



On Peer-to-Peer Location Management in Vehicular Ad Hoc Networks

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ABSTRACT

Vehicular ad-hoc networks (VANETs) have been gained importance for the inter-vehicle communication that supports local communication between vehicles without any expensive infrastructure and considerable configuration efforts. How to provide light-weight and scalable location management service which facilitates geographic routing in VANETs remains a fundamental issue. In this paper we will present a novel peer-to-peer location management protocol, called PLM, to provide location management service in VANETs. PLM makes use of high mobility in VANETs to disseminate vehicles' historical location information over the network. A vehicle is able to predict current location of other vehicles with Kalman filtering technique. Our theoretical analysis shows that PLM is able to achieve high location information availability with a low protocol overhead and latency. The simulation results indicate that PLM can provide fairly accurate location information with quite low communication overhead in VANETs.. [Article copies are available for purchase from InfoSci-on-Demand.com]

Keywords: Kalman Filter; Location Management; Peer-to-Peer; VANET

INTRODUCTION

Vehicular Ad-hoc Networks (VANETs) have received considerable attention in recent years due to its potential in supporting vast value-added and customized applications. By leveraging low cost and high bandwidth wireless interface

installed on each vehicle, a VANET can be deployed quickly and economically. It provides high data rates, and is more cost-effective than systems that need pre-installed infrastructures (e.g. cellular networks). Hence a wide-range of applications such as increasing road safety, providing passengers with business information and

entertainment, and improving traffic flow and efficiency on the roads, can be provided using VANETs as the communication infrastructure (Riva, O., Nadeem, T., Borcea, C., & Ifode, L., 2007; Morris, R., Jannotti, J., Kaashoek, F., Li, J., & Decouto, D., 2000; Dikaiakos, M., Florides, A., Nadeem, T., & Ifode, L., 2007; Festag, A., Fler, H., Hartenstein, H., Sarma, A., & Schmitz, R., 2004). Because of the short communication range of each network interface, multi-hop data transmission may be needed for end-to-end data delivery in VANETs. Recent study in multi-hop routing in VANETs (Zhao, J., & Cao, G., 2006; Mo, Z., Zhu, H., Makki, K., & Pissinou, N., 2006; Naumov, V., Baumann, R., & Gross, T., 2006; Sun, W., Yamaguchi, H., Yukimasa, K., & Kusumoto, S., 2000; Lochert, C., Hartenstein, H., Tian, J., Fler, H., Herrmann, D., & Mauve, M., 2003) has shown that, with the global position system (GPS) and digital map (e.g. Map Mechanics, 2005), geographic routing, in which data packets are forwarded from the source to the destination with the aid of nodes' location information, has high end-to-end packet delivery ratio, low end-to-end delay and low control overhead. In Zhao et. Al studied the carry-and-forward scheme, named VADD, which delivers packets in sparse VANETs where disconnection happens frequently. In Mo, Z. et. Al (2006) a multi-hop routing protocol, called MURU, was proposed to set up robust end-to-end path for urban VANETs. An advanced greedy forwarding (AFG) (Naumov, V., et. Al, 2006) based on GPSR was proposed to increase packet delivery ratio in VANETs. All these protocols assume an efficient location management service is available to provide the source node with the destination's location. Therefore, it is fundamentally important to design a good location management scheme in VANETs to support geographic routing and other location-based applications.

Up to date some location management schemes have been proposed in mobile wireless ad hoc networks (MANETs) (Li, J., Jannotti, J., Decouto, D., Karger, D., & Morris, R., 2000; Xue, Y., Li, B., & Nahrstedt, K., 2001; Kiess, W., Fler, H., Widmer, J., & Mauve, M., 2004;

Basagni, S., Chalamtac, I., Syrotiuk, V. R., & Woodward, B. A., 1998; Sasson, Y., Cavin, D., & Schiper, A., 2005) and most of them are grid-based. That is: they divide the network area into ordered grids and select location servers based on a particular grid mapping algorithm. As all these schemes adopt the client-server architecture, they usually involve two phases: location update and location query. In the location update process, mobile nodes periodically send their up-to-date location information to one or more location servers to update their locations. In the location query process, a node queries target node's location servers for target node's location information.

However, in a VANET where vehicles are highly dynamic, how to efficiently select proper location servers for a node turns out to be extremely difficult (if possible). Moreover, updating a node's location frequently and explicitly makes the client-server architecture inefficient in terms of communication overhead. Therefore an efficient location management protocol in VANETs should have the following characteristics. First, it is able to be adaptive to high mobility in VANETs. Second, since the diameter of a VANET can be large, the location management protocol should be scalable. To satisfy these two requirements, in this article we propose a novel location management protocol, called PLM (Peer-to-peer Location Management), which achieves the design goal by combining local information exchange and intelligent information processing technique. The basic idea of the PLM protocol is to disseminate a node's historical location information to other nodes in a peer-to-peer manner which does not require any pre-specified servers. By employing a carry-and-disseminate method, a node is able to disseminate its location information to other nodes far away from it through multi-relayed dissemination with the help of node mobility in VANETs. Then each node independently applies Kalman filter (Welch, G., & Bishop, G.) to process received location information. As a result, a node is able to predict other nodes' location information without querying location servers. An on-demand query method is also proposed

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