

# Study of standards and national ITS architectures within the E-FRAME project

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## ABSTRACT

Modern Intelligent Transport Systems (ITS) are now being widely deployed; in order to ensure that these deployments will bring maximum benefit to end users and other stakeholders, an ITS architecture, which defines how the deployed system would fit into overall ITS structure, has to be defined. Help is available to achieve these goals from the European ITS Framework (FRAME) Architecture, now being upgraded by the European project E-FRAME. Within this project also the importance of mutual influence between standards and architecture is judged.

**KEYWORDS: ITS architecture, European FRAME architecture, E-FRAME, standards, cooperative systems**

## 1. Introduction

ITS systems nowadays provide a useful tool for increasing safety, capacity, comfort and other parameters of transport systems. In implementing ITS systems, however, complexity grows with the number of installed systems [1]. This poses a threat to their effectiveness, manageability, maintainability, extendibility, refurbishment over time and to overall costs. For instance, if a city wishes to implement ITS systems for Public Transport management, Parking Management, Traffic Management and Traveller Information, it would also like them to cooperate, at least to a certain level and to produce benefits of synergy, rather than to counteract or contradict each other. It is therefore evident that having a certain level of integration and interoperability would produce significant benefits in terms of consistency, maintenance and overall cost. Refurbishment with newly emerging technologies over time and extension with new systems

and services would also be easier, more effective and less expensive. Overcoming the possible problems with too many incompatible systems, and benefiting from possible synergies of having interoperable systems, requires the use of agreed Architecture.

## 2. ITS architectures

According to [2] and [3], the basic objective for the creation of a transport-telematic architecture is the achievement of the interoperability between individual telematic applications, including the maximum use of available infrastructure by all telematic applications, while keeping their own individual system requirements (technical requirements: safety, reliability, availability, integrity, etc.; transport related requirements: transport comfort, minimisation of external requirements of the transport related process, maintaining transport policy objectives at national and European level, etc.).

The result of the ITS architecture should be a design of individual subsystems and functional blocks, including the definition of their system parameters for OBU (On-Board Unit), telecommunication environment and processing centres for all kinds of transport telematic applications. Correctly conceived architectures of transport telematic systems in systems development have a direct impact on the following factors:

- Efficient building of telecommunication environment and corporate networks reduces their expenditures;
- Considerable reduction of transmitted information reduces expenditures of transmission,
- Definition of requirements from the part of organisations allows the existing operators to offer services with these over-standard requirements, which results in reduction of expenditures when building special telecommunication environments,
- Economical convenience of new solutions of the information transmission leads to the increase in demand for new telecommunication networks technologies, particularly in the field of access networks,
- It is possible to secure modular development of telematic systems in single branches and organisations using the existing systems.

Going all the way down in development of telematic applications with the use of ITS architecture would result in unique architectures for each deployment, therefore it was realised that it would be much more efficient to have a Framework Architecture, from which individual ITS Architectures can be developed. In 2000 the European ITS Framework Architecture was prepared by a European Commission funded project KAREN [1]. The principal advantages of doing this are:

- It is quicker, and therefore cheaper, to produce a suitable ITS Architecture from a Framework Architecture,
- Each derived ITS Architecture has the same properties as the Framework Architecture from which it has been produced. This facilitates the use of similar equipment in different deployments, and thus extends their potential market.

## 2.1. FRAME

The European ITS framework architecture (FRAME architecture) provides the high level view of ITS systems and their implementation. Together with standards, it helps national, regional and local authorities, as well as service providers, to plan and realise their goals within ITS in a way that is coherent, cost effective and extendible in area and over time. It also helps industry and service providers to produce and procure in a cost-effective way in markets that are European in scale. Travellers and drivers do not directly use the European ITS Framework Architecture, but may be involved in market research when a specific ITS implementation is defined and will experience the benefits of its results once implemented.

