# APARTICULARY COMMONGOAL

Both the European Commission's ITS Action Plan and ITS Directive make reference to the term 'architecture' - but is its meaning entirely clear in an ITS context? PETER JESTY and RICHARD BOSSOM explain how the FRAME Architecture, first published as the European ITS Framework Architecture as long ago as 2000, can be used to support the requirements of the ITS Action Plan and ITS Directive



The saying that "the whole is greater than the sum of its parts" applies rather neatly to Intelligent Transport Systems Architecture. An ITS Architecture provides a framework to plan, analyse and understand the business, organisational and technical consequences of integrated ITS.

The European ITS Framework (FRAME) Architecture was created to provide a common approach or 'language' throughout the EU to enable ITS to be integrated, for example when planning cross border services. It covers most ITS applications and services that are currently being used or considered and the tools to support its use are freely available on the Internet at www.frame-online.net

So, does it work? The FRAMEArchitecture was first published decade ago in 2000. Version 4, which includes Cooperative Systems, was published in 2010 and it has been used successfully in different ways by a huge number of nations, regions, cities and projects throughout the EU.

Just as pertinently - is it difficult to use? Because the FRAME Architecture is intended for use within the European Union it conforms to the precepts of subsidiarity and thus does not mandate any physical or organisational structure on a Member State. As a consequence, the creation of a fully documented

national, regional, urban or project architecture subset of the FRAME Architecture is a significant task that requires training for the few (usually somewhere between two and five) people who will undertake the actual work of creating the ITS Architecture The resultant ITS Architecture itself will be understood easily by those who need to use it.

# A top-down approach

The FRAME Architecture is intended to be used within a top down approach to the planning and deployment of ITS. Its use may, or may not, be preceded by the creation of a formal reference model to describe the overall concept. Since this is a decision for a Member State, FRAME does not provide one. In the top-down approach, all ITS Architectures should have a system structure which shows, as a minimum, the functions that create the ITS Application or Service (the Functional Viewpoint) and the location of those functions together with the data that flows between those locations (the Physical Viewpoint).

Further analysis can be carried out to provide, for example:

- Organisational Viewpoint who owns, manages and operates each physical unit and other organisational issues;
- Information Viewpoint information that is used, its attributes and relationships: "FRAME has
- Communications Viewpoint requirements for communications between physical units in each location.

The FRAME Architecture enables the overall concept and system structure to be described in a manner that is technology independent. This is to ensure that, as technology evolves, all the higher level requirements can remain unchanged.

The information contained within the system structure is sufficient for manufacturers and system providers to produce their equipment and provide their services, each with their own distinctive features, but all conforming to the common purposes expressed in the overall concept and system structure. Thus standards can be identified and ITS services can be provided across the EU in a similar way.

"The FRAME Architecture has proven to be an efficient tool in the elaboration of a national or regional architecture for advanced services to travellers," explains former European Commission DG INFSO Head of Unit, André Vits. "Several Member States have given their support to this approach, but many more should consider using the FRAME documentation in their procurement process and signing up to the FRAME Forum Board,"

#### **Description techniques**

The technique used to describe an architecture will, to some extent, depend of the type of architecture being described. Since an architecture is a form of requirement specification it needs to be understood by those who will specify and use it as an architecture, as well as by those who will use it to develop systems that conform to it. Thus, for example, most modern software architectures are described using an object-oriented (OO) approach using UML, which is the technique software engineers are most familiar with, and is commonly used during system design.

An ITS Architecture, however, describes the system structure and needs to be understood by all those involved with planning ITS applications and services, eg traffic engineers, electrical/ electronic engineers, regulators, traffic managers and road operators, and experience has shown that when ITS Architectures have been created using OO techniques with UML they have not been understood and therefore not used.

The FRAME Architecture therefore follows the approach taken successfully in the USA and uses Data Flow Diagrams, which are not only suitable for describing function-oriented processes, but are also intuitive to read and easily understood.

