

BLUETOOTH

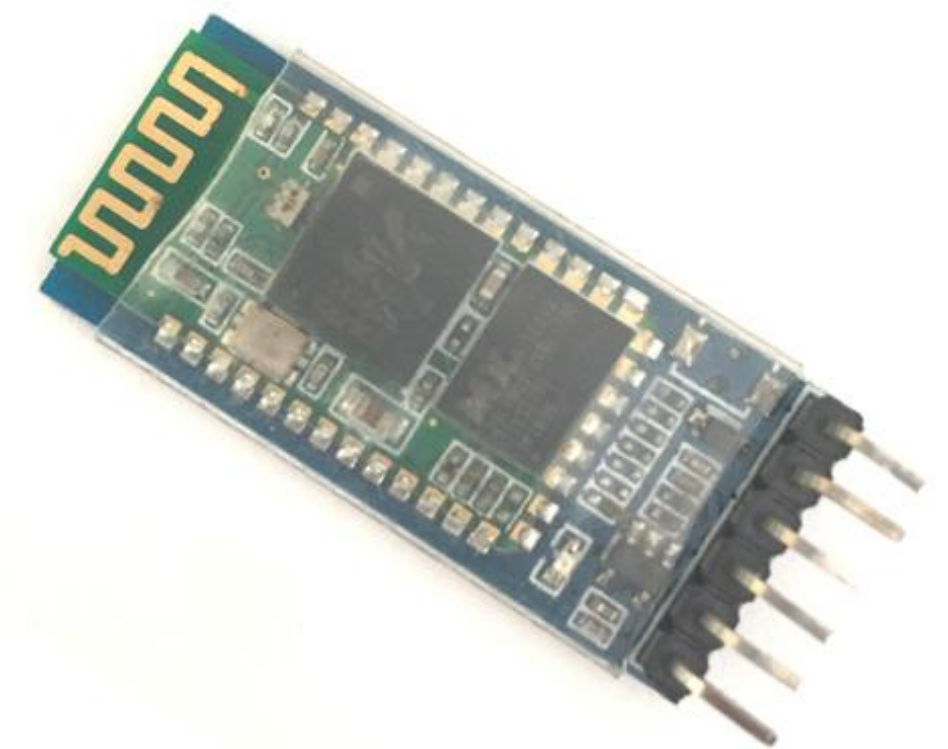


Overview

- Wireless Technology Standard.
- Used for exchanging data through radio waves making cables and cords obsolete.
- Short distance communication.
- Named after a danish king, Harald Bluetooth.
- Develop and managed by Bluetooth Special Interest Group (SIG).
- SIG has more than 35,000 member companies in the areas of telecommunication, computing, networking, and consumer electronics.



Technical Specs



- Low cost as cables – chip \$5
- Secure as cables – must support authentication and encryption
- Able to function in a noisy environment.
- Bluetooth technology operates in the unlicensed industrial, scientific and medical (ISM) band at **2.4 to 2.485**

GHZ. The 2.4 GHZ ISM band is available and unlicensed in most countries.

- Uses a spread spectrum hopping,
- Bluetooth operating range depends on power class
- Bluetooth supports 1Mbps data rate for version 1.2 3Mbps data rate for Version 2.0 combined with Error Data Rate.

I. Bluetooth Technology

- evolution of data rates and features

	v1.1 (02.2001)	v1.2 (11.2003)	v2.0 (11.2004)	v3.0 (04.2009)	v4.0 (12.2009)
data-rate	732,2 KBit/s	1 MBit/s	2,1 MBit/s	up to 24 MBit/s (peer-to-peer)	still 2,1 / 24 MBit/s
new features	Received Signal Strength Indication	Adaptive Frequency-Hopping spread spectrum (AFH)	Enhanced Data Rate (EDR)	high speed channel on WLAN basis	Bluetooth low energy protocol

Ranges of Bluetooth devices by class

Class	Max. permitted power		Typ. range ^[2] (m)
	(mW)	(dBm)	
1	100	20	~100
1.5 (BT 5 Vol 6 Part A Sect 3)	10	10	~20
2	2.5	4	~10
3	1	0	~1
4	0.5	-3	~0.5

Bluetooth Network Configuration

- Bluetooth enabled electronic devices connect and communicate wirelessly through shortrange devices known as **Piconets**.
- Master -Slave Mechanism
- When more than two Bluetooth devices communicate with o a **PICONET**.
- A Piconet can contain up to seven slaves clustered around a single master.
- The device that initializes establishment of the Piconet becomes the **master**.

