BLUETOOTH TECHNOLOGY
A BOON TO WIRELESS COMMUNICATION

Nitesh Rijal
rijal.it@gmail.com
NCIT

Gopal Pd. Shah
gopal20612005@hotmail.com
NCIT

ABSTRACT

Today's world has been converted into a global village and this is basically because of the development in the field of networking and communication. Wireless communication is growing at the rate of FLASH. And Bluetooth Technology is an example of it.
Bluetooth is an open standard for short range digital radio. Bluetooth is considered as wireless PAN technology that offers fast and reliable transmission for both voice and data .Bluetooth devices will eliminate the need for cables and provides a bridge to existing networks and thus it has a great scope in near future.
The goal of Bluetooth is to connect desperate devices(PDAs, cell phones, printers, faxes etc.) and allow them to seamlessly work together in a small environment such as an office or home.
According to the leading proponents of the technology, Bluetooth is a standard that will ultimately—

**Eliminate wires and cables between both stationary and mobile devices.*
**Facilitate both data and voice communication.*
**Offer the possibility of ad-hoc networks and deliver synchronicity between personal devices*

INTRODUCTION

Wireless technologies, in the simplest sense, enable one or more devices to communicate without any physical connections. Wireless networks serve as the transport mechanism between devices and among devices and the traditional wired networks.
Wireless networks are of many and diverse type but are frequently categories into three groups based on their ranges. They are:-

a)WWANs (Wireless Wide Area Networks)
b)WLANs (Wireless Local Area Networks)
c)WPANs (Wireless Personal Area Networks)

Bluetooth is wireless protocol for sending audio and video data between mobile computers - laptops, notebooks, Handheld Computers, PDA's and other blue tooth enabled devices including print servers. Bluetooth is a computing and telecommunications industry specification that describes how mobile phones, computers and PDAs can easily interconnect with each other and with home and business phones and computers using a short wireless connection.
Bluetooth requires that a low-cost transceiver chip (costs less than $5) be included in each device which is to be Bluetooth-enabled. The transceiver transmits and receives in a previously unused ISM (industrial, scientific, medical applications) frequency band of 2.45 GHz that is available globally. Connections within the devices can be point-to-point or multi point. A frequency hop scheme allows devices to communicate even in areas with a great deal of electromagnetic interference. Built-in encryption and verification is also provided by Bluetooth standard for security purposes.
Key characteristics of Bluetooth technology is mentioned in the following table:--

Ch aracteristics	Descriptions
Physical layer	Frequency Hopping Spread Spectrum (FHSS)
Frequency band	2.4 -2.4835GHz (ISM)
Hop frequency	1600 hops/sec
Data rate	1 Mbps (RAW) . Higher bit rates are anticipated
Data and network security	Three modes of security (none , link level and service level) , two levels of device trust ,and three lev els of service security .

	confidentiality , challenge-response for authentication . PIN- derived keys and limited management .
Operating range	About 10 meters (30 feet) ; can be extended to 100 meters .
Throughput	Upto approximately 720Kbps .
Positive aspects	No wires and cables for many interfaces . ability to penetrate walls and other obstacles . costs are decreasing with a $5 cost projected . low power and minimal hardware .
Negative aspects	Possibilities for interference with other ISM band technologies . relatively low data rates. Signals leak outside desired boundaries.

HISTORY

The original architect for Bluetooth, named after the 10 th century Danish king Herald Bluetooth, was Erriction Mobile Communication . In 1998 IBM , Intel , Nokia and Toshiba formed the Bluetooth SIG (Special Interest Group) , which serves as the Governing body for the specification . Today more than 2000 organizations are part of the Bluetooth SIG, comprising leaders in the telecommunications and computing industries that are driving development and promotion of Bluetooth technology. The idea that resulted in the Bluetooth wireless technology was born in 1994 when Ericsson Mobile Communications decided to investigate the feasibility of a low-power, low-cost radio interface between mobile phones and their accessories. The idea was that a small radio built into both the cellular telephone and the laptop would replace the cumbersome cable used today to connect the two devices. The radio technology showed possibilities to become a universal bridge to existing data networks, a peripheral interface, and a mechanism to form small private ad hoc groupings of connected devices away from fixed network infrastructures.

