A

Seminar report

On

BLUETOOTH TECHNOLOGY

Submitted in partial fulfillment of the requirement for the award of degree
Of Computer Science

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Preface

I have made this report file on the topic **BLUETOOTH TECHNOLOGY,** I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to ……..who assisting me throughout the prepration of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

Acknowledgement

I would like to thank respected Mr…….. and Mr. ……..for giving me such a wonderful opportunity to expand my knowledge for my own branch and giving me guidelines to present a seminar report. It helped me a lot to realize of what we study for.

Secondly, I would like to thank my parents who patiently helped me as i went through my work and helped to modify and eliminate some of the irrelevant or un-necessary stuffs.

Thirdly, I would like to thank my friends who helped me to make my work more organized and well-stacked till the end.

Next, I would thank Microsoft for developing such a wonderful tool like MS Word. It helped my work a lot to remain error-free.

Last but clearly not the least, I would thank The Almighty for giving me strength to complete my report on time.

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BLUETOOTH TECHNOLOGY

OBJECTIVE:

The objective of this report is to provide an informative overview about *Bluetooth technology* which has in fact already become a global de facto standard for wireless connectivity. In this report I am including the fundamentals of Bluetooth, how it evolved, the working, and the technical specifications. Moreover, I am penning down a few of its advantages and disadvantages from a consumer and provider point of view which further leads on to describing a few of its vast and varied applications. I am concluding on the note of what Bluetooth technology presently is and what potential it has in our world and life.

INTRODUCTION:

During the past two decades, the advancement in microelectronics and VLSI technology dipped down the cost of many consumer electronic products to a level which was affordable for the common man. The first quarter of 2001, saw the vending of about 32.5 million PCs. The sale of cellular phones is predicted to reach 1 billion in 2005. With increase in the number of electronic devices, comes in the need of connecting them together for maximum interoperability and utilization. These devices connect with each other using a variety of wires, cables, radio signals and infrared light beams, and an even greater variety of connectors, plugs and protocols. Bluetooth is devised to replace these cables.

Bluetooth is a global standard for wireless connectivity. Bluetooth technology facilitates the replacement of the cables used to connect one device to another, with one universal short-range radio link operating in the unlicensed 2.45 GHz ISM band. The main objectives of Bluetooth technology can be described as follows,

- *Cable replacement*: Getting rid of the various types of cables and wires required for interconnectivity between various devices would enable the lay man to use all electronic devices without wasting time and money.
- *Small size*: the Bluetooth device is very small so that it can be attached to any device required like the cell phones without adding much to the weight of the system.
- *Low cost*: Bluetooth is aimed to be a low cost device approximately $5 in the near future.
- *Low power*: The utilization of power is very less (within 100 mW) as it is short range equipment and so it facilitates the use of small batteries for its usage.

Besides the characteristics mentioned above, Bluetooth can imitate a universal bridge to attach the existing data networks, and also as a mechanism for forming ad-hoc networks. Designed to operate in noisy frequency environments, the Bluetooth radio uses a fast acknowledgement and frequency hopping scheme to make the link robust.

HISTORY:

In 1994, Ericsson in Sweden launched an initiative to study a low-power, low-cost radio interface between mobile phones and their accessories. After three years, In 1997, Ericsson approached various manufacturers of mobile electronic devices to

discuss the development and promotion of this short range wireless radio link as alone this phenomenon could not be implemented.

Thus in 1998, Ericsson, IBM, Intel, Toshiba and NOKIA formed the Special Interest Group (SIG) for the promotion and development of BLUETOOTH technology. The first Bluetooth silicon was also ready in 1998. As we can see that the SIG included two market leaders in mobile telephony, two in laptop computing and one in digital signal processing technology. The biggies being in the game gave an impetus to thousands of companies to join hands with the SIG for the endorsement and expansion of this technology.

