Chapter 16

mTrigger: An Event-Based Framework for Location-Based Mobile Triggers

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ABSTRACT

Location-based triggers are the fundamental capability for supporting location-based advertisements, location-based entertainment applications, personal reminders, as well as presence-based information sharing applications. In this chapter, we describe the design and the implementation of mTrigger, an event-based framework for scalable processing of location-based mobile triggers (location triggers for short). A location trigger is a standing spatial trigger specified with the spatial region over which the trigger is set, the actions to be taken when the trigger conditions are met, and the list of recipients to whom the notification will be sent upon the firing of the location trigger. The mTrigger framework consists of three alternative architectures for supporting location triggers: (1) the client-server architecture, which allows mobile clients to register and install location triggers of interest on the mTrigger server system; the server being responsible for processing location triggers, performing associated actions and sending out notifications upon firing of triggers; (2) the client-centric architecture, which enables mobile users to manage and process location triggers on their own mobile clients; and (3) the decentralized peer-to-peer architecture, which allows mobile users to collaborate with one another in terms of location trigger processing. The server-centric architecture is particularly suitable for supporting public and shared location triggers, enabling effective sharing of location trigger processing among

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multiple users. The client-centric architecture is more suitable for users possessing mobile clients with high computational capacity and more sensitive to the location privacy of their location triggers. The decentralized peer-to-peer architecture provides on-demand and opportunistic collaboration in terms of location trigger evaluation. Clearly, the performance optimizations for server-centric architecture should focus on efficient and scalable processing of location triggers by reducing the bandwidth consumption and the amount of redundant computation at the server; whereas, the performance optimizations for client-centric architecture and decentralized architecture should also take into account energy efficiency of mobile clients in addition to computational efficiency. In addition, processing of location triggers with moving target of interest requires the knowledge of position information of the moving target and may not be suitable for the client-centric architecture. This chapter will describe the design principles and the performance optimization techniques of the mTrigger framework, including a suite of energy-efficient spatial trigger grouping techniques for optimizing both wake-up times and check times of location trigger evaluations.

INTRODUCTION

Location-based services such as location-based advertisement, location-based entertainment and location-based personal assistant are emerging business applications that demand location-based mobile triggers. Location triggers are standing spatial triggers. Similar to time-based triggers that are used to remind us of the arrival of a future reference time point, location triggers are set on a spatial location of interest, which subscribers of the trigger will travel to at some future time instant. Companies or merchants may use location triggers to support location-based advertisements; for example, Bloomingdale’s may send a 20% sale coupon to its medallion member shoppers who are located within five miles of its stores. Individuals use location-based triggers to set up personal reminders indicating the arrival to a spatial location of interest. For instance, a user could set a spatial alarm (Spatial Alarms Project, n.d.) on her mobile client, which alerts her whenever she is near the dry cleaner or her favorite grocery store in her neighborhood, reminding her to pick up or drop her dry cleaning items, or automatically retrieving her stored grocery list.

Dey and Abowd (Dey, A., & Abowd, G., 2000) describe a context-aware system for supporting reminders in order to provide appropriate signals at appropriate times. For example, a reminder for bringing a paper for a meeting is most effective when the user is leaving her office to head for the meeting room. (Dey, A., & Abowd, G., 2000) primarily deals with building a context-aware toolkit for supporting reminder delivery at appropriate times. The ability to locate users using GPS, cell phone positioning and other navigational systems makes context-aware reminder systems feasible. PlaceMail (Ludford, P., Frankowski, D., Reily, K., Wilms, K., & Terveen, L., 2006). studies issues related to location-based information systems in order to support useful location-based reminder systems and functional place-based lists. The study determines that effective reminder delivery depends on people’s movement patterns through an area and the geographic layout of the space. However, none of the previous work emphasizes the ability to process reminders (or more generally, location-based triggers) efficiently from a systems-based perspective. This chapter focuses on optimization techniques which should be deployed for efficient and scalable processing of location-based triggers in different systems-based architectural settings, including a server-centric, client-centric and decentralized architecture. We also consider bandwidth and energy constraints on the client side, which are resource-constrained devices despite significant enhancements in the
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