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ZigBee: The New Bluetooth Technology

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Abstract

This abstract tells about a Wireless Technological Device which is popular for extremely Low Power, and Low Bit Rate Wireless PAN Technology called ZigBee. ZigBee is designed for wireless Automation and other lower data tasks, such as smart home automation and remote monitoring. ZigBee is a low-cost, low-power, wireless mesh networking standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications, the low power usage allows longer life with smaller batteries, and the mesh networking provides high reliability and larger range. Due to the low-cost and low-power usage this wireless technology is widely used in Home Automation, Smart Energy, Telecommunication Applications, Personal Home, Hospital Care. ZigBee enables new opportunities for wireless sensors and control networks. ZigBee is standard based, low cost, can be used globally, reliable and self healing, supports large number of nodes, easy to deploy, very long battery life and secure.[1]

1. Introduction

Now a day's every electronic devices is provided with sensor controller. It is every difficult to provide charged batteries to controllers and also to maintain them. At the same time it must provide devices from wizards. Imagine your home appliances communicating with each other or you controlling them using your cell phone or PC. You are able to monitor and control the ambient temperature, moisture and noise in the individual rooms, find out which room your kids are in or unlock the entry door to let your friend in from a remote location. In the not too distant future, all this will be possible with ZigBee, which is expected to become a Big B. It would be common to find as many as a hundred of ZigBee chips around the house in the form of light switches, fire and smoke detectors, thermostats, kitchen appliances, video and audio remote controls, security systems, etc. [2]

Fig 1: ZigBee and its applications

1.1. Overview

ZigBee is a low-cost, low-power, wireless mesh networking standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications, the low power-usage allows longer life with smaller batteries, and the mesh networking provides high reliability and larger range.

The ZigBee Alliance, the standards body which defines ZigBee, also publishes application profiles that allow multiple OEM vendors to create interoperable products.

The current list of application profiles either published or in the works are:

- Home Automation
- ZigBee Smart Energy
- Telecommunication Applications
- Personal Home
- Hospital Care [3]

1.2. History

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.

The ZigBee Alliance announced in October 2004 that the membership had more than doubled in the preceding year and had grown to more than 100 member companies, in 22 countries. By April 2005 membership had grown to more than 150 companies, and by December 2005 membership had passed 200 companies. 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.

The first stack release is now called ZigBee 2004. The second stack release is called ZigBee 2006, and mainly replaces the MSG/KVP structure used in 2004 with a "cluster library". The 2004 stack is now more or less obsolete.

ZigBee 2007, now the current stack release, contains two stack profiles, stack profile 1 (simply called ZigBee), for home and light commercial use, and stack profile 2 (called ZigBee PRO). ZigBee PRO offers more features, such as multi-casting, many-to-one routing and high security with Symmetric-Key Key Exchange (SKKE), while ZigBee (stack profile 1) offers a smaller footprint in RAM and flash. Both offer full mesh networking and work with all ZigBee application profiles.

ZigBee 2007 is fully backward compatible with ZigBee 2006 devices: A ZigBee 2007 device may join and operate on a ZigBee 2006 network and vice versa. Due to differences in routing options, ZigBee PRO devices must become non-routing ZigBee End-Devices (ZEDs) on a ZigBee 2006 network, the same as for ZigBee 2006 devices on a ZigBee 2007 network must become ZEDs on a ZigBee PRO network. The applications running on those devices work the same, regardless of the stack profile beneath them.

The ZigBee 1.0 specification was ratified on 14 December 2004 and is available to members of the ZigBee Alliance. Most recently, the ZigBee 2007 specification was posted on 30 October 2007. The first ZigBee Application Profile, Home Automation, was announced 2 November 2007. [4]

1.3. Understanding ZigBee

ZigBee offers green and global wireless standards connecting the widest range of device to work together intelligently and help you control your world.

After 10 years and millions of implementations every year, ZigBee standards prove you can rely on the widest variety of smart and easy-to-use products for just about anywhere you work, live or play. Our innovative standards are designed to let product manufacturers help their customers create their own Internet of Things and M2M wireless sensor networks to gain greater control of, and even improve, everyday activities.

ZigBee lets you easily and cost-effectively add intelligent new features that improve the efficiency, safety, security, reliability and convenience of your products. You can help your customers save both energy and money, or give them the tools they need to gain control of their homes. It's even possible to help people maintain their independence and allow them to closely monitor their health and fitness.