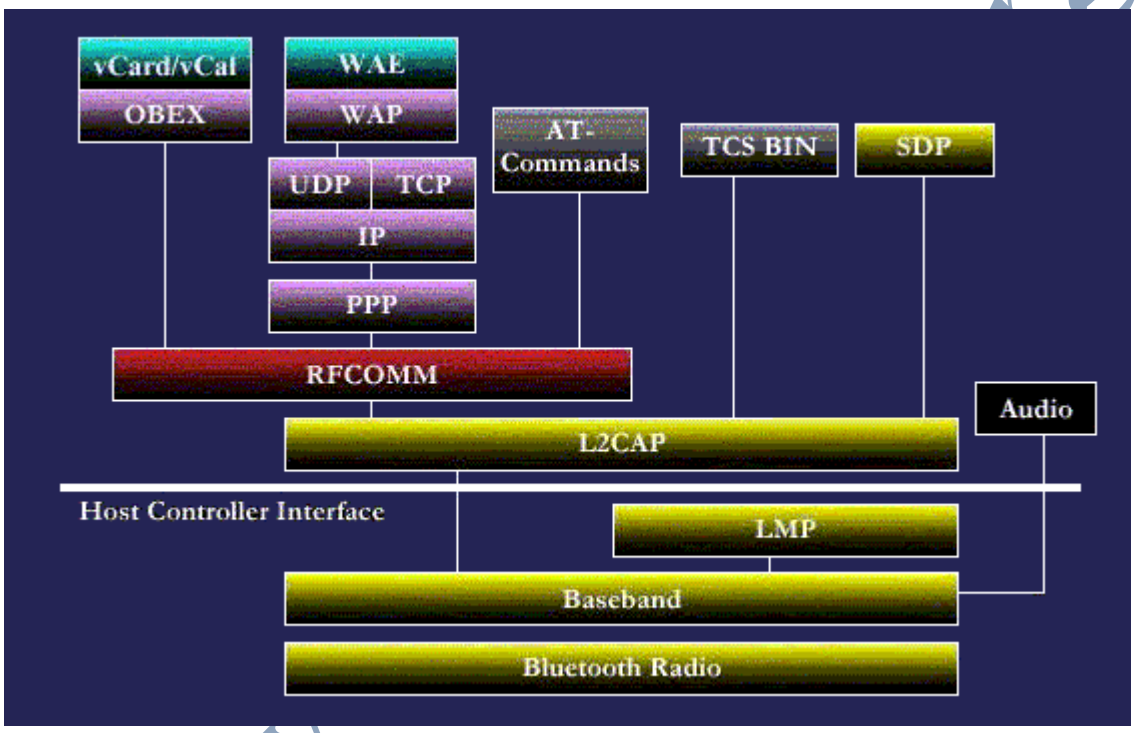
One would wonder how Bluetooth got its name. It has an interesting heritage. Bluetooth is named after the 10th century Viking King Harald Blatand (Blatand meaning Bluetooth). He was instrumental in uniting the countries in the Baltic region like Sweden, Denmark, Norway and thus emerging as a powerful force. Bluetooth aims at uniting the computing and telecommunication world and so achieving the same greatness.

WORKING OF BLUETOOTH:

Basically, Bluetooth is the term used to describe the protocol of a short range (10 meter) frequency-hopping radio link between devices. These devices implementing the Bluetooth technology are termed Bluetooth - enabled. Documentation on Bluetooth is divided into two sections, the Bluetooth Specification and Bluetooth Profiles.

- The **Specification** describes **how the technology works** (i.e. the Bluetooth protocol architecture),
- The **Profiles** describe **how the technology is used** (i.e. how different parts of the specification can be used to fulfill a desired function for a Bluetooth device).

BLUETOOTH PROTOCOL ARCHITECTURE:



As the report is designed mainly for the spread spectrum techniques course, the protocols in the lower level are described more extensively and the upper layer protocols are just mentioned with a very brief description.

Moreover, one should note that the upper layer protocols are totally dependent on the lower level protocols whereas the lower level protocols can function independently even with a totally different set of upper protocols.

