Enabling the Deployment of Open In-Vehicle ITS Stations

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Abstract

There are two main requirements for ITS applications and services in road transport: an ITS enabled infrastructure, and the deployment of ITS stations in vehicles. Hence several ITS projects have developed prototypes of computing and communication platforms for vehicles. These projects showed the feasibility and benefits of ITS equipped vehicles. Moreover political and industrial stakeholders have stressed the need for ITS in road transport. However, such platforms have not yet been deployed. An open in-vehicle ITS station could solve this. However, there are still many challenges for such a concept. In this paper we will present an approach for how to ease the way for the deployment of open in-vehicle ITS platforms. This approach includes policies and actions, consensus building among the involved stake holders, the definition of the standards, and the description of the often disregarded business ecosystem and business cases.

Keywords

Open platforms, ITS station, security, standardisation, business models, ecosystem.

Motivations

Road transport has an important impact on the economy and daily life in most regions of the world. Cost, environmental impact, safety, and information integration are important issues to consider when planning future road transportation systems that will be populated by conventional and electrical vehicles using ITS enabled roads. In this future scenario, new possibilities for services arise, while government norms and standardisation evolve to allow an efficient orchestration of all the agents involved (1) (2) .

Vehicle on-board embedded systems should provide real-time capability, if required, while interacting with other vehicles, road infrastructures and third party services in a flexible and evolving manner, thus forming an ecosystem of co-operating heterogeneous agents. At this point, it is important to move from the classical hardware-software co-design paradigm to a more software intensive approach by providing open platforms which assure dependability and security. Because of the unique malleability that software offers, it is possible to build more advanced systems more cheaply and flexibly than ever before. This approach would lead to a separation of concerns (3) between the execution platform and the applications, which could be of mixed criticality. Such a system is referred to here as an open in-vehicle platform.

From a technical point of view, a lot of the necessary enabling technologies: (e.g. subsystem isolation in space and time, efficient resource sharing, trusted access to security services and protected resources) have already been investigated in several research projects, e.g., CVIS (4), OVERSEE (5), EVITA (6), and PRECIOSA (7).

However, such a platform has still not been deployed, because of a lack of a consensus building process, common standards, and approved business models.

Consensus Building

One characteristic of open systems is that they affect many stakeholders. In the case of open in-vehicle platforms, it is even more complex, since they affect different industries (automotive and IT). Furthermore, due to the safety and economic impact, there is also a strong interest by public authorities, which keeps this topic a constantly active field of research. Hence, most of the knowledge of this area is still located in research institutes and universities.

However, there are numerous viewpoints in the dialogue on open in-vehicle systems; cf. the discussion on the open e-Call platform in Europe (8). Hence, we propose a consensus building process which involves all stakeholders, including the users (i.e. drivers). We suggest reusing established structures, e.g. in Europe by setting up a subgroup of the eMobility Forum or organizing a CENELEC (9) workshop. Obviously, these activities need to be linked at an international level. The result of such a process will be input for standardisation and agreement on business ecosystems.

Standardisation

A standardisation process for open in-vehicle platforms is an essential step for enhancing and focusing research and easing the deployment of ITS in road transport. There are several aspects which must be taken into account during a standardisation process, and standardisation could lead to results on different levels.

The first aspect to take into account is interoperability. This is a widely known problem when different implementations or systems have to cooperate in order to provide services. Future Intelligent Transport services could have critical problems for numerous reasons if interoperability is not taken into account at the very beginning. One reason is that in order to reduce development costs, all stakeholders need to have a common ground to build on. Another is due to the increasing versatility of the software embedded in current and future cars, buses and trucks. The market has evolved from strictly automotive dedicated systems, e.g. ABS, towards a wide variety of software and external devices to provide a wide range of services, for instance comfort, infotainment, and social networking anytime and anywhere.

To facilitate interoperability, the involved actors have to be able to rely on a minimum set of standards which provide sufficient information and requirements to ensure the cooperation between systems without producing new liabilities.