Says Vits: "As 'cooperative systems' based on vehicle to vehicle and vehicle to infrastructure communication are emerging and many projects are prototyping both hardware and software for these new applications, there was an urgent need to expand the FRAME architecture to include these functionalities, thus also new data elements and data flows. I would therefore recommend developers and transport operators to consult the FRAME architecture and provide along their work feedback to the authors."

# The FRAME contents and methodology

A distinctive feature of the FRAME Architecture is that it is designed to have sub-sets created from it and therefore it is

unlikely to be used in its entirety. Indeed, on occasions, it contains more than one way of performing a service and the user can select the most appropriate set of functionality to deliver it in that environment. Thus the FRAMEArchitecture is not so much a model of ITS implementations, as a framework from which specific models of ITS implementations can be created in a systematic and common manner.

As mentioned previously, the FRAME Architecture was first published in 2000 and with the recent additions from the E-FRAME project, it now covers the following areas of ITS:

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- Emergency Notification and Response Roadside and In-Vehicle Notification;
- Traffic Management Urban, Inter-Urban, Parking, Tunnels and Bridges, Maintenance;
- Public Transport Management Schedules, Fares, On-**Demand Services:** 
  - Driver Support Systems including Cooperative Systems;
- Traveller Assistance Pre-Journey and On-Trip Planning, Travel Information;
  - · Law Enforcement;
  - · Freight and Fleet Management; and
  - Provide Support for Cooperative Systems.

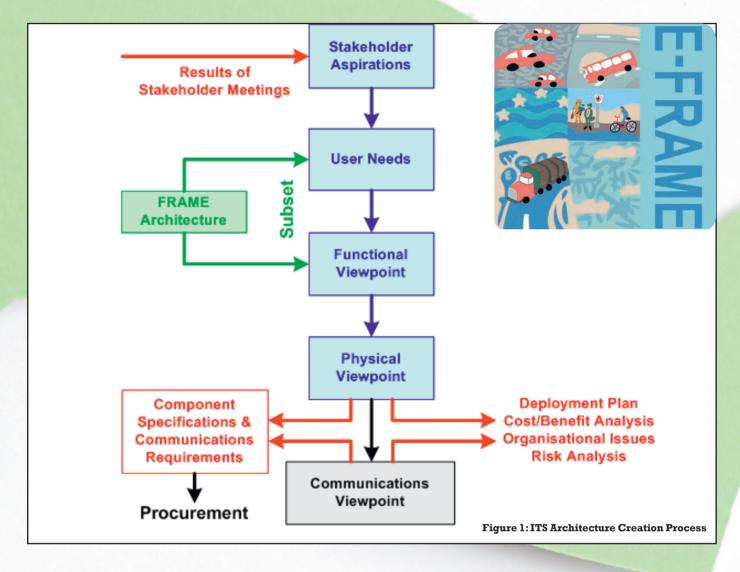
#### **User needs**

Since the FRAME Methodology does not impose any structure on a Member State, the FRAME Architecture comprises only a set of User Needs which describe what ITS can provide, and a Functional Viewpoint showing how it can be done.

The Methodology, which is supported by computer-based tools, assists the creation of logically consistent sub-sets of the FRAME Architecture Functional Viewpoint and the creation of subsequent Physical Viewpoints.

The FRAME Architecture can be used in a number of scenarios, one of which is to plan large-scale integrated ITS deployment over a number of years. Starting from a vision of





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what the various stakeholders, eg politicians, engineers and travellers, would like to have, a sub-set of the FRAME Architecture is used to provide a high-level model, or ITS Architecture, of the way that ITS will be implemented to provide it. This can then be analysed, for example for safety issues; a deployment programme can be created, and high-level product specifica-

tions can be produced for Calls for Tender from various equipment suppliers and system integrators.

#### Multi-modal issues

Whilst the FRAME Architecture is centred on road-based ITS, there are occasions when it is necessary to receive data from and/or supply data to other transport modes. In addition to the "obvious" exam-

ple of travel information, there are other traffic management examples associated with road traffic crossing another mode, for example lifting bridges over canals, rail level crossings. The FRAME Architecture accommodates these situations by having an entity that represents the other modes, and the data that passes to/from them.

