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Chapter VI

Modeling and Management of Location and Mobility

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Abstract

Location modeling represents inclusive mobile objects and their relationship in space, dealing with how to describe a mobile object's location. The goal of mobility modeling, on the other hand, is to predict or statistically estimate the movement of mobile objects. With the increasing demand for multimedia applications, location-aware services, and system capacity, many recognize that modeling and management of location and mobility is becoming critical to locating mobile objects in wireless information networks. Mobility modeling and location management strongly influence the design and performance of wireless networks in many aspects, such as routing, network planning, handoff, call admission control, and so forth. In this chapter, we present a comprehensive survey of mobility and location models, and schemes used for location-mobility management in cellular and ad hoc networks, which are discussed along with necessary, but understandable, formulation, analysis, and discussions.

Introduction

One of the most salient features of wireless communications is that users can deploy a variety of wireless devices to communicate with others regardless of their location. While mobility support provides flexibility and convenience, it introduces many challenging issues in network design, planning, and performance evaluation. With the increasing demand for multimedia applications, location-aware services, and system capacity, many recognize that modeling and management of location and mobility is becoming critical to locating mobile objects in wireless information networks. Mobility modeling and location management strongly influence the choice and performance of mobility and resource management algorithms, such as routing, handoff, and call admission control, in a variety of wireless networks. For these reasons, it is important to understand mobility modeling and location management mechanisms, and the manner in which these mechanisms depend on the characteristics of the network and mobile environments. This chapter is concerned with issues in, and methods for, mobility modeling, location management, and applications in wireless wide-area networks (WWAN), wireless local-area networks (WLAN), and ad hoc networks.

The movement pattern of users plays an important role in system design, network management, and performance analysis of mobile and wireless networks. Therefore, the objective of mobility modeling is to estimate the current and future locations of a mobile user upon the arrival of a connection request, which involves many parameters such as moving speed, call duration time, distance between the last known position and destination, and geographical conditions. Management of location, however, deals with the problem of how to register or update the new location of a mobile user with the system, and how to locate a mobile terminal given the information in system databases. Location modeling represents inclusive mobile objects and their relationship in space. In other words, location modeling deals with how to describe a mobile object's location, which is, in turn, related to mobility modeling since the goal of mobility modeling is to predict or statistically estimate the location of mobile objects.

The location of a mobile object can be modeled or described by different methods depending on the network infrastructure. In cellular networks, a base station serves as an access point in delivering radio services. Since each base station covers one cell in cellular networks, the location of a mobile object is limited to one cell throughout a wireless system. That means, as long as we know in which cell a mobile stays, its location is determined in terms of a cell. Inside a cell, determining the exact positions of mobile nodes rather than finding the residing cell is considered a *geolocation* problem. This is similar to the localization problem in WLANs and ad hoc networks in which the location of mobiles cannot be represented by the cell in which a mobile stays. In wireless ad hoc networks, mobile nodes communicate with each other directly rather than through base stations as in cellular networks. Since each mobile node has a very limited transmission range, communications between any two nodes, which are not within the other's coverage, can only be accomplished through intermediate nodes with routing functions. Therefore, routing is very important in ad hoc networks because the communication of mobile objects relies on routing paths, where mobility models must be considered in