Chapter 7
An Adaptive Fuzzy-Based Service-Oriented Approach with QoS Support for Vehicular Ad Hoc Networks

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ABSTRACT

An attempt in implementing on-demand, QoS supported Vehicular Ad hoc Network (VANET) routing algorithms has taken new dimensions. Delivering information in time to achieve reliability across vehicles (nodes) is still being a challenge among the VANET research groups. An effort to develop a QoS adaptive routing schemes using soft computing techniques is made in this research work. SADVA – An adaptive fuzzy based QoS service oriented approach for VANET is presented in this paper. The performance of SADVA is compared with AODV (Perkins, Royer, & Das, 2003), GV-GRID (Li, & Yu, 2007), DSR (Johnson, Maltz, & Hu, 2004), FSR (Gerla, 2002), DYMO (Chakeres, & Perkins, 2006), REDEM (Prabhakar, Sivanandham, & Arunkumar, 2011b), and QARS (Prabhakar et al, 2011a). SADVA employs fuzzy logic system to determine the vehicle's speed over an effective time period for different types of service in use between multiple VANET nodes to engage or cooperate in communication. This chapter focuses on designing and developing QoS aware routing protocol for multi-hop VANET. Metrics such as number of packets received per second, percentage of packet loss and time for route establishment are used to analyse the network situation. Simulation test runs are carried out using Two Ray Ground propagation model where vehicular traffic is generated according to a Poisson process.

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INTRODUCTION

Vehicular ad hoc networks (VANETs) are self-organizing networks and self-manageable, where the data or information can be organized in a distributed fashion without any centralized authority (a predefined infrastructure) using 802.11-based WLAN technology. A VANET can be assumed as an integration of multiple wireless/mobile networking technologies such as WiFi IEEE 802.11, WiMAX 802.16, Bluetooth, IRA, ZigBee for providing an effective communication between vehicles on dynamic mobility.

VANET helps to incorporate safety measures in vehicles, and also supports streaming communication between vehicles, infotainment and telematics. Road Side Units (RSU) are gateways either fixed or minimal in mobility on the road sides, to provide interim connectivity to vehicles. Hence the vehicles and road side units form a vehicular ad hoc network. VANET has recently received considerable attention in the automotive sector, VIC'S (Chen, Lin, & Lee, 2010), CarTALK 2000 (Cartalk, 2011), NOW (NoW, 2010), (Torrent, 2008) and different industry groups (C2C-CC, 2011).

Reliability and timely information delivery are key objectives in VANETs, which bring QoS into the picture. Extensive research has been carried out to implement QoS support for on-demand multi-service routing algorithms for VANETs. Providing optimal QoS for a specific period of time with varying number of nodes (vehicles) is the biggest challenge for the VANET research groups. This research work addresses the importance of providing optimal QoS for multimedia applications in VANET as well as, in assessing the validity of the vehicle-to-vehicle and vehicle-to-interface communication scheme for effective QoS.

It has been understood that, in VANET communications, the key component is the movement pattern of vehicles, also called the mobility model. Mobility models determine the location and speed of nodes in the topology at any given instant, which in-turn strongly affect network connectivity and throughput.

Few of the mobility models being used from ns-2 simulator (NS2, 2010) are Manhattan Grid model (Baghavan, & Barghavan, 1997), and Random Waypoint Model (Bianchi, 2000). An accurate analysis outcome requires a good mobility model that has captured all the aspects of mobility as explained in (Bechler, Storz, & Franz, 2003; Briesmeister & Hommel, 2000a). Another challenging issue in VANETs is congestion control (Blum, Eskandarian & Hoffmann, 2004). In case of congestion, normally the end-points detect overload conditions at intermediate nodes and reduce its data rate.

In VANETs, the topology changes within seconds and a congested node used for forwarding just a few seconds ago, might not be used at all at the point in time when the source reacts to the congestion. Broadcasting in a wireless network suffers from a number of drawbacks (Namboodiri & Gao, 2007). If multiple nodes transmit at the same time, they cause destructive interference. This is known as a collision of the two messages at the given receiver. In order to avoid collision, each node needs to retransmit/broadcast information with a random delay. In spite of this random delay, collisions still occur, and this may result in a portion of the network not receiving a certain broadcast message.

Communication in VANETs can be either done directly between vehicles as one-hop communication, or vehicles can retransmit messages, thereby enabling the so called multi-hop communication. In order to increase coverage or robustness of communication, relays at the roadside can be deployed (Yousefi, Mousavi & Fathy, 2006). Since the nodes are highly mobile, data transmission is less reliable and sub optimal: