Routing Technique for Inter Slave Bonding in Bluetooth Scatternets Formation

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Abstract—Bluetooth has gained popularity from last few years due to its simple and economical Bonding features. Bluetooth was established to bond few devices together within some predefined range. But today’s technologies required Bonding of larger networks using shortest path, less time consumption and minimum possible utilization of resources. The inherited nature of Bluetooth technology is to search and make Bonding with other devices within allowable range having time consuming long query/query scan and pager/page scan process, this process result in a scatternet formation and inefficient Bonding. Usually in this scatternet formation each and every slave is bonded with every available slave whether Bonding is required or not. This simple means the wastage of resources. Another very inefficient operation in scatternet formation is, suppose if we have two piconets A and B, forming a scatternet, piconet A having 7 slaves and 1 master, similarly piconet B also have 7 slaves and 1 master, if slave number 6 of piconet A wants to communicate with slave number 4 of piconet B for this Bonding formation the inherited process of Bluetooth is “Slave 6 of piconet A go to its master and generates a request that it wants to communicate with slave 4 of piconet B, Master of piconet A goes to Master of piconet B with this request, afterwards Master of piconet B checks whether its slave 4 is free or not at the moment, if slave 4 is free Master sends back acknowledgment to Master A to allow Bonding between both slaves and Master A calls its slave 6 to communicate. After this long, time consuming and resources consuming process Bonding is started if and only if the link is still established but if link has disconnected then again for Bonding of slave 6 and slave 4 this inefficient process is revised ………..having look at this Bonding scenario practically for only two slaves Bonding 6 routing paths/resources are required which is very inefficient approach of Bluetooth Bonding due to which Bluetooth is unable to transfer/receive heavy data with reliability, research on Bonding shown that in wireless Bonding routing has to be very efficient having shortest distance between two nodes ability to handle larger data. in this paper we present an algorithm which successfully Address the above discussed problems. This proposed work concludes and will prove that slaves should be communicating directly to each other and they must be bidirectional as well. This work is basically an extension chain of our previously published research on various dimensions of Bluetooth technology. [1, 2, 3].

Key Words: Bluetooth, Piconets, Scatternets, Routing

1 Introduction

i. Bluetooth

Bluetooth is a restricted sort radio Bonding set with economical, robust, and flexible, was proposed to substitute the cables. The essential idea of cable substitution was picked-up rapidly and over 2500 companies joined the Bluetooth Special Interest Group (SIG). Bluetooth is chosen to offer the base of the IEEE 802.15.1 standard for Wireless Personal Area Networks [5], and carries both synchronous traffic like voice, and asynchronous data transmission as well. The Bluetooth has generally short range (10 meter) or an average range (100 meter) having
utmost capability of 720 kbps per channel, with a throughput of 1Mbit/sec. Bluetooth lies in the unlicensed industrial, scientific and medical band at 2.4 to 2.48 GHz, also having a frequency hopping spread spectrum (FHSS), full duplex signal of 1600 hops/sec. the RF output of Bluetooth is particular as 0 dBm (1 mW) in the 10m-range edition and -30 to +20 dBm (100 mW) in the longer range edition.[1, 2, 5].

**ii. The Piconet**

The primary component of a Bluetooth Bonding is a piconet, comprises of single master device and seven active slave devices, they can communicate with each other simply using their master. Figure 1 shows a piconet. All devices in a piconet share the same frequency hopping string by the use of a slotted time division duplex (TDD) technique having the highest bandwidth of 1 Mbps. because all the data transfer has to go from beginning to end in master device, it has total hold over the Bonding inside its own piconet. According to rigorous TDD method, a slave node is permitted to transfer in a slot simply under three situations:[4, 6]

- In case of ACL Bonding, the master polls the slave asking if it desires to impel a Bonding;
- as a master impel a transmit packet in the previous slot; and
- The slave formerly has a portion for that slot, like in the order of SCO Bonding.

![Figure 1. A typical Bluetooth Piconet](image1)

The active slaves, supplementary nodes can be connected to a piconet in parked situation in which they shell out notice but do not contribute. As they desire to take part, they are switched in and one of the active nodes is switched out. By means of this method, approximately 255 nodes can be approximately connected to the piconet. One of the slaves acquires the function of master when a stand-in master departs the piconet. Through piconet arrangement, the master assigns an active member address to every node, and exercises the addresses for Bonding in excess of the piconet. As well as each piconet use a dissimilar Frequency Hopping succession (FHS) in order to decrease interference with near piconets. [3, 4, 7]

**iii. The Scatternet**

To expand the number of nodes in the network, a scatternet constitute of a number of piconets as shown in Figure 2, and show a scatternet consist of of three piconets. As scatternets width more than a single piconet, so a small number of nodes take action as bridges and incharge of packets relaying across piconet limitations. Each piconet is recognized through its specific FHS in scatternet.

