BLUETOOTH

- Bluetooth is a wireless LAN technology designed to connect devices of different functions such as telephones, notebooks, computers (desktop and laptop), cameras, printers, coffee makers, and so on. A Bluetooth LAN is an ad hoc network, which means that the network is formed spontaneously.
- Bluetooth technology has several applications. Peripheral devices such as a wireless mouse or keyboard can communicate with the computer through this technology.
- Today, Bluetooth technology is the implementation of a protocol defined by the IEEE 802.15 standard.

Architecture:

Bluetooth defines two types of networks: piconet and scatternet.

Piconets

- A Bluetooth network is called a piconet, or a small net. A piconet can have up to eightstations, one of which is called the primary the rest are called secondaries.
- Note that a piconet can have only one primary station. The communication between theprimary and the secondary can be one-to-one or one-to-many.

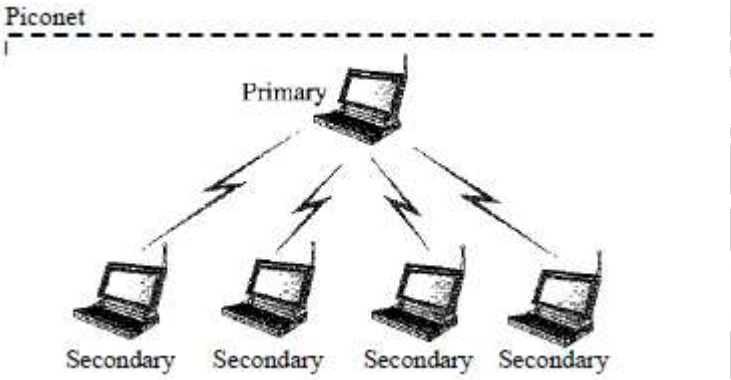

Fig: Piconet.

- Although a piconet can have a maximum of seven secondaries, an additional eight secondaries can be in the *parked state.* A secondary in a parked state is synchronized with the primary, but cannot take part in communication until it is moved from the parked state.
- Because only eight stations can be active in a piconet, activating a station from the parked state means that an active station must go to the parked state.

Scatternet:

- Piconets can be combined to form what is called a scatternet. A secondary station inone piconet can be the primary in another piconet.
- This station can receive messages from the primary in the first piconet (as a secondary) and, acting as a primary, deliver them to secondaries in the second piconet.
- A station can be a member of two piconets.

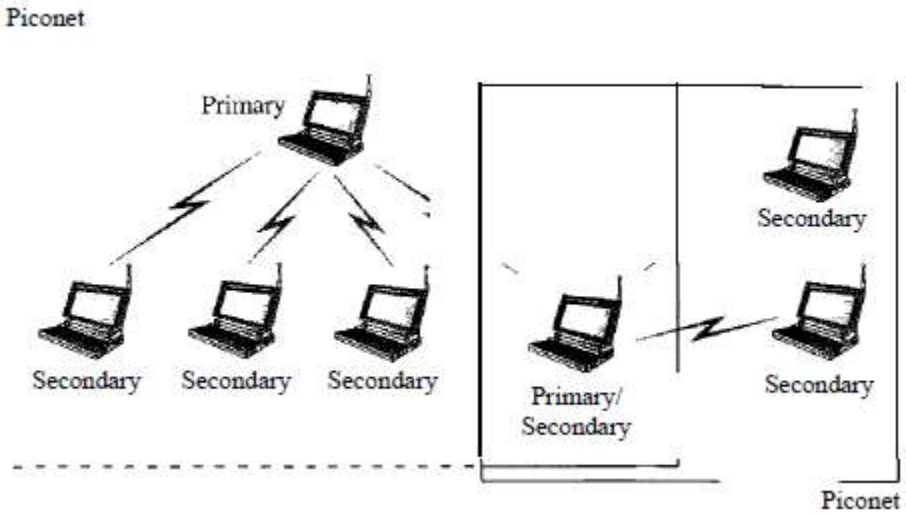

Fig: Scatternet.

Bluetooth Devices:

- A Bluetooth device has a built-in short-range radio transmitter. The current data rate is1 Mbps with a 2.4-GHz bandwidth.

Bluetooth Layers

- Bluetooth uses several layers.

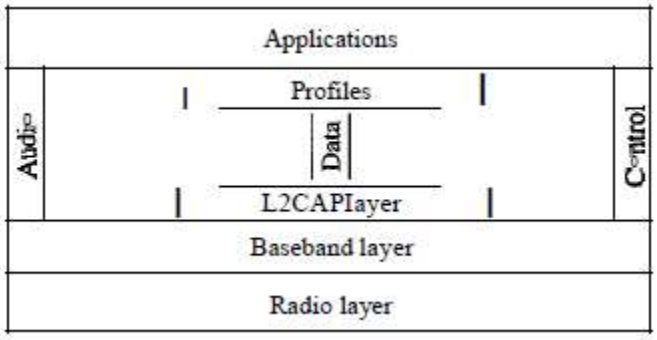

Fig: Bluetooth layers.

Radio Layer

- The radio layer is roughly equivalent to the physical layer of the Internet model. Bluetooth devices are low-power and have a range of 10 m.

