

Technical Review of Bluetooth Communication Protocol

Introduction

Bluetooth communication is governed by IEEE 802.15.1 standard and is described as short-range radio frequency connectivity [1]. This wireless communication protocol can be used to send data between two Bluetooth enabled devices. It is targeted at short-range, low power communication applications especially in the Internet of Things (IoT) market. This paper reviews the Bluetooth wireless communication protocol.

Current State of the Art

Bluetooth has advanced since its introduction in 2002. Currently, Bluetooth 4.2 Low Energy is the newest generation available. Its introduction has paved the way for Bluetooth 5.0 that will be introduced in early 2017 [2]. Because these generations are new to the market or not available yet, most of the Bluetooth products on the market have not integrated the newest Bluetooth 4.2 and may use an older generation such as Bluetooth 4.0 Low Energy. These new generations of Bluetooth are aimed at the Internet of Things market [3].

Bluetooth technology is used in many products. If a customer wants to add Bluetooth technology to an existing item, Texas Instruments manufactures many Bluetooth modules. The CC2564MODx module incorporates Bluetooth 4.1 along with an antenna to broadcast the signal to the receiving device [4]. The module retails for \$14.73 on DigiKey [5]. Additionally, the RFDuino manufactured by Simblee is a microcontroller that already incorporates Bluetooth 4.0 technology. It retails for \$29.95 on Sparkfun [6]. These items are relatively simple applications, but Bluetooth can scale up to much larger devices.

An example of a more complicated application of Bluetooth is the cell phone. Most cell phones have Bluetooth communication capabilities. This allows cell phones to communicate with all the IoT devices available for personal use. According the Bluetooth website, the consumer can use Bluetooth to connect his/her smartphone to his/her smart watch heart rate monitor, control the music playing on speakers, and remotely control household devices such as thermostats, door locks, lights, and televisions [3].

How the Underlying Technology Functions

Bluetooth communication protocol is governed by IEEE 802.15.1 protocol. As this protocol states, Bluetooth uses short-range radio waves to send data as opposed to wires. The radio waves that send the data operate in the unlicensed 2.4GHz frequency band. In order to combat interference with other signals, the transmitting frequency of the packet depends on the hopping sequence. This hopping

sequence occurs at 1600 hops/second. The selection of this free frequency occurs in the master device. In a connected network, there is one master device and all the others act as slaves. A master device and up to seven slave devices characterize a piconet. These piconets may overlap. For example, a device can be a slave in many piconets and a master in only one piconet. This overlapping of piconets creates a scatternet. The scatternet is important for transmitting data over longer distances [7].

The coverage area and power consumption are measures of performance. The coverage area is the distance between which two devices can communicate. A large coverage area requires more power. For example, the typical coverage area of 100 meters consumes about 100mW of power [7]. In comparison, 2.5mW of power will transmit signals 10 meters [8]. Connecting piconets into a scatternet (as described above) can allow data to flow from one coverage area to another [7].

Basic Building Blocks for Implementation

Bluetooth requires both hardware and software in order to be implemented. A Bluetooth transmitter/antenna and receiver are required in order to communicate data. Most cell phones already have the correct hardware installed along with many household electronic devices, as discussed above [3]. If the devices do not have Bluetooth hardware installed, it needs to be added using a Bluetooth module or dongle. The transmitter/antenna will send the data through the determined radio frequency and the receiver will receive this signal. There are amplifiers available to boost the Bluetooth signal and allow the data to be sent a greater distance. Industrial XR has a standard range of one kilometer and an extended range up to ten kilometers [9].

In order for the communication to be successful, the Bluetooth devices must be paired. This is a software operation that searches for other Bluetooth devices and connects to desired item per user selection. Once two devices are paired, they become bonded and will automatically connect when within range [8]. The Bluetooth devices now agree to communicate and will be able to send data according to IEEE 802.15.1 protocol.

References

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