Course: ITS solutions for traffic and safety management

Topic 5. European ITS Framework Architecture

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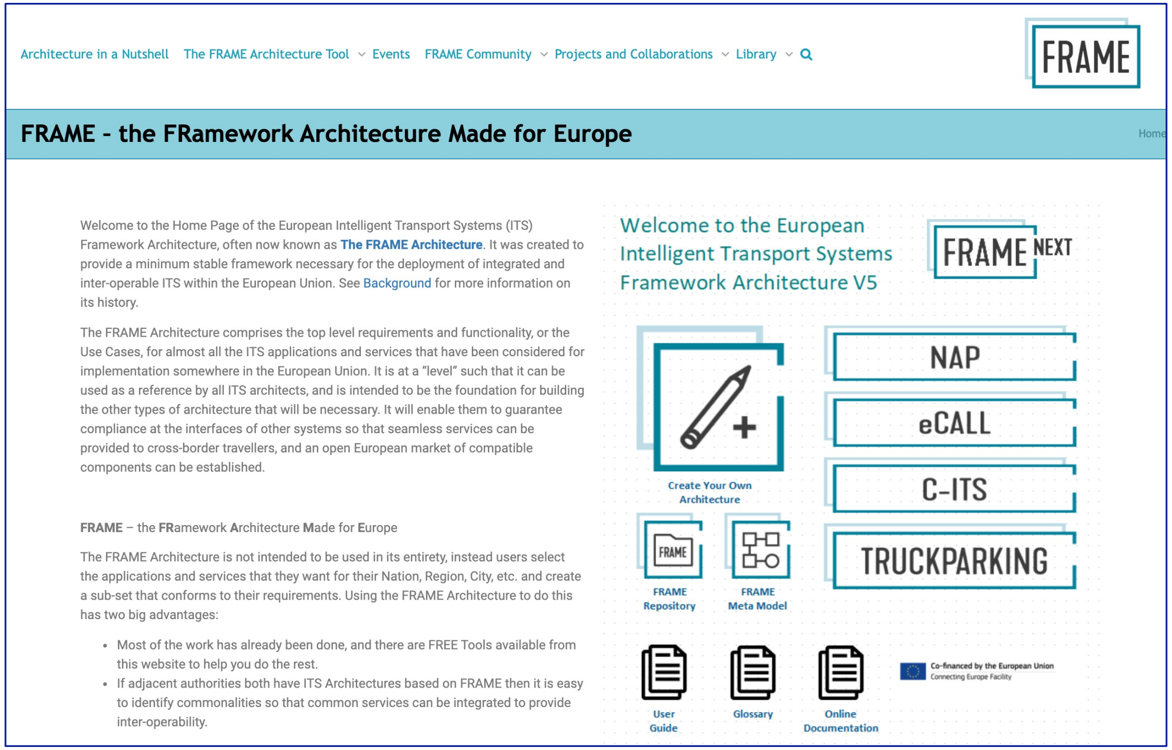
Website of European ITS Framework Architecture (FRAME)

https://frame-online.eu/

FRAME – the FRamework Architecture Made for Europe



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FRAME NEXT

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FRAME NEXT is a project that extends the European ITS Framework Architecture, in short FRAME, with the activities of the different member states in Europe, with the priority areas concerned by the ITS directive and with the methodologies and tools that make a modern ITS architecture attractive and appealing for its users. At the same time project partners from ten active EU Member States and Norway contribute their current developments and best practices and share their experiences with other stakeholders from public authorities and industry.

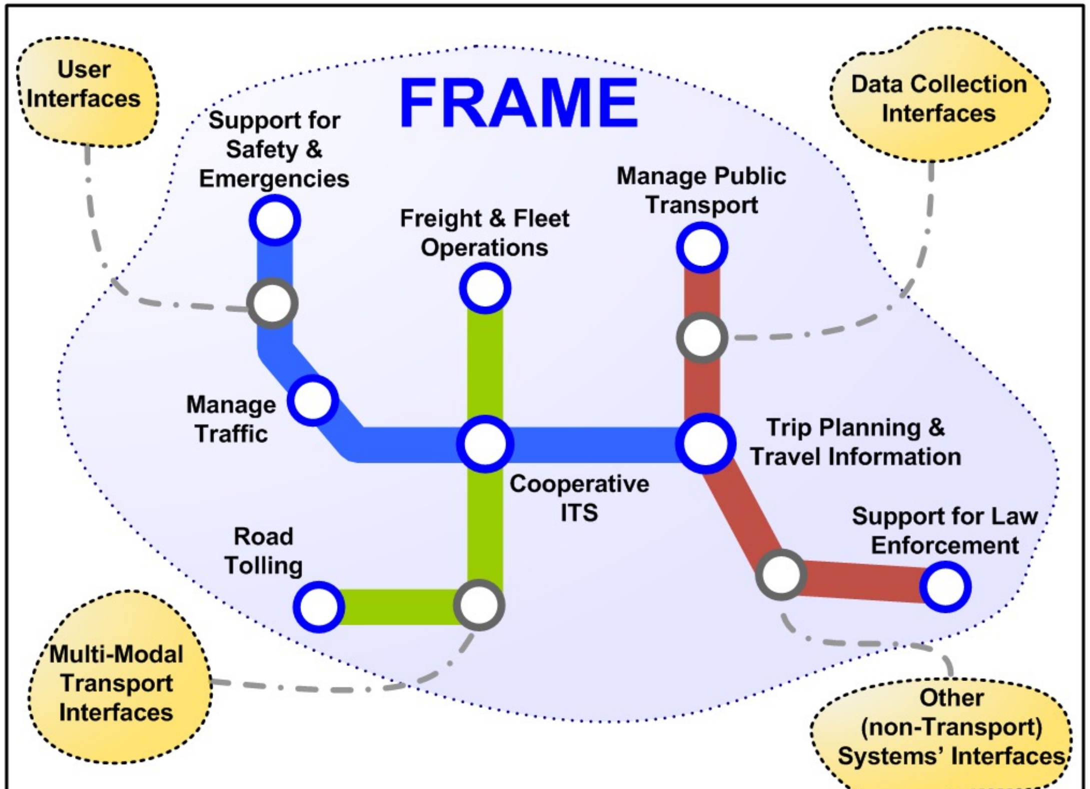
FRAME NEXT is a project that extends the FRAME Architecture with the activities of the different member states in Europe, within the priority areas of the ITS directive (Directive 2010/40/EU) and with the methodologies and tools that make a modern ITS architecture attractive and appealing for its users.

