

BLUETOOTH 4 AND ZIGBEE COMPARISION

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Abstract -- This Paper gives you Detail Knowledge about Bluetooth 4 and Zigbee Comparison. By Reading this Paper you are able to understand the Meaning of Bluetooth Technology and Zigbee Technology and Comparison between them in Technical term.

Index term – Adaptive frequency hopping, Bluetooth, Type of Bluetooth, Zigbee, Zigbee standard



1. ABSTRACT

This Paper gives you Detail Knowledge about Bluetooth 4 and Zigbee Comparison. By Reading this Paper you are able to Understand the Meaning of Bluetooth Technology and Zigbee Technology and Comparison between them in Technical term .

2. INTRODUCTION

In the Past, Information is Transferred from one device to the another device with the help of the Cable. This Process is Expensive and not suitable for the faithful Communication due to its Hardware Complexity.

Bluetooth technology first developed by Ericsson in 1994. Main aim of this Technology was to Remove the need of the Cable Connection between Devices such as PDA and PCs. Although the Infrared Communication Existed at time. It required Line of Sight Contact. Due to Unlimited Potential of BWT the Bluetooth special group was formed in 1998 to develop the Bluetooth Specification IEEE 802.15.

ZigBee-style networks began to be conceived around 1998, when many installers realized that both Wi-Fi and Bluetooth were going to be unsuitable for many applications.

ZigBee is a specification for a suite of high level communication protocols using small, low-power digital radios based on an IEEE 802 standard for personal area networks. ZigBee has a defined rate of 250 kbit/s, best suited for periodic or intermittent data or a single signal transmission from a sensor or input device.

3. BLUETOOTH

The **Bluetooth** SIG adopted the code name as a tribute to the tenth-century Viking king Harald Blåtand who peacefully united Denmark and Norway. Harald liked to eat blueberries, which gave his teeth the coloration that lead to the nickname "Bluetooth."

Bluetooth technology was invented in 1994 by engineers at Ericsson, a Swedish company. In 1998, a group of companies agreed to work together using Bluetooth technology as a way to connect their products. These companies formed the Bluetooth Special Interest Group (SIG), an organization devoted to maintaining the technology. This means that no single company "owns" Bluetooth technology, but that many members of the Bluetooth SIG work together to develop Bluetooth technology.

Bluetooth technology was originally intended to be a wireless replacement for cables and wires between things like phones and headsets or computers, keyboards and mice. Bluetooth technology has continued to mature and now you can create new connections that weren't possible using wires, like connecting your mobile phone to your car stereo, or printing a picture directly from your camera phone.

3.1 BASIC OF BLUETOOTH

The key features of Bluetooth technology are robustness, low power, and low cost. The Bluetooth Specification defines a uniform structure for a wide range of devices to connect and communicate with each other.

When two Bluetooth enabled devices connect to each other, this is called pairing. The structure and the global acceptance of Bluetooth technology means any Bluetooth enabled device, almost everywhere in the world, can connect to other Bluetooth enabled devices located in proximity to one another.

Connections between Bluetooth enabled electronic devices allow these devices to communicate wirelessly through short-range, ad hoc networks known as **piconets**. Piconets are established dynamically & automatically as Bluetooth enabled devices enter and leave radio proximity meaning that you can easily connect whenever and wherever it's convenient for you. Each device in a **piconet** can also simultaneously communicate with up to seven other devices within that single piconet and each device can also belong to several piconets simultaneously. This means the ways in which you can connect your Bluetooth devices is almost limitless.

The range of Bluetooth technology is application specific. The Core Specification mandates a minimum range of 10 meters or 30 feet, but there is no set limit and manufacturers can tune their implementations to provide the range needed to support the use cases for their solutions.

It separates the frequency band into hops. This spread spectrum is used to hop from one channel to another, which adds a strong layer of security.

Signals can be transmitted through walls and briefcases, thus eliminating the need for line-of-sight. Devices do not need to be pointed at each other, as signals are omni-directional.

