Tri-City intelligent transporttion system TRISTAR

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Abstract – **Intelligent Transportation Systems provide many tools such as advanced management traffic systems or emergency systems to improve transportation systems. Towns of Tri-City Aglomeration started to work out conceptions of traffic management systems according to agreement established in Sopot in 2002. The paper concerns description of aglomeration system - the first stage of conception works.**

1. Introduction

An effective and convenient transportation system is the basis for developing business and improving the quality of life. The public expects to be able to drive to work, school and to places of recreation. While the car helps meet those needs, it also poses a risk to the environment and health. In particular, the car itself makes its life more difficult. This situation sets the context for many cities worldwide to introduce intelligent systems for managing transportation [1], [2], [3], [4]. In an effort to build an ITS, the cities of the Tri-City Conurbation at a 2002 meeting in Sopot, made the decision to develop a concept of traffic management. The underlying studies are already finished, i.e. a general concept of the Intelligent Transportation System in the Tri-City Conurbation and a general concept of an integrated urban traffic management system on the Tri-City Ring-road [5] and general concepts of traffic management systems in Gdynia [6] and Sopot [7].

The study in question will help to:

- gather knowledge about Intelligent Transportation Systems,
- begin work on building a professional team to build and operate the Conurbation Transportation System,
- identify and justify the need for integrated traffic management systems on the Tri-City Ring-road, in Gdynia and Sopot and in Gdańsk, Pruszcz, Rumia and Reda,
- develop detailed traffic management systems,
- develop an action plan.
- prepare a pilot project,
- prepare an application for national and international assistance for the project.

2. Why ITS

2.1 External Reasons

Intelligent Transportation Systems (ITS) are used to improve transportation systems to make them more efficient, effective and safe. These systems offer a wide range of possibilities, beginning with advanced traffic control systems using light signalisation to accident warning systems. Studies in the USA, Japan and Europe show that by using ITS [2], [3] we can:

- reduce expenditure on transport infrastructure by as much as 30 – 35 %, and obtain the same effects in terms of system efficiency,
- increase by as much as 20 % the efficiency of transport systems (in terms of capacity) without having to spend money on road works,
- significantly reduce the number of incidents and casualties,
- reduce travel time,
- significantly reduce CO2 emissions,
- help the economy by increasing production of electronic equipment.

Transport development programmes across Europe make extensive use of intelligent transportation systems and integrated traffic management. Poland too has recognised the need for modern transportation systems. Relevant work, however, still remains uncoordinated. The National Development Plan 2004 – 2006 [8] in its transport section includes an operational plan Transport – Maritime Economy. The programme includes two priorities:

1. Sustainable development of the transportation system.
2. Safer road infrastructure.

Priority 2 Activity 3 says "development of traffic control systems" and will be eligible for European Union funding. The government's document "e-Poland" sets out plans to develop intelligent transportation systems in Poland [9]. With the upcoming membership in the European Union, Poland decided to adopt main development goals in the area of intelligent transportation. These include:

- development of an intelligent system of safe transportation,
- development of systems for collecting information and databases,
- development of a databank on hazardous materials,
- reduction of urban congestion.

2.2 Internal Reasons

A diagnosis of the Tri-City Conurbation transportation systems identified a number of transportation problems [5], [6], [7]:

- high level of congestion, in particular during peak times, negatively affecting the conditions and quality of travel both for individual and public transportation, loss of time and poorer quality of life of the community and negative impact on the environment,
- lack of parking space, in particular in downtown areas, leading to congestion caused by driving in search of parking spaces,
- high costs of incidents and high costs incurred when traffic is stationary as a result of road incidents,
- rescue operations are affected because of the difficulty with identifying the scene of the incident, reaching it and providing help,
- lack of information about traffic and driving conditions both before and during travel.

