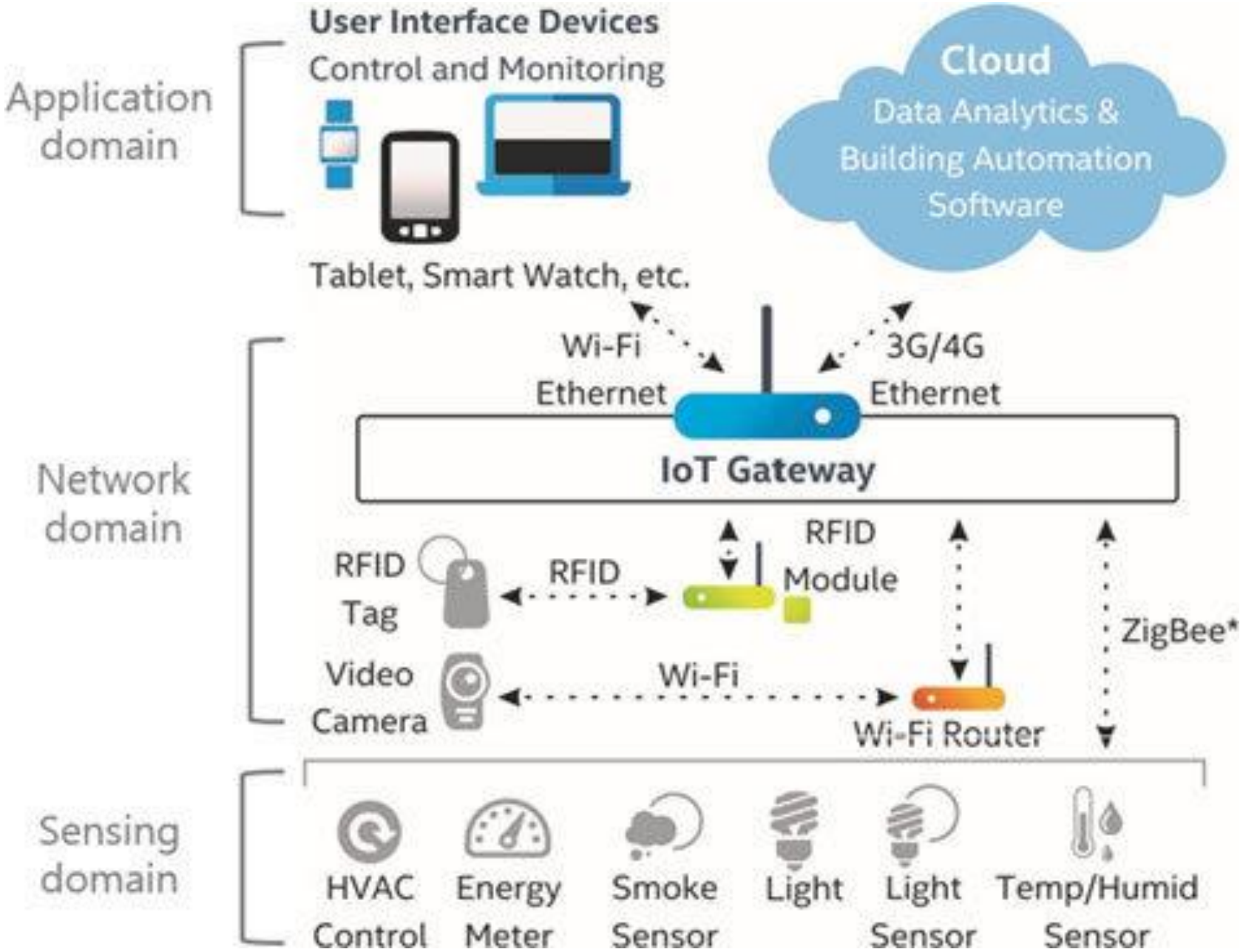