Both synchronous and asynchronous applications are supported, making it easy to implement on a variety of devices and for a variety of services, such as voice and Internet

The Aim of "Bluetooth" has been set quite high. It is to arrive at a specification for a technology that optimizes the usage model of all mobile computing and communications devices, and providing Global usage ,Voice and data handling. The ability to establish ad-hoc connections.

3.2 SPECIFICATIONS

Bluetooth technology operates in the unlicensed industrial, scientific and medical (ISM) band at 2.4 to 2.485 GHz, using a spread spectrum, frequency hopping, full-duplex signal at a nominal rate of 1600 hops/sec. The 2.4 GHz ISM band is available and unlicensed in most countries.

Bluetooth technology's adaptive frequency hopping (**AFH**) capability was designed to reduce interference between wireless technologies sharing the 2.4 GHz spectrum. AFH works within the spectrum to take advantage of the available frequency. This is done by the technology detecting other devices in the spectrum and avoiding the frequencies they are using. This adaptive hopping among 79 frequencies at 1 MHz intervals gives a high degree of interference immunity and also allows for more efficient transmission within the spectrum.

Range may vary depending on class of radio used in an implementation:-

Class 3 radios – have a range of up to 10 meter or 33 feet.

Class 2 radios – most commonly found in mobile devices – have a range of 50 meters or 150 feet

Class 1 radios – used primarily in industrial use cases – have a range of 100 meters or 300 feet.

The most commonly used radio is Class 2 and uses 2.5 mW of **power**. Bluetooth technology is designed to have very low power consumption. This is reinforced in the specification by allowing radios to be powered down when inactive.

The Generic Alternate MAC/PHY in Version 3.0 HS enables the discovery of remote AMPs for high speed devices and turns on the radio only when needed for data transfer giving a power optimization benefit as well as aiding in the security of the radios.

Bluetooth low energy technology, optimized for devices requiring maximum battery life instead of a high data transfer rate, consumes between 1/2 and 1/100 the power of Classic Bluetooth technology.

It has low power consumption, drawing only 0.3 mA in standby mode. This enables maximum performance longevity for battery powered devices. During data transfer the maximum current drain is 30 mA. However, during pauses or at lower data rates the drain would be lower.

Gross data rate is 1Mbit/s, with second generation plans to increase to 2 Mbit/s. One-to-one connections allow maximum data transfer rate of 721 kbits/s (corresponding to 3 voice channels).

3.3 BLUETOOTH WORKING

BWT-enabled devices operate in the unrestricted 2.4-gigahertz (GHz) Industrial, Science, Medical (ISM) band. The ISM band ranges between 2.400 GHz and 2.483 GHz. BWT-enabled devices use seventy-nine 1-megahertz frequencies (from 2.402 to 2.480 GHz) in the ISM band. BWT-enabled devices use a technique called frequency hopping to minimize eaves dropping and interference from other networks that use the ISM band. With frequency hopping, the data is divided into small pieces called packets. The transmitter and receiver exchange a data packet at one frequency, and then they hop to another frequency to exchange another packet. They repeat this process until all the data is transmitted.

BWT devices randomly hop between frequencies up to 1600 times per second—much faster than the other types of devices that use the ISM band. This means that if another device, such as a 2.4-GHz cord less phone, interferes with a BWT network at a particular frequency, the interference only lasts for about 1/1600 of a second until the BWT devices hop to another frequency. This gives BWT networks a high immunity to interference from other 2.4-GHz devices.