Because of the above factors, the decision was made to implement the ITS in the cities of the Tri-City Conurbation as a way to alleviate or solve the problems. Priority number one is the

development of a conurbation-wide ITS and implementation of an integrated system for managing traffic. This work is necessary not just because of the national and international trends in the area, but because of the current traffic conditions in the Tri-City Conurbation, making an integrated traffic management system a must. This is further justified by the following factors:

1. With more business and social activity, traffic and mobility in the Tri-City Conurbation are rising too, making traffic conditions more difficult, while the existing road infrastructure, traffic systems and control do not meet the needs of the types and volumes of traffic.
2. An integrated traffic management system is one way to improve traffic and make optimal use of the Tri-City Conurbation's traffic capacity. The traffic management system itself, however, does not mean that the road system needs no further development. Work must run parallel, i.e. system development and infrastructure development.
3. The Pomorskie region's spatial policy includes a sustainable transportation policy designed to reduce the demand for the passenger car and increase the use of public transportation. To implement the policy more decisive steps are needed to improve the effectiveness and convenience of public transportation.
4. The Tri-City Conurbation with its sea ports and maritime economy businesses carries a lot of freight transportation leading to substantial traffic of heavy goods vehicles in the city. With the growth of national and international traffic in the area, including the establishment of the Pomorskie Logistic Centre, telematics will have to be introduced into goods traffic management.

3. SYSTEM CONCEPT

3.1 Assumptions

The assumptions to the Gdansk Conurbation's ITS presented below are the result of analyses and comparisons between European and American advanced traffic management systems and the identified transportation problems.

1. The Tri-City ITS should include all elements of the Tri-City Conurbation transportation system which need to be co-ordinated between the industries, areas and organisations providing the service and organisations using the system.
2. The Tri-City ITS should include the requirements and needs of the local systems and ensure co-operation between them and ways to integrate them.
3. The Tri-City ITS should include national and international needs and allow for the involvement of a number of companies and organisations, become part of international programmes and gain access to international funding.
4. Before work on the system begins, standards of procedures and equipment must be developed. The system can then be divided into stages to be managed by local authorities and agencies responsible for Tri-City traffic and transportation. The standards and procedures will help ensure compatibility of all ITS elements and identical traffic management.

3.2 System Objectives

The objective of implementing the ITS in the Tri-City Conurbation is to:

- make a more effective use of the existing road and transportation infrastructure,
- reduce accidents,
- reduce congestion on the primary network,

- improve travel conditions,
- increase demand for public transportation,
- monitor and protect the environment,
- better manage all elements of the transportation system,
- better manage the roads,
- increase the effectiveness of rescue,
- improve systems for informing drivers and travellers about traffic conditions.

The objectives can only be achieved by integrating and co-ordinating all elements of the transportation system.

3.3 System Architecture

The Tri-City Intelligent Transportation System **TRISTAR** (acronym from the Polish words: **TR**ójmiejski **I**nteligentny **S**ystem **T**ransportu **A**glome**R**acyjnego „**TRISTAR**") should be a set of tools for efficient and effective transportation infrastructure management and efficient traveller service across the Tri-City Conurbation. TRISTAR will consist of an intelligent infrastructure, intelligent vehicles and an intelligent management system. Because no national guidelines on system architecture are available, the system is based on European, Japanese and American models. Ultimately, TRISTAR will comprise the following sub-systems:

- integrated road traffic management system,
- integrated public (passenger) traffic management system,
- integrated goods traffic management system (logistic centres),
- integrated rescue management system (integrated rescue system),
- integrated transportation information system.

The overall system architecture is illustrated in Figure 1.

