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IIOT - BLUETOOTH

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WHAT IS BLUETOOTH ?

- **Bluetooth** is a wireless standard that devices **use** to exchange data between one another: it's how your smartphone transmits audio to your favorite wireless headphones for playback.
- Bluetooth is managed by the Bluetooth Special Interest Group (SIG), which has more than 35,000 member companies in the areas of telecommunication, computing, networking, and consumer electronics. The IEEE standardized Bluetooth as **IEEE 802.15.1**, but no longer maintains the standard. The Bluetooth SIG oversees development of the specification, manages the qualification program, and protects the trademarks

BLUETOOTH RANGE

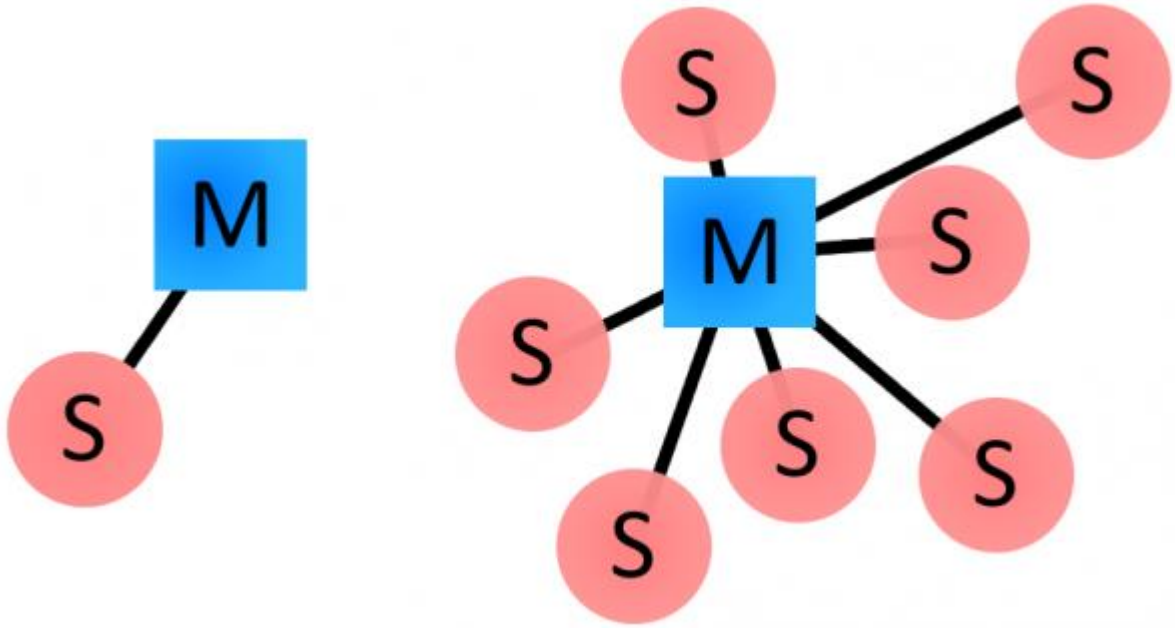
1. Bluetooth is a standardized protocol for sending and receiving data via a 2.4GHz wireless link. It's a secure protocol, and it's perfect for short-range, low-power, low-cost, wireless transmissions between electronic devices.
2. Bluetooth operates at frequencies between 2.402 and 2.480 GHz, or 2.400 and 2.4835 GHz including guard bands 2 MHz wide at the bottom end and 3.5 MHz wide at the top.[18] This is in the globally unlicensed (but not unregulated) industrial, scientific and medical (ISM) 2.4 GHz short-range radio frequency band.
3. Bluetooth uses a radio technology called frequency-hopping spread spectrum. Bluetooth divides transmitted data into packets, and transmits each packet on one of 79 designated Bluetooth channels. Each channel has a bandwidth of 1 MHz. It usually performs 1600 hops per second, with adaptive frequency-hopping (AFH) enabled.[18] Bluetooth Low Energy uses 2 MHz spacing, which accommodates 40 channels

WHY BLUETOOTH IS REQUIRED

Bluetooth is a wireless technology that uses low-energy radio waves to send wireless data between Bluetooth-enabled devices. It's similar to Wi-Fi in that it operates over radio waves. However, Bluetooth can work between any two enabled devices and does not require additional network equipment such as routers or modems, making it a popular choice for sending data between mobile electronics over close ranges. Bluetooth works over a maximum distance of 164 feet between devices, but that range is more than enough for many home, car, health and consumer electronics applications.