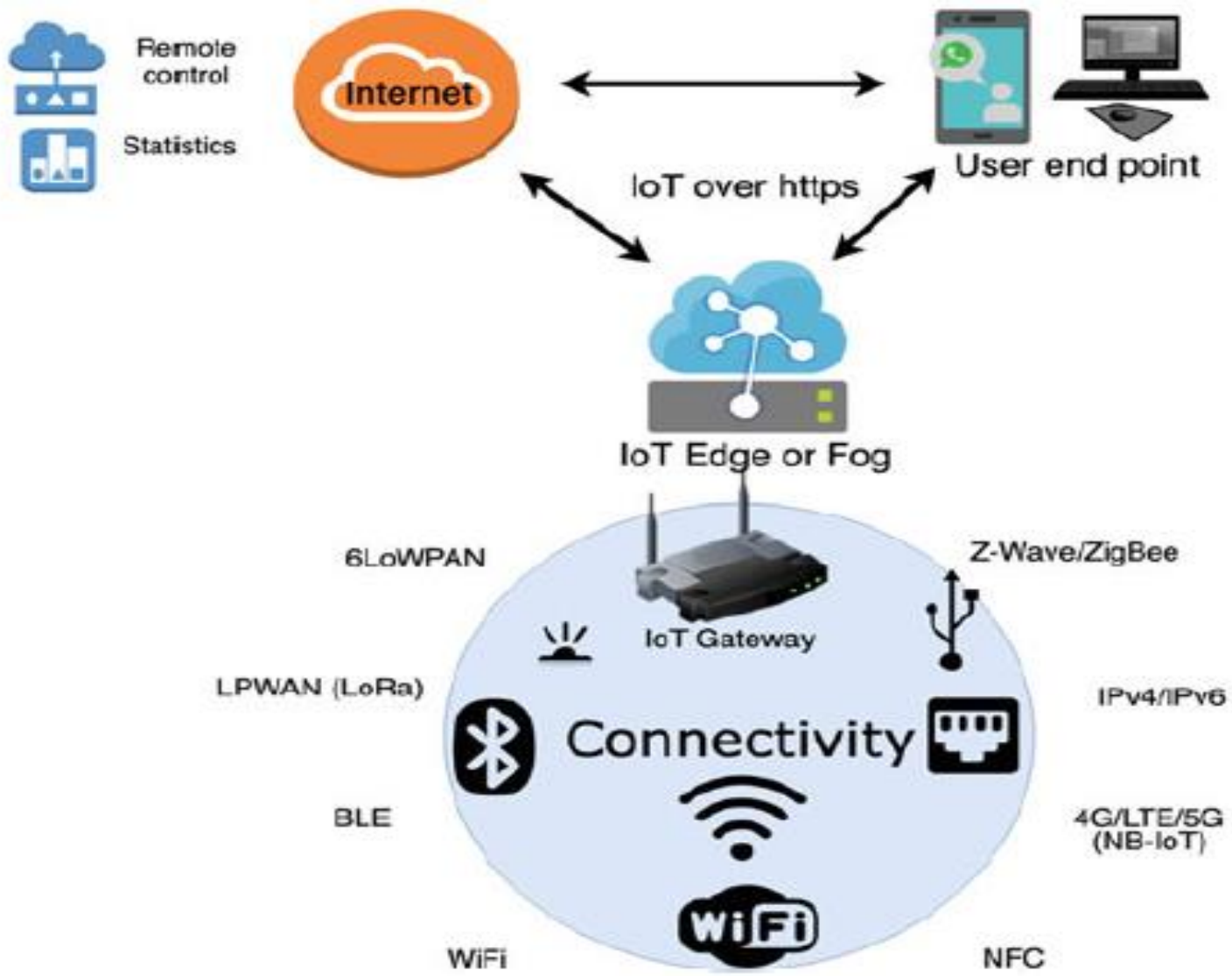
NFC, GPS, Sigfox communication