Thanks to ZigBee, it's never been easier to differentiate your products and services while also making them smarter and greener. [5]

2. How ZigBee works?

ZigBee operates in 16channels of 2.4GHz ISM band and provides a data rate of 250 Kbps. It has been designed for single channel 868 MHz, which provides20 kbps in Europe. ZigBee device can function either as anode or a coordinator. A node is like a client or slave device that receives commands/data from a coordinator. A node cannot initiate connection with another node. The coordinator device is the master or the slaved device that can control up to 255 active nodes.

ZigBee devices can form PAN using: star, cluster tree or mesh topology. Multi network coordinators can be linked together to form a large network to control up to 65536 devices. Advanced encryption standards (AES) will enable highly secure networks and applications. Profile will provide highly inter operable products and solutions.

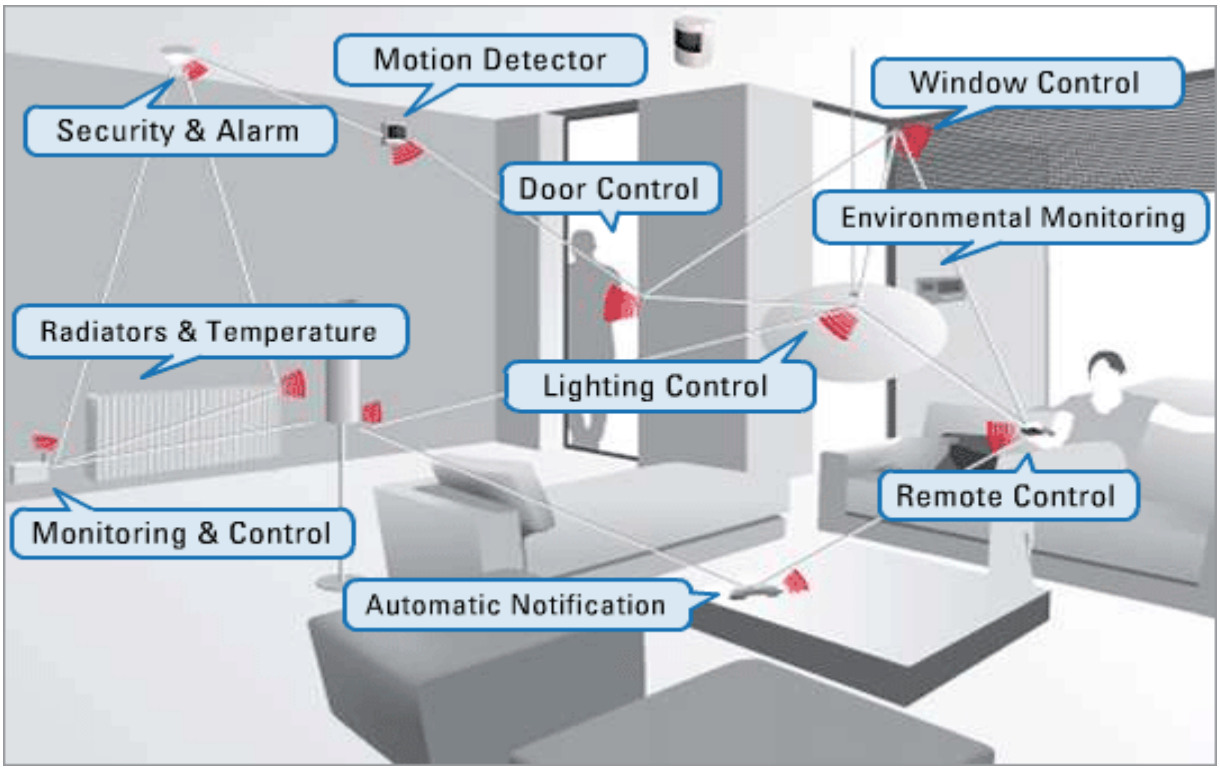

Fig 2: ZigBee and its uses

3. Architecture

3.1. ZigBee device types

Three types of ZigBee devices:

i. **ZigBee coordinator (ZC):** The most capable device, the coordinator forms the root of the network tree and might bridge to other networks. There is exactly one ZigBee coordinator in each network since it is the device that started the network originally. It stores information about the network, including acting as the Trust Center & repository for security keys.

ii. **ZigBee Router (ZR):** As well as running an application function, a router can act as an intermediate router, passing on data from other devices.

iii. **ZigBee End Device (ZED):** Contains just enough functionality to talk to the parent node (either the coordinator 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]

