ARCHITECTURAL CHALLENGES IN DESIGNING OF DATA TRANSACTION SYSTEM FOR SHORT RANGE COMMUNICATION

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Abstract—

Bluetooth technology is intended primarily as a replacement of cables between electronic devices, as in Personal Area Networks (PANs), or for connecting the components of a computer system. In addition, larger topologies like "scatternets" are targeting wider geographical area applications in colleges, universities, factories, warehouses, shopping malls and various sensor network applications. For scatternet formation and scheduling issues, less attention has been given to optimizing scatternet topologies. Sizing a scatternet in terms of minimizing the number of piconets has been addressed.

The short range communication technologies like scatternet formation has not been formally defined in the Bluetooth SIG specifications. As a result, numerous protocols have been proposed. While modeling ad-hoc networking, in general, is complex, the additional restrictions imposed by the Bluetooth specifications—such as low cost of the device, low power consumption and network resilience while using piconets that have a maximum of seven active nodes—have created a significant challenges.

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This paper addresses the challenges of scatternet formation for multi-hop to Bluetooth based personal area and adhoc networks, with minimal communication overhead. In a multi-hop adhoc network, all wireless devices are in the radio vicinity of each other, e.g., electronic devices in a laboratory, or laptops in a conference room.

In this paper we apply a method to multi hop networks, by showing that position information is then not needed. Each node can simply select a virtual position, and communicate it to all neighbors in the neighbor discovery phase. In this paper, architectural challenges during design of short range communication technologies are considered.

Keywords- *piconet; sactternet; Personal Area Network (PAN); adhoc network.*

I. INTRODUCTION

Bluetooth is a low-cost, low-power radio technology, intended as a replacement of cables between electronic devices [1]. Bluetooth devices can form small networks called "piconets" and information is exchanged seamlessly among devices in the piconet. An example of a piconet application is for connecting a mobile phone, laptop, palmtop, headset, and other electronic devices that a person carries around in his everyday life. Such a network is sometimes called a Personal Area Network (PAN). A piconet may, from time to time, also include devices that are not carried along with the user, e.g., an access point for Internet access or sensors located in a room.

Bluetooth piconets may be inter-connected to form larger networks called scatternets. It requires some units, called gateways, to time–division their presence among the piconets they belong to. The formation of such "scatternets" enhances the networking capabilities of Bluetooth and makes it suitable for a wide range of applications. Also, Bluetooth devices are expected to be widely diffused in almost every electronic device in the future. Such a large diffusion is likely to bring down the cost of Bluetooth devices and enable Bluetooth-enabled devices to be used in a wide array of applications in various scatternet architectures.

In general, there will be two distinct modes in which Bluetooth-based scatternets will be used [2]. One will be in dynamic environments, such as a conference, where a scatternet will be formed on-the-fly and will allow Bluetooth-enabled users to share information such as visiting cards, multimedia files etc. The second mode of use of scatternets will be in static environments. In this mode, scatternets will be configured similar to the way we configure wired networks. An example of a static mode is a network connecting household appliances. Another example is a college / university or shopping mall, in which a scatternet covering the whole college / university or mall may direct the student/staff or client towards the information or products he is interested in, or advise. A scatternet can also be used in "monitoring systems", as in patient monitoring in a medical services context. Yet another example of static mode is security applications using a network of camera-enabled Bluetooth nodes. Such environments will typically involve nodes operating on mall batteries. The low power and medium bandwidth of Bluetooth (1 Mbps) make it a good fit in such environments.

Scatternet architectures have received attention in the literature recently. The scheduling of gateways among piconets has been addressed in. Scatternet formation has been addressed in, but the environments dealt with are typically dynamic where nodes enter and leave the network throughout its lifetime. However, gateway scheduling and scatternet structures studies reported so far do not present any quantitative analytic results regarding network performance behavior.

In Section 2, we discuss scatternet: a set of picinet. In Section 3, we have discussed how the formation of network occurs. In Section 4, we mention our proposed extended proximity wireless transaction system design. In Section 5, we present problems to be addressed during the formation of short range wireless transaction system. Section 6 presents our concluding remarks and potential future work.

II. SCATTERNET: A SET OF PICONET

When there is a collection of devices paired with each other, it forms a small personal area network called 'piconet.' A piconet consists of a master and at most seven active slaves. Each piconet has its own hopping sequence and the master and all slaves share the same channel. In a piconet, the master and slave devices transmit packets in even and odd slots, respectively.

