Chapter 8
Evaluation of the LORA–CBF Routing Algorithm with Selective Gateway in an Ad Hoc WiMAX Network

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ABSTRACT
Vehicular Ad-Hoc Networks (VANETs) are characterized by their high mobility, where wireless links between vehicles unpredictably can change. This mobility makes it very challenging to establish and maintain a communication link in vehicular networks; therefore, networking in these kinds of networks has become a very intense area of study. Consequently, research of ad hoc routing and medium access control strategies has become an intensive part of current study. The research community has expressed considerable interest in introducing WiMAX as medium access technology and geographic strategies for routing algorithms. This work presents an evaluation of the LORA-CBF geographic routing algorithm that permits seamless communication in an ad-hoc WiMAX network.

INTRODUCTION
Vehicles are an important tool in everyday life. In fact, in major cities, people spend an important part of each day in their vehicles, either driving or stuck in traffic jams. Today, there are many existing technologies designed to make vehicular road travel safer, easier and more enjoyable (e.g. geographical positioning system, proximity sensors, multimedia communication). Despite these advances, however, the impact of these devices in the areas of comfort and safety is somewhat limited because the information gathered by
these cannot be share among vehicles, due to a lack of network connectivity. Therefore, the great challenge for these kinds of networks is to meet the issues placed on both the medium access and routing algorithms.

In order to share data more effectively and dynamically in applications, thus improving passenger safety, convenience, and comfort, protocols and network devices must provide both timely and reliable data transfer among vehicles. Deploying network devices in vehicular scenarios represents a huge technical challenge that involves every layer of the communication model; however, this is particularly important for the lowest three layers (i.e. physical, medium access and network). This is primarily due to the highly dynamic network environment, characterized by the constant entry and exit of nodes, and the difficulty of handling highly dense vehicular networks (Aquino, Gonzalez, Villaseñor, & Crespo, 2009; Aquino, Gonzalez & Villaseñor, 2008; Aquino, Rangel & Edwards, 2008; Aquino & Edwards, 2006).

According to Briesemeister, Schäfers & Hommel, (2000), the highly dynamic nature and multiple demands imposed on vehicular networks means that participating nodes must:

- Have radio transceiver technology that provides omni-directional coverage
- Be capable of rapid vehicle-to-vehicle communications to keep track of dynamic topology changes
- Possess highly efficient routing algorithms that fully exploit network bandwidth.

However, unlike other scenarios, nodes in vehicular networks undergo constant and rapid change. In conventional networks, nodes can move slowly or even be static, however, in vehicular scenarios, the network topology can change in a fraction of a second. For example a car accident can turn a highway scenario where vehicles are free to move from lane to lane at speeds exceeding 90km/h to a city scenario where travel speeds can be extremely restricted and movement between lanes is impossible.

This chapter presents the challenges of incorporating WiMAX and geographic routing (i.e. LORA-CBF) in vehicle-to-vehicle multi-hop networks. We believe that a mixture of geographic routing algorithm that is supported by a WiMAX layer can outperform proposals explored until now in vehicle-to-vehicle networks.

This chapter also compares Ad hoc On-demand Distance Vector (AODV) and Location Routing Algorithm with cluster based flooding (LORA-CBF) in a static, dense scenario in WiMAX-mesh mode as the first step in order to develop a fully mobile communication subsystem.

The rest of this chapter is organized as follows, Section 2 is an overview of the literature of VANETs and WiMAX related proposals as well as a brief review of routing protocols in VANETs, Section 3 presents LORA-CBF algorithm, in Section 4 the simulation setup is described, Section 5 shows the analysis of the gathered results and finally in Section 6 the chapter conclude.

LITERATURE REVIEW

Multi-Hop Vehicular Networks under WiMAX

Numerous researchers have worked to overcome issues related to vehicular communications (e.g. Brown, Cullen, Brackstone, Gunton & McDonald, 2000; Rajamani & Shladover, 2001; Varaiya, 1993; Yang, Liu & Zhao, 2004; Yin, et al. 2004; Car2car Communication Consortium, 2010; Communication for eSaftey, 2010; SAFESPOT Integrated Project, 2010). In 2004, the IEEE group created the IEEE 802.11p (WAVE) task force; the workforce established a new standard that essentially employs the same PHY layer of the IEEE 802.11a standard, but uses the 10 MHz bandwidth channel instead of the 20 MHz bandwidth of IEEE 802.11a. With respect to the MAC layer, WAVE is based on a