A Study on Bluetooth Wireless Technology

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ABSTRACT:
A Bluetooth ad hoc network can be formed by interconnecting pico nets into scatter nets. The constraints and properties of Bluetooth scatter nets present special challenges in forming an ad hoc network efficiently. This paper, the research contributions in this arena are brought together, to give an overview of the state-of-the-art. Simply stated, Bluetooth is a wireless communication protocol. Since it’s a communication protocol, you can use Bluetooth to communicate to other Bluetooth-enabled devices.

I. INTRODUCTION

Bluetooth is a networking technology aimed at low-powered, short range applications. It was initially developed by Ericsson, but is governed as an open specification by the Bluetooth Special Interest Group. Bluetooth is a recently proposed standard for short range, low power wireless communication. Initially, it is being envisioned simply as a wire replacement technology. Its most commonly described application is that of a “cordless computer “consisting of several devices including a personal computer, possibly a laptop, keyboard, mouse, joystick, printer, scanner etc., each equipped with a Bluetooth card. There are no cable connections between these devices, and Bluetooth is to enable seamless communication between all them, essentially replacing what is today achieved through a combination of serial and parallel cables, and infrared links. However, Bluetooth has the potential for being much more than a wire replacement technology, and the Bluetooth standard was indeed drafted with such a more ambitious goal in mind. Bluetooth holds the promise of becoming the technology of choice for adhoc networks of the future. This is in part because its low power consumption and potential low cost make it an attractive solution for the typical mobile devices used in adhoc networks. Bluetooth is a specification for Wireless Personal Area. It is a way to connect and exchange information and data between mobile phones, laptops, digital cameras and video games. The communication is wireless and has the range of up to 10 meters. The Following diagram represents the working of the piconet in the Bluetooth devices. It shows master and the slaves in its working. Master A has 4 slaves as slave 1 slave 2 slave 3 and slave 4. Slave 4 also acts as an master in other piconet which has its own slaves i.e. slave 5 and slave 6.
II. BLUETOOTH OPERATION

Bluetooth basics are as follows:

1. Connection establishment

2. Concept of an ad-hoc pico net

In this section, we briefly describe the basic features of a Bluetooth network. Nodes are organized in small groups called piconets. Every piconet has a leading node called “master,” and other nodes in a piconet are referred to as “slaves.” A node may belong to multiple piconets, and we refer to such a node as a “bridge.” A piconet can have at most 7 members. Refer to figure for a sample organization. Every communication in a piconet involves the master, so that slaves do not directly communicate with each other but instead rely on the master as a transit node. In other words, Bluetooth provides a half-duplex communication channel. Communication between nodes in different piconets must involve the bridge nodes. A bridge node cannot be simultaneously active in multiple piconets. It is active in one piconet and “parked” in others. Bluetooth allows different activity states for the nodes: active, idle, parked, sniffing. Data exchange takes place between two nodes only when both are active. Activity states of nodes change periodically.

WHY IT IS CALLED BLUETOOTH?

The heart of the Bluetooth brand identity is the name, which refers to the Danish king Harald "Bluetooth" Blaatand who unified Denmark and Norway. In the beginning of the Bluetooth wireless technology era, Bluetooth was aimed at unifying the telecom and computing industries. Bluetooth can be used to wirelessly synchronize and transfer data among devices. Bluetooth can be thought of as a cable replacement technology. Typical uses include automatically synchronizing contact and calendar information among desktop, notebook and palmtop computers without connecting cables. Bluetooth can also be used to access a network or the Internet with a notebook computer by connecting wirelessly to a cellular phone.

III. CHALLENGES IN BLUETOOTH DESIGN
The Bluetooth specifications have left several design issues open to implementation, when it comes to its use as a networking technology. The objective is to allow designers flexibility so as to cater to the individual network requirements. However for adapting the technology towards large scale deployment in adhoc networks it is imperative that there be a systematic procedure for attaining some of the most common design objectives. We first examine the open issues and then discuss why these need to be carefully “nailed down” in order to satisfy certain universal design objectives. A predominant open issue is how to decide which nodes become masters, slave and bridges. In Bluetooth, nodes are assumed physically equivalent with respect to their Bluetooth capabilities, so that the master and slave states are purely logical. This is a useful feature in the context of adhoc networks where nodes will likely be reasonably homogeneous, but it also introduces several problems. This is because the decision for a node to become slave or master affects the connectivity that will be available to other nodes. In addition, a node needs to decide the number of piconets it should join, and when multiple choices are possible, which subset of piconets to choose. This latter issue arises because a node may have several masters within its communication range. Note that the master of one piconet can participate as a slave in another one. There are multiple facets to the decision of how many piconets a node should join. On one hand, bridge nodes that belong to multiple piconets improve connectivity, which reduces the number of communication hops needed to transfer data between any two nodes and can, therefore, improve overall throughput.

