



European ITS framework architecture for transportation planning support

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ABSTRACT

This paper gives an overview on some chosen aspects of transportation planning process and decision making. This article aims to show how FRAME Architecture can be seen as a decision support tool for transportation planners, transportation engineers, IT engineers and decision making persons.

KEYWORDS: ITS Architecture, European Framework ITS Architecture, FRAME, Systems Engineering, system requirements, strategic planning

1. Introduction

The use of information and communication technologies in road transport has progressed remarkably during last 40 years. Intelligent Transportation Systems are seen as a power tool to provide sustainable growth. ITS Systems have become more effective, that's why are widely deployed. The more advanced this systems are the more difficult to manage them in a cost-effective way, especially in the context of maintenance. Today's systems mostly are not open and do not provide geographic continuity and interoperability. Solution for this problem is strategic planning which allows to control and easily plan the spendings. This approach is based on European Framework ITS Architecture – FRAME, which can be use as a model of any ITS System and a guide for decision makers, contractors and system engineers. FRAME is expressed in terms of user needs and functional requirements gathered into consistent groups. FRAME offers also support for organizational issues, cost/benefit analysis, risk analysis, communication requirements, deployment programme, component specification and for defining the system boundary.

2. Transportation Planning

Planning is an integral part of decision making process. Plans establish a context in which we anticipate when and where future developments will occur. With founding constraints, plans tell a region what it can afford, and what it cannot. Transportation planning is an important part of defining a vision for the future

and of establishing strategic transportation investment and system operation directions...[1] for the defined area. Intelligent Transportation Systems are enhanced “traditional transportation” by means of ICT technologies. This technology addition requires new approach for decision making process support because of different lifetime of the projects, more number of stakeholders and necessary ICT knowledge required for more complicated problem solving. However, the basics of the planning process are the same for ITS and “traditional transportation” and in each case is to generate information useful to decision makers for the specific types of decisions they are facing. The scope of Intelligent Transportation Systems projects vary widely from national level to specific ITS services. That's why it is needed to have different kind of strategies for different types of planned implementations.

3. FRAME ITS Architecture

3.1 What is the FRAME Architecture

European framework ITS Architecture is the result from Framework Programmes funded by European Commission since 1998. For that time FRAME is continuously enhanced – with cooperative systems being added by the E-FRAME project (2008-11)[2]. FRAME Architecture covers the following areas of ITS[3]:

- Electronic Fee Collection – enables the acceptance of payment for services provided by other areas of ITS

- Emergency Notification and Response – enables the Emergency Services to respond to incidents.
- Traffic Management
- Public Transport Management
- In-Vehicle Systems
- Traveler Assistance
- Law Enforcement
- Freight and Fleet Management
- Support For Cooperative Systems

FRAME Architecture is intended to use within the European Union, that's why consists only user needs, and functional viewpoint to not mandate any physical or organizational structures on its users.

3.2 FRAME Architecture in European Policy

From many years European Commission is looking for the basis for deployment interoperable ITS services. As a result Action Plan (2008) and ITS Directive (2010) are the first written documents which aims to define the necessary measures to develop EU ITS Framework Architecture. Action 2.3 from the Action Plan and actions from the priority areas II: "Continuity of traffic and freight management ITS services" (action 1.1/1.5) and from priority area IV: "Linking the vehicle with the transport infrastructure" (action 1.1/1.2) from the ITS Directive. [4][5]

FRAME Architecture was funded from the beginning from European Commission budget and it seems to be natural consequences to be the biggest candidate for mentioned earlier EU ITS Framework Architecture. Action 2.3 from [6] aims to "define, adopt and support the deployment of a multimodal European ITS Framework architecture, based notably on the FRAME model and the results of E-FRAME project (2008-11)".

4. Results of FRAME ITS Architecture

FRAME architecture can be modeled the same way as systems in system theory or systems engineering. The inputs are the stakeholder aspirations and the output is the result of the FRAME transformation process[7].



Fig. 1. FRAME as a system

Inputs are a structure consisting of a set of Stakeholder Aspirations $S_a = \{x_1, x_2, \dots, x_n\}$. Outputs are a collection of results from FRAME Architecture $R_s = \{S_b, D_p, O_p, C_s, C_r, CB_a, R_a\}$, where: S_b – System boundary, D_p – Deployment programme, O_p – Organisational issues, C_s – Component specification, C_r – Communication requirements, CB_a – Cost/Benefit analysis, R_a – Risk analysis.

4.1 System boundary

System boundary is what is insight our system. System boundary consist of subsystems and modules. In Systems Engineering field these are called components. "A software component is a unit of composition with a contractually specified interface and explicit context dependencies only.[8] These interfaces creates a boundary of the system. Interfaces are defined by the physical data flows between our system and external entities called terminators/actors. Each terminator has its own responsibility which is outside the scope of defined system.

4.2 Deployment programme

Deployment programme often called mitigation strategies is the way how to get from legacy systems (if exists) to intelligent transportation vision. From the picture below it can be seen that the most important part is the interim which is the precisely defined transition based on the ITS architecture document. This document needs to be extended to software or hardware component specification which fulfill the requirements from the legacy systems and ITS Architecture document.

