STUDY OF VARIOUS SHORT-RANGE WIRELESS TECHNOLOGIES

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Abstract
Various short range wireless technologies like Bluetooth, ultra-wideband, ZigBee, home RF, IR wireless and Wi-Fi are used for short range wireless communications with low power consumption. In recent years Bluetooth, Wi-Fi, home RF and ultra-wide band was mostly used for home automation, communication and controlling home devices. But, nowadays there are some other technologies like ZigBee which give their best for controlling home devices, home automation and communication. This paper presents a study of various short range wireless communication standards and gives the comparison between them in various terms such as range, frequency band, rate, multiplexing scheme, application and power transmission etc.

Keywords: **Bluetooth Technology, ultra-wideband Technology, ZigBee Technology, Home RF Technology, IR wireless Technology and Wi-Fi Technology.**

I. INTRODUCTION

Different Wireless standards are becoming more and more popular around the world. For long distance communication long range wireless standards or protocols are used. We all also adapted for wireless lifestyle, people uses the wireless technologies for day to day life. The purpose of the using these various technologies are to make life simple and more convenient. The using these technology worlds become small and come close to each other more rapidly. A number of different wireless technologies have been introduced for very short distances.

Short range wireless technologies are used for short distance communication. These are called as 'short-range wireless communication technologies'. In this Signals travel from a few centimetres to several meters.

In this paper the different short range wireless technology like UWB, Wi-Fi, Bluetooth, ZigBee etc. are studied, On the basis of this study, it is suggested that which short range wireless technology should be better to use for the industry and home automation, computer networking and data communication purpose. The study and comparison presented in this paper would benefit application engineers in selecting an appropriate protocol for appropriate purpose

II. TECHNOLOGY

A. Bluetooth technology

Bluetooth is also known as the IEEE 802.15.1 standard. It is based on a wireless radio system and designed for short-range communication. Bluetooth is a type of wireless communication standards used to transmit voice and data at high speed using radio waves. Bluetooth technology is developed from the combined contributions of the members of the Bluetooth Special Interest Group founded by Ericsson, IBM, Intel, Nokia and Toshiba presently made up of around 1,800 members. Dr. Jaap Haartsen is the one who invented Bluetooth while working at Ericsson in the 1990s. Bluetooth uses low power and require low cost, short-range radio technology intended to replace the cable connections between mobile phones, PDAs, computers and other portable devices. Bluetooth is a replacement for cables between these devices to communicate with each other, establishing a personal area network. A device needs to be approximately within distance 10 meters to each other. The typical data rate is around 2 Mbps.

Bluetooth technology has now established itself in the market place enabling a variety of devices to be connected together using wireless technology. Now a day Bluetooth technology formed its own connecting remote headsets to mobile phones and it is also used in a huge number of other applications. The development of Bluetooth technology has been progressed from many past years so that it is now an integral part of many household devices. Mobile phones, laptops and many other devices use Bluetooth for short range connectivity. In this form of application, Bluetooth has been a significant success.

Bluetooth signals operate in the 2.4 GHz frequency band. Every device using Bluetooth has a small microchip that can send both voice and data signals. In a typical set up, one device operate as the master and one or more other devices operate as slaves. The master device uses link manager software to identify other Bluetooth devices to create link with them to be able to send and receive data. Bluetooth uses spread spectrum frequency hopping technology (SSFH), i.e. it uses multiple frequencies at the same time to limit interference when using multiple devices.

Figure1-Bluetooth technology

B. ZigBee Technology-

ZigBee is IEEE 802.15.4 standard based technology for low data rate, low power consumption, reliability and short range applications. ZigBee has become a primary solution in several applications such as remote monitoring, health care, home automation, telecommunication, building automation, interactive toys, energy management and efficiency. ZigBee is a short range wireless technology that is used for communication, remote control and sensor applications which is suitable to operate in unpleasant radio environments and in isolated locations. ZigBee technology is based on IEEE 802.15.4 standard which defines the physical and MAC layers. Above that, ZigBee defines the application and security layer specifications in to provide service to other and accept services between products from different manufacturers. In this way ZigBee is a best of the 802.15.4 specification.

