Incidence of new Telematic Systems for Transports in Romanian Information Society

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Abstract*:* Key technologies had occurred in the last years, and became available at low cost for typical civil applications, spreading from research field to industrial integrated wide area systems. The transports economical branch can take real benefits from new technological achievements such as: information technology, mobile communications and internet, satellite global positioning and so on. The authors present in this paper the incidence of Intelligent Transport Systems in Romanian information society, in accordance with EU policies for candidate countries, with reference to a dedicated solution, result of a local research process.

Keywords: Intelligent Transport Systems, Telematics for transports, IT, e-commerce, communication, positioning

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1. Introduction –EU Policies and Documents

Generally known as systems to make transport processes safer, faster and more environmental-friendly, ITS (Intelligent Transport Systems), part of the Information Society, are transport systems that apply information, communications and control technologies to improve the operation of transport processes. From all transport modes, the road transportation is one of the most disorganized and subjected to incidents: there are many vehicles with a single occupant, the degree of traffic discipline is generally moderate, signaling and professional means to improve traffic safety are at a low level of implementation in most countries, except those high economically developed. Thus, in the past 80's, some countries in Europe (Great Britain, Holland, Belgium, France), North America (USA and Canada), Asia (Japan) and Australia took independently the initiative to reduce the number of road incidents and make road transportation a better organized mode. The technologies used, based on three core features – IT, automation and communication, in an integrated environment, became ITS tools, also called "Transport Telematics". Telematics help operators and travelers to make better and coordinated decisions, improve traffic flow, reduce environment pollution and make travel more safe, fast and pleasant for all participants. These objectives are common to all regions around the world although their priority may vary from one region to another. According to these facts and consequently, in the years that followed, several multi-national organizations took initiative to implement ITS (ERTICO, ITS America, VERTIS etc.) and the process became a general policy. The process of collection, processing, transferring, and dissemination of information to users are the key features of ITS. All these activities help traffic participants and rulers to take better coordinated, informed and intelligent decisions.

The EU has set forth a clear vision for ITS, both for member countries and for candidate ones, using specific policies and key objectives aimed at progressing important IT initiatives and maintaining a coordinated European effort. The array of ITS applications has encouraged the EU to include ITS programmes and tools in the scope of its Common Transport Policy, as well as providing recommendations1 and initiatives in order to create a single, European market for ITS products and services.

Since the 90's, the European Union has been working on establishing major trans-European networks that interconnect Member State telematics and telecommunications infrastructure. A series of research and development programmes funded through the European Commission's 4th and 5th Framework in RTD have been intended to alleviate problems facing transport infrastructure networks and put research into action. The Guidelines adopted in 1996 for TEN-T2 aim at promoting the information society through telematics for transports and developing the quality in this area of services borderless. One of the most important objectives in the EU policy is to improve the road transport efficiency, safety and sustainability. A connected action in EU policy is the Action Programme for Road Transport Telematics (created in 1997) containing proposals dealing with key priority areas such as RDS-TMC3, traffic data exchange and advanced vehicle control systems.

In the years after 2000, ITS implementation process across Europe received a big boost with the e-Europe Action Plan, which created the fundament for new project developments. The European Commission has established the MIP4 for 2000-2006, to provide high levels of investment. Also, the White Paper (WP), entitled "European Transport Policy for 2010: Time to Decide" consists of a state-of-the-art analysis, regarding transport policies and mobilities and refocuses the investment policy on the demands and needs of European citizens. Organized in four main sectors dealing with modal shifts, bottleneck elimination and managing globalization, the WP contains sixty measures which envisage a fulfilling of European needs in the field of transports.

Our country, as a candidate to EU, has its own strategy for ITS implementation, despite the fact there does not exist a global policy for implementation of an ITS Euro-region. Our country's national policy in R&D for transports include national programmes such as: AMTRANS, INFOSOC and RELANSIN.

The authors of the paper, in the frame of the national R&D programme AMTRANS, in cooperation with their partners5, developed a project concerning in an "Integrated Electronic System for Vehicle Monitoring, Mobile Data Communications and e-Commerce in Road Transportation". This project, and other similar actions in R&D field, affiliate our country to modern technologies for transports.