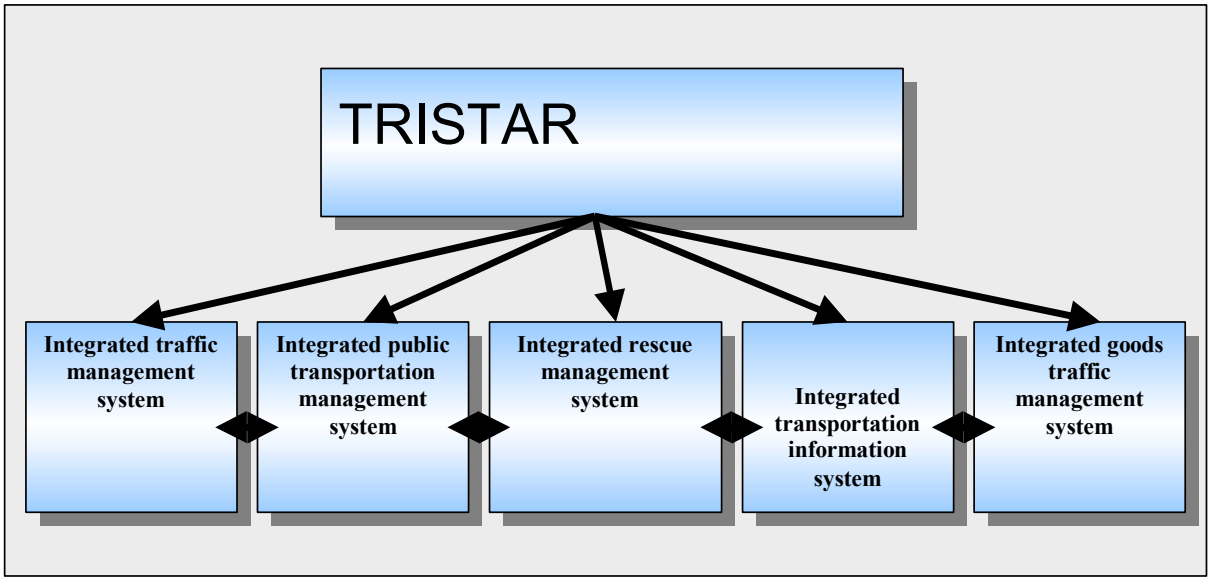

Fig. 1 Overall system architecture TRISTAR.

Of the five sub-systems, three are partly operational in the Gdansk Conurbation.

3.4. System Coverage

The traffic management system will cover the entire conurbation as well as adjoining areas, extending beyond the conurbation (Fig. 2).

