ITS Architecture Framwork

A framework for the development of ITS architectures

Forschungs- und Entwicklungsvorhaben
der Bundesanstalt für Straßenwesen

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Short report

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Content

1 Task

Within the project "ITS Framework Architecture - a Framework for the Development of ITS Architectures" a framework for the development of architectures for Intelligent Transport Systems (ITS) was developed. Today, intelligent transport systems form an important technological and organisational basis in the application areas of road traffic. In addition, the importance of information and communication technology for the increasing networking of these systems is also growing and at the same time brings new challenges in the introduction and integration of new systems into existing ITS landscapes. In order to ensure "intelligent" mobility in Germany and Europe, the consistency of information and the associated integration of the corresponding systems are an important prerequisite. In this way, ITS is intended to reduce congestion and emissions and to increase the reliability, punctuality and safety of road traffic.

In order to support and simplify the development and operation of intelligent transport systems, the freely available ITS framework architecture will provide a tool to increase the supply of ITS and its innovation. Based on the experience of the companies involved in the project, the stability of ITS is to be increased and its development methodically supported by design recommendations.

In addition to the technical point of view, which is often in the foreground, the cooperation between the actors involved in the provision of mobility services in terms of content and organisation must also be considered. In fact, ITSs are generally offered jointly by several actors. For example, construction site information is collected by many municipalities and consolidated on a central platform such as the mobility data marketplace and made available to navigation service providers. In the example, we therefore have many different players involved in data collection, data preparation and the provision of an intelligent transport service for an end customer.

Each of the actors has its own architecture, with its own internal goals, applications and processes. These views are represented in the ITS pyramid of the FGSV. The pyramid describes the architecture of the individual actors on a high abstraction level.

In order to be able to offer a common intelligent transport service, the different actors must cooperate and their architectures should be interoperable at all levels of cooperation (see also Figure 1 ITS pyramid). The ITS framework architecture developed as part of this project now provides the corresponding implementation framework for the realization of comprehensive ITS architectures.

In the ITS framework architecture, basic definitions are made for concepts, standards and mechanisms necessary to ensure the interoperability of distributed communicating applications, components and organisations at different levels. Since terms are often used in different ways in a specific business context, the ITS framework architecture provides formal definitions in a glossary for common understanding. In particular, synonyms and homonyms can make it unnecessarily difficult for partners to communicate correctly in practice.

2 Methodology of investigation

In addition to a uniform understanding of terms, the framework for ITS architectures offers the necessary methods and prerequisites for achieving goals. The project is based on the international standard ISO/IEC/IEEE 42010 as well as on the framework for the development, implementation and maintenance of enterprise architectures of the Open Group (The Open Group Architecture Framework, TOGAF), which is currently available in version 9.1. Among other things, TOGAF offers a procedure model, the so-called Architecture Development Method (ADM), techniques for supporting individual steps in the procedure model, as well as a meta-model with building blocks and artifacts, which are required or recommended for describing an architecture in the form of models.

In the project, the recommendations on procedure, building blocks and artifacts from TOGAF were transferred to the context of intelligent transport systems. Tayloring specifically addresses the interoperability between different actors at all levels of the ITS pyramid and provides instructions on how to develop an ITS architecture and provides them in a wiki.

The ADM from TOGAF and the levels of the ITS pyramid are largely identical. In phase A of ADM, the objectives of architecture development and the parties involved are defined. The resulting artifacts from phase A are to be assigned to the strategy level of the ITS pyramid. In phase B of ADM, the current and desired target status of the business architecture is described, the differences are worked out and documented with the help of business process diagrams and other models. The corresponding artifacts can be assigned to the business level of the ITS pyramid. Phase C describes the current and desired state of the data and application architecture. Data models and applications are used for this purpose. The following figure provides an overview of this (see Fig. 1 - The ITS pyramid).

