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Experimental Studies of Bluetooth Wireless Technology

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Abstracts

The Bluetooth wireless technology is designed as a short-range connectivity solution for personal, portable and handheld electronic devices. Since, May 1998 the Bluetooth SIG steers the development of the technology through the development of an open industry specification, including both protocols and application scenarios, and a qualification program designed to assure end-user value for Bluetooth products. This article highlights the Bluetooth wireless technology.

Keywords: Bluetooth, Hotspot, Internet, GPRS or Wi-Fi facility,UWB.

Introduction

Bluetooth is a networking technology aimed at low-powered, short range applications. It was initially developed by Ericsson, but is governed as an open specification by the Bluetooth Special Interest Group . Bluetooth is a recently proposed standard for short range, low power wireless communication. Initially, it is being envisioned simply as a wire replacement technology. Its most commonly described application is that of a “cordless computer “consisting of several devices including a personal computer, possibly a laptop, keyboard, mouse, joystick, printer, scanner ,etc., each equipped with a Bluetooth card. There are no cable connections between these devices, and Bluetooth is to enable seamless communication between all them, essentially replacing what is today achieved through a combination of serial and parallel cables, and infrared links. However, Bluetooth has the potential for being much more than a wire replacement technology. This is in part because its low power consumption and potential low cost make it an attractive solution for the typical mobile devices used in adhoc networks. Bluetooth is a specification for Wireless Personal Area. It is a way to connect and exchange information and data between mobile phones, laptops, digital cameras and video games. The communication is wireless and has the range of up to 10 meters. Imagine the situation. You go to your office. You connect your notebook to the LAN port. You switch it on. It goes through the entire process of booting up and then you transfer the data to your desktop computer this around process takes around 10-15 minutes, depending upon speed of your notebook. Bluetooth will also enables to transfer files, photos, and songs from the mobile to other device. The Bluetooth comes in with a wireless headsets and it comes in free with the mobile phone or computer, the wireless headset also useful for people who like to be on the go or while

driving the car, as they are hands free. This paper includes some previous work done on bluetooth scatternet.

Why it is called Bluetooth?

The heart of the Bluetooth brand identity is the name, which refers to the Danish king Harald "Bluetooth" Blaatand who unified Denmark and Norway. In the beginning of the Bluetooth wireless technology era, Bluetooth was aimed at unifying the telecom and computing industries .Bluetooth can be used to wirelessly synchronize and transfer data among devices. Bluetooth can be thought of as a cable replacement technology. Typical uses include automatically synchronizing contact and calendar information among desktop, notebook and palmtop computers without connecting cables. Bluetooth can also be used to access a network or the Internet with a notebook computer by connecting wirelessly to a cellular phone.

Working of Bluetooth

(LAN) technology, also referred to as Wi-Fi, finds itself with an increasing rate in corporate and academic office spaces, buildings, and campuses. Furthermore, with slow, but steady rate, the 802.11b technology makes inroads in pub 3.3.1 Radio Layer Bluetooth works similar to other wireless technologies. It transmits data in the form of bits (**ones and zeros**) over a radio frequency. This function is defined by radio layer .Bluetooth transceivers use Gaussian Frequency Shift Keying (GFSK).In GFSK, the binary zero is represented by negative frequency deviation and binary one is represented by positive frequency deviation. The Bluetooth transceivers are available in three Power classes. The range is without obstacles.

The technical challenge

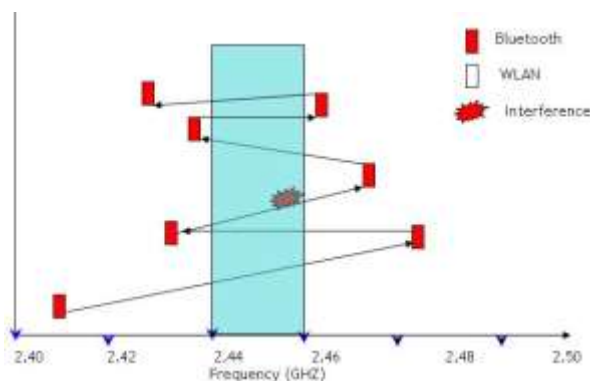
The special interest group (SIG) formed its own task group to handle the interference issues. Both Bluetooth and IEEE 802.11 groups looking for some techniques that can eliminate the interference issues .