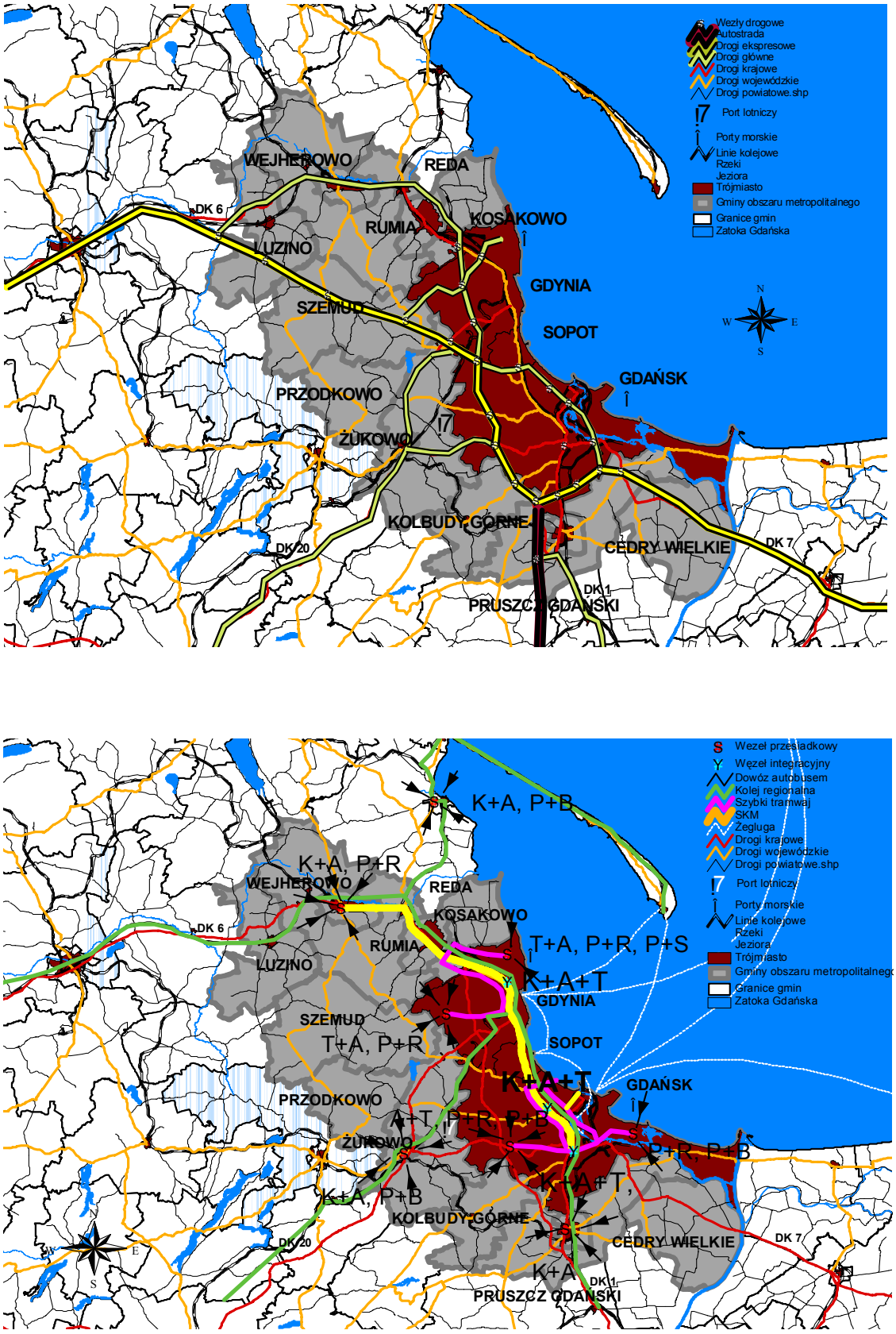

Fig. 2 The planned coverage of TRISTAR (targeted transportation network including public transportation).

The targeted system coverage is the following:

- the towns of Pruszcz Gdański, Gdańsk, Sopot, Gdynia, Rumia, Reda and Wejherowo including the street networks and car parks,
- express roads, i.e. the existing Tri-City Ring-road (S-6) and the planned South Ring-road of Gdańsk (S-7) and the Lębork Route (S-6),
- the beginning of the A-1 motorway,
- national roads 1 in Pruszcz Gdański and 6 in Rumia, Reda and Wejherowo,
- railway transportation network – city rail SKM,
- public transportation network in Pruszcz Gdański, Gdańsk, Sopot, Gdynia, Rumia, Reda and Wejherowo.

A more detailed determination of the sub-areas and sub-systems will be made as work on the system progresses, i.e. using measurements, traffic analyses and transportation needs in the particular parts of the conurbation. The current computer technology should allow a fully automatic traffic management in the sub-areas.

3.5 Integrated Road Traffic Management System

The Tri-City Conurbation integrated road traffic management system was divided into five systems to manage the elements of the road network in sub-areas of traffic control. Each system manages a specific type of traffic in a specific area through a number of sub-systems. The sub-systems operation will be integrated in their respective management centres. Because traffic control is a complex process and covers a number of problems of Tri-City traffic, a Co-ordination Centre will be established to co-ordinate all sub-systems in the conurbation. The structure of the road traffic management system in the Tri-City Conurbation, including sub-areas and areas managed by road authorities, should be as follows:

- urban traffic management systems,
- freeway traffic management system,
- national non-urban traffic management system.

Urban traffic management systems. The Gdansk Conurbation has three urban traffic management systems in the following areas:

- urban traffic management system in Gdańsk,
- urban traffic management system in Sopot,
- urban traffic management system in Gdynia.

Each of the systems will use the following sub-systems, allowing it to meet its functions:

- street traffic control sub-system,
- road safety sub-system,
- access control and parking management sub-system,
- traffic information sub-system.

Figure 3 shows examples of a sub-system for managing traffic in the particular parts of the Tri-City. Each city will have the same number of sub-systems and functions. There are plans to extend the urban traffic management system to include the neighbouring towns such as Rumia, Reda, Wejherowo and Pruszcz Gdański. The reason for the division is that road infrastructure is the responsibility of each city's authorities. Each system will be supervised and co-ordinated by its respective Urban Traffic Management Centre.

