Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 52 (2015) 294 – 301

Procedia Computer Science

The 6th International Conference on Ambient Systems, Networks and Technologies (ANT 2015)

Cluster connectivity assurance metrics in vehicular ad hoc networks

Mohamed Aissa[a], Abdelfettah Belghith[b] *, Badia Bouhdid[c]

[a]*Universty of Nizwa, Nizwa, Sultanate of Oman*
[b]*College of Computer and Information Sciences, King Saud University, Saudi Arabia*
[c]*HANA Research Laboratory, Universty of Manouba, Tunisia*

Abstract

Many applications introduced by Vehicular Ad-Hoc Networks (VANETs), such as intelligent transportation and roadside advertisement, make VANETs become an important component of metropolitan area networks. In VANETs, mobile nodes are vehicles which are equipped with wireless antennas; and they can communicate with each other by wireless communication on ad-hoc mode or infrastructure mode. Clustering vehicles into different groups can introduce many advantages for VANETs as it can facilitate resource reuse and increase system capacity. The main contribution of our work is a new strategy for clustering a VANET and improvements in many classical clustering metrics. One of the main ideas is the definition of a new optimized selection metric for the clustering of vehicular nodes, in the framework of Next Generation Vehicular ad-hoc Network. These metrics should select clusterheads which provide safe clusters and avoid collisions with adjacent vehicle nodes and intend to create stable clusters by reducing reclustering overhead and prolonging cluster lifetime

Peer-review under responsibility of the Conference Program Chairs

Keywords: Vehicular ad hoc networks, clustering, cluster metrics

1. Introduction

In recent years, Vehicular Ad-Hoc Networks (VANETs) have presented an important field of research because they create many new applications such as dissemination of safety and traffic condition messages and control of

* Corresponding author. Tel.: +0-000-000-0000 ; fax: +0-000-000-0000 .
E-mail address: abelghith@ksu.edu.sa or abdelfettah.belghith@ieee.org

Peer-review under responsibility of the Conference Program Chairs
doi:10.1016/j.procs.2015.05.088

vehicle flow formations. The development and improvement of vehicular safety technologies can significantly reduce the accident rate and improve road safety. In a typical VANET, there are two types of wireless nodes, mobile units and roadside units[1]. Mobile units can be any kind of vehicles which are equipped with wireless antennas, such as buses, cars, trucks, etc. Roadside units are some fixed wireless nodes installed on the roadside, and these units can provide wireless connections to the Internet for mobile units[1]. Usually, roadside units are access points which are provided by Internet Service Providers (ISPs). As a result, there are two kinds of wireless communications in VANETs, vehicle to vehicle (V2V) communications and vehicle to infrastructure (V2I) communications. Using V2V communications, vehicles can communicate with other vehicles in ad-hoc mode; and vehicles can transmit emergency messages in this mode. Conversely, using V2I communications, vehicles can access the Internet and communicate with correspondent nodes through the Internet[1,18].

Clustering is a technique to group nodes into several clusters. Each node in the cluster structure plays one of three roles: Cluster Head (CH), Cluster Gateway (CG), and Cluster Member (CM)[2]. The CH in a cluster plays the roles as coordinator and backbone. It is in charge of all the communications inside a cluster, managing medium access and allocating the resource to cluster members[3]. A CG is a border node of a cluster that can communicate nodes belonging to different clusters[2].

The clustering scheme has been well investigated in wireless ad-hoc networks in recent years. However, considering the characteristic of VANETs, such as high speed, sufficient energy and etc., the clustering schemes proposed for conventional wireless ad-hoc networks are not suitable for VANETs[1]. Therefore, clustering schemes for VANETs should be designed specifically[1,18].

It is inevitable that the highly dynamic topology of VANETs will disturb cluster formation and re-organisation, increasing the cluster instability[4,16,17].For example, vehicles change their speeds and lanes rapidly and frequently[3]. The high-mobility nature of VANETs will bring huge computation overheads to vehicles when they use highest-degree algorithm to elect the CH. Therefore, a clustering algorithm must strive to maintain cluster stability and retain the cluster contents and structure for as long as possible, as otherwise, the frequent re-clustering processes will degrade the performance of communication[4]. The size of a cluster should be well controlled. In the case of a small cluster, the vehicle chosen as CH can rapidly leave the confines of the cluster, causing a recurrent algorithm of choosing new CH. In the case of a large cluster the vehicle chosen as CH stay there longer even though there might be another vehicle which could be more efficient as a CH. Therefore, it is of great importance that the cluster size should neither be too large nor too small.

Multi-hop clustering algorithms proposed for VANET[1] use the changes in the packet delivery delay to calculate the relative mobility between vehicles in multi-hop distance. However, calculating packet delivery delay requires very accurate synchronization among the vehicles, which is not feasible for such dynamic networks.

In[2], the authors have proposed a new clustering algorithm that considers both node position and node mobility in vehicular ad hoc environments. The proposed algorithm intends to create stable clusters by reducing reclustering overhead, prolonging cluster lifetime, and shortening the average distance between CHs and their cluster members. Most important, this algorithm supports single and multiple CHs. Simulation results show the superiority of the clustering algorithm over the other three well-known algorithms. Shortening average distance between CHs and their cluster members could generate collisions. Our contribution is to constraint this average distance.

In[4], the authors present a beacon-based clustering algorithm aimed at prolonging the cluster lifetime in VANETs. They use a new aggregate local mobility criterion to decide upon cluster re-organisation. The scheme incorporates a contention method to avoid triggering frequent re-organisations when two CHs encounter each other for a short period of time. However, nodes that have lost their cluster-head due to merging or mobility and cannot find nearby clusters to join, they will all become CHs almost at the same time. These nodes will take a period where they will decide as to who will be the new cluster-head.

A novel user-oriented Fuzzy Logic-based k-hop distributed clustering scheme for VANETs that takes into consideration the vehicle passenger preferences is proposed in[5]. The novelty element introduced is the employment of Fuzzy Logic as a prominent player in the clustering scheme.

In[6], the authors propose a distributed clustering algorithm which forms stable clusters based on force directed algorithms. They propose a mobility metric based on forces applied between nodes according to their current and their future position and their relative mobility. The force applied between the vehicles reflects the ratio of divergence or convergence among them.