Collaborative mechanism

The groups agreed on the proposal that protocols to be implemented in the same device for independent solution and that solution will rely on the interference detection and estimation. This kind of solution is named as collaboration mechanism or Bluetooth interference aware scheduling (BIAS) which is based on MAC scheduling i.e. both protocols be implemented in the same device, for transmitting voice packets, the priority is given to Bluetooth while for transmitting data; IEEE 802.11 is given the priority. The advantage of this techniques using scheduling policy is that it does not require any changes in the FCC rules; in addition, scheduling in the Bluetooth specification is vendor implementation specific. Therefore one can easily implement the scheduling policy with the currently available Bluetooth chipset. Another technique is known as overlap avoidance (OLA) which uses different encapsulations to avoid frequency collision between IEEE 80211 and Bluetooth.

Non collaborative Mechanism

The Bluetooth and IEEE 802.11 interference testing is still in progress. For most of application the performance level is reasonable (less than 25% degradation throughput) but for Bluetooth audio or any real time streaming application, the performance is not satisfactory. The blocked channel caused by the interference results in the degradation of the performance of channel due to the



retransmission of data again and again. And thus very difficult for audio or real time streaming to maintain it. The poor voice rate and reduced data rate compels Bluetooth specification of move to another technique

called adaptive frequency hopping or non collaborative mechanism. Adaptation of frequency hopping was introduced by the Bluetooth special interest group (SIG) in the Bluetooth 1.2 version. Adaptive frequency hopping technique restores the bad performance of reduced data rate by identifying the high error rates or bad channels and after that these channels are excluded. In this way, the retransmissions are controlled. The channels which are used by WLAN are excluded and the Bluetooth packets are restricted to those channels where there is a less chance of interference. The adaptive frequency hopping technique increases the Bluetooth throughput and maximizing the spectrum usage .

Bluetooth Coverage

Bluetooth's short range could be a problem for some applications ,e.g., to cover a large area, more number of Bluetooth receivers would be required every 10-100 meters, but this is not the economical way to implement such thesis. Here are few experiments by which the Bluetooth range could be extended when the internal built in antenna is replaced with the external one. The Bluetooth USB dongle has a small antenna which can communicate with Bluetooth device within a range of 10 meters. This small built-in antenna could be replaced with a more efficient one.

Bluetooth Antennas

The Bluetooth antennas are used to extend the range of Bluetooth. The main purpose is to transmit signals and receive. Blue antenna has many characteristics e.g. gain and direction. It's operation. Antenna performance is very important factor as the same antenna is used for sending the signals and receiving the signals. The main issues which are involved with Bluetooth antenna are power coupling losses between antenna and the transmitter. Then there are antenna placement issues.



Figure Bluetooth antenna sends and receive diagram The Figure 8 explains the process and functional of Bluetooth antenna, the antenna sends the signal P_i to receiver and P_t is the transmitted signal. P_r is reflected back antenna. The ratio at the transmitter is P_i/P_t . The maximum power which is radiated from antenna must be matched the connected device. Which in most RF circuit cases is 5- ohm impedance and it is consider best for the antenna feed points.

New usage models

The Bluetooth SIG is attempting to enable new usage models and create additional benefits for users of portable telephony and computer products. In addition to the examples presented in Section I, the SIG wants to enable the following future possibilities.