FRAME NEXT project has three main phases of work: State-of-the-Art Analysis, Evolution Cycle, and Dissemination and Outreach.

European ITS Framework Architecture (FRAME)

The European ITS Framework Architecture is also called the FRAME Architecture or is referred to as FRAME. On the basis of the FRAME Architecture it is possible to develop consistent architectures for various ITS systems and services that can communicate with each other at the urban, regional, national and international level.

The FRAME Architecture is a set of high level requirements and functionalities on the basis of which interoperable ITS systems and services can be designed. FRAME gives its users “a full freedom” because it does not impose any restrictions on designing ITS systems and services – it shows “what” needs to be done and not “how”.

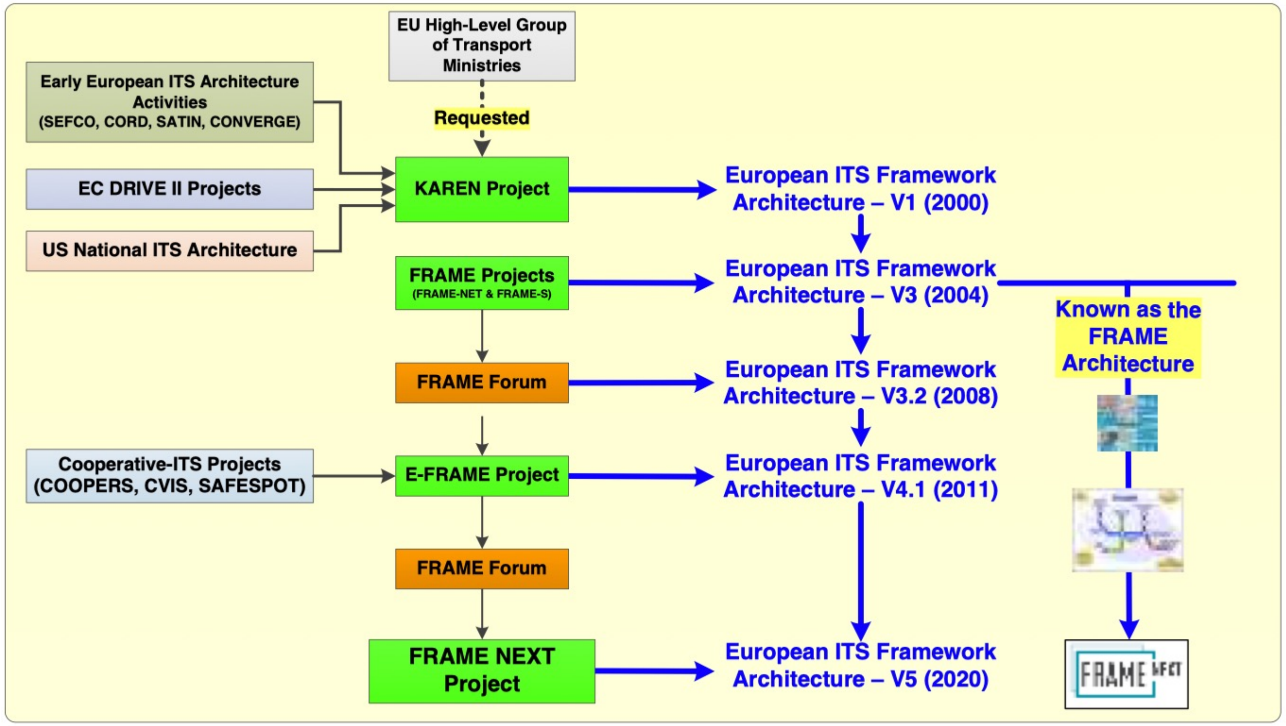


https://itslaboratories.com/frame-architecture/

European ITS Framework Architecture (The FRAME Architecture)

The European ITS Framework Architecture, now more familiarly known as "The FRAME Architecture", was developed initially during the 1990's and the first version was published in 2000 (see Figure 1). It is analogous to, but not the same as, the US ITS Architecture ARC-IT. FRAME has since been updated, and its tools enhanced, by the projects FRAME-S (2001 – 04) and E-FRAME (2008 – 11).

From 2017 the project FRAME NEXT has been continuing this work and, in particular, has revisited the tools that had been developed by the earlier projects. After a review of various possible new tools, it was decided to transfer the FRAME ITS Architecture to Enterprise Architect (EA) from SPARX, which also provides additional features.



Motivation

The ITS Architecture creation process should begin by collecting the aspirations of the various Stakeholders in the development of the new, or revised, set of services. These stakeholders are usually high-level engineers, managers and (sometimes) politicians, and it usually takes some time (months) to arrange the necessary meetings, and to formulate the desired set of ITS Mission Statements and hence the description(s) of the desired ITS Services (Figure 1).

Figure 1 shows a simplified, and traditional, set of processes. In practice, especially for a large proposal, additional aspects need to be considered (see Figure 4). Traditionally the management of road transport was always the responsibility of the public sector, but in more recent times the private sector is now also included, and hence the requirement for payment and profit, i.e. the Business Outcomes.

Figure 2 shows that these additional factors can have an influence on the later stages of the development and, if it is to go smoothly, and with no expensive 'surprises', these early stages must be concluded properly.