Application domain
User Interface Devices
Control and Monitoring
Tablet, Smart Watch, etc.
Cloud
Data Analytics & Building Automation Software
Network domain
Wi-Fi
Ethernet
3G/4G
Ethernet
IoT Gateway
RFID Tag
RFID
RFID Module
ZigBee*
Video Camera
Wi-Fi
Wi-Fi Router
Sensing domain
HVAC Control
Energy Meter
Smoke Sensor
Light
Light Sensor
Temp/Humid Sensor


Remote control
Statistics
Internet
User end point
IoT over https
IoT Edge or Fog
6LoWPAN
Z-Wave/ZigBee
IoT Gateway
LPWAN (LoRa)
IPv4/IPv6
Connectivity
BLE
4G/LTE/5G (NB-IoT)
WiFi
NFC

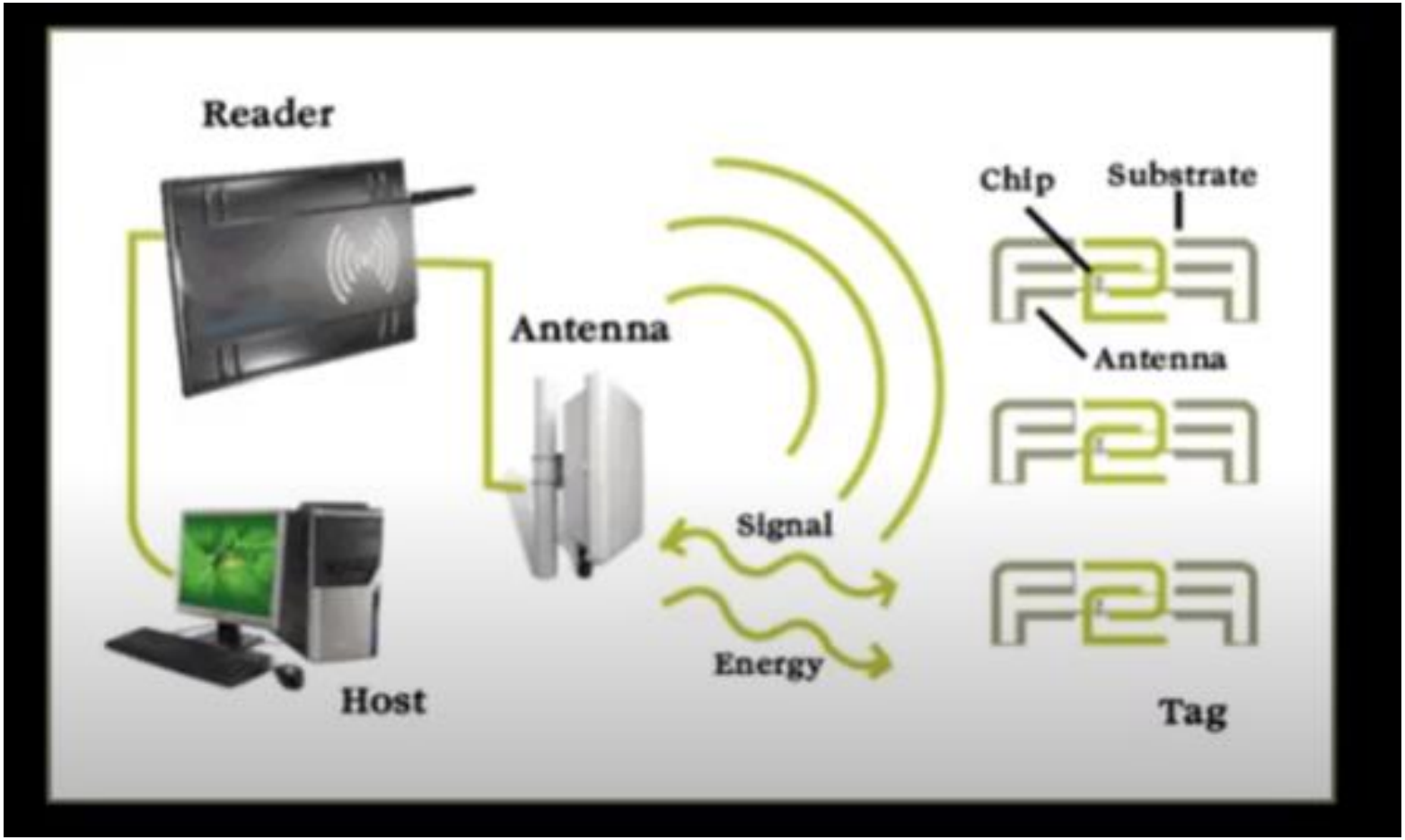
Bluetooth

- Bluetooth is an universal for short range wireless voice and data communication.
- It is a Wireless Personal Area Network (WPAN) technology and is used for exchanging data over smaller distances.
- This technology was invented by Ericson in 1994. It operates in the unlicensed, industrial, scientific and medical (ISM) band from 2.4 GHz to 2.485 GHz.
- Bluetooth ranges up to 10 meters. It provides data rates up to 1 Mbps or 3 Mbps depending upon the version

Bluetooth Low Energy(BLE)

- Bluetooth and Bluetooth Low Energy are used for very different purposes. Bluetooth can handle a lot of data, but consumes battery life quickly and costs a lot more.
- BLE is used for applications that do not need to exchange large amounts of data, and can therefore run on battery power for years at a cheaper cost. It all depends on what you're trying to accomplish.

RFID(Radio frquency identification)



- **Radio-frequency identification** (**RFID**) uses electromagnetic fields to automatically identify and track tags attached to objects.
- An RFID system consists of a tiny radio transponder, a radio receiver and transmitter. When triggered by an electromagnetic interrogation pulse from a nearby RFID reader device, the tag transmits digital data, usually an identifying inventory number, back to the reader. This number can be used to track inventory goods.
- There are two types of RFID tags:
- *Passive tags* are powered by energy from the RFID reader's interrogating radio waves.
- *Active tags* are powered by a battery and thus can be read at a greater range from the RFID reader, up to hundreds of meters.