- ***The Three-in-One Phone.*** In this scenario, you are able to use the same phone wherever you are. When you're at the office, your phone functions as an intercom (no telephony charge). At home, it functions as a portable phone (fixed line charge). And when you're outdoors, the phone functions as a mobile phone (cellular charge).
- ***The Briefcase Trick.*** Use e-mail while your notebook is still in the briefcase. When your notebook receives an email, you'll get an alert on your mobile phone. You can also browse all incoming e-mails and read those you select in the mobile phone's window.
- ***The Automatic Synchronizer.*** Automatic background synchronization keeps you up-to-date. Automatic synchronization of data on your desktop, notebook, personal digital assistant (PDA), and mobile phone. For instance, as soon as you enter your office the address list and calendar in your notebook will automatically be updated to agree with the one in your desktop, or vice versa. Collect a business card on your phone and add it to your address list on your notebook Pc

Future of Bluetooth Hotspot Technology

On some requests the server hangs and cannot respond to any more requests. The reason for this behavior, though not sure, is most probably due to the data handling which is done specially for http request and any other request may have a different format which might be causing the server to get locked in the loop. As an improvement we can handle other types of requests. The port of the remote host to connect to, in the present implementation, is hard coded to 80. Generally the port used for secure connection is different and thus the present implementation will not be able to respond to secure transactions like logins, or other authentication tasks. The situation can be saved if we code to abstract which port to connect to from the request header. There seems to be some serious defect in handling of the threads. There are times when the data gets intermingled and nothing presentable actually comes out of the data received. We came to this conclusion after a site which had two frames displayed data in a way that each frame displayed others data as if the data got loaded in the wrong frame. Well if the data actually gets mixed on the way the above configuration of exactly reversing the

threads is unlikely. But no other explanation could be thought of.

Future developments

As discussed in the previous section, one of the primary reasons for the success of Bluetooth is the fact that it is a standard developed and constantly upgraded by the Bluetooth Special Interest Group (SIG). Bluetooth has constantly evolved from Bluetooth version 2.0 to the latest version 3.0 with enhanced data rate (EDR), which increases data rate from 24Mbps to 3 Mbps and the overall transmission rate to 3 Mbps. The new specification also aims to reduce power consumption further by 50 %. However one of the most important future developments in Bluetooth would be the incorporation of Ultra Wide Band (UWB) radio technology in Bluetooth. The Bluetooth SIG and the UWB work groups have decided to collaborate and work together to make this happen. UWB is an emerging wireless technology for short range communication. UWB is also a low power technology like Bluetooth, but offers much higher data rates. As opposed to Bluetooth, UWB can offer up to 100 Mbps. Initially this could have been perceived as a threat to Bluetooth since this had the potential to replace Bluetooth as the standard of choice for Wireless Personal Area Networking (WPAN). SIG announced that it would collaborate and work together with the UWB work group to adopt the UWB technology to Bluetooth. The SIG's decision to work with UWB workgroup is a very smart move to leverage the branding, trust and marketability of Bluetooth and the technical advantages of the emerging UWB technology to meet the customers growing needs. Applications not requiring the high data rates will still use the present technology, while multimedia applications can benefit from the UWB's higher data rates. This not only benefits Bluetooth, but it also prevents standardization agencies from creating yet another technology with similar functionalities which would simply confuse the product manufacturers and end users. Presently Bluetooth is the chosen wireless standard to interconnect various devices and hence is used in mobile phones, PDA's, laptops, printers, etc. Although version 3.0 has been specified, most commonly used is Bluetooth versions 1.2, 2.0. In the future when these devices support more profiles and possibly when data rates are further increased by use of UWB. The future applications in Bluetooth could be categorized based on what would drive them. Some of them could be as follows:

- The cost of Bluetooth chipsets is fast reducing and further decrease together will decrease in power consumption will enable its use in

disposable sensors, Personal tags etc. A pilot Project in this regard has been demonstrated at the Zoological Park in Denmark. Children visitors at the Zoo are given Bluetooth enabled tags which will help parents determine their location in Zoo, thus ensuring children's safety. Similarly Bluetooth enabled sensors and communication devices are used in the city of Oslo to monitor critical waterlevels at pumping stations.

