Chapter 14

Applications in Vehicular Ad Hoc Networks

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ABSTRACT

The various sensors and wireless communication devices have been extensively applied to daily life due to the advancements of microelectronics mechanism and wireless technologies. Recently, vehicular communication systems and applications become more and more important to people in daily life. Vehicular communication systems that can transmit and receive information to and from individual vehicles have the potential to significantly increase the safety of vehicular transportation, improve traffic flow on congested roads, and decrease the number of people of deaths and injuries in vehicular collisions effectively. This system relies on direct communication between vehicles to satisfy the communication needs of a large class of applications, such as collision avoidance, passing assistance, platooning. In addition, vehicular communication systems can be supplemented by roadside infrastructure to access Internet and other applications. This system forms a special case of mobile ad hoc networks called Vehicle Ad Hoc Networks (VANETs). They can be formed between vehicles with vehicle to vehicle (V2V) communication or between vehicles and an infrastructure with vehicle to infrastructure (V2I) communication. The applications and characteristics of VANETs are introduced and presented in this Chapter.

INTRODUCTION

Recently, the various sensors and wireless communication devices have been extensively applied to daily life due to the advancements of microelectronics mechanism and wireless technologies. Vehicular transportation is one of the main modes of transportation for millions of U.S. citizens and hundreds of millions around the world in spite of increasing oil prices and environmental concerns. However, 38,252 Americans were killed in 2003 with 2,697,000 seriously injured. Furthermore,

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each day the average American spends 2.5 hours in his/her vehicle, a significant percentage of this time in traffic jams and at stop lights. The statistics are similar in many other parts of the world (Sichitiu et al., 2008). On an average day in the United States, vehicular collisions kill 116 and injure 7900. More health care dollars are consumed in the United States treating crash victims than any other cause of illness or injury; the situation in the European Union is similar, with over 100 deaths and 4600 injuries daily, and the annual cost of € 160 billion. Governments and automotive companies are responding by making the reduction of vehicular fatalities a top priority (Robinson et al., 2006).

Vehicular communication systems that can transmit and receive information to and from individual vehicles have the potential to significantly increase the safety of vehicular transportation, improve traffic flow on congested roads, and decrease the number of people of deaths and injuries in vehicular collisions effectively. This system relies on direct communication between vehicles to satisfy the communication needs of a large class of applications (e.g., collision avoidance, passing assistance, platooning, and so on). Vehicular communication systems can be supplemented by roadside infrastructure to access Internet and other applications. This system forms a special case of mobile ad hoc networks called Vehicle Ad Hoc Networks (VANETs). They can be formed between vehicles with vehicle to vehicle (V2V) communication or between vehicles and an infrastructure with vehicle to infrastructure (V2I) communication.

VANETs can increase security, efficiency and comfortable trip in collecting road traffic. Such systems can enable a wide range of applications, such as collision avoidance, emergency message dissemination, dynamic route scheduling, route navigation, and real-time traffic condition monitoring. Traditional vehicular networks for reporting accidents or traffic conditions rely on certain infrastructure, such as road-side traffic sensors reporting data to a central database, or cellular wireless communication between vehicles and a monitoring center. The advantage of VANET is not needed to deploy too many expensive infrastructures to be installed on every road and intersections. VANETs are emerging as the preferred network design for intelligent transportation systems. VANETs are based on short-range wireless communication (e.g., IEEE 802.11) between vehicles. However, the disadvantage of VANETs is in supporting complex network protocols. The existing researches focus on medium access control (MAC) and routing issues, in particular pointing to the mismatch between the need of inter-vehicle communication applications for group communications and the services offered by mobile ad hoc network (MANET) routing protocols.

Several applications enabled by vehicular communication systems are classified. The most commonly considered applications are related to public safety and traffic coordination. Traffic management applications, traveler information support, and various comfort applications have the potential to make travelling more efficient, convenient and pleasant. For each type of application, we consider its addressing and real-time requirements and the type of vehicular communication necessary for its implementation.

Generally speaking, vehicular communication systems are classified into three major types, inter-vehicle communication (IVC), roadside-to-vehicle communication systems (RVC), and hybrid vehicular communication (HVC).

IVC systems are completely infrastructure-free and only need some in-vehicle equipments. Depending on whether the information is retransmitted at intermediate hops or not, we can further distinguish between single-hop and multi-hop IVCs, SIVCs and MIVCs, respectively. SIVC systems are useful for applications requiring short-range communications, e.g., lane merging, automatic cruise control. MIVC systems are more complex than SIVCs but can also support applications that require long-range communications, e.g., traffic