European ITS architecture Frame Next - framework for harmonization of ITS development

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Abstract

Digitization of the transport system requires upgrading the physical transport infrastructure with digital infrastructure through the development of intelligent transport systems that will enable the digital integration of the EU transport system. Although the EU countries have made a significant contribution to the development of ITS, the necessary level of harmonization of the ITS system in the EU has not yet been achieved. Although the EU directives related to the development of ITS have been passed, the interoperability of ITS services has not yet been achieved, which makes the development of the ITS services market at the EU level difficult. In order to more effectively develop ITS and integrate ITS services, the EU launched a project to upgrade the European framework ITS architecture through the FRAME NEXT project. The European ITS architecture framework represents a framework for harmonizing the development of ITS in the EU and can be used as a framework for the development of ITS in Bosnia and Herzegovina. EU countries as well as neighboring countries should harmonize the development of ITS using the European framework ITS architecture FRAME NEXT as a framework for ITS development.

Keywords*: Intelligent transport systems, ITS architecture, digitization, harmonization*

1 Introduction

The development of the ITS system follows the development of information and communication technologies that enable new sources and new areas of application of traffic data. The number of participants in the process of collecting, processing and distributing traffic data within the connected and automated mobility system is continuously increasing. The development and implementation of new technologies in the transport system has an impact on the development of new ITS services and access to information through the improvement of access and exchange of traffic data and information. This contributes to the increase in the quality of ITS services and provides new possibilities for monitoring and managing the traffic system. The EU Sustainable Mobility Strategy [1] sets clear political goals and a framework for a sustainable digital transition of the transport system. Although the road infrastructure in the EU is very developed, a satisfactory level of safety has not yet been achieved. It is estimated that the costs of traffic accidents in road traffic are about 2.0% of GDP in EU countries, so a program to increase safety has been adopted, which aims to achieve the level of zero traffic fatalities "Vision Zero" by 2050. This will require the development of automated and connected vehicles and further development of physical and digital road infrastructure with the application of ITS services. Digitization of the EU traffic and transport system will contribute to the development of safer, more environmentally friendly and efficient mobility. The development of the ITS system encourages better use of the existing infrastructure and greater efficiency of the TEN-T network. The European adaptation plan for the digital age represents the political framework for the development of the ITS system in the EU [2]. The European ITS Framework Architecture provides common business views on ITS services and provides a unique European ITS terminology. The European FRAME-NEXT framework ITS architecture provides a framework for harmonizing political and technological concepts and business processes for the development of ITS services.

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2 Quality of ITS services

The effectiveness and acceptance of ITS services by users depends on the quality of ITS services from the perspective of users. ITS services rely on data collected from different sources and from different traffic data providers that have a significant impact on the content and quality of traffic data. Data quality assurance in the ITS system requires the definition of common data quality level criteria as well as unique methods of assessing the quality of ITS services. Data quality criteria are the basis for evaluating the quality of ITS services. Data quality contains a temporal dimension related to delay and a spatial dimension related to location. The quality of the data shows how well the information from the virtual environment of the ITS service matches the state of the physical environment and the user's requirements. ITS service quality requirements determine how well individual ITS services meet user expectations. The methods of assessing the quality of ITS services include monitoring the performance and availability of equipment, the procedure for determining the perception of the quality of the ITS service by the user, and the procedures for testing the ITS service in relation to the quality of the data. The quality of ITS services requires determining the rights and responsibilities of each stakeholder in the process of collecting, processing and sharing data and information, observing the entire life cycle of ITS services. It is necessary to ensure continuous quality control of ITS services and the process of managing data and information flows. The meta data should also contain a field that provides information about the quality of the data. In this way, the data provider will be able to transparently describe the quality of his data, and the user will be able to assess whether the offered data quality meets his requirements. The European ITS architecture should provide clear guidelines that describe the content of traffic data for ITS services, as was done in the DATEX II specifications. The TN-ITS is organized as an EU association that aims to encourage and facilitate exchange of traffic data between providers and users of ITS services [3]. National access points (NAP) are the backbone of the ITS digital infrastructure in the EU. The coordinated European NAP mechanism based on the European ITS FRAME NEXT architecture will enable the standardization and interoperability of ITS services on the EU transport network. The goal is to enable the sharing of data based on the CEN TS 17268 specification, which affects user confidence in traffic data. The main source of EU mobility data available through the NAP are DATEX II and TN-ITS. It is necessary to create a unique EU framework for the exchange of traffic data that will enable the timely provision of information on changes in the attributes of the road network and other physical elements of the road infrastructure, including public transport data, geometric parameters, including digital maps for ITS applications.

3 EU framework ITS architecture

ITS systems are developed over a long period of time during which changes in technology and user requirements occur. This leads to frequent changes in the ITS service in terms of technology and organization. In order to successfully implement technological and functional changes in the ITS system, ITS architecture is used for its development and implementation. The ITS architecture represents a model of the presentation of the organizational and functional properties of the ITS subsystem, the mutual relationships of its components and the relationship with the environment, observing the entire lifetime of the ITS system.