- Unlike a barcode, the tag does not need to be within the line of sight of the reader, so it may be embedded in the tracked object.
- RFID tags are used in many industries. For example, an RFID tag attached to an automobile during production can be used to track its progress through the assembly line.

Near-Field Communication

- Near Field Communication (NFC) is a short-range, wireless connectivity standard that enables contactless communication and data exchange between compatible devices held in close proximity.
- A subset of Radio-Frequency Identification (RFID) technology, NFC operates on a base transmission frequency of 13.56 MHz and offers secure data transmission within a distance of approximately 10 centimeters.

- 125 - 134 KHz – **Low Frequency (LF)** – An extremely long wavelength with usually a short read range of about 1 - 10 centimeters. This frequency is typically used with animal tracking because it is not affected much by water or metal.
- 13.56 MHz – **High Frequency (HF) & Near-Field Communication (NFC)** – A medium wavelength with a typical read range of about 1 centimeter up to 1 meter. This frequency is used with data transmissions, access control applications, DVD kiosks, and passport security – applications that do not require a long read range.
- 865 - 960 MHz – **Ultra High Frequency (UHF)** – A short, high-energy wavelength of about a one meter which translates to long read range. Passive UHF tags can be read from an average distance of about 5 - 6 meters, but larger UHF tags can achieve up to 30+ meters of read range in ideal conditions. This frequency is typically used with race timing, IT asset tracking, file tracking, and laundry management as all these applications typically need more than a meter of read range.
- As a general rule, higher frequencies will have shorter, higher-energy wavelengths and, in turn, longer read ranges.

- RFID is the process by which items are uniquely identified using radio waves, and NFC is a specialized subset within the family of RFID technology.
- Specifically, NFC is a branch of High-Frequency (HF) RFID, and both operate at the 13.56 MHz frequency. NFC is designed to be a secure form of data exchange, and an NFC device is capable of being both an NFC reader and an NFC tag. This unique feature allows NFC devices to communicate peer-to-peer.
- NFC devices are an ideal solution for applications including but not limited to access control, consumer electronics, transport, payments, healthcare, information collection, information exchange, coupons, and ticketing

What is ZIGBEE

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

Why another short-range communication standard ?

- Zigbee standard is specially 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.

- One of the most commonly used standard for Internet of things (IOT).