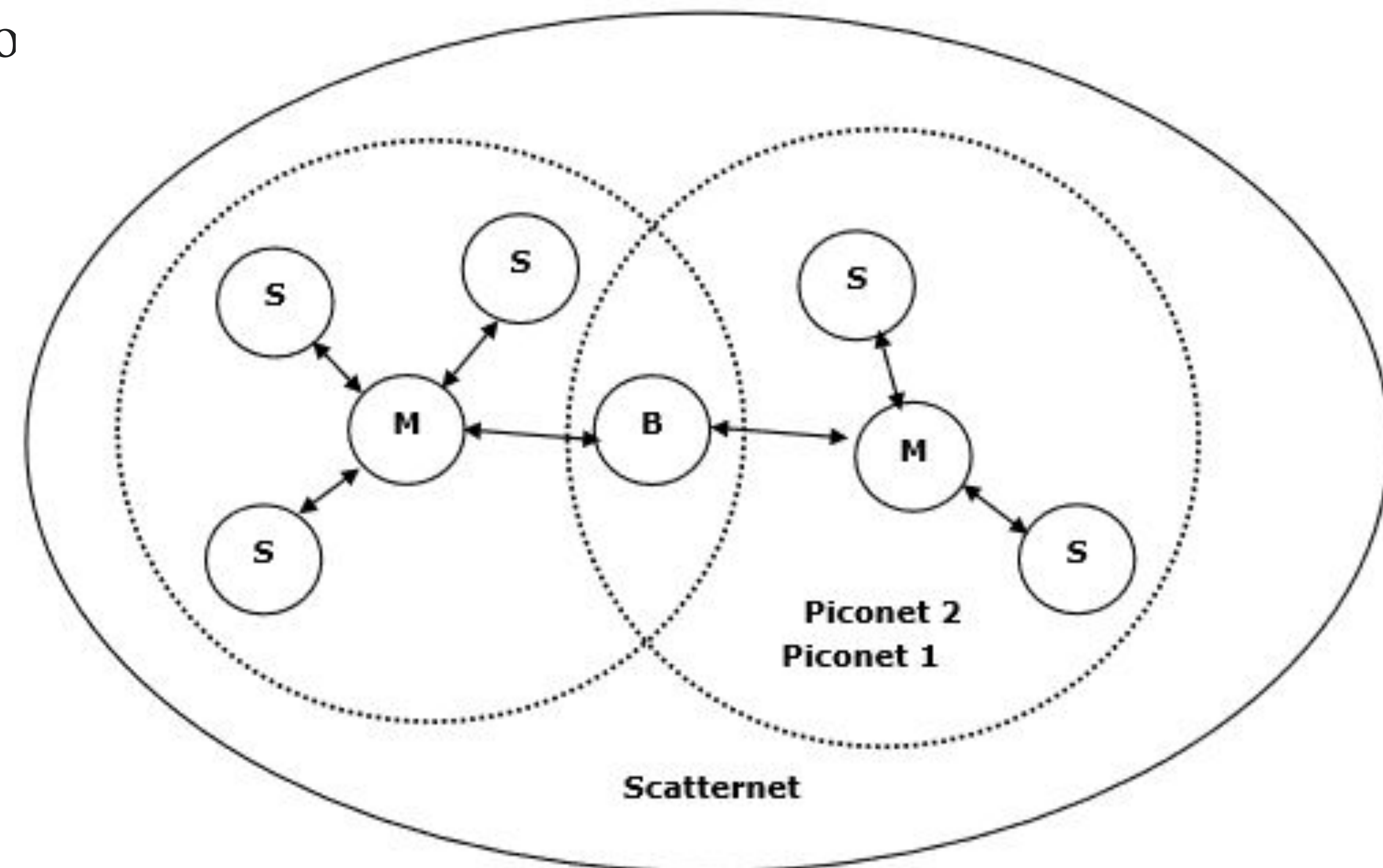
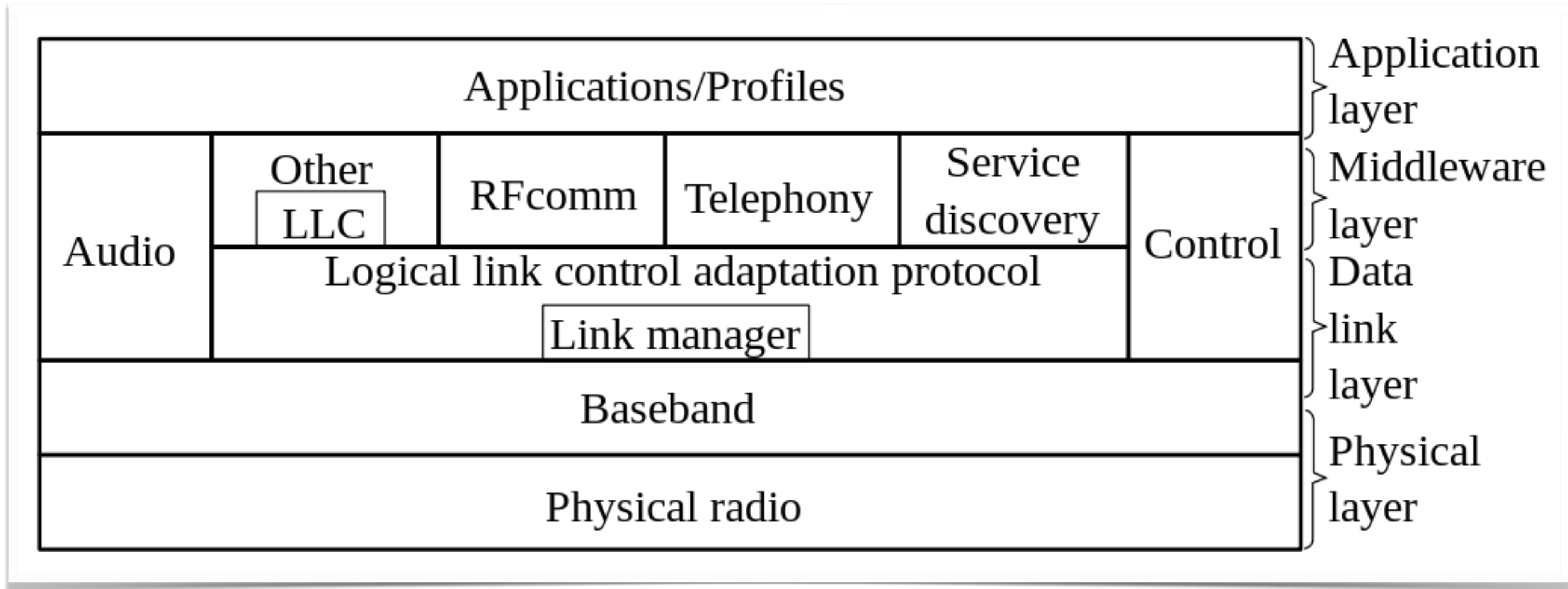


Figure: Piconets and Scatternets

Features of Piconets

- Within a Piconet, the timing of various devices and the frequency hopping sequence of individual devices is determined by the clock and unique 48-bit address of master.
- Each device can communicate simultaneously with up to seven other devices within a single Piconet.
- Each device can communicate with several piconets simultaneously.
- Piconets are established dynamically and automatically as Bluetooth enabled devices enter and leave piconets.
- There is no direct connection between the slaves and all the connections are essentially master-to-slave or slave-to-master.
- Slaves are allowed to transmit once these have been polled by the master. Slaves are allowed to transmit once these have been polled by the master.
- Devices resident in adjacent piconets provide a bridge to support inner-piconet connections, allowing assemblies of linked piconets to form a physically extensible communication infrastructure known

Bluetooth Protocol Stack



Protocols

RADIO PROTOCOL

- Responsible for the modulation and demodulation of data into RF signals
- The radio layer describes the physical characteristics a bluetooth device's receiver-transmitter component must have.

BASEBAND PROTOCOL

- Responsible for channel coding and decoding.
- Digitizes the signals received by the radio for passing up the stack.
- Formats the data it receives from the Link Controller(upper protocol) for transmission over the channel

Link Manager

- Responsible for establishing and maintaining the links between Bluetooth units.
- Handles Link setup ,authentication , link configuration and security procedures.
- Establishes all connections with the help of baseband protocol

Host Controller Interface

- The host controller interface defines uniform methods for accessing and controlling the lower layers of the protocol stack (baseband and the link manager).

Logical Link Control and Adaptation Protocol (L2CAP)

- Multiplexing data between different higher layer protocols.
- Segmentation and reassembly of packets.
- Providing one-way transmission management of multicast data to a group of other Bluetooth devices.
- Quality of service (QoS) management for higher layer protocols.

Service Discovery Protocol

- Defines procedures for discovering services of other devices.
- Determining the characteristics of those services.

Telephony Control Protocol Specification (TCS) defines call

- Control signalling for establishing speech and data calls between bluetooth devices



Bluetooth vs Other Wireless Technologies



Technology	Ideal Application	Range (m)	Data Rate (Mbps)	Current Required	Cost (\$)	Connection Type
IR	Device synchronization, data transfer	1	16	Low	10	Single Freq
Bluetooth	Cable Replacement, Ad hoc PAN	10-100	< 1	Medium	10	FHSS
802.11b	High speed LAN	100+	11	High	45	DSSS

