Chapter 69
A Survey of Wireless Backhauling Solutions for ITS

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ABSTRACT

The deployment of more sustainable land transportation is a non-debatable global issue. It is generally agreed that Information and Communication Technology (ICT) will play the role of the main enabler to achieve the ambitious objective of improving transportation efficiency, thus reducing pollution, time and resource wastage, and accidents. In this chapter, after briefly introducing the general architecture of the ICT infrastructure for the new generation of Intelligent Transportation Systems (ITSs), the authors provide a survey of the wireless technologies available for implementing the data network required to transfer information between the peripheral devices, installed roadside and in the vehicles, and the data center where the actual storage and logic resides. Specifically, they consider the following alternatives: IEEE 802.11 in a Wireless Mesh Network (WMN) configuration, IEEE 802.16/WiMAX, Long Term Evolution (LTE), and HiperLAN/2. The latter is investigated in further details by providing results from preliminary laboratory trials carried out in the Italian project IPERMOB.

INTRODUCTION

In the last years, we have witnessed a widespread diffusion of embedded systems in everyday's life, which is now combining together with the advances of communication technologies to create a new ecosystem of applications and services that are highly pervasive and have a strong social connotation. The case of Intelligent Transportation Systems (ITSs) is definitely among the domains in which a leapfrogging step forward is envisaged. In general, ITS refers to the automated control of traffic, based on both data collected on real-time and prediction models derived from historical

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information, so as to achieve a new level of transportation efficiency. This will improve the quality of life of drivers, passengers, and citizens at large, through a significant reduction of accidents and CO2 emissions. Among the others, emergency services are especially important due to their direct impact on society (Martinez, Toh, Cano, Calafate, & Manzoni, 2010). For this reason, at a European level, the application of the ITS Directive for road and urban transport is one of the actions of the Digital Agenda[1] in the pillar ICT for Social Challenges, while similar interest is shown by all developed countries.

One of the first comprehensive reports on ITS is Weissenberg (1998), commissioned by a consortium of public authorities in California, whose findings are still surprisingly valid after 12 years, at least in their essence. In fact, some of the report highlights are that ITS projects need to match local requirements and markets, they are very complex and consisting of “assembled technology” and, hence, require incremental growth and innovation. Finally, it is pointed out that measured data from operational ITS projects is extremely valuable for operations management as well as for regional planning. Especially this last finding is dramatically true nowadays, and applies in particular to urban scenarios, which is the focus of this work, because of the additional challenges it brings with respect to inter-city connection roads and highways. In fact, in densely populated areas, data collection is more difficult, due to the high deployment costs, and traffic behavior is most unpredictable, due to the highly dynamic traffic patterns.

In a modern ITS, gathering of measured data, which is central to the system operation, is carried out by means of devices, which we call sensors. Sensors are generally deployed in the area of interest, possibly in an incremental manner and they are usually fixed entities located roadside for easiest data collection. Data must be conveyed from the sensors to a centralized data center, with storage and analysis functions, which is typically operated by a local authority, e.g., the City Council, or an authorized third party. The deployment of such an information transportation infrastructure with traditional cabled technology, e.g., fiber optic or copper, is overly difficult and tremendously expensive due to high installation costs and physical constraints. Therefore, we argue that the use of wireless technologies is a de facto necessity to reduce the installation time and costs. Our statement is supported by the flourishing of working groups in different standardization bodies for the regulation of ITS wireless communications, including the IEEE, whose reference architecture is described in IEEE P1609.0 Draft Standard for Wireless Access in Vehicular Environments (WAVE) - Architecture, and ETSI 302 665 Intelligent Transport Systems (ITS); Communications Architecture.

The main contribution of this work is a critical survey of standard technologies for creating the wireless infrastructure of a urban-scale ITS, which are attractive for their limited equipment and operation costs. Furthermore, we analyze in details the wireless infrastructure that we have realized in a regional Italian project using the HiperLAN/2 radio technology, also reporting the results obtained in a laboratory prototype of the system.

BACKGROUND

In this section we introduce the key components of an ITS for accurate positioning of our contribution. In the following we broadly reuse the ETSI 302 665 terminology.

An ITS is composed of four main sub-systems. The roadside sub-system is a static device, often called Roadside Unit (RSU), positioned along the road for collecting measurements through sensors, actuating feedbacks via, e.g., Variable Message Signs (VMSs), and acting as a gateway for vehicle communications. The vehicle sub-system, often called On-Board Unit (OBU), resides into the car,