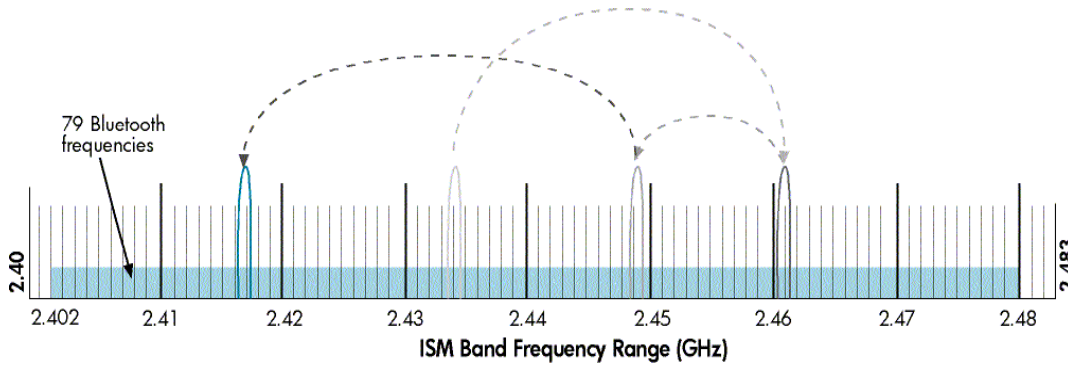


Figure 1. BWT-enabled devices hop between frequencies up to 1600 times per second.

BWT-enabled devices form network **Topologies** called **piconets** and **scatternets**. A piconet consists of up to eight BWT-enabled devices (Figure 2). When a piconet is established, one device sets the frequency-hopping pattern and the other devices synchronize their signals to the same pattern. The device that sets the frequency-hopping pattern is called the primary device and the other devices are called secondary devices. Each piconet has a different frequency-hopping pattern to differentiate its signals from the signals of other piconets.

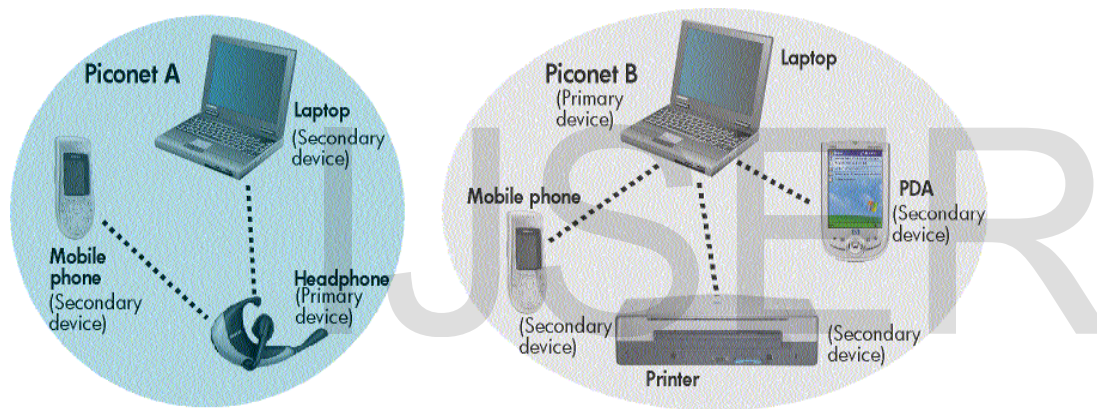


Figure 2. A piconet consists of up to eight BWT-enabled devices.

3.4 TYES OF BLUETOOTH

1. Bluetooth v1.0 and v1.0B

Versions 1.0 and 1.0B also included mandatory Bluetooth hardware device address (BD_ADDR) transmission in the Connecting Process which was a major setback for certain services planned for use in Bluetooth environments.

2. Bluetooth v1.1 and v1.2

Version 1.1 Ratified as IEEE Standard 802.15.1-2002. Many errors found in the 1.0B specifications were fixed. Added possibility of non-encrypted channels.

Version 1.2 IEEE Standard 802.15.1-2005. Higher transmission speeds in practice, up to 721 kbit/s. Introduced Flow Control and Retransmission Modes for L2CAP.

3. Bluetooth v2.0 + EDR

This version of the Bluetooth Core Specification was released in 2004 and is backward compatible with the previous version 1.2. The main difference is the introduction of an Enhanced Data Rate EDR for faster data transfer. The nominal rate of EDR is about 3 Mbit/s, although the practical data transfer rate is 2.1 Mbit/s. EDR uses a combination of GFSK and Phase Shift

Keying modulation (PSK) with two variants, $\pi/4$ -DQPSK and 8DPSK. EDR can provide a lower power consumption through a reduced duty cycle.