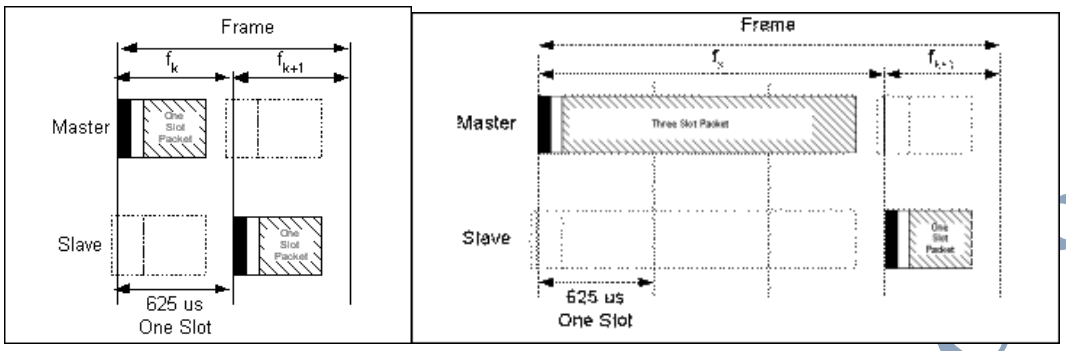
Bluetooth Radio: The Bluetooth Radio (layer) is the lowest defined layer of the Bluetooth specification. It defines the requirements of the Bluetooth transceiver device operating in the 2.4GHz ISM band. The Bluetooth air interface is based on three power classes,

- Power Class 1: designed for long range (~100m), max output power of 20 dBm,
- Power Class 2: ordinary range devices (~10m), max output power of 4 dBm,
- Power Class 3 short range devices (~10cm), with a max output power of 0 dBm.

The radio uses Frequency Hopping to spread the energy across the ISM spectrum in 79 hops displaced by 1MHz, starting at 2.402GHz and stopping at 2.480GHz.Some countries use the 79 RF channels whereas countries like Japan use 23 channels. Currently, the SIG is working to harmonize this 79-channel radio to work globally and has instigated changes within Japan, Spain, and other countries. Also, the Bluetooth radio module uses GFSK (Gaussian Frequency Shift Keying) where a binary one is represented by a positive frequency deviation and a binary zero by a negative frequency deviation. BT is set to 0.5 and the modulation index must be between 0.28 and 0.35. The receiver must have a sensitivity level for which the bit error rate (BER) 0.1% is met. For Bluetooth this means an actual sensitivity level of -70dBm or better.

Baseband: The Baseband is the physical layer of the Bluetooth. It manages physical channels and links apart from other services like error correction, data whitening, hop selection and Bluetooth security. As mentioned previously, the basic radio is a hybrid spread spectrum radio. Typically, the radio operates in a frequency-hopping manner in which the 2.4GHz ISM band is broken into 79 1MHz channels that the radio randomly

hops through while transmitting and receiving data. A piconet is formed when one Bluetooth radio connects to another Bluetooth radio.



Both radios then hop together through the 79 channels. The Bluetooth radio system supports a large number of piconets by providing each piconet with its own set of random hopping patterns. Occasionally, piconets will end up on the same channel. When this occurs, the radios will hop to a free channel and the data are retransmitted (if lost). The Bluetooth frame consists of a transmit packet followed by a receive packet. Each packet can be composed of multiple slots (1, 3, or 5) of 625us. A typical single slot frame typically hops at 1,600 hops/second. Multi-slot frames allow higher data rates because of the elimination of the turn-around time between packets and the reduction in header overhead.

LMP: The Link Manager Protocol is used by the Link Managers (on either side) for link set-up and control.

HCI: The Host Controller Interface provides a command interface to the Baseband Link Controller and Link Manager, and access to hardware status and control registers.

L2CAP: Logical Link Control And Adaptation Protocol supports higher level protocol multiplexing, packet segmentation and reassembly, and the conveying of quality of service information.

RFCOMM: The RFCOMM protocol provides emulation of serial ports over the L2CAPprotocol. The protocol is based on the ETSI standard TS 07.10.

SDP: The Service Discovery Protocol provides a means for applications to discover which services are provided by or available through a Bluetooth device. It also allows applications to determine the characteristics of those available services.