The standardisation process should take into consideration previous results and de facto standards which have been widely accepted by users. One example is the AUTOSAR standard (10) in Europe which has been defined, accepted and used by a wide number of car and OEM manufacturers. Another standard could be the CVIS project (4) results that provide a definition of an architecture enabling Vehicle-to-Infrastructure communication relying on a wide set of media dedicated to ITS services. At the European level there is also (11) defining the ITS communication architecture.

Nonetheless, a standardized open vehicular platform that is able to support a wide range of applications from infotainment to automotive safety software needs more than the existing standards. To reach this goal, it is mandatory to define other characteristics. For a common open platform to have many types of applications running at a same time, the requirements must be sufficiently strict to avoid liabilities. Thus, defining a set of requirements would be the first starting point for standardisation. An essential step would be to provide various sets of clear and detailed requirements with different levels of security and dependability assurances. For instance, the techniques of the Common Criteria standard (12) could be applied to generic components of open in-vehicle platforms. This step would include aspects such as application isolation, timing constraints, and privacy.

Furthermore, there is a need for open and standardized interfaces for developing and integrating applications. This includes aspects such as middleware services, runtime environments, and access to communication resources, which will facilitate the software development and deployment process.

The different levels of security and dependability (S&D) can be easily related to the runtime environment and access to resources. Since a future standardized open vehicular platform should support non-automotive applications, e.g. internet browsing, it should be possible to define both the levels of S&D and the runtime environments as part of the definition of an application cluster. An application cluster is a group of applications which have the same level of security, dependability, and access to drivers. The implication is that an application cluster should contain the same “kind” of applications, e.g. infotainment, telematics, automated driver assistance systems, or ITS. For instance, in the OVERSEE project (5), a hypervisor is used to ensure the spatial and temporal isolation between clusters. In the hypervisor ontology, a cluster is called a partition.

Standardisation is therefore a mandatory step to enable an open in-vehicle station. As presented above, it will require the active participation of all the stakeholders, industrial and academic, to reach an agreement. It is also the basis for creating an ecosystem.

Business Ecosystem and Business Models

The promotion of the use of ITS platforms relies on the creation of a business ecosystem involving all the stakeholders (e.g. government, standardisation organizations, car manufacturers, OEMs, and third party software developers). It is possible to define two phases that results in a business ecosystem: the proof of concept phase, and the ecosystem building phase.

Several cooperative research projects developed open platforms, e.g. European R&D projects such as TECOM (13), OVERSEE, CVIS, SEVECOM (14) or PRESERVE (15)Each resulting platform is focused on a particular aspect, such as V2X communication but each one is a basis for enabling an ecosystem which relies on proven technology. This phase could be considered to be the “proof of concept”.

Based on these results, standardisation and industrial initiatives take place. Standardisation as depicted in the previous section is a major part of the consensus building, which enables a common open platform development initiative. At the same time, it is necessary to promote cooperation with individual ventures. AUTOSAR (10) and GENIVI (16) in Europe are relevant examples that have successfully emerged from this step. This phase called "ecosystem building".

Therefore the ecosystem is created since the technologies are available and proved. From that, a business can be developed on different models depending on the size and the role of the companies in the business ecosystem.

It is easy to identify the actors in such a market: customers, service providers, software developers, and platform providers.

Platform providers supply the platform. Software developers develop software executed on top of the platform directly used by customers or services providers. Service providers supply end-to-end solutions. Customers could be car owners, car manufacturers, insurance companies, or public authorities.

It is necessary to define the interfaces between the platform suppliers and the software developers/services providers. Within the structure of the interfaces, application developers can invent new products, and services providers can propose innovative solutions to fit the needs of the market.

