



# **ITS as a market of development and cooperation opportunities in the field of innovation - a study based on the OPTI'CITIES project**

**P. BARDADYN**

NEUROSOFT LTD., Robotnicza 72, 53-608 Wrocław

EMAIL: piotr.bardadyn@neurosoft.pl

## **ABSTRACT**

This paper presents stipulation of cooperation intensifying operations on the supranational, public and private level as in Opticities project, which is a cooperation of 6 European cities implementing ITS systems. Namely: Madrid, Lyon, Birmingham, Turin, Gothenburg, Wrocław and research and development units. The main task and goal for Wrocław will be a supervision over a realization of comprehensive vehicle's identification project and a research verifying systems' efficiency made by Neurosoft and Volvo France. One of crucial elements of the subsystem will be the technology of ADR boards video-identification – informing about dangerous substances or goods transported as a freight load.

**KEYWORDS:** ADR, dangerous goods, cooperation

## **1. The value and potential of the market**

ITS, as an infrastructural branch of major importance is a well developing and promising market despite the economic crisis. Due to the assumption of systems inclusiveness mechanisms and products offered in the ITS global markets are characterized by interoperability, which gives the manufacturers and integrators opportunities of global development of their products and services. Industry reports estimate the global market of ITS will rise to \$ 24 billion by 2017 with a growth rate of 12% per year.

At the EU budget summit held on February 7th-8th Poland was granted nearly 73 billion Euros which will be administered in the field of aid funds and commonality policy grants in the years 2014-2020. Thus, the current concern about the lack of finance for the development of infrastructure and new technologies, including telematics problems in the country, have been temporarily allayed. This allows a more optimistic planning of the development of innovative technologies and methods that will help to minimize the gap between the infrastructure of Poland and its western

neighbors in the entry into the third decade of the twenty-first century.

The regular or congressional opinion-forming bodies are to implement the strategies that which enable this objective. The responsibility for the implementation of projects is assumed by all the sector entities, both public and private, which contribute to the overall performance of the work associated with the construction of roads, intelligent transport systems, communication systems and road safety. Apart from the implementation of trans-national cohesion strategies, each of the institutions and companies should have its own strategy for the development with a clearly marked target in the decade in which the subsidies with whole certainty will no longer be granted. Each of the actors of the market should be able to answer the question: 'where will you be in 10 years and what goals will you have reached by that time?'

## 2. The EU's role in the creation of ITS – creation of the development strategy

The tasks all industry entities will face lie, at least in part, within the decision-making framework of the executive bodies set up by the European Commission. One of the documents formulating such a strategy is 'The ITS Deployment Road Map' as of December 10th, 2012 issued by the the EasyWay Technical Coordination Team headed by Jonas Sundberg.

The report was prepared by the EasyWay Technical Coordination Team (TCT) as the implementation of the second part of the project under the same name. The report was a joint work of the TCT team and expert teams, analytical teams and business associates.

The data collected in this paper was to present a "balanced" prospect of the ITS development and the possibilities of deployment of such services in Europe in the next decade. The leading role in setting the strategy was and will be played by the authorities and operators of roads in particular countries - in Poland it is the GDDKiA which also functions as an architect, placing orders and coordinating the work of the relevant working groups in the creation of a national infrastructure development strategy. The priorities and actions proposed in this strategy to a large extent reflect the views and elaborated models of groups organized around the ITS Poland association.

The findings and conclusions drawn from the above-cited report, expressed mainly in the form of sketches of the stages of development, should not be seen as an absolute obligation, as they reflect differential assumptions regarding the regional development in terms of technological, economic and political life. This and any other development strategy should reflect the perspective of a particular time and must be updated in the course of time.

It is worth paying attention to two aspects raised in the document:

1. the enumeration of the various generations of ITS, whose arrangement answers the question about the target stage of development of particular branch for the moment, and
2. the current schedule for the development of technology – how we should look at the ITS industry in technological and product aspects.

Naturally, also in the context of their own business and the projects being implemented.

The differences between particular generations of ITS are not clear and the specific subsystems or services may belong to more than one generation. The following description can be considered an illustration of the predictions based on the status quo, rather than a rigid definition of the stages of development. Eventually, plans are subject to change.

