AN EXPANDED BLUETOOTH NETWORK-A SOLUTION TO THE SHORT RANGE BLUETOOTH COMMUNICATION

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ABSTRACT

Bluetooth is a short range, low power, low cost wireless communication technology designed to connect phones, laptops and PDAs. The greater availability of portable devices with Bluetooth connectivity imposes wireless connection between enabled devices. This paper considers the problems of Bluetooth communication and also proposes a new expanded network to overcome the basic limitation of Bluetooth devices that is the range constraint. This creates a network of devices that will include laptops, set top devices and also mobile phones. The main purpose of this proposal is to establish a network will enable the users to communicate outside the range without any range constraint.

KEYWORDS

Bluetooth, Pico net, Scatter net, Frequency hoping, ISM

1. INTRODUCTION

Mobility originated from the desire to move either toward resources or away from scarcity. Mobile computing is concerned about the movement of physical devices, user applications and mobile agents. Bluetooth technology developed by Ericsson Mobile Communications and it replace the cables used to connect devices, with one universal short-range radio link. These radio waves are operating in the unlicensed ISM band and also having 2.45 GHz frequency. Bluetooth uses a spread-spectrum frequency-hopping technique which takes a narrowband signal and spreads it over a broader portion of the available radio frequency band. . This prevents the interference with other devices. Since only the intended receiver is aware of the transmitter's hopping pattern, only that receiver can make sense of the data being transmitted. This technique ensures Bluetooth's security and limits interference.

The Bluetooth technology eliminates the need for cables, connectors. So the expenses for cables and connectors are reduced, which gives large economic benefit [1]. Bluetooth devices are very small so that it can be attached to any device without reducing its portability. Bluetooth devices are low cost devices and the utilization of power is also very less. The effective range of Bluetooth devices is 32 feet (10 meters). A major challenge lies in Bluetooth communication is this range constraint. This paper studies the basic limitation of Bluetooth communication and also presents a possible solution for this. The paper tries to explore the basic routing algorithm and it can be used for expanding the range of Bluetooth devices.

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The rest of this paper is organized as follows. Section 2 gives the overview of Bluetooth technology. Section 3 describes the complexities involved in Bluetooth communication. A brief description of the proposed protocol is given in section 4. Salient features of new protocol are described in section in 5. The application and the area of significance are discussed in section 6 and conclusion is given in section 7.

2. BLUETOOTH ARCHITECTURE-AN OVERVIEW

Bluetooth is the term used to describe the protocol of a short range (10 meter) communication. It places an important roll in wireless communication. The goal of Bluetooth specification is the uniform structure for a wide range of devices to connect and communicate with each other. These specifications are developed and licensed by the Bluetooth Special Interest Group (SIG). The Bluetooth SIG consists of companies in the areas of telecommunication, computing, networking, and consumer electronics. The data transfer rate of Bluetooth is 1Mbps. The Bluetooth specification can support three synchronous voice channels at 64 Kbps each. Bluetooth devices typically require 1mW of power to operate.

Bluetooth devices are organized as a network of two to eight devices called Pico nets. A Bluetooth piconet consists of a single master device and one or more slave devices. Each node in the Pico net uses the same frequency hopping technique. A slave or master in one Pico net can communicate with the master or slave in other Pico net. This bridging structure is termed as scatter net (Figure 1). In addition to seven slave nodes in the Pico net, there can be up to 255 nodes in the network. The Bluetooth model is working under the concept of Bluetooth protocol stack. Bluetooth network is divided into different layers as shown in (Figure 2). It has many protocols groups loosely into layers. This layering structure is different from any other reference model. The radio layer is somewhat similar to the physical layer of internet model. By using frequency hoping technique reduce the interferences. Base band layer is roughly equivalent to Mac sub layer in internet. In this TDMA is used as the access method. Single slave and multiple slave communication is possible in this layer. There are two links used for communication. Synchronous connection oriented and asynchronous connection less. Next layer is the L2CAP layer. Multiplexing, Segmentation and Reassembly, QOS and group management are the main duties of the L2CAP layer.

