21 Efficient Overlay Mediation for Mobile Location-Based Services

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Abstract

Data communication in mobile and cellular environments is still in its infancy. Data traffic generated by mobile users lacks the diversity of the fixed Internet. On the one hand, the limited bandwidth available for mobile users is still a major hurdle for some Internet applications. On the other hand, a universal inexpensive mobility solution built to support the different wireless architectures while offering service ubiquity is still missing. Despite this, some applications such as location-based services (LBS) have found a natural application domain by mobile users. Data traffic, in such applications, is generated by users accessing information linked to their movement context. To improve access to these services while limiting the effects of mobility, communication should occur near the edge, while staying localized. In this paper, a distributed approach is proposed for mediating location information between heterogeneous geographic information servers in a peer-to-peer manner. A design methodology is proposed to ensure the localized impact of mobility-lead communication overhead. Both numerical and simulative analyses are carried out.

Keywords: mobile LBS, vertical handover, overlay, range queries, clustering

21.1 Introduction

Data services in wireless cellular networks still have not reached the extent of the fixed Internet, partly due to lacking bandwidth and to a costly mobility management. Cellular networks track the user’s position in order to limit interruptions due to handover, which is an essential quality of service requirement for voice services,
and also to deliver calls initiated by remote correspondent nodes. With the development of new wireless techniques such as cooperative and mesh networking, more bandwidth is offered at the wireless edge, but so is the diversity which new mobility management techniques have to deal with. In such scenarios vertical handover could lead to improvement of access to bandwidth but might introduce lengthy interruptions.

Mobile or ubiquitous location-based services (Rao & Minakakis 2003) are an example where mobility is a major incentive to communication. Normally, we talk about LBS (Schiller & Voisard 2004), even for services accessed through fixed Internet in a centralized manner, if the service on offer is associated to a geographic location (e.g. online access to a database or geographic information servers (GIS)). A mobile LBS, in contrast, allows mobile users to ubiquitously and adaptively access different content and information which is tailored to their changing location. The location of the user is taken into account to deliver timely, relevant content and information.

In this paper the transition between wireless networks is not of focus, but rather placing the LBS in a distributed manner as near to the mobile as possible. This is done thanks to an overlay-based architecture, which allows efficient and distributed range queries while taking into account the distributed nature of GIS servers and their heterogeneity. The overlay reorganizes the data scattered among the different GIS on a new plane to allow quick readapting to the status of the managed objects and retrieval of data with minimal communication overhead. The P2P overlay offers in this case a type of middleware that mediates content information back to the user. Mobility management is intrinsic to the overlay solution, which takes the user’s location and movement into account.

The paper is structured as follows. The related work is presented in Section 21.2. Section 21.3 takes an example application with hard requirements such as decentralized GIS, timeliness of data retrieval, and a dynamic status change of the retrieved LBS data. Section 21.4 presents the analytic analysis of the range query cost. The structure of the overlay is further optimized as a result of the analysis. Simulation results, in Section 21.5, also confirm the structure choices of the overlay system. Section 21.6 concludes the paper.

### 21.2 Related Work

Most mobile LBS assume a mobility solution at the lower layers. While mobility research has matured regarding cellular networks and even 3G and beyond scenarios (Akyildiz et al. 2004), major efforts are still needed in WMNs and Ad-Hoc networks (Akyildiz et al. 2005). Using overlays to manage mobility or as a support for mobility has also resulted in several proposals including earlier work by Stemm