- Open source standard that was developed by ZIGBEE Alliance

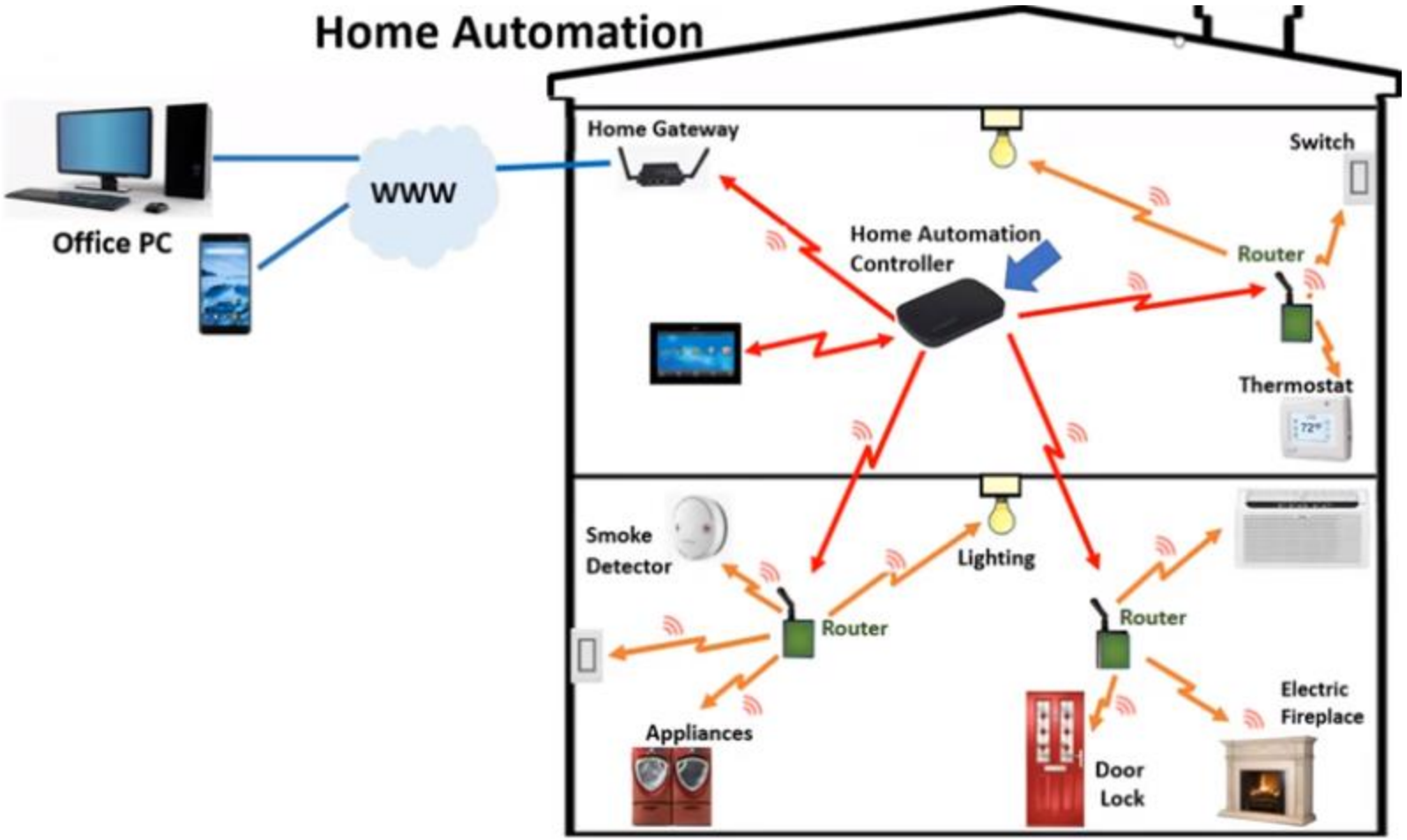
zigbee alliance

ZIGBEE Applications

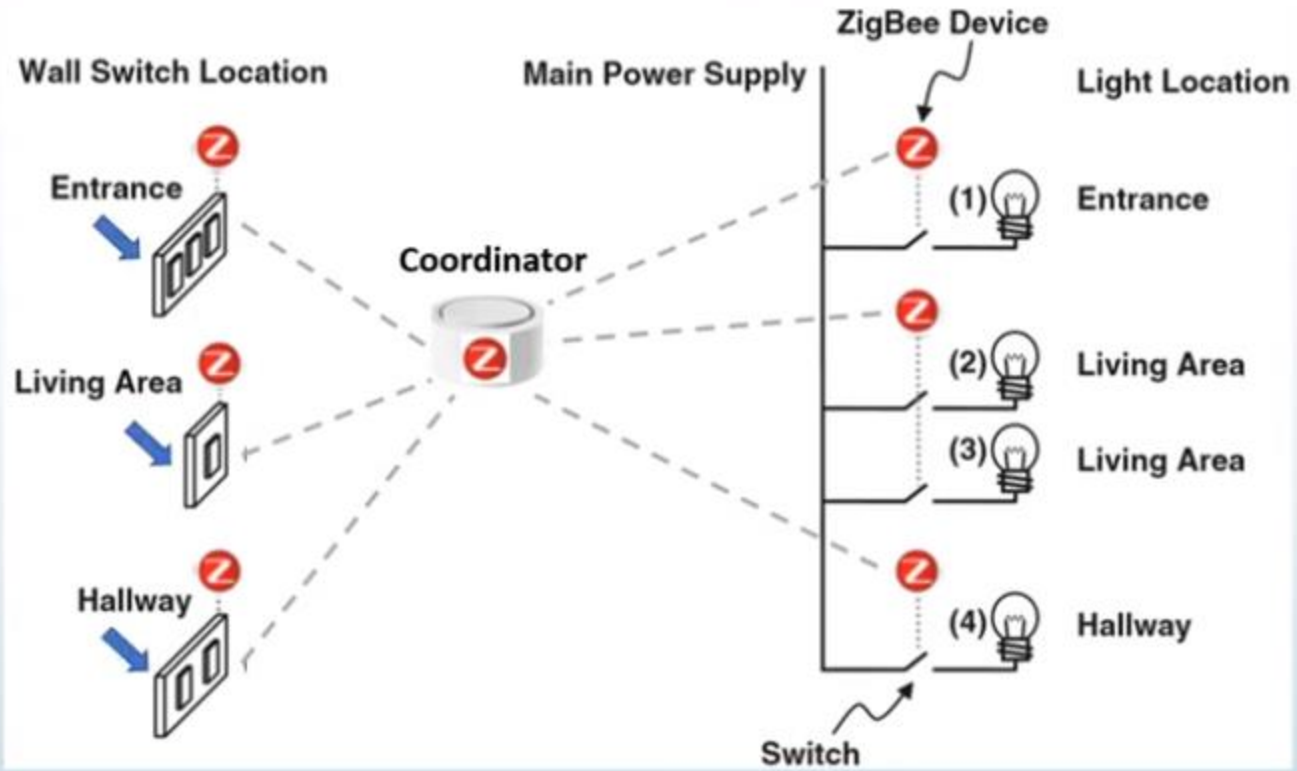
- Home automation
- Medical data collection
- Industrial control systems