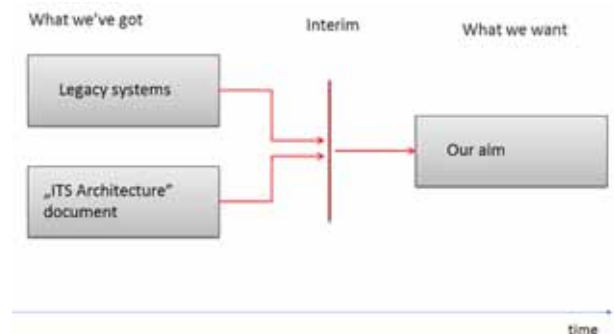


Fig. 2. ITS Deployment programme

4.3 Organisational issues

ITS implementation frequently involves both public and private organizations, including local authorities, public transport operators, equipment manufacturers, service providers. Before service can be deployed successfully, their relative roles and responsibilities (financial and organizational) must be clearly established.[9] Organisational issues comes from system boundary and division the system into subsystems and modules (components). Each component is deployed and managed by specific organization which is responsible for developing and/or maintaining defined group of functionalities. These human entities are responsible for properly functioning of each part of the system and the consequences of not meeting defined service level agreements could be easily punished.

Another business is that "to achieve the main goal of deployment involves hitting a lot of subtargets – meaning not only the technology deployments but agreeing on who does what and working with the public authorities that will have to carry on the work after the project finishes, when there is no further funding." [10] Organisational issues helps us to create good business models before the deployment starts.

4.4 Component specifications

Most contemporary Intelligent Transportation Systems exist in highly dynamic environments. Their requirements change frequently and they must be built or modified on challenging development schedules. These systems are mainly decentralized and built from modules called components. Every component has a component specification. Each component's specification defines the basic characteristics of the interfaces (inputs and outputs) and operations. Development of pluggable components is a key motivation of valuable design approach. That is, it should be possible to understand precisely what a component does based on the specification for the operations in its interfaces. It should be possible to replace one component by another that implements the same set of interfaces i.e. traffic signal controllers software or hardware. It should thus be possible to reuse a component reliably with several different components in different contexts.

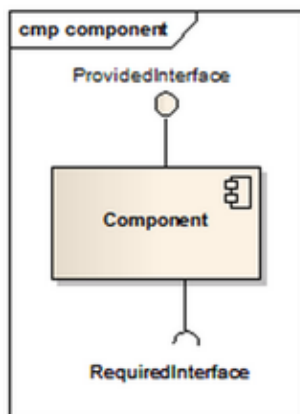


Fig. 3. Component with interfaces (UML 2)

4.5 Communications Requirements

Communications requirements defines requirements for physical dataflows within our system and between system and terminators. Physical viewpoint creates the framework for actual design of the system (such as location of the functions, location of the data and level of detail of the data, etc. Telecommunication choices are made through complex decision making process because of the necessary bandwidth and costs. Communications requirements are also linked to the appropriate standards. FRAME Architecture (physical viewpoint) shows us from where to where information goes.

4.6 Cost Benefit analysis

Benefit-cost analysis (BCA) is a technique for evaluating a project or investment by comparing the economic benefits with the economic costs of the activity. Benefit-cost analysis has several objectives. First, BCA can be used to evaluate the economic merit of a project. Second the results from a series of benefit-cost analyses can be used to compare competing projects. BCA can be used to assess business decisions, to examine the worth of public investments, or to assess the wisdom of using natural resources

or altering environmental conditions.[11] Cost benefit analysis should be an important tool for ITS decision makers. It is closely connected to the component specifications where estimated cost of each component may be established. Knowing our budget we can choose which components we can afford with the precise definition of the interfaces needed for further development.

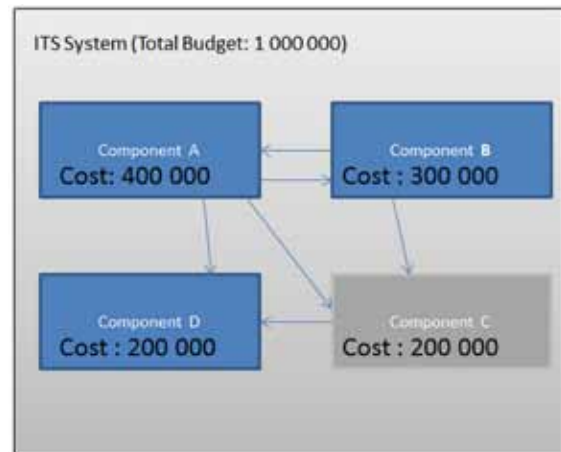


Fig. 4. Component based C/B analysis

4.7 Risk analysis

Regarding to PMBOK [12] plan risk management process is organised around five consecutive phases:

- Identify risk - process is used to identify and gather all risks and their nature, which could impact the project. SWOT analysis is a part of this process.
- Perform qualitative risk analysis - this process is performed quickly to determine as soon as possible which risks are the highest priorities on the project. It uses the probability and impact matrix (PIM) to prioritise and rank risks.
- Perform quantitative risk analysis - assigns a projected value (usually this value is stated in terms of cost or time) to the risks that have already been ranked by the previous process.
- Plan risk responses - this process, plan risk response is, plans for how each risk will be managed, and who will be responsible for them.
- Monitor and control risks - is the process of implementing risk responses plans, tracking identified risks, identifying new risks, and evaluating risk process effectiveness throughout the project.

Plan risk management should take place early in the project because it will have a significant impact on all aspects such as scope, time, cost, quality, and procurement.

5. Conclusion

As shown in this article FRAME Architecture is a great tool for decision makers to plan ITS Systems in a more convenient and efficient way. The results from FRAME could be the part of Terms of Reference or high level specification of particular design. This paper showed that having ITS Architecture could not be an aim

as itself but the mean to an end. Risk analysis and Cost Benefit analysis could be used for strategic planning. System boundary and organizational issues may be used for dividing the responsibilities for each part of the system and the communications requirement, deployment programme and component specification should be applied to the all technical issues.

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