Scope of Bluetooth in Future

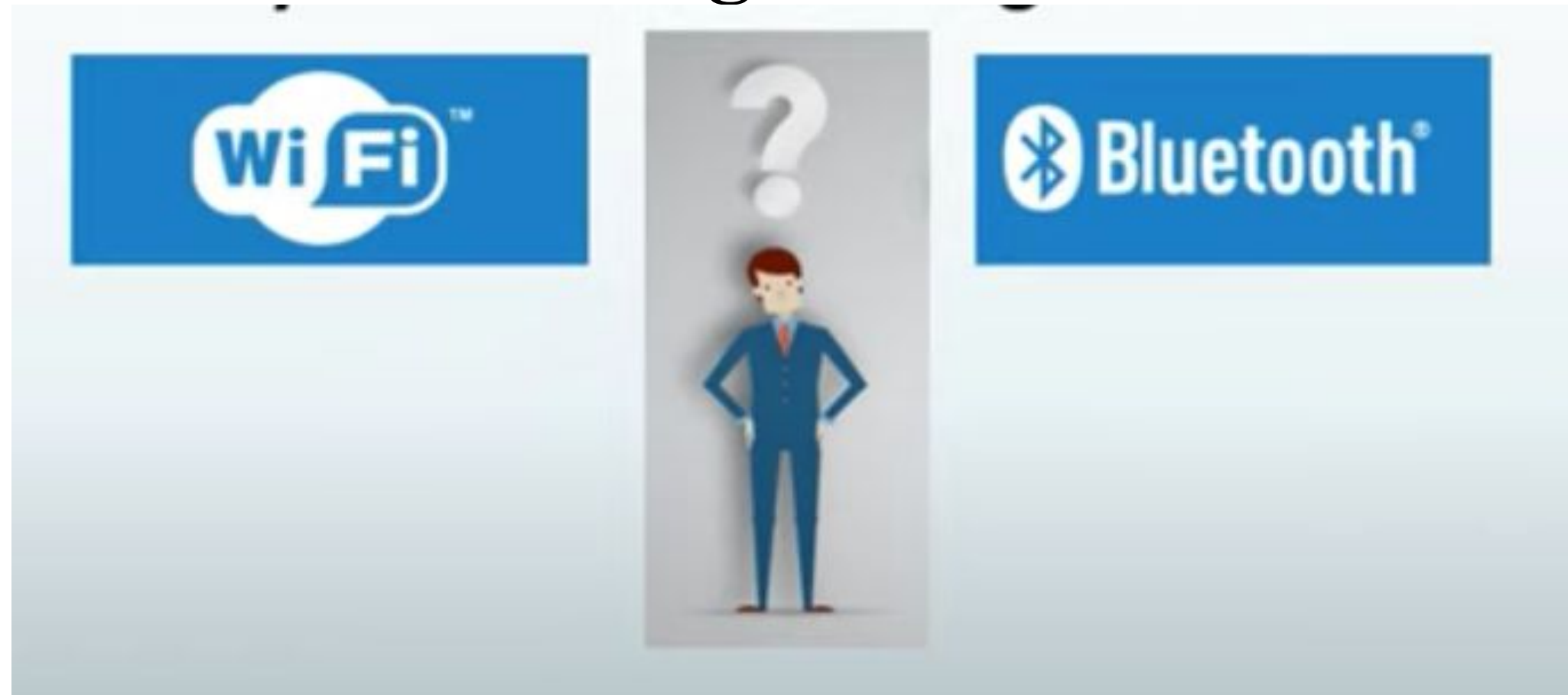
- A good future ahead because of meeting the basic means of connectivity.
- Currently a protocol is being searched that would support large ad-hoc networks
- Latest version of bluetooth both its securities and capabilities.
- New versions of Bluetooth are meeting the high speed and large range.
- Many companies are creating impressive bluetooth applications in demand.



ZIGBEE

- Zigbee is a wireless standard that defines a set of communication protocols for short-range communications.

Why another short-range communication standard

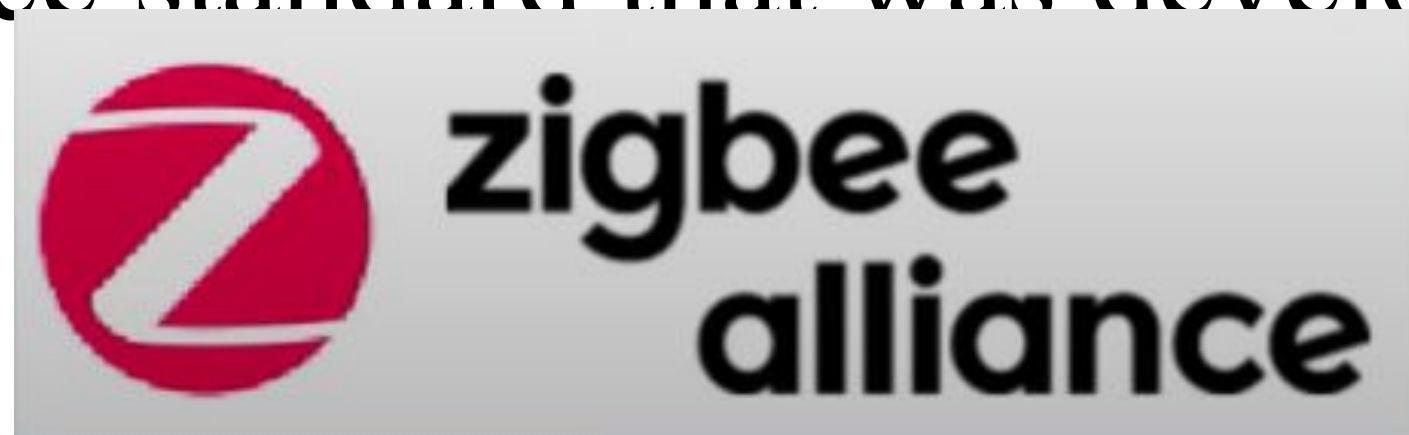


- Zigbee standard is especially build for control and sensor networks



What is ZIGBEE?

- Zigbee is a standard that addresses the need of very low-cost implementation of Low power devices with low data rate for short range wireless communications.
- ZigBee gets its name from the zig zag Dance of Bees.
- One of the most commonly used standard for Internet of things.
- Open source standard that was developed by Zigbee Alliance.



ZIGBEE Applications

- Home automation
- Medical data collection
- Industrial Control systems

Purpose:

