Chapter 21

Mobility Prediction in Mobile Ad-Hoc Networks

Damianos Gavalas
University of the Aegean, Greece

Charalampos Konstantopoulos
University of Piraeus, Greece

Basilis Mamalis
Technological Educational Institution of Athens, Greece

Grammati Pantziou
Technological Educational Institution of Athens, Greece

ABSTRACT

A Mobile Ad hoc NETwork (MANET) is a collection of wireless mobile nodes forming a network without using any existing infrastructure. All mobile nodes function as mobile routers that discover and maintain routes to other mobile nodes of the network and therefore, can be connected dynamically in an arbitrary manner. The mobility attribute of MANETs is a very significant one. The mobile nodes may follow different mobility patterns that may affect connectivity, and in turn protocol mechanisms and performance. Mobility prediction may positively affect the service-oriented aspects as well as the application-oriented aspects of ad hoc networking. At the network level, accurate node mobility prediction may be critical to tasks such as call admission control, reservation of network resources, pre-configuration of services and QoS provisioning. At the application level, user mobility prediction in combination with user’s profile may provide the user with enhanced location-based wireless services, such as route guidance, local traffic information and on-line advertising. In this chapter we present the most important mobility prediction schemes for MANETs in the literature, focusing on their main design principles and characteristics.

INTRODUCTION

Mobile ad hoc networks are self-organizing and self-configuring multi-hop wireless networks capable of adaptive re-configuration when they are affected by node mobility. A mobile ad hoc network is composed of peer nodes with equal networking capabilities which are able to function as mobile routers i.e., to forward packets and maintain routes.
Packets can be forwarded in multi-hops from the source nodes to the destination nodes with no need for underlying fixed network infrastructure (e.g., routers and base stations). Therefore, mobile ad hoc networks are not constrained in their deployment by any need for underlying infrastructure and they can be deployed rapidly in situations where wireless access to a backbone is impossible and an infrastructure is difficult to install (e.g., disaster recovery). In addition to the traditional problems of wireless networks (bandwidth optimization and transmission quality enhancement) mobile ad hoc networks introduce new issues such as ad-hoc addressing, increased energy constraints, self-configuration and adaptive reconfiguration, as network topology is affected by node mobility. Furthermore, because of the real-time nature of ad hoc network applications (e.g., collaborative mobile computing, battlefield communications, emergency search and rescue operations, disaster recovery), data traffic is routed under timing constraints requiring proactive route construction and maintenance procedures.

Mobility prediction may positively affect the service-oriented aspects (network level) of ad hoc networking as well as the application-oriented aspects (application level). At the network level, accurate mobility prediction may be critical to tasks such as call admission control, congestion control, reservation of network resources, pre-configuration of services and QoS provisioning. At the application level, user mobility prediction in combination with user’s profile may provide the user with enhanced location-based wireless services, such as route guidance, local traffic information, tourism services, on-line advertising, etc. Given that 4G and beyond wireless ad hoc and hybrid networks will support real-time multimedia applications, the need for mobility prediction is of great significance.

Because of the importance of mobility prediction in ad hoc networks, there is a significant amount of research work on the topic, while in some cases the proposed techniques follow ideas or approaches used in fixed infrastructure type networks. However, prediction approaches for fixed infrastructure type networks are usually inappropriate in the case of ad hoc networks since: (1) Mobility prediction in fixed wireless networks is based on the use of a static underlying network infrastructure, while in ad hoc networks mobility prediction must be done in a highly dynamic environment, where the network topology is changing and the mobility of other nodes should be taken into consideration. (2) Ad hoc networks are usually applied in emergency operations and military environments, where future node movements cannot be based on a record of previous movements because of the dissimilar requirements of each situation. (3) Since mobility prediction methods for ad hoc networks are executed on the mobile nodes, they should be more light-weight than the methods for fixed wireless networks, typically executed on the base stations.

In this chapter we shall present the most important mobility prediction schemes for mobile ad hoc networks in the literature, focusing on their main design principles and characteristics.

BACKGROUND

Wireless mobile networks can be classified as infrastructure-based networks and ad hoc networks. The former type includes networks with fixed base stations and each mobile node connects to the network by communicating with a base station which is within its communication range. A Mobile Ad hoc NETwork (MANET) is a collection of wireless mobile nodes forming a network without using any existing infrastructure. All mobile nodes function as mobile routers that discover and maintain routes to other mobile nodes of the network and therefore, can be connected dynamically in an arbitrary manner. Therefore, a MANET is self-organized i.e., it is deployed and managed independently of any preexisting infrastructure, while it autonomously determines
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