RICHARD BISHOP, PETER JESTY and RICHARD BOSSOM on how designing and defining the architecture of intelligent transportation systems is far from simple…but ultimately worthwhile and rewarding

Drawing inspiration

Integrated ITS offers benefits across the board. The promise is more efficient systems - for instance, why not collect data once and use it many times?

Mature ITS deployments are expected to be large complex systems. Given this, systems engineers recommend the creation of a Systems Architecture early in a system's lifecycle to define its structure and/or behaviour. Hence the use of Intelligent Transport Systems Architecture, or ITS Architecture, is part of good engineering practice.

If a common ITS Architecture is used for a number of ITS deployments, citizens will see a planned approach in which compatible equipment works everywhere and in the same way. Authorities and operators will see a planned approach, which is technology-independent with defined standards, multiple sources for equipment, and hence suppliers in competition. Manufacturers will see a planned approach, low risk investment and a large market place.

What does "architecture" mean anyway?

"Architecture" is such a familiar word but with rather nebulous meaning, depending on context and speaker. In fact its use should be inferred as an adjective meaning "a regular defined structure" rather than as a noun that implies "this is the way to do it". The term 'Architecture' has a number of different meanings within ITS...and, not only may an ITS Architecture comprise a number of different 'viewpoints' (looking at something from different angles), but some aspects, eg behaviour, may be described at higher levels of abstraction (using 'reference models').

Unfortunately, many people do not fully understand the implications of this nebulousness. The FPIV project CONVERGE-SA (1996-98) did explain how everything fits together as "Levels of Architecture" but even this explanation is not always understood and/or applied correctly. Academically speaking, we are in the field of Functional Logic Abstraction (at more than one level).

"The FRAME Architecture provides a common language with which to describe ITS applications"

Flexibility: good news, bad news

The FRAME Architecture, mostly funded by the European Commission, was first published in 2000 to support the deployment of integrated ITS throughout the EU. It comprises a set of User Needs, which show what ITS services provide, and a Functional Viewpoint, which show how they do so. Information on FRAME is at http://www.frame-online.net/.

Since there is currently no agreement between the EU Member States as to how particular ITS services shall be regulated, managed and provided, FRAME does not currently provide advice on how its functionality should be incorporated into physical entities that would be shown in a Physical Viewpoint. However this may change as a result of the implementation of the ITS Action Plan and ITS Directive.

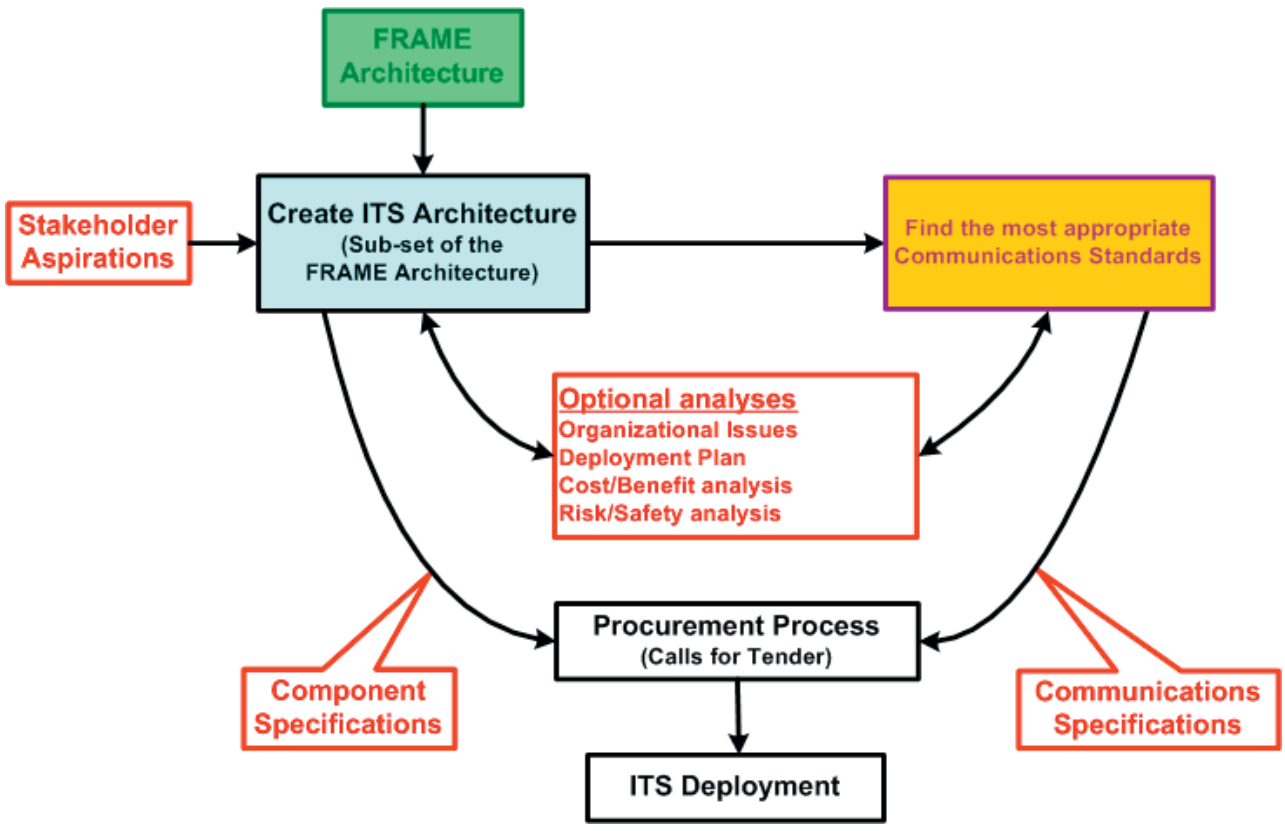
The FRAME Architecture can be used in a number of scenarios, one of which is to plan large scale integrated ITS deployment over a number of years. Starting from a vision of what the various stakeholders, eg politicians, engineers and travellers, would like ITS to do, a sub-set of the FRAME Architecture is used to provide a high-level model, or ITS Architecture, of the integrated ITS that will provide it. This can then be analysed, for example for options, cost/benefit and risks; a deployment programme can be created, and high-level product specifications can be produced for Calls for Tender from the various suppliers (see Figure 1 below).

