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Intelligent Transportation Systems in Bydgoszcz

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ABSTRACT

The authors presents a description of the implemented project Intelligent Transportation Systems (ITS) in Bydgoszcz. Mainly it describe the purpose and functions of various segments of the System posed. The content is based on the concept and technical specifications of the project.

The paper consists of a diagnosis of the existing transport infrastructure of the city along with cause difficulties in traveling. Also raised issues of public transport infrastructure occurring in the city. Lists the existing constraints in organizing bus and trams connections in the city. Drew care in the middle of doing and planning investments in improving the operation of trams.

The following section presents an area, which there will be a draft System. Principal explanation shall be posed the tasks and goals of the implemented project and the results, that will be achieved by running a traffic control center and public transport. Describing the implemented ITS project consists of a presentation of the different sub-systems in the area of: traffic control by devices functioning of ITS, giving priority to pass through the junction for selected transport measures, constant traffic monitoring using video observation, public transport management, support for dynamic passenger information at bus stops and website, display information about the occupancy of parking space and display short messages informing about any obstacles on the way and guiding drivers to alternate routes.

Implemented components and control devices, including traffic observation should contribute to improve the passage of vehicles in Bydgoszcz. It is expected, that this will increase the efficiency of use of existing transport infrastructure, will help users to better plan their travel and contribute to increasing the attractiveness of public transport.

KEYWORDS: ITS, SCATS, CSR, Bydgoszcz

1. Introduction

A real life in XXI century, where humans are constantly struggling with the difficulties associated with congestion of urban road network, the factors affecting eliminating or reducing the loss of time caused by congestion in major transport corridors or while driving through the intersection contribute to a significant improvement of traffic conditions and to save resources.

Constant increase in development of information technology causes the appearance of newer and newer technologies in engineering traffic telematics. These tools facilitate and improve comfort of journey not only to drivers and passengers of personal transport, but also public transport, or even severe.

City of Bydgoszcz has prepared a draft of Intelligent Transport Systems (ITS), which took first place in the ranking of grant applications submitted under the competition 8.3 Rozwój Inteligentnych Systemów Transportowych POIiŚ. The predicted cost of the project is estimated at 69 063 102.00 PLN, of which the sum of 56 286 661.70 PLN is the amount of the grant from the European Regional Development Fund, which accounts for 85% of eligible costs [1].

The procedure for public procurement carried out in the restricted tender procedure was launched on 9 September 2011.

The process was to appoint the first five of the twenty companies with the most experience and best references. Then launched a tender procedure for the task, which was to select a contractor provided the criterion of lowest price and best execution concept design.

On 15 October 2012 Zarząd Dróg Miejskich i Komunikacji Publicznej (ZDMiKP) through a public bulletin announced the emergence of the contractor. It is a company Sprint S.A. which performance of the contract valued at 53 984 700.00 PLN. This company can boast of preparing a similar project for Trójmiasto agglomeration called "TRISTAR" which objectives include improvement in local transport, in the organization of traffic and safety, or to provide drivers with dynamic information on the prevailing traffic conditions. Also in Rybnik, the company carried out the task of Electronic Passenger Information, which purpose was to install 167 monitors displaying dynamic passenger information [2].

Project of Intelligent Transportation Systems in Bydgoszcz was divided into four segments:

- Traffic-control with real-time video surveillance,
- Public transport management with dynamic passenger information,
- Parking information,
- Guiding vehicles on the alternative roads.

According to the agreement signed on 9 January 2013, for the purchase, installation and commissioning of the project components, Sprint SA has a deadline of the task within two years. It is probable that the system will be launched in the first quarter of 2015.

2. Current state of road network

The spatial layout of the city is developed in a specific way in the east-west direction. The average length of an area of the city in this direction is 20 km and in the north-south 6 km. This is the main factor that is responsible for the shape of the road network in the city, and of the most important traffic routes. National and provincial roads, routed through the city shows the nature of basic framework of the street network. The main transport route is routed on the track of national road No. 80 connecting the farthest parts of the city in the east and the west. The main role is played by the national road No. 5 and 25, which are combination of southern and north inlet of the city. The road network, which is in the city, is focused mainly on the access to the central districts. The need to travel through this area of the city is mainly a consequence of the lack of direct connections between the other border settlements. This results in a significant increase in traffic flows, which accumulated in the city during peak hours makes the movement more difficult. Such a big accumulation of traffic in the central area of the city reduces security while driving through the intersection. That is why, it was necessary to introduce traffic control by traffic lights on a considerable part of the road network. Strict downtown and the areas immediately adjacent to this area are leading the main arteries of the city. Intersections controlled in this area significantly extend the travel time by generating wasted time connected with waiting for the green signal and the lengthening queue of vehicles at the inlets. It is noticeable that at complex junctions, through which the national roads are routed. An important fact is that only 31 of the 118 traffic lights form 11 coordinated systems. Other traffic controllers work as isolated systems [4].