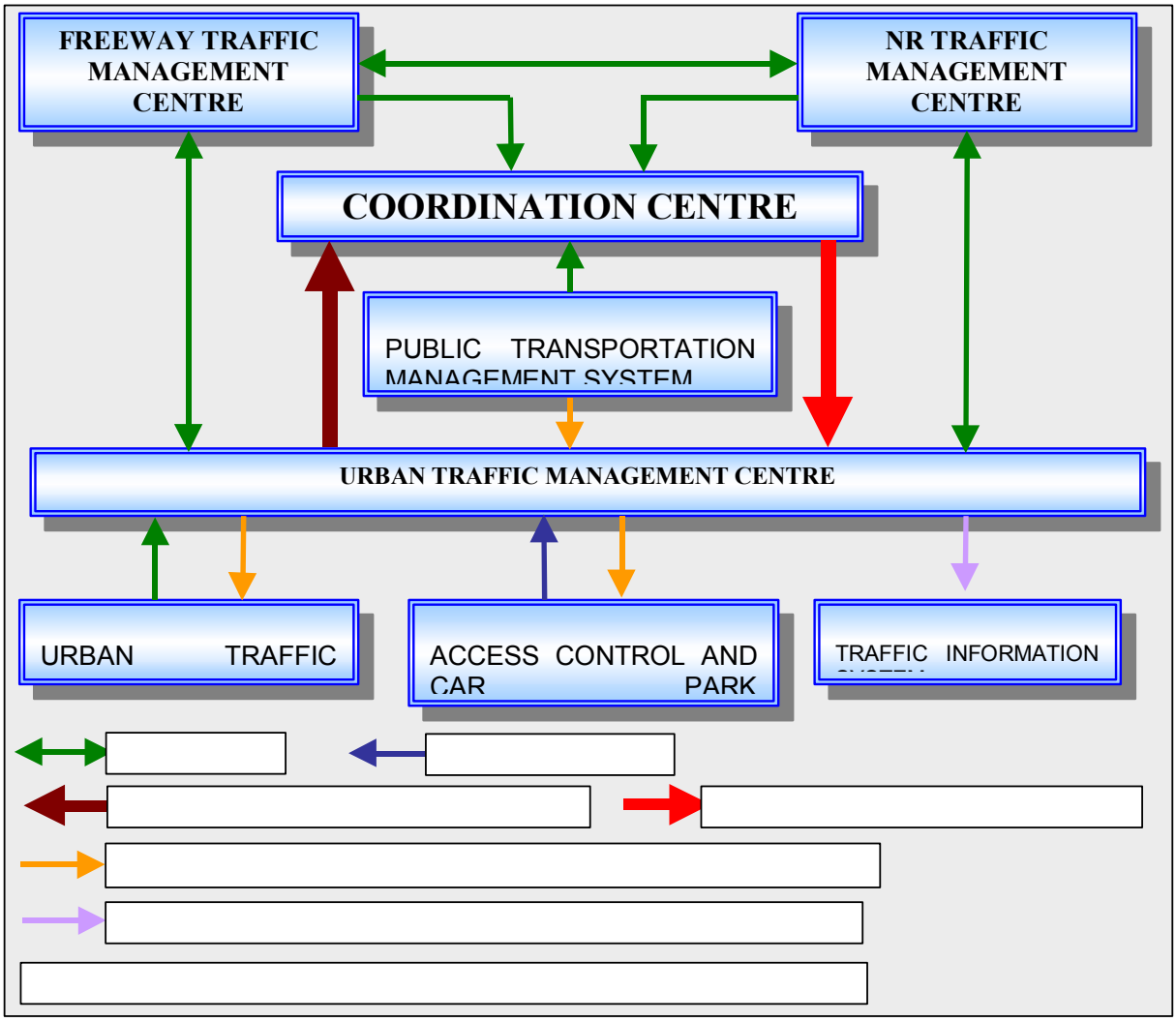

Fig. 3 Structure of the urban traffic management system in the Tri-City Conurbation.

Freeway traffic management system. Integrated Traffic Management System on express roads (OT) will consist of the following sub-systems and cover three elements:

- traffic management system on express road interchanges (OT),
- traffic management system on express road main carriageway (OT),
- traffic management system in the express road corridor (OT).

The architecture presented above shows the targeted traffic management system on the Tri-City Conurbation express roads, however, initially the system will only cover the Tri-City Ring-road as an express road and roads that are part of the Ring-road corridor. Each sub-system of ring-road traffic management will carry out a few functions. The ring-road traffic management system cannot operate efficiently unless co-ordinated with the Gdańsk and Gdynia traffic management systems and the entire Tri-City Conurbation traffic management system. This function will be delivered by the planned Transport Management Centre. And traffic management systems in Gdańsk, Gdynia and Sopot will not be fully operational unless co-ordinated with the ring-road traffic management system. On national roads managed by the Gdańsk branch of the General Directorate of National Roads and Motorways, i.e. national road 1 in Pruszcz Gdański), national road 6 in Rumia, Reda and Wejherowo there are more than 25 signalised junctions. To control and improve traffic on these roads, the Directorate's traffic control systems will be used. As separate urban traffic management systems will be introduced, these systems will change their functions.

Integrated public (passenger) traffic management system. The overall structure of Tri-City traffic management consists of three public transportation systems, a consequence of the three separate public transportation companies. These include:

- Gdańsk Public Transportation Management System (ZKM Gdańsk),
- Gdynia Public Transportation Management System (ZKM Gdynia),
- City Rail Management System (Zakład SKM).

