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THE DEVELOPMENT OF ITS ARCHITECTURE FOR URBAN TRANSPORT – NEW COMPONENTS AND NEW RELATIONS

The authors present in this paper the main tools for ITS Architecture development, in Europe and USA and the use of these tools for specific ITS systems. The paper presents also a plan for development of ITS Architecture for Bucharest area, as first stage, and an ITS System (urban one), as second stage. The end of the paper is represented by the conclusions regarding with the need of development of ITS Architecture as first step of the implementation of Intelligent Transport System at the level of the city (the case of City of Bucharest).

OPRACOWANIE ARCHITEKTURY ITS DLA TRANSPORTU MIEJSKIEGO – NOWE KOMPONENTY I NOWE RELACJE

Autorzy niniejszego referatu przedstawiają główne narzędzia opracowania architektury ITS w Europie i USA oraz użycie tych narzędzi dla określonych systemów ITS. Referat przedstawia plan rozwoju architektury ITS dla obszaru Bukaresztu, na pierwszym etapie, oraz system ITS (miejski) na etapie drugim. Referat kończy się wnioskiem, dotyczącym potrzeby opracowania Architektury ITS jako pierwszego kroku wdrożenia Inteligentnych Systemów Transportu na poziomie miasta (przypadek miasta Bukareszt).

1. INTRODUCTION

The ITS systems are applications of IT, electronics and communications technologies which are implemented in transport systems to increase the efficiency of them [1].

All these technologies, that have implied in ITS, have generated a complex system which is a result of multidisciplinary interconnections between various technical fields.

This complexity of ITS systems need to develop a high vision over the entire system, this vision is ITS Architecture, and it is required to solve functional, informational, physical,

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communicational and organisational aspects according with subsystems and modules of ITS system.

At this moment there are several initiatives for the development of ITS Architecture at European and world levels. The European initiatives are the following: FRAME (Framework Architecture Made for Europe), ARTIST (Italian initiative – phase 2), ACTIF 2 (France), FITS (Finland), ARKTRANS (Norway), TTS-A (Austria), and TEAM (Czech Republic) – for these architecture was developed several software tools for generating parts of ITS Architecture (as functional or physical), for instance OSCAR developed by ACTIF project.

At the world level we have identified the following national architecture preoccupations: The National ITS Architecture v5.0 developed by ITS America (on the base of this architecture was developed Canadian ITS Architecture), ITS Architecture for Japan[3].

All these preoccupations show the fact that it is absolute necessary to develop an ITS architecture for ITS systems, first of all for the national level, after that for local and particular systems.

The first step in ITS development for national level is to generate a Framework ITS Architecture, and on the base of this framework they must develop entire ITS domain. The main reasons for this approach are: unique conception of all the systems and avoiding of interoperability problems.

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2. ITS ARCHITECTURE

The ITS Architecture is a high vision of a system that said which are the minimal functionalities of the system and which are the basic relations between it and other systems (this last condition is necessary to ensure the interoperability of the system).

This architecture is similar, as concept, with PC architecture and it is very important to take in account this similitude because the computer science is one of most relevant components of ITS systems [3]. The PC architecture defines minimum functionalities for a computer, as instance a computer must have a serial interface for communications, like RS 232[4], but the manufacturers can develop various proprietary interfaces for communications, that means that PC will communicate only with specific PCs or other devices on that proprietary interface.

[3] The Japanese initiative was built on the base of National ITS Architecture v4.0

[4] RS 232 serial interfaces was considered just an example for underlining of Architecture's importance

The development of ITS Architecture is an activity which is needed by the several users' categories. For this reason there are two different categories for users:

- Users of ITS systems – for this type of users there was identified several components: **want ITS** – the service provider want the system to solve (or diminish) traffic problems, or to provide information services to the public; **make ITS** – component suppliers will deliver hardware and software components for the system and system integrators will combine the components into a complete system; **use ITS** – the primary users will benefit from the output of the system and the secondary users will control the system and provide input; **rule ITS** – the local authorities have the responsibility for issuing the regulations on how to implement and use the system and international authorities may also issue regulations, as well as standards and recommendations for international interoperability[5][6].
- Users of tools related with ITS systems (ITS Architecture was included here) – the number of users' type is reduced to: make ITS and rule ITS.

