Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 89 (2016) 271 – 282

Procedia Computer Science

Twelfth International Multi-Conference on Information Processing-2016 (IMCIP-2016)

Cognitive Radio Assisted OLSR routing for Vehicular Sensor Networks

Thompson Stephan* and K. Suresh Joseph

Pondicherry University, Pondicherry, India

Abstract

Vehicular Sensor Network (VSN) emerged due to recent developments in Wireless Sensor Network (WSN) and functioning as a way for observing metropolitan environments and enabling vehicles to share relevant sensor data to assist safety, convenience and commercial applications. Data dissemination is an important aspect of these networks and requires timely delivery of important sensor information. In VSNs, rapid mobility of the vehicles causes recurrent topography modifications. The possibility of on-demand protocols that makes routing decisions reactively in Vehicular Networks are restricted owing to its structural instability and current routing protocols, operating in a table-driven fashion like OLSR are unable to cope up with the high demands imposed by vehicular applications. Furthermore, sensor data transmissions are accompanied by rapid fluctuations in the convention of licensed spectrum and acquire more number of channels to transmit huge bandwidth data and result in spectrum scarcity. Existing works on OLSR protocol failed to examine spectrum conditions and calculate utilization of channel. Cognitive Radio (CR) is a possible solution for guiding OLSR to discover unused frequency bands and utilize them opportunistically. This paper presents an optimal OLSR routing for efficient data communication using Cognitive Radio enabled Vehicular Sensor Networks (CR-VSNs). The proposed model was tested under simulated traffic of Chennai urban road map. Delay is observed to be minimal for data communications in CR-VSN.

Peer-review under responsibility of organizing committee of the Organizing Committee of IMCIP-2016

Keywords: Channel Assignment; Cognitive Radio; Link Stability; Optimized Link State Routing; Vehicular Sensor Networks.

1. Introduction

In recent years, Vehicular Sensor network (VSN) has drawn people's interest with its ability to provide inter-vehicular communications, and communication between roadside sensors and the vehicles. Sensors are installed along the roadside to gather environmental data such as urban road conditions (e.g. vehicular traffic, crowd density), air quality monitoring and transmit the observed data to the vehicles which fall inside the data transmission range of the sensor node or route the information to appropriate sink nodes. During such data transmissions, massive channel utilization tends to amplify the data traffic load to higher numbers. Cognitive Radio (CR) alleviates the issue of channel scarcity and provide as a backbone for high bandwidth communication in VSNs. The CR enabled vehicles are used as data forwarders to forward sensed information to their corresponding neighbor vehicles by accessing the spectrum holes that constitute unused channels. Major issue arises due to high mobile nature of the vehicles in VSNs

*Corresponding author. Tel: +91 9789924306.
E-mail address: thompsonexplore@gmail.com

Peer-review under responsibility of organizing committee of the Organizing Committee of IMCIP-2016
doi:10.1016/j.procs.2016.06.058

which heavily affects the Packet Delivery Ratio (PDR) by dropping huge number of packets due to constant topology change of the network. Due to recurrent topology change and frequent detachment of neighbor links makes it hard to model a capable routing protocol for forwarding data to neighboring vehicles. The majority of the routing solutions proposed in the literature for WSNs are not suitable for VSNs because of rapidly varying wireless links between nodes and faces challenges in maintaining routing path due to vehicle mobility. However, energy is not a primary concern for VSNs since vehicles carry large capacity batteries unlike conventional WSNs that constitute low-cost devices. Therefore, maximizing the utilization of VSNs[12] and[13] can be accomplished by searching good routing algorithm among those proposed for VANETs. The classification of routing protocols in Vehicular networks fall into two categories, namely topology based and position based. This research attempt targets the dynamic nature of VSN topology and hence will focus on topology based routing protocol which are divided into proactive and reactive. Reactive routing protocols have failed to cope up with highly dynamic nature of vehicular network because the delay in finding appropriate route is very high because of its reactive nature and thus unfit for VSNs. The majority of routing mechanisms in Vehicular networks most likely rely on table-driven proactive protocols instead of on-demand reactive protocols since proactive routing could cope with the rapid mobility which leads to frequent network partitions and reduces delay in finding the next best link in case of link failure. Optimized Link State Routing protocol (OLSR) which is a traditional ad hoc routing protocol comes as the first choice proactive routing protocol because of its capability to display low latency and enhance delivery ratio of packets in frequently changing topology. Though, the current optimizations of OLSR does not consider channel load as a metric in calculating routing paths because of its inability to detect spectrum conditions and has suffered from frequent path breaks. Bandwidth utilization has tremendously increased in recent years due to high vehicle mass and resulted in intense competition for channel access. OLSR is still finding ways to conquer the channel insufficiency problems and the quickly varying spectrum conditions comes as an additional overhead in finding alternate paths. CR is a promising solution to handle channel scarcity problems and efficiently manage spectrum utilization in vehicular transmissions. CR senses the wireless spectrum licenses to primary users (PUs) and identifies unused channels which we refer to as spectrum holes. During data communication, secondary users (SUs) are allowed to acquire the unused portion of spectrum for transmission without causing any interference to PU activities. The vehicles enabled with CR could utilize the idle channels to forward data among its neighbor vehicles for sensor data communication. This would enable high bandwidth communication, which further reduces the delay of sensor information to reach the sink node and thus allows them to respond quickly. Thus, OLSR assisted CR-VSN is allowed with legal spectrum access and the difficulty of OLSR to calculate dynamic routing paths considering varying spectrum conditions are resolved. The channels allotted for IEEE 802.11p standard that supports inter-vehicle data transmission in VSN are inadequate to satisfy the growing demands of VSN applications. Hence to reduce channel contention, there is requirement to increase channel availability to improve high speed dependable data communication.

The cognition ability to OLSR is given by CR for dynamic optimal channel selection and allocation among available idle channels. Rapid mobility of nodes results in repeated spectrum fluctuations that further increase the complexity of allocating the best channel among available multiple channels from PUs to SUs. Hence, the challenge is to model OLSR routing protocol to efficiently manage spectrum allocation that helps reduce the routing delay. The following issues related to vehicular routing are addressed by this research paper:

- Frequent routing path breakages due to highly dynamic topology have resulted in minimal connectivity time of the vehicular links and lead to unstable paths from source vehicle to destination vehicle. Importantly, vehicles travelling in opposite directions will have very less connectivity time and hence appropriate mechanisms must be in place to enhance the transmission time of two communicating vehicles.
- OLSR suffers from channel scarcity problem caused by inadequate channels due to vehicle mass and high mobility of vehicles and results in frequent link disconnections. Suitable channel allocation techniques must be deployed in OLSR routing to find next best hop with improved link transmission time.

2. Related Works

To efficiently propagate multi-hop information in VSNs, literature survey explores both OLSR routing and CR assisted routing mechanisms in vehicular networks. Although certain routing techniques having different forwarding