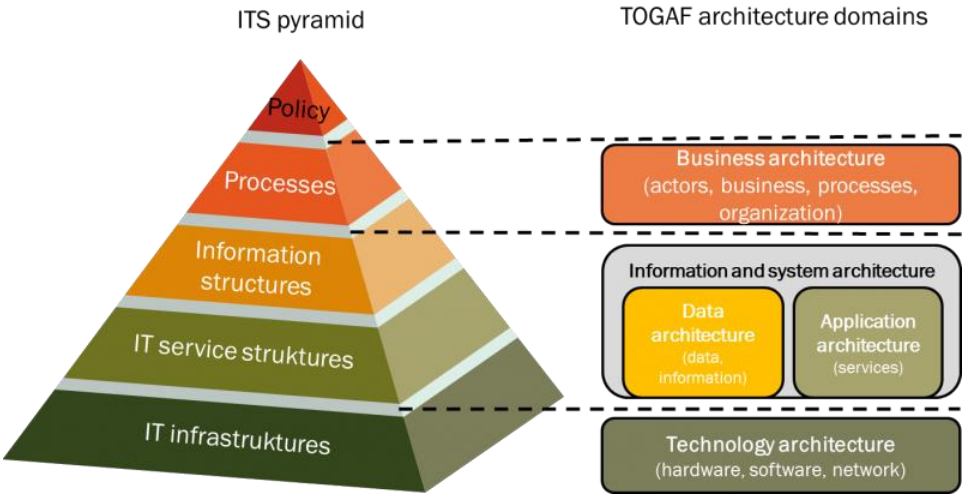

Fig. 1 The ITS-Pyramide

he developed recommendations, glossary and instructions can be used both for the development of real ITS architectures as well as for ITS reference architectures from a delimited ITS domain. As part of the overall project, three first ITS reference architectures have already been developed. These provide concrete recommendations for action for the respective ITS domain based on the specifications of the ITS framework architecture. Specifically, these are ITS reference architectures for individual traffic information, cross-competence traffic management and multimodal travel planning (see Fig. 2 - Instances of ITS architectures).

Each of these ITS reference architectures concretizes a specific field of application and thus represents the basis for the specification, development and implementation of ITS architectures of real ITS services in a concrete application case. The specifications and recommendations of the ITS framework architecture were developed in close cooperation with the three ITS reference architectures. The three ITS reference architecture project teams applied the recommendations of the ITS framework architecture to their domain, returning valuable feedback to the ITS framework architecture, which has already been taken into account in the current state of play. This ensures the comprehensibility, applicability and feasibility of the ITS framework architecture.

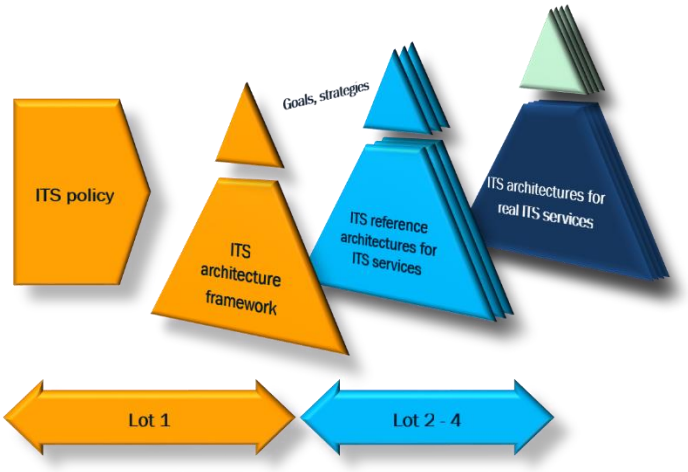

Fig. 2 – Instances of ITS architectures

In addition, a group of supervisors contributed their expertise to the project. The group of supervisors consists of representatives of about 20 organisations. The intermediate status of the project - i. e. the framework and reference architectures - was presented to the group of supervisors on an ongoing basis and the feedback was also taken into account and implemented. On two public workshops, the results were presented to more than 40 organisations and companies from the field of intelligent transport systems. This makes it possible to establish a Germany-wide visibility of the ITS framework architecture. The participating organisations were actively involved in the workshops and their questions and concerns could be answered or resolved.