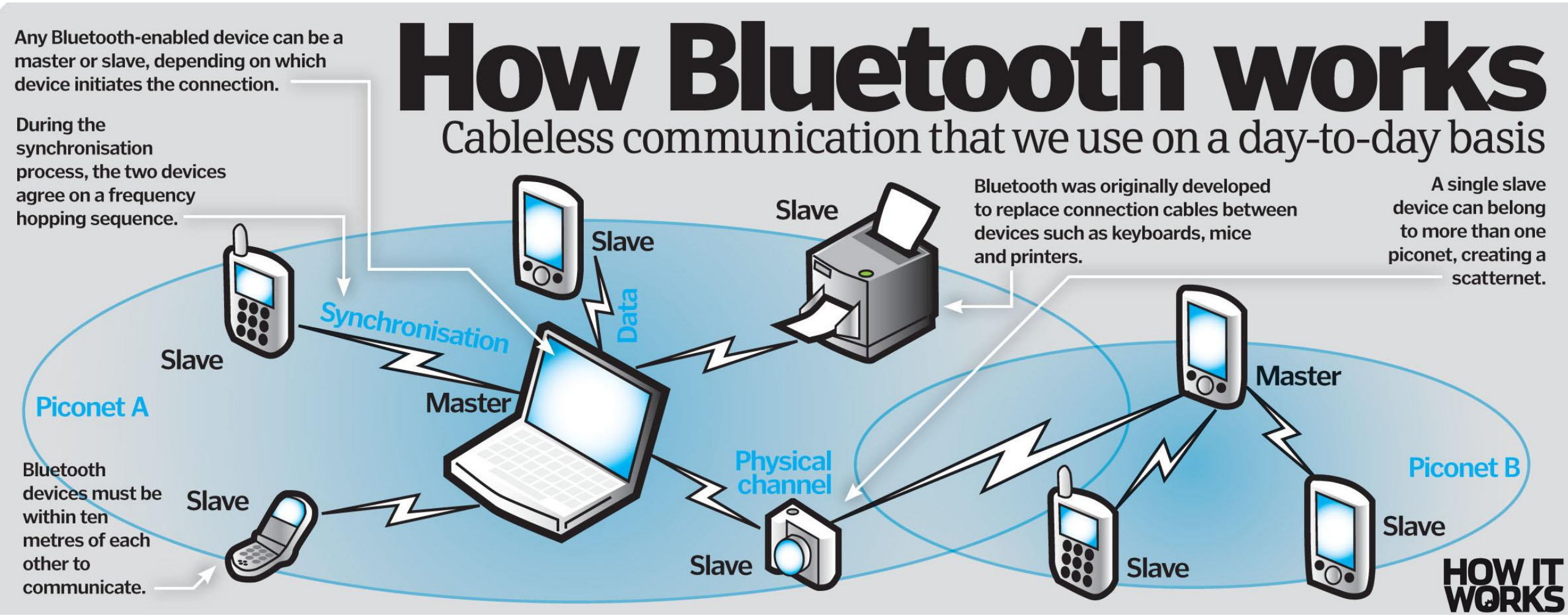
HOW BLUETOOTH WORKS ?

1. Bluetooth networks (commonly referred to as piconets) use a master/slave model to control when and where devices can send data. In this model, a single master device can be connected to up to seven different slave devices. Any slave device in the piconet can only be connected to a single master.



Bluetooth master/slave piconet topologies.

HOW BLUETOOTH WORKS ?



BLUETOOTH ADDRESSES AND NAMES

1. There are two types of Bluetooth Device Addresses, which are called *Public Device Address* and *Random Device Address*.

A Public Device Address is a globally unique 48-bit identifier, which consists of two fields:

- The 24 most significant bits are called the Organizational Unique Identifier, and its purpose is to identify each company. It is administered by the IEEE Registration Authority.
- The 24 least significant bits are assigned by the company, and they serve the purpose of identifying each device.

2. A Random Device Address is a privacy feature of the BLE protocol, and it helps to prevent tracking of a device. BLE provides a resolution mechanism so that only a device which holds the connection link key can identify the device.
3. This address should be visible on most Bluetooth devices. For example, on this RN-42 Bluetooth Module, the address printed next to "MAC NO." is 000666422152:

SETTING THE DEVICE NAME

- Since it would be quite difficult for a user to identify a device using only its BD Address, BLE provides the Device Name property, which is a human-friendly name used to tag a device. This is assigned with the USER_DEVICE_NAME macro, which can be customized in `user_config.h`.

- `/// Device name`
- `#define USER_DEVICE_NAME "DLG-BRBN"`

- `/// Device name length`
- `#define USER_DEVICE_NAME_LEN (sizeof(USER_DEVICE_NAME)-1)`

Bluetooth

1. Bluetooth is a standardized protocol for sending and receiving data via a 2.4GHz wireless link. It's a secure protocol, and it's perfect for short-range, low-power, low-cost, wireless transmissions between electronic devices.

