

Location-Dependent Database Access

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***Abstract.** Database queries stated in a mobile computing environment are significantly impacted by that mobility. In this paper we provide an introduction into the subject of location dependent database access. The coverage is quite broad and is aimed as providing the reader with sufficient content and references to begin research in this area. We include discussions of architecture and an overview of different types of location based mobile queries. A major portion of the paper deals with a detailed examination of nearest-neighbor queries and Voronoi diagrams.*

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1. Introduction

In a mobile and wireless environment, efficient and consistent data access is a challenging research area, because of the weak connectivity and resource constraints. The mobile data access strategies can be essentially distinguished by delivery modes. The modes for server delivery can be described as client pull, server-push, or hybrid:

- *Client pull* (sometimes called *on-demand access mode*): A mobile client first submits a query via the uplink channel and then “pulls” data, from the server through a wireless network (the downlink channel), in the same manner as in a traditional client-server system.
- *The server-push* (also called *broadcast* [15]): The mobile client receives information as a result of his or her whereabouts without having to actively submitting a query. The information sent to the mobile client may be either on a public wireless channel (e.g. a welcome message when entering a new town) or may be a subscription-based (e.g. alert system).
- *The hybrid delivery integrates* both server-push and client pull delivery.

Location-dependent data access assumes that a mobile user queries data where the value is dependent on his/her location. A typical query of this type is:

“Where is the closest restaurant?”

This query may be stated explicitly (in the client pull environment) or implicitly (in the push environment). In a broadcast setting, a content provider can broadcast restaurant information for a local area near the broadcast station. A *Location Dependent Query (LDQ)* is a mobile query where the result of the query depends on the location of the user making the query [4, 23, 26]. This definition can be expanded to include a broadcast environment. Here the content of the broadcast is based on the location of the broadcast station. Thus, as a mobile user roams, the result of his implicit query (that is the data that he receives) changes.

We conclude this section by reviewing some terms and background commonly used within location-dependent data and queries in wireless environments. We then briefly overview temporal and spatial database concepts as these are important to understanding location dependent database access. Subsequent sections of this chapter examine architectural issues related to location dependent data access, an overview of location dependent queries, an overview of moving object databases and queries, location modeling and translation, and nearest neighbor queries and indexing.

11. Terminology

As long as people move across the earth's surface, the need to know their current location anywhere and anytime has become a very important constraint in mobile databases. The term *location* refers to the position of a point relative to a geometric subdivision or a given set of disjoint geometric objects [1, 16].

Before studying queries and data access approaches in mobile databases, it is important to emphasize some fundamental properties of location data, such as:

- *Location models* : we distinguish two kinds of location, *geometric* (or geographic) and *semantic* (or symbolic) locations (see Figure 1):
 - The available mechanisms for identifying the *geometric location* can be divided into two basic classes :
 1. A location is specified, in the World Geodetic System 1984 (WGS84), as a three-dimensional unique location – 3 coordinates (latitude, longitude and altitude). These coordinates can be easily provided by a satellite-based positioning system (e.g. the most widely known the Global Positioning System – GPS).
 2. A location can also be considered by a set of coordinates defining an area's bounding geometric shape (such as polygon).

Geometric location can be considered in heterogeneous systems and it is common used in outdoor domain [14]. However, mobile users are often interested in the meaning of location rather than the geometric coordinates.

- *Semantic location* is the logical representation of the real-world entities describing the location space. Entities can be cities, street address, zip code, or system-defined elements such as cell IDs in cellular phone networks, infrared beacons, or WLAN access point IDs in the indoor domain. The last entities are uniquely identifiable by hierarchical naming system such as location trees.

Finally, both geometric and symbolic locations are present and have to be considered in LDQ. In addition, the process of converting a given symbolic location to x, y coordinates (e.g. latitude, longitude) [22] is called *geocoding* (see Figure 1). The opposite function of geocoding is *reverse geocoding*, which is the process of deriving the semantic location of a specified longitude/latitude coordinate.