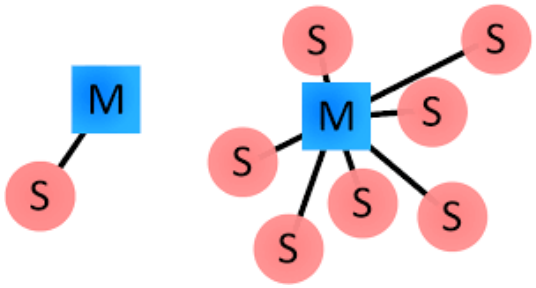
Bluetooth

- Bluetooth is a wireless technology standard used for exchanging data between fixed and mobile devices over short distances using short-wavelength UHF (Ultra High Frequency) radio waves.
- The Bluetooth protocol operates at 2.4GHz in the same unlicensed ISM frequency band where RF protocols like ZigBee and Wi-Fi also exist.
- Wireless Personal Area Networks (PAN).
- Wireless PAN is based on the standard IEEE 802.15.
- RF communication with 2.4GHz spectrum.
- **Two forms of Bluetooth wireless technology systems -**
  - Basic Rate (BR)
  - Low Energy (LE)
- **Bluetooth will support -**
  - wireless point-to-point and
  - point-to-multipoint (broadcast), used devices in a piconet.
- **Point to Point Link -**
  - Master - slave relationship.
  - Bluetooth devices can function as masters or slaves.
- **Basic Rate –**
  - The system includes optional Enhanced Data Rate (EDR) and Alternate Media Access Control (MAC) and Physical (PHY) layer extensions.
  - Basic Rate system offers synchronous and asynchronous connections with data rates of 721.2 kb/s for Basic Rate, 2.1 Mb/s for Enhanced Data Rate and high speed operation up to 54 Mb/s with the 802.11 AMP
- **Piconet -**
  - It is the network formed by a Master and one or more slaves (max 7).
  - Each piconet is defined by a different hopping channel to which users synchronize to.
  - Each piconet has max capacity (1 Mbps).
  - Any slave device in the piconet can only be connected to a single master.
  - The master coordinates communication throughout the piconet. It can send data to any of its slaves and request data from them as well. Slaves are only allowed to transmit to and receive from their master. They can't talk to other slaves in the piconet.



- **Scatternet –**
  - A **scatternet** is a type of ad hoc computer network consisting of two or more piconets.
- **Power Classes -**
  - The transmit power, and therefore range, of a Bluetooth module is defined by its power class.
  - Some modules are only able to operate in one power class, while others can vary their transmit power.
  - There are three defined classes of power:

Ranges of Bluetooth devices by class

Class	Max. permitted power		Typ. range (m)
	(mW)	(dBm)	
1	100	20	~100
1.5	10	10	~20
2	2.5	4	~10
3	1	0	~1
4	0.5	−3	~0.5

- **Common Version –**
  - Bluetooth v1.2
  - Bluetooth v2.1 + EDR
  - Bluetooth v3.0 + HS
  - Bluetooth v4.0 and Bluetooth Low Energy
  - Bluetooth v5.0
- **Connection Process -**

Creating a Bluetooth connection between two devices is a multi-step process involving three progressive states:

1. **Inquiry –** If two Bluetooth devices know absolutely nothing about each other, one must run an inquiry to try to discover the other. One device sends out the inquiry request, and any device listening for such a request will respond with its address, and possibly its name and other information.
2. **Paging (Connecting) –** Paging is the process of forming a connection between two Bluetooth devices. Before this connection can be initiated, each device needs to know the address of the other (found in the inquiry process).
3. **Connection –** After a device has completed the paging process, it enters the connection state. While connected, a device can either be actively participating or it can be put into a low power sleep mode.

- **Active Mode –** This is the regular connected mode, where the device is actively transmitting or receiving data.
- **Sniff Mode –** This is a power-saving mode, where the device is less active. It'll sleep and only listen for transmissions at a set interval (e.g. every 100ms).
- **Hold Mode –** Hold mode is a temporary, power-saving mode where a device sleeps for a defined period and then returns back to active mode when that interval has passed. The master can command a slave device to hold.
- **Park Mode** – Park is the deepest of sleep modes. A master can command a slave to "park", and that slave will become inactive until the master tells it to wake back up.

- **Bonding and Pairing –**
  - When two Bluetooth devices share a special affinity for each other, they can be bonded together. Bonded devices automatically establish a connection whenever they're close enough.
  - No UI interactions are required! Bonds are created through one-time a process called pairing. When devices pair up, they share their addresses, names, and profiles, and usually store them in memory. The also share a common secret key, which allows them to bond whenever they're together in the future.
  - Pairing usually requires an authentication process where a user must validate the connection between devices. The flow of the authentication process varies and usually depends on the interface capabilities of one device or the other.

- **Bluetooth Protocol Stack -**