ISSN : 0976-8491 (Online) | ISSN : 2229-4333 (Print)

Voice Over Bluetooth: An Overview

[1]Manisha Dawra, [2]Sheelu Sharma, [3]Anita Chauhan
[1]Al-Falah School of Engineering and Technology, Faridabad, Haryana, India
[2,3]Echelon Institute of technology, Faridabad, Haryana, india

Abstract
Wireless communication helps you to control electricity cost and time consumption so that we can save without compromising on comfort. The appeal is in the freedom given to the user to be mobile. A relative newcomer, Bluetooth, has made real time audio/video transmission in mobile and pervasive environments possible. In comparison with many other wireless standards, Bluetooth is more cost and power-effective, making it ideal for small and light mobile devices. This paper describes the use of Bluetooth technology for communication on Ad-Hoc network. Bluetooth is a low cost, low power, short range radio technology intended to transfer data between cell phones. Bluetooth is also used as a medium for voice communication between cell phones. In this paper, we will describe ways of connectivity in Bluetooth, Bluetooth technology used and the algorithm we will use for connectivity.

Keywords
ACL, Bluetooth, L2CAP, LLC, SCO

I. Paper Outline

Section II provides the Introduction regarding AdHoc network and Bluetooth. Section III, provides overview of Bluetooth technology, the characteristics of Bluetooth technology. Section IV, provides the information regarding types of connectivity in Bluetooth. Then section V, provides the algorithm to implement the voice transmission on Bluetooth in MANET. Section VI, provides the conclusion of the work.

II. Introduction

Ad-Hoc network is Self-organizing and adaptive network. Allows spontaneous formation and deformation of mobile networks. In Adhoc network each mobile host acts as a router and supports peer-to-peer, peer-to-remote communications. Ad-Hoc network needs reduced administrative cost and provides ease of deployment. An example of AdHoc network is shown in fig. 1.

Fig. 1: Ad-Hoc Network

Communication is essential in day to day life. People communicate with each other for business and other purposes. Here we are using Bluetooth for communication in AdHoc Network. Mobile phones are most popular wireless devices. The services that the phone provides such as SMS facility, call facility etc. ,have attracted billions of people across the globe. In order to use make use of such facilities, one has to pay a certain amount of service charges to the service provider. In this paper we try to use Bluetooth for communication with no charges. Bluetooth to be used as walkie-talkies for voice communication, without any service charges. The communication medium is Bluetooth, which is a short-range radio service radio service with a range of 10 meters.
Bluetooth [1,5], is a flexible and capable technology for providing short-range radio communications between devices in an Ad-Hoc manner using the 2.4GHz band. Bluetooth networks introduce new and novel methods for creating Ad-Hoc networks based on a master and slave relationship between devices. Each Bluetooth device is a peer and a device that initiates an inquiry, is normally the master however, after paging the master may be switched to a slave. A master device can have up to seven active slaves. All the slaves within a piconet can only communicate with the master and not with any other slave. A master device can connect to up to 255 devices, which may be connected to other networks or in one of the modes (Active, Park, Hold, Sleep). The current Bluetooth networking topology includes the creation of piconets and scatternets. Typically, most mobile devices are low powered and have limited power storage. Here Bluetooth is ideally suited as a low power radio transceiver (transmitter and receiver) operating at up to 1Mbps. Voice traffic is normally carried using synchronous connection oriented links (SCO) as specified by the headset [2] and cordless phone profiles [3] using a 64Kbps channel with a guaranteed quality of service for both incoming and outgoing streams. Streaming high quality music of compact disk quality requires a greater bandwidth than SCO links can provide. The Bluetooth connection type capable of higher bandwidths is the Asynchronous Connection-Less (ACL) link.