ZigBee is a complete open global standard gained ratification by Institute of Electrical and Electronics Engineer (IEEE) in 2003. It is based on the earliest version of IEEE 802.15.4 with varying data rates 20 to 250kbits/s which operates in 868 MHz, 915 MHz and 2.4GHz, It is created by ZigBee Alliance which is supported by number of companies such as Chipcon, Ember, and Free scale, Honeywell, Mitsubishi, Motorola, Philips and Samsung. It uses direct sequence spread spectrum to transmit the data by using Binary Phase Shift Key (BPSK) and Orthogonal Quadrature Phase Shift Key (O-QPSK) modulation techniques.

Reasons for using ZigBee over proprietary protocol are its encryption techniques provide more security. Provides long battery lifetime due to low duty cycle. Easy to deploy its cost is low and used globally. This ZigBee consists of three types of devices: ZigBee coordinator, routers and end point devices. The Coordinator is the root of the network as it acts as a bridge to other networks. It handles and stores the information for source and destination operations within the internet network. Routers pass data to other devices as intermediaries. In order to make longer battery life and to reduce complexity, end point devices are used for limited function.

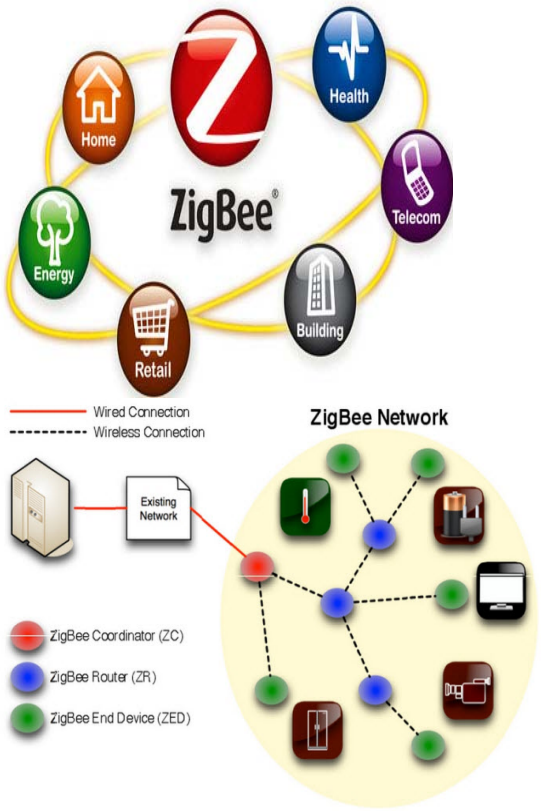

Figure2-ZigBee technology

C. Ultra-Wideband Technology

Ultra-Wide Band (UWB) technology is a redio technology used for transmitting digital data at very high rate and use very low power. It is used for short range communication. It uses high bandwidth communication over a large portion of radio spectrum. Ultra-wideband was formerly known as pulse radio. Ultra-wideband radio can carry a huge amount of data over a distance up to 230 feet at very low power (less than 0.5 mill watts) and also carry signals through doors and other obstacles that tend to reflect signals at more limited bandwidths and a higher power.

It is Originally designed for commercial radar systems, UWB technology has applications in consumer electronics and wireless personal area networks (PAN). It is an ideal solution for wireless connectivity in the range of 10 to 20 meters between consumer electronics (CE), mobile devices, and PC peripheral devices which provides very high data-rate and use very little power consumption. It is ideal for bandwidth, cost, power consumption, and physical size requirements for future electronic devices.

Through the years (1960s–1990s) the United States military developed the UWB technology that was first used for ground penetrating radar. In 1998, the Federal Communication Commissions (FCC) identifies the importance of UWB technology and started the regulatory review process of the technology. At that time in February 2002 the FCC report formed, in which UWB technology was authorized for the commercial uses with different applications, operating frequency bands as well as the transmitted power spectral densities.

