Chapter I

Introduction:
An Emerging Area of Vehicular Networks and Data Exchange

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ABSTRACT

Emerging vehicular networks in the forms of Intra-Vehicle (InV), Vehicle-to-Vehicle (V2V), and Vehicle-to-Infrastructure (V2I) communications will enable a variety of applications for safety, traffic efficiency, driver assistance, as well as infotainment to be incorporated into modern automobile designs. At the same time, networked Electronic Control Units (ECUs) are increasingly being deployed in automobiles to realize functions such as engine management, air-bag deployment, and even in intelligent brake systems. In addition, users now expect to sit in an automobile and have their brought-in devices, and beamed-in services harmoniously integrated with the built-in interfaces inside the automobile. Thus, widespread adoption of vehicular networks is fast becoming a reality and critical data is being exchanged with-inside and with-outside vehicle via vehicular networks. This chapter gives an overview of this emerging area of vehicular networks, its potential applications, its potential wireless technologies for data exchange, and its research activities in the Europe, the United States (U.S.), Japan, and Singapore.

INTRODUCTION

In recent years, control systems of automobiles have moved from the analog to the digital domain. In particular, x-by-wire systems are appearing and have driven research efforts of the whole automotive industry for the recent decade. Networked Electronic Control Units (ECUs) are increasingly being deployed in automobiles to realize diverse functions such as engine management, air-bag deployment, and even in intelligent brake systems. For example, at least 70 networked ECUs are employed in a Mercedes S-Class car (Heffernan & Leen, 2008; Vasilash, 2005). At the same time, emerging vehicular networks in the forms of Intra-Vehicle (InV), Vehicle-to-Vehicle (V2V), and Vehicle-to-Infrastructure (V2I) communications will enable a variety of applications for safety, traffic efficiency, driver assistance, as well as infotainment to be incorporated into modern automobile designs.
(V2V), and Vehicle-to-Infrastructure (V2I) communications are fast becoming a reality and will enable a variety of applications for safety, traffic efficiency, driver assistance, as well as infotainment to be incorporated into modern automobile designs.

There are currently a number of study groups working on car communications and defining the standards for various applications. InV Communications, such as CAN (Controller Area Network, 2008; CiA, 2008), LIN (Local Interconnect Network, 2008), FlexRay (2008), are used for interconnecting in-car ECUs, sensors, and so on. V2V Communications, such as IEEE 802.11p (IEEE 802.11p, 2008; Jiang & Delgrossi, 2008), Dedicated Short Range Communications (DSRC) (Dedicated Short Range Communications, 2008), may be used for safety applications. V2I communications, e.g. IEEE 802.11p and IEEE 1609 Family of Standards for Wireless Access in Vehicular Environments (WAVE, 2008) may be used for traffic information.

In addition, users now expect to sit in an automobile and have their brought-in devices and beamed-in services harmoniously integrated with the built-in interfaces inside the automobile. To integrate mobile phones and digital music players, Ford designs Ford Sync that integrates voice-activated in-car communication and entertainment system (Ford Sync, 2008). RM MICHAELIDES provides wireless CAN interfaces to transmit CAN between different networks using Bluetooth, RFID (radio-frequency identification), Infrared, UHF (ultra high frequency), etc (Michaelides, 2008). A Controller Area Network Gateway to ZigBee was described in (Kuban, 2007). There are some wireless CAN products, such as CANRF (Dammeyer, 2008) and CAN Bridge (Matric, 2008). The performance of wireless CAN in terms of latency and throughput was studied in (Dridi, Gouissem, Hasnaoui, & Rezig, 2006).

Thus, with vehicular networks fast becoming commonplace, critical data is being exchanged with-inside and with-outside vehicle via vehicular networks, and new technologies have been developed for vehicular networks. This chapter is meant to introduce the emerging area of vehicular networks and data exchange, give an overview of the new technologies for car communications, and present automotive research activities in the Europe, the United States (the U.S.), and Japan as well as in Singapore.

**CAR COMMUNICATIONS**

New technologies are being developed for vehicular networks and these networks provide an efficient method for today's complex car communications. Figure 1 shows the example of InV, V2V and V2I communications.

InV provides communication among ECUs/sensors in a vehicle while V2V and V2I provide communications among nearby vehicles and between vehicles and nearby fixed roadside equipment. Vehicular networks are a cornerstone of the envisioned Intelligent Transportation Systems (ITS). By enabling vehicles to communicate with its function systems via InV communication, with other vehicles via V2V communication as well as with roadside base stations via V2I communication, vehicular networks will contribute to safer and more efficient roads by providing timely information to drivers and concerned authorities.

**Potential Applications**

The emerging vehicular networks will enable a variety of applications for safety, traffic efficiency, driver assistance and infotainment:

1. **Safety**: Vehicular network technologies will be applied to reduce accidents so as to save lives and reduce injuries. Examples of such applications include vehicle breakdown and obstacle detection, lane departure warning, accident warnings, collision warning,