Purpose

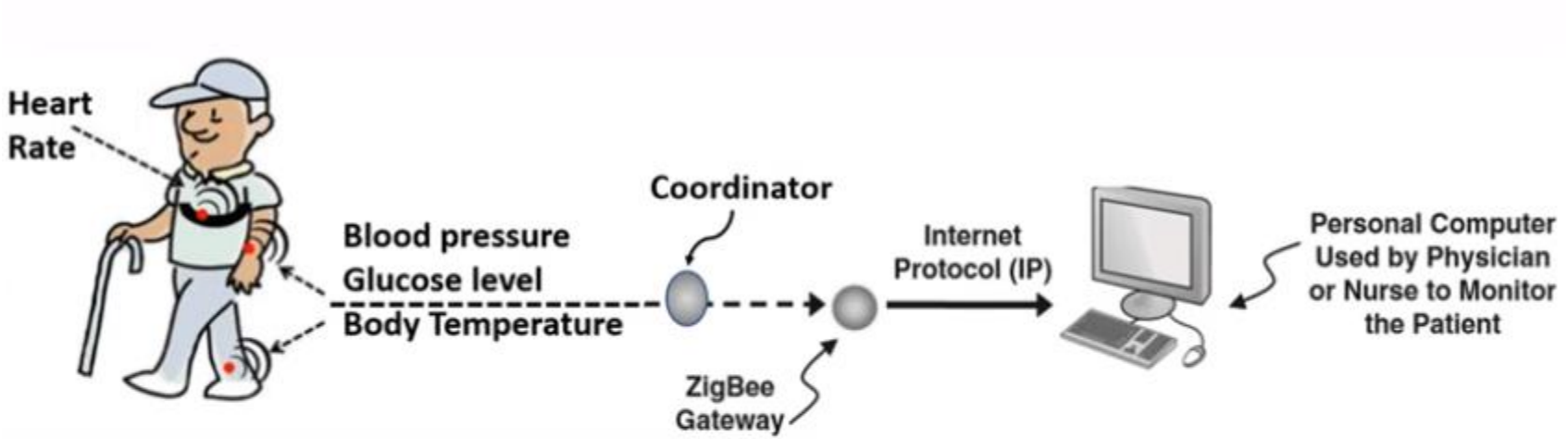
- **Collect information**
- Perform **Control tasks** inside a building


Home Automation
Office PC
WWW
Home Gateway
Switch
Home Automation
Controller
Router
Thermostat
Smoke
Detector
Lighting
Router
Router
Appliances
Electric
Fireplace
Door
Lock

Home Automation



Remote monitoring system



Wi Fi

Too much power
High Data Rate (overkill)

Bluetooth

7 devices max

General characteristics of Zigbee standard

- Low power consumption:

Devices can typically operate for several years on a single battery.

- Low data rate: 20 kbps – 250 kbps

WIFI: 11Mbps, Bluetooth: 1Mbps

- Short Range:

Up to 75-100 meters indoor
Up to 300+ meters (line of sight)

- Network Join time: ~30 msec

WIFI: Up to 3 seconds, Bluetooth: Up to 10 seconds

- Support small and large networks

Up to 65000 devices (in theory) / 240 devices (in practice)

