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INTELLIGENT TRANSPORT SYSTEMS - AN ADVANCED SYSTEMS OF IMPROVEMENT IN TRANSPORT'S EFFICIENCY

Abstract

In urban agglomerations with a significant density of road infrastructure solving transportation problems through further investment in infrastructure is an activity inefficient. Each reserve capacity of road and street circuits obtained by the development of infrastructure, it is immediately used. In this situation, new concepts of solutions which meet the growing demand for public transport. One is the Intelligent Transportation Systems (ITS), which provide a broad set of various technologies used in transport in order to protect the lives of participants traffic, improve the efficiency of the transport system and the protection of environmental resources natural.

The paper shows the conditions for the application of intelligent transport systems. Describes the architecture and operation of creating intelligent transportation systems. The paper presents the benefits of the introduction of the urban area of intelligent transport systems and the measures taken for their development in Poland.

INTRODUCTION

Nowadays, due to the rapidly growing road transport it is necessary to use modern information and communication technologies to enhance the efficiency, safety, and minimize the negative impact of transport on the environment. Providing all these actions can be accomplished through the implementation of Intelligent Transport Systems (ITS). Solving transportation problems in cities can be achieved through better traffic control and optimization of traffic flow. ITS reinforces positive attributes of transport (accessibility, mobility) while minimizing its negative rate impacts (e.g. congestion, incidents movement) [14, 20, 2]. ITS represents a structural approach (users, areas of application and technology) oriented to the needs of users who are satisfied through the integration of advanced technology capabilities (communications, information, intelligent monitoring and control, the new generation of motion control systems, vehicle navigation and location) in the various fields of application (planning, management, monitoring control, intelligent vehicles and intelligent infrastructure) [1].

1. ESSENCE OF INTELLIGENT TRANSPORT SYSTEM

Intelligent transport systems form a broad spectrum of many tools based on information technology, wireless communication and vehicle electronics allowing for effective and efficient management of transport infrastructure and efficient services for travelers. The combination of these solutions with the physical transport systems, adapted to the needs of these systems and the activities conducted by them are referred to as telematics transport [12]. Telematics technologies are introduced to the elements of the transport infrastructure and

vehicles (Fig. 1). The main purpose of these activities is the management of vehicles, loads, and routes thereby increasing the safety improvement, minimizing the traffic, reducing travel time and reducing fuel consumption. Therefore, intelligent transport systems are used for such aspects as:

- management of urban traffic,
- management of public transport
- management of accidents and emergency services
- providing traffic information to travelers
- management of toll systems and for the use of transport services
- automatic recording of traffic violations
- advanced technologies in vehicles [20].

Often intelligent transport systems are particularly useful in situations where:

- an access to the areas of the city is difficult, leading to inhibition of investment, activity of corporate entities, mobility of the population, which limits the development of the area,
- is necessary to protect the historic part of the city or residential areas against air pollution and noise,
- sustainable development of public and private transport becomes a condition for the further development of the city.

The characteristics of intelligent transport systems are :

- integration of technology, the tools and software that provide an efficient flow of information,
- “intelligence "is understood as the ability of the system to make independent decisions in varying situations,
- high flexibility and adaptability - the possibility of creating the configuration according to the needs,
- efficiency defined as the universality of benefits [19].

