ESTIMATION OF IMPORTANCE OF INTELLIGENT TRANSPORT SYSTEMS (ITS) ARCHITECTURE

Aldona Jarasuniene

Transport Research Institute
Vilnius Gediminas Technical University,
Plytines str. 27, LT-10105, Vilnius-16, Lithuania
Ph: +370 2745076, fax: +370 2699711
E-mail: ajarasuniene@yahoo.com

This paper introduces the important concepts of system architecture, including why it is needed and how it has been developed and applied around the word. In the past, control systems for road traffic were often installed to provide just one or two services working independently as separate subsystems, In contrast, complex management, control and data-gathering services are provided simultaneously by ITS. While there are risks of a number of subsystems working in conflict with one another, there are significant opportunities for an amalgamation of these subsystems working in synergy. System architecture provides the logical framework, based on user requirements for planning, defining, and integrating intelligent transportation systems. A national or regional system architecture is a formal statement of the national or regional approach to ITS, and the first step on the way to creating detailed designs. In addition, the establishment and use of the ITS architecture adds considerable value to the overall ITS development process in various ways.

Keywords: *ITS Architecture, shared vision, risk management, levels of ITS Architecture*

1. Introduction

In the past, control systems for road traffic were often installed to provide just one or two services working independently as separate subsystems, In contrast, complex management, control and data-gathering services are provided simultaneously by ITS. While there are risks of a number of subsystems working in conflict with one another, there are significant opportunities for an amalgamation of these subsystems working in synergy. System architecture provides the logical framework, based on user requirements for planning, defining, and integrating intelligent transportation systems. A national or regional system architecture is a formal statement of the national or regional approach to ITS, and the first step on the way to creating detailed designs [1–4]. In addition, the establishment and use of the ITS architecture adds considerable value to the overall ITS development process in various ways.

2. Importance of ITS Architecture

ITS architecture defines: the functions (e.g. gather traffic information or request a route) that are required for ITS; the physical entities or subsystems where these functions reside; the information flows and data flows that connect these functions and physical subsystems together into an integrated system [5–7].

ITS architecture analysis provides other aides for planning and implementation of ITS deployments, including a deployment programme, an organizational viewpoint, cost/benefit and risk analysis studies.

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Stakeholder driven. ITS architecture is developed from a set of functional requirements based on user needs and user services defined through consultations with users and stakeholders. Thus, the architecture ensures that the ITS to be implemented is responsive to the needs of all stakeholders, rather than implementing technology for technology's sake.

Promotion of ITS Standards Development. The ITS architecture will also show clearly and unambiguously the key processes which require a standardised interface, especially for communications and data exchanges. By defining the different subsystems and the data that have to flow between them, the architecture provides the context for standards development.

Provision of Commercial Benefits. Design and implementation of standardised ITS subsystems and components in conformance with the ITS architecture will stimulate an open market in equipment and software supply, permit economies of scale, ensure consistency of data and information, encourage investment, and help to ensure interoperability.

Risk Management. A good ITS architecture will consider failure modes and support logical steps to achieve gracious degradation of system performance under abnormal conditions. The development of an ITS architecture also requires that transport policies and assumptions regarding who plays what role are made explicit. This allows joint decisions between partners to be made in concert, reducing the risk of one organisation making wrong guesses as to what other organisations are going to do. By facilitating the development of standards, the ITS architecture also reduces the risk of de facto or proprietary standards perpetuated by the dominant manufacturers.

Linking ITS to the Transport Planning Process. ITS needs to be integrated into the local or regional transportation plan. An ITS architecture supports this integration by forcing all involved to identify the intended relationship between ITS and conventional transportation plans and solutions. It can also add substance to those plans through the definition of what is required to provide which services and the priority for their implementation.

Providing a Basis for System Development. The physical architecture and, if created within the architecture, a document describing the theory of operations, will provide a rigorous basis for defining the function of specific data processing modules, identifying where the processing should be carried out, and what data has to be acquired and shared between data processing units. Thus, the architecture provides a first-class platform from which system development can be started.

Provide a Framework for Future Expansion. ITS architecture provides a framework for system expansion and technological upgrades. By starting with a broadly-based architecture, one has a basis for evolution and expansion. New services, systems, or geographic coverage can be added without expensive re-engineering or retrofits to existing systems, provided always that the expansion fits within the functional parameters that underpin the architecture.

3. Levels of ITS Architecture

There is an analogy between ITS architecture and house architecture. The architecture of a house may have to be expressed in various forms to suit the audience. For the homeowner, the architect shows them artist sketches and floor plans. For the construction workers, the architect shows them drawings of beams and columns and gives precise dimensions. Similarly, the system architecture of a particular ITS may be expressed in various forms that are mutually consistent. The selection of a particular form depends on the needs and the audience at hand.

ITS architecture is primarily about information exchange and control between systems at various levels of abstraction, as depicted in the multi-level model in Figure 1. The CONVERGE project defined these levels as a way of explaining the uses that should be made of the various models and viewpoints that may comprise an architecture [8]. Traffic and transport managers lay down high-level properties, or policy, at Levels D and C, and the architectural structure at Level B is then devised so that it conforms to these properties. Level A is not strictly part of the architecture though it is often referred to as such, and represents the stage at which a supplier designs a system, or component, that conforms to the architecture.

