INTELLIGENT TRANSPORT SYSTEMS AND INTELLIGENT TRANSPORT MANAGEMENT

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Abstract: *The potential of Intelligent Transport Systems (ITS) wich will assist in the realization of traffic policy goals lies in a wide variety of applications in different forms of transport, both for passengers and for cargo. This is the case not only for road transport, where applications include: electronic tolls, dynamic traffic management (including variable speed limitations, parking and booking, and real-time navigation), real-time information and other driver assistance systems like Electronic Stability Control and Departure Warning System. The benefits of introducing ITS solutions is to improve the economy, efficiency and security of the transport system. The benefits are grouped in conjunction with accompanying measurements and effects: safety, efficiency, productivity and cost reduction and impact on the environment. Collective level of benefits that can be achieved at the state level, with well-developed traffic infrastructure, are impressive.*

Key words: *ITS, traffic, smart traffic*

1. Introduction

The basic characteristics of ITS are better management and improved response of the traffic system, which makes it intelligent. In order for the system to be "intelligent", it must adapt to the environment and be able to collect and process enough data in real time. ITS was introduced into the professional and scientific dictionary in 1994 in Paris.

ITS can be defined as a holistic, management and information and communication upgrade of the classic traffic and transport system which significantly improves traffic performance through more efficient transport of passengers and goods, improving traffic safety, comfort and protection of passengers, reducing environmental pollution, etc .. ITS brings a solution to current traffic problems in the form of intelligent roads that are presented as an upgrade of the current infrastructure. In addition to the physical functions of road upgrades, the upgrade also implies greater informativeness of drivers. The main goals of ITS are safety, efficiency, environmental protection and improvement of roads by applying technology. Advances in information transmission, communication, location and sensor technology also bring advances in ITS.

The goals of ITS are also greater informativeness of the road, which would be achieved by integrating various systems. Some of them are safe driving systems that inform the driver about potential dangers outside his field of vision, current traffic information in a wider area that is not directly accessible to the driver, information about potential delays. By using this information, the driver could avoid potential traffic difficulties. They also inform the driver about current road conditions which reduces the chances of accidents. Technologies such as ABS (anti-lock breaking system) and automatic collision avoidance system to help the driver steer the vehicle. In general, all these changes represent a transition from passive safety mode to active mode and a major step towards automatic management at several levels.

2. The role and importance of intelligent transport systems in the development of traffic and transport

The term 'Intelligent Transport Systems' and the acronym ITS were introduced after the First World Congress of ITS, held in 1994 in Paris in 1994. Before that, the term "traffic control" was used in a similar term, ie the

terms "road control" were used. transport telematics "and" intelligent road systems ". At the beginning of the 21st century, traffic experts agree that successfully solving the growing problems of traffic and transport is no longer possible without the application of the complete concept and technologies of ITS (Intelligent Transport Systems).

ITS is a management and information-communication upgrade of the classic traffic and transport system, so that significantly higher throughput is achieved. This allows for greater throughput, security, protection and environmental friendliness compared to solutions without ITS applications. The attribute "intelligent" generally means the ability to act adaptively in changing conditions and situations, where it is necessary to collect enough data and process them in real time. Existing ITS functional areas and services The International Organization for Standardization (ISO) has defined 11 domains of ITS:

1. passenger information, 2. traffic and operations management, 3. vehicles, 4. freight transport, 5. public transport, 6. emergency services, 7. electronic payments related to transport, 8. personal security in traffic transport, 9. supervision weather and environmental conditions, 10. major disaster response management, 11. national security.

In the area of passenger information services, static and dynamic information on the traffic network, pre-road and road information services, and support to services that collect, store and manage information for planning transport activities are included. The pre-trip information service enables users to get useful information about available modes, weather or travel prices from home, ie from their workplace or other public location. On-trip information includes real-time travel information, estimated travel time depending on existing conditions, availability of parking spaces, traffic accidents, etc. Information is provided via terminals at bus and train stations, squares, transit points, vehicle screens or portable personal terminals. Route guide and navigation services may relate to road and road information on the optimal route or route to a designated destination. The choice of the best route is based on information about the transport network and public transport and includes multimodal options with solutions such as park and drive (Park & Ride).