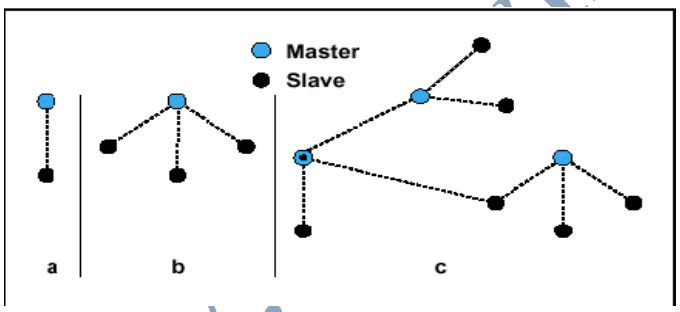
PROFILES:

The profiles have been developed in order to portray how implementations of user models are to be accomplished. The user models describe a number of user scenarios where Bluetooth performs the radio transmission. A profile can be described as a vertical slice through the protocol stack. It defines options in each protocol that are compulsory for the profile. It also defines parameter ranges for each protocol. The profile concept is used to decrease the risk of interoperability problems between different manufacturers' products. For example: The Headset profile defines the requirements for Bluetooth devices necessary to support the Headset use case. The Fax profile defines to support the Fax use case. There are as many profiles as applications which are growing everyday.

NETWORK TOPOLOGY

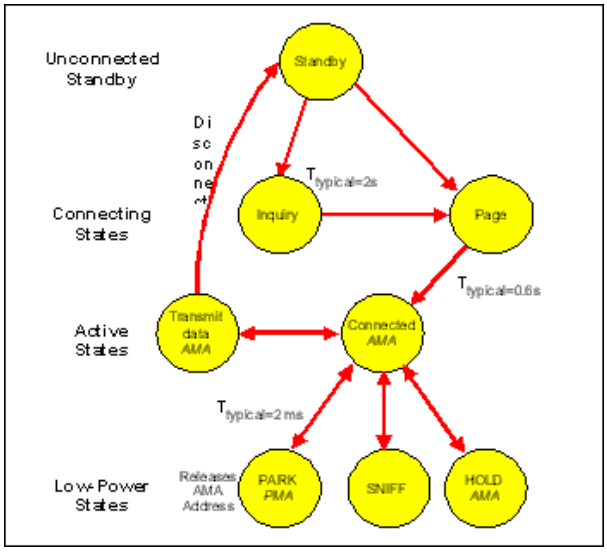
The Bluetooth system supports both point to point and point to multipoint connections.

PICONETS: Bluetooth radios connect to each other in piconets, which are formed by a master radio simultaneously connecting up to seven active slave radios [3 bit address] in an Ad-hoc manner. There can be up to 256 parked slaves [8 bit address] which like the active members are synchronized to the master clock. Each piconet has a unique hopping sequence. To form a piconet, the Bluetooth radio needs to understand two parameters: the hopping pattern of the radio it wishes to connect to and the phase within that pattern. In forming a piconet, the master radio shares its Global ID with the other radios, which then become slaves and provide all the radios with the correct hopping pattern. The master also shares its clock offset (represented by the clock dial) with the slaves in the piconet, providing the offset into the hopping pattern. This information can easily be exchanged via the FHS packet.



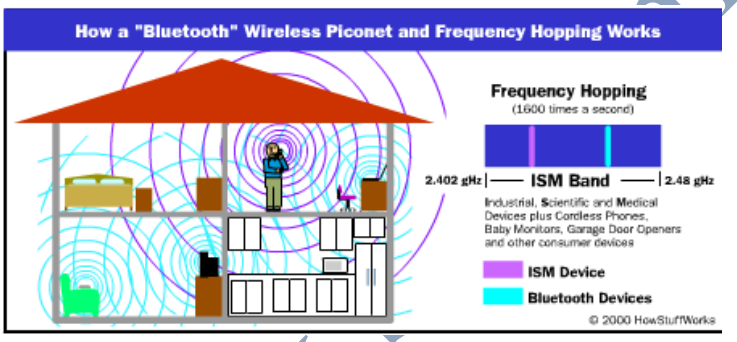
SCATTERNETS: Two or more piconets with overlapping coverage areas form the scatternet. Slaves in one piconet can be master or slave in the other piconet [Achieved by TDM].Up to 10 fully loaded piconets can coexist in a scatternet. Any devices in multiple piconets employ TDM. The two types of links that can be establishes between the master and slaves are named

SCO: Synchronous Connection Oriented and **ACL**: Asynchronous Connection Less link



The communication protocol is described by the following state diagram. Standby is the default state.