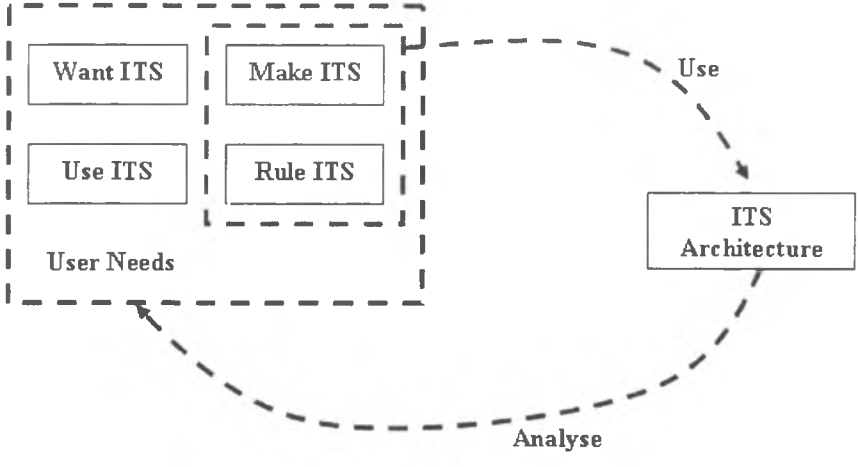

Fig.1. Users of ITS systems and ITS architecture

Other point related with ITS Architecture is the level of approaching. For this issue is important to determinate that is the area of architecture: European, regional, national, local and system level. We think that the National ITS Architecture is the first step in the development of ITS, this architecture must be made in connection with other architecture initiatives for ensuring the interoperability at the European level [2].

[5] The source of this information regarding to users' classification was Converge project (and Frame project)

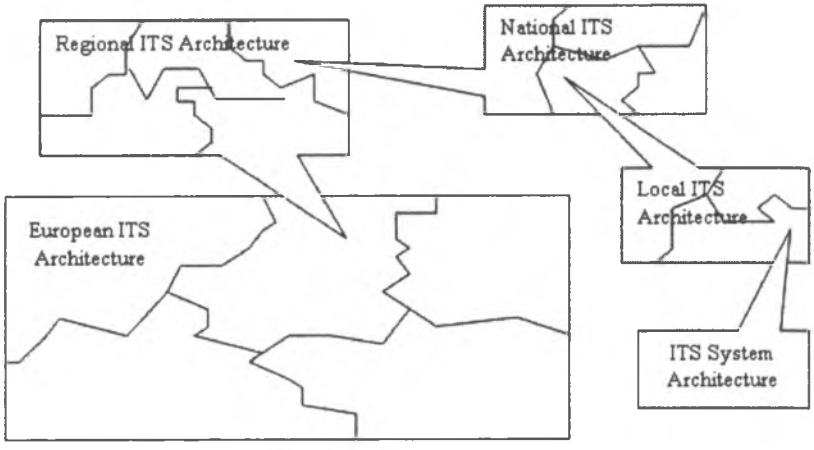

Fig.2. ITS Architecture at different levels of application

At this moment there are two main tools for the development of ITS Architecture: one of them in Europe – European Framework ITS Architecture developed by Karen and Frame and the second one in US – The National ITS Architecture v5.0 developed by ITS America. The approaching of American ITS architecture is a mandatory one and for European architecture is functional. The American version was designed for identifying the commercial packages of ITS systems and one entity who desires to build a part of ITS system can to focus its activities on one commercial package. The European architecture forms a framework for future developments of ITS in Europe (and other world areas) and establishes functionalities of future ITS systems.

An ITS architecture has several components, as following: functional, physical, communicational, organisational and security component[6]. For the generation of comprehensive architecture the designers will use and other elements, like: user needs, reference models, and several analyses (cost/benefits and risk).

3. URBAN AREA AND ITS SYSTEMS

The transport systems are vital for urban area, because all activities in the city are made by people and goods movements. For this reason they must find solutions for increasing efficiency of transport systems. Urban area has a particularity, which involve special measures for transport policy, that the transport infrastructure can not be developed on extensive way (the city has a limit to extensive extension of transport infrastructures), but an intensive way to improve transport systems is available. This way for intensive improvement is covered in a great part by intelligent transportation systems.