4. Bluetooth v2.1 + EDR

Bluetooth Core Specification Version 2.1 + EDR is fully backward compatible with 1.2, and was adopted by the Bluetooth SIG on 26 July 2007. 2.1 allows various other improvements, including "Extended inquiry response"(EIR), which provides more information during the inquiry procedure to allow better filtering of devices before connection; and sniff sub rating, which reduces the power consumption in low-power mode.

5. Bluetooth v3.0 + HS

This Bluetooth Core Specification was adopted by the Bluetooth SIG on 21 April 2009. Bluetooth 3.0+HS provides theoretical data transfer speeds of up to 24 Mbit/s, though not over the Bluetooth link itself. Instead, the Bluetooth link is used for negotiation and establishment, and the high data rate traffic is carried over a collocated 802.11 link.

The main new feature is AMP (Alternate MAC/PHY), the addition of 802.11 as a high speed transport. The High-Speed part of the specification is not mandatory, and hence only devices sporting the "+HS" will actually support the Bluetooth over 802.11 high-speed data transfer.

The high speed (AMP) feature of Bluetooth v3.0 was originally intended for UWB, but the Wi Media Alliance, the body responsible for the flavor of UWB intended for Bluetooth, announced in March 2009 that it was disbanding, and ultimately UWB was omitted from the Core v3.0 specification.

6. Bluetooth v4

The Bluetooth version 4.0 and has been adopted as of 30 June 2010.

3.5 BLUETOOTH V4

The Bluetooth SIG completed the Bluetooth Core Specification version 4.0 and has been adopted as of 30 June 2010. It includes Classic Bluetooth, Bluetooth high speed and Bluetooth low energy 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,^[44] is a subset to Bluetooth v4.0 with an entirely new protocol stack for rapid build-up of simple links. As an alternative to the Bluetooth standard protocols that were introduced in Bluetooth v1.0 to v3.0, it is aimed at very low power applications running off a coin cell. Chip designs allow for two types of implementation, dual-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. In late 2011, new logos "Bluetooth Smart

Ready" for hosts and "Bluetooth Smart" for sensors were introduced as the general-public face of BLE. Cost-reduced single-mode chips, which enable highly integrated and compact devices, feature a lightweight Link Layer providing ultra-low power idle mode operation, simple device discovery, and reliable point-to-multipoint data encrypted connections at the lowest possible

This generation of Bluetooth is split into two groups: Bluetooth Smart Ready and Bluetooth Smart. To understand why the tech has been split, you first have to look at the challenges facing Bluetooth as we know it. Those challenges are battery drain and the constant pairing and re-pairing of connected gadgets. Bluetooth 4.0 is designed to be more intelligent (hence: Bluetooth Smart) about managing those connections, especially when it comes to conserving energy. The new generation of Bluetooth tech places less emphasis on maintaining a constant stream of information. Instead, it focuses on sending smaller bits of data when needed and then puts the connection to sleep during periods of non-use. When two 4.0 devices are paired, they waste less battery power because the connection is dormant unless critical data is being shared. With the previous generation of Bluetooth, it was best to shut down your hardware when it was not in use. Now the Bluetooth Special Interest Group estimates between 1 and 2 years of battery power in some devices with Bluetooth 4.0. Using that analogy, the drone ships are Bluetooth Smart devices. These peripherals connect to Bluetooth Smart Ready smartphones, tablets, and notebooks. Bluetooth Smart gadgets can also remain paired with Smart Ready devices even when they're not used for hours or days at a time. Thanks to Bluetooth 4.0's emphasis on wake and sleep modes, Smart peripherals that aren't in use can remain in sleep mode indefinitely; they can also wake from that sleep mode in an instant, paired and ready to share data with a Smart Ready tablet, notebook, or smartphone. Bluetooth Smart Ready gadgets are primary devices—think smartphones, notebooks, and tablets—that can receive and share Bluetooth signals from such accessories as speakers, headphones, fitness accessories, and even medical tools such as heart-rate monitors and electronic thermometers. Think of Bluetooth Smart Ready devices as a

mothership, waiting to send and receive data from smaller drone ships around it. Bluetooth 4.0 actually offers three specifications in one, all of which can work individually or in tandem, according to the Bluetooth SIG. Classic Bluetooth is the familiar standard that wirelessly connects peripherals with other devices at a speed of around 3 megabits per second (Mbps).

