Chapter 3
The Role of Communication Technologies in Vehicular Applications

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ABSTRACT
Vehicular networks attract a lot of attention in the research world. Novel vehicular applications need a suitable communication channel in order to extend in-vehicle capabilities and, be aware of surrounding events. However, these networks present some peculiarities, such as high mobility or specific topologies. These features affect the performance of applications; hence, more effort should be directed to identify the final necessities of the network. Few works deal with application requirements that should be considered when vehicular services are designed. In this chapter this gap is filled, proposing an analysis of application requirements mapped with suitable communication technologies for physical/MAC and network layers. This study contains key factors that must be taken into account not only at the design stage of the vehicular network, but also when applications are evaluated.

INTRODUCTION
Nowadays, communications become essential in the information society. Everyone can get information anywhere, even in mobility environments, using different kinds of devices and communication technologies. In this frame the vehicle is another place where users stay for long periods. Thus, in addition to safety applications, considered as the most important services, other networked applications could bring an additional value for the
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comfort of drivers and passengers, as well as for driving efficiency, in terms of mobility, traffic fluency and environment preservation. However, such kinds of networks are characterized by a strong mobility, a high dynamicity of vehicles and specific topology patterns. Moreover, these networks experience significant rates of packet losses and very short communication periods. These properties affect the performance and feasibility of vehicular applications. The proper operation of vehicular applications remains a great challenge nowadays, and specific requirements should be considered. In our opinion, such kind of applications should be initially studied from the communication technology point of view. An analysis of the requirements, in terms of technologies at different abstraction levels, should help to design efficient applications. In this chapter an analysis of available communication and network technologies is given, and a study about how they can fulfill main networking requirements of ITS applications is stated.

This chapter scrutinizes the vehicular application requirements in terms of communication technologies. First, broad background and our point of view are presented. In order to explain the main focus of our chapter, we started by describing vehicular applications and services, selecting, thus, the most representative ones as cases of study and defining their networking requirements. So, before analyzing the application requirements against the capabilities offered by current communication possibilities, we introduce the most common communication technologies in the vehicular field as solutions issues, as well as and some of the most standardized level-three. Finally, some concluding remarks end the chapter.

BACKGROUND

Numerous research works deal with vehicular services, essentially those related to traffic safety, but also traffic efficiency and infotainment are of special importance. However, the achievement of the functional goals of these applications is strongly linked to technological requirements, which vary from one application to another. For instance, safety applications should operate with good location accuracy, and real-time and scalable communications; distributed games or talk applications, however, do not require great scalability or real-time features.

To ensure the appropriate operation of these applications regarding networking, new technological requirements, far away from those identified in fixed networks, appear in vehicular communications. This kind of solutions usually needs to cover many networking necessities for their efficient operation. In this chapter, the most important ones are studied, being identified as: location awareness, geocast capabilities, penetration rate dependency, time awareness, permanent access and mobility.

To meet these demands, a number of communication technologies at access level are currently available. The most important ones are briefly introduced, such as Bluetooth, DSRC (IEEE 802.11p), cellular networks and satellite. Moreover, these technologies are analyzed according to the covered communication paradigms, vehicle to vehicle (V2V), vehicle to infrastructure (V2I) or infrastructure to vehicle (I2V), and the destination nodes involved in the communication (1-to-1 or 1-to-n). In the same way, some of the main network (level-three) technologies studied in standardization bodies of vehicular communications are discussed, in order to determine which of the networking requirements can be covered with them. NEMO [Devarapalli, Wakikawa, Petrescu, & Thubert et al.2005] as well as some common MANET and VANET proposals are briefly described, but also more specialized concepts, like Multihoming [Ernst, Montavont, Wakikawa, Ng, & Kuladinithi et al.2007], Flow distribution [Soliman, Montavont, Fikouras, & Kuladinithi et al.2007, Larsson, Eriksson, Mitsuya, Tasaka, & Kuntz et al.2008], Route Optimization