Two or more piconets connected to each other by means of a device (called 'bridge') participating in both the piconets, form a scatternet. The role of the bridge is to transmit data across piconets. Figure 1 shows a scatternet structure in which devices 'a' and 'c' play the master role and device 'b' acts as the bridge [3].

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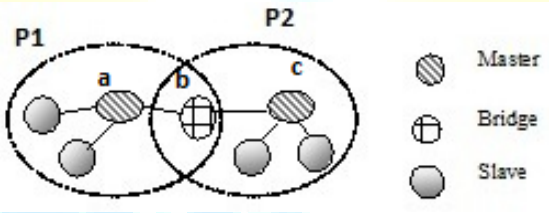


Figure 1 Scatternet Structure

III. FORMATION OF NETWORK

There has been a comprehensive study to propose an efficient formation of connected short range communication technologies like scatternet. One important problem that exists with scatternet as well as piconet formation is to keep track of the device that comes in and goes out of the network—since these are low-power handheld devices with limited communication range over Bluetooth. A device connects to another device at random, according to their 48-bit Bluetooth addresses and clocks, which control the hopping behavior in inquiry or inquiry scan states. Most protocols seek to reduce the scatternet formation time and form fast routing algorithms. It turns out that a good scatternet formation protocol should:

- BE FULLY DISTRIBUTED AND RELY ON LOCAL INFORMATION
- GENERATE CONNECTED SCATTERNETS
- Be resilient to the disconnection of nodes anywhere in the scatternet
- Provide multiple routes for robustness and be self-healing

- Limit the number of bridges
- Limit the number of roles a device can assume
- Be aware of device resources

While forming a scatternet, keep in mind that you are dealing with, in general, small, energy and processing-power-starved devices. The following points should be taken care of while developing scatternet formation protocols:

- Minimise scatternet construction time
- Minimise the amount of control data transmitted
- Minimise the number of hops required for communication between devices, in order to improve response times
- Minimise power consumption. Master-and-bridge mode of operation requires more power than slave mode
- Minimise the number of roles assigned to nodes
- Minimise the number of piconets to provide faster routing and reducedpacket collisions
- Maximise the amount of data throughput

Given a scatternet, you can evaluate its performance based on the number of piconets, the number of nodes per piconet, the number of bridge nodes, the number of roles per node, average traffic delay, throughput and maxi-mum traffic delay. Numerous models have been proposed for constructing Bluetooth scatternets, some of which may require modifications to the existing Bluetooth specifications [4].

IV. PROPOSED EXTENDED PROXIMITY WIRELESS TRANSACTION SYSTEM DESIGN

The proposed proximity wireless transaction system is to design a transaction system to deliver data packets in Bluetooth scatternet.

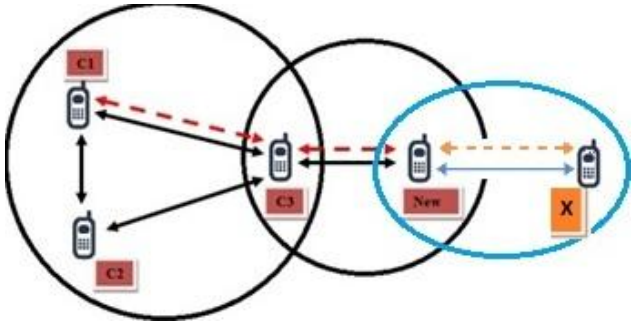


Figure 2 proposed architecture design with multiple hops

In proposed design extends the range of short range network, in which one of the node works as bridge through which node can connect with remote node which is not in the range. For example C1, C2 and C3 are in one network and new node is in different network. C3 is a common node through which we can able to communicate among C1 to new via C3 as shown with dotted line in figure 2. [5]

Furthermore we can send message C1 to C2 directly as well as C1 to C2 via C3 in the same network.

By implementing this architecture, we can achieve following:

1. It is possible to transfer data/messages between scatternet.
2. Each device has membership information to deliver / forward data / message.
3. Performance analysis of the model.(transfer rate, packet loss etc)[6].

V. PROBLEMS TO BE ADDRESSED

The Bluetooth scatternet formation devices are generally small, running on batteries, with low-powered CPU and low memory. At the same time, these are highly mobile and may frequently move in and out of the network. This leads us to think about following issues:

1. What is the optimal number of piconets in the scatternet and how many nodes are there? The number of bridge nodes increases (proportionally) with the increasing number of piconets.