Frequency Hopping Spread Spectrum



Frequency-Hopping Spread-Spectrum (FHSS) is a spread spectrum modulation scheme that uses a narrowband carrier that varies frequency in a pseudo random pattern known to both transmitter and receiver. To an unintended receiver, FHSS appears to be a short-duration impulse noise. Only transmitters and receivers that are synchronized on the same hop frequency pattern will have access to the transmitted data. The transmitter switches hop frequencies 1,600 times per second to assure a high degree of data security. Also compared to DSSS, FHSS is simpler to build with higher noise immunity.

TECHNICAL SPECIFICATIONS

SPECIFICATIONS	
Frequency band	2.4 GHz ISM band
Modulation	Gaussian shaped BFSK
Range	10 -100 m
Physical layer	FHSS
Coverage	Omni-directional. Non line of sight transmission
Data rate	1 Mbps/723 Kbps
Hopping rate	1600 hops/sec at 1 hop/packet
Channels	79/23 channels
Channel length	625 microseconds long
Data packet	Up to 2,745 bits in length
Reliable and secure	Good. Link layer authentication and encryption
Cost	$ 20 aims at $5 endpoint
Power	0.1 W (Active)
Acceptance	SIG have about 2500 member companies
Data / Voice support	One asynchronous data channel (732.2 kbps and reverse 57.6 kbps) OR Three simultaneous synchronous voice channels (64 kbps) OR Simultaneous asynchronous and synchronous channels.

Piconet	1 master and 7 slaves
Scatternet	Up to 10 piconets in a scatternet
Links	SCO and ACL links

ADVANTAGES

- Low Power Consumption
- Works in noisy environments
- No line of sight restriction
- Reliable and secure
- The 2.45 GHz ensures universal compatibility. Also complies with airline regulations
- The qualification and logo program ensure higher quality
- Very Robust as the radio hops faster and uses shorter packets

DISADVANTAGES

- Too many unfeasible applications so do we really need it ?
- No handoff / handover capability
- Initial stages so it needs to prove its worth
- Few analog or FH cordless phones have designed to operate at the 2.4GHz band. Certainly interference exists in between, but more serious effects would be exerted on analog 2.4GHz cordless phone
- ***802.11*** ***Bluetooth***

  Represents Internet Represents faux internet

  Already proved itself Still to prove

Widespread connectivity Connect at close proximity

APPLICATIONS

Bluetooth has a varied number of applications. Each application has a corresponding profile. Some of them are named as follows

- Mobile phones
- Digital cameras
- Home networking
- Music
- Medical
- Child monitoring
- Three-in-one phone, etc
- Laptops, desktops, pda's
- Printers
- Data access points
- Office equipment
- Senior assisted living
- Wireless headsets

CONCLUSION

Bluetooth technology is a short-range wireless specification aimed at simplifying communications among Internet devices and between devices and the Internet. In conclusion it can be said that Bluetooth refers not only to a technology but also to a standard and a specification. The take off that Bluetooth has taken is remarkable, capturing the attention and money of major corporations throughout the world. If it can live up to its expectations and satiate the needs of a global market in an easy and

inexpensive way , it promises to become a uniting force in the wireless world and endow us with the freedom of mobility like never before.

SUGGESTIONS FOR FURTHER STUDY:

If I had more time to work on this research topic, I would have liked to explain the coexistence mechanisms for interference mitigation in the 2.4GHz band. This can be studied from the IEEE paper on the same, published in September 2003, Volume: 2, Issue: 5, By Chiasserini, C.F. & Rao, R.R. Also, I would like to have provided a detailed comparison between Bluetooth and 802.11 LAN. Another interesting addition could have been a detailed explanation of the Bluetooth profiles explaining the protocols for various applications. Comparing this close proximity communication device with Infra red and Home RF can also add more value to the study of Bluetooth.

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