A bridge device typically participates in more than one piconet, but can only be active in one at a time. A Bluetooth node could be a slave in many piconets but role as master in just one piconet. [8, 9].

**2 Inter-devices Bonding**

Bluetooth devices are generally structured into cluster of two to eight devices named as Piconet having one master device, and 7 slave devices maximum 256 parked slaves (shown in Figure 1). The master of a piconet possess, administrate and reconcile contact within a piconet, there is nothing to distinguish between Master and Slave devices.

![Figure 2. A typical Scatternet Configuration](image2)
which node is allowable to send, and at which time. More particularly any packet Bonding in a piconet must go through its own master. A slave in a piconet is allowable to transmit a packet if and only if it polled from side to side from its master in the previous time slot. In each and every data transmission master must impel data in every available even numbered slots and the slaves respond in the succeeding odd numbered slots.[8, 9]

i. Bonding Procedure

The most significant and uncontrollable time consuming stage of Bluetooth Bonding is the Bonding establishment linking two unknown and disconnected devices. Whereas each piconet is based on an ad hoc network, as nodes don't have any previous information of additional devices within the range, and they also don't know how to create a Bonding. As Bluetooth utilize frequency hopping, so there is no universal channel on which the potential master and slave can make Bonding, and will able to set up Bonding. [2, 3, 4].

Figure 3 shows the state diagram of a variety of stages of Bonding organization amid two unidentified devices. Setting up a Bonding in Bluetooth have two segments (Figure 4): First is the inquiry phase in which a device (afterward turn into the master) attempts to find out new devices in its transmission range and finds out its addresses, the second phase is paging phase in which the real Bonding is established and handshaking starts. A device by evade to be in Standby state. At times, all devices go away from Bonding or in the standby states to go in Inquiry or Inquiry scan status. [2, 3, 4].

1) Query

In this state the inquirer transmits the inquiry messages on a particular inquiry hop series decided by a internationally recognized Inquiry Access Code. Uses 32 frequencies also divide them into 2 trains A and B. [4, 8]

2) Query search

An unexposed device remains in the Inquiry scan form. The requirement recommend that the unexposed device is in sleep form, wake up occasionally (just the once in every 2.56s) and get Bonding for question packets in the frequency determined as of its device. And stays in inquiry scan state maximum for 32 time slots, [4, 8]

3) Page

The exact organization of link comes about in the page state. Device initialize the paging process called the Master. It comprises of itself and the paged device. When the master go into the page state, it first attempts to decide the hop succession and stage on which the potential slave will pay attention by making an approximation from the data it composed as in Inquiry state. [4, 8]

4) Page Scan

In page scan the device watch for page messages within its own Device Access Code (DAC) intended for a definite time period on a selected frequency. The device in page scan awakens up occasionally at dissimilar frequency, and pays attention for 32 slots.

ii. Bonding State

On one occasion a device is linked to a piconet, the master occasionally throw out messages in its piconet to remain the piconet connected. Every slave in the piconet pays attention to each packet thrown out from the master to bring into line itself to the piconet, so, on decide if the packet was planned for them (hence examine the AM_ADDR field). The standard proposes that any Bluetooth device be in Bonding state may be in one of the four forms: Active, Sniff, Hold or Park. [7, 8]

Active: The master with the meaning of transmits a number of data or sample any slave must be in Active mode. [4]

Hold: this mode is mainly used to carry out other tasks in the host device (printing, scanning) but not for other Bonding. [4]
Sniff: this mode is used as transceiver of the slave hence conserves power. At the same time as a slave goes in sniff form, the slave breaks off to pay attention for packets on every slot. [4]

Park: slave has to be in extreme action in this mode and presents AM_ADDR and also presents an eight bit Parked member address which is given to its device. That address is utilized for unparking the slave by it’s the master.[4]

3 Bonding problems and issues
If a power cable has to be connected then wireless connectivity is turning into ineffective thing. Mobility can be attained as long as the device is battery activated. Therefore power consumption turned into an vital concern. Efforts have been made to maintain power consumption to the least, if possible not more than a small fraction of the power consumed by its host device. Various low power modes have been offered to permit the unit to regulate its power consumption to the least amount necessary and utilize full power only when vigorously busy in Bonding. Power has to be increased in ad hoc wireless network if one node wants to communicate with other node directly. Power is higher at a level which is above the threshold value for the receiver.

Contrary from some networks, energy utilization in ad hoc wireless networks mostly depends on the power state of senders. Power consumption has nothing to do with the number of receivers.