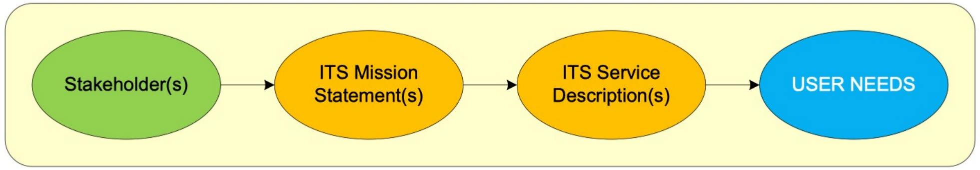


Figure 1. The High-Level Objectives

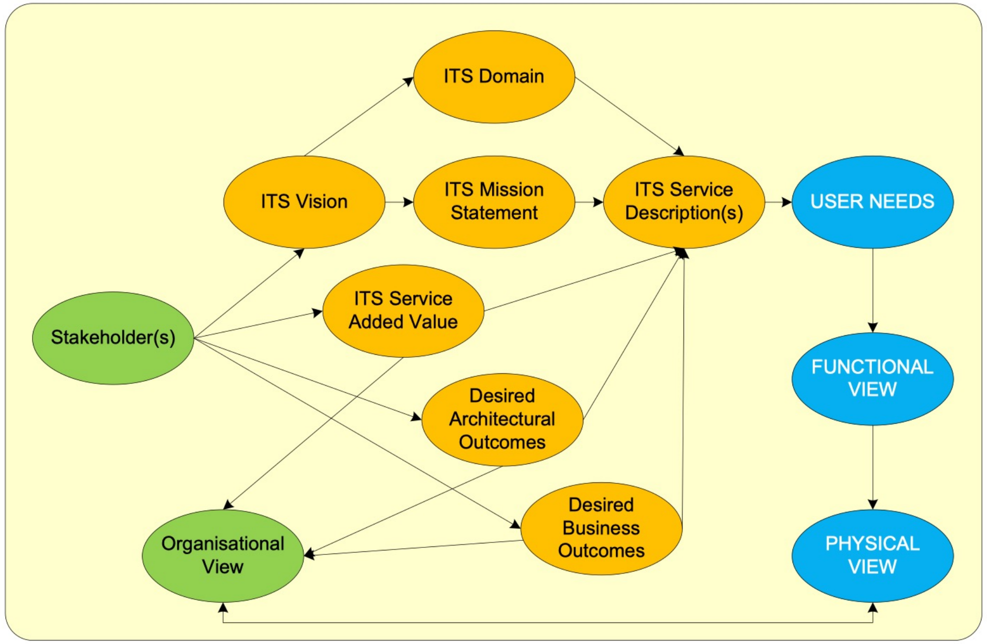


Figure 2. Detailed Objectives

HAMK HÄMEEN AMMATTIKORKEAKOULU HÄME UNIVERSITY OF APPLIED SCIENCES
TALLINNA TEHNIKAKÕRGKOOL TTK UNIVERSITY OF APPLIED SCIENCES
TSI TRANSPORT AND TELECOMMUNICATION INSTITUTE
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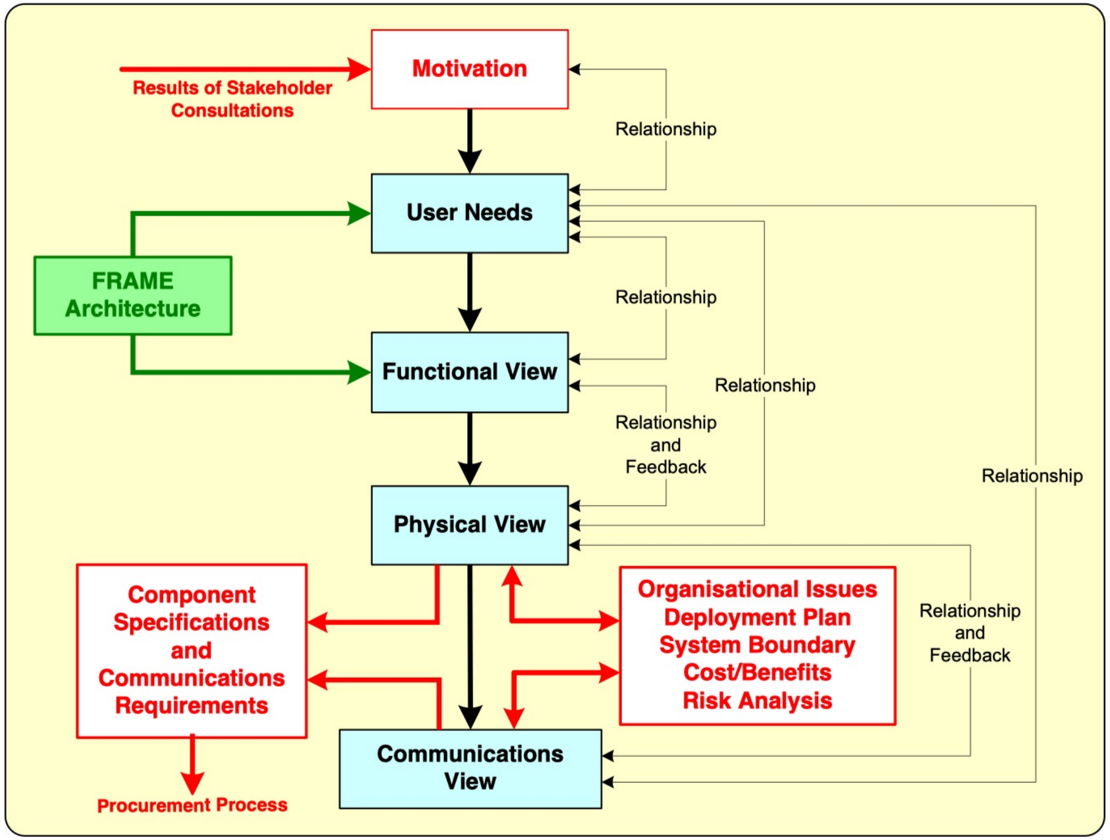
ITS Architecture Development

The FRAME Architecture covers most ITS applications and shows the relationships between their Functions and Data. Figure shows the principal processes that should be gone through during the creation of an ITS Architecture sub-set for a specific deployment.