In future the public transportation management system will be extended to include ZKM Wejherowo and ZKM Tczew. Each of the systems will use the following sub-systems, allowing it to meet its functions:

- sub-system for monitoring public transportation vehicles,
- sub-system for controlling public transportation vehicles,
- sub-system for passenger information,
- sub-system for public transportation service information.

The operation of the individual centres will be co-ordinated by the Co-ordination Centre, part of the future Conurbation Transport Authority. The City Rail Management System is not linked with any of the cities. The reason for this is that City Rail covers the entire Tri-City and parts outside it and uses the infrastructure of the Polish State Railways, making City Rail control a responsibility of the State Railways. For this reason a major responsibility of the Co-ordination Centre will be to co-ordinate the various types of transport , i.e. City Rail and ZKM Gdańsk and ZKM Gdynia.

Integrated rescue management system. Systems for managing rescue are usually linked with road incident management systems. These include systems for automatic vehicle localisation, computer-aided vehicle dispatch, priority vehicle fleet management and vehicle positioning. Each of the systems helps reduce the time to reach the scene of the incident. Using the tools offered by ITS requires a specific logical structure of the road incident management system. Structures for the Tri-City Conurbation system were proposed. Incident management begins when the operator at the Rescue Information Centre receives information about an incident. There will be Centres for each poviat linked to the conurbation's Management Centre. Incident management terminates when normal traffic is restored. Incident information can be passed on to the Rescue Information Centre via the Management Centre (for automatic incident detection) or directly by radio (taxi drivers, delivery vehicles) or by telephone (a single number 112). The police, fire service and those responsible for breakdown recovery reach the scene of the incident independently from one another. The road service and public transportation operator become involved when a major repair is required or a long lasting detour. The Co-ordination Centre will play a major role, managing traffic to minimise disturbance and inform drivers (by variable message signs, text messages, the Internet, RDS) about the incident or the preferred routes. Incident management systems help to reduce the detection time, arrival time and time to restore normal traffic. The system of automatic incident detection and camera surveillance (CCTV cameras) helps detect road incidents on the street network. The system can be used by a number of operators who identify and register incidents location, the number of vehicles involved, projected time to recovery). Incident management systems also help to reduce congestion caused by the incident and consequently, reduce time loss, fuel usage and exhaust emissions.

Integrated transportation information system. There will be 3 basic sub-systems of Tri-City transportation information, each of which working together with a wide range of communications devices and information media operators. The idea is to provide traffic information and traffic updates to the biggest possible number of users. The information to be provided to Tri-City traffic users will include three groups of information:

- traffic conditions,

- weather and environment,
- strategic car parks, such as P+R.

Integrated goods traffic management system. ITS systems are also used for managing heavy goods and delivery vehicles traffic. Management techniques using ITS benefit the drivers of delivery vehicles, transport companies and logistic centres who co-ordinate goods traffic. ITS helps to increase the effectiveness of management without investing in the infrastructure. ITS can be used in the following areas of delivery vehicles management:

- safe transit (exchange of information, automatic vehicle and driver inspection),
- shipment administration (vehicle registration, permits for special shipments, automatic fees),
- electronic vehicle monitoring (document inspection, border traffic, inspecting loads),
- managing shipments at logistic centres (travel schedules, routing, route information, shipment monitoring).

ITS enables a more efficient exchange of information among drivers, operators and logistic centres, in particular in case of long haul transport. The use of advanced information exchange systems helps to improve HGV traffic and save time. Because of the efficient exchange of information and automatic monitoring of loads vehicles are not overloaded. The use of ITS helps monitor the technical condition of the vehicles, including buses.

3.6 Stages

To ensure efficient operation of all transportation and traffic management systems by the Centre, they will have to be implemented and developed gradually. Because the system will include a number of types of transportation, road authorities and transportation authorities, different organisations, the entire TRISTAR system cannot be built all at once. Consequently, several stages are projected.

Stage One. In the first stage, the cities and road and traffic authorities will build their own independent systems for control followed by systems of traffic management. Joint work will be critical to allow the adoption of common standards, guidelines, etc.

Transition stage. In the transition stage, the cities and road and traffic authorities will begin exchanging information between the management systems and use mutual help and services. At this stage some of the urban systems, traffic management systems and public transportation systems will probably become integrated. Figure 4 shows an example of an integrated traffic and transportation management system.

