Chapter 1

Mobility Prediction and Mobile–aware Routing Protocols in MANETs

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ABSTRACT

Ad hoc wireless networks comprise of mobile devices that use wireless transmission for communication without the need for a pre-existing infrastructure. One of the main characteristics of ad hoc networks is that they are self-organizing, which necessitates that all networking functions be performed by the nodes themselves. When designing mobile ad hoc networks, several challenges arise due to the shared nature of the wireless medium, limited transmission range of wireless devices, and node mobility. Node mobility poses a greater challenge as it makes routes more prone to frequent ruptures, which in turn degrades the overall network performance. If the future movement of the node can be predicted in a precise way, the impact of mobility can be decreased, and the overall performance of the network can be improved. This chapter provides an introduction and a critical review on some of the existing mobility prediction models and their effect on the performance of existing routing protocols.

1. INTRODUCTION

A mobile ad hoc network (MANET) is a self-configurable network of mobile nodes that are connected through wireless links without a pre-defined infrastructure. Every node in the network is capable of functioning as a mobile router, which facilitates the multi-hop forwarding of packets from a source node to a destination node. The objective of this network architecture is to achieve increased flexibility, mobility and ease of management compared to wireless networks with fixed infrastructure (McDonald & Znati,
1999). However, the multi-hop nature and the lack of infrastructure in MANETs pose a number of challenges on the design of routing protocols and the supported applications. Since all the nodes can move freely anytime, the network topology is highly dynamic and random. As a result, traditional routing protocols designed to operate in networks with fixed infrastructure exhibit poor behavior and incur large overhead when operating in MANETs. The main reason for mobility to impact the performance of routing protocols is due to its impact on the average link duration between two nodes which in turn affects the path duration. Vehicular ad hoc networks (VANETs) are emerging within the realm of intelligent transportation systems and many of the concepts and discussions related to MANETs can be readily applied to the VANETs, however with appropriate considerations for relatively higher speed, existing smart control and communication entities and relatively predictable movement directions in VANET infrastructure. In this chapter, some of the mobility prediction technologies are reviewed and discussed.

BACKGROUND

Most of the research in MANETs is simulation-based with performance evaluation done under varying conditions. These simulations have several parameters such as user traffic and radio communication pattern, mobility model, propagation model, etc. The mobility model has a major impact on the link and route lifetime distribution which in turn impacts the protocol and application performance. Several mobility models have been proposed in the literature to provide better understanding and quantify mathematically the mobility of the ad hoc network nodes (Sadagopan, Bai, Krishnamachari & Helmy, 2003). One of the motivations behind the mobility models is the potential of mobility prediction. Knowing deterministically or probabilistically helps make an informed decision. Various stochastic mobility models, such as the random waypoint or the random reference group mobility model, are used to study the impact of mobility on the link and route lifetime (Camp, Boleng & Davies, 2002).

Mobility prediction has been extensively used in cellular networks in handoff management and resource reservation. In MANETs, mobility prediction techniques can mitigate the problems emerging from their mobile nature and can be applied to design efficient routing protocols (Su, Lee & Gerla, 2001). The quest of mobility prediction in MANETs is to predict the link quality as a measure of the mobility state of a node (Farkas, Hossmann, Ruf & Plattner, 2006). A viable mobility prediction scheme should offer a high level of prediction accuracy with minimal control overhead.

MOBILITY PREDICTION PROBLEM

Mobility prediction in general is the problem of estimating the trajectory of future positions of the nodes in mobile networks. Mobility prediction in MANETs is used in location-aided routing and mobility-aware topology control protocols. Various mobility metrics have been proposed as a measure of the topological change in MANETs. Mobility prediction can also be used to improve routing protocol performance, to reduce routing overhead and to aid in proactive route reconstruction. The general assumptions made in the problem of mobility prediction are (Farkas et al. 2006):

- It is possible to observe the current mobility states of the node.
- The behavior of the nodes shows some mobility pattern.

However, there is an inherent difference between mobility prediction in cellular networks and MANETs due to the difference in the network structure and the behavior of the nodes. In cellular networks, the base station which is one end of the communication link between two nodes is fixed and resource reservation is done through the base