

Chapter 2

A Probabilistic Routing Protocol in VANET

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ABSTRACT

The key attribute that distinguishes Vehicular Ad hoc Networks (VANET) from Mobile Ad hoc Networks (MANET) is scale. While MANET networks involve up to one hundred nodes and are short lived, being deployed in support of special-purpose operations, VANET networks involve millions of vehicles on thousands of kilometers of highways and city streets. Being mission-driven, MANET mobility is inherently limited by the application at hand. In most MANET applications, mobility occurs at low speed. By contrast, VANET networks involve vehicles that move at high speed, often well beyond what is reasonable or legally stipulated. Given the scale of its mobility and number of actors involved, the topology of VANET is changing constantly and, as a result, both individual links and routing paths are inherently unstable. Motivated by this latter truism, the authors propose a probability model for link duration based on realistic vehicular dynamics and radio propagation assumptions. The paper illustrates how the proposed model can be incorporated in a routing protocol, which results in paths that are easier to construct and maintain. Extensive simulation results confirm that this probabilistic routing protocol results in more easily maintainable paths.

DOI: 10.4018/978-1-4666-0119-2.ch002

INTRODUCTION

The last few years have witnessed the rapid development of Intelligent Transportation Systems (ITS) and Vehicular Ad hoc NETWORKS (VANET) that promise to revolutionize the way we drive. In the not-so-distant future vehicles equipped with computing, communication and sensing capabilities will be organized into a ubiquitous and pervasive vehicular network that can provide numerous services to travelers, ranging from improved driving safety and comfort, to location-specific services, to delivering multimedia content on demand, and to other similar value-added service. Indeed, the fact of being networked together promotes car-to-car communications, even between cars that are tens of miles apart.

The short transmission range mandated by DSRC (Dedicated Short Range Communications) has as a natural corollary the fact that communications between vehicles are usually multihop. For example, consider a car that travels down an interstate and whose passengers are interested in viewing a particular movie. The various blocks of this movie happen to be available at various other cars on the interstate, often miles away. Cars in various lanes move at different speed, making the underlying network highly dynamic. In such a network, individual communication links are short-lived and the routing paths that rely on a multitude of such links are inherently unstable. The simplest routing strategy is blind flooding based. However, flooding-based routing is known to waste network resources, since each packet is transmitted multiple times, often unnecessarily. The “broadcast storm” that is resulted by flooding method has been shown to dramatically reduce network throughput. In an effort to reduce the effects of flooding, the past years have seen a flurry of well-deserved activity in the area of designing light-weight routing protocols in both MANET and VANET. A word of caution is in order here: due to their fundamental differences already

mentioned, routing algorithm devised specifically for MANET cannot be simply ported to VANET.

In support of routing over large distances, in addition to vehicle to vehicle communications VANET relies (or will rely in the near future) on pre-deployed roadside infrastructure that facilitate not only access to the Internet but, indeed, can also assist with the task of propagating packets between vehicles, even in sparse traffic. The roadside infrastructure relays or even buffers packets until a suitable vehicle is available to carry it further. In addition to roadside infrastructure, the geographic position of individual vehicles is used to optimize the routing process. Such a feature is enabled by the phenomenal proliferation of commercially-available GPS receivers that cost a few tens of dollars. Vehicles aware of their own geographic position as well of that of their neighbors can select a greedy/efficient routing path to forward packets. However, in spite of their intrinsic appeal, neither the infrastructure-based nor the geographic position based routing methods are perfect and there is a lot of room for improvement. One component that seems to be lacking is an understanding of the volatility of individual links in a routing paths.

With this in mind, the motivation of this paper is to provide a reliable routing scheme that takes into account the lifetime of individual links. Since mobility is one of the reasons that VANET differs so significantly from MANET, we analyze the relationship between key mobility parameters (signed velocity and acceleration) to build a novel probability model that can predict the lifetime (duration) individual communication links. Furthermore, we propose a probability model based on the mobility analysis. We believe that an understanding of the probability distribution of link duration is fundamental to describing the dynamics of vehicles communications. With such an understanding firmly in hand, one can select routing paths that are likely to be stable and are easier to maintain at both the local and global level.

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