Chapter 5

Information Sharing in VANETs

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ABSTRACT

This chapter looks at a vehicular ad hoc network (VANET) as a peer-to-peer network, where mobile users may request information contents as well as provide them to other nodes, and it addresses the major technical issues that emerge when dealing with information sharing in VANETs. After briefly reviewing some proposals appeared in the literature on application and network protocols for data exchange in VANETs, the chapter focuses on a possible application for data sharing between vehicular users, which exploits the pull-based approach. It then highlights the main challenges in such a scenario and introduces some mechanisms that can be applied to solve two major issues in content sharing: content query propagation and content caching. A comparison among the schemes presented for query propagation, as well as between the mechanisms introduced for data caching, is shown through simulation results derived using the network simulator ns2. Finally, future challenges and emerging research topics for content sharing and dissemination in VANETs are outlined.

INTRODUCTION

Vehicular networking has established itself, in the short span of the last few years, as one of the most promising fields of research within the larger context of metropolitan-scale wireless networking. Enabling vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication, a pervasive deployment of vehicular networking technologies would have an unprecedented impact on mass road transportation. As a matter of fact, potential applications encompass several facets of every-day private and public transportation, including road safety (e.g., warning of out-of-sight collisions), traffic monitoring and planning (e.g., prevention of vehicular congestion), driving assistance (e.g., quick automatic reactions to drivers’ errors), priority traffic assistance (e.g., notification of ambulance
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approaching), and travel time reduction (e.g., real-time re-routing based on traffic conditions, advertisement of free parking slots). In addition, one can think of applications not directly related to road transportation, but targeted at infotainment, such as news updates, weather forecast, notification of nearby points of cultural or popular interest, advertisement and rating of local shops, hotels, restaurants.

Many of the applications listed above require that a user aboard a moving vehicle is able to retrieve a specific content, typically of small size, from a large set of items. Infrastructure-centric solutions may result impractical or costly: the high density of users (i.e., vehicles) with potentially heavy content request rate would require a pervasive deployment of Road Side Units (RSUs) that poses both feasibility problems (seamless high-throughput connectivity over large areas is still far from becoming a reality) as well as political and economic issues (which institution or company is going to provide the service, whom and how much it is going to charge for it).

On the other hand, the dense presence of collaborative users makes the scenario ideal for the pure ad-hoc networking paradigm adopted by Vehicular Ad-hoc Networks (VANET). The information, generated by few sparse RSUs, could be carried around and exchanged by swarming vehicles, and thus disseminated over the desired areas without any need for an ubiquitous infrastructure. Users aboard cars could then request and retrieve desired contents from other mobile users, in a pure peer-to-peer (P2P) fashion with no monetary cost implied.

However, VANETs are distributed, self-organizing communication networks built over traveling vehicles, and are thus characterized by nodes with very high speed and constrained movement patterns. Such specific features result in short-lived links and extremely fast network connectivity dynamics, that make it hard to organize the stable overlays that are traditionally employed in wired P2P networking. This requires that protocols for information sharing in VANETs are re-thought from their foundations, and that novel solutions are devised for key aspects such as the query propagation through the network and the content caching at peer nodes.

In this chapter, the problem of information sharing in VANETs is addressed. Different approaches can be used for information sharing, such as pull-based, push-based or epidemic techniques (Hauspie, 2004; Hayashi, 2006). Here, a pull-based approach is adopted, according to which nodes require information by issuing query messages. More specifically,

- First, it is shown that a data-centric approach can work well in the dynamic vehicular environment, by evaluating a data-centric P2P protocol for data retrieval in VANETs;
- Building on the above approach, the chapter then tackles the problem of the query propagation from requesting peers toward content providing peers, evaluating a number of schemes aimed at reducing the broadcast storms induced in the network by a trivial flooding approach;
- Finally, the problem of content caching is addressed, considering solutions that have been proposed in the literature to avoid that peer nodes swamp their storage capacity with needless information, reaching at a time an effective distribution of the different information items within the network.

The considered schemes and approaches are discussed considering realistic car mobility in urban vehicular environments. The aim of this chapter is to show that VANETs can be efficiently exploited for information sharing among vehicular users, given that dedicated techniques are adopted for the protocol design.
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