3.2. Architecture

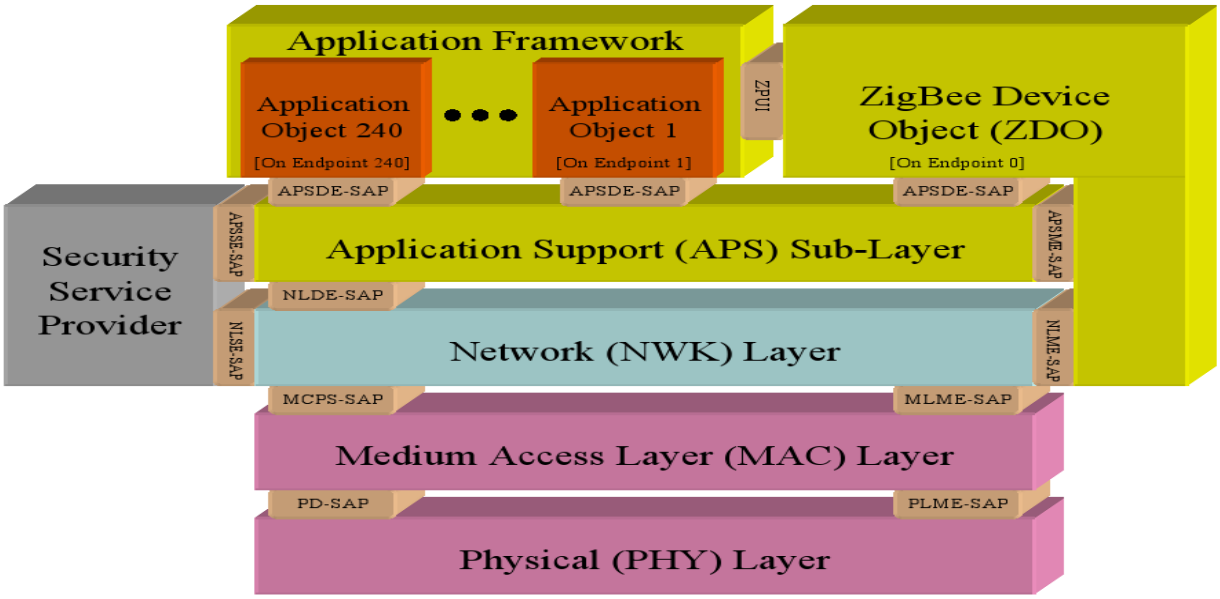

Fig 3: ZigBee Architecture

I. Physical Layer

The Physical Layer was designed to accommodate the need for low cost yet allowing for high level of integration. The use of direct sequence allows the analog circuitry to be very simple and very tolerant towards inexpensive implementations.

II. MAC Layer

The media access control (MAC) layer was designed to allow multiple topologies without complexity. The power management operation doesn't require multiple modes of operation. The MAC allows a reduce functionality device (RFD) that needn't have flash nor large amounts of ROM or RAM. The MAC was designed to handle large numbers of devices without requiring them to be "parked".

The network layer has been designed to allow the network to spatially grow without requiring high power transmitters. The network layer also can handle large amounts of nodes with relatively low latencies.

III. SECURITY

Security and data integrity are key benefits of the ZigBee technology. ZigBee leverages the security model of the IEEE802.15.4

MAC sub layer which specifies four security services:

i. **Access Control**- the device maintains a list of trusted devices within the network
ii. **Data Encryption**, which uses symmetric key 128-bit advanced encryption standard
iii. **Frame Integrity** to protect data from being modified by parties without cryptographic keys
iv. **Sequential Freshness** to reject data frames that have been replayed- the network controller compares the freshness value with the last known value from the device and rejects it if the freshness value has not been updated to a new value.

The actual security implementations is specified by the implementer using a standardized toolbox of ZigBee Security Software. [2]

4. Comparison of ZigBee with other technologies

Standards	Bandwidth	Power Consumption	Protocol Stack Size	Stronghold	Applications
Wi-Fi	Up to 54Mbps	400+ mA TX	100+ KB	High Data Rate	Internet browsing, PC networking, File transfer
Bluetooth	1Mbps	40mA TX	~100+ KB	Interoperability, capable replacement	Wireless USB, Handset, Headset
ZigBee	250kbps	30mA TX	4"32KB	Long battery life, low cost	Remote Control, battery-operated, sensors

Table 1: Comparison between ZigBee, Bluetooth and Wi-Fi.

5. Uses of ZigBee

ZigBee protocols are intended for use in embedded applications requiring low data rates and low power consumption. ZigBee's current focus is to define a general-purpose, inexpensive, self-organizing mesh network that can be used for industrial control, embedded sensing, medical data collection, smoke and intruder warning, building automation, home automation, etc.