UWB radios can use frequencies from 3.1 GHz to 10.6 GHz that is the band more than 7 GHz wide. Depending upon central frequency each radio channel can have a bandwidth of more than 500 MHz. After that FCC has put severe broadcast power restrictions due to such a large signal bandwidth. By doing this UWB devices can make use of extremely wide frequency band while emitting very less amount of energy to get detected by other narrower band devices. UWB device can co-exist with other wireless devices because UWB device signal cannot interfere with other narrower band device signals. UWB is considered as Wireless USB that is it replaces the standard USB and fire wire (IEEE 1394) solutions because of its higher data-rate compared to USB and fire wire. UWB signals can co-exists with other short/large range wireless communications signals due to its own mechanism.

Figure3-UWB technology

D. Wi-Fi Technology- Wi-Fi (802.11a, b, g)

It is IEEE based standard. Wi-Fi is a communication technology for short distance wireless local area networking with devices uses IEEE 802.11 standards. Wi-Fi is designed by the Wi-Fi Alliance. Wi-Fi is a very popular short

range wireless networking technology. Wi-Fi stands for "wireless fidelity". The Wi-Fi was invented by NCR Corporation AT&T in Netherlands in 1991. By using Wi-Fi we can exchange or transfer the information between two or more devices. It uses radio waves to establishment of connection and to exchange data. A Wi-Fi connection is established using a wireless adapter to create hotspots - areas near a wireless router that are connected to the internet network and allow users to access internet services. Once configured it provides wireless connectivity to your devices by releasing frequencies between 2.4GHz - 5GHz, based on the amount of data on the network. Wi-Fi is commonly called as wireless LAN (local area network). Wi-Fi allows local area networks to operate without cable and wiring. It is used for home application and business networks. A wireless adaptor transfers the data into a radio signal and also transfers the data into antenna for users

Some series of Wi-Fi are 802.11a, b, g, n. The 802.11a will transmit data at a frequency of 5GHz. It can transmit a maximum of 54 megabits of data per second. The 802.11b will transmit data at a frequency of 2.4GHz, which is a relatively slow speed. one can transmit a maximum of 11 megabits of data per second. The 802.11g will transmit data at frequency of 2.4GHz but it can transmit a maximum of 54 megabits of data per second

The more advanced series of Wi-Fi is 802.11n and it transmit a maximum of 140 megabits of data per second and uses a frequency level of 5GHz.

Figure4- Wi-Fi Technology

E. Home RF Technology

Home RF was a wireless networking specification for home devices. It was developed in 1998 by the Home Radio Frequency Working Group, a consortium of mobile wireless companies that included Proxim Wireless, Intel, Siemens AG, Motorola, Philips and more than 100 other companies.

Home RF used frequency hopping spread spectrum (FHSS) in the 2.4 GHz frequency band and in theory could achieve a maximum of 10 Mbit/s throughput; its nodes can travel within a 50 meter range of an wireless access point while remaining connected to the personal area network (PAN). Home RF allowed both voice telephone signals and data signals to be exchanged over the same wireless network. Therefore, in Home RF, cordless telephones and laptops, for example, could share the same bandwidth in the same home or office. Available Home RF local area networks (LANs) supported 1.6 Mbit/s, relatively slow compared to technology marketed under the Wi-Fi brand name. For example, second generation 802.11b LANs supported 11 Mbit/s. 802.11n reaches a maximum of 600 Mbit/s. Several standards and working groups focused on wireless networking technology in radio frequency (RF).

