Navigation Route based Stable Connected Dominating Set for Vehicular Ad Hoc Networks

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ABSTRACT

Forming a virtual backbone has been always a significant technique for ad hoc networks to achieve high efficiency in various applications, including mobility management, broadcast based information dissemination, etc. This is especially true for Vehicular Ad Hoc Network (VANET), because most of VANET applications rely on broadcasting messages. Among others, constructing the Connected Dominating Set (CDS) is a popular approach to forming virtual backbone in ad hoc networks, including VANETs. Although quite a lot of work has been done on CDS algorithms for ad hoc networks, almost all existing algorithms focus on minimizing the size of CDS, i.e. the number of nodes in CDS. In this paper, the authors consider to improve the stability of CDS, i.e. to reduce the changes of CDS during the runtime of a VANET. By making use of vehicle navigation route, the authors propose a new metric to selecting CDS node with high stability. Then, based on the new metric the authors design a CDS algorithm, which can construct a CDS with higher stability than the CDS by existing algorithms. Such advantage is validated via extensive simulations.

Keywords: Connected Vehicle, Connected Dominating Set, Data Dissemination, Vehicular Ad Hoc Network, Vehicle Navigation

1. INTRODUCTION

Vehicular Ad hoc NETwork (VANET) (Hartenstein & Laberteaux, 2008) enables vehicles to communicate with other vehicles (V2V) or infrastructures (V2I) via wireless communications. VANETs can help drivers to acquire real-time information about road conditions, which is important for drivers to react on time. VANETs are attracting more and more attention all over the world. Applications of VANET range from driving support services, e.g. warning messages dissemination (Xu, Mark, Ko & Sengupta, 2007; Pandey, Garg & Gore, 2012)

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Due to the characteristics of VANET applications, broadcasting is the predominating communication mode in VANETs (Li, Wang, 2007; Willke, Tientrakool & Maxemchuk, 2009; Tseng, Ni, Chen & Sheu, 2002). To achieve high scalability and low communication cost, a virtual backbone is usually adopted in VANETs for broadcasting or other scenarios, including medium access control (Yvonne, Bernhard & Peter, 2007; Su & Zhang, 2007), packet routing (Li & Wang, 2007), broadcasting (Bononi & Felice, 2007), and other network services (Wu, Wang, Ben, Wang & Mohsen, 2012). Due to the challenge of high topology dynamicity (Yousefi, Mousavi & Fathy, 2006), how to construct a virtual backbone has been a hot topic in the research of VANETs for many years.

Among others, establishing a Connected Dominating Set (CDS) (Pricilla Rajakumari & Bhuvaneswari, 2013; Meghanathan & Terrell, 2012; Cha, Ryu, Kim & Jeon, 2013) has been widely used to cope with topology dynamicity in establishing backbone.

On the other hand, CDS formation in VANETs is not a trivial task due to the high dynamics of vehicle mobility. Although quite a number of CDS algorithms (Meghanathan & Terrell, 2012; Sheu, Tsai, Lee & Cheng, 2009; R. Ramalakshmi & S. Radhakrishnan, 2012; Ramalakshmi & Radhakrishnan, 2012) have been proposed for general ad hoc networks, CDS in VANETs is rarely studied (Meghanathan & Dasari, 2013). More importantly, almost all existing CDS algorithms focus on how to reduce the number of nodes in the CDS set. This is because the size of CDS will significantly affect the efficiency of upper layer broadcasting or other application protocols. Roughly, a smaller CDS set will save communication cost more than a larger one.

Differently, in this paper, we consider how to construct a stable CDS in VANETs. Due to topology changes or other dynamicity factors, the CDS of a VANET may need to be changed from time to time. A stable CDS may keep unchanged for a longer time than an unstable one, so that less cost is consumed for constructing and maintaining CDS.

To construct a stable CDS, we propose a new algorithm to select CDS nodes according to the navigation route information of vehicles. Nowadays, navigation systems based on GPS or alternative techniques have been very popular in vehicles. The driving route of a vehicle is usually planned by the navigation system when a vehicle starts. The route may also be changed during driving. Such a route obviously indicates the future movement path of the corresponding vehicle. Then, CDS can be determined based on such navigation route.

However, making use of navigation route in CDS formation is not a trivial task. The route information must be converted into a value of time so as to reflect the stability requirement. Since a route usually consists of several road segments, how to compare the routes of different vehicles and calculate their overlapping time is necessary but not easy. Also, the cost of route information exchange must be considered seriously. Different from simple data like position and speed, route data is more complex and larger. Although the route of a vehicle may not change frequently, vehicles need to exchange such information with respect to CDS changes. The overhead of route data exchange may require much wireless communication resources.

To address the issues above, we design a residual route time function, which quantitatively calculates the time during which two vehicles may keep to be neighbors. With this function, we design a metric to evaluate the priority of domination (being CDS nodes). Our metric also includes the number of neighbors as input, to guarantee the size of the CDS remaining small.

To examine the performance of our navigation route based CDS algorithm, we conduct extensive simulations using ns3. The vehicle mobility data are firstly generated by SUMO (SUMO, 2014) and then integrated with ns3. We also simulate traditional Minimum Connected Dominating Set (MCDS) algorithm for comparison purpose. The results show that, our
A Similarity Measure for Process Mining in Service Oriented Architecture
Joonsoo Bae, Ling Liu, James Caverlee, Liang-Jie Zhang and Hyerim Bae (2010). *Web Services Research for Emerging Applications: Discoveries and Trends* (pp. 87-103).
[www.igi-global.com/chapter/similarity-measure-process-mining-service/41519?camid=4v1a](www.igi-global.com/chapter/similarity-measure-process-mining-service/41519?camid=4v1a)

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