[6] This component was introduced for the first time by National ITS Architecture v5.0 developed in US

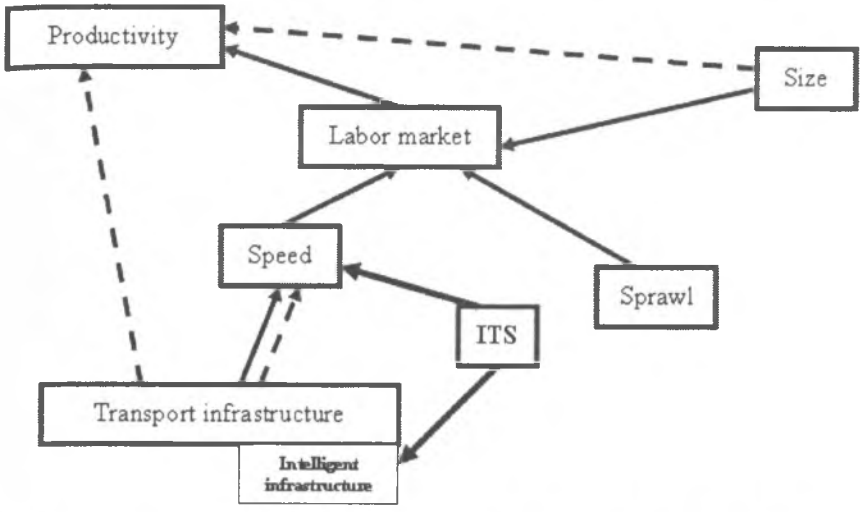

Fig.3. The role of ITS to improve city productivity through transport infrastructure and speed

In Fig.3[7] is presented the relations between ITS and factors of city productivity (The sprawl represents the relative location of jobs and home and it is defined as the average potential job-home distance; Size represents the dimension of the city (number of inhabitants); speed means the average speed which people go from the origin to destination in that city) [4].

For a specific urban area, like City of Bucharest, is absolute necessary to evaluate the state of transport system and the relations between involved organisations. They must build a list of urban organisations which are involved in transport activity, and after that they must identify the functions of these organisations and the relations of them with the ITS systems. Bucharest has a very complex structure of transport system, because there are many organisations involved in transport activities. In the following figure it is represented a flow chart of city transport and the connections with ITS system.

[7] This figure is adapted from the paper „The Development of Public Transport Management based on ITS Architecture" presented by the main authors at international conference „ITS '05 Prague" in Prague, Czech Republic

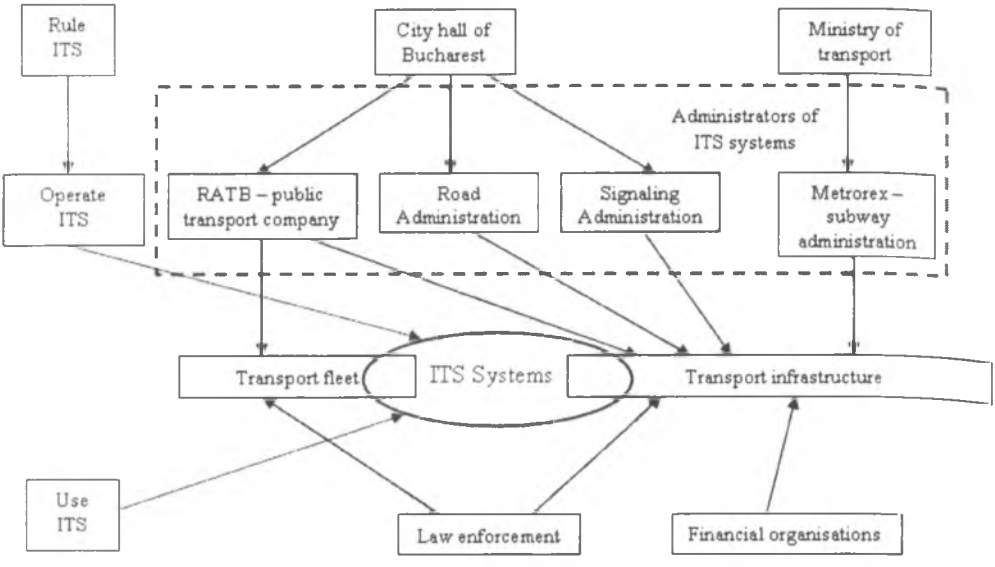

Fig.4. Organisational Structure of Transport System for Bucharest and the connection with ITS