The European ITS framework architecture is technology independent, i.e. particular technologies are not included. Thanks to this fact the FRAME architecture is durable and enables the use of different technologies even those that are not yet introduced. The FRAME architecture is based on functions. During an ITS implementation using FRAME architecture the requirements are based on stakeholder aspirations, i.e. demands that ITS stakeholders have on the ITS system. The stakeholder aspirations (often expressed in natural language) are transformed into User Needs – from a formalized set of more than 500 needs covering most possible ITS application and services. Necessary functions to fulfil these User Needs are defined in the functional viewpoint (formerly called functional or logical architecture). These two items are covered by the FRAME Architecture (see Figure 1). Based on the Functional Viewpoint the Physical Viewpoint and subsequently Communication Viewpoint (formerly called physical and communication architecture) are developed.

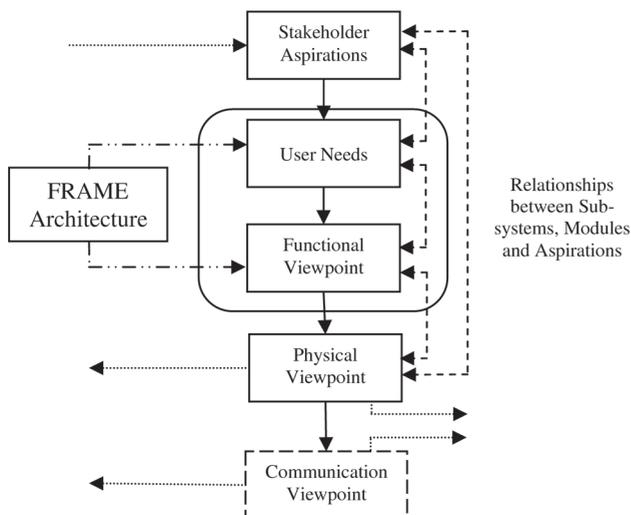


Fig.1.The FRAME methodology

## 2.2. E-FRAME

From its beginning, the FRAME Architecture is being continuously upgraded and supported by subsequent European projects (FRAME-NET, FRAME-S). The current support project, E-FRAME (2008-2011) aims to integrate the functionalities needed for the implementation of cooperative systems into the architecture. Main goals of the E-FRAME project are to provide support for the creation of inter-operable and scalable Cooperative Systems

throughout the EU, to extend the FRAME Architecture to include Cooperative Systems, and to show how it can be used to develop and implement Cooperative Systems throughout member states or regions, and provide one-to-one advice and guidance to nations, regions and projects and to provide a centre of knowledge that is commercially and politically neutral, and which serves everyone's long term interests.

### 3. Current national ITS architectures in Europe

It has been stated that FRAME architecture provides the groundwork for the creation of national ITS architectures. These national ITS architectures can be adapted to local specifications covering their special local needs – e.g. User Needs for ITS systems can differ for a given regional or national area and the ITS architecture has to follow these demands. For this reason, part of the E-FRAME project is studying existing national ITS architectures to find out the way they have been created, the standards/tools that have been used, and the impact of created architecture on deployment of ITS and also on the development of new standards or the updating of the existing ones.

The history of national architectures goes back to the end of 1990s when the first national architectures (in a similar time as the FRAME architecture) were created. It was the result of recognizing the need for ensuring cooperation between different quickly developing systems, which were resulting from the boom of technologies. Since that time several European countries have introduced their national architectures. The important ones in Europe are as follows [4]:

- In France the ACTIF architecture (first version) was produced in 2000. It is a high level architecture based on a draft of the FRAME architecture. It is used to model the subsystems needed for ITS implementations and has been applied by a wide range of jurisdictions and organisations in France. The ACTIF architecture has undergone a number of major updates and is now in Version 5, which incorporates the results of case studies into the architectural framework. These studies are also meant for broad technical and political audience to help them understand where does the architecture help and where it can be used to their benefits,
- Italian ARTIST architecture was created in 2003 based on the European FRAME architecture and ACTIF architecture. It is used by different subjects – e.g. EU projects, universities, local authorities, etc. The emphasis is laid on multimodal transport of hazardous

goods, integrated management of emergency calls and goods distribution in urban areas. Since it also deals with the organisational and business aspects of ITS, it has introduced an Organisational Architecture,