III. Bluetooth Overview

A. Bluetooth Technology Characteristics

Bluetooth operates in the unlicensed 2.4 gigahertz (GHz) to 2.4835 GHz Industrial, Scientific, and Medical (ISM) frequency band. Numerous technologies operate in this band, including the IEEE 802.11b/g WLAN standard, making it somewhat crowded from the standpoint of the volume of wireless transmissions. Bluetooth employs Frequency Hopping Spread Spectrum (FHSS) technology for all transmissions. FHSS reduces interference and transmission errors and provides a limited level of transmission security. With FHSS technology, communications between Bluetooth devices use 79 different radio channels by hopping (i.e., changing) frequencies about 1600 times per second for data/voice links and 3200 times per second during page and inquiry scanning. A channel is used for a very short period (e.g. 625 microseconds for data/voice links), followed by a hop designated by a pre-determined pseudo-random sequence to another channel; this process is repeated continuously in the frequency-hopping sequence.
Bluetooth also provides for radio link power control, where devices can negotiate and adjust their radio power according to signal strength measurements. Each device in a Bluetooth network can determine its Received Signal Strength Indication (RSSI) and make a request of the other network device to adjust its relative radio power level (i.e., have the transmission power incrementally increased or decreased). This is performed to conserve power and/or to keep the received signal characteristics within a preferred range.

Fig. 2, depicts the basic Bluetooth network topology. In a piconet, one device serves as the master, with all other devices in the piconet acting as slaves. Piconets can scale to include up to seven active slave devices and up to 255 inactive slave devices.

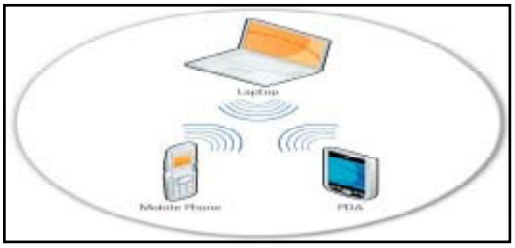

Fig. 2: Bluetooth Ad-Hoc Topology

The master device controls and establishes the network (including defining the network's frequency hopping scheme). Although only one device can serve as the master for each piconet, Time Division Multiplexing (TDM) allows a slave in one piconet to act as the master for another piconet simultaneously, thus creating a chain of networks [4]. This chain, called a scatternet, allows several devices to be networked over an extended distance in a dynamic topology that can change during any given session. As a device moves toward or away from the master device, the topology, and therefore the relationships of the devices in the immediate network, may change. Fig. 2, depicts a scatternet that connects three piconets.

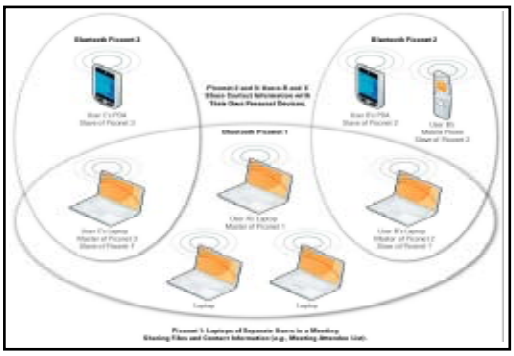

Fig. 3: Bluetooth Networks (Multiple Scatternets)

Routing capabilities supported by Bluetooth networks control the changing network topologies of piconets and scatternets and assist in controlling the flow of data between networked devices. Bluetooth uses a combination of packet-switching and circuit-switching technologies. The use of packet switching in Bluetooth allows devices to route multiple packets of information over the same data path. This method does not consume all the resources of a data path, thereby allowing Bluetooth devices to maintain data flow throughout a scatternet.

1. Bluetooth Stack

Bluetooth uses a protocol stack of seven layers.
(i). The radio layer describes the physical radio system.
(ii). The Baseband Layer is responsible for transmission and reception of data packets, error detection and encryption.

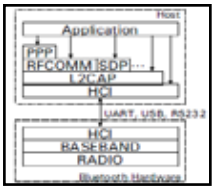

Fig. 4: Bluetooth Stack

(iii). The Host-Controller-Interface (HCI) separates the Bluetooth hardware from the part of the protocol stack that is usually implemented in software.
(iv). The Logical Link Control and Adaption Protocol (L2CAP) layer multiplexes different data streams, manages different logical channels and controls fragmentation.
(v). Multiple higher layer modules may access the L2CAP layer in parallel. These higher layer modules may consist e.g. of RFCOMM for emulation of serial connections, OBEX for transmission of serialized data objects or SDP for service discovery.