Connection Process

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.

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).

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.

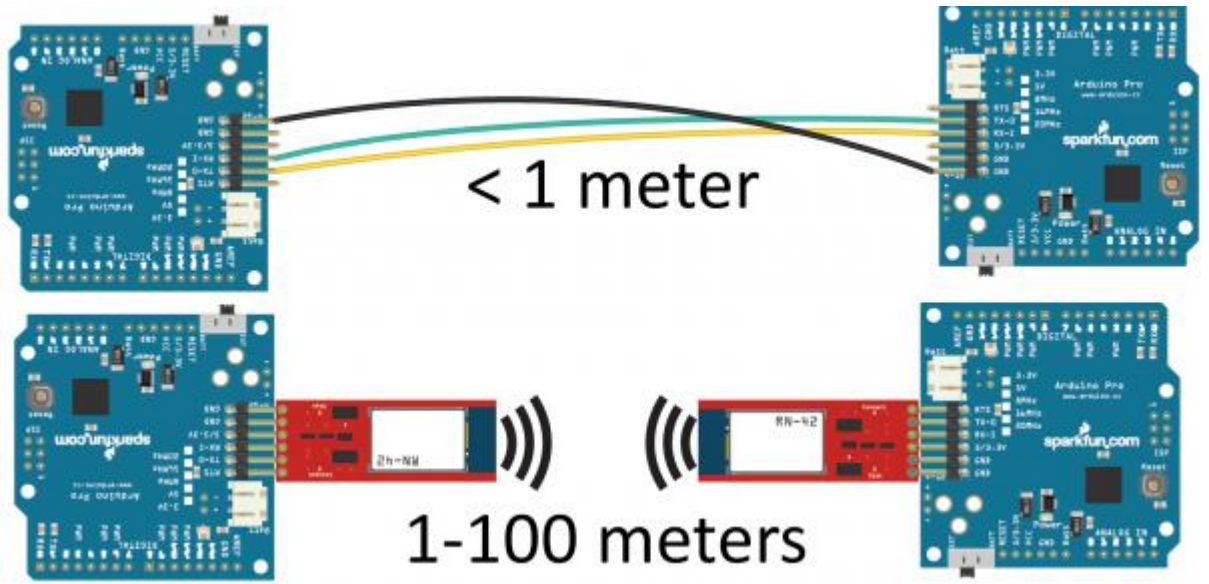
Park Mode -- Park is the deepest of sleep modes. A master can command a slave to "park", and that slave will become inactive until the master tells it to wake back up.

Power Classes

Class Number	Max Output Power (dBm)	Max Output Power (mW)	Max Range
Class 1	20 dBm	100 mW	100 m
Class 2	4 dBm	2.5 mW	10 m
Class 3	0 dBm	1 mW	10 cm

