ON BOARD COMMUNICATIONS PLATFORM FOR SERVICES DEPLOYMENT IN VEHICLES

Bottom-up Approach for Intelligent Transport Systems Deployment

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Keywords: Vehicle Embedded Systems, VANET, OBD, V2V/V2I Communications, Intelligent Transport Systems.

Abstract: This paper reflects the advances and results of two research projects supported by the Basque Government. The objective of this work is to build a device which allows the driver to communicate with his vehicle, with other vehicles and the infrastructure on the road. This Intelligent On Board Unit will be able to learnt from driver behavior and the environment. Based on this knowledge, the OBU could advise the driver on actions to take while driving. The modules implemented and the test scenario that has been built to validate the proposed architecture, are shown in this article.

1 INTRODUCTION

The new information technologies and communications applied to intelligent transportation systems can improve transportation efficiency in areas such as safety, pollution or infotainment. To give the vehicle the ability to communicate with other vehicles (V2V) or infrastructure (V2I) enables the deployment of many services designed to improve the quality of passenger transport, safety or reducing contaminant emissions (Chisalita, 2006)

In this paper, the work of the Intelligent Transport research group from the University of Deusto in the area of vehicle embedded systems is shown. First, projects focus on this area of application are enounced, making special mention on projects recently approved by the European Union. In section 3, the proposed platform is described, and in section 4, each block of this platform is explained. Finally, the future work and conclusions are presented.

2 RELATED WORK

Except some initiatives emerging for certain manufacturers, such as The Genivi Alliance (Macario, 2009), there is not an on-board platform with an open architecture. There is not any system able to provide access to information from inside the vehicle, from external infrastructure or even from other vehicles and also support the implementation of services, consumers of such information relating to any of the areas of intelligent transport.

There are various initiatives and European research projects in this area. The most significant are summarise below:

CVIS (Cooperative Vehicle Infrastructure Systems): Coordinated by ERTICO, this project focuses on providing cars with a technology solution capable to communicate securely with other vehicles (V2V) and with the nearby roadside infrastructure (V2I) (Toulminet, 2008). The project is focused primarily on core cooperative technology.

COOPERS (Cooperative systems for Intelligent Road Safety): This project, coordinated by Austria Tech, proposes to connect the vehicles through continuous wireless communication with the road infrastructure to provide services that improve driving safety (Toulminet, 2008).

m:Via-Future of the Intelligent Transportation Systems: Led by Telefónica I+D, this project focuses on the use of networks and mobile or wireless technologies to increase road safety and add value as infotainment, vehicle support, comfort and traffic optimization.

Main difference between the solution proposed in this paper and those mentioned above are mainly based on bottom-up approach adopted in this project. Instead of doing the analysis of

Hernández-Jayo U., Angulo I., Perallos A. and Sainz N. (2010).
ON BOARD COMMUNICATIONS PLATFORM FOR SERVICES DEPLOYMENT IN VEHICLES - Bottom-up Approach for Intelligent Transport Systems Deployment.
In *Proceedings of the International Conference on Wireless Information Networks and Systems*, pages 205-208
DOI: 10.5220/0002948802050208

requirements from the services to be developed, this project focuses on developing a general platform, capable of obtaining information from inside and outside the vehicle, over an open and scalable architecture on which to deploy all services related to intelligent transportation.

3 PLATFORM PROPOSAL TO PROVIDE INTELLIGENT TRANSPORTATION SERVICES

The challenge is to provide connectivity, intelligence and real time information to mobile elements (vehicles) in a lacking of connectivity environment. Moreover, in this scenario many elements play as sources and destinies of information: other vehicles, road infrastructure, driver and passengers, traffic management centers, and so on. Therefore, a system like this should include on board elements and those systems placed on the roadside. Related to the on board system:

- The system will be able to collect data from the vehicle data buses. Interaction with and integration other on board devices and gadgets is a desired capability too. Likely, more and more gadgets will be launched in the following years. This system works as a concentrator of current on board devices and gadgets and some others that could arise in the
- On board system has to provide a human machine interface (HMI) compatible with the driving. It enables the provision of information by users to the system as well as the consumption of the services by them.
- Communications with externals elements (Vehicular Ad-Hoc Network - VANETS) are needed in order to broadcast internal data and to access to external services. It might support a wide range of wireless communications technologies to fulfil the interaction requirements with all the external elements.

