Journal of Network and Computer Applications 34 (2011) 207–222

Contents lists available at ScienceDirect

Journal of Network and Computer Applications

journal homepage: www.elsevier.com/locate/jnca

VWCA: An efficient clustering algorithm in vehicular ad hoc networks

Ameneh Daeinabi [a], Akbar Ghaffar Pour Rahbar [a,*], Ahmad Khademzadeh [b]

[a] Computer Networks Research Lab, Department of Electrical Engineering, Sahand University of Technology, Tabriz, Iran
[b] Iran Telecommunication Research Center, Iran

ARTICLE INFO

Article history:
Received 25 June 2009
Received in revised form
21 July 2010
Accepted 26 July 2010

Keywords:
Vehicular ad hoc networks
Clustering
Dynamic transmission range
Connectivity
Monitoring
Attackers

ABSTRACT

Vehicular ad hoc networks (VANETs) are appropriate networks that can be used in intelligent transportation systems. Among challenges in VANET, scalability is a critical issue for a network designer. Clustering is one solution for the scalability problem and is vital for efficient resource consumption and load balancing in large scale networks. As our first algorithm, we propose a novel clustering algorithm, vehicular clustering based on the weighted clustering algorithm (VWCA) that takes into consideration the number of neighbors based on dynamic transmission range, the direction of vehicles, the entropy, and the distrust value parameters. These parameters can increase stability and connectivity and can reduce overhead in network. On the other hand, transmission range of a vehicle is important for forwarding and receiving messages. When a fixed transmission range mechanism is used in VANET, it is likely that vehicles are not located in the range of their neighbors. This is because of the high-rate topology changes and high variability in vehicles density. Thus, we propose an adaptive allocation of transmission range (AATR) technique as our second algorithm, where hello messages and density of traffic around vehicles are used to adaptively adjust the transmission range among them. Finally, we propose a monitoring of malicious vehicle (MMV) algorithm as our third algorithm to determine a distrust value for each vehicle used in the VWCA. The effectiveness of the proposed algorithms is illustrated in a highway scenario.

1. Introduction

Communication among vehicles is an important field of study for transportation systems. Vehicular ad hoc networks (VANETs) are appropriate networks that can be applied to intelligent transportation systems (Nadeem and shankar, 2006). VANET is based on short-range wireless communication among vehicles. VANETs are built on-the-fly and do not need any investment, except the wireless network interface that will be a standard feature in the next generation of vehicles. The Federal Communications Commission (US FCC) has allocated 75 MHz of spectrum in the 5.9 GHz band for the Dedicated Short Range Communication Standard (DSRC) for VANET communications. The purpose of DSRC is to enhance bandwidth and to reduce latency for vehicle-to-vehicle and vehicle-to-infrastructure communications (Abdulhamid et al., 2007).

Scalability is a critical issue among many challenges running for VANET technology. In practice, when a flat-topology network contains a large number of vehicles, a large percentage of limited wireless bandwidths should be used for the control of overhead such as routing packets. Without using dedicated communication hardware such as routers, the development of a hierarchical clustering system within the network is a possible method to optimize communication within the network (Fan et al., 2007). Clustering is vital for efficient resource consumption and load balancing in large scale networks. Routing based on clustering is appropriate for vehicular networks because vehicles may be formed as clusters in roads. The advantages of clustering can be summarized as follows (Liu et al., 2007): (1) clustering can facilitate the reuse of resources and then can improve the capacity of VANET, (2) clustering can decrease the amount of information that is used to store the network state, (3) the amount of routing information propagated in the network can be reduced in cluster-based routing, (4) a cluster-head (CH) can gather the status of its members and build an overview of its cluster condition, and (5) distant vehicles outside a cluster usually do not need to know the details of specific events occurring inside the cluster.

In clustering, vehicles are located inside clusters, where each cluster has one cluster-head, and one or more members. Vehicles that form a cluster are coordinated by the relevant cluster-head. Vehicles in one cluster communicate together directly, but vehicles that are located in two different clusters can communicate together via cluster-heads. Each vehicle can play three roles: cluster-head, gateway, and member. If one vehicle is located within two or more clusters, it is called a gateway.

* Corresponding author. Tel.: +98 411 5263374.
E-mail addresses: a_daeinabi@sut.ac.ir (A. Daeinabi), akbar_rahbar92@yahoo.com, ghaffarpour@sut.ac.ir (A.G. Pour Rahbar), zadeh@itrc.ac.ir (A. Khademzadeh).

1084-8045/$ - see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jnca.2010.07.016