4. ZIGBEE

ZigBee-style networks began to be conceived around 1998, when many installers realized that both Wi-Fi and Bluetooth were going to be unsuitable for many applications. In particular, many engineers saw a need for self-organizing ad-hoc digital radio networks.

The IEEE 802.15.4-2003 standard was completed in May 2003 and has been superseded by the publication of IEEE 802.15.4-2006. In the summer of 2003, Philips Semiconductors, a major mesh network supporter, ceased the investment. Philips Lighting has, however, continued Philips' participation, and Philips remains a promoter member on the ZigBee Alliance Board of Directors.

ZigBee is the only standards-based wireless technology designed to address the unique needs of low-cost, low-power wireless sensor and control networks in just about any market. Since **ZigBee** can be used almost anywhere, is easy to implement and needs little power to operate, the opportunity for growth into new markets, as well as innovation in existing markets, is limitless. Here are some facts about ZigBee:

- With hundreds of members around the globe, ZigBee uses the 2.4 GHz radio frequency to deliver a variety of reliable and easy-to-use standards anywhere in the world.
- Consumer, business, government and industrial users rely on a variety of smart and easy-to-use ZigBee standards to gain greater control of everyday activities.
- With reliable wireless performance and battery operation, ZigBee gives you the freedom and flexibility to do more.
- ZigBee offers a variety of innovative standards smartly designed to help you be green and save money.

ZigBee is targeted at applications that require a low data rate, long battery life, and secure networking. ZigBee has a defined rate of 250 kbit/s, best suited for periodic or intermittent data or a single signal

transmission from a sensor or input device. Applications include wireless light switches, electrical meters with in-home-displays, traffic management systems, and other consumer and industrial equipment that requires short-range wireless transfer of data at relatively low rates.

The ZigBee specifications were ratified on 14 December 2004. The ZigBee Alliance announced availability of Specification 1.0 on 13 June 2005, known as ZigBee 2004 Specification. In September 2006, ZigBee 2006 Specification is announced. In 2007, ZigBee PRO, the enhanced ZigBee specification was finalized.

4.1 ZIGBEE DEVICE & OPERATION

1. **ZigBee Co-ordinator (ZC):** The most capable device, the Co-ordinator forms the root of the network tree and might bridge to other networks. There is exactly one ZigBee Co-ordinator in each network since it is the device that started the network originally (the ZigBee LightLink specification also allows operation without a ZigBee Co-ordinator, making it more usable for over-the-shelf home products). It stores information about the network, including acting as the Trust Center & repository for security keys. In the Past, Information is Transferred from one device to the another device with the help of the Cable. This Process is Expensive and not suitable for the faithful Communication due to its Hardware Complexity.
2. **ZigBee Router (ZR):** As well as running an application function, a Router can act as an intermediate router, passing on data from other devices.
3. **ZigBee End Device (ZED):** Contains just enough functionality to talk to the parent node (either the Co-ordinator or a Router); it cannot relay data from other devices. This relationship allows the node to be asleep a significant amount of the time thereby giving long battery life. A ZED requires the least amount of memory, and therefore can be less expensive to manufacture than a ZR or ZC.

4.2 ZIGBEE STANDARD

The foundation of every ZigBee standard and specification is the powerful IEEE 802.15.4 physical radio standard operating in unlicensed bands worldwide at 2.4GHz (global), 915Mhz (Americas) and 868Mhz (Europe). It delivers raw data

throughput rates of 250Kbs at 2.4GHz (16 channels), 40Kbs at 915Mhz (10 channels) and 20Kbs at 868Mhz (1 channel). Transmission distances are remarkable for a low-power solution, ranging from 10 to 1,600 meters, depending on power output and environmental conditions, such as other buildings, interior wall types and geographic topology.

4.3 TRAFFIC TYPES

ZigBee/IEEE 802.15.4 addresses three typical traffic types. Data is **Periodic**. The application dictates the rate, and the sensor activates, checks for data and deactivates. Data is **Intermittent**. The application, or other stimulus, determines the rate, as in the case of say smoke detectors. The device needs to connect to the network only when communication is necessitated. This type enables optimum saving on energy. Data is **Repetitive**, and the rate is fixed a priority.