These specifications might be supported by a hardware device which hosts the in-vehicle embedded system. Furthermore, it should be based on an open software platform to allow adding new services. This makes the system scalable and flexible for future developments. The functional components of the OBU's architecture are shown in Figure 1.

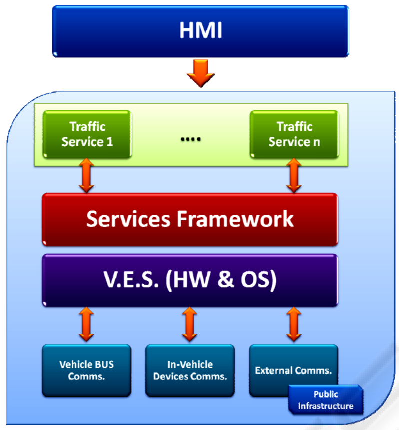

Figure 1: Functional components of the On-Board Unit architecture.

Once the proposed architecture is deployed in a real scenario, there is a wide range of services that could be provided. For example: remote monitoring services based on data acquired from the vehicle (consumptions, temperature, and so on), fleet management services, driving assistance services (i.e, recommended routes or alerts warnings), traffic management services, assistance services used by the entities which manage the road infrastructures and traffic (councils, for example) or passenger information services (infotainment, tourism and advertisement). Some of these services will be accessed through web portals or fat clients at home or in the management centers. Other applications will be accessed from car.

In the test scenario designed to check the proposed ITS platform, a particular service for traffic alerts broadcasting has been considered. In this service drivers can report real time information about the road state and special events, as well as their position, while they are driving. This information is available in a traffic portal. This site informs about the state of the traffic in a selected geographical region.

4 CURRENT DEVELOPMENTS

To check the platform described in the previous section, specific modules have been developed.

4.1 Developed Modules

A prototype of On board Unit (OBU) has been developed (Figure 2). Thanks to this prototype, the user will be able to receive data: a) from the vehicle; b) from the gadgets inside the vehicle (PDAs, cellular, sensor networks, etc.); c) elements placed out of the vehicle; d) from the user, thanks to a Human Machine Interface.

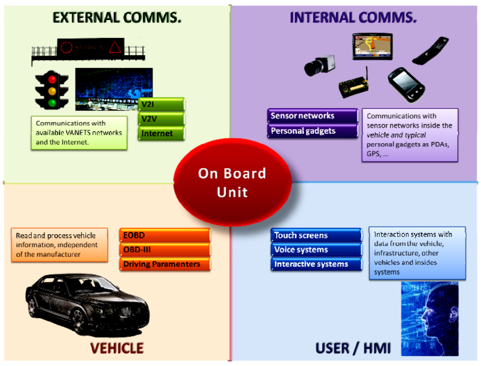

Figure 2: On Board Unit description.

4.1.1 Communications with the Vehicle

One of the goals of this project is that any user can use the platform that here is presented. As well, the control center or the user can obtain data from the vehicle either in real time or those data can be saved in a file. To satisfy both requirements, we are working with the standard OBD-II. Thanks to this standard, data are running in the bus can be sniffed and the user can access to this information. To communicate the OBU with the data bus in the vehicle, a Bluetooth interface has been used. Using this interface, the user can collect data related with the vehicle: speed, revolutions, fuel level (load), and engine temperature and so on. This information can be shown in a graphical interface (Figure 3) or be saved to analysis later.

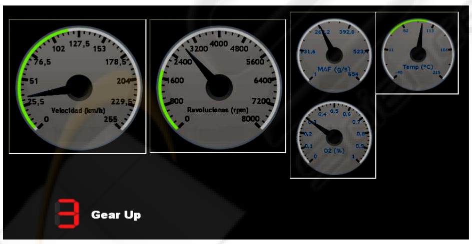

Figure 3: OBD graphical interface.

