GHz** band and uses frequency-hopping spread spectrum to minimize interference from other wireless devices.

Bluetooth Protocols

► Baseband Link Layer:

- ✓ It controls the **timing** and **framing** of data packets.
- ✓ It handles tasks such as **establishing** and **managing connections**, **error correction**, and **flow control**.
- ✓ It manages the **formation of piconets** and handles the switching of devices between active and low-power modes to conserve energy.

Bluetooth Protocols

► Link Manager Protocol Layer:

- ✓ It performs the management of the already established links which includes authentication and encryption processes.
- ✓ It is responsible for creating the links, monitoring their health, and terminating them gracefully upon command or failure.

Bluetooth Protocols

► Logical Link Control and Adaption (L2CAP) Protocol layer:

- ✓ It is also known as the **heart** of the Bluetooth protocol stack and It is responsible for providing a **reliable data link** between two Bluetooth devices.
- ✓ It allows the communication between **upper** and **lower** layers of the Bluetooth protocol stack.
- ✓ It **packages the data packets** received from upper layers

Bluetooth Protocols

► **Service Discovery Protocol (SDP) layer:**

- ✓ SDP is responsible for **discovering and describing the available services** on Bluetooth devices.
- ✓ It allows devices to inquire about the services provided by other devices and establish **connections for specific services**.
- ✓ SDP defines how devices can identify each other's capabilities and services, making it possible to establish connections for tasks such as **file transfer, audio**

Bluetooth Protocols

- ▶ **RFCOMM (Radio Frequency Communication) layer:**
 - ✓ RFCOMM is a protocol used to emulate serial communication over Bluetooth.
 - ✓ It provides a virtual serial port for applications to use, making it easy to integrate Bluetooth into existing software that relies on serial connections.
 - ✓ It provides a serial interface with WAP and OBEX.

Bluetooth Protocols

► **OBEX:**

- ✓ It is short for Object Exchange.
- ✓ It is a communication protocol to exchange objects (such as files, contacts, and other data) between 2 devices.

► **WAP:**

- ✓ It is short for Wireless Access Protocol.
- ✓ It is used for internet access.

Bluetooth Protocols

► **Telephony Control Protocol (TCS):**

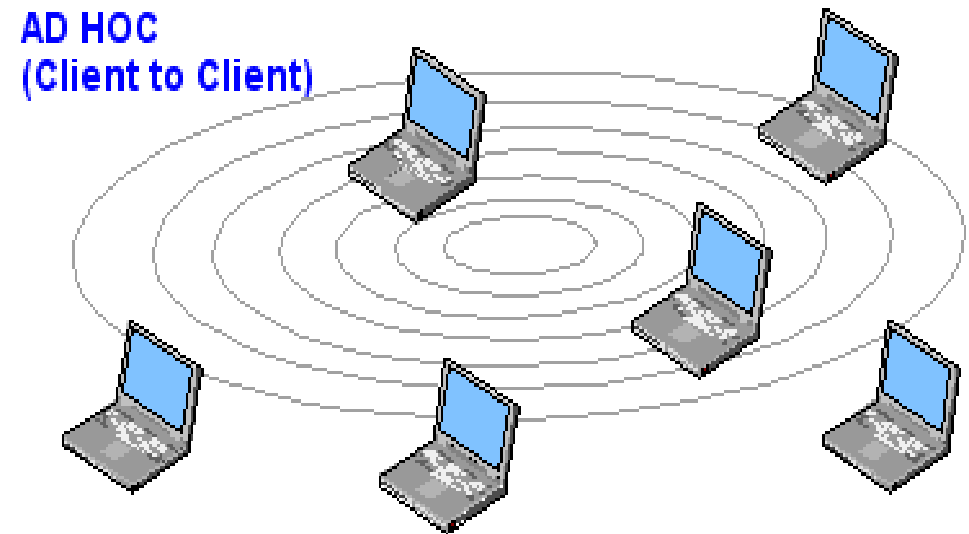
- ✓ It provides telephony service.
- ✓ The basic function of this layer is **call control (setup & release)** and group management for the gateway serving multiple devices.