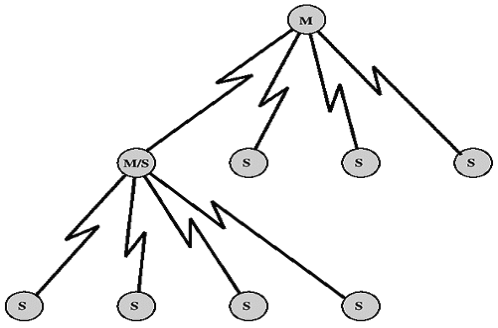

Figure 1.Scatternet

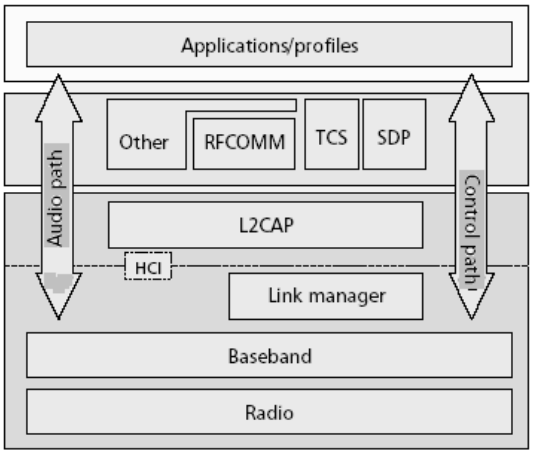

Figure 2.Bluetooth Layers

Bluetooth networking transmits data via low-power radio waves. It communicates on an International agreed frequency (ISM) of 2.45 gigahertz. A Time Division Multiplexing (TDD) technique is used in this communication. This divides the channel into 625p slots and, with a 1 MBPS symbol rate, a slot can carry up to 625 bits. Transmission occurs in packets and each packet is transmitted on a different hop frequency with a maximum frequency hopping rate of 1600 hops/s. Based on output power rating Bluetooth devices are divided into three classes. Most powerful devices are in class 1 category. These can have up to 100 mW of power, and a range of about 40 m - 100 m (130 - 330 ft). Class 2 devices are lower power, with up to 2.5 mW of power and a range of about 15 m - 30 m (50 - 100 ft). Third category is class 3. This uses less power up to 1 mW and a range of about 5 m - 10 m (16 - 33 ft). Most of the Bluetooth devices will fall under class 2 or class 3.

3. DRAWBACK AND CHALLENGES IN BLUETOOTH COMMUNICATION

The present scenario using Bluetooth has many drawbacks. Data can be transmitted only over short distances, network overloading may occur, if one path is busy then we have to wait till the path is cleared, data transmission rate will be slow if network is busy etc are some of the obscurity in Bluetooth network. The devices in the network have low power. So this low power limits the range of a Bluetooth device to about 10 meters (32 feet paper). Even with the low power, Bluetooth doesn't require line of sight between communicating devices. The nodes in Pico net are classified into four categories according to their states. These are active, idle, parked and sniffing. Data exchange takes place only between active nodes but the nodes periodically change its states. This imposes a greater challenge in Bluetooth design. Which node is selected as a master, and how many nodes that can be used to connect to other Pico net are the challenging areas.

Bluetooth is primarily intended to facilitate short range data transfer using low power. The main disadvantage of this technology is the nodes involve in the data transfer have to be very near each other. Because of this range constraint most of the time the greater number of Bluetooth enabled devices are inactive. So the communication throughput is decreased. In this paper we are concentrating on the range limitation of Bluetooth communication and we are trying to expand the range by using the enabled intermediate devices.

4. EXPANDING THE RANGE-A NEW SOLUTION

The main goal of this paper is to overcome the basic limitation of Bluetooth devices. The range of Bluetooth devices are usually of 10 meters. This range restriction is overcome by allowing a device to another device outside its range through an intermediary device, which has access to both the devices (figure 3).

First step of expansion is to establish a network. To set up the network each device broadcast a list of accessible devices within its range. Each device updates their table of accessible devices according to this list. Each device prepared a list of other devices that can be accessed directly or indirectly. If a device wishes to send a message to another device in this list, a path is found through intermediary device through which the destination can be reached and forwards the message to the first device in the path. But the intermediate devices dynamically choose the path through which the message is forwarded depending upon the traffic and availability of devices.

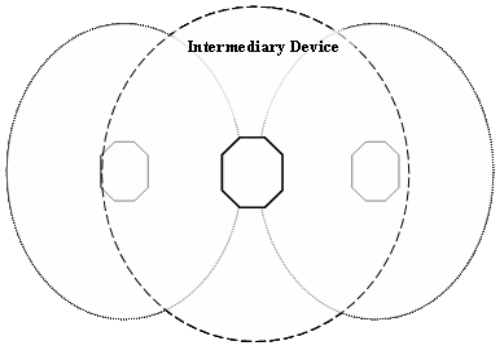

Figure 3.Expanding range using intermediate device

5. SALIENT FEATURES OF NEW SOFTWARE

This paper tries to expand the range of Bluetooth data transfer by involving intermediate devices between the sender and receiver. A message from the source goes to one or more intermediate device finally ends up at destination. This is typically considers as a client server architecture. The device which sends the data is the client and receives the data is the server. The client node expands its network by searching for the Bluetooth enabled device in its range. All devices continue this searching for devices within the range until the destination is reached. A model of the proposed system is in the figure 4.