5.1. Typical applications area include

- **Home Entertainment and Control** - Smart lighting, advanced temperature control, safety and security, movies and music
- **Home Awareness** - Water sensors, power sensors, smoke and fire detectors, smart appliances and access sensors
- **Mobile Services** - Mobile payment, Mobile monitoring and control, Mobile security and access control, Mobile healthcare and Telecommunication assist
- **Commercial Building** - Energy monitoring, HVAC, lighting, access control
- **Industrial Plant** - Process control, asset management, environmental management, energy management, industrial device control
- **Water Sensor** - It is used in big water towers that helps to indicate us that tank is going to full and also take care to stop water motor.
- **Fire Sensor** - It used in big hotels to stop fire wizards in accidents and also it calls fire engine.
- **Health Centers** - It says to doctor up to date information of the patient and also take care of him by changing condition of room.

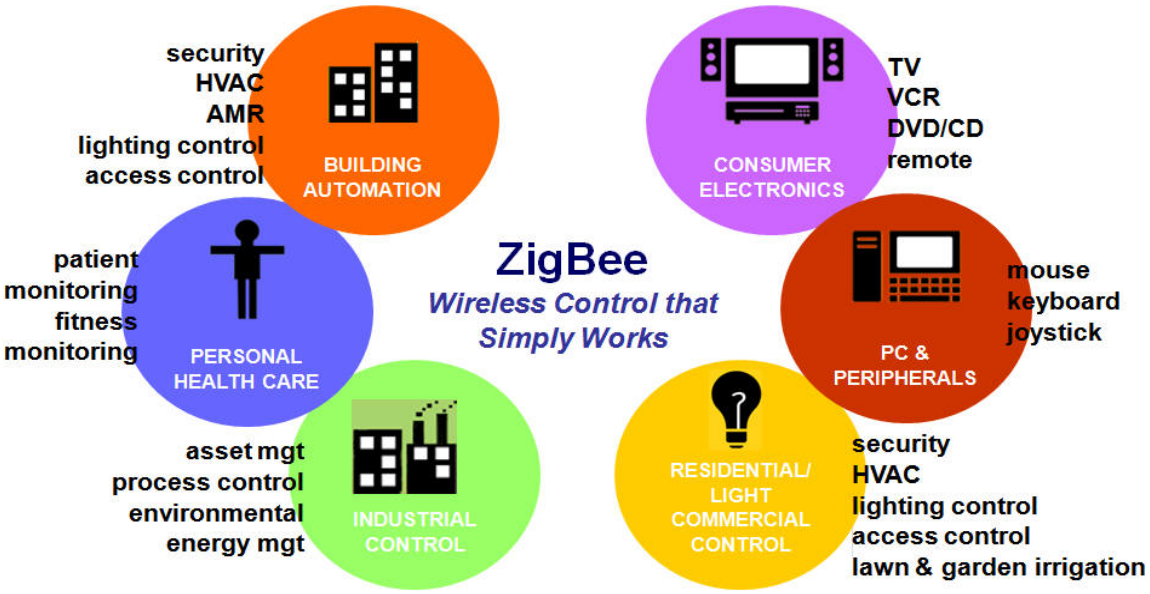

Fig 4: ZigBee applications

6. Advantages and Disadvantages of ZigBee

	Advantages	Disadvantages
1.	Reliable and self healing	Not many end devices available yet
2.	Supports large number of nodes	Replacement with ZigBee compliant appliances can be costly
3.	East to deploy	Highly risky to be used for official private information
4.	Very long battery life	
5.	Low power consumption	
6.	Low Cost	
7.	Easily implemented	
8.	Flexible network structure	

Table 2: Advantages and Disadvantages of ZigBee

7. Security Services of ZigBee

As one of its defining features, ZigBee provides facilities for carrying out secure communications, protecting establishment and transport of

cryptographic keys, ciphering frames and controlling devices. It builds on the basic security framework defined in IEEE 802.15.4. This part of the architecture relies on the correct management of symmetric keys and the correct implementation of methods and security policies.