2. Its in Information Society

Traffic dispatching in the railway transportation continuously monitors train safety, identity, position, speed etc. Inland waterways are also dispatched by the means of transponders and global positioning techniques, and increased traffic safety is achieved. For road vehicles, the situation is different: there is a greater number of vehicle drivers, the traffic is more dense, sometimes jammed, and vehicle monitoring is difficult, especially in international trips. Further on, a system that could be able to inform traffic managers and drivers according to different changes in traffic, optimal routes, ramp metering etc. is very useful and necessary. ITS can provide all these needs by the following sub-systems:

- ATMS – Advanced Traffic Management Systems – integrated complex systems that manage signaling in road junctions, in order to create a safe, fast and continuous traffic flow. In our country some projects have been implemented in Bucharest and other cities (for example, using "UTOPIA" strategy to improve traffic conditions at the tram line 41 in Bucharest, a traffic control/environment monitoring system (INFOSOC) in 6-th District, Bucharest etc.);
- APTS – Advanced Public Transportation Systems – systems used for a better public transport, including all means of urban transportation and multi-modal stations;
- AVCS – Advanced Vehicle Control Systems – technologies to make vehicles safer, including enhanced visibility, collision avoidance systems and improved braking performances;
- CVO – Commercial Vehicles Operations – a set of measures made to informatize all procedures for operations in freight international transportation, including credentials administration, cross-border information concerning dangerous goods transportation etc.;

1 EU White Paper on Transport Policy

2 TEN-T – Trans-European Network for Transport

3 Radio Data Services – Traffic Management and Control

4 Multi-annual Initiative Programme

5 National Institute for Research in Information Technology – ICI Bucharest

- ATIS – Advanced Traveler Information Systems – systems used to improve decision-making processes for transports, both for transport networks administrators and for traffic participants; they include Variable Message Signing technologies, Radio Data Services, in-vehicle signing, dynamic message information etc.

The following section of the paper describe the AVL section of an extended integrated CVO solution using e-commerce, IT, communication and positioning technologies, all in an open architecture; the system is the result of a R&D project and its novelty consists in the high degree of integration and versatility.

3. System's functional architecture

The Integrated Electronic System for Vehicle Monitoring, Mobile Data Communications and e-Commerce in Road Transportation, result of a Romanian R&D project, is a highly sophisticated structure that allows the following operations:

- Web electronic registration of freight owners;
- Web electronic registration of transport companies and their offers for transport;
- Remote traffic monitoring techniques, from a dispatching centre: automatic vehicle location, along with the transmission of some vehicle parameters;
- *Mobile communication and orders transmission on board;*
- Remotely, web monitoring of vehicles, along with presentation of the actual position, or history of positions of the monitored vehicles, on a geographic window via internet;
- Data storage of important events, vehicle positions and other economic information;
- Emergency facilities etc.

The architecture of the system comprises three main sections:

- The e-commerce section;
- The GPS-AVL section and vehicle monitoring;
- The web section