Band

- Bluetooth uses a 2.4-GHz ISM band divided into 79 channels of 1 MHz each.

FHSS

- Bluetooth uses the frequency-hopping spread spectrum (FHSS) method in the physical layer to avoid interference from other devices or other networks.
- Bluetooth hops 1600 times per second.

Modulation:

- Bluetooth uses a sophisticated version of FSK, called GFSK. GFSK has a carrier frequency. Bit 1 is represented by a frequency deviation above the carrier; bit ()is represented by a frequency deviation below the carrier. The frequencies, in megahertz

Baseband Layer:

- The baseband layer is roughly equivalent to the MAC sub layer in LANs. The access method is TDMA. The primary and secondary communicate with each other using time slots.
- Note that the communication is only between the primary and a secondary; secondaries cannot communicate directly with one another.

TDMA:

- Bluetooth uses a form of TDMA. TDD-TDMA (time division duplex TDMA). TDD-TDMA is a kind of half-duplex communication in which the secondary and receiver send and receive data, but not at the same time.
- This issimilar to walkie-talkies using different carrier frequencies.

Single-Secondary Communication:

- If the piconet has only one secondary, the TDMA operation is very simple. The primary uses even numbered slots (0, 2, 4, ...); the secondary uses odd-numbered slots (1, 3, 5, ...).
- TDD-TDMA allows the primary and the secondary to communicate in half-duplex mode. In slot 0, the primary sends, and the secondary receives; in slot 1, the secondary sends, and the primary receives. The cycle is repeated.

Multiple-Secondary Communication:

- The process is a little more involved if there ismore than one secondary in the piconet. The primary uses the even-numbered slots,but a secondary sends in the next odd-numbered slot if the packet in the previous slot wasaddressed to it.

- All secondaries listen on even-numbered slots, but only one secondary sends in any odd-numbered slot.

Physical Links

- Two types of links can be created between a primary and a secondary: SCQ links and ACL links.
- SCO A synchronous connection-oriented (SCO)
- ACL An asynchronous connectionless link (ACL)

Frame Format:

- Access code. This 72-bit field normally contains synchronization bits and the

identifier of the primary to distinguish the frame of one piconet from another.

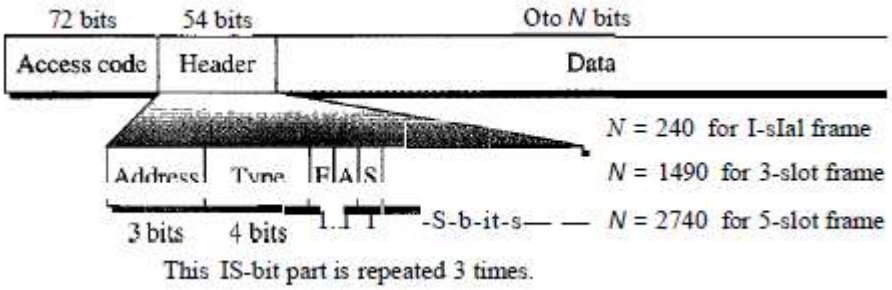

Fig: Frame format types.

- Header. This 54-bit field is a repeated I8-bit pattern. Each pattern has the following subfields:

1. **Address.** The 3-bit address subfield can define up to seven secondaries (l to 7).If the address is zero, it is used for broadcast communication from the primary to all secondaries.
2. **Type.** The 4-bit type subfield defines the type of data coming from the upper layers. We discuss these types later.
3. **F**. This I-bit subfield is for flow control. When set (1), it indicates that the device is unable to receive more frames (buffer is full).
4. **A**. This I-bit subfield is for acknowledgment. Bluetooth uses Stop-and-Wait ARQ; 1 bit is sufficient for acknowledgment.
5. **S**. This I-bit subfield holds a sequence number. Bluetooth uses Stop-and-Wait ARQ; 1 bit is sufficient for sequence numbering.
6. **HEC**. The 8-bit header error correction subfield is a checksum to detect errors in each 18-bit header section.

Payload. This subfield can be 0 to 2740 bits long. It contains data or control

information corning from the upper layers.

L2CAP

- The Logical Link Control and Adaptation Protocol, or L2CAP (L2 here means LL),is roughly equivalent to the LLC sublayer in LANs. It is used for data exchange
- ACL link; SCQ channels do not use L2CAP.The L2CAP has specific duties: multiplexing, segmentation and reassembly, quality of service (QoS), and group management.

Fig: L2CAP data packet format.

Multiplexing

- The L2CAP can do multiplexing. At the sender site, it accepts data from one of the upper-layer protocols, frames them, and delivers them to the baseband layer.
- At the receiver site, it accepts a frame from the baseband layer, extracts the data, and delivers them to the appropriate protocol layer.

Segmentation and Reassembly:

- The L2CAP divides these large packets into segments and adds extra information to define the location of the segments in the original packet. TheL2CAP segments the packet at the source and reassembles them at the destination.

QoS

- Bluetooth allows the stations to define a quality-of-service level.

Group Management

- Another functionality of L2CAP is to allow devices to create a type of logical addressing between themselves. This is similar to multicasting.

Other Upper Layers

- Bluetooth defines several protocols for the upper layers that use the services of L2CAP;these protocols are specific for each purpose.