USAGE MODELS

While Bluetooth usage model is based on connecting devices together, it is focused on three broad categories:

a) Voice/Data Access Points :

This is one of the key initial usage models and involves connecting a computing device to a communicating device via a secure wireless link (see fig. 1).

For e.g. A mobile computer equipped with Bluetooth technology could link to a mobile phone that uses Bluetooth technology to connect to the Internet to access e-mail. The mobile phone acts as personal access point.

This would allow any mobile device equipped with Bluetooth technology to easily connect to the Internet while located within 10 meters of that access point. These access points could, of course , support much higher data rates than today's modems as public spaces could connect a varity of private Bluetooth access points via a LAN that is routed to the Internet over a DSL line , allowing each access point a private 1 Mbps connection to the Internet .

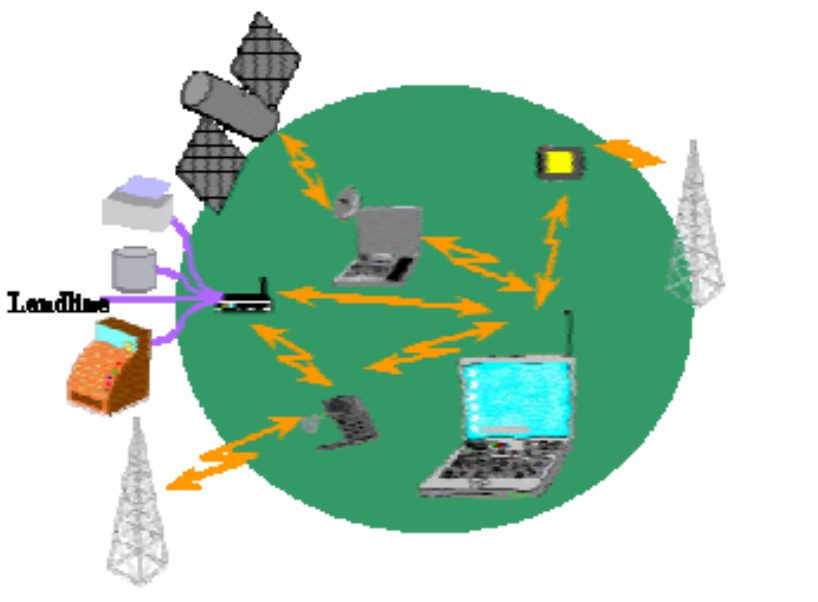

Figure 1: Voice/data access points

b) Peripheral Interconnects:

This model involves connecting other devices together as shown in fig. 2.

The Bluetooth link is built into the mobile computer; therefore, the cost of the peripheral

device is less because an access point is not needed. Additionally many of these devices can be used in multiple markets. For example, a Bluetooth headset used in the office could be connected to a Bluetooth access point that provides access to the office phone and multi-media functions of the mobile computer. When mobile, the same headset could be used to interface with the cellular phone (which can now remain in a briefcase or purse).

Figure 2: Peripheral interconnects

c) Personal Area Networking:
This last model focuses on the Ad-hoc formation and breakdown of personal networks. Imagine meeting someone in an airport and quickly securely exchanging documents by establishing a private pico net. In the near future, Bluetooth kiosk could provide access to electronic media that could be quickly downloaded for later access on mobile devices.

Figure 3: Personal Area Networking (PAN)

ARCHITECTURE

The Bluetooth technology is divided into two specifications: the core and the profile specifications. The core specification discusses how the technology works, while the profile specification focuses on how to build interoperating devices using the core technology.

Radio Frequency Layer
The Bluetooth air interface is based on a nominal antenna power of 0dB (1mW) with extentions of operating at upto 20dB (100mW) worldwide. The air interface compiles with most country's ISM band rules upto 20dBm. The radio uses frequency hopping to spread the energy across the ISM spectrum in 79 hops displayed by 1MHz, starting at 2.402GHz and stopping at 2.80GHz. Currently the SIG is working to harmonize this 79-channel radio to work globally and has instigated changes within Japan, Spain and other countries.
The nominal link range is 10 cm to 10m , but can be extended to more than 100m by increasing the transmit power (using the 20 dBm option) .