Depending on allotted time slots, called GTS devices operate for fixed durations. ZigBee employs either of two modes, **Beacon** or **Non-Beacon** to enable the to-and-fro data traffic.

Beacon mode is used when the coordinator runs on batteries and thus offers maximum power savings, whereas the non-beacon mode finds favor whether coordinator is mains-powered.

In the **Beacon mode**, a device watches out for the coordinator's beacon that gets transmitted at the periodically, locks on and looks for messages addressed to it. If message transmission is complete, the coordinator dictates a schedule for the next beacon so that the device 'goes to sleep'; in fact, the coordinator itself switches to sleep mode.

The **Non-Beacon** mode will be included in a system where devices are 'asleep' nearly always, as in smoke detectors and burglar alarms. The devices wake up and confirm their continued presence in the network at random intervals

5. COMPARISON B/W ZIGBEE AND BLUETOOTH 4.

A. Orientation

Bluetooth basically eliminates the cabling between electronic products such as between computer and printer or between phones and headsets. Moreover, Bluetooth is more oriented towards user mobility whereas ZigBee aims for grand scale automation and remote control. In addition, Zigbee is extremely resistant to interference, coexists effectively with other wireless applications in home and because of its mesh networking capabilities, is very easy to install by people without the need for any special installation services.

B. Response time

A powered down Zigbee device can wake up and get a packet across a network in around 15 ms. A Bluetooth device in a similar state would take 3 seconds to wake up and respond. This feature is very important for timing critical messages.

C. Network range

Bluetooth's network range is 10 meters (without a amplifier) whereas Zigbee has a range up to 75 m.

D. Nodes per network

Bluetooth supports 8 nodes per network whereas Zigbee can support up to 255 nodes per network.

E. Power consumption

Bluetooth uses battery which requires frequent recharging whereas Zigbee uses battery which can last up to 10 years. "Zigbee won't kill Bluetooth but it might replace it".

Standard	Zigbee	Bluetooth 4
IEEE Spec.	802.15.0 4	802.15.1
Frequency band	2.4 Ghz	2.4 Ghz
Maximum signal rate	250 kb/s	1-3Mb/s
Nominal Range	10-1600 m	10 m
Nominal Tx. Power	-25 to 0 dbm	0-10 dbm
No.of RF Channels	16	79
Bandwidth	2 MHz	1-3 MHz
Modulation Type	BPSK, QPSK	GFSK

Spreading	DSSS	FHSS
Basic Cell	Star	Piconet
Extension of Cell.	Mess, Cluster	Scatternet
Max. Cell Nodes	>65535	8
Encryption	CTR	E0 stream
Auth.	CBC-MAC	Shared secret
Data Protection	128 bit CRC	128 bit CRC

Table 1. Comparison Table

6. CONCLUSION

It is likely that ZigBee will increasingly play an important role in the future of computer and the communication technology. In terms of protocol stack size, ZigBee's 32 KB is about one-third of the stack size necessary in other wireless Technology (for limited capability end devices.

The stack size is as low as 4 KB). The IEEE802.15.4based ZigBee is designed for remote controls and sensors, which are very many in number, but need only small data packets and, mainly, extremely low power consumption for (long) life.

Because BWT-enabled devices operate in the unrestricted 2.4-GHz ISM band, numerous manufacturers can develop BWT-enabled products to use this frequency band. From PDAs that automatically synchronize contact information with your laptop and cell phone, to a car that automatically adjusts the seat and mirrors as you approach it, Bluetooth wireless technology will eventually unite all the gadgets in your world and change forever the way you work and play. The Bluetooth SIG told us that many Bluetooth Smart peripherals will be released in 2012, including wireless 3D glasses, home entertainment remote controls, and medical devices. The Bluetooth SIG also hopes to see Bluetooth expand into ovens, refrigerators, thermostats, and lighting systems. If that happens, dimming the lights or checking on the turkey could be a simple matter of using an app on your phone.

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