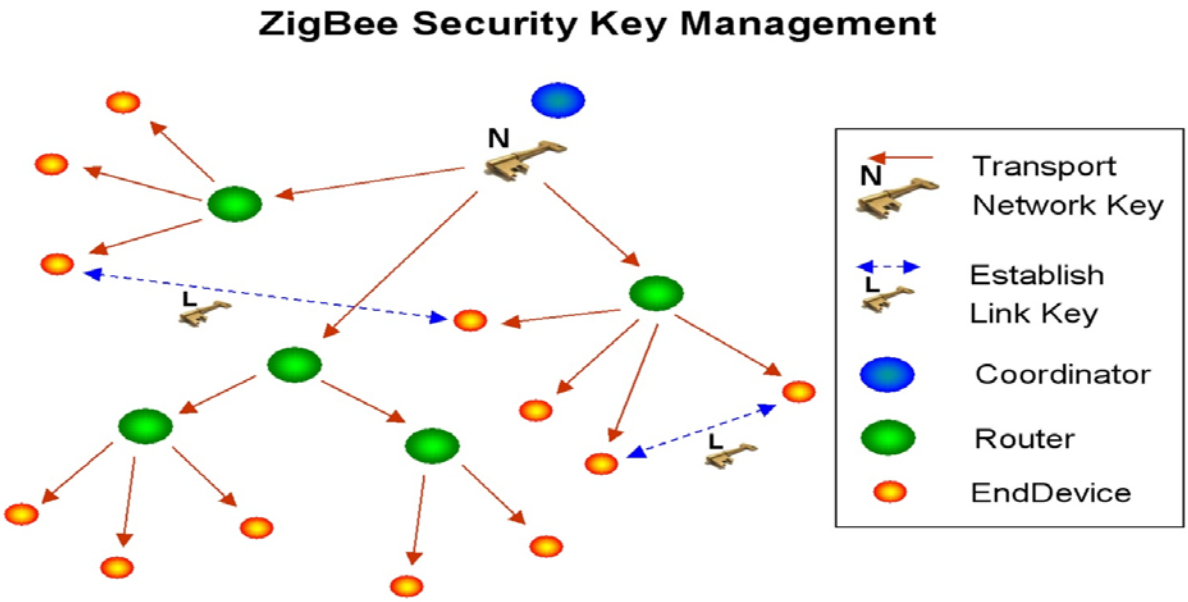

Fig 5: ZigBee security system

7.1. Basic Security Model

The basic mechanism to ensure confidentiality is the adequate protection of all keying material. Trust must be assumed in the initial installation of the keys, as well as in the processing of security information. In order for an implementation to globally work, its general conformance to specified behaviors is assumed.

Keys are the cornerstone of the security architecture; as such their protection is of paramount importance, and keys are never supposed to be transported through an insecure channel. A momentary exception to this rule occurs during the initial phase of the addition to the network of a previously unconfigured device. The ZigBee network model must take particular care of security considerations, as ad hoc networks may be physically accessible to external devices and the particular working environment cannot be foretold; likewise, different applications running concurrently and using the same transceiver to communicate are supposed to be mutually trustworthy for cost reasons the model does not assume a firewall exists between application-level entities.

Within the protocol stack, different network layers are not cryptographically separated, so access policies are needed and correct design assumed. The open trust model within a device allows for key sharing, which notably decreases potential cost. Nevertheless, the layer which creates a frame is responsible for its security. If malicious devices may exist, every network layer payload must be ciphered, so unauthorized traffic can be immediately cut off. The exception, again, is the transmission of the network key, which confers a unified security layer to the network, to a new connecting device. [4]

8. Characteristics of ZigBee

i. Data rates of 20 kbps and up to 250 kbps
ii. Star or peer-to-peer network topology
iii. Support for low latency devices
iv. Low power usage consumption
v. 3-Frequencies band with 27 channels
vi. Extremely low duty cycle (<0.1%) [6]

9. Features of ZigBee

i. Low power consumption
ii. High density of networks
iii. Simple protocol, global implementation

iv. Network flexibility
v. Small size- less then 9mm*9mm

10. ZigBee a future revolution

Due to its low power output, ZigBee devices can maintain themselves on a small battery for many months, or even years, making them ideal for install and forget purposes, such as most small household systems. Predictions of ZigBee installation for the future, most based on the fiery use of ZigBee in automated household tasks in China, look to a near future when upwards of sixty ZigBee devices may be found in an average American home, all communicating with one another freely and regulating common tasks seamlessly.

11. Conclusion

Above given theory I can conclude that in future we are going to see a world with no cables. We can give protection to the entire electronic deceive. We can take care and can avoid fire wizards. This pace helps science technology to step into far words that help us to protect electronic deceives. By underneath all above statements I can say "ZigBee is going to Big B"

References

[1]: http://www.scribd.com/doc/49652219/zigbee-abstract

[2]: http://www.scribd.com/doc/48466961/zigbee-tech-in-w-less

[3]: http://www.creativeworld9.com/2011/04/zigbee-technology-abstract.html

[4]: http://en.wikipedia.org/wiki/ZigBee

[5]: http://www.zigbee.org/About/UnderstandingZigBee.aspx

[6]: http://www.slideshare.net/rakeshkumarchary/zigbee-technology-ppt-edited