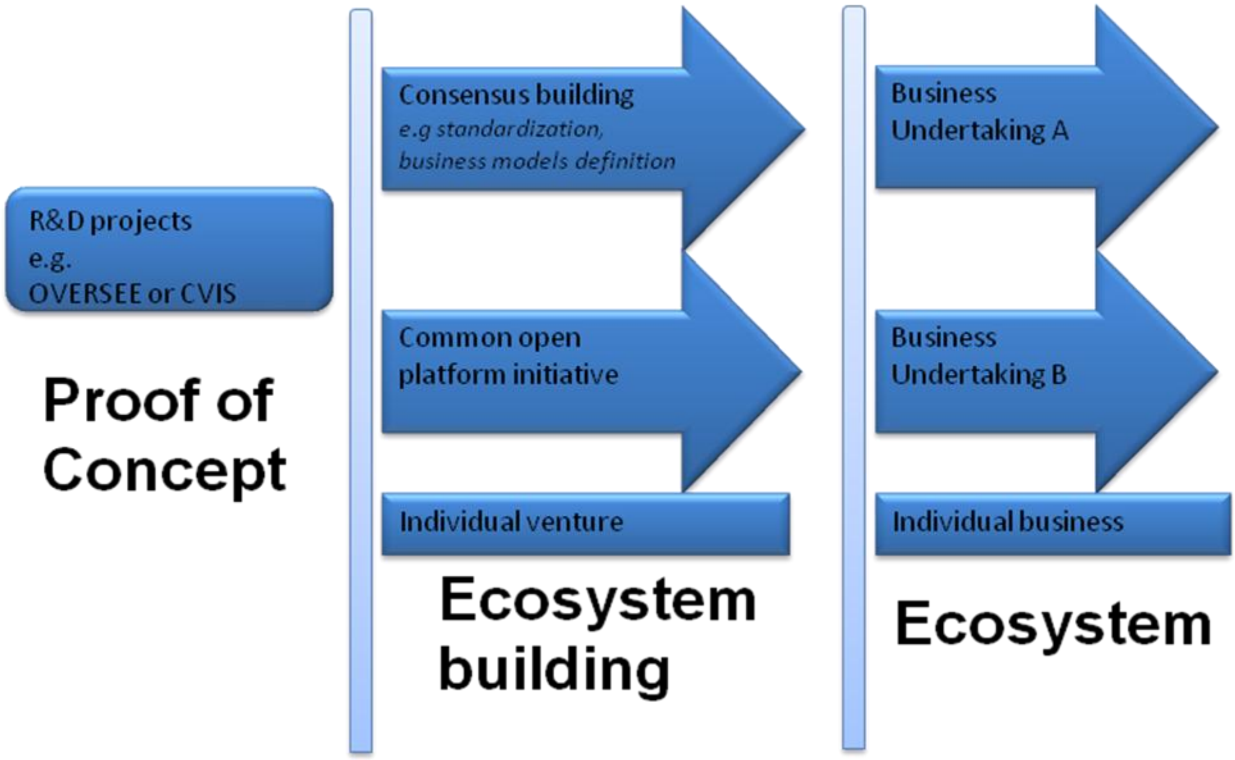

Figure: From Proof of concept to deployment

It is possible to foresee several derived business models which are oriented towards services, applications and OEMs:

1. Service oriented: a company is paid by users to provide certain services. This situation is similar to existing systems such as mobile phone services. For example, an insurance company provides a service that sets the cost of your insurance according to information provided by embedded software that reports the vehicle usage.
2. Application oriented: a company provides applications that can be dynamically installed or removed by the user. This could be done through an on-line application store that offers services in many areas, e.g. infotainment, navigation, ITS.
3. OEM oriented: the OEM of a car can offer software downloads to update the embedded software on the platform to ensure product quality control.

These business models are not incompatible and can work together, as Apple proved with its iPhone, iPad, and App Store. Numerous variations of the following scenario are possible: an OEM develops and sells an application through app stores developed and run by other companies. Some of these applications can only be used by paying another service provider. For example, an application offers a travel planner based on GPS which provides dynamic routing. It takes into account current traffic information which must be purchased by the local road infrastructure system.