In Bydgoszcz, as contrasted with a model example of public transport, the bus line network is a major connection network. Not enough developed tram network system causes a lack of coherence of existing connections. In addition, this network largely coincides with the bus routes. This has a negative impact on the efficiency of the public transport, as it is a tram infrastructure, which is a smaller percentage of collision with road vehicles, should serve as a basic framework for communication lines. Buses should be a complement to this system and transport passengers from peripheral areas to the main transport interchanges. However, the investments are performed and announced to change this situation, as given in November 2012, the investment linking Central Station with the existing tram network. In June 2013 the construction of a tram line to the largest area of the city – Fordon – will started. Further developments such as the construction of crossing for tram trains over the Kujawska street and extension the lines within the Solskiego and Piękna street and continue to Grunwaldzkie roundabout and Poznan' square should cause - with appropriate adjustment of bus lines - replacement of vehicles which acting main roles in public transport. Transport infrastructure has been enriched with dynamic passenger information system as part of a separate project "small ITS", which was implemented with the launch of the tramway to the Central Station. Within the project all rail vehicles and public buses in Bydgoszcz have been equipped with a GPS module with on-board computer, allowing the location of the vehicle and determine the approximate time of arrival at bus or tram stop. Stops on the newly built road are equipped with LCD monitors that display chronologically information about line number and the actual time of arrival at the platform of bus/tram stop. This system allows the supervision of the carrier's fleet and enables real-time preview of the line vehicle in a room of Public Transport Management ZDMiKP. Archived data also allow printing such parameters as travel time, time at stop and time of leaving this stop for any vehicle of particular line.

Fig.1. Passenger service on the new platform stop equipped with a dynamic passenger information system.

3. Objectives and tasks of the system

The area of implementation of the ITS includes the central part of the city, which is limited by Kamienna, Artyleryjska and Zygmunta Augusta street – in the north, Dworcowa, Królowej Jadwigi, Marszałko Focha, Kruwszwicka and Szubińska street – in the west, Piękna, Solskiego and Wojska Polskiego street – in the south, Ujejskiego, Jana Pawła II and Wyszyńskiego street – in the east.. The area also contains a traffic corridor from Fordońskie roundabout to Wyścigowa street, along the Fordońska street. The operating range of the system is indicated in Figure 2.

The main task of the project will be to accelerate the movement of tram transport in the two corridors. Central, east-west, is situated between the planned interchange Bydgoszcz East (under a separate project BiT City), and the Grunwaldzkie Roundabout. The second corridor in north-south direction, includes track in Gdańska Street from the intersection of the Jagiellońska and Marszałka Focha street to the intersection of the Artyleryjska and Kamienna street - the boundary of the system. This will require reducing individual traffic in these corridors by controlling flow to them and to create better conditions at possible alternative routes. The purpose of the implementation of the central traffic and public transport management system is to improve the movement conditions on the streets within the area of operation of the system by providing the appropriate components.

The main expected results after running the system are relative savings in time [3]:

- a passing car in the area of functioning system at the level of 6.03%,
- the public transport travel in a tram in the area of system at the level of 8.33%.

Fig.2. Area of operation of ITS in Bydgoszcz.

Traffic Control Centre (CSR) will cover an area of 52 intersections with traffic lights, where 45 of them are currently working in the field of controlled traffic light signals, and the remaining 7 were included into the project installation of traffic lights. It is expected to reprogram all of the traffic lights drivers in the area in such way, which allow achieving optimization of the traffic control in the area covered in Figure 2. This task will consume up to 30 km of fiber optic cables [3].

Traffic control system will be supported by video surveillance. A planned task of video surveillance is mainly observation the area of intersections or selected item of infrastructure (road section) based on CCTV. In these areas will be also implemented automatic collection of data on characteristics of the vehicles through cameras ARCP. The aim of equipping the major intersections in the area covered by the central control is collecting data about vehicles entering the area, leaving it and next determining the approximate route of the vehicle. Monitoring the area also has the task of providing visual information for moderators (traffic engineers), for example in the detection of threats. Automatic recording characteristics of the vehicles is mainly based on a set of license plates with the overall dimensions of the vehicle (type classification) and it will also perform the functions of gathering data on the mobility of vehicles staying in the area of operating system. It will primarily enable to provide information for vehicle alternative route guidance subsystem [3].