IV. Types of Connection

Bluetooth supports both synchronous services such as voice traffic and asynchronous services such as busty data traffic. The specification defines two different physical link types:

- SCO: Synchronous Connection Oriented
- ACL: Asynchronous Connectionless

A. SCO Link

The SCO [6], link is a symmetric point to point link between the master and the single slave in the piconet. The SCO link involves reservation of slots and can be considered as circuit-switched connection between master and slave. The master can support three SCO link to the same slave and different slave.
The master send SCO packets at regular intervals. The specific SCO slave is allowed to respond in the following slots unless the master addressed a different slave in the previous slot. The specification defines three pure SCO packets and one hybrid SCO packets, which carries an asynchronous data field in addition to a synchronous voice field.

B. ACL Link

The ACL [6], link provides a packet switched connection between the master and all active slaves in the piconet. A slave can send an ACL packet if it has been addressed by the master in the previous slot. To ensure integrity, ACL packet are retransmitted. Only a single ACL link can exist between master and slave. The master schedules ACL packets in the slot not reserved for the SCO links.

V. Implementation

The sender side consists of four functional units :

- User interface
- Multimedia
- Hardware
- Bluetooth communication layer

The sender side service provider consists of two functional units:

- Bluetooth communication layer
- Network communication layer

The receiver side consists of four functional units:

- User Interface
- Multimedia
- Hardware(speaker)
- Bluetooth communication layer

A. User Interface

This module is implemented at the sender's and receiver's mobile. This module provides the user a way to interact with the system. The user can view the contact list and user can select the user with whom he wants to talk. The user can accept or reject calls. The user can also add new contacts into his existing contact list.

User interface at sender's end
1. Contact list shown
2. Read users' selection
3. If 'add contact' the
Read and add new contact
Else
'show contact'
Read user's input
4. If option=call then
Initiate the call
If no response with in time period't' then
Display no response and exit from application
If receiver's response is 'accept' then
Display speak
Read for user's input
If input=call transfer then
Change the role of the sender and the receiver
If input=terminate then
Stop application
End
If receiver's response=reject then
Stop the application
End
User interface at Receiver's end
(i). Display to the receiver "user calling"
(ii). Read the receiver's input which can be either accept call or reject call
If receiver's input = reject then
Terminate the call and stop the application
Else Display "listen"
Upon getting "call transfer" message from sender Switch the senders and receivers roles
End

B. Multimedia Module

The multimedia module is responsible for reading the voice data at the sender's end and then playing the voice data at the receiver's end. The microphone in the mobile cellular phone device is used in order to record the data. A speaker at the receiver mobile cellular phone is used to play the recorded data.

C. Bluetooth Layer Module

Bluetooth is the transmission medium for communication between mobile phone and the service provider. In this design, Bluetooth Module consists of four different stages.

1. Sender's Side

The Mobile Bluetooth object receives the destination device's Bluetooth address with which call has to be setup. First it checks whether the service is available in current vicinity. If there is no service then it intimates the User Interface module and exits. If the service is available, the Bluetooth module establishes a connection with the service provider. Once the connection is established the sender and destination Bluetooth address is sent and it waits for control packet from the service provider and after getting it, the control packet is placed in the control flag. If the packet is "Not Found" it stops. If the packet is "Reject" it stops else if the packet is "Accepts", the multimedia will start buffering the data and then the write method will be called. Write method sends the buffered voice packets and control packets if any, to service provider. If the packet is "Transfer", then the read method will be invoked.

D. Network Module

This module is responsible for sending the digital voice packets from the service provider at sender's side to the service provider at the receiver's side. This is also responsible for sending control packets from either of the sides and delivering it to the other side. This module is implemented at the sender's and receiver's side service provider.

