Journal of Network and Computer Applications 34 (2011) 1252–1262

Contents lists available at ScienceDirect

Journal of Network and Computer Applications

journal homepage: www.elsevier.com/locate/jnca

Dynamic Congestion Control through backup relay in Bluetooth scatternet

Sheikh Tahir Bakhsh *, Halabi Hasbullah, Sabeen Tahir

Department of Computer and Information Sciences, Universiti Teknologi PETRONAS, Bandar Seri Iskandar, 31750 Tronoh, Perak, Malaysia

ARTICLE INFO

Article history:
Received 6 August 2010
Received in revised form
26 November 2010
Accepted 21 January 2011
Available online 31 January 2011

Keywords:
Bluetooth
Piconet
Scatternet
Congestion control
Backup relay

ABSTRACT

Bluetooth is a low power wireless technology designed to connect various short-range devices such as laptops, cameras, cell-phones, head-phones, navigators, etc. Bluetooth has limited resources and its devices are connected in ad hoc fashion. The Bluetooth specification allows only eight active devices to communicate within its smallest networking unit known as piconet. Multiple piconets can be connected together through at least one common device, known as relay to form a bigger network called a scatternet. The performance of a scatternet is highly determined by the performance of the relay since it acts as a switch between multiple piconets, where inter-piconet scheduling is the main task to perform. However, the presence of too many relays in the network may cause inefficient use of the limited resources. In contrary, less number of relays may lead to congestion problem because each relay has to participate in multiple piconets and supports several connections. One possible solution is to reorganize the nodes in the scatternet, in order to increase the available bandwidth and to reduce the traffic flows on the congested link. Hence, primarily this paper addresses the issues of traffic congestion on a link by analyzing traffic load in the network. To achieve this, activation of a backup relay is performed by applying role-switching operation, and this technique is called Dynamic Congestion Control (DCC). With DCC, the route length is assured not to increase as to alleviate message and packet overheads in scheduling. The simulation results are evidence that DCC has reduced transmission delays and has increased the scatternet lifetime from 25% to 50% as compared to RVM and LORP techniques.

1. Introduction

The advancement in communication technology has improved our daily life. The recent research has focused on wireless communications to provide consumer with more mobility and flexibility. Bluetooth (2010) is a representative of cable replacement technology for connecting electronic devices. Bluetooth device has 3 different ranges of classes: one, ten and hundred meters. Most devices operated on 10 m coverage of Class 2. Bluetooth has limited resources like battery power, bandwidth, active members per cell, etc. Hence, the resources must be utilized efficiently. Bluetooth is used for both transmissions, as for voice and data. Bluetooth is globally available in license-free of 2.4 GHz Industrial-Scientific-Medical band and serves as the baseline for the IEEE 802.15.1 Wireless Personal Area Network (WPAN) (Whitaker et al., 2005; Melodia and Cuomo, 2004). Bluetooth can be used in a cellular manner by mean of access points for wireless LAN applications, which increases the opportunities for wider applications. Bluetooth is more popular in the business due to its supports for WPAN applications by the existing communication devices. Bluetooth gets more attention from industry and scientist and its uses are increasing in our daily life (MDR,/MDR, 2010).

A Bluetooth device identifies other devices through their Bluetooth Device Address (BD_Addr) and clock. Initially, Bluetooth device is in the standby mode and not associated to any device. The master of the piconet performs the inquiry operation to find the new devices within its range by broadcasting the ID packets. Each device enters to inquiry scan (listen to the master) mode to connect the master if it already exists in its range. In the second phase, the page and page scan procedure is used to get the Bluetooth address, clock and device class for synchronization. The master goes to page and slave enter to page scan mode (receives the message on physical channel) (Bluetooth, 2010). The master allocates the AM_Addr to slave; it range is from 1 to 7. As connection is then established allowing both the devices to start communication using a Time Division Duplex (TDD) mechanism. Bluetooth devices have an agreement for communication according to the slot, each slot is 625 μs length. Bluetooth uses the different types of packets like, control (ID, NULL, POLL, FHS), voice (HV1, HV2, HV3, DV), and data (DH1, DH3, DH5, DM1, DM3, DM5) packets. Bluetooth supports 1, 3 and 5 slots packets, each higher slot packet consumes more time as compared to lower slot packet. For instance, DH5 consumes more time as compared to

* Corresponding author. Tel.: +60175150798.
E-mail address: comsiansatd@gmail.com (S. Tahir Bakhsh).

1084-8045/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jnca.2011.01.010