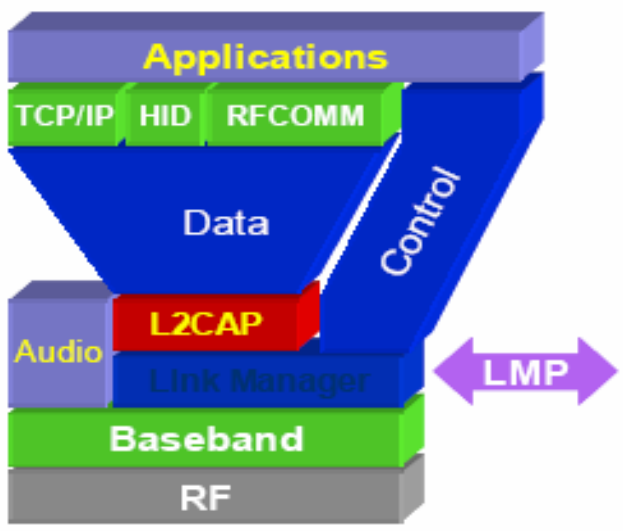

Figure 4: Bluetooth architecture

The Bluetooth Baseband
As mentioned earlier the basic radio is the hybrid spread spectrum radio. Typically the radio operates in a frequency-hopping manner in which the 2.4GHz ISM band is broken into 79-1-MHz

channels that the radio randomly hops through while transmitting and receiving data. 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 625microseconds . A typical single slot frame is illustrated in figure 5, which typically hops at 1600hops/sec. Multi slot frame allow higher data rates because of the elimination of the turn-around time between packets and the reduction in header overhead.

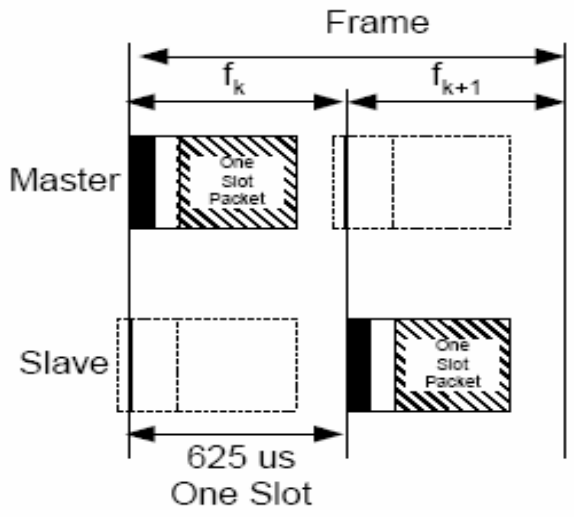

Figure 5: Single slot frame

FREQUENCY

The designers of Bluetooth have designed it to operate in the unlicensed 2.4 GHz-2.4835 GHz ISM frequency band. Because numerous other technologies also operate in this band, Bluetooth uses a Frequency Hopping Spread Spectrum (FHSS) technology to solve interference problems.

The FHSS scheme uses 79 different radio channels by changing about 1600 times per second. One channel is used in 625 microseconds followed by a hop in a pseudo-random order to another channel for another 625 microseconds, this process is repeated continuously.

DATA RATE

Bluetooth networks can support either one asynchronous data channel with up to three simultaneous synchronous speech channels or one channel that transfers asynchronous data and synchronous speech simultaneously . In ISM band Bluetooth technology permits transmission speeds of up to 1Mbps and achieve a throughput of approximately 720 Kbps . Although the data rates are low , it is adequately fast for many of the applications for which Bluetooth was conceived . Different data rates in different channel – configurations is given in the following table :

Configurations	Max. data rate upstream	Max. data rate downstream
3 simultaneous voice channels	64 Kbps *3 channels	64 Kbps *3 channels
Symmetric data	433.9 Kbps	433.9 Kbps
Asymmetric data	723.2 Kbps or 57.6 Kbps	723.2 Kbps or 57.6 Kbps