Surveillance and elimination of incidents on roads include detection, response and clearing of incidents on roads or in their immediate vicinity. Only a smaller number of the total number of incidents relate to traffic accidents involving vehicles and there are injured or fatalities. In addition to a posteriori action, detection and clearing, accident prediction and prevention is performed. Prevention of secondary accidents is especially important. The focus is on traffic accidents and accidents and if the system includes a response to other causes of small incidents (tire puncture, vehicle disappearance, etc.) and major accidents and catastrophes (earthquakes, landslides, large fires, etc.). Transport infrastructure maintenance management is a group of services based on the application of ITS technologies in the management of road maintenance, ie the associated communication and information infrastructure. The integration of different payment systems and institutions included in the system includes technical-technological and inter-organizational solutions.

3. Intelligent vehicles, smart roads and smart traffic

The ITS functionality of the intelligent vehicle is realized through telematic equipment that is upgraded to the basic equipment and devices of motor vehicles and trailers. At the same time, it is necessary to ensure compliance with regulations and ordinances on technical conditions of vehicles in traffic on roads or other roads.

Road lighting devices and ITS solutions to improve visibility can significantly increase traffic safety while reducing the number and severity of the consequences of traffic accidents. Active safety systems are becoming an important part of the vehicle and an important factor in improving traffic

safety. Initial estimates that in 10 years ITS will halve the number of fatalities and injuries, have been largely realized.

Automated, ie intelligent roads are realized by information and communication upgrade of the classic road, which includes a system of telecontrol, telemetry, telecommand and mobile communication.

Smart Roads will send information that will be used by vehicles and traffic infrastructure. The roads of the future will be a digital communication channel that will not only share information about traffic, but also information about temperature, precipitation, road conditions and warnings of potentially dangerous situations such as fog, and similar situations in real time.

Also, information about some objects or people on the road will also be immediately available, as well as a report of damage to the roads. Keywords are "real time" and only if the information is collected, processed and transmitted without time interval, it is possible to get a digital image of traffic in real time. In cities where network coverage is much better a large amount of data can cause a system crash. One solution could be to introduce a 5G standard that far exceeds all previous standards in terms of communication speed. The capacity of the 5G network, which should be introduced by 2020, exceeds the capabilities of the existing 4G LTE standard by 1000 times.

When solar roads that transmit energy to the vehicles that drive on them are mentioned, it can sound like a perpetuum mobile, and the question is how much their performance would cost. “The cost of maintaining standard asphalt roads is one euro per square meter per year,” explains Müller-Judex. "After deducting the investment costs, solar roads can earn eight euros per square meter per year. “There are also ideas about using solar roads as a heat source. Thus, during hot days, the road surface is heated to more than 60 degrees, and this heat could be used to heat buildings near roads, etc. Unlike solar cells that produce electricity by the sun, in this case small amounts of electricity are generated deformations caused by the passage of the vehicle. Although these are small quantities, they would be sufficient to power the sensors, especially in areas where there is no electrical infrastructure. In addition, the roads will be able to purify the air in the future. The idea is to install stones coated with titanium oxide, which is a photocatalyst, in the slabs and fences along the road.

Traffic is an activity related to everyday life and production, whose task is to transport people and goods from one place to another. Due to traffic jams, in more developed parts of the world, drivers and passengers in vehicles spend several billion hours and spend tens of billions of dollars a year. Solutions for traffic jams are mainly found through projects based on the use of computer systems and simulations of different traffic cases, ie in the unification of information and traffic infrastructures. The application of modern information technologies encourages the establishment of new infrastructure consisting of networks of roads, railways, airports, stations and ports connected by Internet-based systems. Efficiency and quality are significantly influenced by intelligent systems that improve the mobility and safety of road users, because they provide proactive maintenance and faster and better diagnostics.

All advanced solutions, significantly, increase the productivity of the company's business. By applying the IoT solution, traffic regulation reduces costs and increases passenger satisfaction, which indirectly reduces the number of traffic accidents.

Future solutions will be based on the application of smarter and more environmentally friendly vehicles and their connection with infrastructure facilities, such as gas stations, parking lots, garages, etc. Wider application of advanced information technologies, in addition to vehicle communication with infrastructure, will enable vehicle communication.

Examples of the implementation of intelligent transport systems are the integration of traffic control systems (traffic flow management, traffic light management, variable traffic messages, highway access

control, speed control, parking management, etc.), public transport management (traffic routing, incident management, violator identification, maintenance transport infrastructure) and information for passengers (delivery of information).