### Generation 1: Lack of coordination of investment and exploitation

The implementations of ICT services in the daily routine work are dealt with by responsible entities (mainly road operators, public transport operators, etc.). Systems and services are locally limited

and implemented without the harmonization or coordination from the national level.

### Generation 2: Harmonization of services

Services are developed in accordance with the common specifications and standards, offering harmonized services (e.g. common look and functionalities). The service deployment is still uncoordinated and is subject to discretion and individual decisions of the stakeholders.

### Generation 3: Harmonized services, coordination in the initial stage

Services are developed in accordance with the specifications and standards. The coordination of the implementation is established according to certain priorities, in specific nodes, in the cities etc. where coordinated traffic and transport management is in operation. Promoting integration has been initiated, which ultimately enables e.g. multimodal and cross-border services for travelers.

### Generation 4: Harmonized services, full coordination, partially integrated systems

Coordinated implementations (for key network elements) on the basis of commonly agreed plan. The actors' activities strive towards establishing a European road transport system based on interoperable services. The system integration is still limited to dedicated cross-border corridors, urban areas, etc.

### Generation 5: Full integration

All ITS systems are integrated and active. Each new vehicle interacts with the system automatically, regardless of the jurisdiction of the subsystem, country of origin etc.; the system is also able to manage the generic structure of both new and older generation vehicles. Drivers are free to use the information function and the traffic monitoring function of the system through their on-line system connection.

### Generation 6 Further development

In the context of the above-mentioned generations a timetable of implementations which are crucial for the development of interoperable and multimodal ITS system has been drawn up. Below there is the schedule adopted by the cited Easy Way document where 'milestones' of the most important implementations have been marked. In the context of architecture development, data exchange protocols and basic traffic information :

- 2013 Creation of specifications for parking management systems.
- 2014 Completion of work on dictionaries of urban information for travelers in accordance with the DATEX II protocol.
- 2015 Completion of work on dictionaries of access limitations according to the Datex II protocol.
- 2015 Specification of the interfaces within the European Road Information.
- 2015 Definitions and quality criteria for linking the data available in the standards of detection levels and the quality of vehicle classification.
- 2015 Specification of interfaces concerning data exchange in European traffic routes (vehicles' weight, weather conditions, time of travel, etc.) and metadata formats.

- 2016 The prevalence and availability of traffic information on a European scale.
- 2016 Datex II protocol availability on a European scale.
- 2017 Transfer of existing and projected traffic conditions through integrated transmission facilities on a European scale.
- 2017 Static speed limit standard on a European scale.
- 2018 Implementation of the monitoring standard and road traffic management within 75% of the integrated road network.
- 2019 Dynamic speed limit standard available in the European network.

In the context of the development of standards for technologies and products working as a measurement and communication field infrastructure:

- 2014 Development of minimum of standards for safety signs.
- 2015 Development of standard symbols and pictograms for safety signs.
- 2015 Development of standards of variable message signs (VMS) for technology and communication.
- 2015 Presentation of the proposed standard of information transmission to vehicles within the Smart-Drive Systems.
- 2015 Creation of pilot transport corridors being part of a multi-modal transport environment.
- 2016-2017 Complete monitoring of critical, selected sections of the road network.
- 2017 Implementation of information and traffic incidents management system.
- 2019 Creation of alternating traffic lanes management systems in the Easy Way road network.
- 2019 Standardization of interfaces (symbols, pictograms) on an European scale.
- 2019 Implementation of complete infrastructure management systems on the roads within the TEN-T program.
- 2019 Dynamic regulation of the allowed speed.

### 3. Innovative solutions – trends

Intelligent transport systems improve the overall transport infrastructure through the use of a wide range of, usually innovative, technological aspects. The use of navigation, vehicle identification and communication technologies such as the Global Positioning System (GPS), Dedicated Short Range Communication (DSRC), Make and Model Recognition etc. applied in the ITS improve the functioning of the monitoring and informing the drivers and vehicles. Increasing achievements in the field of environment and economy have also had a positive impact on investment in the intelligent transport systems market.

