lamaPLC Communication: Bluetooth basic

Bluetooth is a short-range wireless technology standard for exchanging data between fixed and mobile devices over short distances and building personal area networks (PANs). In the most widely used mode, transmission power is limited to 2.5 milliwatts, giving it a concise range of **up to 10 metres** (33 ft).

It employs UHF radio waves in the ISM bands, from 2.402 GHz to 2.48 GHz. It is mainly used as an alternative to wired connections to exchange files between nearby portable devices and connect cell phones and music players with wireless headphones.

Bluetooth is managed by the Bluetooth Special Interest Group (SIG), which has over 35,000 member companies in 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 the development of the specification, manages the qualification program, and protects trademarks. A manufacturer must meet Bluetooth SIG standards to market a device as Bluetooth.

The name *“Bluetooth”* was proposed in 1997 by Jim Kardach of Intel, one of the founders of the Bluetooth SIG. The name was inspired by a conversation with Sven Mattisson, who related Scandinavian history through tales from Frans G. Bengtsson's The Long Ships, a historical novel about Vikings and the 10th-century Danish king Harald Bluetooth. Upon discovering a picture of the runestone of Harald Bluetooth in the book A History of the Vikings by Gwyn Jones, Kardach proposed Bluetooth as the codename for the short-range wireless program, which is now called Bluetooth.

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, enabling adaptive frequency-hopping (AFH). Bluetooth Low Energy uses 2 MHz spacing, which accommodates 40 channels.

Bluetooth is a packet-based protocol with a **master/slave architecture**. One master may communicate with up to seven slaves in a piconet. All devices within a given piconet use the clock provided by the master as the base for packet exchange. The master clock ticks with a period of 312.5 µs; two clock ticks make up a slot of 625 µs, and two slots make up a slot pair of 1250 µs.

In the simple case of single-slot packets, the master transmits in even slots and receives in odd slots. The slave, conversely, receives in even slots and transmits in odd slots. Packets may be 1, 3, or 5 slots long, but in all cases, the master's transmission begins in even slots and the slave's in odd slots.

The Bluetooth SIG completed the Bluetooth Core Specification **version 4.0** (*called Bluetooth Smart*) and has been adopted as of 30 June 2010. It includes Classic Bluetooth, high speed, and Bluetooth Low Energy BLE protocols. Bluetooth high speed is based on Wi-Fi, and Classic Bluetooth consists of legacy Bluetooth protocols.

Bluetooth Low Energy (**BLE**), previously known as Wibree, is a subset of Bluetooth v4.0 with an entirely new protocol stack for rapidly building simple links. As an alternative to the Bluetooth standard protocols introduced in Bluetooth v1.0 to v3.0, it is aimed at low-power applications powered by a coin cell. Chip designs allow for two implementation types: dual-mode, single-mode, and enhanced past versions. The provisional names Wibree and Bluetooth ULP (Ultra Low Power) were abandoned, and the BLE name was used for a while.

The Bluetooth SIG released the Bluetooth Core Specification **Version 5.4** on 7 February 2023.

Bluetooth is defined as a layer architecture consisting of core protocols, cable replacement protocols, telephony control protocols, and adopted protocols. Mandatory protocols for all Bluetooth stacks are **LMP** *(Link Manager Protocol)*, **L2CAP** *(Logical Link Control and Adaptation Protocol)* and **SDP** *(Service Discovery Protocol)*. In addition, devices that communicate with Bluetooth almost universally can use these protocols: **HCI** *(Host Controller Interface)* and **RFCOMM** *(Radio Frequency Communications)*.

Bluetooth Low Energy

Bluetooth Low Energy (**BLE**), referred to as Bluetooth® LE, is a wireless communication technology designed for short-range data exchange between electronic devices. It emerged to address the need for energy-efficient wireless communication across various applications, especially when power consumption is a critical concern.

Unlike its predecessor, Bluetooth Classic, which is optimized for continuous and relatively high-data-rate communication, Bluetooth LE minimizes energy consumption while maintaining connectivity. This makes Bluetooth LE particularly suitable for applications that require long battery life, such as fitness trackers, healthcare devices, smart sensors, and *Internet of Things* (**IoT**) devices.

The range of a Bluetooth Low Energy connection can vary depending on several factors. Still, in typical scenarios, it can extend up to approximately **50 meters** in a line-of-sight environment.

Bluetooth Low Energy devices operate using different roles and modes that define how devices interact with each other.