#### Prime stake

Once the Stakeholders for a region or city have identified how they would like to manage their traffic and public transport, the architecture team can identify the corresponding User Needs and hence the functions that will provide the required applications and services. It is not normally necessary to create diagrams of the resulting Functional Viewpoint. Before the Physical Viewpoint can be produced, consideration has to be taken both as to where it is sensible for each function to be located (eg, communications and maintenance issues) and who

> will own, manage and operate them, and their inter-relationships.

> The functions are then allocated to locations, or sub-systems, and the resultant Physical Viewpoint can be created. It is often advantageous to split the functionality of a large sub-system into a number of Modules. See Figure I above.

> An analysis of the data that flows between each sub-system will provide the required

characteristics of each link (the Communications Viewpoint). If suitable standards exist then they can be used, or a new standard can be created if necessary. When deployment is to take place over a number of years it will be necessary to choose the order in which this will be done.

Sometimes this is dictated for technical reasons (this will not work until that is in place), but on other occasions the decision may have political overtones. In the latter situation it can be useful to create a matrix showing the relationship between Stakeholder Aspirations and the physical sub-systems and modules.

# **Cooperative systems**

Cooperative systems will not be deployed in isolation to any other ITS application or service, indeed many cooperative system services require information from a traffic management system.

The FRAME Architecture now contains all the applications and services that were considered by the COOPERS, CVIS and SAFESPOT IPs and can thus show how this may be done. Once a Physical Viewpoint has been created for the local situation, the corresponding Communications Requirements can be identified. It is at this point that the work of the COMeSafety and PRE-DRIVE-C2X projects, and/or the corresponding standards produced by CEN and ETSI as a result on Mandate M/453, can be consulted to define the communications links fully.

### Action stations: a directive

The ITS Action Plan and ITS Directive require the provision of certain EU-wide applications and services and the creation of one or more "architectures" to support them. Once the European Specification for each ITS application and service has been agreed, an ITS architecture for it can be created using a sub-set

of the FRAMEArchitecture. This will enable the required standards to be identified and, if necessary, their creation initiated. It will also provide a technology independent description of each application and service so that manufacturers and suppliers can ensure their products will work together as required. This creation of each European Specification should be undertaken by a team of experts in the topic under consideration, with the addition of a small ITS Architecture team who will also ensure a common "look and feel" to the result.

It should be noted that this process will inevitably result in the creation of Physical Viewpoints for use throughout the EU and that, over time, the need for separate bespoke ITS Architectures will diminish. Just some of the advantages of taking this approach include the following. Each resulting ITS Architecture will be based on the FRAMEArchitecture, and thus use the same terminology. Common elements will be easy to identify, as will be the merging of two or more ITSArchitectures. The latter will be important as Member States create their own ITS Architectures and need to include those that result from the ITS Action Plan or ITS Directive.



## Other stakeholders

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There are a number of existing stakeholders, for example POLIS and EasyWay, who are already following certain agendas. Other initiatives, such as that for Cooperative Systems, have created a number of architectures/viewpoints of their own.

> If these are to come together as partners in Europe-wide integrated ITS, then they all need to be part of a process and to contribute to the creation of an overall concept to ensure that their desires are mutually consistent. It will also be necessary to ensure that the rôles of all those involved in a complex set of applications such as Cooperative Systems are properly defined, ie no gaps or overlaps. It is assumed that such work will be facilitated by the European Commission.

The FRAME Architecture can support this

work by providing consistent descriptions of system structures that all relevant stakeholders can (be trained to) understand. It may also be used to support the creation of the overall concept by providing alternative solutions, and to define the chosen integrated ITS that results.

Says André Vits, fittingly: "It is extremely important that the effort put in drafting the FRAME architecture finds its way into the development of standards. This needs a firm commitment of both industry and Member States to achieve and adopt these standards as soon as possible." TH

> For more iinformation on FRAME and E-FRAME vist www.frame-online.net or email info@frame-online.net