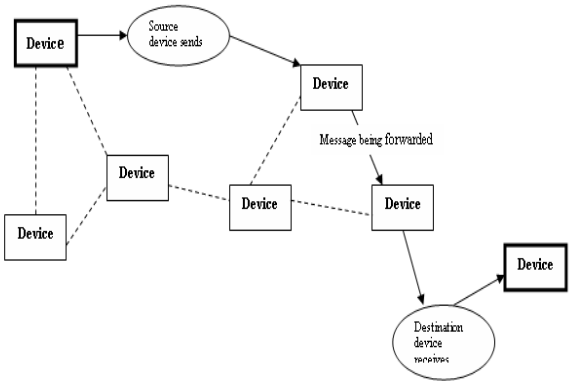

Figure 4.Model for the proposed system

This network consists of devices of smaller speed and relatively smaller network. The routing algorithm I have chosen is distance vector routing algorithm. The operation of the algorithm is as follows. When a node starts it can directly access its immediate neighbours. Each node creates a list of nodes that can be accessible. Each node, on a regular basis, sends to each neighbour its own current idea of the total cost to get to all the destinations it knows of. Cost is determined by the number of nodes in the path. The neighbouring nodes examine this information and update their routing table accordingly. Over time, all the nodes in the network will discover the best next hop for all destinations, and the best total cost.

A node wants to send message to another node in the network first it check whether this node is in the range of the sender. If so then it can directly send message. Otherwise it will set a path to the destination through the intermediate devices. Each device sends their accessible device to its neighbours so the sender can calculate the shortest path to the destination. Once the routing path is finalised then sender node can access the destination. Each intermediate node in the path is involved in the routing process and each will be aware of the data transmission.

In any Bluetooth data transfer the nodes are not fixed so any node can move from the network and new node can come up at any time. If any node is added to the network then it finds its immediate neighbours and prepares its routing table. And this routing table is send to all nodes that can be directly accessible. If any node wishes to move out of the network then it send a withdraw message to their immediate nodes. In both cases all nodes update their routing table accordingly. If any node updates its routing table then inform their neighbours and send the routing table to them.

When a node send a packet to another node in the network if it reaches correctly at the destination then it will send the acknowledgement. If the sender does not get the acknowledgement before the timer turned off then the route discovery process is repeated. Sender must send the same packet through another shortest route if the current route does not exist. The path selection is crucial and is to be selected depends on the shortest path criteria and load balancing criteria.

6. APPLICATIONS AND AREA OF SIGNIFICANTS

With the development of Bluetooth technology, many Bluetooth devices come into our living, such as Bluetooth earphone, Bluetooth home-network etc. Recently, the Bluetooth technology is the fastest growing technology which enables devices to connect and communicate. Data dissemination is the main application intended to the Bluetooth network. We can send text messages as well as picture messages to any Bluetooth enabled devices via Bluetooth communication. Bluetooth is actually the replacement of traditional wired serial communication in test equipment, GPS receivers and medical equipment.

The popular use of Bluetooth technology is wireless control and communication between any devices with Bluetooth capability. The devices can be cell phone, mouse, keyboard, cordless headset, camera, PDA, printer, computer etc. Bluetooth can also help different devices to communicate with each other. For example, if you have a phone, a PDA, and a computer and all the three devices have Bluetooth capabilities, then with the support of appropriate software on each device you can look up a phone number on your PDA and then place a call direct from the laptop or PDA without touching your cell phone. Ad hoc networking and remote control are the significant applications. Another attractive application is wireless networking between PCs in a confined space where little bandwidth is required. By using Bluetooth communication technology transfer of files between devices via OBEX is possible.

7. CONCLUSIONS

In this paper, I have listed out the common shortcomings of Bluetooth data transmission. Efficiency of connection establishment has been analysed and suggested a method to overcome the basic limitation of Bluetooth communication that is the range constraint. With this new network, the range of the devices that can be accessible is expanded. This expansion is done through the enabled intermediate devices. When a device tries to connect to other devices, first it finds the devices that can be accessed directly or indirectly. Then it can establish a path to the destination through the intermediate devices and forward the message.

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