The increases, in turn, incur significant overhead: loss of one or more time slots to readjust clocking when shifting from one piconet to another, more traffic than non-bridge nodes and increased battery power consumption to perform these tasks.

2. What is the optimal number of piconets in which a bridge should participate?: The more the piconets with which a bridge communicates, the less the time during which the bridge will be available for dealing with traffic from/to each individual piconet, thus increasing the likelihood of bottlenecks, at the bridge itself.

3. Formation delay and resilience: How much time is required to construct, optimize and maintain the scatternet? The ad-hoc, dynamic nature of a Bluetooth network requires constant modifications to the scatternet topology to support devices that join and leave. How to handle the nodes that join or leave the scatternets?

4. Routing: Does the scatternet topology allow efficient routing of messages?

The major challenge is to find the available routing path and keep the track of available paths in the network.

We have to evaluate the possibilities of Bluetooth in a mobile ad-hoc network. Therefore we need to develop an interface in Java (J2ME with wireless plug-in) and eclipse emulator from which; it will be possible that mobile devices (mobile phones, PDAs) can interact with each other in a short range wireless network formation.[3][5][7]

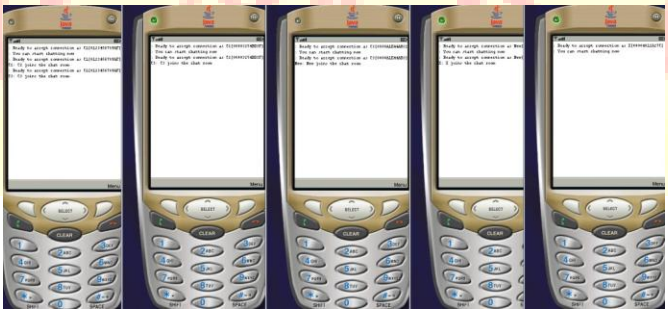


Figure 3 Nodes in emulator

Firstly, in the neighbor discovery phase, each node learns about its one-hop or two-hop neighbors. This procedure is called inquiry procedure in Bluetooth specifications. It is performed by each node randomly entering inquiry or inquiryscan mode (with equal probabilities, or alternating between the two modes), and randomly selecting the length of each inquiry/inquiry scan cycler epeatedly until a time out. One modification needed for our applicationis that nodes exchange their positions in addition to their Bluetooth IDs, which is a trivial addition to the packet content.[8]

As shown in figure-1, we have achieved through our proposed architecture. The issue arises when try to extend the network by adding another piconet in the network as per figure-2 to find particular routing path for particular node.

When, node C1 send to message to node X in piconet 3, every intermediate node, like C2, C3, New along with source and destination node; frequently update the routing table and refresh the routing path. This will create a multiple recursive garbage path as shown in figure – 4.

As C1 is in piconet 1, it is not having knowledge about node in piconet 3. So every time it has to rely on node in piconet 2. So it has two set of addresses (direct and indirect) for communication from piconet P1 to piconet P3 and repeatedly it will add the intermediate node address in the link path and that resultant into a recursive path list. [9]