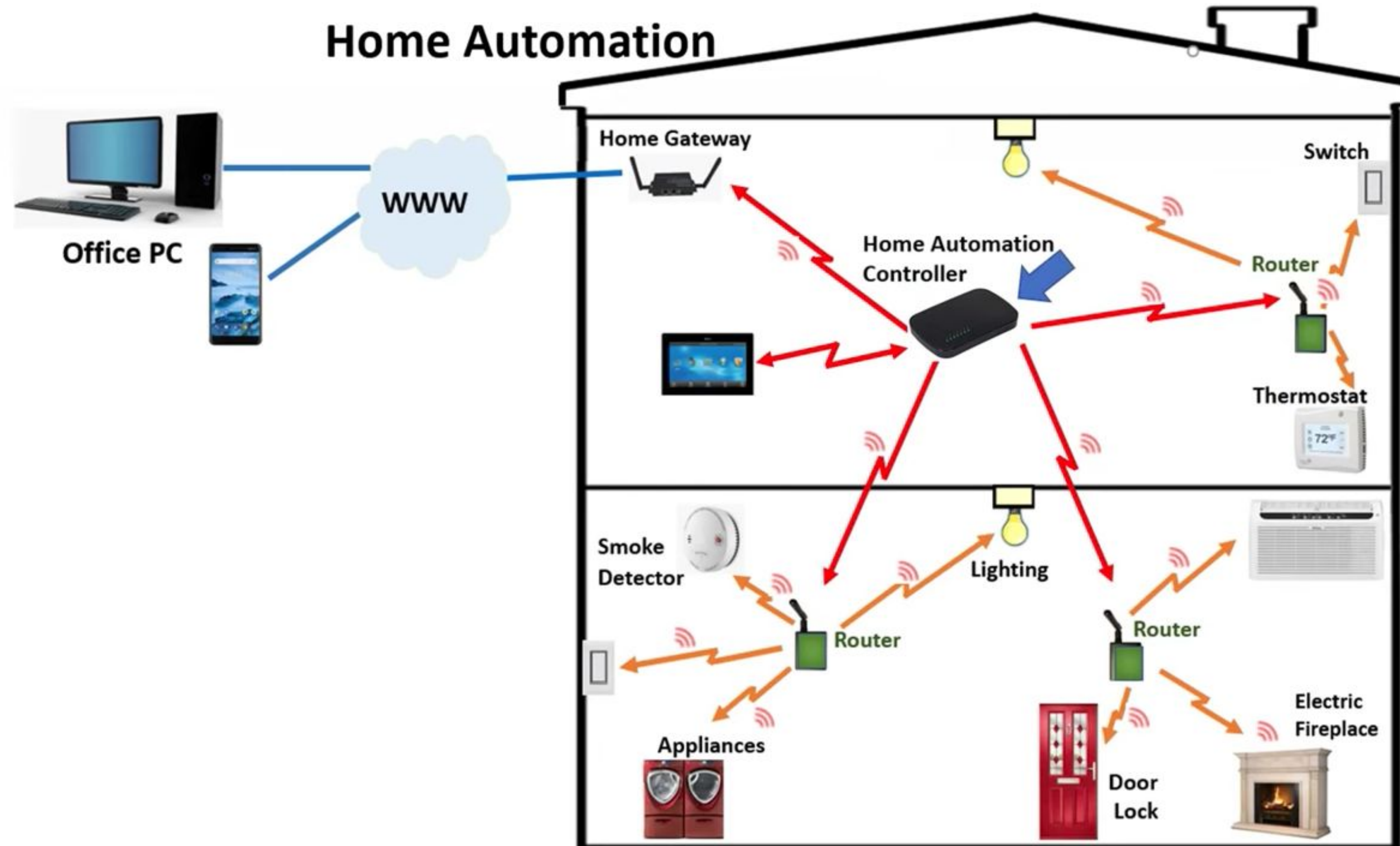
- Collect information
- Perform control tasks inside a building



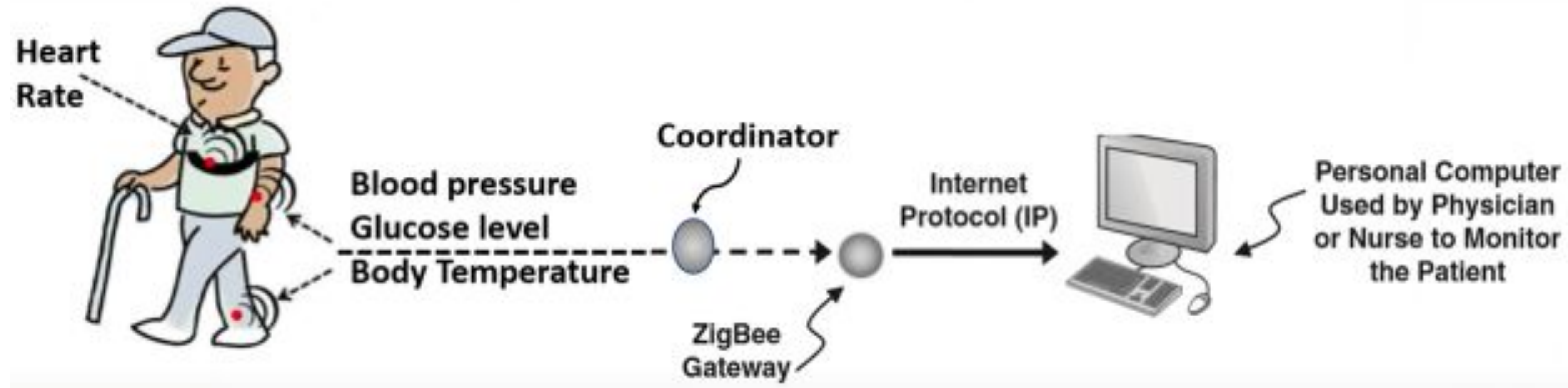
Home Automation

Supported Devices

- Lights
- Door Locks
- Switches
- Smoke Detectors
- Fans
- Appliances
- Etc..



Remote Monitoring System



Why can't use these?



General Characteristics of Zigbee Standard

General Characteristics



- **Low Power consumption:** Devices can typically operate for several years on a single battery.

- **Low Data rate:** 20kbps-250 kbps.

Wifi: 11 Mbps, Bluetooth: 1 Mbps



- **Short Range:** Upto 75-100 metres indoor and upto 300+metres(line of sight).

- **Network Join time:** ~30 msec

Wifi: Upto 3 seconds, Bluetooth: Upto 10 seconds

- **Support small and large networks:** Upto 65000 devices(in theory)/240 devices(in practice).

Wifi: Upto 32 devices, Bluetooth: upto 7 devices.