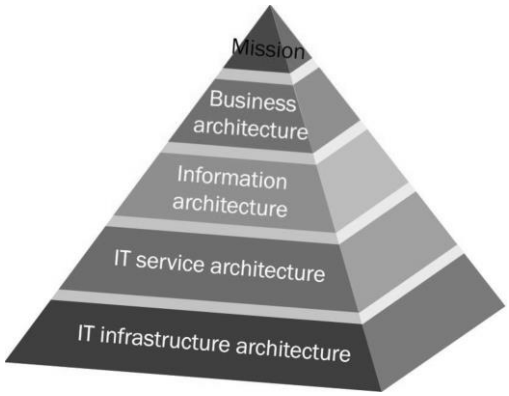

Fig. 1. Frame next architecture model [4]

Through the KAREN, FRAME and FRAME-NEXT projects, the European Union has developed a European ITS framework architecture in order to harmonize the development of ITS services in the EU. Through the FRAME project, the European framework ITS architecture created a set of user requirements and a functional view that represented a common framework for the creation of national ITS architectures in the EU. The technical point of view was often in the focus of the ITS service

creation process, and service provision was mainly the responsibility of one entity.

Rapid technological changes and changes in user requirements in the field of ITS generate organizational changes and changes in the way ITS services are provided. In addition to the technical point of view on ITS services, it is necessary to take into account the cooperation of various actors involved in the provision of ITS services. In order for different actors to be able to offer common ITS services, they must cooperate on a business and technical level, and their architectures must be interoperable. Through the FRAME project, the European framework ITS architecture has defined concepts and standards that ensure the interoperability of ITS services in the EU. Through the FRAME-NEXT project, a systematic approach to the business perspective of ITS services was introduced, shown in figure 1. This led to a paradigm shift in the field of ITS services from a support approach to the creation of technical ITS systems to an approach to the creation of business ITS services.

4 Standardization of data in the ITS environment

The European strategy for data gave great importance to the process digitization and the development of sustainable mobility [5]. In order to increase the efficiency of the use of traffic data, it is necessary to standardize traffic data sets and enable the sharing of traffic data between interested actors. Wide availability of traffic data will enable the development of efficient and user-friendly ITS services. All EU ITS regulations and directives include certain data standards used in the ITS system. In addition to the DATEX II standard, other data standards such as NeTEx, TAP-TSI, OJP etc. are also used. DATEX II was developed as a standardized solution for the exchange of data and information between traffic centers, ITS service providers and data and information collection and distribution companies. NeTEx (Network Timetable Exchange) is a standard for data exchange in public transport whose goal is to standardize data in public transport information systems. NeTEx is based on open technologies (XML, XSD, UML) that enable operators to present data in a unique format and use unique protocols. The NeTEx standard includes network topology, tariffs and timetables. The TAP-TSI standard (The Technical Specification for Interoperability on "Telematics Applications for Passengers") is a standard that enables the standardization of data and messages in EU rail transport. This standard includes data on timetables, tariffs, reservations, information for passengers, etc. The OJP (Open Journey) standard provides a unique interface for authorized users to access data. This standard is used for distributed travel planning. This standard limits the collection of data at a centralized level in order to limit the risk of delays in data exchange and enable better utilization of data. GTFS (Google Transit Feed Specification) is a data format that can easily be imported into Google Maps. This standard is used by various applications for travel planning, timetables, data visualization, mobile data for real-time information, etc. It is a relatively simple tool to be read by humans and machines.

5 Harmonization of ITS development in the EU

The European Union adopted Directive 2010/40 EU in order to create prerequisites for the development of ITS systems in EU countries [6]. The ITS development plan in the EU included six priority areas:

- real-time information for passengers and drivers
- information related to road traffic safety
- multimodal travel information
- information related to safety and reservation of truck parking lots
- interoperable eCall system
- cooperative intelligent transport systems C-ITS

The EU is continuously improving the regulatory framework for the development of ITS in order to improve ITS services in the field of real-time traffic information, real-time traffic management, development of multimodal travel information, etc. The development of ITS, in addition to new technologies, also requires new approaches that will enable the interoperability of ITS services in the traffic and transport system of the EU. In order to successfully carry out digital transformation in the field of mobility, it is necessary to expand the scope of ITS services in real time, new types of real-time data from new sources are needed to enable safer, more efficient multimodal travel on the transport network. Although the EU has invested significant funds for the development of the ITS system, the desired level of integration of ITS services and their interoperability has not yet been achieved due to

