

Review on Bluetooth Technology with BLE 5.0

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Abstract- Bluetooth is short range wireless technology network, which is managed by SIG (Special Interest Group). Bluetooth technology has started from cable replacement and it has been continued to Low Energy and then Mesh Technology. As per requirements of Application Development, different specifications are available in the market. Every specification has their own pros and cons. Specification of Bluetooth 5.0 is known as Low Energy Device. The study of BLE 5.0 demonstrates Design and performance evolution of BLE 5.0 at Link Layer and PHY. The Link Layer and Physical Layer (PHY) of the BLE 5.0 architecture are used in controller. It has been decreases complexity of hardware and power consumption. The designing language of the Link Layer and PHY is synthesizable Verilog.

Keyword – Bluetooth Technology, PHY, verilog, IoT, BLE 5.0, wireless.

I. INTRODUCTION:

Bluetooth replaces cables in devices like keyboard, mouse or a PCs, which is known as wireless technology standard for exchanging data over short distance using radio waves. This technology is also referred as "Low Power Technology", and use cases are to connect sensors with phones or PCs. BLE 5.0 uses 2.4 GHz ISM band (this band is freely available), and is aimed is to run on batteries for longer periods of time and may need to consume less power - months, or it can be even years.

BLE 5.0 was introduced in the previous version 4.0 of the Bluetooth specification in 2010. BLE 5.0 was not an upgraded version of Bluetooth Classic, BLE 5.0 is new technology which is focuses on Internet of Things (IoT) applications where less data transfers at low speed. It is very important to notice difference between Bluetooth Classic and BLE 5.0 in terms of technical specification, implementation and the types of applications they're each suitable for.

LE has gone through some major revisions and changes in the short time since its official release in 2010, where BLE 5.0 was released in December 2016 with major updatable BLE 5.0 was introduced with many updates in the BLE Specification and focused to Low Energy. Some of the most important enhancements include double the speed, four times the range, and eight times the advertising data capacity.

Every technology has its own benefits and limitations, and BLE is no exception. It is important to know benefits and limitations to be able to determine that BLE is suitable for the specific application and use cases. BLE 5.0 specifications characterizes how Bluetooth devices will gather themselves for the purpose of exchange data or information.

A. Bluetooth Specifications:

The Bluetooth specifications are required in the wireless world to stand for better future. There are many specifications in Bluetooth technology.

Bluetooth specifications characterizes how Bluetooth devices will gather themselves for the purpose of communication.

1) Bluetooth 1.0 and 1.0 B

This specification has many problems. The external hardware is required during transmission procedure.

2) Bluetooth 1.1

The Bluetooth 1.1 was rectified as IEEE standard 802.15.2 in 2000. This specification improved many aspects of the previous version.

3) Bluetooth 1.2

The Bluetooth 1.2 has faster connectivity compare to the previous versions. The adaptive frequency hopping spectrum introduced in Bluetooth 1.2. The transmission speed is around 725 kb/s.

4) Bluetooth 2.0 + EDR

This version was realised in 2004. The EDR is stands for Enhanced Data Rate for transfer data fast. The bit rate is 3MB/s in this specification.

EDR uses modulation techniques are GFSK, pi/4 DQPSK and 8 DPSK.

In this specification the EDR is optional feature.

5) Bluetooth 3.0 + H.S.

HS is stands for high speed. The Bluetooth 3.0 + H.S. is released in April, 2009. The major new feature of the Bluetooth 3.0 + HS is its AMP (Alternate PHY/MAC).

6) Bluetooth 4.0

Bluetooth SIG has released Bluetooth 4.0 in June, 2010. The Bluetooth 4.0 is also known as Bluetooth smart. It is well known for its higher speed and Bluetooth Low Energy Protocol. BLE is used for low power consumption.

7) Bluetooth 4.1

There are many features introduced in this specification. This specification was released in 2013.

8) *Bluetooth 5.0*

New features of Bluetooth Low Energy 5.0 are 4x the range, 2x speed, and 8x broadcast messaging capacity.

Bluetooth 5 provides three low energy PHYs:

LE 1M PHY –1M/s bit rate; uncoded. This PHY is used in Bluetooth 4.0.

LE Coded PHY (new) – 1Ms/s with error correction coding. Used for Bluetooth 5's "4x range".