- **Low cost of products and cheap implementation.**

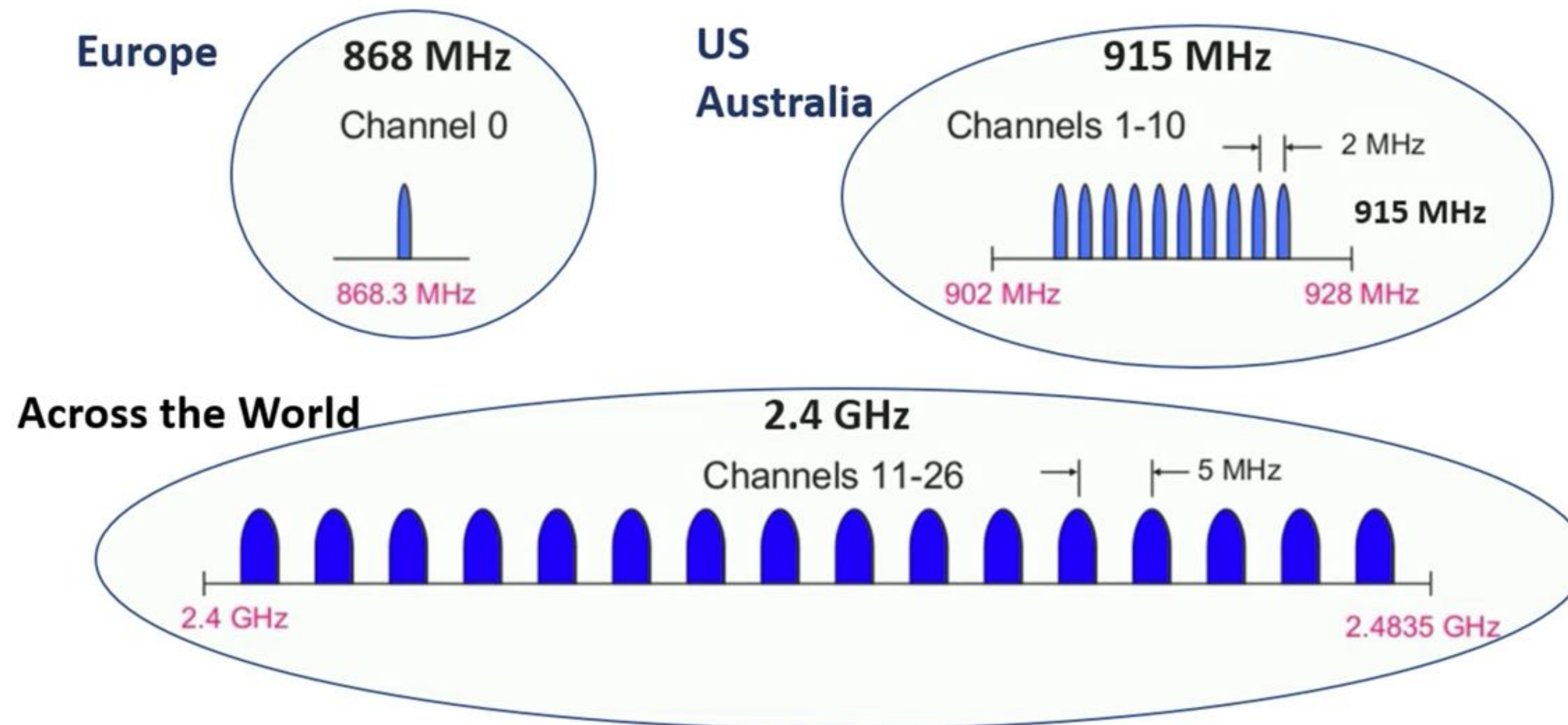
Simplicity of the technology

Open Source Protocol

- **Security:** Uses AES cryptographic algorithm.

Operating Frequency Bands

- There are three frequency bands currently assigned to ZigBee:



- Only one channel will be selected for use in network.

ZIGBEE DEVICES

Coordinator

- Most Capable Device
- Root of the network
- One coordinator in each network

Tasks:

- Channel Selection
- Assign an ID to the network
- Allocates unique address to each device
- Initiates and transfer messages in the network

ZIGBEE Devices

Routers

- Act as intermediate nodes between the coordinator and the end devices.
- Route traffic between different nodes.
- Receive and store messages intended for their children
- Can allow other routers and end devices to join the network.

End Devices

- Contains just enough information to talk to the parent node.
- They may sleep (a standby),which makes end devices a suitable choice for battery operated devices.
- All traffic to end device is first routed to its parent.

ZIGBEE Network Architecture

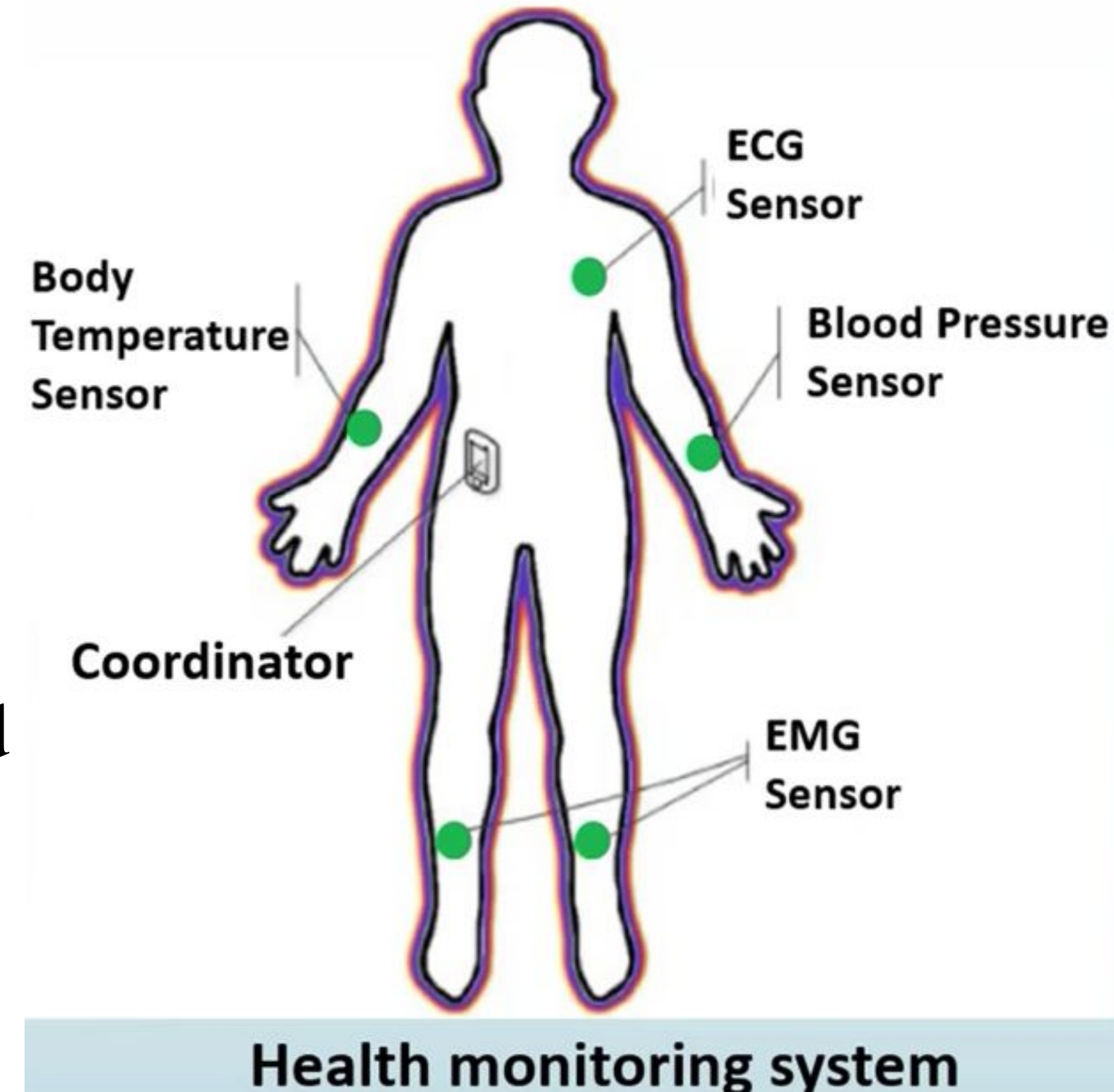
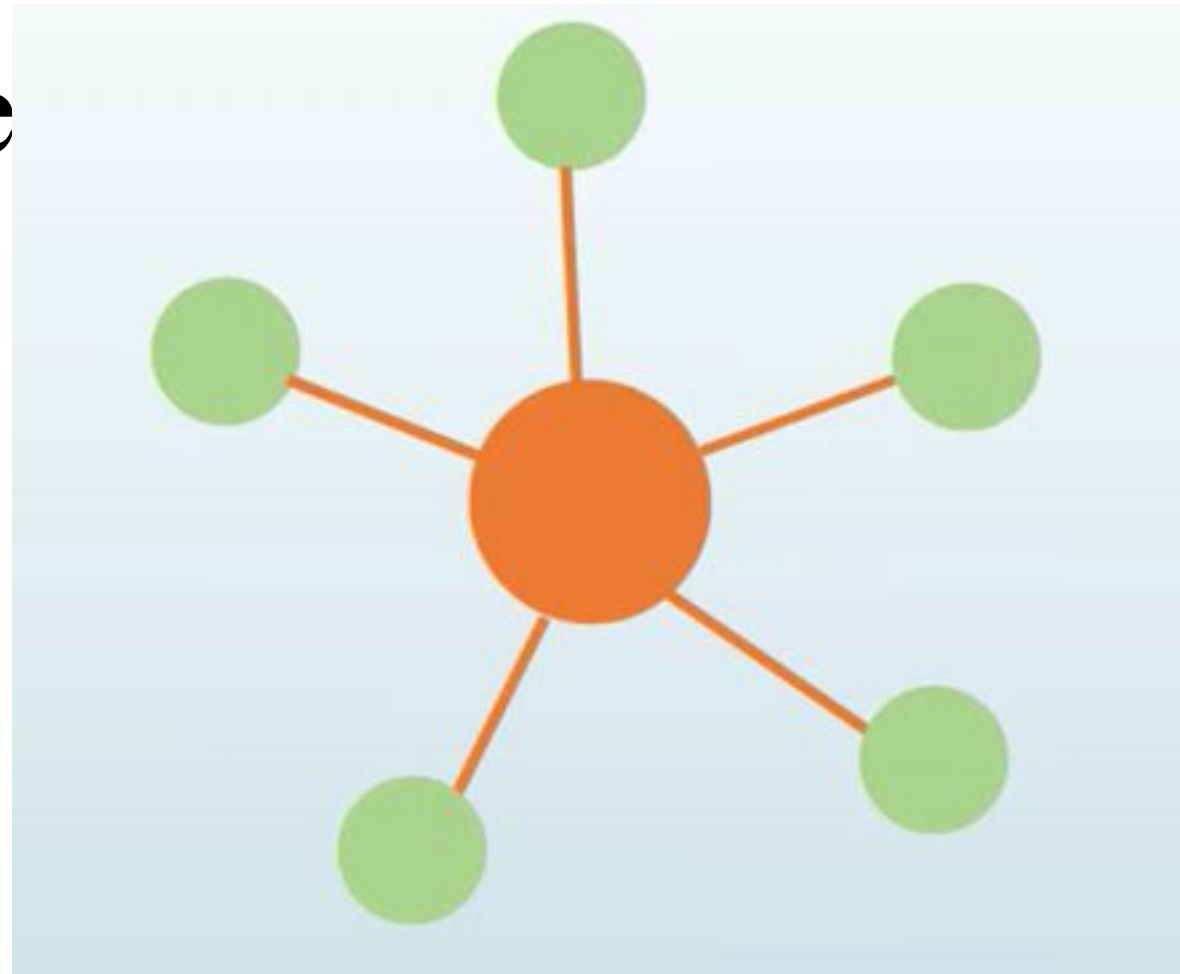
Types of Zigbee Topologies