The main systems of the ITS market are those related to: Advanced Air Traffic Management Innovations (ATMI), Advanced Travelers Information System (ATIS), system of price regulation for the use of roads and toll collection, Advanced Public Transportation Systems (APTS) and Commercial Vehicle Operations (CVO). Among these types of traffic management, public transport systems and their operation are the areas seen and implemented

by the European Commission as the priority ones. Management of commercial vehicles fleets will gain importance in the near future due to constant improvements in transport infrastructure and in the logistics industry.

Currently developed and implemented applications in accordance with the directions of the development of the ITS market are primarily the fleet of vehicles monitoring and management, vehicle collision avoidance systems, traffic lights control systems and variable message signs systems, parking management systems and traffic safety systems. Priority and specific “fashion” for the implementation of such applications as the first ones in the developed ITS markets show the experience not only present in Poland, but mainly of the countries which are more advanced in the development of ITS, such as the USA, Canada, Germany, France, England or Japan. The main aim of the ITS architects in these countries is creating conditions for a smooth flow, traffic congestion, comfort and road safety.

The subject of the cited Easy Way report and its main objective was to identify indirectly the stimuli and limitations of the growth opportunities of the intelligent transport systems market. A positive identification of trends and key factors of the success in the industry is namely necessary and possible only because of the EU investment in research and development. Participation and investment of public institutions and companies (usually these initiatives are combined) in the areas of R&D create a profile of activity in particular areas and suggest the choice of the strategy of development for interested and already participating parties, especially investors and direct beneficiaries such as: Road Transport Inspection (ITD). Reports in the form of documents, such as that issued by Easy Way, constitute a specific list of market players and their objective assessment from the transnational perspective. They emphasize the properties of checked and problematic solutions related to intelligent transport systems and their interoperability at the European level as a target.

Research&Development works and implementation of as many entities as possible within the cited specifications will result in earlier achievement of the jointly agreed objectives; moreover, they will improve and mark the marketers’ strategies.

### 4. OPTI’CITIES - description of the project

An example of such cooperation intensifying efforts at transnational, public and private level is e.g. a project subsidized by the 7th framework programme called Opticities. The European Commission experts evaluating the projects submitted to the competition chose and allowed the co-operation of six European cities implementing ITS systems. They are: Madrid, Lyon, Birmingham, Turin, Goeteborg and Wroclaw. Apart from them, Research&Development units of public and non-public nature also take part in the project.

The vision of the Opticities project is to assist in the infrastructural development European cities with the assumption of development and testing easily ‘transferrable’ innovative solutions adding value to the existing functionalities and using

them complementarily. 'Opticities strategy focuses on optimizing the transport network through the development of public-private partnership and suggesting solutions for user-friendly passenger and transport solutions' - says the document submitted to the commission assessing the projects in the competition.

Opticities assumes innovation in terms of:

- a new management model between private-public entities through creating a data exchange architecture, its quality and access to it;
- developing a European standard for multi-modal urban solutions in the context of data exchange and the exchange of data of common interfaces;
- presentation of predictive tools and support of the decision-making process in the management of transport in the form of multimodal Traffic Control System combined with the acquisition and analysis of data in urban traffic;
- creation of multimodal navigation working in real-time, integrated with route recalculation systems and their presentation in vehicles - it will be the first such attempt in the world - the leader of this solution is the city of Wrocław with engineering support of Volvo France and Neurosoft;
- implementation of pilot navigation in the urban transport and delivery to support drivers and fleet operators in optimizing schedules and distribution.

The European nature of the project is ensured through participation within a consortium of 23 partners from eight member states. The consortium includes six cities and other ITS industry entities (research institutes, manufacturers of hardware and software solutions and automobile manufacturers), as well as public roads and road transport operators.

The increase of the efficiency of systems run under the supervision of public supervisory bodies will be measurable in terms of: the increase of the systems' performance in 5 years, the integrity of the systems and services of particular cities, the transferability of the results to be implemented in other European cities.

In the preparatory stage the efficiencies that should be met after the successful completion of the implementation stage were established. It is essential to remember that it is planned for a period of three years, which can make it difficult to measure and verify it in terms of the parallel work carried out. However, the effectiveness of the methods will be reflected in the following numbers accepted:

- reduce of CO<sub>2</sub> consumption by 1.5 MT among the cities participating in the project due to the 6% modal change of means of transport;
- increasing market demand of 211 million Euro per year through the modernization of methods of design and implementation stages management, as well as the increase of implementation capacities of innovative products;
- 10% reduction in use of private cars which will generate 3.6 million square meters of public space in the partner cities.

