Wireless Data Broadcast Schemes for Location-Dependent Information Services Under a Geometric Location Model

KwangJin Park, Korea University, Republic of Korea
MoonBae Song, Korea University, Republic of Korea
Chong-Sun Hwang, Korea University, Republic of Korea

ABSTRACT

Indexing techniques are used to implement selective tuning in wireless environments. Indices are broadcast together with data to help mobile clients locate the required information. As a result, clients stay in doze mode most of the time. The drawback of this solution is that broadcast cycles are lengthened due to additional index information. In this paper, we introduce the broadcast-based LDIS scheme (BBS) for the mobile computing environment. In the BBS, broadcasted data objects are sorted sequentially, based on their location, and the server broadcasts the location-dependent data (LDD) without additional indices. Then, we present a data prefetching scheme and OBC (Object Boundary Circle) in order to reduce the client’s tuning time. The performance of the proposed scheme is investigated in relation to various environmental variables, such as the distributions of the data objects, the average speed of the clients, and the size of the service area.

Keywords: broadcasting; cache; distributed database management system; location-dependent data; mobile computing; prefetching; spatial data; spatial database

INTRODUCTION

In Location-Aware Mobile Services (LAMSSs), the server is characterized by the large number of mobile clients and stationary objects that they have to manage. In this environment, both mobile and stationary clients have the ability to issue spatial queries. The broadcasting of spatial data is an effective way of disseminating data in a wireless mobile environment, since this method can be scaled up without any penalty being incurred, when the number of users grows. In broadcast-based approach, mobile clients must wait until the server
broadcasts the required information. Therefore, client waiting time is determined by the overall length of broadcast data. Moreover, performance of the query processing obtained with a broadcasting method is highly dependent on the order in which the data is broadcast. Therefore, the question of how to organize the sequence of the broadcast data is a very important issue.

In this paper, we first introduce the broadcast-based location-dependent data delivery scheme (BBS). In this scheme, the server periodically broadcasts reports, which contains the IDs of the data objects (e.g., building names) and the values of the location coordinates to the clients. The broadcast data objects are sorted sequentially, based on their location, before being broadcast. Then, we introduce the prefetching scheme in LDIS for the mobile computing environment. The main contributions of our work can be summarized as follows: (1) the client can perform k-NN (Nearest Neighbor) query processing without index information. In this case, the best access time is obtained, since no index is broadcast along with the file (Imielinski et al., 1994); (2) the client simply adjusts the value of $k$ when it performs k-NN query processing; and (3) it reduces the query response time, since the client prefetches the desired data object in the cache in anticipation of future accesses.

The rest of the paper is organized as follows: The second section gives the background of the broadcast model and cache maintenance scheme. The third section describes the proposed BBS scheme and prefetching method. The performance evaluation is presented in the fourth section. Finally, the fifth section concludes this paper.

BACKGROUND

With the advent of high speed wireless networks and portable devices, data requests based on the location of mobile clients have increased in number. However, there are several challenges to be met in the development of LDISs (Lee et al., 2002), such as the constraints associated with the mobile environment and the difficulty of taking the user’s movement into account. Hence, various techniques have been proposed to overcome these difficulties.

Data Dissemination

There are two basic approaches to disseminating data to mobile clients (Deolasee et al., 2001; Stathatos et al., 1997).

- **Pure push (broadcast).** The server periodically broadcasts all the data items, while clients are passive listeners who make no requests. Its major advantage is that it can be accessed concurrently by any number of clients without any performance degradation. However, its limitation is that it can be accessed only sequentially, as clients need to wait for the data of interest to appear on the channel.

- **Pure pull (unicast).** This is standard client-server model, where all requests are explicitly made to the server. The server is responsible for processing the query and returning the answer directly to the client. The average data access time depends on the aggregate workload as well as the network load, but not on the size of the database.

Disseminating data through a broadcast channel allows simultaneous access by an arbitrary number of mobile users and thus allows efficient usage of scarce bandwidth. In Acharya et al. (1995), they introduce a technique for delivering data objects to the clients in asymmetric environments. In this scheme, groups of pages, such as hot and cold groups, with different broadcast frequencies are multiplexed on the same channel. Then, those items stored on the faster disks are broadcast more often than those items on the slower disks. Figure 1 shows an example of three different broadcast programs. As shown in the figure, a hot data item such as data item 1 is broadcast four times than cold data items such as data items 4 and 5.

However, the wireless broadcast environment is affected by the battery power restrictions of the mobile clients. Air indexing is one of techniques that attempts to address this is-
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