- Star Topology
- Mesh Topology
- Tree Topology

ZIGBEE Network Architecture

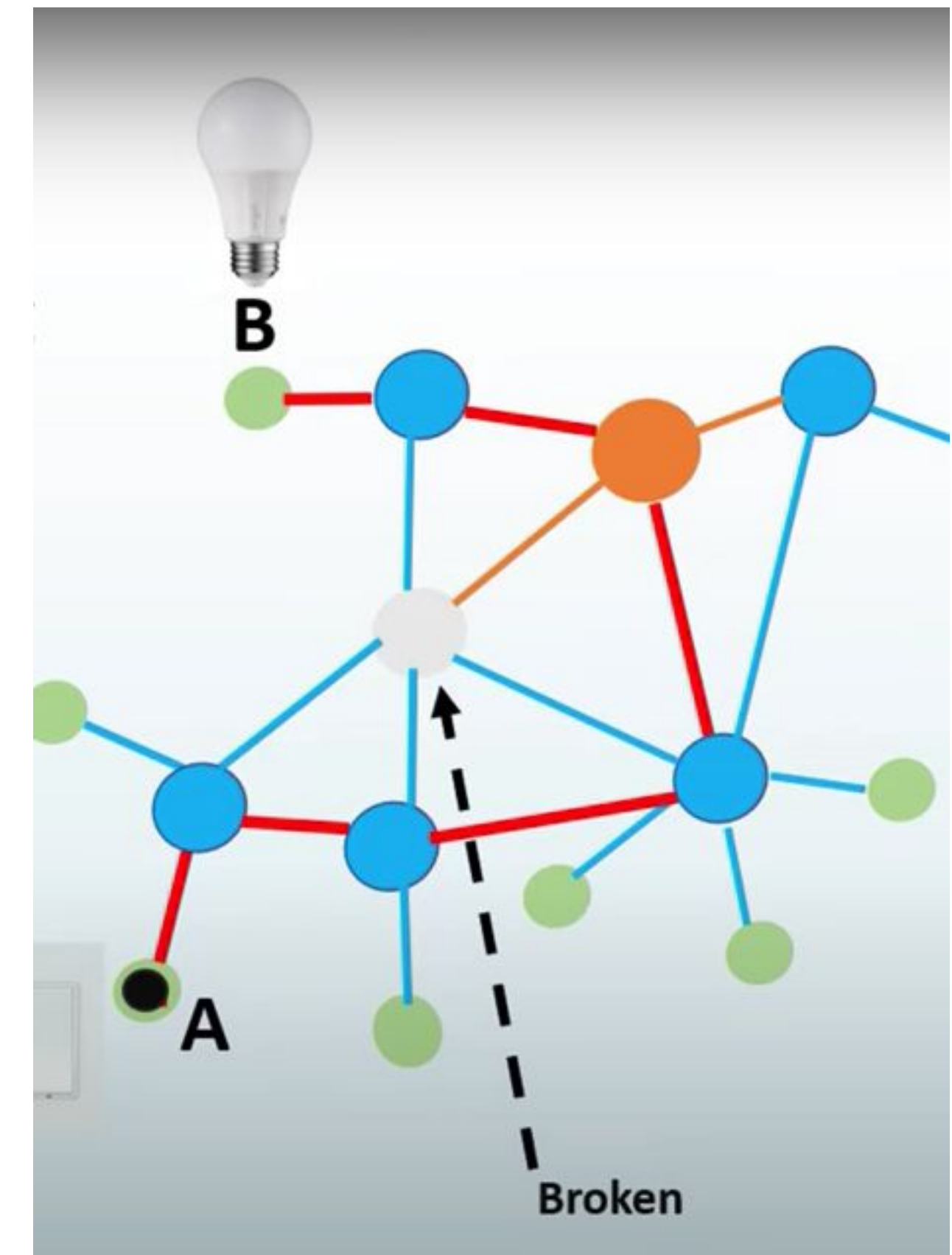
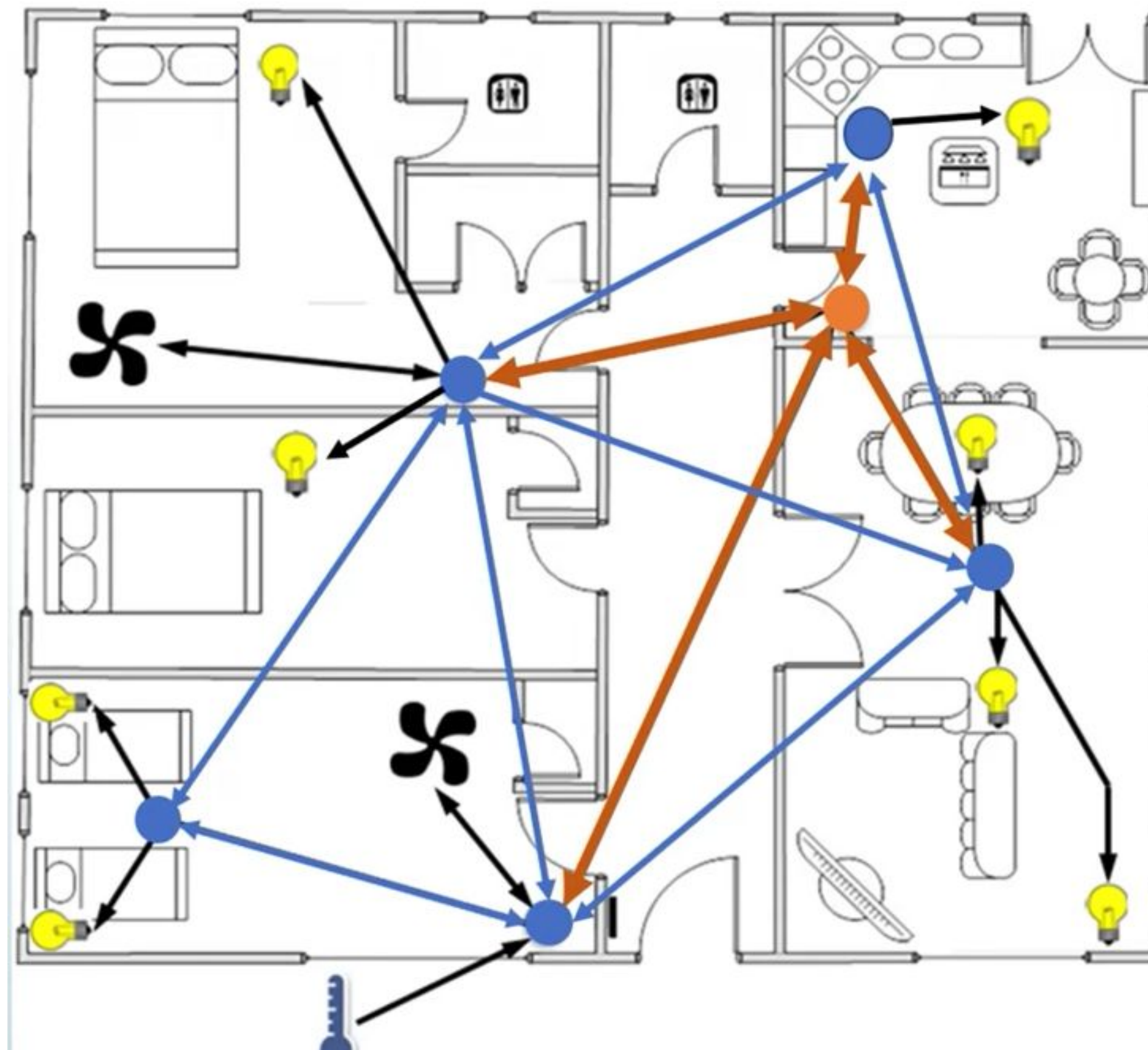
STAR Topology