Information delivered by telematics systems (vehicle tracking, navigation, e-toll collection, etc.) is most often transmitted over a 3G or 4G mobile network.

One of the ITS services is real-time traffic monitoring; it is most often realized as a part of the vehicle location and navigation system. In the automotive industry, in addition to the system for monitoring and reporting on the operation of individual parts of the vehicle, we work on providing information on distance from other road users, road conditions, information on the current condition of vehicles, etc.

4. Benefits in the application of ITS

The benefits of ITS can be observed through different categories of ITS performance indicators, which are linked to the following basic indicators:

- Traffic safety, - Flow - traffic regulation, - Ecology - environmental protection, - Transport productivity. Over the past decade, hundreds of tests and operational studies of the performance of ITS have been conducted and experiences in North America, Europe, Japan, and Australia have been analyzed. The research is conducted in order to find out what are the effects of ITS in the real traffic environment before launching and realizing major investments that ITS will require. The benefits are grouped according to the accompanying measurements and effects: safety, efficiency, productivity and cost reduction and environmental impact. Summary overviews of the level of benefits that can be achieved at the state level, with a well-developed transport infrastructure are impressive. When developing and implementing new ITS projects, there are three approaches to measuring the effects and benefits of ITS:

- Results and analysis of experiences of other systems, - Execution of pilot projects and determination of expected benefits in a specific context, - Using a simulation model. For the analysis and evaluation of benefits, it is first necessary to determine the areas of benefit and measurable quantities from which values for users can be estimated. Benefits can be expressed in financial indicators related to individual users or as external effects. Part of the benefits can be individually expressed in monetary terms, while other benefits are to be viewed as a public good.

The design of effective ITS solutions implies the possibility of assessing the ITS performance using appropriate methods, such as:

- Method of measuring physical effects, - Method of benefit analysis, - Cost-effectiveness analysis (E / C), - Benefit-cost analysis (B / C).

If the benefits of ITS projects can be expressed financially, then it is sufficient to use standard (B / C) methods to evaluate the ITS project. Otherwise, it is necessary to use cost / effectiveness analysis methods (C / E analysis). An important feature of the cost / effectiveness analysis method (C / E) is to avoid the shortcomings of the (B / C) method. To measure the benefits and costs of individual ITS projects, they use customized (B / C) (benefit / cost) methods where the state of the system without ITS and the state of the system with the implementation of ITS are compared. All significant costs and benefits are determined at market prices which are reduced to present value.

ITS can reduce the number of accidents, their maintenance and the time required to service accidents. ITS can also reduce the consequences of traffic accidents, even if the number of traffic accidents has not decreased compared to the reference observation calendar. ITS can provide the necessary resources to respond to an accident, if it is part of a national management strategy in the traffic safety system.

There are two measurable indicators for improving safety, namely the percentage of

reducing the number of accidents and the percentage of reducing the time of rescuing the injured. The model is a direct indicator of safety, but it is difficult to obtain an empirical form for operational research tests, because real accidents are not common. The impact of assistance time on mortality and other factors such as the severity of the accident is analyzed.

Data for Europe show that if the time to provide assistance in a traffic accident is reduced by 43 percent, a 7 to 12 percent increase in survivors is recorded.

The benefits of improving efficiency for worldwide operational tests for various ITS products and services are manifold. The most important applications include speed management (warning, driver feedback) and vehicle and driver monitoring. Many applications will increase the prevention of injuries to individual road users (children, the elderly, etc ...)

Some examples include:

- Adaptive speed control systems, - Sudden event detection and system warnings, - Fast accident response time, - Speed camera systems and traffic signal execution, - Automatic traffic management for pedestrians and cyclists, - Monitoring of weather and microclimatic conditions, - Increasing possibilities system prediction, - Collision prevention systems.

