Chapter 1

Querying Issues in Pervasive Environments

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ABSTRACT

Pervasive computing is all about making information, data, and services available everywhere and any-time. The explosion of huge amounts of data largely distributed and produced by different means (sensors, devices, networks, analysis processes, more generally data services) and the requirements to have queries processed on the right information, at the right place, at the right time has led to new research challenges for querying. For example, query processing can be done locally in the car, on PDA’s or mobile phones, or it can be delegated to a distant server accessible through Internet. Data and services can therefore be queried and managed by stationary or nomadic devices, using different networks.

The main objective of this chapter is to present a general overview of existing approaches on query processing and the authors’ vision on query evaluation in pervasive environments. It illustrates, with scenarios and practical examples, existing data and streams querying systems in pervasive environments. It describes the evaluation process of (i) mobile queries and queries on moving objects, (ii) continuous queries and (iii) stream queries. Finally, the chapter introduces the authors’ vision of query processing as a service composition in pervasive environments.

INTRODUCTION

The market of data management is lead by the major Object-Relational Database Management Systems (ORDBMS) like Oracle (http://www.oracle.com), UniversalDB2 (http://www-01.ibm.com/software/data/db2/) or SQLServer (http://www.microsoft.com/sqlserver/2008/en/us/). Dur-
ing the last twenty years, in order to better match the evolution of user and application needs, many extensions have been proposed to enhance the expressive power of SQL and the DBMS functions. In this context, querying is one of the most important functions’ (Wiederhold 1992; Domenig and Dittrich 1999) for accessing and sharing data among information sources. Several query-processing mechanisms have been proposed to efficiently and adaptively evaluate queries (Selinger 1979; Graefe and McKenna 1993; Graefe and Ward 1989; Kabra and DeWitt 1998; Haas and Hellerstein 1999; Bougamim 2000; Urhan and Franklin 2000; Avnur and Hellerstein 2000; Hellerstein et al. 2000; Raman and Hellerstein 2002). New classes of dynamic distributed environments (e.g., peer-to-peer where peers can connect or disconnect at any time) introduce new challenges for query processing. Some works add indexing structures to P2P architectures for efficiently locating interesting data and/or improving query languages expressivity (Abiteboul et al. 2004; Abdallah and Le 2005; Abdallah and Buyukkaya 2006; Labbe et al. 2004; Karnstedt 2006; Papadimos 2003). Such systems rely on a global schema and often pre-determined logical network organizations and are in general poorly adapted to query processing introduced in pervasive environments.

Pervasive computing is all about making information, data and services available everywhere and anytime thereby democratizing access to information and opening new research challenges for querying techniques. Today every activity (at home, for transportation and in industries) relies on the use of information provided by computing devices such as laptops, PDA’s and mobile phones and other devices embedded in our environment (e.g. sensors, car computers). Given the explosion of amounts of information largely distributed and produced by different means (sensors, devices, networks, analysis processes) research on query processing is still promising for providing the right information, at the right place, at the right moment.

Motivating Example

Let us consider an application for guiding and assisting drivers on highways. We assume several devices and servers connected to various network infrastructures (satellite, Wifi, 3G) give access to services that provide different kinds of information about traffic or weather conditions, rest areas, gas stations, toll lines, accidents and available hotels or restaurants. Different providers can offer such services, but with different quality criteria and costs. Drivers can then ask “Which are the rest areas that will be close to me in two hours and that propose a gas station, lodging facilities for two people and a restaurant and where hotel rooms can be booked on line”. Such a query includes classical aspects (retrieve the list of hotels and their prices) and continuous spatio-temporal aspects (determine the position of the car in two hours with respect to traffic and average speed). It may also use different kinds of technical services (look up, matching, data transmission, querying) and business services (hotel booking, parking places availability, routing).

In pervasive environments as the one shown in our example, query processing implies evaluating queries that address at the same time classical data providers (DBMS), nomadic services, and stream providers. Query processing must be guided by QoS (quality of service) criteria stemming from (i) user preferences (access cost to data and services); (ii) devices capabilities such as memory, computing power, network bandwidth and stability, battery consumption with respect to operations execution; (iii) data and service pertinence in dynamic contexts i.e., continuously locate providers to guide data and services access considering QoS criteria such as efficiency, results relevance and accuracy. Thus, querying in pervasive environments needs mechanisms that integrate business data providers, query evaluation and data management services, for optimally giving access to data according to different and often contradictory changing QoS criteria. In our