The light-blue boxes show the principal results that are obtained through the use of the EA tool, whose basic features are described later in this document. The white boxes show the process that must be done initially (Motivation), and the additional information that may also be obtained for the ITS Architecture sub-set that is created.



FRAME. User needs

User Needs provide a formalised description of the Services that will be provided through the deployment of the results from the creation of an ITS Architecture. What the Stakeholders themselves want should be expressed in their own words in their Stakeholders' Aspirations. These Aspirations are then "mapped" to the User Needs so that a particular ITS Architecture can be created from the Framework Architecture. The resulting ITS Architecture is then used to plan the deployment of what is needed to deliver the Services (or aspirations) identified by the Stakeholders.

The User Needs are divided up according to the principal area in which the Services operate. Hence there are User Needs for: traffic management, freight movement, fleet operation, and public transport, plus facilities for electronic payment, law enforcement, security and incident response, links between vehicle and roadside, and traveller assistance.

Most User Needs are served by one or more Functions, and they are used to identify those parts of the FRAME Architecture that will be needed to satisfy the Stakeholders' Aspirations. However, this matching cannot be exact and the architect must ensure final compleness and consistency (with the assistance of The Selection Tool).

User Needs that have no Functions listed in the Trace Tables relate to physical or communications requirements connected with the provision of the Services.

1. General ITS User Needs

1.1. Architectural Properties
1.2. Data Exchange
1.3. Adaptability
1.4. Constraints
1.5. Continuity
1.6. Cost/Benefit
1.7. Expandability
1.8. Maintainability
1.9. Quality of Data Content
1.10. Robustness
1.11. Safety
1.12. Security
1.13. User Friendliness
1.14. Special Needs
1.15. Privacy
1.16. Communications

2. ITS User Needs of Infrastructure Planning and Maintenance

2.1. Transport Planning Support
2.1.1. Objectives
2.1.2. Information Management
2.1.3. Planning
2.1.4. Evaluation
2.1.5. Reporting
2.2. Infrastructure Maintenance Management
2.2.1. Basic Services
2.2.2. Activation
2.2.3. Monitoring
2.2.4. Maintenance Units
2.2.5. Contracts

3. ITS User Needs of Law Enforcement

3.1. Policing/Enforcing Traffic Regulations
3.1.1. Objectives
3.1.2. Evidence Collection

5. ITS User Needs of Emergency Services

5.1. Emergency Notification and Personal Security
4.1.1. Basic Services
4.1.2. Stolen Vehicles
5.2. Emergency Vehicle Management
5.2.1. Basic Services
5.3. Hazardous Materials and Incident Notification
5.3.1. Basic Services
5.3.2. Incident Management
5.3.3. Planning

6. ITS User Needs of Travel Information and Guidance

6.1. Pre-trip Information
6.1.1. Objectives
6.1.2. Modal Choice
6.1.3. Information Handling
6.1.4. Traveller Interaction
6.2. On-trip Information
6.2.1. Objectives
6.2.2. Mode Change
6.2.3. Information Handling
6.2.4. Traveller Interaction
6.3. Personal Information Services
6.4. Route Guidance and Navigation
6.4.1. Objectives
6.4.2. Information Handling
6.4.3. Traveller Interaction

4. ITS User Needs of Financial Transactions

4.1. Electronic Financial Transactions
4.1.1. Objectives
4.1.2. Traffic Management
4.1.3. Revenue Sharing
4.1.4. Transaction
4.1.5. Enforcement

8. ITS User Needs of Intelligent Vehicles

8.1. Vision Enhancement
8.1.1. Basic Services
8.2. Automated Vehicle Operation
8.2.1. Objectives
8.2.2. Collision Avoidance
8.2.3. Lane Keeping
8.2.4. Platooning
8.2.5. Short Range Communications
8.2.6. Speed Control
8.2.7. Supporting Tasks
8.3. Longitudinal Collision Avoidance
8.3.1. Objectives
8.3.2. Collision Avoidance
8.3.3. Supporting Tasks
8.4. Lateral Collision Avoidance
8.4.1. Objectives
8.4.2. Collision Avoidance
8.4.3. Lane Keeping
8.4.4. Supporting Tasks
8.5. Safety Readiness
8.5.1. Basic Services
8.5.2. eCall
8.5.3. Automatic Parking
8.5.4. Environmental Monitoring
8.5.5. Accident Data Recording
8.5.6. Traffic Information & Signs
8.5.7. Vehicle Information
8.5.8. Improper Use
8.6. Pre-crash Restraint Deployment
8.6.1. Basic Services

9. ITS User Needs of Freight & Fleet Management

9.1. Commercial Vehicle Pre-Clearance
9.1.1. Basic Services
9.2. Commercial Vehicle Administrative Processes
9.2.1. Basic Services
9.3. Automated Roadside Safety Inspection
9.3.1. Basic Services
9.4. Commercial Vehicle On-Board Safety Monitoring
9.4.1. Basic Services
9.5. Commercial Fleet Management
9.5.1. Objectives
9.5.2. Road Freight Management
9.5.3. Road Freight Fleet Management
9.5.4. Road Vehicle, Driver, Equipment and Cargo Management
9.5.5. Freight Distribution
9.5.6. Inter-modal Interface
9.5.7. Hazardous Goods Vehicle Management
9.5.8. Driver Rest Areas
9.5.9. Loading Zone Management

10. ITS User Needs of Public Transport Management

10.1. Public Transport Management
10.1.1. Objectives
10.1.2. Scheduling
10.1.3. Monitoring
10.1.4. Incident Management
10.1.5. Information Handling
10.1.6. Communications
10.1.7. Priority
10.2. Demand Responsive Public Transport
10.2.1. Objectives
10.2.2. Information Handling
10.2.3. Communications
10.2.4. Route Guidance
10.2.5. Reporting
10.3. Shared Transport Management
10.3.1. Basic Services
10.4. On-Trip Public Transport Information
10.4.1. Objectives
10.4.2. Information Handling
10.4.3. Traveller Interaction
10.5. Public Travel Security
10.5.1. Basic Services