The organisations of policy in transport for Bucharest area are City Hall of Bucharest (for surface public transport and surface transport infrastructure) and Ministry of Transport[8] (for underground transport). Also, there are four main administration entities for fleet and infrastructure administration which are possible administrators of future ITS systems for urban area. This complex structure makes difficult the management of ITS systems for Bucharest and the unique solution is to create an independent entity for the deployment and management of ITS system (this case is specific for Public Transport Management – Urban Traffic Control system[9]).

The complexity of organisational structure of transport system generates the necessity of ITS Architecture. This architecture must be developed in connection with a national ITS Architecture, because the transport system for urban area is connected with suburban and highway transport systems.

4. ITS ARCHITECTURE FOR URBAN AREA

We consider that the proper tool for development of ITS Architecture in Romania is The European Framework ITS Architecture developed by FRAME project. But this framework must be adapted to specificity of Romanian transport system.

The case study is focused on Bucharest area and the process of ITS Architecture generation is presented in the following figure.

[8] The administration of subway system in bucharest is ensured by METROREX, which is a public company and it is subordonated to Ministry of Transport

[9] At this time it is the first stage of PTM-UTC system for Bucharest

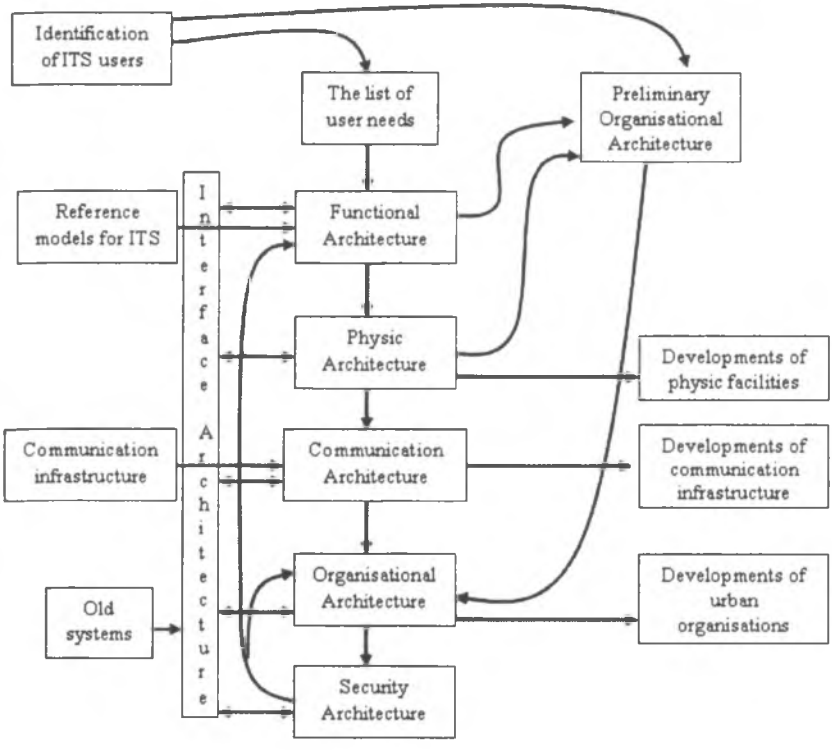

Fig.5. The components of ITS architecture

We have used the FRAME methodology to develop a local ITS Architecture with several modifications. Firstly, after the identifying of user needs they must build an organisational architecture (a preliminary one) because must identify from start which is involving in ITS management and who is the procedure for sharing the benefits and responsibilities for system operating. Secondly, on the base of reference models and user needs they will generate the functional architecture, which will describe the functionalities of the system and the information will be exchanged between system functions. Thirdly, they will develop a physic architecture, which will contain the specifications of physical entities which perform the functions of Functional Architecture. Fourthly, they will use the physic architecture and a survey over existent communication infrastructure to develop specific (for urban area) communication architecture[10]. By use of Communication Architecture, they will generate recommendations for developments of communication infrastructure.