WIFI: Up to 32 devices, Bluetooth: Up to 7 devices

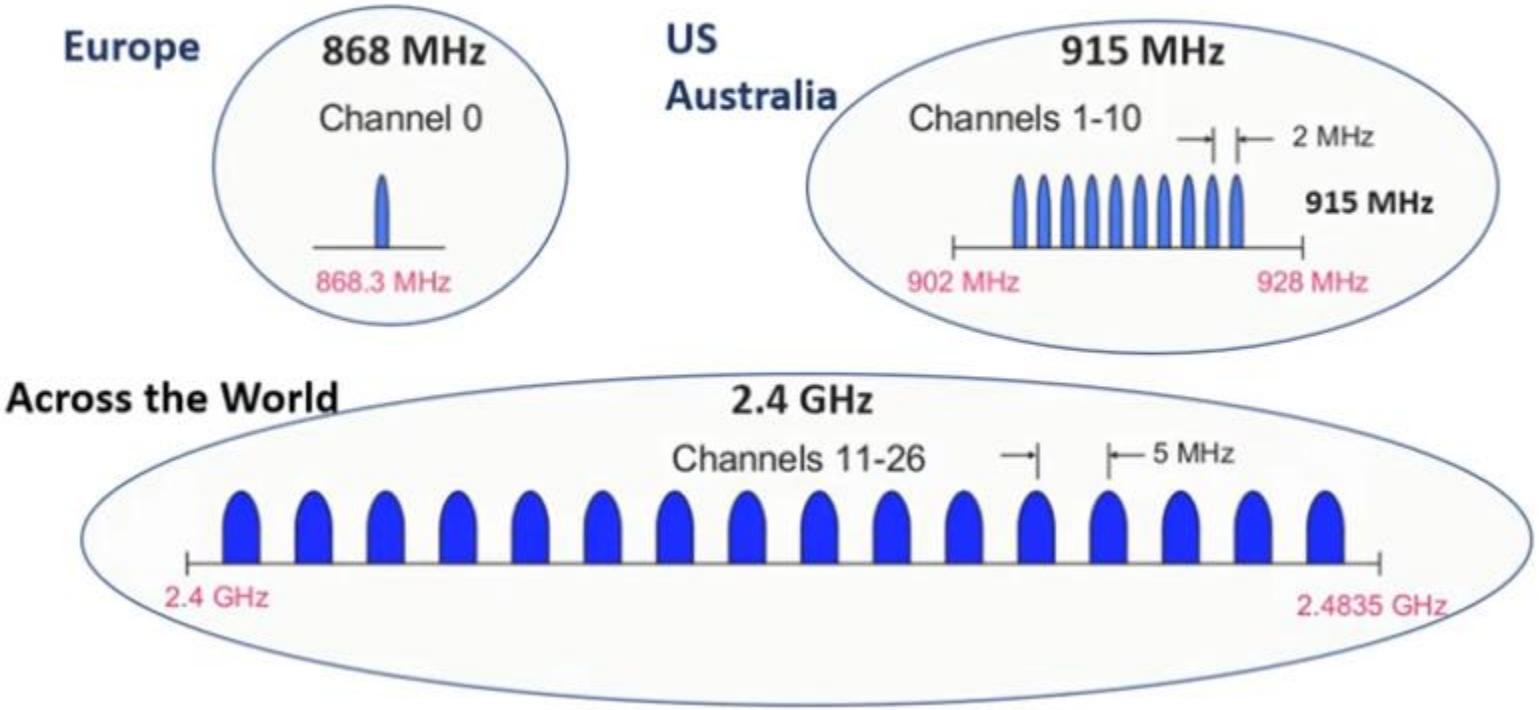
- Low cost of products and cheap implementation

Simplicity of the technology

Open source protocol

Operating frequency band

- There are three frequency bands currently assigned to ZigBee:



4. ZigBee

- Standard: ZigBee 3.0 based on IEEE802.15.4
- Frequency: 2.4GHz
- Range: 10-100m
- Data Rates: 250kbps

5. Z-Wave

- Standard: Z-Wave Alliance ZAD12837 / ITU-T G.9959
- Frequency: 900MHz (ISM)
- Range: 30m
- Data Rates: 9.6/40/100kbit/s

1. Wi-Fi

- **Standard:** Based on 802.11n (most common usage in homes today)
- **Frequencies:** 2.4GHz and 5GHz bands
- **Range:** Approximately 50m
- **Data Rates:** 600 Mbps maximum, but 150-200Mbps is more typical, depending on channel frequency used and number of antennas (latest 802.11-ac standard should offer 500Mbps to 1Gbps)