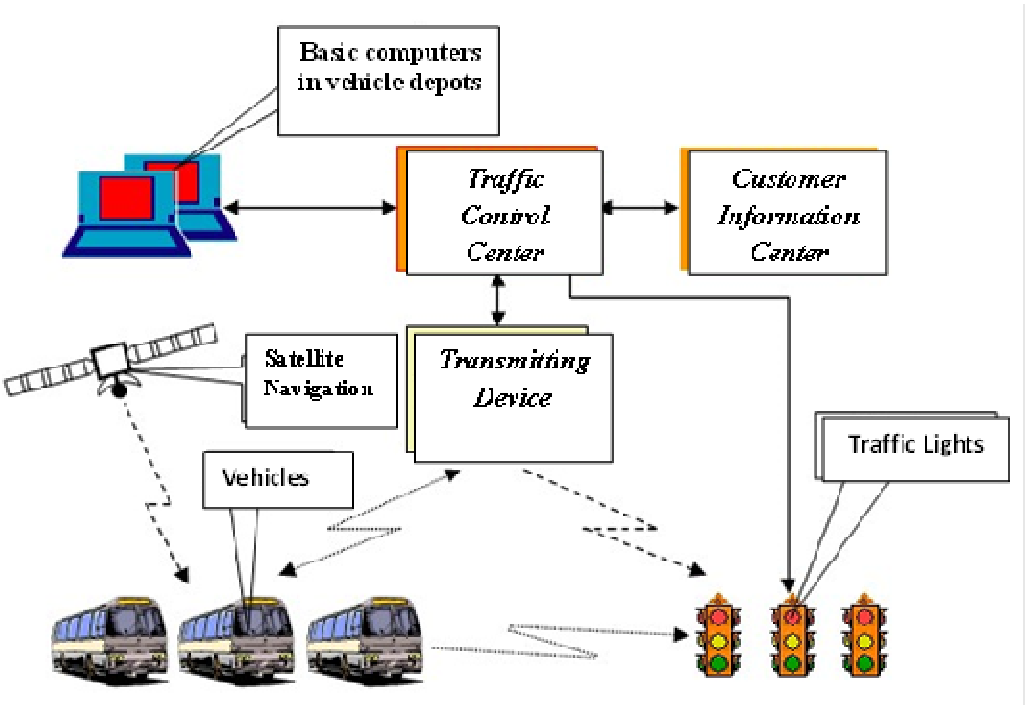

Fig. 1. Basic telematics system
Source: [21]

ITS are created by combining working together various telematics solutions, often under the control of a man supported by specific, special telematics applications or tools for particular tasks. Telematics solutions can be tailored to the isolated mode of transport (e.g. road transport) and for the selected geographic area (e.g. an administrative unit of the country, but also can integrate and coordinate the continental or global transport system. Such solutions tend to have an open architecture and are scalable: if necessary they may be extended, corrected and modernized. Their aim is to ensure that interoperability of system components and the interaction with users, which will provide safer travel and transportation, increase the reliability of transport, make a better use of the infrastructure and get better economic results, as well as reduce environmental degradation.

The basis for intelligent transport systems is a smooth flow of information within the system which is reflected in the construction of the system. The individual components of the system communicate with each other by exchanging information, processing it, and then give it to the public. The development of intelligent transport systems is shown in Figure 2.

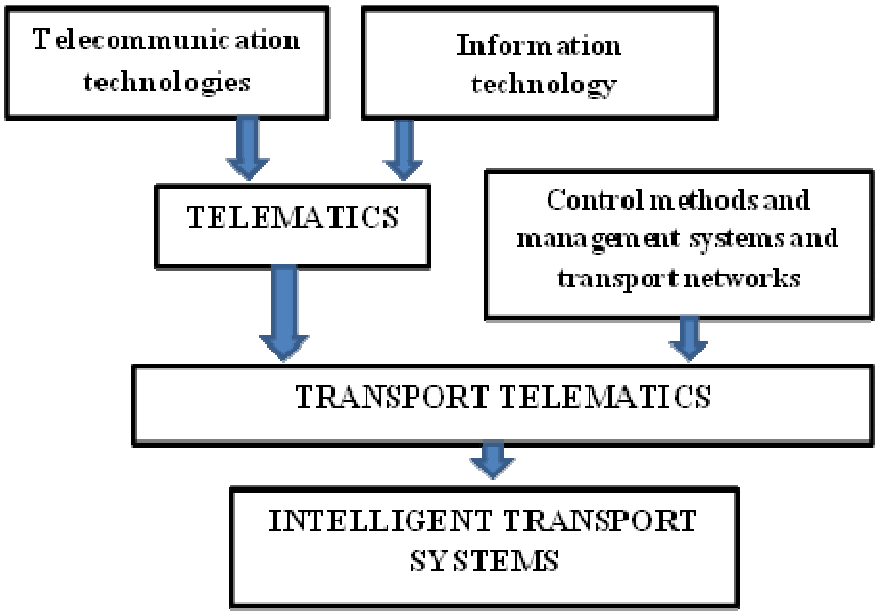

Fig.2. Development of intelligent transport systems
Source: [20]

One of the most important tasks posed by the regions of Europe, or the world by introducing intelligent transport solutions is to establish a so-called ITS architecture. ITS architecture is understood as a set of links (logical, physical and communication) between the elements of the systems that create Intelligent Transportation Systems to create measurable solutions that are easy to maintain and manage [3]. A common recognition of the structural framework for the development of intelligent transportation system is formed in the domestic architecture of three specific architecture: functional, physical, and communication.