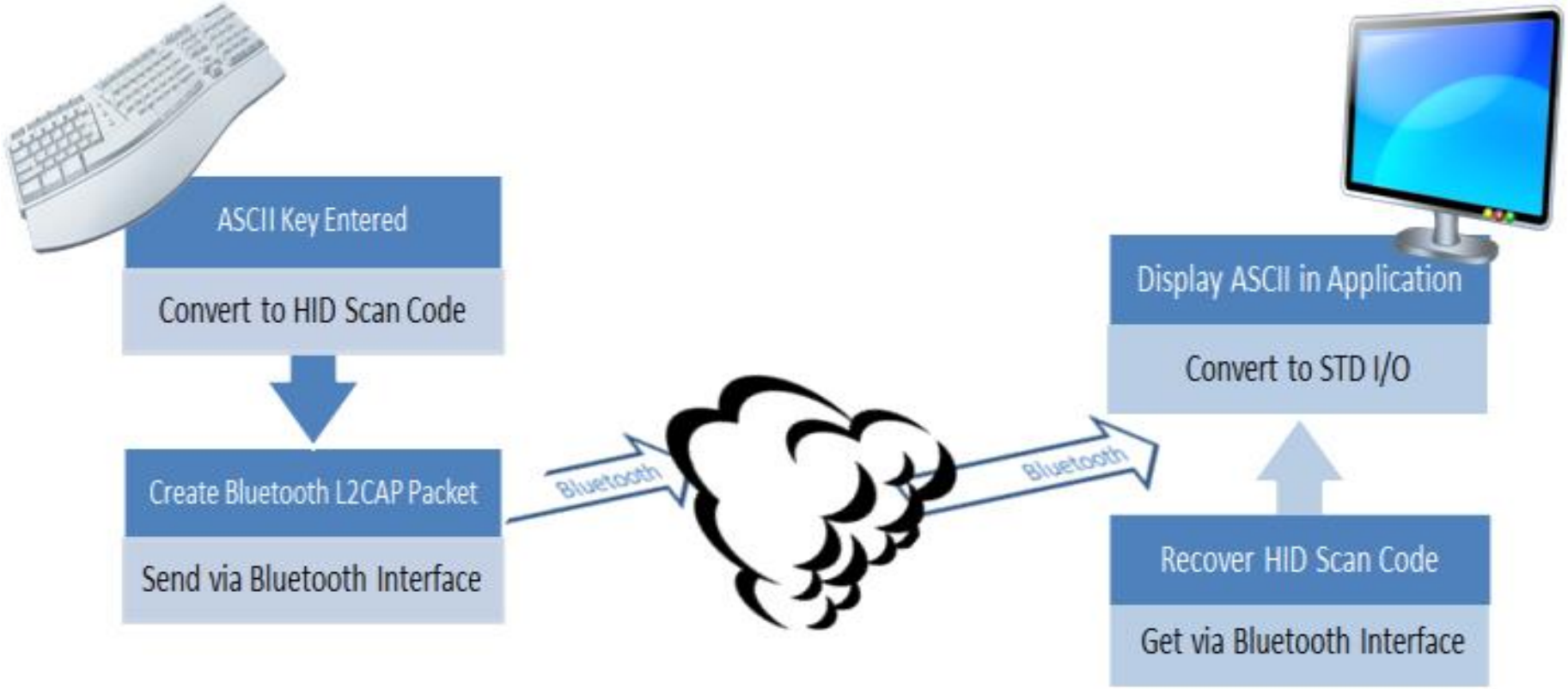
Bluetooth - Serial Port Profile (SPP)

1. If you're replacing a serial communication interface (like RS-232 or a UART) with Bluetooth, SPP is the profile for you. SPP is great for sending bursts of **data** between two devices
2. Using SPP, each connected device can send and receive data just as if there were RX and TX lines connected between them. Two Arduinos, for example, could converse with each other from across rooms, instead of from across the desk



Human Interface Device (HID)

1. HID is the go-to profile for Bluetooth-enabled user-input devices like mice, keyboards, and joysticks. It's also used for a lot of modern video game controllers, like WiiMotes or PS3 controllers.



Bluetooth - Common Versions

- **Bluetooth v1.2**

  The v1.x releases laid the groundwork for the protocols and specifications future versions would build upon. Bluetooth v1.2 was the latest and most stable 1.x version.

- **Bluetooth v2.1 + EDR**

  The 2.x versions of Bluetooth introduced **enhanced data rate (EDR)**, which increased the data rate potential up to 3 Mbps (closer to 2.1 Mbps in practice). Bluetooth v2.1, released in 2007, introduced **secure simple pairing (SSP)**, which overhauled the pairing process.

- **Bluetooth v3.0 + HS**

  You thought 3 Mbps was fast? Multiply that by eight and you have Bluetooth v3.0's optimum speed -- 24 Mbps. That speed can be a little deceiving though, because the data is actually transmitted over a WiFi (802.11) connection. Bluetooth is only used to establish and manage a connection.

Bluetooth v4.0 and Bluetooth Low Energy

Bluetooth 4.0 split the Bluetooth specification into three categories: classic, high-speed, and low-energy. Classic and high speed call back to Bluetooth versions v2.1+EDR and v3.0+HS respectively. The real standout of Bluetooth v4.0 is **Bluetooth low energy (BLE)**.

Bluetooth - Wireless Comparison

Name	Bluetooth Classic	Bluetooth 4.0 Low Energy (BLE)	ZigBee	WiFi
IEEE Standard	802.15.1	802.15.1	802.15.4	802.11 (a, b, g, n)
Frequency (GHz)	2.4	2.4	0.868, 0.915, 2.4	2.4 and 5
Maximum raw bit rate (Mbps)	1-3	1	0.250	11 (b), 54 (g), 600 (n)
Typical data throughput (Mbps)	0.7-2.1	0.27	0.2	7 (b), 25 (g), 150 (n)
Maximum (Outdoor) Range (Meters)	10 (class 2), 100 (class 1)	50	10-100	100-250
Relative Power Consumption	Medium	Very low	Very low	High
Example Battery Life	Days	Months to years	Months to years	Hours
Network Size	7	Undefined	64,000+	255

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THANK YOU

JUST BE
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AND
FOCUSED