Chapter 2.5

Data Dissemination and Query Routing in Mobile Peer-to-Peer Networks

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ABSTRACT

In this chapter the authors study the problems of data dissemination and query routing in mobile peer-to-peer networks. They provide a taxonomy and discussion of existing literature, spanning overlay topologies, query routing, and data propagation. They proceed by proposing content-driven routing and adaptive data dissemination algorithms for intelligently routing search queries in a peer-to-peer network that supports mobile users. In the authors’ mechanism, nodes build content synopses of their data and adaptively disseminate them to their most appropriate peers. Based on the content synopses, a routing mechanism is being built, to forward the queries to those peers that have a high probability of providing the desired results. The authors provide an experimental evaluation of different dissemination strategies, which shows that content-driven routing and adaptive data dissemination is highly scalable and significantly improves resource usage.

INTRODUCTION

Mobile ad-hoc networks composed of mobile devices such as laptops, cell phones and PDAs with limited communication power and transmission range have emerged as a widely deployable infrastructure without the need of centralized support (Cao et al., 2005; Kortuem et al., 2001; Papadopouli and Schulzrinne, 2001). The typical characteristic of these networks is that the users are interested in receiving data and services available in their vicinity, or want to be notified about local events that are pertinent to their interests. Receiving this information by forming mobile peer-to-peer networks offers several advantages in comparison to retrieving it from fixed access points or the satellites of a cell phone carrier: First, the
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costs for installing, maintaining, and operating an infrastructure to provide the requested data are avoided. Second, data are updated automatically as users move, without the overhead of continuously collecting updates in centralized locations. This is particularly useful for locations where users change frequently, such as busy streets or stores. Third, users find themselves in places and situations where an infrastructure may not exist, or is not accessible. Examples include trying to access traffic information while driving in isolated areas (Xu et al., 2004), or trying to retrieve emergency notifications after a natural disaster. Finally, mobile peer-to-peer networks enable users to publish data in a cost-efficient way, in addition to receiving them. This gives rise to a wealth of new applications, such as identifying nearby users with similar interests (Amir et al., 2004), or locally organized events. Thus, enabling mobile devices to dynamically self-organize in ad-hoc networks and communicate in a peer-to-peer fashion enables cost-effective data dissemination for a variety of environments and applications. Mobile nodes that are in the transmission range of each other can communicate with their peers directly. To communicate with peers outside a node’s transmission range, messages are propagated across multiple hops in the network.

The goal of this chapter is to study the problems of data dissemination and query routing in mobile peer-to-peer networks. We explore the synergy of mobility and peer-to-peer, focusing on the aforementioned problems. We identify the challenges introduced by mobility. We survey existing approaches and identify their shortcomings. Finally, we explore promising data dissemination and query routing solutions and evaluate their performance and overhead experimentally.

Delivering data to interested users in an efficient manner in a mobile environment challenges existing peer-to-peer solutions for wireline networks due to several reasons: First, peers have limited bandwidth and energy, which restrains the message overhead allowed for data dissemination protocols. Second, peer connections are transient, due to the frequent movement of the mobile nodes. This makes it costly to maintain an overlay topology on top of the underlying network topology, which is the way wired peer-to-peer networks are built, and to keep up-to-date routing information. The performance of wired peer-to-peer dissemination protocols would be further exacerbated in a mobile environment due to churn and network partitioning. Churn is introduced by peers frequently joining and leaving the network, while network partitioning is caused by node mobility.

The remaining of this chapter is organized as follows: The Survey of Existing Research section surveys existing solutions for data dissemination and query routing in mobile peer-to-peer networks, focusing on overlay topologies, query routing for data discovery, and data propagation. The Mobile Peer-to-Peer Data Dissemination and Query Routing section presents mechanisms for content-driven routing and adaptive data dissemination. The Experimental Study section describes an experimental study of the performance of data discovery and dissemination mechanisms. Finally, we present our conclusions and discuss avenues to future work.

SURVEY OF EXISTING RESEARCH

We extend our discussion of existing research in the area into three different directions: Topologies for organizing the network to facilitate peer interaction, query routing mechanisms for data discovery, and mechanisms for data propagation. Table 1 summarizes our taxonomy of the relevant literature.

Overlay Topology

Topologies like Distributed Hash Tables (DHTs) impose structure on wired peer-to-peer networks in order to improve data lookup times. Creating
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