7. ITS User Needs of Traffic, Incidents and Demand Management

7.1. Traffic Control
7.1.1. Objectives
7.1.2. Monitoring
7.1.3. Planning
7.1.4. Traffic Control Centres
7.1.5. Traffic Flow Control
7.1.6. Exceptions Management
7.1.7. Origin-Destination Computations
7.1.8. Speed Management
7.1.9. Roadside-Vehicle Communications
7.1.10. Adaptive Traffic Control
7.1.11. Lane Management
7.1.12. Parking Management
7.1.13. Vulnerable Road Users
7.2. Incident Management
7.2.1. Objectives
7.2.2. Emergency Services
7.2.3. Information Management
7.2.4. Reporting
7.2.5. Post-Incident Management
7.2.6. Pre-Incident Management
7.2.7. Hazardous Goods
7.3. Demand Management
7.3.1. Objectives
7.3.2. Zoning
7.3.3. Pricing Management
7.3.4. Parking Management
7.3.5. Vulnerable Road Users
7.3.6. Car Sharing
7.4. Cooperative Systems - Traffic Safety
7.4.1. Road Hazard Warning
7.4.2. Ghost Driver Management
7.4.3. Lane Utilization
7.4.4. Speed Management
7.4.5. Headway Management
7.4.6. Collision Warning
7.4.7. Vulnerable Road User Warning
7.4.8. Emergency Vehicle Warning
7.5. Cooperative Systems - Traffic Efficiency
7.5.1. Traffic Flow Optimisation
7.5.2. Advanced Adaptive Traffic Signals
7.5.3. Flexible Lane Allocation
7.6. Cooperative Systems - Value-Added and Other Services
7.6.1. eCall
7.6.2. Enhanced Route Guidance and Navigation
7.6.3. Access Control
7.6.4. Service Continuity

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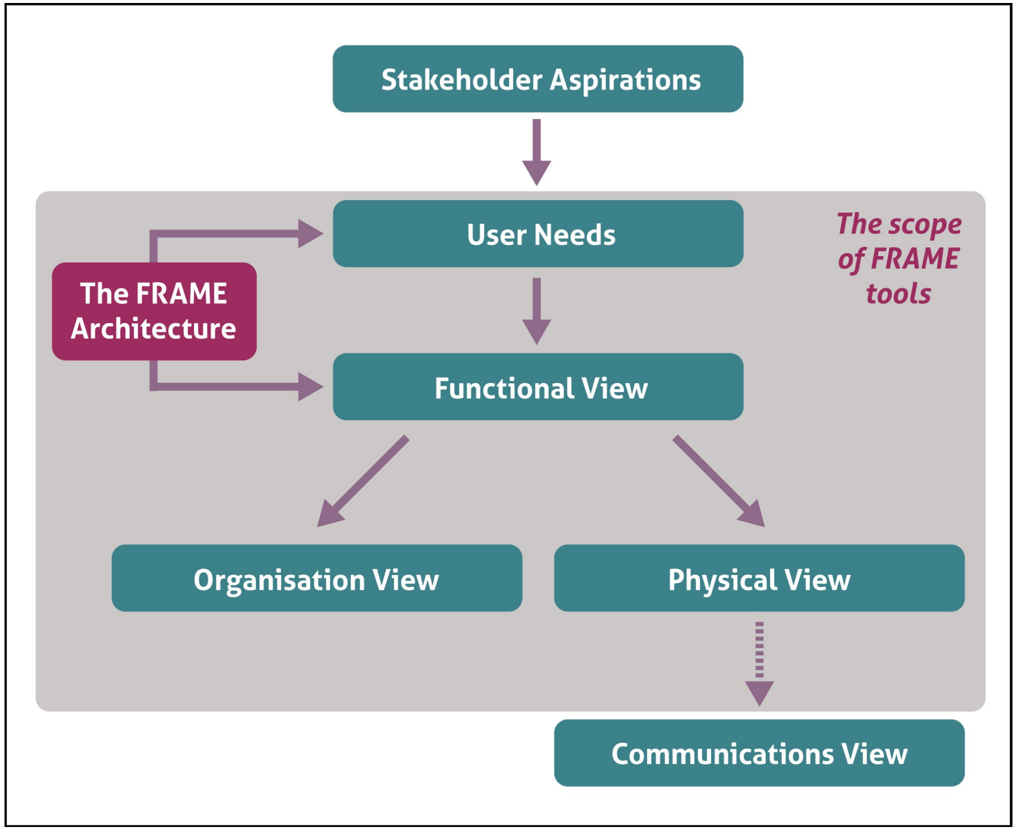
The simplified methodology for creating an ITS Architecture from the European ITS Framework Architecture



Stakeholder Aspirations. Stakeholder Aspirations are statements that express the expectations and desires of the various stakeholders for the services that the ITS implementation will provide. They should be written by the stakeholders, but experience has shown that help is often needed from the architecture team.

User Needs. It is normal to find that the Stakeholder Aspirations will have been written in a variety of styles. Sometimes they can also be obscure and inconsistent. It is thus necessary to re-write them in a consistent manner that is suitable for the next stage in the process. The result is a set of User Needs that express the Stakeholder Aspirations in a consistent and stylised manner whose meaning is clear and whose properties are testable.

Functional View. A Functional View (sometimes called a Logical View) shows the functionality that will be required to fulfil the User Needs, and hence the Stakeholder Aspirations. When using the European ITS Framework Architecture the Functional View is shown as Data Flow Diagrams that contain functions, data stores and terminators, and the data that flows between them. Each of these is provided with its own description which, in the case of functions, includes statements explaining what they do. Since the European ITS Framework Architecture comprises a Functional View that satisfies all of its User Needs, the architecture team only has to select those parts of it that serve the User Needs that have been mapped to the Stakeholder Aspirations.