Functional architecture contains definitions and descriptions of the functions that should be used in the ITS architecture so that it can meet the expectations of users specified in the "Users' Needs". It is therefore a representation of the system in a logic term taking into account the relationship with the environment and, in particular, with the system users and data sets applied in the system. The data sets are sometimes presented in a separate" information structure". Physical architecture includes definitions and descriptions of methods of how functional architecture components can be grouped in the form of physical units. The main feature of these units is the ability to perform services specified in the" Users' Needs." They are created with diverse technical equipment (including software) on the platform of

road infrastructure (often described as systems, as an example). Communication architecture provides definitions and defines measures allowing for the exchange of information between different parts (components) of the system (means of transmission of physical data streams). These include two complementary aspects, recognized by methodologies and separate proceedings: providing resources (technological independence!) and communication of the message. It is also located the determination of the contents of the information [22].

At present in Poland the ITS solutions are "random" in the sense that individually meet the predetermined role, but when combined they can lead to a situation in which these systems are incompatible and will not be able to work together without bringing the same potential benefits. An important feature of telematics applications is the ability to efficiently association of various subsystems and placing them in a coordinated function. The standardization of telematics systems is to ensure their proper interaction and the possibility of further development. No clarified standards of national or regional ITS architecture results in a "technological islands" with diverse architecture, which later expands. If their borders join then the incompatible systems manifest.

ITS Architecture are created as specific national and special situations, with larger areas of cooperation, as the architecture of correlated or - as in the case of the European Union - as a framework architecture of intelligent transport FRAME. In order to develop the structure of ITS in Europe KAREN project was launched as well as the aforementioned project FRAMES ((Framework Architecture Made for Europe), which aims at assisting users to update and improve the European ITS architecture. This structure is used as the base for ITS implementation in European countries.

2. EFFECTS OF INTELLIGENT TRANSPORT SYSTEMS IN ROAD TRANSPORT OPERATION

Due to the variety of ITS and their applications the improvement of services is determined in a different way in the most important areas in terms of transport efficiency and making it more friendly to users and the environment. In the urban area with a high density of road infrastructure the increasing of the capacity of road infrastructure development is not very effective as the appearance of free space is immediately filled. Hence, it is advisable to implement a solution that uses Intelligent Transportation traffic management which is aimed primarily to improve the efficiency of existing infrastructure without the need for its further development. Research carried out in urban areas where ITS systems have already existed for some time (Canadian, Japanese, European) show that their use will increase the efficiency of network bandwidth measured by as much as 20 %. In urban systems, benefit-cost ratio calculated for the period of 10 years is between 1,5-34, the most profitable systems are characterized by traffic at intersections and central areas [12]. Many years of research in the U.S., Japan and Europe show [4], [5], [18] that the use of systems which apply ITS methods and means contribute to:

- reduction of spending on transport infrastructure by as much as 30-35 % to obtain the same results to improve the efficiency of the system, as in the construction of new road sections ;
- increase by up to 20% bandwidth transport network elements without the new road section; - a significant reduction in the number of road accidents and their victims;
- travel time savings ;
- reduction of CO_2 emissions (e.g. due to reducing the number of controls and improvement of the flow of traffic) [11].

The introduction of the computing methods and tools, however, requires additional equipment infrastructure in many technical elements associated with the acquisition, processing and distribution of information. These are complementary components:

– sensors providing a source of information on traffic and road conditions (counters vehicles, weather forecast stations, mostly cameras, satellite receivers, etc.);
– device for data transmission network (fixed line communications and motor systems, long - and a short-range ones, specialized communication systems);
– the information processing devices (computer systems);
– equipment for distribution and presentation of information necessary for the control, management and communication of users (digital broadcasting, variable message signs, light control, etc.) [22].

Intelligent networks of traffic management affect the flow of traffic to solve the problems of automatic toll collection systems for motorways and express roads, they provide automatic control of vehicle speed, dynamic adjustment of speed limits to current driving conditions, the transmission of data on the number of free parking spaces. Road signs with variable content significantly improve the urban traffic control both steering systems, parking and congestion warning and unforeseen events. It also gives information on alternative routes. Traffic congestion is a growing problem in the countries of Central and Eastern Europe, which affects all groups of transport users. This problem can be reduced by increasing the yield or the management of the transport network needs to move people. The main of them are parking, charges for public transport and guiding entering certain areas. Paid parking systems, particularly in town centers and other crowded areas, have become an effective and important tool of demand management. This solution is widely used in the centers of large cities. The implementation of a system controlling the entrances to certain areas of the city can be an effective tool to protect residential areas from a sudden and uncontrolled influx of vehicles [16].