► **Application layer:**

- ✓ It enables the user to interact with the application.

Ad-hoc Network

- It is a decentralized type of wireless network where devices or nodes communicate with each other directly, without the need for a central access point or a pre-established infrastructure



Ad-hoc Network

- ▶ Devices in the network communicate directly with each other, and each device has equal importance (can act as both a transmitter and a receiver)
- ▶ Ad hoc networks are also sometimes referred to as "peer-to-peer" or "spontaneous" networks.

Features of Ad-hoc Network

- ▶ **Peer-to-Peer (Decentralization)** - no central administration
- ▶ **Dynamic** - network's topology can change rapidly as devices move in & out
- ▶ **Low Power** - nodes may use power management techniques to conserve energy.
- ▶ **Autonomous** - nodes make decisions about routing, power management, and data transmission independently
- ▶ **Multi-Hop Communication** - Data is relayed through

Advantages of Ad-hoc Network

- ▶ **Rapid Deployment** - It is quicker and easier to set up than infrastructure network.
- ▶ **No Single Point of Failure** - If one node goes down, the network can often find alternative routes for data transmission
- ▶ **Cost-Effective** - do not require infrastructure hardware such as AP or router and no expense of deployment and maintenance.
- ▶ **Self-Organization** - nodes collaborate to establish and maintain network connections. This simplifies network management and reduces the need for centralized control

Challenges of Ad-hoc Network

- ▶ One of the biggest concerns with an ad hoc network is **security**.
- ▶ If cyber-attackers get within signal range, they will generally be able to connect to a wireless ad hoc network and, therefore, to the device.
- ▶ Furthermore, users cannot disable their SSID broadcast in ad hoc mode, meaning that the network name cannot be hidden (since, they're not always appropriate).

Challenges of Ad-hoc Network

- ▶ However, because ad hoc connections are temporary and only accessible within 100 meters, they can be ideal for some situations.
- ▶ Attackers cannot hack into a device from far away and do not have unlimited time to plan their attack.

Classifications of Ad-hoc Network

Mobile ad hoc networks (MANETs)

- This is a self-configuring, self-organising, wireless network of mobile devices.

Vehicular ad hoc networks (VANETs)

- This is network formed by communication between moving vehicles and other roadside devices.

Wireless mesh networks

- The devices connected to these networks forms a wireless mesh, depending upon the mobility patterns, nature of devices and inter-device distances.

Smart phone Ad Hoc Networks (SPANs)

- These are peer - to - peer networks created by smartphones within range of each other without requiring any cellular carrier networks, wireless access points etc.

Wireless Sensor Networks (WSN)

- Sensors are portable devices that capture specific information from environment like temperature, humidity, traffic volume etc. WSNs form ad hoc networks to capture information on the fly.

Applications of Ad-hoc Network

- ▶ **Military**: Ad hoc networks are often used in military applications, where communication infrastructure may not be available or where the network needs to be rapidly deployed and reconfigured.
- ▶ **Disaster Recovery**: Ad hoc networks can be quickly set up in disaster-stricken areas to provide communication among rescue teams or affected individuals.
- ▶ **Sensor Networks**: Ad hoc networks are used in wireless sensor networks where sensors communicate with each other to

Examples of Ad-hoc Network

- ▶ Ad hoc networks can be created using devices like smartphones, laptops, or IoT devices.
- ▶ For example, you can set up an ad hoc Wi-Fi network between two laptops to share files without needing a Wi-Fi router.
- ▶ Using a cellular-connected smartphone that is configured in Wi-Fi ad hoc mode so that Wi-Fi capable laptops can connect to the Wi-Fi ad hoc network to gain internet access over the smartphone's cellular internet link.