- As noted in the previous section, mobile phones are increasingly becoming Personal Information Management Devices and most of today's phones are equipped with Bluetooth. This electronic identity can be used for electronic authentication and authorization on company and university campuses. It can be used for enabling purchase of goods at super markets and can enable ticket less travel. It can be used to enhance security on office premises by automatic locking of computer terminals, managing of telephone calls etc at offices as demonstrated by the X Company Blue position in their products.
- There are several wireless technologies available, which can be used to determine the location of a person. Global Positioning System (GPS)
- Bluetooth can be used to interconnect various home appliances like refrigerator, oven, home security system, lights etc which can all be controlled by a Bluetooth enabled PDA or Mobile phone

Drivers and Barriers

Companies and organizations do in depth research into the technology, its use cases, present and future markets, support and backing from regulatory authorities and standardization bodies before investing in a particular technology. In this regard one of the strong drivers for the Bluetooth standard and its wide acceptance in the industry is the Bluetooth Special Interest Group (SIG). From its initial founder members Ericsson, Nokia, Intel, IBM and Toshiba the SIG has added more than 2000 members. This increasing functionality of mobile phones, there has been an increase in the need for exchange of such information between devices. **Wireless USB offers a solution to replace USB cables in a far simpler manner as opposed to traditional Bluetooth.** This could be thought of as one of the barriers for this technology. At the same time, vendors like NOKIA believe that Wireless USB is a complementary technology and hence is not a real threat or barrier to Bluetooth **Support for both voice and data.** The air

protocol must support good quality real time voice, where "good" is considered to be wired phone line quality. Voice quality is important to both end-users who are accustomed to it, and for speech recognition engines whose accuracy depends on it.

UWB

UWB has recently attracted much attention as an indoor short-range high-speed wireless communication. One of the most exciting characteristics of UWB is that its bandwidth is over 110 Mbps (up to 480 Mbps) which can satisfy most of the multimedia applications such as audio and video delivery in home networking and it can also act as a wireless cable replacement of high speed serial bus such as USB 2.0 and IEEE 1394. Following the United States and the Federal Communications Commission (FCC) frequency allocation for UWB in February 2002, the Electronic Communications Committee (ECC TG3) is progressing in the elaboration of a regulation for the UWB technology in Europe. From an implementation point of view, several solutions have been developed in order to use the UWB technology in compliance with the FCC's regulatory requirements. Among the existing PHY solutions, in IEEE 802.15 Task Group 3a (TG3a), multiband orthogonal frequency-division multiplexing (MB-OFDM), a carrier-based system dividing UWB bandwidth to sub-bands and direct-sequence UWB (DS-UWB), an impulse-based system that multiplies an input bit with the spreading code and transmits the data by modulating the element of the symbol with a short pulse have been proposed by the WiMedia Alliance and the UWB Forum, respectively. The TG3a was established in January 2003 to define an alternative PHY layer of 802.15.3. However, after three years of a jammed process in IEEE 802.15.3a, supporters of both proposals, MB-OFDM and DS-UWB, supported the shut down of the IEEE 802.15.3a task group without conclusion in January 2006. On the other hand, IEEE 802.15.3b, the amendment to the 802.15.3 MAC sublayer has been approved and released in March 2006.

Simple Pairing Achievements- User Actions (1-3 are mandatory, 4 is optional)

- 1) DISCOVER (Add Device)
- 2) SELECT (Select Device)
- CONNECT and ENCRYPT
- (no user action)
- 3) VALIDATE (Confirm Device)
- 4) TRUST (Add to Trusted Devices)

Possible future Bluetooth + UWB Applications Possible Applications:

- Replacing wired mice and keyboards on PC

- Replacing wired audio cables on PC/DVD/Home Entertainment
- Connection to mobile terminals/PC for data synchronization , e.g. PIM
- Connection to TV/DVD/Mobile devices/Projector for Audio/Video transfer
- Connection to Hi-Fi/Mobile devices/MP3 for Audio streaming and transfer clips
- Connection to Hi-Fi/MP3 player/Mobile Devices for music transfer/ synchronization
- Connection to Printer for printing high resolution images
- Connection to TV as smart remote control
- Connection to Mobile Terminal/Gaming peripherals for Gaming Activities, e.g. Controller
- Connection to Mobile device/Routers/Access points for Internet access
- Connection to Wireless Speakers for audio transfer
- Connection to TV/Mobile Devices for navigational/infotainment data transfer, e.g. GPS information.