## 4.1 The role of Wrocław and partners

The task and the main purpose of Wrocław is to supervise the project of creating the comprehensive vehicle identification station and to control the research aiming at verifying the efficiency of the systems implemented by Neurosoft with the cooperation of Volvo France.

The basis for the submission of such idea was observation of the current realities of traffic in metropolises and medium-sized cities. The increase in traffic in recent years has a negative impact on the public and private transport environment, which is a visible fact to every road user. Difficulties in public transport are caused by the constant increase in the number of the vehicles in the urban areas. The organization of urban traffic is characterized by inadequate to the real needs development. These trends result in a kind of 'narrowing' of urban infrastructure, slowing the traffic down and increasing the overall transportation costs.

Preventing the future problems anticipated on the basis of the current situation and report forecasts must result in actions aiming at avoiding serious communication difficulties and, in their context, social difficulties in the next decade. The implementation of multimodal transport rules should help in addressing current and future tasks of the traffic engineers. Transition of traffic management systems in the urban infrastructure (and not only) certainty requires telematics technology upgrades. Architecture of the road network, particularly in Western Europe is a more or less closed subject.

Implementing instruments for direct precise multi-threaded and individual analysis of the traffic flows, vehicle structure and the meteorological situation will add to the IT structure of the system the data necessary for a comprehensive analysis and prediction of the traffic congestion by reducing and minimizing travel times. The innovative solutions proposed by Wrocław in the OPTI'CITIES project are based on the acquisition of data collected on the main road of city entrances. Integrated data will be used to make the traffic more smooth and to improve safety being also a support tool for traffic engineers. The methodology and innovative techniques for identification of vehicles are discussed in the next section.

The system, as seen by the user, will support the driver in making decisions regarding the choice of the route, and in special cases, e.g. for vehicles carrying dangerous goods or vehicles with non-standard dimensions, weight or shape the system will order the driver to apply to the guidelines. A positive factor is the system alarming of the truck drivers who do not comply with the road guidance transmitted in the form of alarm messages. Such exceptions will be caught by extra video-identification points and directed to the designated recipients.

## 4.2 Methodology of the data preparation and presentation

The message transmitted over a communication device to a commercial vehicle driver will contain information concerning the vehicle (class, make, model, weight, height, the fact if it is carrying dangerous materials) and the route which was intended

as the most optimal concerning the time travel for this vehicle in the city structure. The information transmitted in real-time is to improve the urban traffic. Creating routes designated for carriers of goods is to relieve other routes. The Volvo freight management system will be one of the components used to build a fleet management system of freight vehicles in Wrocław. It will be based on the data provided by measurement devices in the form of .xml files. The .xml file will contain the integrated data from measurement devices in the form of:

- quartz pressure sensors;
- laser scanners (outlines of objects);
- digital cameras (video-analysis)
- induction loops (an electromagnetic spectrum), will serve as input data to the automatic transit system operation.

At the stage of the project submission the following preparatory implementation and analysis methodology was adopted:

1. the analysis of system and functional needs;
2. design and construction of the model (mockup);
3. interfaces and communication protocols adjustment in order to integrate the sources and recipients;
4. identification of quality requirements for automatic image, weight and shape analysis systems;
5. adjusting the algorithms to the primary and secondary image processing to use a variant MMR method;
6. adjusting the algorithms of vehicle search in the image, object tracking, class and make and model identification with the use of the so-called hybrid techniques, that is with the use of additional identifying instruments (laser and quartz sensors);
7. development of research on the algorithms of vehicle's consistent model and make classification using the hybrid method:
  - classification based on morphological characteristics;
  - classification on the basis of a detailed image;
  - classification based on the 3 D model
8. development of algorithms for color classification of the vehicle:
  - dominant color detection;
  - analysis of the histogram of a color occurrence
9. implementation of a double image segmentation in terms of number plates and ADR plates reading;
10. improvement of ADR plates detection and reading
11. use of the image analysis for identification and classification of the road users
12. use of automatic analysis of the pressure sensors for vehicles identification and classification;
13. use of automated analysis of laser sensors for measure the vehicle contours;
14. creating a method of fast transmission, circulation and the archiving of data;
15. proposing methods of data presentation.