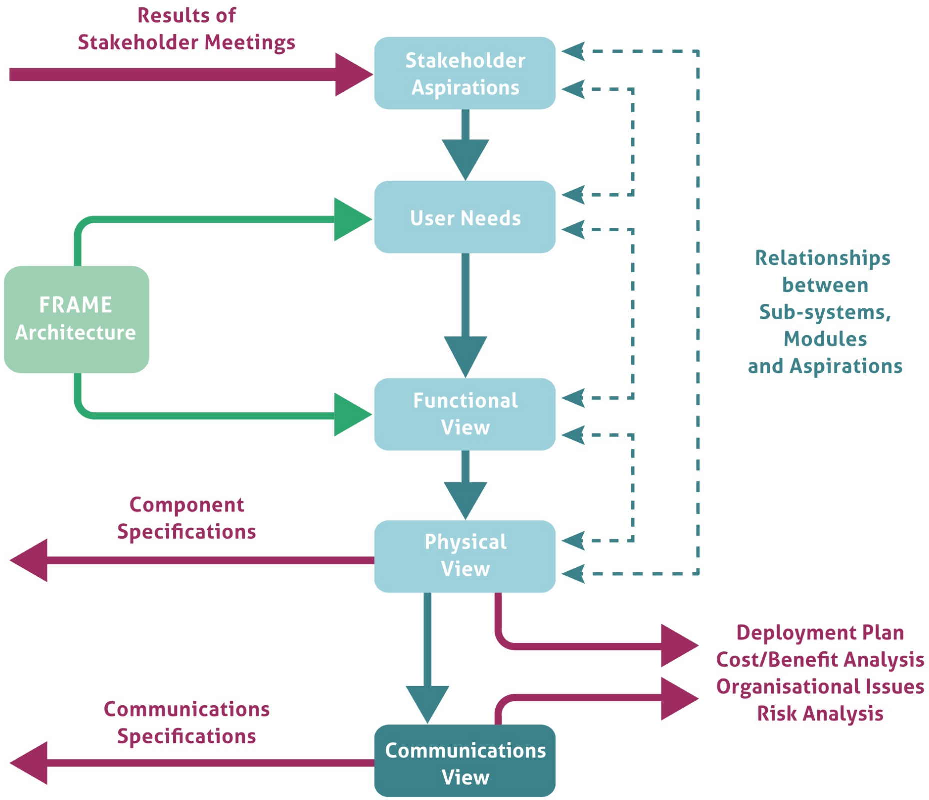
Physical View. Once the Functional View is complete, the architecture team allocates each item of functionality to a location, either within a sub-system, or within a module that is part of a sub-system. Once this has been completed the component (sub-system or module) specifications can be created from the definitions of the functions and data stores contained within them.

View. The Organisational Viewpoint is usually a derivative of the Physical Viewpoint. It is used to show the organisations that will own, and/or operate, and/or maintain the Sub-systems and Modules in the Physical Viewpoint. This is very useful for highlighting the relationships between different organisations and any conflicts that may arise. It can also be used to look at how data will have to be, or could be, shared between organisations.

Communications View. A consequence of allocating the functionality to sub-systems (and modules), is that it is immediately clear which Functional Data Flows lie within a sub-system (or module), and which pass between one sub-system and another, or between one module and another. Those that pass between sub-systems or modules make up the Physical Data Flows, and represent a communication channel between sub-systems, and/or between modules.
Since sub-systems are, by definition, located in different places (e.g. in a traffic management centre, at the road side, in a vehicle) it is possible to produce communications specifications by analysing the contents of each Physical Data Flow. This analysis may elicit that an existing Standard may be used for the communications. Alternatively it can be used as the basis for defining a new Standard if the need for one can be agreed.

Creating an ITS Architecture using FRAME

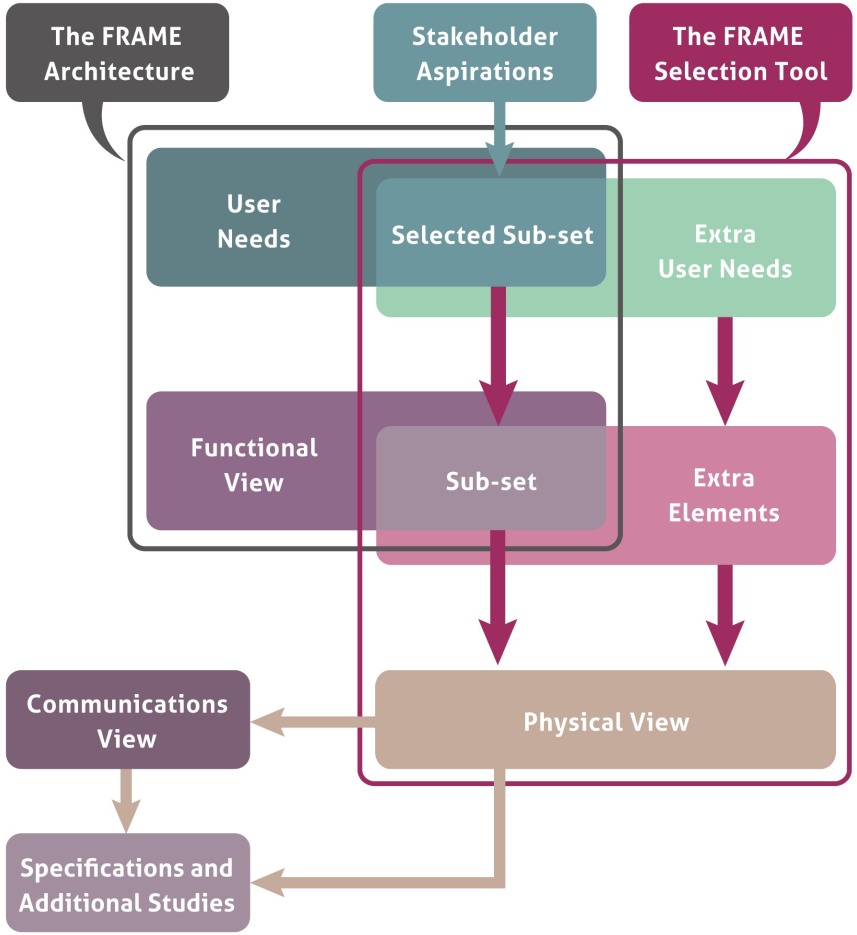
The methodology for creating an ITS Architecture from the FRAME Architecture is illustrated in the figure below. The use of particular technologies or supplier products is not included in the FRAME Architecture. This is important for two reasons. Firstly the ITS Architectures created using the methodology will not become obsolete through advances in technology, or product development, and secondly it opens up the possibility for the development of new technologies to enable particular functionality to be provided.