Central Device

A central device in Bluetooth LE is typically more capable with features like a higher CPU power, more memory, or a larger battery. Central devices take on the role of initiating connections to peripheral devices. For example, your smartphone is often a central device when connecting to Bluetooth LE peripherals like fitness trackers, smart sensors, or an Arduino board.

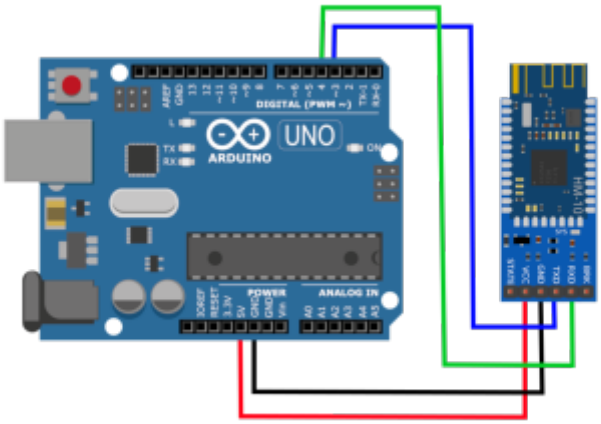
Peripheral Device

Peripheral devices are generally resource-constrained compared to central devices (e.g., an Arduino board compared with your smartphone). Peripheral devices advertise their presence and data to central devices. Compared to Bluetooth Classic, Bluetooth LE devices don't maintain a continuous connection to the central device to save power.

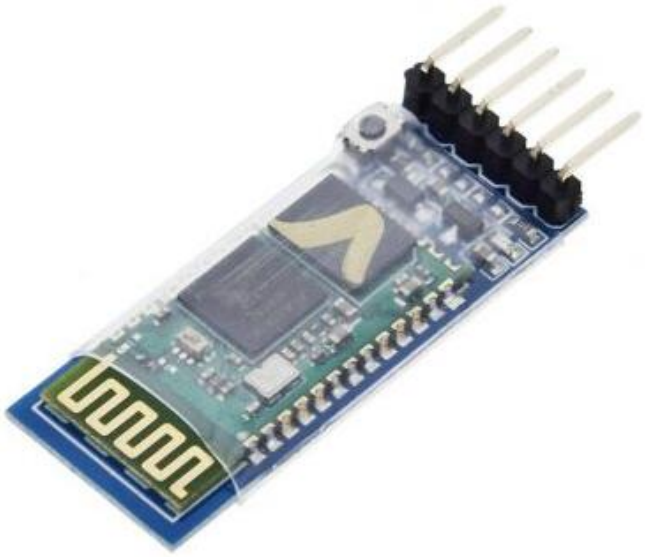
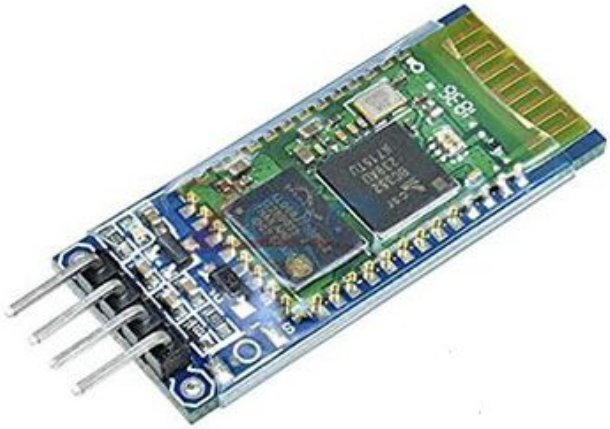
ArduinoBLE Library

The ArduinoBLE Library is the main library enabling Bluetooth Low Energy on compatible Arduino

boards.



HC-xx type modules most often perform Arduino Bluetooth communication. The two basic types of these are HC-05 and HC-06; their comparison:

HC-05	**HC-06**
	
- HC-05 module can either be a master or slave - It has a push button - HC-05 has five header pins	- HC-06 module can only be a slave - No push button - HC-06 has only four header pins

Sources

Wikipedia: https://en.wikipedia.org/wiki/Bluetooth
Arduino: https://docs.arduino.cc/learn/communication/bluetooth/#frequency-bands-and-range

Bluetooth topics on lamaPLC

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communication, bus, bluetooth, ISM, IEEE, 802.15.1, BLE, LMP, L2CAP, RFCOMM, IoT, Arduino, HC-05, HC-06