8. OPERATING RANGE:

Bluetooth provides three different classes of power management . class 1 , class 2 and class 3 . These three levels of operating power are summarized in the following table :

Type	Power	Power level	Operating range
Class 1 devices	High	100mw(20dB)	Upto100 meters
Class 2 devices	Medium	2.5mw(4dB)	Upto 10 meters
Class 3 devices	Low	1mw(0dB)	0.1 to 10 meters

APPLICATIONS

Bluetooth has a tremendous potential in moving and synchronizing information in a localized setting. Potential for Bluetooth applications is huge, because we transact business and communicate more with people who are close by than with those who are far away - a natural phenomenon of human interaction. The following list represents only a small set of potential applications - in future many more imaginative applications will come along:

By installing a Bluetooth network in your office you can do away with the complex and

tedious task of networking between the computing devices, yet have the power of connected devices. No longer would you be bound to fixed locations where you can connect to the network. Each Bluetooth device could be connected to 200 other devices making the connection of every device with every other possible. Since it supports both point to point and point to multipoint it will virtually make the maximum number of simultaneously linked devices unlimited.

The Bluetooth technology connects all your office peripherals wirelessly. Connect your PC or notebook to printers, scanners and faxes without the ugly and trouble some cable attachments. You can increase your freedom by connecting your mouse or the keyboard wirelessly to your computer.

If your digital cameras in Bluetooth enabled, you can send still or video images from any location to any location without the hassle of connecting your camera to the mobile phone on the wire line phone.

Bluetooth allows us to have three way phones. At home, your phone functions as a portable phone (fixed line charge). When you're on the move, it functions as a mobile phone (cellular charge). And when your phone comes within range of another mobile phone with built-in Bluetooth wireless technology it functions as a walkie-talkie (no telephony charge).

In meetings and conferences you can transfer selected documents instantly with selected participants, and exchange electronic business cards automatically, without any wired connections.

Connect your wireless headset to your mobile phone, mobile computer or any wired connection to keep your hands free for more important tasks when you're at the office or in your car.

Have automatic synchronization of your desktop, mobile computer, notebook (PC-PDA and PC-HPC) and your 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.

Automatic Message Delivery: Compose e-mails on your portable PC while you're on an airplane. As soon as you've landed and switched on your mobile phone, all messages are immediately sent.

Upon arriving at your home, the door automatically unlocks for you, the entry way lights come on, and the heat is adjusted to your pre-set preferences.

IBM researchers are working on a number of personal devices like a WatchPad that could be connected with other devices through Bluetooth. The Watch Pad is very thin and contains 8MB of RAM. They are also working on a version of CyberPhone called CyberPhone - that can project data onto a small mirror. The CyberPhone can show as much information as a small PDA because of high resolution VGA screen.

You enter the airport-waiting lounge, equipped with Bluetooth-enabled Internet ports. Via the ports, you and other guests use Bluetooth-enabled laptops, PDAs, and other devices to access your office or home-based servers via the airline server. Using voice-over IP, you also make "free" Internet voice calls courtesy of your airline.

SECURITY

The way that the Bluetooth radio system is used in mobile devices and the type of data carried on these devices (eg. a corporate mobile computer) makes security an extremely important factor.

Security for Bluetooth is provided on the various wireless links- on the radio paths only. The three basic security services defined by the Bluetooth specifications are the following:

a)Authentication:

A goal of Bluetooth is the identity verification of communicating devices. This security service addresses the question “Do I know with whom I am communicating? “

b)Confidentiality:

The intent of this security service is to prevent information compromise caused by passive attack. It addresses the question “Are only authorized devices allowed to view my data? “

c) Authorization:

This security service allows the control of resources. This security services addresses the

question “Has this device been authorized to use this service?”
All of these security services are provided by the means of generation of several keys for linking and for data encryption while two devices are inter-communicating.