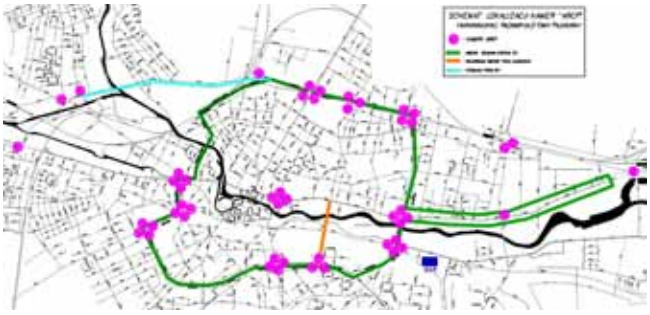

Fig.3. The proposed ARCP cameras locations.

Public Transport Management Subsystem, which includes the supervision of dynamic passenger information, consists of three tasks. The first is the acceleration of tram traffic in the two major transport corridors. This activity will consist in giving absolute priority to passage in areas of intersections controlled by the CSR. In other corridors within the area, a priority will be transmitted in an active or passive way, depending on the interval scheduled time to arrive at the bus stop platform. The second task is to increase the attractiveness and quality of passenger service by the above-mentioned system of priorities to accelerate the speed of travel in the area of operation of ITS. Also, the installation of an information system at the stops, which will make it installed an additional 180 LCD monitors (90 locations) displaying a dynamic passenger information, should increase popularity of public transport. In addition, a priority providing function should contribute to improving the punctuality of arrival at bus stops. The third task is to increase the improvement of making decisions and also operational and strategic decisions in public transport.

In this subsystem, the project contractor is obliged to equip 80 trams in short-range radio transmitters so that it will be possible to give priority at intersections controlled by traffic lights based on data from the location of the vehicle relative to the time table schedule. Giving priority will be based on data from the on-board computers installed in vehicles as part of a contract under the

name "small ITS". This computer will be submitted to the drivers vehicle's current position based on GPS. On-board computer in tram will connect to the radio signals reaching the driver and sent a telegram containing standardized information such as the number of the application, line number, course number, deviation from the timetable. Intersection controller will take into account the request of priority based on the data of traffic flows [3].

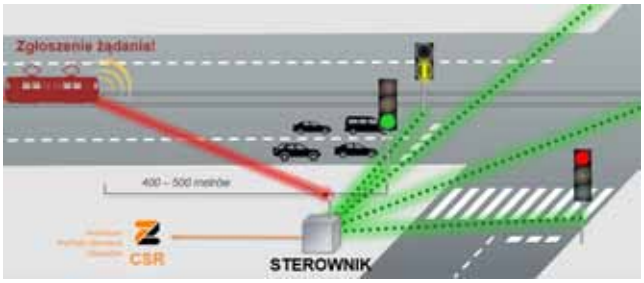

Fig.4. Scheme of providing priority for public transport.

In addition, in this segment of the functioning system will be installed 20 pieces of new information kiosks with ticket distribution function. Three tramway turnouts will be equipped with complete automation of the drives.

Segment of Intelligent Transport Systems in Bydgoszcz Project, responsible for the guidance of vehicles on the alternative road, is to provide information to road users. This information will be sent directly to installed in the area of traffic management variable message signs (VMS) and to the newly developed website. This subsystem will provide information about any disruption to road traffic, the recommended travel speed on a particular section of the road, the overloads on specific sections of streets, ongoing road works, predicted average travel times to the nearest main road network element [3].

Fig.5. Simulation of variable message sign VMS displayed on any programmable LED matrix.

Within this segment 20 system loops will be installed, which task is to send to CSR the information about traffic flow into the central area. Separately, in 10 of them will be installed additionally weather stations, containing inter alia temperature sensors (environment, surface), the ambient humidity, atmospheric pressure, freezing temperature and concentration of the road brine. The objective is the acquisition and archiving of meteorological data occurring on the streets.