- This is the simplest and less expensive implementation.
- There are no routers in this architecture.
- End device can not communicate directly with another end de



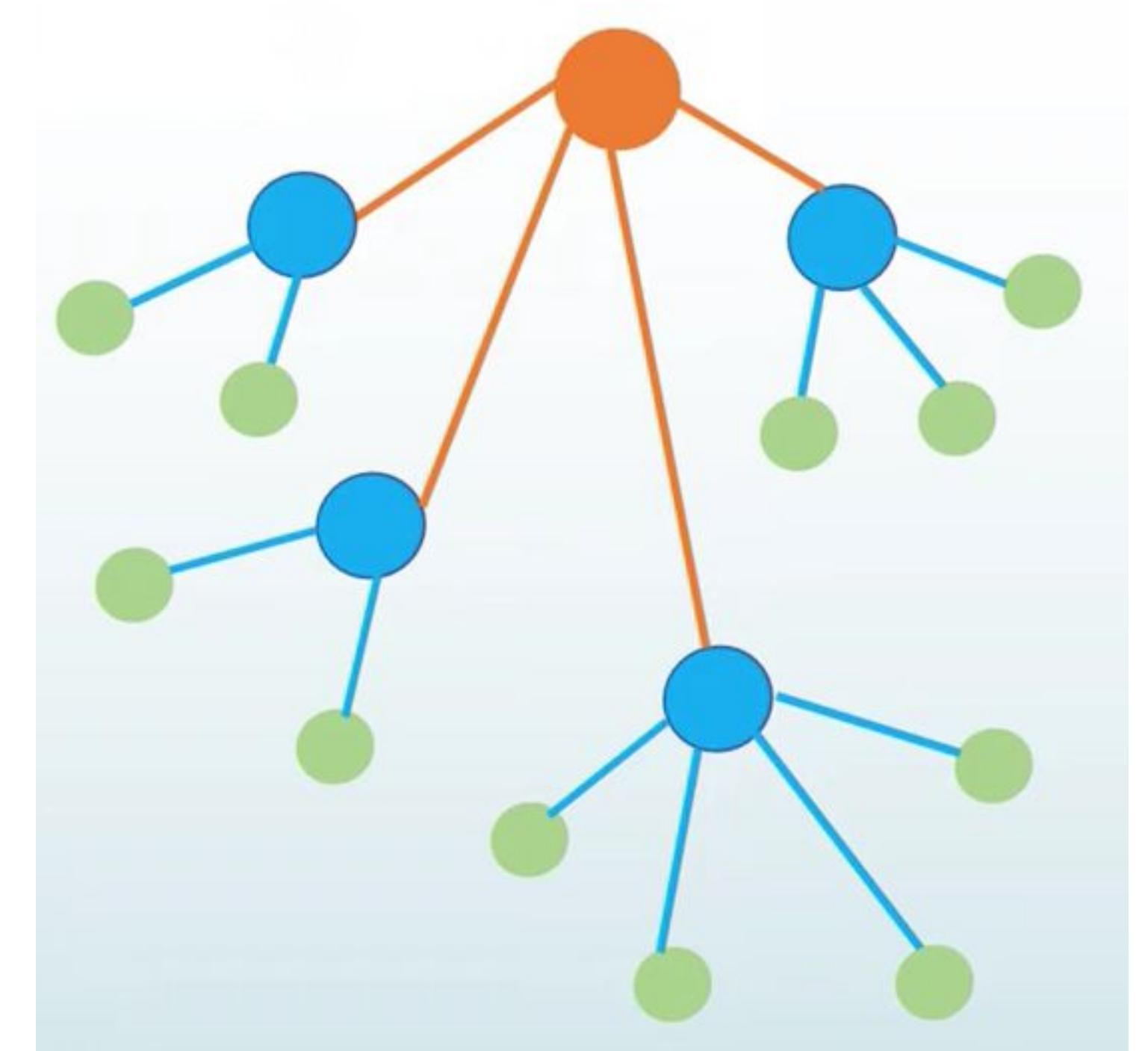
Mesh Topology

- Every node is connected with the neighbouring node(except for the end devices).
- A message hops from one device to another to reach its destination.
- If a node fails, data can be re-routed using another path.
- Self-Healing Process.



Tree Topology

- Its not very different from a mesh configuration
- Routers are not interconnected.