### 4.3 An example of research issues - ADR plates reading

One of the essential elements of the vehicle identification and routing subsystems will be the technology of ADR plates (indicating the hazardous substance or goods carried as freight

cargo) video-identification. This software element, originating from DSP techniques will be in particular dealt with by engineers from Neurosoft – a company having more than 20 years of experience in OCR technology based on neural networks.

Transportation of dangerous goods poses potentially higher risk of hazards on the road. The number of vehicles carrying goods continues to increase along with the increasing volume of traffic on the roads. Therefore, the knowledge of the routes (when, where, what dangerous goods are transported, the number of vehicles) through critical sections of the road network such as tunnels, bridges or urban areas is essential for the processes of traffic management and safety.

The A annex to the international convention on the transportation of goods and ADR dangerous substances (drawn on Geneva on September 30th, 1957, ratified by Poland in 1975, reapproved every two years, currently applicable in 46 countries) – contains a division of all hazardous materials manufactured in the world into 13 classes of risk (and detailed classification of these materials in particular classes). Additionally, this Annex sets out general and specific conditions of packing hazardous goods, requirements for labeling products, packages and vehicles carrying dangerous goods and the conditions for technical examination of packages and their special labeling.

The document also contains a list of all known dangerous materials that may be transported on public roads along with the unequivocal UN numbers assigned to them. The algorithms directing or alarming vehicles that are subject to load restrictions will be based on those guidelines.

Each transport company is obliged to place on the vehicle the ADR plate with its UN number and the designation of the hazard type corresponding to the transported cargo. ADR plate is usually mounted in front of the hood and the back of vehicles.

ADR plate (orange reflective signboard placed on vehicles carrying dangerous substances) contains two identification numbers of transported substances, that is:

- hazard identification number - two or three digits (in the numerator)
- Material identification number - four digits (the denominator).

Standard plate size is 40x30 cm.

If hazardous substances are transported in specially marked containers or tanks, no additional information (codes / signs) are required to be placed on the ADR plate on the back of the vehicle - the markings are on the side of vehicles or containers.

All known automatic ADR plates recognition systems based on video-detection detect in the first stage the presence of the board on the image, then with the use of a variety of algorithms they recognize sequences of characters that appear on it (OCR). Due to the detection method they can be divided into two main groups - in the solutions available on the market there are different alternatives using elements of each of them:

- Analysis of each image/frame for the presence of the ADR plate
- Recognition of the vehicle carrying hazardous materials with the use of other methods (laser) and then initiation

(triggering) of one or a sequence of images containing an ADR plate.

In both cases the camera must be equipped with an infrared radiator so that the identification of the plate can be carried out in low light or no light conditions.

The position of the ADR plate in the image is determined on the basis of so-called characteristic signs of dangerous materials (length to height of the plate ratio, the regularity of occurrence of certain horizontal and vertical lines). It is essential to take into account the signs of unusual dimensions - the so-called small ADR plates. In this context it is problematic to recognize an empty plate - with no special signs - because they are easily confused with warning plates.

The system performs the reading of the material identification and hazard number with the use of OCR algorithms which analyze pre-selected areas, defined as places with a high probability of plate occurrence. If the system detects the presence of the plate and the result of the OCR recognition is not satisfactory the next frame / next image is automatically analyzed - until a better quality numbers recognition is achieved.

At the end of 2009 there were three measurement points in Germany equipped with a system which automatically identifies vehicles carrying dangerous materials. The promising results of the tests conducted at these points will contribute to the research conducted in Wrocław.

## 5. Conclusion

In the international research and development activities carried out in Wrocław public-private partnerships are included in the European strategy for the development of the ITS and expansion of transport infrastructure in accordance with its assumptions. Improving and testing the innovative technologies in urban areas will be an added value. The ultimate goal will be to

multiply the most effective solutions as standard ones. In this way, in the public context the condition of interoperability will be met which will be a unique opportunity for innovative companies of fully protected implementation of public procurement of proven and very often unprecedented solutions into the market.

This great objective will be achieved in three years which will be a time of fascinating and ambitious tasks taken on the scale not practiced in the industry so far.

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