Using this information from the mechanic and electronic of the vehicle, software applications can be developed. For now, one service focus on *eco-driving* has been developed. Knowing the engine torque and reading the speed and rpm, this service recommends the user the best speed gear ratio. Thus, the fuel consumption and CO_2 emissions can be reduced.

4.1.2 External Communication

Using the wireless communications systems that OBU implements, the vehicle can interchange information with elements placed on the road. These elements and the vehicles create a Vehicular Ad-hoc Network (Ducourthial, 2009).

The objective of the external communications module is that the user be reported with real time information about the road state and special events. This information has to be shown inside the vehicle, so OBU has to implement an interface to read and display these data. For example, special vehicles as ambulances, police or firefighters can generate alerts to inform about their situation and route. Then, the OBU can recommend actions to the user in an active way.

4.1.3 Internal Communications

As it is described in the previous section, the user can generate information from his vehicle and send it to the VANET. To give out his information, he has instruments to transmit events inside the vehicle.

Sensor networks can be deployed inside the vehicle. These can be used to monitor the driver's physical parameters (heart rate, temperature, etc) (Nakanishi, 2007). The data from these networks could be collected by the OBU for a later analysis. Users' gadgets as PDA or cellular can be used as an interface to generate information or to receive data from the vehicle or the external devices. Thanks to these devices, the user can export data to his laptop at home and register all the information generated in a journey.

4.1.4 Human Machine Interface

The main requirement is that the HMI interface is interactive and non-intrusive, that is, it should be used by the driver while driving.

Currently, the developed OBU implements a touch screen that restricts their use when the car is moving, but we work to incorporate a voice system to it.

4.2 Test Scenario

To validate both the OBU and the elements developed to be outside the vehicle, a test scenario is designed in which the operation of these elements has been validated and verified.

4.2.1 Traffic Site

For this scenario, a traffic site has been created. On it, the information of each vehicle connected to the system is showing. Of each vehicle can get the position, the route and the type of vehicle, a unique identity and its speed. We distinguish different types of vehicle: common vehicle, ambulance, emergency ambulance, emergency vehicle (fire, police).

In addition, each of these vehicles can report incidents such as traffic jams, accidents or heavy rains. These events are reflected in the traffic portal with its position, time and date.

4.2.2 OBD Data Collection

To access the data running through the vehicle communication bus, Bluetooth interface is connected to the connector OBDII in the vehicle. Then, the information is sent to the device that has played the role of the OBU.

Then, these data are analyzed and either they are displayed using a graphical user interface or they are stored. These stored data can be analyzed or sent to the traffic site which can keep track of these parameters.

4.2.3 VANET Simulation

Moreover, using the NS2 network simulator, the performance of communications between a moving vehicle and the RSU has been simulated.

In this simulation, a vehicle sends periodically an alarm message to the RSU. The vehicle could be for example an ambulance, and it is moving through different areas under different RSU's coverage. The objective of the simulation is to measure how successful any RSU within the area receives the messages in order to guarantee the alarm message reception.

5 FUTURE WORK

Currently we are working to increase the amount of data read from OBD. With these data will improve the eco-driving service and provide other services like remote diagnostics and monitoring vehicle maintenance. As well, we are analyzing how we can use the communication bus in the vehicle to obtain specific information of electrical vehicles. With this information we will provide services geared exclusively to electric cars.

The HMI module is the less developed, so we are working to improve the interactivity in a non-intrusive way using voice recognition systems.

6 CONCLUSIONS

All of the projects presented in the state-of-art of this article, are based on top-down approach. That is: the ITS architecture is designed from the point of view of the services. Once the services are designed, the hardware platform is developed. The problem of these approaches is that they are no easily scalable, because new services may require new hardware. Most of the times, change the hardware design is difficult and expensive.

However, the on board platform presented here, is designed following a bottom-up approach. First, the hardware is designed to support different type of services. This hardware meets the characteristics necessary to support new and future type of services.

The goal of this initiative is to deploy an on board platform with several communications interfaces and develop services to validate it. Some of those services are shown in this article (event generation, eco-driving, and so on).

Add new capabilities to the platform, create new services based on new V2V and V2I concepts, and finally, check the whole system (platform and services) in a real scenario are the objectives of the following steps.

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