LE 2M PHY (new) –2Ms/s uncoded. Used for Bluetooth 5's "2x speed". So, with two new PHYs, we gain 4x range and 2x speed, and additional message capacity.

31 octets payload was maximum in BLE 4.0. In Bluetooth 5, increased the payload to 255 octets by adding additional advertising channels and new advertising PDUs.

In non-connectable advertising, interval reduces from 100ms to 20ms. It is known as High-duty cycle non-connectable advertising.

II. DIFFERENT LEVELS OF THE ARCHITECTURE

Given figure 1 showing the different levels of the architecture of BLE 5.0:

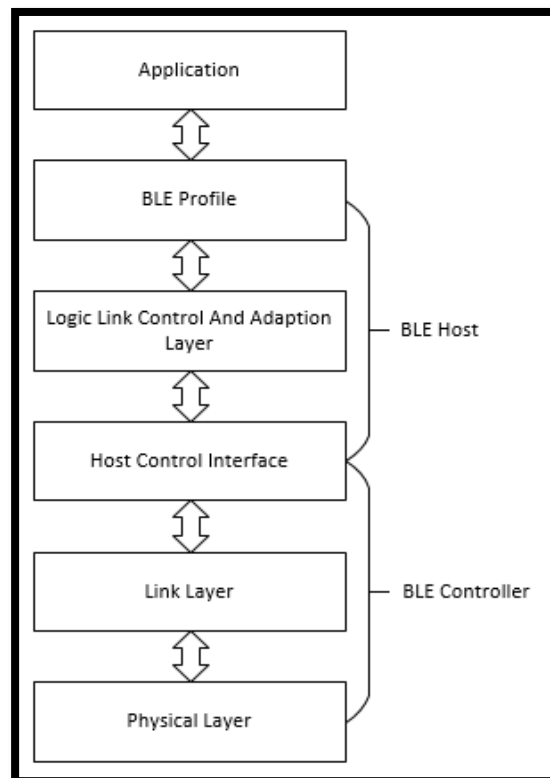


Figure 1 BLE Architecture

A. The physical layer (PHY)

Physical layer is also referring as radio channel. The PHY exchanges information from one device to another and modulation/demodulation of message. It operates in freely available ISM band.

B. The Link Layer

Link Layer interfaces with the PHY and provides the higher levels of an abstraction. It has authority for managing states as well as the timing requirements for adhering of Bluetooth Low Energy 5.0 available on SIG.

C. The Host Controller Interface layer

The Host Controller Interface Layer is used for communicate with lower layers of BLE 5.0. This layer is exist on different chips or on same chip as per requirement of user.

III. Benefits and Limitations

A. Benefits:

- 1) Bluetooth Low Energy 5.0 has better range, speed, and broadcast messaging capacity.
- 2) Two sets of advertising channels for transmit data at lower energy and lower power lose. Low power consumption is even low compared with low power technologies' BLE 5.0 sends data at low speed by keeping radio off.
- 3) The specification for BLE 5.0 is freely available on SIG, no cost to get official documents. With other wireless protocol, company would have to be a member of group for technology to access the specification.
- 4) Lower cost of modules and chip sets, even when compared to other similar technologies or upgraded version of devices. Most importantly, it is existence in the market in most smartphones.

B. Limitations:

- 1) Data Throughput: PHY of BLE 5.0 is limiting by data rate, rate of data at which the radio transmits data on PHY layer. The data rate is depending on version which we used. In BLE 5.0, the rate is different depending on mode and PHY used.
- 2) Range: BLE 5.0 was designed for the short range and low power applications and hence the distance is the limitation. There are some factors, which limits the range of BLE 5.0. It works with 2.4 GHz ISM band, which is affected by obstacles around us Like metals, walls, human bodies and water.
- 3) LE compatible device: Bluetooth Low Energy controllers inherit some aspects of Bluetooth Classic Controller, so these controllers are not compatible.

A. Conclusion

The conclusion of the paper is to introduce Bluetooth specifications before BLE 5.0. There are many specifications, which had improved parameters to overcome its limitations before BLE 5.0. It also gives overview of Bluetooth Low Energy 5.0 technology and benefits of the Bluetooth 5.0 as well as limitations.

B. Future scope

The Bluetooth Specification can improve further from Bluetooth 5.0. As every technology has its pros and cons, such that this technology also has its pros and cons. In the later specification, we can improve the connectivity device and other limitations for the same.

C. References

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