Since there is not a pan-European approach to implementing ITS services, FRAME has to be very flexible. But flexibility can be both a blessing and curse since using FRAME in a specific instance can sometimes take more that just an hour or two. This is in contrast to using the US National ITS Architecture, which in some instances is quite straightforward, helped by the fact that due to the "federal" approach to ITS in the US, it has a Physical Viewpoint. However many of the features and the services it supports are specific to the US.

FRAME encompasses cooperative systems

The FRAME Architecture may also be used to provide a common language with which to describe ITS applications and services anywhere with the EU. These descriptions can then be used as the basis for Standards, eg as a result of European Commission Mandate M/453 for the completion of standards, and/or common deployments, e.g. as a result of the ITS Action Plan, ITS Directive or as part of the EU-US Task Force.

Thus the FRAME Architecture goes hand-in-hand with the current cooperative systems standardisation activities. The latter focuses on the communications aspects, while the FRAME



Architecture focuses on the functional aspects, i.e. what the functionality does, and how it relates to other services. Together they provide a full definition of a cooperative systems architecture and thus form a key role in the deployment of cooperative systems, as part of integrated ITS, across Europe.

FRAME-ing architectures Europewide

The FRAME Architecture has been used successfully to create ITS Architectures for a number of EU Member States, Regions, Cities and Projects. Some nations, such as Norway and Germany, are using (high-level) reference models to understand the required behavior (command and control) of their ITS before "coming down" to a level at which the FRAME Architecture could be used. This creates an unnecessary misunderstanding when those architectures are sometimes referred to as "a non-FRAME" architectures. In actuality, they are doing a "FRAME-plus" approach.

The FRAME Forum

Whilst at first sight it might seem to be a contradiction in terms, the FRAME Architecture will need continual maintenance to reflect the changes in ITS over the years. Thus it does not have the properties required of a Standard, which has to remain fixed over long lengths of time.

There is a consequential need for the FRAME Forum, comprising representatives of its users, to manage this maintenance into the future.

The FRAME Forum specifically avoids any commercial bias to maintain credibility. Becoming members of the FRAME Forum will help key stakeholders manage the future of the FRAME Architecture.

IntelliDrive℠: the US ITS Architecture

The ITS Joint Program Office within USDOT/RITA has embarked on an in-depth update to the US ITS Architecture to incorporate the needs of the IntelliDrive℠ program. During the Vehicle Infrastructure Integration era, a VII Architecture was produced which represented current thinking. Walt Fehr, who leads this activity for the ITS JPO, notes that it has been several years since this update was performed, and now they want to do carefully document today's approach within IntelliDrive℠.

The work, conducted by Lockheed-Martin under contract to the JPO, will start with defining user needs, upon which a concept of operations will be developed. From the con-op, requirements will be defined, and the resulting architecture will be based on these requirements. The process is now in its early stages and Fehr projects that this effort will generate some outputs in summer 2011. They are interested in "looking sideways and over the shoulders of anyone involved," he says. Given the FRAME and similar activities in Europe, the opportunity is ripe for some substantial cross-Atlantic collaboration.

2011: key to cooperative ITS Deployment

2011 will see European Commission-sponsored cooperative field operational testing beginning, and most likely Safety Pilot starting in the US as well. Combined with these extensive architecture efforts we are seeing the essential steps taking place to lead to deployment of cooperative systems – and the resulting safety, mobility, and environmental benefits – later in this decade. TH

For further information on Europe's E-FRAME architecture see the online version of the November/December issue of Thinking Highways Europe/Rest of the World *edition*