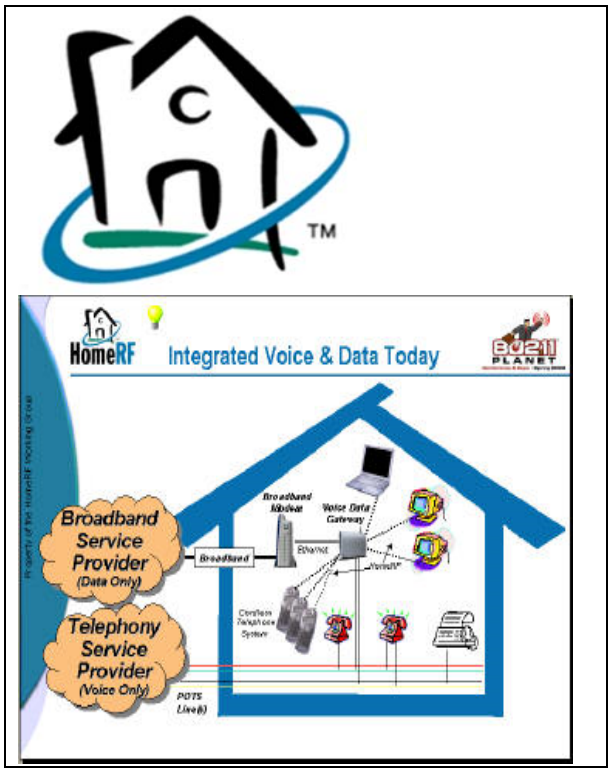

Figure5-Home RF Technology

F. IR Wireless Technology

IR wireless technology uses infrared (IR) radiation for communication. Infrared is wavelengths somewhat longer than those of red light. Visible red in the spectrum is the shortest-wavelength IR borders; the longest-wavelength IR borders radio waves. Infrared technology allowed computer hardware and software devices to communicate via short-range wireless signals in the 1990s. By using IR wireless technology computers could transfer files and other digital data in bi-directional way.

IR wireless is used for short- and medium-range communications system and control. Some systems operate in line-of-sight mode that is there must be a visually not blocked straight line or easily noticed straight line through space between the source and destination. Other systems operate in diffuse mode, also called scatter mode. This type of system can function when the source and destination are not directly visible to each other. The application of IR wireless technology is mostly in home automation; home devices control units, robot controlling systems, medium-range communication, mobile phones, laser communications, headsets, modems, and printers and other peripheral devices. In IR wireless technology rays cannot pass through walls that is it is blocked by walls. So that in IR communications, communication is usually not possible between various rooms of a home or between different houses near to each other unless they have facing windows, this is disadvantage of IR wireless technology. But IR wireless operates more efficiently within the range of 20-25 Ft. in the environment without WLAN equipment's.

Figure6-IR wireless technology

Comparative table

	IR Wireless	**Bluetooth**	**Wi-Fi**	**Home RF**	**ZigBee**	**UWB**
Standards	IrDA	IEE802.15.1	IEE802.11	-	IEEE802.15.4	IEEE1394
Data Rate	20-40 Kbits/s 115 Kbits/s 4 & 16 Mbits/s	1 Mbits/s	11 & 54 Mbits/sec	10 Mb/s	20, 40, and 250 Kbits/s	50-100Mb/s,
Modulation method	DSSS	FSK/PSK/GFSK	BPSK/QPSK	FHSS/GFSK	BPSK/O-QPSK	BPSK/QPSK
Information transmition	Infrared radiation	Radio waves	Radio waves	Radio waves	Radio waves	Radio UWB pluses
Range	<10 meters (line of sight)	10 meters	50-100 Meters	50 meters	10-100 Meters	170 meters
Coexistence mechanism	Frequency hoping	Adaptive freq. hopping	Dynamic freq. selection	Frequency hopping	Dynamic freq. selection	Adaptive freq. hopping
Networking Topology	Point to point	Ad-hoc, very small networks	Point to hub	Ad-hoc, very small networks	Ad-hoc, peer to peer, star, or Mesh	Point to point
Operating Frequency	380 MHz	2.4 GHz	2.4 and 5 GHz	2.4 GHz	868 MHz (Europe) 2.4 GHz (worldwide)	3.1-10.7 GHz
Complexity (Device and application impact)	Low	High	High	Low	Low	Medium
Power Consumption	Low	Medium	High	Low	Very low	Low

Typical Applications	Remote control, pc, phone, PDA, laptop links	Wireless connectivity between devices such as phone, PDA, laptop, headsets	Wireless LAN connectivity, Broadband internet access	Scene and remote control lighting, Security alarm interfaces and sensors, Home sensors	Industrial control and monitoring, Sensors networks, building automation, Home control and automation, Toys, games	Target senser data collection Industrial control and monitoring, Precision locating and tracking Sensors networks, building automation, home control, Streaming video, Home entertainment applications

III. CONCLUSION

This paper provide overview of various short range wireless technology like IR wireless Bluetooth, Wi-Fi, Home RF, UWB and ZigBee, with terms of data rate, modulation method, protocol complexity, and power consumption. Furthermore, application, range and security are also compared. Hence it enables user to understand which particular short range wireless technology can be used as per the application.

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