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A distributed mobile database implementation on Pocket PC mobile devices communicating over Bluetooth

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ABSTRACT

This paper describes a distributed database system implementation built on top of stand-alone mobile databases found on mobile devices. At the heart of the architecture are elected devices that take on the role of data directories which collect the schema of the databases and become the contact points for all nodes that wish to submit queries against the distributed database. The system is implemented on Pocket PCs that run the Microsoft WinCE operating system and communicate using Bluetooth, thus limiting the architecture to eight devices, which is a restriction imposed by piconets. Sample databases were configured on the devices that ran the *SQL Server CE* database engine, and a list of 170 sample queries of varying complexities were designed to conduct performance evaluation. This evaluation involved measurement of query response time, generated traffic, and device energy consumption. The obtained results indicated the feasibility of the system and its potential for providing mobile users with a framework for aggregating disparate data that are stored in mobile databases in the wireless ad hoc network.

1. Introduction

As mobile applications have become more ubiquitous, the demand for database data in mobile settings has increased, and this has created a need for engineering database architectures that are

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suitable for such dynamic environments (Chan and Roddick, 2005). The most interesting and promising form of such environments is the mobile ad hoc network (MANET) in which a mobile host can act as a source of information, destination, or a router that transfers data toward its destination. Mobile hosts are generally small computing devices with relatively limited resources that can join or leave the network unexpectedly at any time. In addition to the increasingly more complex applications that are targeting such devices, more sophisticated mobile database management systems are being engineered to offer capabilities that parallel those of enterprise level database systems.

The ultimate goal of our design and implementation is to provide a system through which mobile devices share data in disconnected settings (i.e., away from an access point that connects these hosts to a fixed network and through it to a central data source). That is, our work targets environments in which mobile hosts collaborate in answering each other's queries. More specifically, we develop a distributed database system on top of isolated mobile databases that exist on the mobile devices that happen to be in close proximity with each other. The protocol we consider for communication is Bluetooth which is prevalent on mobile devices due to its low cost and efficient utilization of battery power. The implementation of the system involved several issues relating to locating the data sources for the particular query, fragmenting the query among the participating mobile devices, and joining the individual results by some mobile device before returning them to the client application.

The rest of the paper is organized as follows. Section 2 provides a survey of related work and briefly describes the employed technologies in our implementation. Sections 3 and 4 describe the design and implementation of the system, respectively, while Section 5 presents the performance results. Finally, the paper is concluded in Section 6.

2. Literature overview

The developed application described in this paper tackles three main areas, namely, connectivity using the Bluetooth communication protocol, collaboration between mobile devices, and distributed databases in MANETs. Accordingly, this section briefly discusses related work done in those areas.

A study of recent research trends and experimental guidelines in MANETs, which was presented by Dow et al. (2005), surveyed more than 1300 MANET related papers from 1998 to 2003. It was found that topics like routing and power management attracted most of the attention, while issues such as IP addressing, fault tolerance, and collaboration were also popular among MANET researchers. In the qualitative analysis covered by the studied papers, factors such as scalability, stability, and reliability were of primary concern in major MANET issues. The framework of distributed mobile databases addressed in this paper is collaborative in the sense that nodes (mobile devices) cooperate by providing services to each other in order to answer a mobile node's query. Therefore, the subject of this paper contributes to the thrust of MANET research, and provides an actual implementation on Pocket PCs that communicate using Bluetooth (BT) through the formation of a *piconet*, where one *master* device can connect with up to seven active *slave* devices. A set of piconets connected through sharing devices form a *scatternet*. Although proposed in the standards, this function is still not well-developed today. Several scatternet protocols have been proposed but the *BlueTrees* (Zaruba et al., 2001) and *BlueStars* (Petrioli et al., 2003) are most known and have been the subject of further studies and comparisons (Amin et al., 2006; Basagni et al., 2004). Of concern to our work is the fact that current implementations of Bluetooth communication on mobile computing devices, like Pocket PCs and PalmOS handhelds, do not support master–slave role switching, and therefore scatternets. For this reason, our current implementation is limited to a wireless network of eight or less devices that communicate and form a piconet structure. Similarly, previous works that involved BT communication were limited to piconets. For example, Altundag and Gokturk (2006) developed a scatternet formation protocol and implemented a chat room application that utilized this protocol using J2ME. However, given the lack of scatternet and master–slave role switching on mobile phones, major features of the proposed protocol did not make it to the implementation, and as a result, the chat room application was restricted to work within a single piconet.