C. Bluetooth Classic vs. Bluetooth Low Energy

With BLE, Bluetooth has made a paradigm shift in design. Bluetooth 2.0 EDR and Bluetooth 3.0 HS were designed with faster data rates in mind, I contrast BLE 4.0 was designed with lower power consumption in mind. BLE 4.0 is not designed to stream large amounts of data; it is designed to periodically send short bursts of data. There are 2 types of BLE4.0 devices, dual mode which is backwards compatible with previous BT versions, and single mode which only supports BLE4.0. Dual mode devices that perform high data rate streaming do not benefit from the low power consumption of BLE4.0, which is only accomplished when BLE low data rate mode is used. Figure 4 illustrates the technical details of each and makes it clear to see that it is not a question about which is better, but which is better suited for the specific application

Technical Specification	Classic Bluetooth technology	Bluetooth low energy technology
Distance/Range	100 m (330 ft)	50 m (160 ft)
Over the air data rate	1-3 Mbit/s	1 Mbit/s
Application throughput	0.7-2.1 Mbit/s	0.27 Mbit/s
Active slaves	7	Not defined; implementation dependent
Security	56/128-bit and application layer user defined	128-bit AES with Counter Mode CBC-MAC and application layer user defined
Robustness	Adaptive fast frequency hopping, FEC, fast ACK	Adaptive frequency hopping, Lazy Acknowledgement, 24-bit CRC, 32-bit Message Integrity Check
Latency (from a non connected state)	Typically 100 ms	6 ms
Total time to send data (det. battery life)	100 ms	3 ms [citation needed], <3 ms [26]
Voice capable	Yes	No
Network topology	Scatternet	Star-bus
Power consumption	1 as the reference	0.01 to 0.5 (depending on use case)
Peak current consumption	<30 mA	<20 mA
Service discovery	Yes	Yes
Profile concept	Yes	Yes
Primary use cases	Mobile phones, gaming, headsets, stereo audio streaming, automotive, PCs, security, proximity, healthcare, sports & fitness, etc.	Mobile phones, gaming, PCs, watches, sports and fitness, healthcare, security & proximity, automotive, home electronics, automation, Industrial, etc.

Feature

- Built in CC2564 single-chip Bluetooth fully supports BT 2.1 + EDR, BLE
- Supports maximum Bluetooth data rate over HCI UART interface.
- Supports multiple Bluetooth profiles with enhanced QoS, both mono and stereo, assisted A2DP

Application

- Medical (ex Heart Rate Monitor, Blood Pressure Sensor, Blood Glucose Meter)
- Thermometer
- Flood Alarm
- Heating Control
- Automatic Key Control
- Industrial Sensors
- Toys

- Entertainment Devices
- Mobile Accessories
- All Bluetooth Wireless Application

Conclusion

Here we see that all device has depend on wireless communication. gprs Bluetooth hotpot system wi-fi all are most import part of our computer life or we can that our daily life .We can't communicate each other without these devices , Bluetooth is a wireless technology which can do much more than just replace data cables between devices. With the release of the Bluetooth version 3.0 specification supporting higher data rates, Bluetooth is clearly a good choice for Wireless Personal Area Networks. The use of Bluetooth by mobile phone manufactures has been a great driver for this technology along with the push from the Bluetooth Special interest Group. In order to further increase market penetration, Bluetooth SIG should quickly address some of the security and interoperability issues I discussed. The device vendors must strictly adhere to the SIG's Bluetooth specification and address interoperability issues on their own initiate as well. This will further increase users trust in this technology and also create a healthier market place. The SIG's move to work together with UWB work group is a an excellent move and I believe that there should be more initiatives like that to increase the marketability of this technology and also to better serve the end users.

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