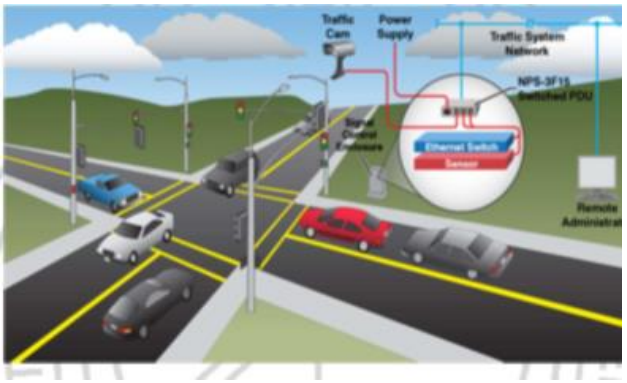

Figure 1. ITS - traffic incident prevention

The functions of an intelligent means of transport to prevent accidents help the driver to avoid or prevent an accident by using systems located in the vehicle that assess the significance of the threat, taking into account the condition of the driver. The goal of these functions is to help the driver, changing his behavior in some situations. Depending on the significance and proximity of the threat, the system will inform the driver about the danger as soon as possible, warn him if the driver did not react in time and actively help him react independently in order to avoid a traffic accident. Complementary ITS functions help the driver to move at a safe speed, keep a safe distance, drive in the same lane, avoid overtaking in a critical situation and avoid collisions with vulnerable road users. traffic safety and improving the efficiency of the traffic system. 5. New management technologies in public urban transport

The efficiency of public mass passenger transport in cities would be significantly increased if regular, even, accurate and fast public city transport was provided. Increasing the regularity and accuracy of public urban transport reduces the cost of its execution due to the even load and movement of the vehicle, which increases the speed of the vehicle, for the same level of quality, which also reduces the need to invest in the development of this function. transportation. Thanks to a unique combination of the most modern means of computer technology, radio communications, microprocessor and radio electronic devices, the system of automatic control and management of JGPP enables to determine the position of each vehicle with very high precision of time and space deviation from planned movement. This makes it possible to control traffic completely automatically, to collect a significant amount of information, not only on the execution of a given timetable but also on the state of occupancy and a number of other data on vehicle and line operation, in addition to automatic connection using coded information between each vehicle center and each of the drivers. This system is a powerful tool for automatic traffic management, collection and storage of numerous information, which at a fully technological and future level provides all the conditions

for a significant increase in the efficiency of urban traffic. The main task of automatic control is to stabilize the timetable in real time.

The system of central traffic management and control consists of four subsystems:

- Subsystem for information collection, - Subsystem for information transmission, - Subsystem for information processing, - Subsystem for providing data, information and orders to working staff with passenger notification. Today, a number of major public transport companies manage and control the operation of their vehicles through an electronic computer system.

The basic functions are:

1. Broadcasting of coded information from the vehicle to the center: - The distance traveled by the vehicle, - Vehicle occupancy, - Speed of movement, - Criteria for changing the city regime. 2. Establishment of voice information from the vehicle to the center and vice versa (at the call of the dispatcher): - Causes of disturbances, breakdowns, passengers standing at stations and the like, - Other unforeseen situations, - Changes in the mode of operation. 3. Data processing in the center: - Comparison of data on the distance traveled by the vehicle and the planned timetable, - Analysis of data on passenger flow, - Analysis of additional information, - Request for receipt of correction criteria from the computer center. Most metro systems have a center from which traffic control is performed on one line or the entire network. In the center there is a control panel on which the network is shown and on which electric lights indicate the position, signal and occupancy of signal blocks (trains). Some newly built metro systems perform continuous traffic control using electronic computers that provide accurate data on the movement and position of each train on the network at all times. This type of traffic control gives optimal results in terms of reliability, which is a factor of special importance for networks with connected lines, where the delay on one line can be transferred to other lines.

Conclusion

Traffic, or its growth and impact on the environment is the basic problem of modern society. Thus, the need for better control and organization of traffic has stimulated the need for new technology that would be effective in this. Therefore, ITS is designed to help the current classic transport system to achieve better coordination, safety and efficiency. Its application does not eliminate the classic methods of control, police service, etc., does not diminish the activities of these services that perform regular road inspections, but certainly helps them to discover the location of the accident and the possibility of going to the field to help resolve the situation. The speed and timeliness of data transfer of the ITS system is simply a link in every larger and more developed traffic center. Thus, the main goal of an intelligent transportation system is to integrate the system to improve the movement of people, goods and information. In addition to this main goal, which has been achieved in the countries where it has been introduced, but is also being improved, it has encouraged the achievement of additional desirable goals. The work efficiency and capacity of the transport system, mobility have increased, and the rate of accidents and damages caused by transport has decreased, as well as energy consumption. It also enables better control of harmful effects on the ecological system, ie environmental protection.

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