Targeted stage. In the final stage all sub-systems will become integrated with TRISTAR.

4. CONCLUSION

The assumptions to TRISTAR, the Tri-City Conurbation intelligent transportation system, show the system's final vision, but a lot needs to be done before it is complete. To build the system, we need to:

- build a team of people taking an interest in the system,
- finalise the concept as part of "roundtable" discussions involving the relevant organisations, local authorities, road and traffic authorities,
- include TRISTAR in the strategies and plans of the region, cities and road and traffic authorities,
- promote the idea of the system on seminars and training courses,
- develop a pilot project,

- prepare applications for financial assistance (national and international sources),
- prepare designs and specifications,
- carry out the pilot project (projects),
- continue to develop the system based on experience from the pilot project.

The first pilot project could be the Integrated Traffic Management System for the Tri-City Ring-road and a part of the Integrated Traffic Management System in Gdynia, Gdańsk or Sopot.

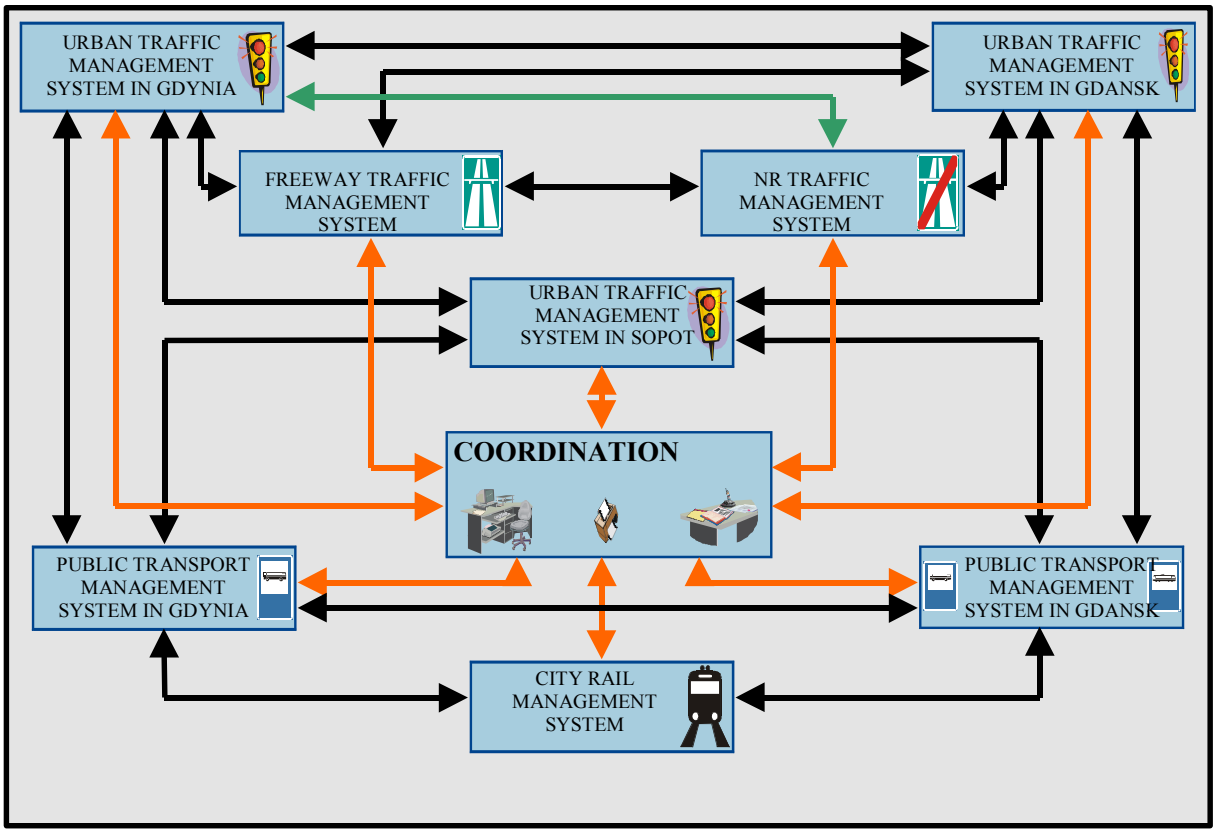

Fig. 4 Proposed integrated traffic and transportation management system in transition in the Tri-City Conurbation TRISTAR.

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