2. Bluetooth

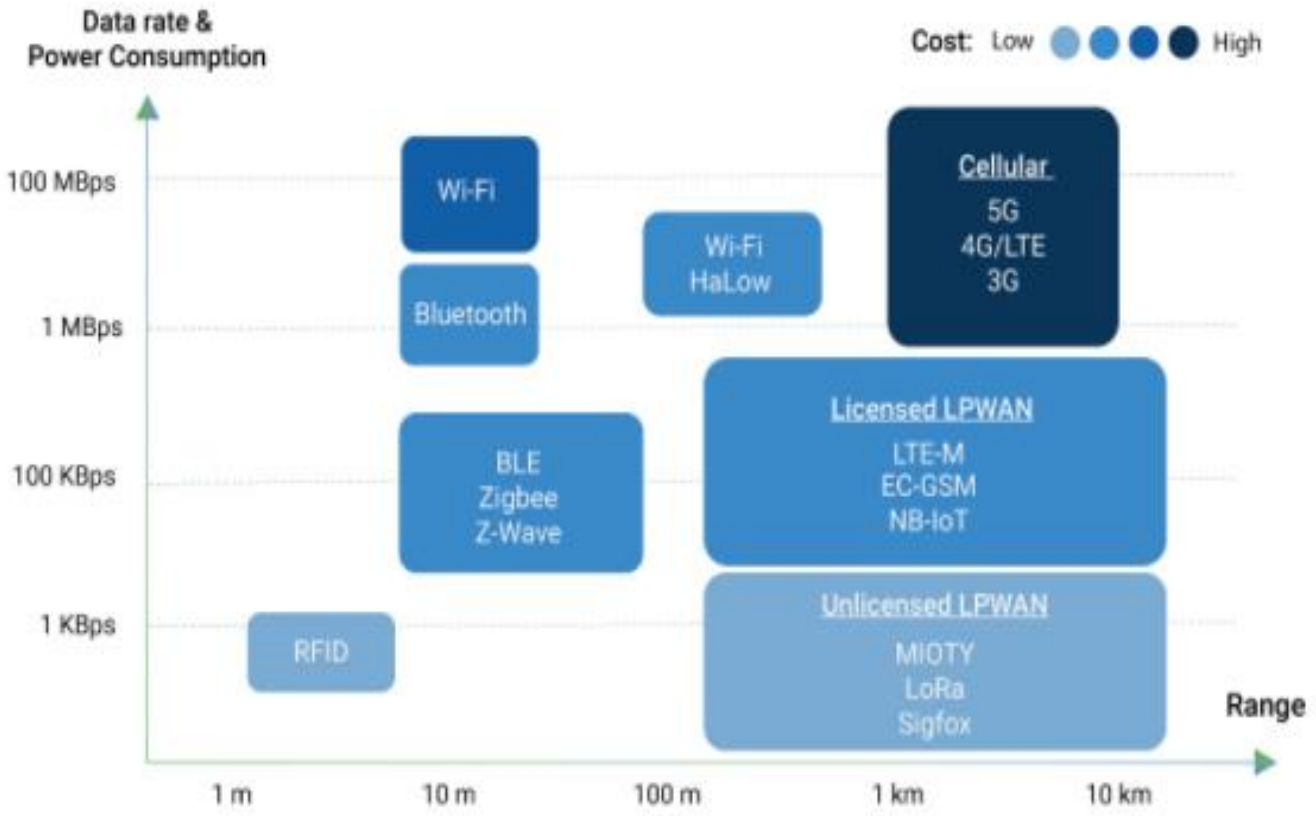
- **Standard:** Bluetooth 4.2 core specification
- **Frequency:** 2.4GHz (ISM)
- **Range:** 50-150m (Smart/BLE)
- **Data Rates:** 1Mbps (Smart/BLE)

LPWAN

- Low-Power Wide Area Networks (LPWANs) are a new phenomenon in Industrial IoT (IIoT). Providing long-range communication on small, inexpensive batteries that last for years.
- LPWANs can connect several types of IIoT sensors and facilitate numerous applications from remote monitoring and worker safety to building controls and facility management.
- LPWANs can only send small blocks of data at a low rate, and therefore are better suited for use cases that don’t require high bandwidth and are not time-sensitive.

- Today, existing LPWANs operate in both the licensed (NB-IoT, LTE-M) and unlicensed (e.g. MIOTY, LoRa, Sigfox etc.) spectrum with varying degrees of network performance.
- For example, while power consumption is a major issue for cellular-based, licensed LPWANs; Quality-of-Service and scalability are main considerations when adopting unlicensed technologies.

IOT protocols comparison



NarrowBand IoT (NB-IoT)

- The NB-IoT provides low energy consumption, small volumes of data and transmission over large distances.
- operates at even lower bandwidths (180 kHz/channel) and lower data rates (20 kbps) in the licensed LTE spectrum

- The NB-IoT provides low energy consumption, small volumes of data and transmission over large distances or deep within buildings.
- It is based on release 13 of 3GPP and operates at even lower bandwidths (180 kHz/channel) and lower data rates (20 kbps) in the licensed LTE spectrum. Mobility is sacrificed in favor of better indoor coverage and support for larger number of devices.
- NB-IoT is managed by cellular operators with expected costs and regulations on access to this network

LTE-M

- **LTE-M** or **LTE-MTC**(“Long-term Evolution Machine Type Communication"), is a type of low power wide area network radio communication technology standard developed by 3GPP for machine to machine and internet of things (IoT) applications.
- The advantage of LTE-M over NB-IoT is its comparatively higher data rate, mobility, and voice over the network, but it requires more bandwidth, is more costly.

- Extended coverage GSM IoT (EC-GSM-IoT) is a standard-based Low Power Wide Area technology. It is based on GPRS and designed as a high capacity, long range, low energy and low complexity cellular system for IoT communications.

How does Lora-based sensor send and receive data