1. Network Module at Sender's Side

At the sender's side, this module first obtains the Bluetooth address of the destination mobile from the Bluetooth module. After obtaining the Bluetooth address, this module will multicast the Bluetooth address to the service providers which have the application. After this, the module will create a server and will wait for a time period't'. If no response is got within that time period, intimation is sent to the Bluetooth module that no response is received.

The 'System-Mobile thread' will listen for terminate packet from the sender as well as the receiver. If it receives a terminate packet then it will stop the application. When the connection is established one more thread is created. This is the 'Mobile-System thread' and it will listen to the packets from Bluetooth module. It will send the packets to receiver's side service provider until it gets a control packet.

2. Network Module at Receiver's Side

At the receiver's side, this module waits for the Bluetooth address sent by the sender. After obtaining the Bluetooth address, this module will forward the address to the Bluetooth module and wait for the response from Bluetooth module. If no response is got from the Bluetooth module within time period 't', then no response intimation is sent to the sender's service provider.

Otherwise this module will establish the connection with the server at sender's service provider and this connection acts as the 'System-Mobile thread'. This thread listens to the incoming digital voice packets from sender's side and forwards it to the Bluetooth module until a terminate packet arrives. When the connection is established, this module will create the 'Mobile-System thread'. This thread will be listening for the packets from the receiver's mobile and will continue to do so until a terminate packet arrives. Upon arrival of the terminate packet the application is stopped.

VI. Conclusion

Communication is increasing in day to day life. To provide such unlimited communication in Adhoc network with no cost Bluetooth technology is used. It provides two types of link SCO and ACL links. SCO is circuit switched link with no retransmission of packet. ACL is connectionless less communication. It provides integrity and more than one connection handled between master and slave. But there is some problem in AdHoc network has some problems:

1. Event updates are sent often – a lot of control traffic
2. Routing table may not be able to, converge
3. Routing loop may exist
4. Mobility affects signal transmission ->Affects communication
5. Mobility affects channel access
6. Mobility affects routing

References

[1] J.C. Haartesen,"The Bluetooth Radio System", IEEE Journal, February 2000.
[2] Bluetooth Special Interest Group,"Specification of the Bluetooth System: Part K:6 Headset Profile", Version 1.1, 2002
[3] Bluetooth Special Interest Group,"Specification of the Bluetooth System: Part K:3 Cordless Telephony Profile", Version 1.1, 2002.
[4] Frank Kargl-Stefan, Ribhegge-Stefan, Schlott-Michael, "Bluetooth-based Ad-Hoc Networks for Voice Transmission" Proceedings of the 36th Hawaii International Conference on System Sciences 2003.
[5] Nathan Muller,"Bluetooth Demystified", 2001, McGraw Hill.
[6] Specification of Bluetooth System Core Vol 1.2 Path for Bluetooth study and J2ME: [Online] Available: http://www.bluetooth.org, www.java.sun.com

Ms. Manisha has obtained M. Tech (Computer Engineering) from Maharishi Dayanand University, Rohtak and currently, working as Senior Faculty in Computer Science and Engineering Department. She has seven years of industrial, academic and consulting experience span a broad range of fields including Software Engineering, Computer Networking, Software Testing, Multimedia Technologies, and implementation of Software Models for various projects. She has conducted and contributed her skills in various seminars and conferences on computer and its allied areas. She has also presented her research papers in various conferences, seminars and workshops of repute.

Sheelu Sharma has received her B.E in IT form CITM, Faridabad, India in 2008 and pursuing M.Tech in Computer Engineering from Advanced Institute of Technology, Palwal, India (MDU). She is working as a lecturer in Computer Science department at Echelon Institute of Technology, Faridabad, India from 2008 to till now. She has four years of academic experience. Her research interest includes Cloud Computing, Computer Networks and Wireless Communication.

Ms. Anita has obtained her B.E in CSE from CITM, Faridabad, in 2008 and pursuing M.Tech (Computer Engineering)from Maharishi Dayanand University, Rohtak and currently working as lecturer in Computer Science and Engineering Department. She has four years of academic experience .Her area of interest are Software Testing, Multimedia Technologies and Wireless communication. She has conducted and contributed her skills in various seminars and conferences on computer and its allied areas.