

An Enhanced Protocol for Bluetooth Scatternet Formation and Routing

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ABSTRACT

Formation of scatternet using Bluetooth devices increases device tractability thereby inviting new networking applications to be designed on it. In this paper we propose Bluetooth Scatternet Formation and Routing Protocol (BSFRP). It is a distributed protocol that handles node mobility and enables multi-hop communication. BSFRP defines rules for topology discovery, scatternet formation and routing. The scatternet phase of the protocol works on the principle of leader election. For routing, AODV is modified to address the constraints of scatternets. It improves the AODV route discovery phase by considering hop count, residual node's power, and route lifetime for best route selection. Simulation results show that the scatternet formed by BSFRP has the following properties: the number of piconets formed is close to the universal lower bound, each device on an average does not assume more than 1.15 roles, and the scatternet does not contain any master-slave bridge.

Keywords: Ad-Hoc Network, Bluetooth, Mobile Node, Network, Routing, Scatternet Formation, Topology Discovery

1. INTRODUCTION

Bluetooth is an open specification for short range wireless communication and networking, originally intended for personal area communications between portable and/or fixed elec-

tronic devices (Forman & Zahorjan, 1994; Law, Mehta & Siu, 2003; Zaruba, 2001). Nowadays it is used in a wide range of applications ranging from Body Area Networks (Cao, Leung, Chow & Chan, 2009) to pervasive computing to distribution of computation (Lee et al.,

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2012). Bluetooth is increasingly used as cable replacement technology to connect devices in a smart home/office environment. The Bluetooth standard allows to form a one-hop network called a piconet consisting of one master and maximum 7 active slaves (bluetooth.com; Bluetooth SIG). All communication between slaves is done via the masters. To expand the physical size of the lower class (short range) Bluetooth networks, the piconets can be joined to form scatternets via Slave-Slave (SS) bridge (a common slave node connected to multiple piconets on a time-sharing basis) or Master-Slave (MS) bridge (a link is established between nodes of multiple piconets) as shown in Figure 1. It allows multi-hop communication among Bluetooth enabled devices thus allowing the provision of a number of new services. There are many real life applications that implicitly require non uniform deployment of Bluetooth-enabled devices. For instance, in a conference hall, Bluetooth-equipped users are seated in groups. Another application can be smart offices where more Bluetooth-enabled sensors can be placed at certain areas in comparison to others. This motivated the development of a scatternet formation and routing protocol namely, "Bluetooth Scatternet Formation and Routing Protocol" (BSFRP) for random node distribution. It is a 3-phase protocol. The first phase is of topology discovery where nodes acquire knowledge of its one and two - hop neighbours by forming temporary piconets. In the next phase, the scatternet is formed based on the mechanism of election of leaders (Law, Mehta & Siu, 2003). Unlike the one described in (Law, Mehta & Siu, 2003), this protocol does not require devices to be in direct communication range of each other and allows relative mobility of the nodes. The scatternet thus formed does not contain any master-slave bridge whereas most of the existing works on scatternet formation contains master-slave bridges. BSFRP divides the nodes into a number of components and each component has a leader. The component may be a single node or a piconet or a scatternet as

mentioned in (Law, Mehta & Siu, 2003). After the protocol terminates the final scatternet is formed with only one leader. In order to enable data transmission in BSFRP, a routing protocol, based on AODV is also proposed. Unlike AODV (Johnson & Maltz, 1996), here the focus is on choosing a route that is durable in order to reduce power consumption for reinitiating route discovery. Moreover, periodic broadcast of HELLO packets is avoided here.

This article is organized as follows. In Section 2 piconet formation in Bluetooth is discussed. This is followed by brief discussion on related works in Section 3. Section 4 describes the working of BSFRP with the help of examples. This is followed by simulation results in Section 5 and Section 6 concludes.

2. PICONET FORMATION IN BLUETOOTH

Bluetooth allows different activity states for the nodes: active, idle, parked, sniffing. The standard also allows multiple roles for the same device. A node can be a master in one piconet and slave in another at different time instants. However switching roles imply more latency. Hence an efficient scatternet formation protocol should minimize the roles assigned to the nodes, without losing network connectivity.

A node discovers its neighbors through inquiring continuously with the inquiry hopping pattern. Nodes that are in inquiry scan mode listen and respond to the broadcast. However, as there is no coordination among nodes, both nodes in vicinity can be in inquiry or inquiry scan mode. Once a node learns information about the inquirer, it transmits its own identity. Subsequently, an inquirer becomes the master to page the other node following a frequency hopping sequence derived from the recipient's identity. For successful paging both nodes should be in opposite modes (master in page mode and recipient in page scan mode). After successful paging, all nodes hop to the pattern of the master. Thus a piconet is established.

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