Developed web portal will visualize the prevailing traffic conditions on the road network in the control area of ITS, make available information about any difficulties in the streets, transmit possible real time images of characteristic points of road infrastructure from CCTV cameras. Will also facilitate users to plan a trip by choosing the optimal route, taking into account the actual traffic conditions prevailing on the road together with the forecast for the next 15, 30 and 60 minutes.

The last segment of the project is subsystem of parking information. Its purpose is to inform about the occupation of paid parking zones in Bydgoszcz. Will involve the installation of 101 new parking ticket machines, 26 tables displaying information about the access availability. Also, the zone controllers are provided with a 10 devices with auxiliary printing functions and taking pictures. Occupancy information will come from data collected by the parking machines about the amount of tickets purchased. The system will estimate the level of occupancy of the area by submitting the data to the display of parking boards. However, due to the nature of urban traffic in the city center, the system will not take into consideration the available number of free parking spaces. To drivers, by tables will be provided only clues about a occupancy state. For example, system will process the data about the number of tickets purchased and the number of groups of customers who have subscribed or are residents of the zone. In this way, the percentage of occupancy of street corridors will be defined. The data processed in this way, will be transferred to the tables in the form of guidelines whether the occupancy is high, moderate or low [3].

Fig.6. Examples of the content displayed on the parking information boards.

4. Conclusion

Project of Intelligent Transport Systems, which will be implemented in Bydgoszcz, is built with multiple segments. The most important segment is responsible for controlling inflow of vehicles into the central area of the city. Others, including a very important providing priority to passage of public transport vehicles, perform complementary part of the total traffic management.

Administration of the flow of vehicles through the control of ITS will be based on data received from the ARCP cameras. Traffic lights control algorithm is based on a SCATS system, which was implemented in Sydney, Dublin or Singapore. The company Sprint SA is an authorized distributor of this system in Poland, so it is expected that traffic control algorithms will be prepared properly.

Traffic Control Centre will be located in the building of ZDMiKP. Engineers working there will have access to a large format screen, built with 9 rimless LCD monitors size of 55 ". It will be a headquarters, which will run down information from all subsystems. It is expected to create three positions: the operator of dynamic passenger information subsystem and supervision of public transport, the operator of CCTV surveillance and the traffic controller.

All integrated with each other segments of the project should result in improved efficiency on movement around the city. Road infrastructure users in Poland usually do not associate with such a large amount of traffic information. After a period of time to adapt to new developments and learning how to use them, the driver but also the passengers of public transport should feel the improvement of the mobility conditions and shorten their travel time.

It is suspected that the profit will not be felt significantly during peak traffic, but beyond them displaying on variable message signs about the prevailing traffic conditions should lead to improvement in occupancy of main transport routes and intersections in the area of control of ITS.

The benefits of installing a system should be enjoyed by city traffic managers. They will have for review, up to date, everything that is happening on the city street network. Video monitoring allows direct insight into situations that will be visualized by SCATS system. Thanks to this, the integration of the control algorithms and the response of an experienced traffic engineer should bring even better results on manage the flow of vehicles.

Archiving such data will provide a desirable material for the persons responsible for the traffic research. Current traffic modeling based on the readings from the sensors installed in the control region of ITS will be one of the most important information that will help the planner to implement the best solutions for road projects.

Bibliography

[1] BIURO INŻYNIERII TRANSPORTU; PRACOWNIE PROJEKTOWE: *Studium wykonalności projektu: "Inteligentne systemy transportowe w Bydgoszczy"*. Poznań 2010

[2] SPRINT S.A.; *Informacja nt. realizacji zamówienia: TRISTAR.* http://www.sprint.pl/tristar.html

[3] ZARZĄD DRÓG MIEJSKICH I KOMUNIKACJI PUBLICZNEJ W BYDGOSZCZY: *Specyfikacje techniczne; Inteligentne Systemy Transportowe w Bydgoszczy – załącznik nr 3*. Bydgoszcz 2012

[4] FUNDACJA „ROZWÓJ UTP": *Studium transportowe miasta Bydgoszczy wraz z oceną stanu bezpieczeństwa ruchu miejskiego – TOM I: Stan systemów transportowych Bydgoszczy.* Bydgoszcz 2012

[5] SPRINT S.A.: *Koncepcja ITS w Bydgoszczy.* Bydgoszcz 2013

[6] SZCZURASZEK T., KEMPA J., BEBYN G., CHMIELEWSKI J.: *Kompleksowe badania i anali-zy niezbędne do wyznaczania kierunków rozwoju sieci drogowej miasta.* Transport Miejski i Regionalny 10/2007