3. EXPERIMENTS WITH IMPLEMENTATION OF ITS IN POLAND

In Poland it is also recognized the need to build a modern transport systems [15], [17], but this work is not yet coordinated. The Ministry of Infrastructure is working on a national ITS architecture that will provide a basis for standardization and harmonization of the implemented methods and means of ITS to ensure the cooperation of individual components. Polish first regional architecture was developed under the concept of Three Cities (Tri-City area in Poland) [6], [7], [8]. In this agglomeration, as in other cities, there are many problems [9], [10] which can be solved through the use of methods and means of ITS. These problems include:
– large street network congestion , especially during peak transport;
– difficulties in finding available parking spaces, especially in central areas,
– the high cost of road accidents and traffic stoppages caused by these events;
– difficulties in the rescue operation for identifying the event and reaching the scene of the incident and the completion of the stock;
– lack of information about traffic conditions and travel conditions both before and during the journey;
– failure of the existing transport infrastructure, traffic organization and control to the current type structure, direction and increasing the volume of traffic;
– an increase in the percentage of car trips in non-pedestrian trips (decrease in the collective transport travel);
– inefficient management of freight.

The Tri –City area took an action to develop a common approach to agglomerate ITS system and its phased implementation [11]. It resulted in the concept of an integrated system for the Tri-City ring road and for Gdynia, Sopot and Gdansk. TRISTAR (Tri Agglomeration Intelligent Transport System) will provide a set of tools for the effective and efficient management of transport infrastructure and efficient service to travellers across the

conurbation. The largest city in Poland (Poznan, Warsaw, Cracow) are also working on the implementation of such systems in their areas.

The project of expansion of intelligent road transport system is also formed in the city of Rzeszow. It includes the development of Dynamic Passenger Information System through the purchase and installation of modules of Passenger Information Tablets, e- kiosks, e- Ticketing System and the construction of a dynamic WIM Vehicle Weighing (Weight in Motion) through the purchase and installation of preselective weighing station. The project was selected in a competition under Measure 8.3 Development of Intelligent Transport Systems, Infrastructure and Environment Programme. The establishment of e- kiosks allows passengers to obtain information about the connections. Without funding the project would be impossible. Therefore, the lack of funds to finance is one of the major barriers to implement ITS in our country on a larger scale.

SUMMARY

The use of ITS in road transport is associated with the maximum use of transport infrastructure. The access to the network nodes for monitoring and forecasting of traffic, the use of intelligent traffic lights to facilitate access to information on road transport, information about the degree of congestion of certain sections and alternative diversions, the increase of road safety are some of the benefits of ITS deployment. Although the use of ITS reduces the costs borne by the State, among others for the travellers to the creation and deployment of ITS is fraught with difficulties mainly of a financial nature. Financial constraints lie on the search for funding from various sources. High efficiency of the use of ITS solutions providing the reimbursement of systems implementation in the short term is the basis of technological development of transport in this direction. Although in our country there have been taken measures to develop the ITS, but they require further implementation of works.

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INTELIGENTNE SYSTEMY TRANSPORTOWE – ZAAWANSOWANE SYSTEMY POPRAWY EFEKTYWNOŚCI TRANSPORTU

Streszczenie

W aglomeracjach miejskich o znacznym zagęszczeniu infrastruktury drogowej rozwiązywania problemów komunikacyjnych poprzez dalsze inwestycje w infrastrukturę jest działalnością nieefektywną. Każde zwiększenie liczby dróg i ulic otrzymane przez rozwój infrastruktury, jest natychmiast wykorzystane. W tej sytuacji wykorzystywane są nowe koncepcje rozwiązań, które spełniają rosnące zapotrzebowanie na transport publiczny. Jednym z nich są inteligentne systemy transportowe (ITS), które zapewniają szeroki zestaw różnych technologii stosowanych w transporcie w celu ochrony życia uczestników ruchu, zwiększenia efektywności systemu transportowego oraz ochrony zasobów środowiska naturalnego.

W artykule pokazano przesłanki zastosowania inteligentnych systemów transportowych. Opisano założenia architektury i funkcjonowania inteligentnego systemu transportowego. Przedstawiono korzyści jakie daje wprowadzenie w aglomeracji miejskiej inteligentnych systemów transportowych oraz podjęte działania zmierzające do ich rozwoju w Polsce.

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