Mobility Management in Wireless Networks - Data Replication Strategies and Applications

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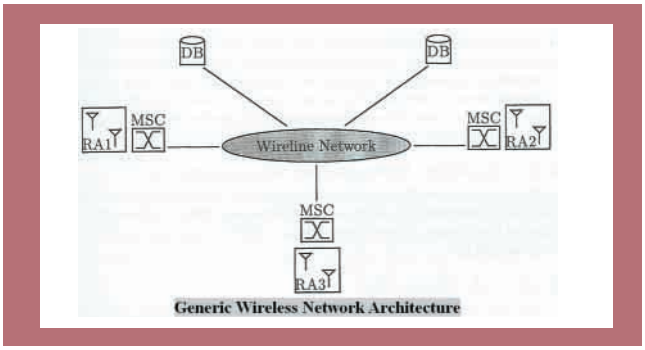
The advances in mobile communication continue to improve human's quality of life. Traditional mobile communication applications were in two-way voice communication, text emails and remote file downloading. The emerging applications in video streaming, sensor networking, telemedicine and surveillance are expected to dominate and shape the next generation of mobile communication systems. One critical feature that enables the ubiquitous communication is the mobility management - which is perceived to provide continuous constant quality of service even under very harsh and unexpected conditions.

Basic mobility management operations include location update as mobile units move around and location lookup as mobile units are wanted. The performance of mobility management techniques can be enhanced by using replicas of user profiles that are kept at various locations. The purpose of replication is to make profile information readily accessible and to reduce the lookup cost and latency. However, to keep these replicas consistent and up-to-date, they must be updated whenever necessary. It is hence worthwhile to replicate if benefit is greater than the overhead.

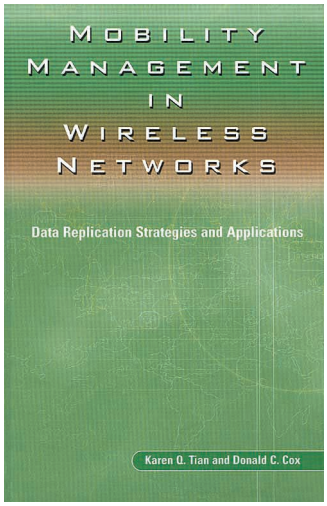
The text book Mobility Management in Wireless Networks by K. Q. Tian and D. C. Cox discusses various techniques to replicate the (mobile) user profiles and performs the comparative study of these techniques. Interestingly, the authors relate the profile replication problem to file allocation problem, and treat as such. With an introduction to mobility management problem including the wireless network architecture and concept of user profile in Chapter 2, authors proceed to discuss two commonly used techniques in mobility management, namely, the use of: location registers (home and visitor) and hierarchical structure. While delaying the answers to the question of "where should a replica of a user profile be kept?" to later chapters, the authors chose to address an architectural question first in Chapter 2. The hierarchical mobility management problem is discussed and solved first on a special type of network - the tree network and generalized later in the book. In order to reduce the number of database lookups, replica pointers are introduced - that avoids searching the hierarchy for the closest replica. Towards the end of the chapter, user profile replication is introduced and it is concluded that the performance of mobility management techniques can be improved by user profile replication.



Generic Wireless Network Architecture

Chapter 3 addresses the question of "where to keep the replicas?". In off-line replication approach, complete knowledge of user calling and mobility statistics are assumed apriori.

This chapter begins with a survey of replication algorithms for mobility management followed by a description of discrete location problem in tree networks. Minimum-cost maximum-flow replication algorithm and threshold-based replication algorithm are discussed. It is shown that the profile replication problem belongs to the family of file allocation problems computer scientists were researching. Discrete location theory originates from the study of the facility location problems in operations research. Recent algorithms in discrete location theory provided the efficient solutions of the file allocation problem on tree networks. The authors went on to develop an optimal off-line replication algorithm that minimizes network cost based on the network structure, communication link costs, user calling and mobility statistics. Optimal replication algorithms were developed for both unicast and multicast replica updates.



In on-line replication algorithm where no prior knowledge of traffic patterns are assumed, the replicas are managed with real-time data. Chapter 4 begins with a survey of the replication algorithms in the literature and then focuses on solving the replication problem on a single edge, followed by solving the replication problem on a tree. A unified framework for the on-line edge replication problem is developed using the offset transit diagram. By fitting previously proposed algorithms into the framework, the relationship between them is demonstrated. It was noted that, though both the tree-based algorithm and threshold-based algorithm follow the same principle, that is, if the benefit of replication is greater than the cost, their scope is quite different. In this chapter, optimal on-line replication algorithms are also developed that adjust the replica placement based on the user calling and mobility patterns. Finally, implementation issues related to on-line replication are discussed.

Chapter 5 was devoted to the demonstration of the performance of off-line and on-line replication algorithms introduced in Chapters 3 and 4 respectively. Extensive computer simulations were performed using realistic traffic models, that confirmed the proposed tree-based off-line and on-line replication algorithms outperform the previously proposed threshold-based algorithm. In particular, the proposed algorithms incur smaller network cost and enable more lookups to be resolved locally than the threshold-based algorithm.

A rich set of references is provided in the book which can serve as a useful tool for any one interested in embarking on advanced studies, research or design in the mobility management particularly in wireless networks. In each chapter, the authors survey the related work - which gives specific references to the problem at hand. The book will be very useful to graduate students in electrical engineering, computer engineering, computer science and industrial engineering disciplines to do advanced study on the mobility management techniques.

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