- Finnish TelemARK architecture was produced in 2000 and although not based directly on KAREN, it has been shown to be equivalent. The results were disseminated through series of training workshops for specific stakeholders. Update of the architecture was provided by FITS programme. Also a corresponding architecture for goods transport has been created,
- Norwegian architecture ARKTRANS has been developed separately from both the European and the US National ITS Architecture. It emphasises the functionality and data flows for multi-modal trip planning with lots of experience from the maritime transport,
- In Austria, the TTS-A architecture was introduced in 2002, and took the FRAME architecture as its “template”. The use of an ITS architecture is required by the Austrian Telematics Master Plan. TTS-A should also cover implementation recommendations based on landscape study of an available technology,
- In the Czech Republic, TEAM architecture was launched in 2005. It is based on the French ACTIF architecture. Now it is being redesigned not only to bring in new functionalities, but also to make the ITS architecture easier to use,
- Hungarian ITS architecture HITS is based on the FRAME architecture. It is still under development. In future it is planned to make the usage of ITS architecture compulsory,
- Also under development is the Romanian ITS architecture NARITS. They have been translating the FRAME tools, and it is planned to use them to build a national ITS architecture when funding permits,
- In the United Kingdom a national ITS architecture does not exist. However, there are several architectures created at the regional level such as the architecture of the County of Kent, and for Transport Scotland. These architectures have not been developed further.

There have been several national projects aimed at the creation of national ITS architectures, project acronyms and their schedules are partially mentioned above. All mentioned projects and their resulting architectures have been influenced by the FRAME architecture, some of the architectures are directly based upon the FRAME. However, it is important to notice that creation of the architecture is “the easy part”, once it is created, it has to be continuously supported by the government and even embedded in requirements for ITS projects. Without available support and regulations an ITS architecture will never be widely used.

## 4. ITS architecture and standards

Standards are required to ensure compatibility between various sub-systems and components of ITS. This is particularly relevant when the various sub-systems and components may be produced by a number of different manufacturers. The standards ensuring this are usually concerned with communications between sub-systems and their functions. However, “simple” communications standards are not always sufficient to produce a working and workable system. Of equal importance is the data that they use, and the behaviour of the sub-systems and functions at each end of the communications link, e.g. that one end can produce information in time for the other to make use of it, and the receiving end will understand the units and format in which the data is being provided.

The above mentioned standardization issues are important when an ITS architecture is used to identify required functions, data flows and interfaces for a particular ITS project. In addition the architecture (even FRAME architecture) itself has to have some framework, within which it could be created. Such a framework is created by architectural standards. Architectural standards define the behaviour and properties of data registries and dictionaries, requirements on the use of architecture, requirements on the modelling tools for architecture creation, templates and some of them even define the ITS architecture itself.

Five categories of standards can be defined according to their place in ITS architecture definition / usage:

- Architectural standards – used only when the architecture is being created or updated. They have no influence on ITS systems,
- Communication standards – used at defined interfaces, where data transmission from one function to another function is needed,
- Data and interface specification standards – used for definition of data structures needed inside ITS functions and behaviour (data / protocol) of the function interaction,
- System parameter specification standards – used for setting the levels of functionality, robustness and interoperability of ITS functions within desired functionality,
- Test procedures standards – used for ensuring that particular ITS components could be used within specific ITS function,

The analysis of the influence of architectural standards on (national) ITS architectures should reveal if they have been used and how. For certain use of an ITS architecture

it is necessary to have a link between functions and “function related” standards (third to fifth category). The communication standards (second category) are usually outside of the scope of high level architecture (European and national). The reason for this is the fact that the FRAME Architecture does not describe any physical and communication viewpoints and is independent of technologies.