Level D architecture needs to reflect the real-world constraints that operate on transport agencies, and to reflect the requirements for such system properties as interoperability between the participating agencies and the retention of information control by the respective agencies. It may show where existing organisational structures must be modified and changed – perhaps quite radically – in order to deliver ITS services. As an example, a traffic control centre (TCC) may need to exchange data with another TCC or a traveller information centre (TIC), possibly across national or language boundaries. Defining the nature and minimum performance specification for this transaction matters a great deal. In some cases a simple telephone line that carries voice messages would suffice. Other cases may require a high-speed secure dedicated data link for closed circuit TV pictures. The required level of interconnection and interoperability has to be specified adequately for architecture analysis purposes although the choice of specific technologies should be left to system designers.

LEVEL D	Multi-agency interoperability properties
LEVEL C	Single agency system properties
LEVEL B	System structure
LEVEL A	Subsystem/component design

Figure 1. Multi-level Model for Analysis of ITS Architecture

The Level D architecture sets the framework within which the Level C architecture can be defined. Level C architecture defines the properties of those systems that operate under the aegis of a single agency, and it can take into account the characteristics of both existing "legacy" systems and future planned systems. The issues dealt with at Levels C and D are similar. The CONVERGE approach separates them because they are dealt with at different times, and may be dealt with by different groups [8].

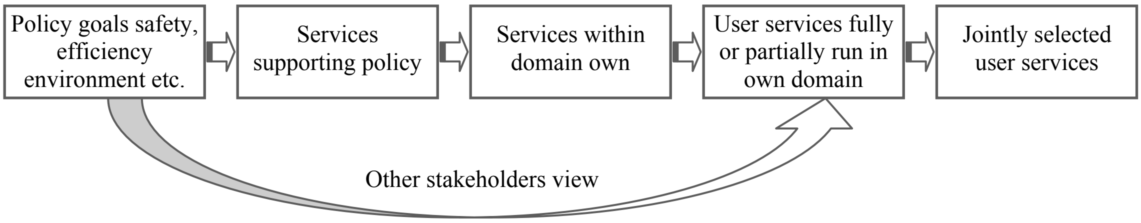

Figure 2. Policy implication of ITS Service selection

4. Logical or Functional Architecture

Logical or functional architecture is in the domain of Level B in Figure 1. The architecture depicts the processes and data flows between processes that are needed to meet the functional requirements previously determined. In developing the logical architecture, the common ground between the various user requirements and ITS services is examined, so that shared functions and common requirements can be grouped within the same set of processes.

5. Physical Architecture

In the context of systems engineering, the physical architecture allocates the processes defined by the logical architecture into physical subsystems, which the hardware and software will deliver. The design of the physical subsystems will be based on the functional requirements, the process specifications, the inter-dependencies and will be affected by whether the functions are to be performed in one or more locations. Thus, the physical architecture allocates specific processes to physical subsystems, taking into account the institutional responsibilities. In the example witch can adapt in Lithuania the interfaces between the four main subsystems in Figure 2 are depicted.

Data flows between subsystems are through four kinds of generic communications media.

6. Regional Architecture and Turbo Architecture

The high-level ITS architectures discussed in the last three subsections are intended to provide a stable and open framework for lower-level ITS systems that would be mutually compatible, consistent and interoperable as far as is practicable. Thus, the European Framework Architecture has provided a reference point for a number of national architectures in Europe, including Austria, France, Netherlands. UK, and the corridor from Northern Germany to Finland covered by the VIKING Project.

In summary, when developing their own ITS architecture, organisations have to make decisions about the form of architecture that they create. This form may be one of following three types – a framework architecture, a mandated architecture, a service architecture. The relationship between these three architectures is depicted in Figure 3.

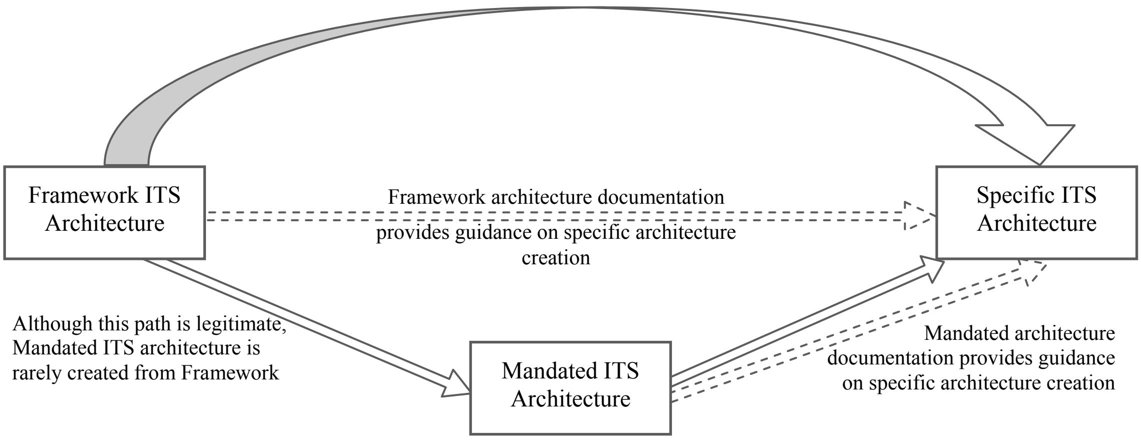

Figure 3. Relationships between architecture types

Some of the ITS architecture initiatives mentioned previously have provided tools to aid the development of specific architectures form them.

Conclusions

ITS system architectures are being developed to fit all the ITS components into a systematic framework so that they will work in concert with one another to deliver the needed user services.

A specific architecture may be expressed in multiple forms. It is important that the decision makers should understand and endorse the concepts and functions that inform the development of ITS operations and organisational architectures.

The systems engineers, for their part, need to work with the logical, physical, and communication architectures that will deliver the operational and functional requirements.

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