Already during the project, the experts from the group of supervisors were able to view all the results obtained. A corresponding wiki was set up at the beginning of the project. Once the project is completed, the wiki can be made accessible to the public at low cost. The wiki can also be used for the further development of the ITS framework architecture.

The development of the ITS framework architecture takes place through the participation of companies, public institutions, software development and consulting firms - in constant exchange with practice. The ITS reference architectures as well as the group of supervisors and the participants of the public workshop contributed in such a way that the results of the ITS framework architecture are relevant and useful.

3 Examination result

In terms of content, the ITS framework architecture focuses on seven views which are of essential importance for ITS architectures and which are described as the seven basic concepts of the ITS framework architecture and are explained below.

- The **ITS service and value-added concept** says that ITS value creation is usually created by the involvement of several roles and many actors in value-added networks. Therefore, the partners involved should agree on a common ITS mission statement.
- In the **ITS role and actor** concept, a metamodel is designed to describe the roles, which can then be described using a template.
- The **ITS target concept** transfers the existing standard of the Business Motivation Model to ITS. In this way, ITS providers can exchange information with the partners involved in a structured manner on common goals.

- The **ITS Capability and Collaboration concept** uses the capabilities known from TOGAF for planning purposes on high abstraction levels. By applying the technique of Capability Based Planning, necessary skills can be identified and subsequently implemented.
- **The tools, views and tools for ITS business architecture** provide concrete recommendations for the presentation of ITS value-added networks, ITS governance and ITS business processes. For modeling the views, IT-based tools can be used to display and maintain artifacts such as tables or diagrams.
- ITS reference models and tools at the **data architecture level** are used to describe information objects, data models and specifications for location reference. The concept helps to identify the required data, exchange formats and interfaces.
- ITS reference models and tools at the **application architecture level** deal with applications and the interfaces between them. Since the applications are not only in different departments of a company, but even with several, organisationally separate partners, the establishment of technical interoperability is a challenge in the implementation of real ITS services, which is met in the ITS framework architecture.

Within the scope of the scientific examination of the topic ITS architecture, two publications emerged during the course of the project, which have enabled a scientific examination of the procedure and the results, as well as promoting the diffusion of knowledge into science and practice. Specifically, this is a contribution to the TRA (Traffic Research Arena) and one to the MKWI (Multikonferenz Wirtschaftsinformatik). The results of the project were discussed with experts for intelligent transport services on the one hand and for the developed methodology on the other. In addition, the project was presented at an Open Group conference to focus on the relationship between ITS architectures and TOGAF. All publications were published with the knowledge and consent of the Federal Highway Research Institute and the Federal Ministry of Transport and Digital Infrastructure.

4 Conclusion for practice

With the completion of the project, Germany now has an ITS framework and three compliant ITS reference architectures for the road sector. Due to the holistic approach, Germany occupies a special position in the EU and deliberately separates itself from related approaches. The holistic approach means that, in addition to technology, applications and interfaces between applications, it also explicitly addresses the business level with processes and roles, as well as the strategy level.

With the aid of the documented and widely recommended ITS architectures, real ITS services can be developed and operated more quickly and easily in the future, i. e. companies and other organisations in the field of ITS can now offer services and innovations based on them. Compliance with the requirements of the ITS framework architecture increases the likelihood that ITS will remain on the market in the long term, as harmonisation and early confrontation with conflicting goals can increase the flexibility required in the market.

Future developments in the field of mobility such as autonomous driving or the consideration of water and air traffic routes may require additional ITS services, which have not been focused in the project so far.

Continuous adaptation and further development is aimed at and necessary to ensure that the ITS framework architecture can meet practical requirements. In future, developments at EU level and the further development of TOGAF as a method should be monitored in particular. On the other hand, efforts at EU level should also benefit from German considerations.