BENEFITS

Bluetooth provides five primary benefits to users. They are:

a) Cable Replacement:
It replaces cables for a variety of interconnections. These include peripheral devices (i.e. mouse and keyboard computer connections), printers, Modems and wireless headsets and microphones that interface with PCs or mobile phone.

b) Ease of file sharing:
Bluetooth enables file sharing between Bluetooth-enabled devices. For example, participants of a meeting with Bluetooth compatible laptops can share files with each other.

c) Wireless synchronization:
Bluetooth provides automatic wireless synchronization with other Bluetooth-enabled devices. For e.g. Personal information contained in address books and data books can be synchronized between laptops, PDAs, mobile phones and other devices.

d) Automated wireless applications:
Bluetooth supports automatic wireless application functions. Unlike synchronization, which typically occurs locally, automatic wireless applications interface with the LAN and internet?

e) Internet connectivity:
Bluetooth is supported by a variety of devices and applications. Some of these devices include mobile phones, PDAs, laptops, desktops and fixed telephones. Internet connectivity is possible when these devices and technologies join together to use each other’s capabilities. For e.g. A Bluetooth enabled laptop can request a mobile phone to establish a dial-up connections, the laptop can then access the Internet through that connection.

MAJOR DEVELOPMENTS RECENTLY

"The three-in-one phone" is one of the new products that benefit from Bluetooth. The idea of the three-in-one phone is very simple. When people are at home, the phone will function as a cordless phone and people only need to pay fixed line charge. When people go out, the phone will function as a mobile phone and they need to pay cellular charge. However when people's phone comes within range of another mobile phone with built-in Bluetooth wireless technology, or in a bluetooth wireless network, the phone can be used "as a walkie-talkie" with no telephone charge. Bluetooth can also be used as "interactive conference". During meetings or conferences, people can transfer their particular documents with selected participants and exchange electronic business cards automatically without any "wired" connection. In daily application, Bluetooth can offer premises-based information specific to where people are at the moment. If people are in a large store and wondering what items are on sale, they just need to turn on their PDA then Bluetooth connection will give them a specific offer based on their location in the store. In business, people no longer require to use cable when setting up a presentation in the future. By having Bluetooth, printer can automatically deliver printouts and audience can watch the presentation on their own Bluetooth-enable laptops simultaneously. Bluetooth can also be used as "automatic synchronizer". Before the development of Bluetooth technology, it takes more times for people to update or enter the information they want into each of their devices. However now Bluetooth can work as an automatic synchronizer to transfer information to people's desktop, mobile computer, PDA and mobile phone. When people enter to their office, the address list, calendar and the to-do-list in their notebook will be updated to automatically.

TOP 5 RECENT BLUETOOTH ENABLED PRODUCTS.

a . *Handheld HP iPAQ rx3715 Mobile Media Companion*
Company: Hewlett-Packard Company

b. *Headset, Mobile Phone Accessory JABRA® BT250™*
Company: GN Netcom A/S

c. ***Automotive Accessory Parrot CK 3100***
Company: PARROT S.A.

d. *SONORIX* ***Bluetooth Audio Player OBH-0100***
Company: OpenBrain Technologies Co., Ltd.

e. ***Mobile Phone Nokia 6600***
Company: Nokia

FUTURE TRENDS

Bluetooth is expected to be built into office applications (e.g. PCs, faxes, printers and laptops), communication applications (e.g. Cell phones, headsets , pagers) and home applications (e.g. DVD players, cameras, refrigerators and microwave ovens) . Applications for

Bluetooth also include vending machines, banking and other electronic payment systems; wireless office and conference rooms; smart homes and in-vehicle communications and parking .

CONCLUSION

The develop ment of Bluetooth is a creative and useful idea that benefits many people. This technology allows a variety of devices, such as PCs, laptops, mobile phones, personal digital assistants and printers, to communicate with each other without cables or hard wiring. Today many companies are still working in the development of Bluetooth devices and they spend lots of money in this new development. They hope that Bluetooth can be applied world widely.

Bluetooth is a rad io system designed for connecting a variety of mobile devices in a secure Ad-hoc fashion.

Much o thought has gone into devel system that provides inter-operability between different devices types while also meeting the requirements of mobile users. The Bluetooth specification is definitely real and is being widely adopted by industry leader. The possibilities for new applications are very exciting with this technology. Thus it has a great scope and diverse applications in near future.

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