The process of creating an ITS Architecture Sub-set

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 structures on its users. Hence the FRAME Architecture makes no assumptions about the way that things are done.

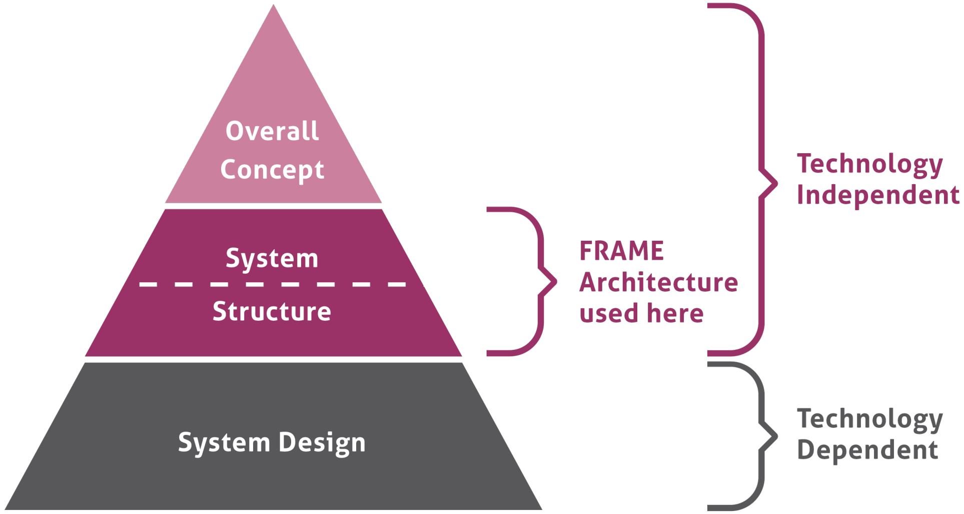
The FRAME Architecture was created to provide a common approach, or “language”, for use throughout the EU so that the implementation of integrated and inter-operable ITS can be planned. It is a framework architecture from which logically consistent sub-sets can be created, which can then be used on their own. The methodology is supported by computer-based tools, and begins with the wishes, or aspirations, of the various stakeholders for ITS applications and services. These are identified within the FRAME Architecture and a sub-set is selected. The sub-set is then customised to fit the region in which they are to be deployed.



The use of the FRAME Architecture in the planning process

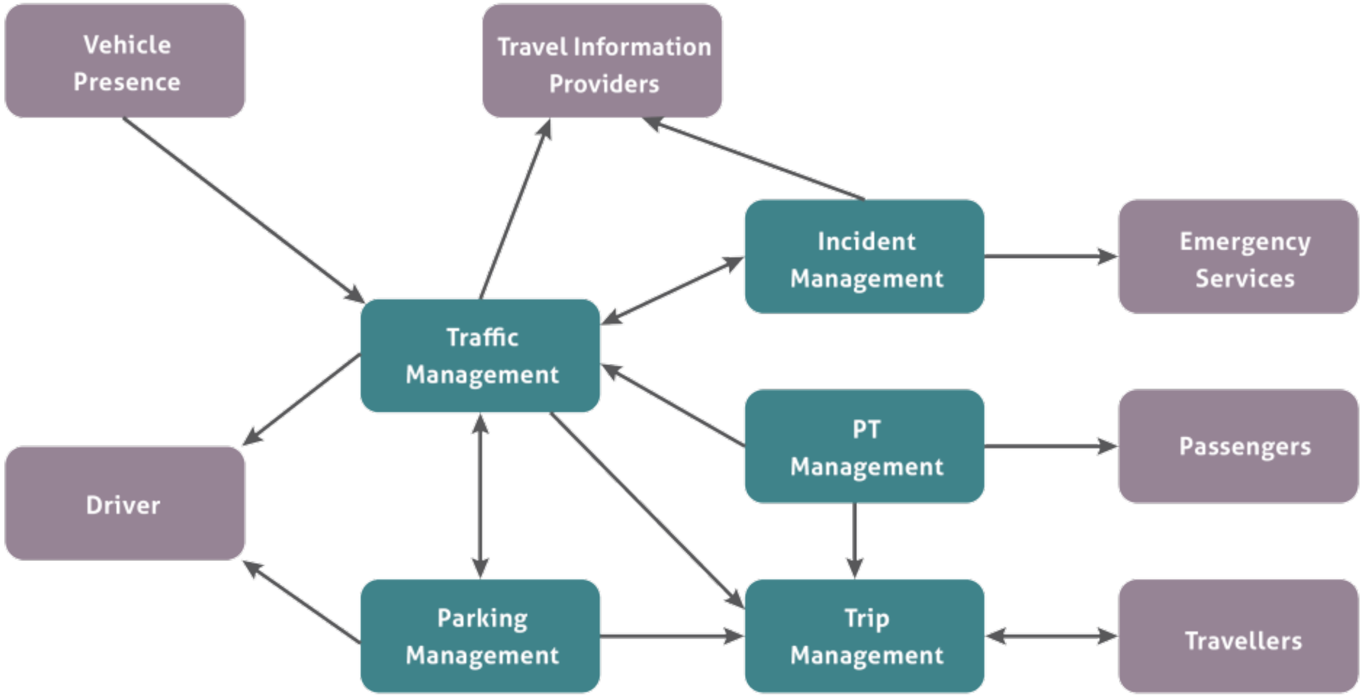
The FRAME Architecture is intended to be used within a top down approach to the planning and deployment of integrated ITS. The overall concept may, or may not, be represented in a formal (reference) model. Since the creation of a reference model requires a number of decisions or choices to have been taken by those implementing and/or regulating ITS, the FRAME Architecture does not provide one.

