Chapter 15
Adaptive Solutions in Multihop Communication Protocols for Vehicular Ad Hoc Networks

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ABSTRACT
The potential for vehicular applications is rapidly increasing. However this variety also demands a flexible multihop communication protocol supporting different communications needs and adapting to the network environment and to context elements specified by the application itself. We think that adaptive solutions, recently starting to be applied to VANET routing and dissemination protocols, have a great potential for solving the problems stated above. The objective of this chapter is to introduce the reader to these kinds of solutions, show their benefits and also mention the challenges involved. Because one important aspect of adaptive solutions (in this case a common communication protocol for all applications), is having in-depth knowledge of the problem to solve, we first review these different vehicular applications and their classification, followed by their communication needs.

INTRODUCTION
Starting with the idea of providing safer driving by using inter-vehicle communication, the concept of vehicular ad hoc networks (VANETs) has been extended to support various applications, which can benefit from wireless short range communication (e.g. IEEE 802.11 standards) between vehicles.

Today, VANET applications range from simple exchanges of data describing the vehicle status, to highly complex, large-scale traffic management including the integration of fixed infrastructure. This diversity goes from active safety applications that are necessary life-saving applications like local danger and emergency braking warnings, to traf-
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Traffic and parking applications that are less critical but can add value to a future installed VANET. In their core functionality, all these applications have one thing in common: the need for a communication (routing or dissemination) protocol to deliver relevant information (e.g., available parking space, traffic conditions, etc.) to potentially interested drivers.

Together, all these potential applications will help promote the adoption of a real world VANET technology. However, this is not an easy task due to the diversity of communications needs by the applications, and, also the very dynamic network conditions specific to VANET environments complicate the design of adequate multihop solutions. This is why we strongly suggest that, for a Network Layer communication protocol for VANET applications dealing with the requirements stated above, important modules of the protocol has to support adaptive solutions or adaptable characteristics.

The goal of this chapter is to explore more in depth the use of adaptive solutions in the design of a communication protocol for VANETs. More precisely, we aim to introduce the reader to the benefits of choosing adaptive proposals and talk about the advantages and challenges of choosing an adaptive solution, and suggest further steps to design such adaptive protocols.

The rest of this chapter is organized as follows. In section 2, we introduce some applications relying on VANETs and discuss different classifications which have been proposed. In section 3, we describe the wide variety of communications protocols used by the applications introduced in section 2. In section 4, we motivate the need of adaptation in the construction of communication protocols to bring VANET applications to the real world. Then, in section 5, we introduce adaptive solutions and show the state of the art of these solutions in dynamic networks like VANETs, after we highlight the challenges to address to design such an adaptive protocol supporting the constraints imposed by the VANET environment. Section 6 ends the chapter with some concluding remarks.

VEHICULAR NETWORKS APPLICATIONS AND DIFFERENT CLASSIFICATIONS

A major requirement in order to propose good adaptive solutions is first to know the environment in which the adaptation will occur. In the case of multihop communication protocols for VANETs, it is imperative to have a general view of all the applications that will use the protocol in the upper layer, know their characteristics and synthesize their communications needs. That is why as a first step, this section illustrates the vehicular applications envisioned by the research community.

The original motivation behind vehicular communications was to improve safety on the roads, as many lives have been lost and much more injuries have been incurred due to car crashes. A driver seeing the brake lights on the car in front of her has only a few seconds to react. Moreover, even if she responded in time, cars behind her could also crash since they were not warned of what was happening in front of them. This has motivated one of the first applications for vehicular communications, namely cooperative collision warning, which relies on vehicle-to-vehicle (V2V) communication. From here on, other safety applications emerged more recently, such as applications that aim at providing drivers with real-time information about traffic conditions.

To better contrast the differences and similarities between the applications envisioned in this kind of networks, instead of listing all these applications specifically one by one, a better approach is to illustrate how they are classified in the literature and how this classification is evolving with the introduction of more potential applications.