IV. DESIGN OBJECTIVES

We describe some of our design objectives in deciding how to best form Bluetooth topologies, and subsequently discuss the challenges involved in satisfying these objectives while exploiting the flexibility offered by the Bluetooth specifications. We are primarily concerned with three major objectives:

1. Connectivity.
2. Distributed operation and low overhead.
3. Throughput maximization.
V. RELATED RESEARCH

In this section, we mention very briefly a number of previous works that have also been motivated by the need to extend the standard specifications, if the Bluetooth technology is to be used in building adhoc networks. The basic assumption behind the scheme is that all nodes are within transmission range of each other. The nodes conduct a leader election algorithm. Salonidis et. al. presents a distributed topology construction scheme in Bluetooth networks [6].

The basic assumption behind the scheme is that all nodes are within transmission range of each other. The nodes conduct a leader election algorithm. The winner knows the identity of all nodes and uses this information to design the desired topology. Thus the algorithm is not scalable if the number of nodes is large. This paper also shows that the average delay involved in synchronizing two nodes (the time spent in the inquiry and the page sequences before the nodes are able to exchange the clock information) is infinite if the nodes have a deterministic sequence of switching between inquiring and inquired (or paging and paged) modes. Bhagwat et al. presents a source routing mechanism for Bluetooth networks [1]. Das et al. [2] and Johnson et al. [4] present distributed scheduling policies for Bluetooth networks.

VI. CASE STUDY

In a routing protocol which utilizes the characteristics of Bluetooth technology is proposed for Bluetooth-based mobile ad hoc networks. The routing tables are maintained in the master devices and the routing zone radius for each table is adjusted dynamically by using evolving fuzzy neural networks. Observing there exists some useless routing packets which are helpless to build the routing path and increase the network loads in the existing ad hoc routing protocols, they selectively use multiple unicasts or one broadcast when the destination device is out of the routing zone radius coverage of the routing table. The simulation results show that the dynamic adjustments of the routing table size in each master device results in much less reply time of routing request, fewer request packets and useless packets compared with two representative protocols, Zone Routing Protocol (ZRP) and Dynamic Source Routing (DSR).

In [1] A routing protocol which utilizes the characteristics of Bluetooth technology is proposed for Bluetooth-based mobile ad hoc networks. The routing tables are maintained in the master devices and the routing zone radius for each table is adjusted dynamically by using evolving fuzzy neural networks. The simulation results show that the dynamic adjustments of the routing table size in each master device results in much less reply time of routing request, fewer request packets and useless packets compared with two representative protocols, Zone Routing Protocol (ZRP) and Dynamic Source Routing (DSR).

In [2] work targets small mobile computers with a Bluetooth wireless link. Embedded in cheap robots with data rich sensors, our target does not have enough processing power to do the required analysis on sensor data. They assume the network is unreliable and provide a retry mechanism in distributing the problem.

In [3] this paper studies the optimization of scatternets through the reduction of communication path lengths. After demonstrating analytically that there is a strong
relationship between the communication path length on one hand and throughput and power consumption on the other hand, we propose a novel heuristic algorithm suite capable of dynamically adapting the network topology to the existing traffic connections between the scatternet nodes.

In [4] the vision of ad-hoc networking with Bluetooth includes the concept of devices participating in multiple "piconets" and thereby forming a "scatternet". However, the details of scatternet support for Bluetooth are not specified yet. This paper presents a scheme for Bluetooth scatternet operation that adapts to varying traffic patterns.

In [5] With the growth in the number of devices with an integrated Bluetooth module, the range of applications based on the Bluetooth technology becomes larger, going beyond peer-to-peer use-cases. This paper considers a hybrid network, consisting both of infrastructure and ad hoc parts, referred to as scatternet with infrastructure support.

In [6] this paper addresses the problem of scatternet formation for single-hop Bluetooth based personal area and ad hoc networks, with minimal communication overhead. In a single-hop ad hoc network, all wireless devices are in the radio vicinity of each other, recent scatternet formation schemes by Li, Stojmenovic and Wang are position based and were applied for multihop networks. These schemes are localized and can Construct degree limited and connected piconets, without parking any node. They also limit to 7 the number of slave roles in one piconet.

VII. CONCLUSION

This paper was intended as a brief introduction to the many challenges that the Bluetooth technology faces if it is to succeed as a technology for building adhoc networks and also gives the small description of related work that had been done in this area. We have described many of the issues that need to be tackled and that have been left unspecified by the current standards. We identified a number of objectives that any solution should aim at meeting, and provided an initial investigation of some of these problems. This is obviously preliminary work, and we are actively investigating many of the problems outlined in this paper. We hope that the paper will also entice others in exploring what we feel is a promising and rich research area.

REFERENCES

[2] Parallel Computation in Mobile Systems Using Bluetooth Scatternets and Java presented by Rob Shepherd, John Story and Dr Saad Mansoor.