The overall concept and the system structure should be described in a technology independent way so that, as technology evolves, all the higher level requirements remain unchanged. The information contained within the system structure enables the ITS industry to produce the equipment and systems that will provide the services wanted by the stakeholders, each with their own distinctive features, but conforming to the purposes expressed in the overall concept and system structure. Thus integrated and/or inter-operable ITS services can be provided across the EU.



Components of an ITS implementation – The Physical View

The system structure contains a number of views. The functionality needed to implement ITS Services is provided by the **Functional View**; which does not impose any specific technical solutions on its users. Each specific implementation requires choices to be made by the stakeholders, in particular which components will be used for the ITS implementation and the links between them (the **Physical View**).

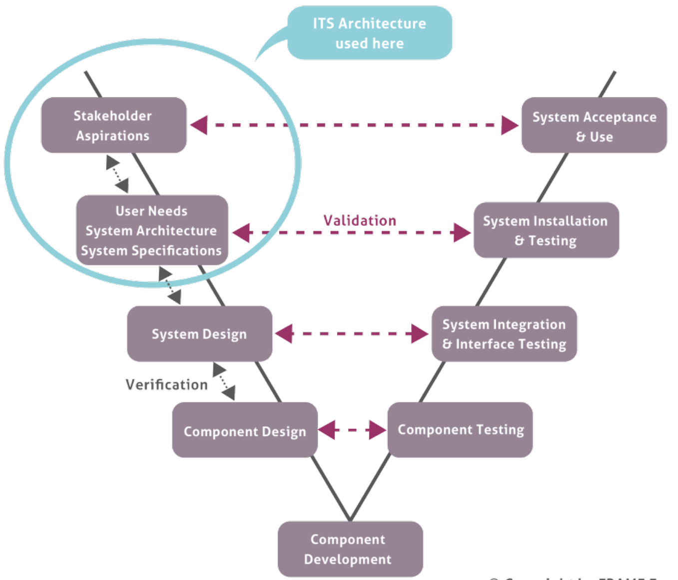


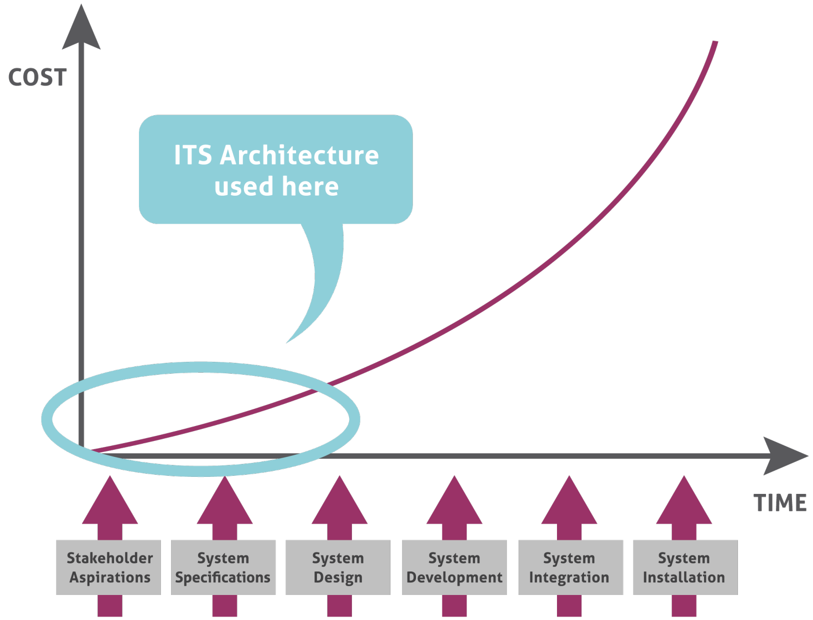
ITS Architecture as part of Systems Engineering

Systems engineering is an interdisciplinary field of engineering that focuses on how complex engineering projects should be designed and managed over the life cycle of the project. Whenever complex integrated systems are being designed it is normal for one of the first design products to be the System Architecture. Thus an ITS architecture is a System Architecture for integrated Intelligent Transport System (ITS).

A system architecture, or systems architecture, is the conceptual model that defines the structure, behavior, and more viewpoints of a system. An architecture description is a formal description of a system, organized in a way that supports reasoning about the structural properties of the system. It defines the system components or building blocks and provides a plan from which products can be procured, and systems developed, that will work together to implement the overall system. This may enable one to manage investment in a way that meets business needs.

The systems engineering process is often depicted using the V-model system lifecycle (see below). This model emphasises the need to ensure that the system is both built correctly, and that it satisfies the aspirations of all its stakeholders.





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DOWNLOADS AND DOCUMENTS

See the software releases of the FRAME architecture and FRAME NEXT extensions.

Software	FRAME Architecture Tool		
Date	Title	Status	Contact
05.10.2021	FRAME_Architecture Tool V5.0.1	The FRAME Architecture Tool V5.0.1 based Enterprise Architect file (*.eapx) and contains the following packages: FRAME Metamodel, FRAME Repository, NAP Reference Architecture and eCall Reference Architecture, all of which are in DRAFT form. The FRAME NEXT project is continuing to develop model improvments and additional Reference Architectures for other ITS Services. As a result of this work the content of the three packages included in this EA file may be subject to change. Any such changes will be documented so that users can understand how any ITS architecture they have created for their own use may have been affected. Any ITS architecture created from a previous version of the FRAME Architecture, e.g. Version 4.1 or earlier, should not be affected and remain valid. Changes to V5.0 are: Update of FRAME Repository Objects and Links, Update and Extension of NAP and eCall ref architecture, new Tools and Scripts	Contact@frame-next.eu
02.04.2021	FRAME_Architecture Tool V5.0	The FRAME Architecture Tool V5 based Enterprise Architect file (*.eapx) and contains the following three packages: Frame Repository, NAP Reference Architecture and eCall Reference Architecture, all of which are in DRAFT form. The FRAME NEXT project is continuing to develop model improvments and additional Reference Architectures for other ITS Services. As a result of this work the content of the three packages	Contact@frame-next.eu

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