Figure 2 depicts the relation between standards and architecture. Arrows symbolize the flow of ideas or information and mean certain type of “one sided” action, i.e. standards for the support of architecture helps to form / define the architecture, while other standards come from the architecture either as a requirement for new standards (at newly defined interfaces) or as set of existing standards which have to be followed.

Three types of influence on the standards can be summarized as follows:

- Have standards been used to create the architecture?
- Has architecture been used in creation of standards?
- Have standards been included into the architecture for some purpose?

### 4.1. Have standards been used to create the architecture?

According to our analysis there is no eminent influence of architecture definition standards on any particular ITS architecture creation. Framework ITS architectures and smaller scale ITS architectures, (designed from a framework ITS architecture), were not explicitly influenced by any of architectural standards. The only exception is the national ITS architecture of Australia where the ISO standardized ITS architecture was used. Other architectural standards just specify how the architecture should be used in standards and implemented in real life (in the form of recommendations and examples), therefore they cannot have any effect on creation of an ITS architecture.

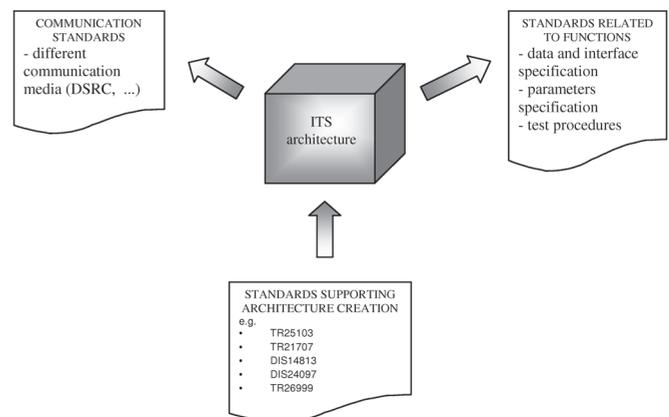


Fig.5. Relationship between ITS architecture and different types of standards

#### 4.2. Has architecture been used in creation of standards?

One of the primary reasons for the creation of the US National ITS Architecture was so that required Communication Standards could be identified. Version 1 led to the setting up of a large number of IEEE standard Working Groups and, about 40-50 new Coms standards have been created.

However, this was not the case for the FRAME ITS architecture, where higher abstraction level does not support identification or creation of new communications standards. According to our findings, other standards which emerged from ITS architecture creation were again architectural standards (technical reports), i.e. implementation standards, requirements on architecture description in standards, etc.

#### 4.3. Have standards been included into architecture for some purpose?

Standards are in particular national ITS architectures (e.g. TEAM) linked to functions and data flows. The effect of this linking is beneficial if the architecture is used for setting up conditions for new ITS projects. Then conformance requirements to standards for certain functionality of ITS project can be automatically used while contracting for the deployment of ITS systems.

### 5. Conclusion

ITS architecture is a powerful tool that eases the creation and enables the compatibility of ITS systems. There are several types of architectures, in Europe the ITS framework architecture FRAME is a high level architecture that supports the creation of national architectures.

Experiences show that so far standards that also serve for ensuring compatibility of systems do not provide efficient support for ITS Architecture creation and are not used. In addition the other way of influencing has not been used in Europe – created architectures have a very low impact on standards under development. Standards for architecture creation face the disadvantage of not being able to react enough quickly to the development of methodologies and therefore they are not able to give timely support.

In several situations the use of ITS architecture is recommended or should even be obligatory. If there are also standards in agreement with the architecture the conditions for contracting the deployment of ITS systems would be simpler. The area where the mutual relation between architecture and standards might be useful was identified to be standards that relate to system functions, and not to the physical level, as reflected in the fundamental principles of European ITS Framework architecture.

Promoting this relation and cooperation of architectures and standards is one of many goals of the E-FRAME project.

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