In the Bonding state, current utilization is decreased and lavish obstruction prohibited by merely sending out when information is accessible. If no constructive information requires to be transferred, no Bonding happens. As ad hoc structures functions on interference-based so there must be any power control mechanism, particularly as dissimilar types of classifications have to work with diverse power characteristics and have to share the same assigned bandwidth. As power control cannot be synchronized in the middle of diverse systems but it cannot be banned that certain schemes forever try to overwhelm their candidate.

Bonding leaning data release systems may requires four additional steps to set up a link between two devices After that the extra phases have a timing issue which originates the long Bonding latency.

Let’s have a look in the single data file transfer process which is based on the Inquiry Response packet from latent slave device, a master device throws out a Paging packet as the first phase in the Paging Procedure. Then the Paging packet is send out by the master node using a Tx slot. The necessity is that the slave device must be with a Rx slot to take delivery of the Paging packet. But if the slave device is with a Tx slot while the master device’s Paging packet reaches at destination, the device cannot be able to take delivery of the packet.

And have to stay for one more Paging packet from its master device. Likewise the master node cannot get Paging Response packet while it is in Tx slot. Since of synchronization problem, devices must be waiting for additional time to throw or get a data packet. Fig. 2 depicts the master and slave devices transferring two packets, Paging and Master Paging Response is there for the entire duration of the Probing Procedure. And this synchronization trouble affects every packet broadcast; resultant is a major delay in Bonding organization. The Bonding delay is very serious problem in real time purposes, like medical, emergency, sensor networks, secure data transfer.[1]

4 Proposed Solutions
In typical Bluetooth Bonding, there is a master and 7 active slave. All the Bonding among the slaves is done through the master node. That is a piconet. Combination of picontes is called a scatternet. In a scatternet, a slave can communicate more than one piconet. A bridge is required for this sort of Bonding among nodes. If a slave from piconet 1 wants to communicate with the slave of piconet 2 then it has to communicate with the master of piconet 2. In section III we have discussed the problems and issues of the Bonding establishment of the Bluetooth. Power consumption and delays are the two key factors which plays a more vital role. We present a new view of network formation in which salve of one piconet can communicate with the slave of piconet 2, this will reduce the power consumption in Bonding establishment and reduces the delays caused by the longer path use for Bonding. Our proposed algorithm is basically of 7 phases.

5 Framework of Proposed Solution
Framework is divided into following phases:

Phase No. 1
A coding method is framed for piconet formation.

Phase No.2
Using defined coding frame work of piconet formation, scatternets are formed.

Phase No.3
Third phase is to limit the scatternet up to 7 piconets.

Phase No. 4
The fourth phase of algorithm is to determine the piconet which required communicaton with eachother.

Phase No.5
This phase is very important and plays very vital role in our algorithm, it has basically two secondary steps, first step is to determine slaves which require Bonding, And second step is to find the path/route and required source for this intersalve bonding.
The above figure shows the presented strategy. The orange nodes show the direct Bonding between two slaves.

**Phase No.6**

The next phase is the calculation of resources for Bonding.

i. How much resources and how long path is required. If the Bonding is based on inherited nature of Bluetooth.

ii. Calculation of resources if our presented approach is used.

**Phase No.7**

Determination of which approach consumes less resources and using shortest path that might be our proposed routing approach which sends the data using direct path.

**Phase No.8**

Receiver slave sends back acknowledgement of receiving data and makes itself free for next bonding round.

vi. Having acknowledgment from receiver slave.

vii. Sending data.

viii. Again having Acknowledgement after receiving data.

In formation of scatternet initially every device attempts to connect itself with every available active slave which makes delay and energy loss in system, after having link slaves turns into waiting mode till an request arrived to transfer data at this stage node has given an ID packet having destination address AM ADDR. Then FHS packet is send by Master to all active slaves as FHS packets received device enters into data transfer mode and updates their status after some specific period of time.

**6 Summary and Conclusion**

In this paper a new preview of Bluetooth slave’s bonding which makes Bluetooth a proficient wireless Bonding standard was presented. To summarize this research the first step was to recognize the major problem of Bluetooth scatternet formation which shows the major problem of Bonding between two slaves. The second phase was to find out an appropriate algorithm which enables both slaves to communicate directly using shortest path approach, the third phase to find that strategy and to implement that algorithm. Final phase was to calculate the cost of slaves Bonding using direct (our) approach in comparison with inherited approach of Bluetooth, and the experimental results clearly shows that our presented approach is much better. Particularly in lieu with time consumption, delay, resource consumption (Bandwidth Utilization), power requirements and data rates as well. The presented approach having characteristics to provide 65% less overhead, also have fault tolerance against link failure, device Bonding loss, device failure chances, having all these competent features data rate is also increased comparatively about 50%, another important feature is the presented approach does not include the extra cost.

**References**