Cluster Tree Network

- Expand Network Range

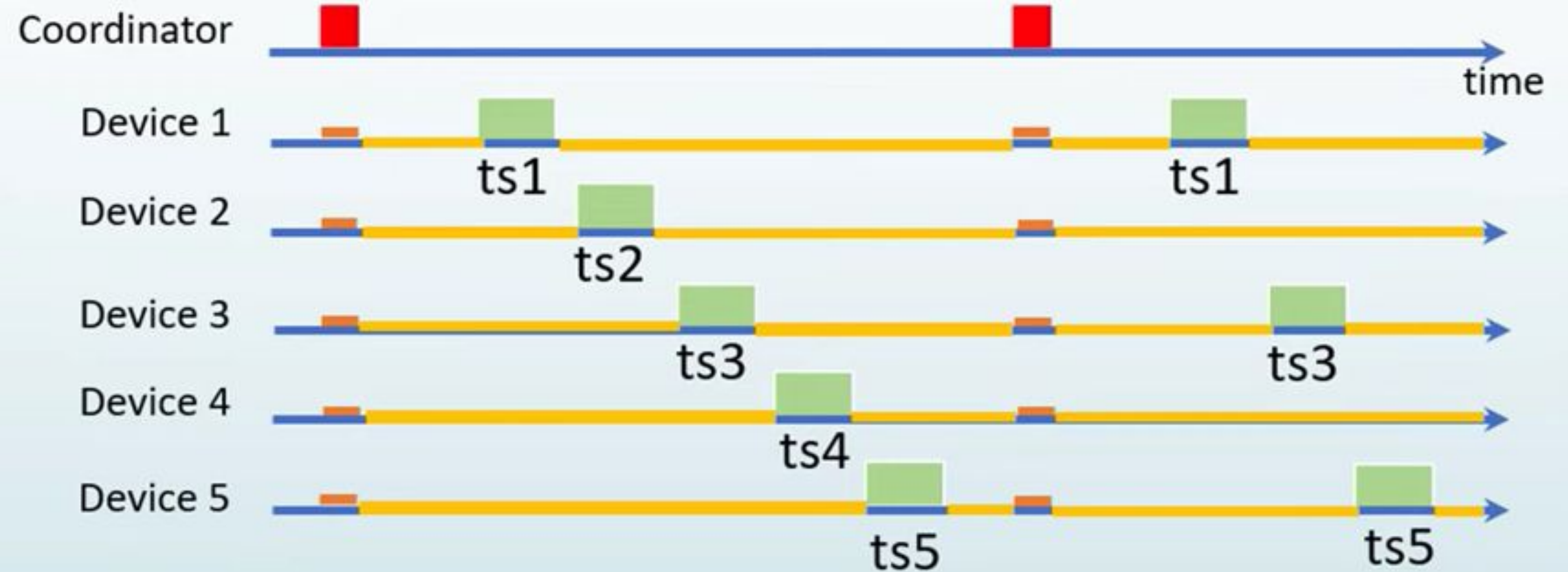
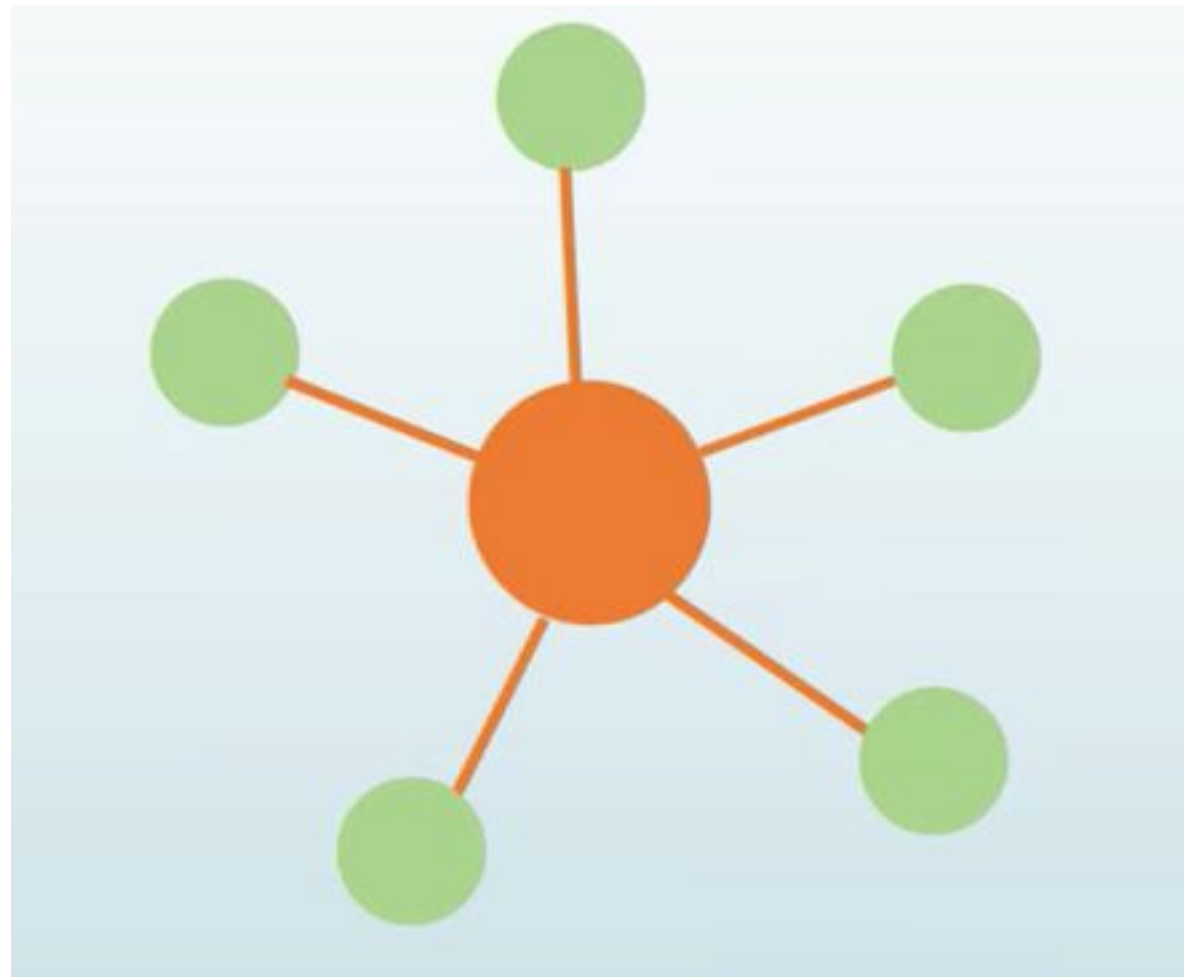
Channel Access

- The coordinator assigns only one channel to the network.
All devices will have to share this single channel to communicate.
- There are two methods for channel access:
 - Contention based method**
 - Contention free method**

Channel Acces

Contention free-method

- The coordinator dedicates a specific time slot to each device. This is called a guaranteed time slot(GTS).
- Beacon is used to synchronise the clocks of all devices in network



Sleep Time



Channel Access

Contention based method

- Devices do not need to be synchronised.
- Carrier Sense Multiple Access-Collision Avoidance Mechanism.
- Anytime a device wants to transmit:
 - It first goes into receive mode.
 - Detect if there is any signal in the channel.
 - Device will only transmit the data if the channel is clear.
 - If the channel is not clear ,the device backs off for a random period of time and tries again.