For the development of organisational architecture they will be used the previous architecture and the preliminary organisational architecture. Finally, the security architecture will be made for entire architecture and the results of it will modify all components of ITS Architecture (for instance, in Functional Architecture must be introduced security function according with Security Architecture).

[10] The authors have used the term „architecture" for elements of ITS Architecture inspide of FRAME project where they have used the term „view point"

Other component of ITS Architecture is Interface Architecture which must be developed to align the old systems to new systems and new technologies (this architecture will contain following elements: functional, physical, communicational and security strictly for interface systems). This new component of ITS Architecture is very important for Bucharest, because there are many pilot systems (developed for small areas not for entire city) which must be interoperable with new systems.

5. DEVELOPMENT PLAN FOR ITS SYSTEMS

They must elaborate a plan for development of ITS systems on the base of ITS Architecture at urban level (in this case for Bucharest city). This plan has three main components: policy, strategy, and design.

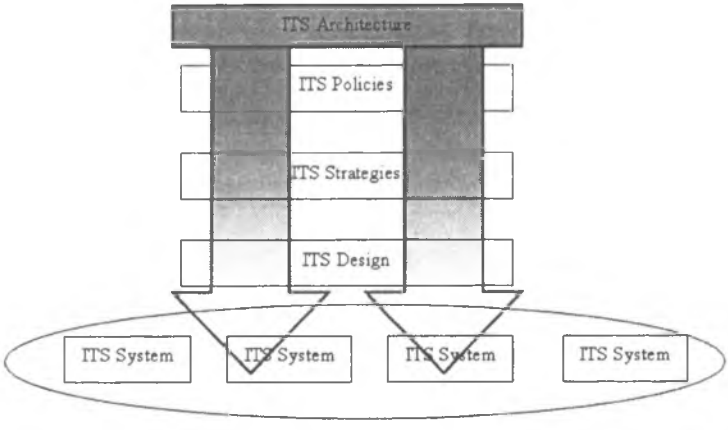

Fig.6. Use of ITS Architecture at three levels of the development plan

First components means that the ITS Architecture will be included in transport policy at national level (Ministry of Transport – national authority) and local level (City Hall of Bucharest – local authority). Without this components will can not be developed an ITS Architecture for Bucharest, because all future systems must have a unique conception for economic and social benefits and the only one way to bring that is the use of ITS Architecture.

At the strategic level, all organisations responsible with ITS administration must include in their strategies one in connection with ITS development. That means they must have an ITS architecture for strategies' elaboration and they must connect their strategy with other initiatives in the field of ITS. For instance, in Bucharest, RATB (the public company for public transport administration) must include in their strategies one according with ITS systems development (e.g. Public Transport Management System) but in the same time other company, METROREX (the administrator of subway system) must include a strategic issue regarding with ITS (for this case PTM has a part that is common for both organisations, Ticketing System).

The last level is design of the system. For this activity is very important to exist an ITS Architecture for a common conception of the ITS systems (this is a most important characteristic of architecture which ensure the interoperability and integration of the ITS systems developed by different system integrators).

6. CONCLUSIONS

In our vision for a sustainable development of transport system in urban area, they must generate an ITS Architecture for the city, as part of National ITS Architecture (this is one condition for interoperability of the systems).

The recommendation is to develop ITS Architecture on the base of FRAME Architecture (as framework) and this must adapted to Bucharest specificity and particular needs.

The extensive development of transport system in urban area is impossible in majority of European cities, and the only one solution for increasing of its efficiency is to develop transport system intensively. One measures for this kind of development is the use of ITS systems and, as first step, the use of ITS Architecture.

The necessity of ITS Architecture is revealed by European initiatives and the extension of the architecture use to other mode of transport (as inland waterway transport – River Information Systems Architecture – developed by COMPRIS project) [5], [7].

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Reviewer: Prof. Wojciech Wawrzyński