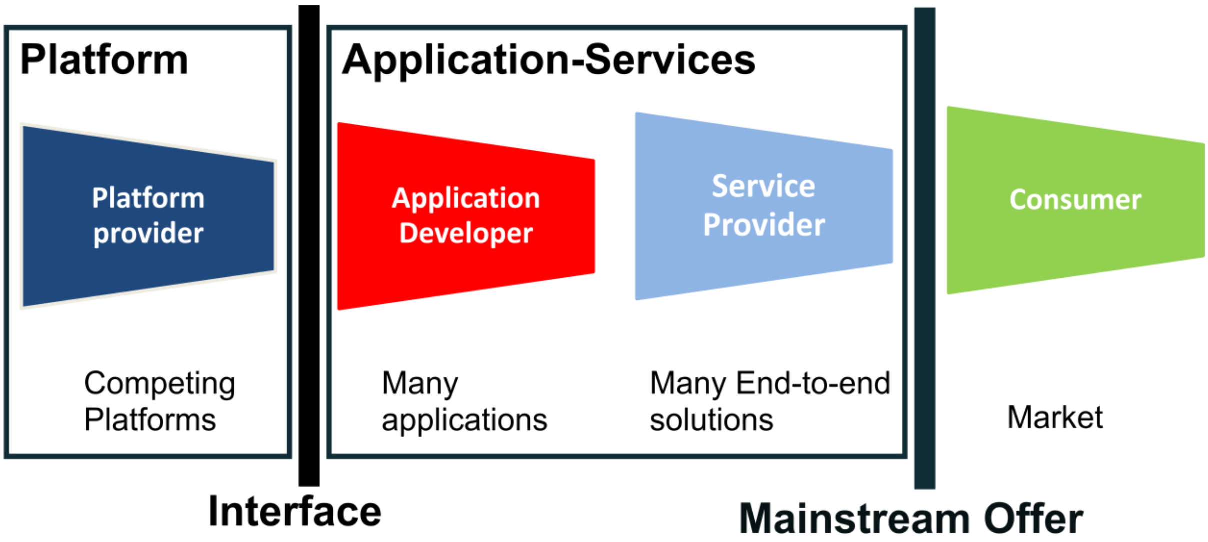

Figure: Interfaces for application and service development

Summary, Challenges and Outlook

Open in-vehicle platforms and ITS stations are a promising concept for the deployment of ITS in road transport. While many related technical problems have been solved, the deployment stage is still missing and some challenges have to be taken into account. Advent of ecosystems depends on widely available technology, associated standards (see section **Standardisation**), compatible business model (see section **Business Ecosystem and Business Models)**.

The future open in-vehicle platforms have to tackle with the following challenges:

- Innovation integration: platforms must flexibly integrate new features (e.g. a data protection mechanism).
- Transversal features integration: Scalability, Quality of Services or liabilities are instances of feature that shall be support by an open in-vehicle platform
- Interoperability: An open in-vehicle platform has to be interoperable. It leads to some questions. Does it really reflect consensus for non agreed items? Do some standards might defeat the interoperability?
- Technology independence

- Multiple business models and multiple service providers: the platform shall enable multiple applications and services to run at the same time
- Privacy enforcement in an environment with multiple applications. Isolation has to be ensured between and within independent vehicle-based applications and interactive applications also for road safety motivation. See (17) for an analysis of barriers.
- Understanding the legal implications of using a platform supporting isolation in terms of liability and possibly developing features that take into account the resulting technical and assurance requirements.

The proof of concept phase provides technical results that can be built on. This is being done by projects as OVERSEE, which demonstrates an approach based on partitioned systems. The technical solutions proposed by this project address a number of challenges and can be easily combined with results from other projects. For example, PRESERVE could be implemented as the Secure Services Partition of OVERSEE, or CVIS could run on top of OVERSEE.

The OVERSEE platform relies on a hypervisor and therefore enforces all the requirements concerning temporal and spatial isolation (18). This allows mixed critical applications to run on the same platform, which enables multiple parallel business models. Moreover, it ensures fewer legal issues due to data and privacy protection (17).

Therefore, the next step toward the global use of an open in-vehicle ITS Stations is composed by two parallel activities: Standardisation and Common Open Platform Initiative. The initiative should be motivating by the reuse of the results of previous project, the proof of scalability at an industrial level and rely on existing and future standards.

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