Connecting the Vehicle with the Environment - Trends and Challenges

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Abstract. Innovations in automotive electronics have become increasingly complex, resulting in high-end vehicles containing more than 70 electronic control units and offering a variety of functions to the driver. In-vehicle telematics and infotainment systems provide services like digital radio, broadcast services, television, and MP3 audio. Future applications and services will integrate information sources available outside and inside the car, requiring vehicle systems connected with in-vehicle Consumer Electronics devices and the outside world. In order to realized the vision of an intelligent networked car, connected with the environment and providing the driver with information according to his demands, common efforts towards car manufacturer and supplier spanning standards for data exchange are required. The paper discusses possible approaches and future challenges.

Keywords. Mobile Multimedia, Vehicle Infotainment, Telematics

1 Introduction

Within the last decade extensive improvements in computing and networking have been made. Mobile radio, as well as the Internet achieved outstanding importance in the way people communicate and access information. Furthermore, other networking technologies have been developed, which serve functions in special markets. Besides great improvements in processor and storage technologies have been made, which enable offering of powerful, small and robust mobile processors and storage solutions.

Naturally, this development still influences the automotive industry. New applications and services for networking within the car and between car and environment which have not been possible so far can be realized.

So far the most promising 'networked' applications have been proposed and developed within the car itself, especially safety and driver assistance applications (e.g. ESP, ACC, Navigation, Multimedia deployment). Nevertheless, it can be anticipated, that new applications and services will be introduced which

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connect the car with the environment (i.e. other cars, mobile devices or infrastructure equipment).

Applications which concentrate on the networking within car itself are specified in cooperation between manufacturer and supplier. Interfaces and data formats can be introduced without necessarily depending on international or industry organizations. Hence the introduction depends on technical possibility and market decision of the manufacturer, respectively.

In contrast, connecting the car with its environment represents a more challenging interface problem. In fact, different scenarios exist. Considering manufacturer specific applications and services, which are provided by the manufacturer itself (e.g. a telematics information portal), the requirements are obvious: The manufacturer and a potentially involved service provider can introduce proprietary data and transmission formats. More flexible solutions, including data exchange with different manufacturer, requires a specification of relevant standards.

2 Approaches for standardized exchange of application data

Defining interfaces is essential when connecting the car with external devices and servers. Except for the physical and transport interfaces of the lower layers (i.e. Layer 1-3) interfaces for data access and data exchange within and between applications are necessary as well. Considering e.g. a use case, where a mobile device provides Exchange of Personal Information Management (PIM) data to the car navigation system, address data formats and access functions must be specified in order to establish a data exchange.

In fact, the lower layers are specified for various transport channels meanwhile (e.g. GPRS, UMTS, BT, WLAN, DAB, DVB, TCP/IP). The simple presentation of existing data formats (such as viewing of HTML/WML within HTTP/WAP Browser, downloading of email on mobile devices, or playing music files) is almost sufficiently solved as well.

In contrast, standardized exchange of application data and context based processing is more challenging currently. Basically two different approaches exist, to enable data access and exchange between devices:

1. Predefinition of fixed data interfaces
2. Execution environments for dynamic download of applications

2.1 Predefinition of fixed data interfaces

The interfaces for the exchange of application data are specified and installed before delivery of the devices. The crucial part is the agreement on standardized interfaces and protocols which are widely supported afterwards. I.e. not only the successful specification is necessary, but the widespread implementation as well. For the definition and introduction of such "well defined" application interfaces different ways are possible: Definition by international standard bodies (specifying de jure standards), international industry consortia (striving for *de facto standards*), or the use of proprietary solutions for single use cases (the latter option seems to be less desirable at a first glance but may be the only realistic introduction scenario for many applications). Examples for international standard bodies and consortia are:

- **Traffic information.** Obviously, one of the most important automotive initiatives is represented by digital broadcasting efforts, e.g. for transmission and automatic processing of traffic information within the navigation (TMC, TPEG, DAB and DVB data services, DAB Java [1]).
- **Automotive Multimedia Interface Collaboration (AMI-C).** An automotive specific and very common approach to introduce communication interfaces on application level has been made by AMI-C [2]. Besides a runtime environment for applications, very specific use cases including formats and data access methods for applications (e.g. billing for parking) have been specified. So far a widespread support and implementation of AMI-C can not be recognized (which also demonstrates the challenge of introducing harmonization within the automotive industry).
- **Car-to-Car and Dedicated Short Range Communication.** Concerning the promising area of DSRC and car-to-car communication various organizations and initiatives started standard efforts, but so far only successful standards for ETC/EFC are available (e.g. ISO/TC204). Nevertheless the new 802.11p protocol may be the base for more advanced car communication applications.
- **Exchange of Personal Information Management (PIM) data.** The driver information specific exchange of PIM data (e.g. exchange of addresses and telephone numbers) makes the dilemma of specifying application interface standards obvious particularly. Besides historically grown, company specific mechanisms (e.g. Active Sync, Hot Sync, PC Suites of mobile phone manufacturers), standards bodies developed solutions as well: Bluetooth, which not only defines lower layers for mobile data transmission, but also profiles for exchange of application data, specified various profiles for PIM purposes (Push, Sync, PhonebookAccess). The Open Mobile Alliance (OMA) [3] developed the data synchronization (DS) and device management (DM) protocol, formerly known as SyncML. So far no final harmonization emerges, though the OMA approach shows a promising development with an increasing number of supporters.

2.2 Execution environments (oder application framework) for dynamic download of applications

A system platform which provides an execution environment that installs and executes applications, helps to solve some of the standards problems addressed above.

First of all, common interfaces or protocols for data exchange need not to be available at once, but can be specified later on. After specifying the data interface finally, an application providing it can be deployed. Besides, the need for definition of common data exchange interfaces is reduced slightly: the provider of an application is enabled to provide Software, including the data access and communication interface, for both, sending and receiving device. Some examples for such application frameworks are:

- **Java/Midlets.** Meanwhile the midlet approach is widely supported in Smartphones and allows to download, install and run new applications [4][5]. Unfortunately communication between midlets on one device is not possible and access of device functions and data is restricted partly.
- **OSGi Framework, .NET Framework.** OSGi [6][7][8] and .NET [9][10][11] are more complex and powerful solutions. The most important difference between OSGi and .NET is that OSGi is Java based and Java has explicitly been developed for use on different OS. In contrast, .NET aims to support many languages on one special OS, Windows. Moreover Java/OSGi represents an "open community". It should be noted, that the introduction of an application framework is naturally coupled to some kind of standardization as well. There must be an agreement on a common platform for such an framework. Interestingly, OSGi defines not only the framework, but some specific interfaces for application data access as well.

3 Requirements for future systems

Standardisation is a pre-requisite in order to pave the way to the intelligent networked car. Moreover, there are some more steps required in order to reach this vision:

- The development of security drafts which protect an open system platform sufficient.
- The development of new business models for telematics applications.
- Solution of the hen's egg dilemmas in appropriate scenarios (e.g., Car to Car, DAB Java), i.e. the finding of proper introduction scenarios .
- New electronic vehicle systems that provide sophisticated communication mechanisms and execution frameworks according to chapter 2, i.e. mechanisms for secure and efficient in-vehicle and inter-domain communication, and means for adding and removing functions dynamically, including solutions for autonomic system configuration and adaptation.

The last item may become a crucial point, due to the fact that on the other hand the complexity of automotive systems is continuously growing: The number of electronic components is increasing, the amount of software in the vehicle is growing, whereas the requirements for safety, security and reliability gain more and more importance.

4 Conclusions

During the last decade extensive improvements in computing and networking have been made in the automotive domain. New applications and services for networking within the car and between car and environment are available. Common vision is the intelligent networked car, connecting itself autarcic to the environment and providing the driver with information according to his demands. But even if the technical requirements are fulfilled by the technology available today, some important steps have to be taken in order to reach the vision of the networked car: The agreement and deployment on manufacturer and supplier spanning standards on application level, and the development of new system platforms providing sophisticated communication mechanisms and execution frameworks that meet the future requirements.

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