the fragmentation of individual solutions and different approaches to ITS applications.
By harmonizing the development of ITS through the application of unique standards, the efficiency of the TEN-T network increases, which contributes to its greater physical and digital integration and interoperability. Continuity and high quality of ITS services on the TEN-T network can be achieved by creating a digital environment that will enable the interoperability of ITS services, which will include the development of technologies, standards and open interfaces based on the European framework ITS architecture [7]. The FRAME NEXT architecture will use a system modeling tool that will not require the purchase of special software licenses for users of the ITS architecture and organizations associated with ITS systems. This approach to the European ITS architecture will enable the evolution of ITS services in the future. This approach will facilitate the involvement of the private sector in the development of ITS systems in addition to government agencies. Different actors must cooperate at the technical and organizational level to jointly offer ITS services that are defined at the organizational level of the FRAME NEXT architecture. The FRAME NEXT project will further improve:
- national access points NAP and eCall system
- cooperative ITS systems C-ITS
- ITS freight transport services
- data exchange through NAPs in the field of road traffic safety and real-time travel information

The national access point NAP at the state level enables the availability of data and information about infrastructure, traffic conditions, and the regulatory framework for the provision of ITS services.

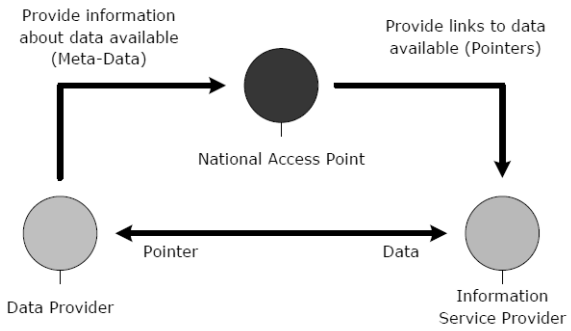

Fig 2. Functions of the national access point [4]

NAP provides travel information and historical data of different modes of transport provided by infrastructure operators, state agencies, carriers, etc. According to the user requirements of state agencies, carriers, infrastructure operators will provide metadata and interfaces that enable access to traffic data via NAP as shown in the figure 2. In order to harmonize the development of national access points in the EU, the reference architecture of national access points was defined through the FRAME NEXT project. The European framework FRAME NEX architecture will define a high-level business framework that will enable strategic and business views on ITS services. This approach to the development of ITS services will enable the identification of business models and interested actors for the development of ITS services and the organizational structure for the provision of ITS services from several actors. In this way, it will be possible to identify the targets. interests and abilities of all actors involved in the creation of ITS services, which will enable greater transparency and harmonization of the process of their development and use.

6 Future development of ITS services in the EU

The technological development of ITS in the EU can be observed in three development phases that include isolated ITS systems, cooperative ITS systems C-ITS and connected cooperative automated mobility systems CCAM which are in the research and development phase. CCAMs represent the future step of ITS development. Harmonization of ITS development requires a holistic view of the evolution of vehicle technology and infrastructure and their mutual digital integration. The directive regulating the connection of road infrastructure with vehicles in order to increase the efficiency and safety of traffic was accepted by the European Commission and the European Parliament in 2019, but it was not accepted by the EU member councils as a single framework for the development of C-ITS [8]. The EU implemented the regulation on the European system of key road infrastructure safety indicators and developed the C-Roads platform. A reference architecture for C-ITS was developed through the FRAME NEXT project. The C-Roads platform encourages the implementation of harmonized C-ITS services, but does not oblige platform Members States to implement them, which makes it difficult to harmonize C-ITS

services. The first group of C-ITS services provides certain information and warnings connecting vehicles and infrastructure. C-ITS services that help in the execution of driving tasks must meet the requirements of functional safety and reliability and enable the successful interaction of road equipment and vehicle equipment [9]. The implementation of C-ITS services requires solving heterogeneous tasks related to the functions of the ITS system and the integrated management of its operations. State agencies and road operators should be open to solutions that offer new technologies and enable their testing and the coexistence of competing technologies in order to encourage the development of the ITS service market and harmonize their integration at the EU level.

7 Conclusion

The current development of ITS in the EU has not achieved the desired goals of physical and digital integration of the EU transport system, which is a consequence of technical, technological, organizational and social limitations. The European framework ITS architecture created a common framework for the development of ITS in the EU and has a significant impact on the interoperability of ITS services and the standardization of ITS system functions. Although most Member States used the European ITS framework architecture as a starting point for the development of ITS systems, a satisfactory level of harmonization of ITS development in the EU has not yet been achieved. Due to different priorities and specificities of transport systems, each member of the EU developed their ITS systems in accordance with their priorities, while insufficient attention was paid to the faster integration of the entire EU transport system. In order to speed up the harmonization of the development of the ITS system in the EU, an action plan for the development of ITS in the EU was adopted, in which common priority areas of ITS development were defined, and the European framework ITS architecture was upgraded through the FRAME NEXT project, which created the prerequisites for faster integration of ITS services on the entire EU transport network.

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