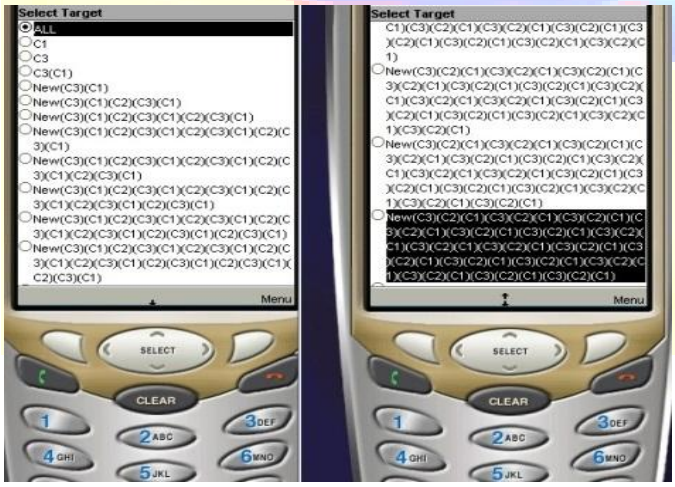
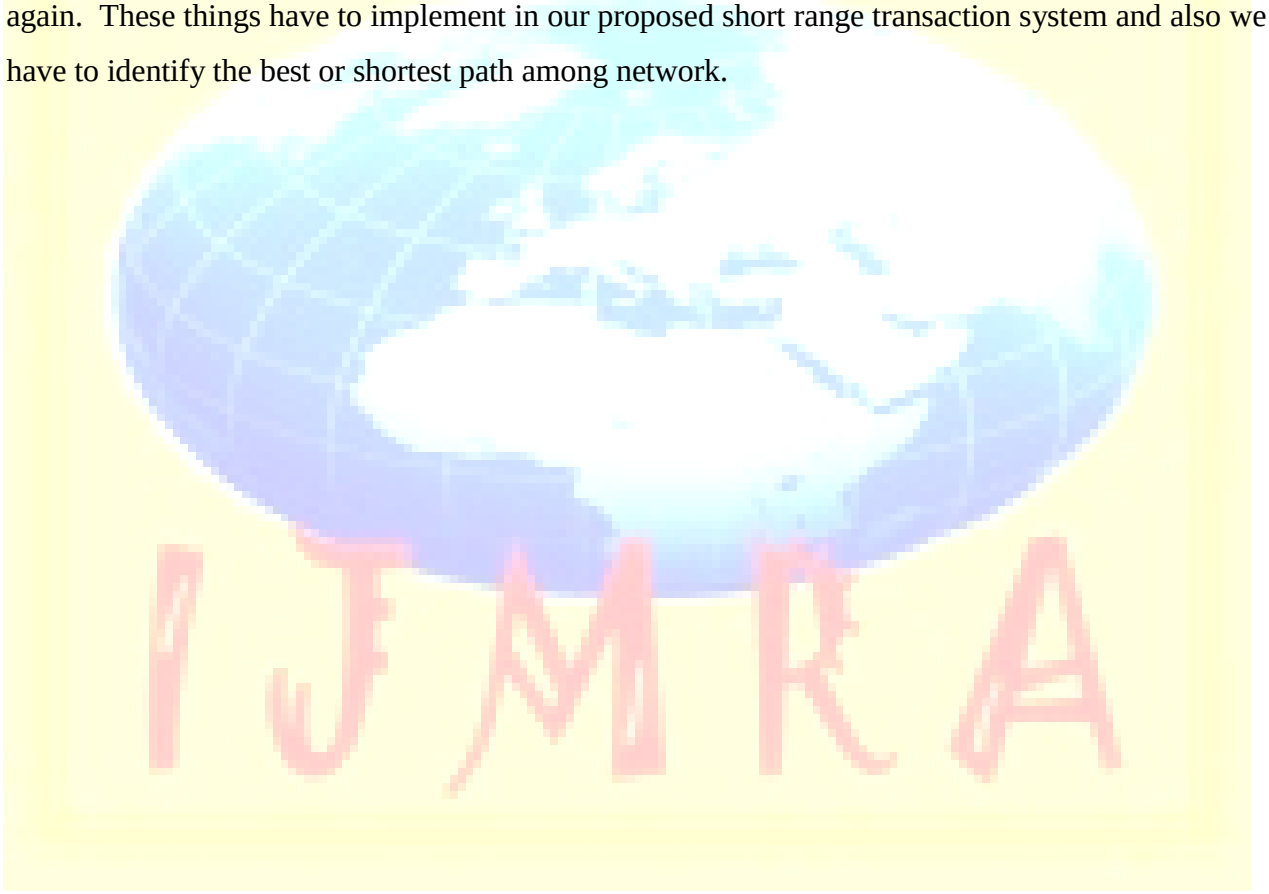


Figure 4 recursive path errors in routing

VI. CONCLUSION AND FUTURE WORK

Due to low-power handheld devices with limited communication range over Bluetooth various challenges have to face during the establishment of short range wireless transaction system.

To overcome with the recursive path errors, we have made change in service discovery process. In the network each node frequently broadcast the list of available or connected nodes with them; accordingly every node refreshes list of direct and indirect connected nodes in respective routing table. Once the particular node in the node is comes in that path it will be listed in the routing table. Again after refreshing or updating the routing table if the same node is present or not that is compare with the path in routing table. If the node is in the path then it will not be considered again. These things have to implement in our proposed short range transaction system and also we have to identify the best or shortest path among network.



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