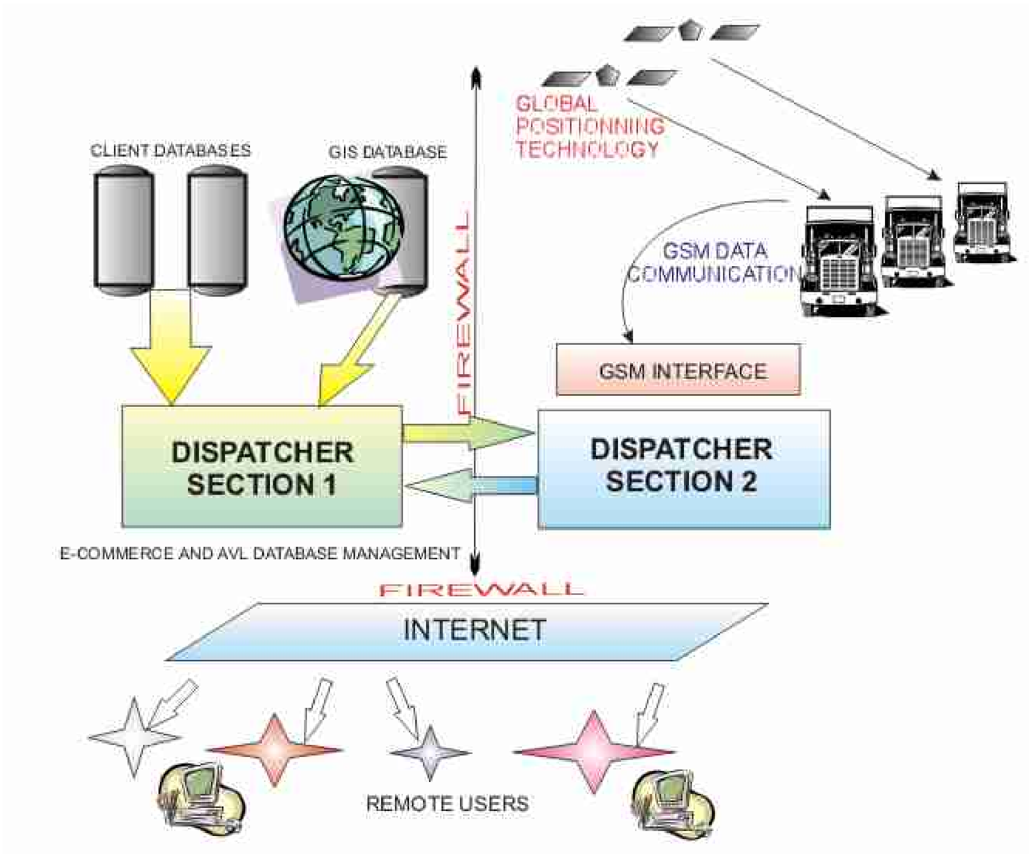

Figure 1: System's Functional Architecture

The figure above depicts the general architecture of the AVL/e-commerce system. The main sections of the system have the following significances:

- Client databases (vehicles, freight etc.); a server which contains information necessary to manage the e-commerce section of the system. Among those information: freight owner companies, spedition houses, documents for electronic transactions etc.;
- GIS (Geographic Information System) database: contains a server used to manage the AVL6 section concerning vehicles positions, electronic maps and collection of other data from vehicle-borne sensors;
- Internet cloud;
- Monitored vehicles – each vehicle has an ID, a SIM[7] card number and a mobile equipment;
- GNSS – Global Navigation Satellite System – any system can be use, but the AVL/e-commerce system is actually designed to use the American NAVSTAR GPS[8];
- GSM local or visited network; used for data communication between vehicles and central dispatcher.

One of the most important sections of the system is the vehicle monitoring section. The GPS-AVL section of the system shows its importance because of its safety functions, including positioning, mobile data communication and emergency situations management. The AVL section of the system works in a simple and reliable manner: at scheduled moments, or on operator's choice, the central Dispatcher sends an interrogative SMS to one selected mobile. The correspondent mobile equipment takes the data from the GPS receiver and other vehicle-borne transducers, converts all data into a new SMS and sends the SMS to the dispatching centre. There are also different possibilities to connect for data transfer to the dispatcher centre: using data (CSD9 or HSCSD10) connection or GPRS11.

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4. Testing the System - Test conditions and equipment

The AVL section of the system and all dependent blocks were both tested in static and dynamic conditions. After the static tests were successful, the dynamic tests had to be made in normal work conditions: a diverse route, on which the monitored vehicle was going to travel was chosen: start from Bucharest, Romania, on highway A1, Piteşti, Sibiu, Arad (Romania) – Szeged, Budapest, Gyor (Hungary) – Wien (Austria) – Prague (Czech Rep.) – Dresden, Hannover, Frankfurt, Nurnberg (Germany) and back to Vienna and to Romania on the same route. The vehicle was equipped with 2 GPS receivers (vehicle borned): Motorola Oncore from the monitored AVL equipment (8 parallel channels) and a Garmin GPS V DeLuxe as a control equipment. Also, two additional handheld GPS receivers (Garmin e-trex) were used to monitor different situations and to compare results in special situations. The software used for the tested equipment was installed on a Laptop PIV Mobile Compaq 2,0 GHz with 256 MB of RAM and we used a special software for the connection with the local mobile equipment and Microsoft MapPoint 2001 Europe adapted. The Garmin receiver was connected to another laptop with Map Source software. Communications were ensured by vehicle-borne GSM modem (900 MHz or 1800 MHz networks enabled) and GSM cell phones with engineering software for GSM network measurements (a Nokia 6110, a Nokia 6210 and a Bosch 506).

6 Automatic Vehicle Location
7 SIM – Subscriber Identity Module – a feature and a device used in GSM communication networks
8 GPS – Global Positioning System
9 Circuit Switched Data make possible mobile data communication at 9600 bps
10 High-Speed CSD make possible mobile data communication at higher speeds up to 54 kbps
11 General Packet Radio Services for data packet transmission and permanent session

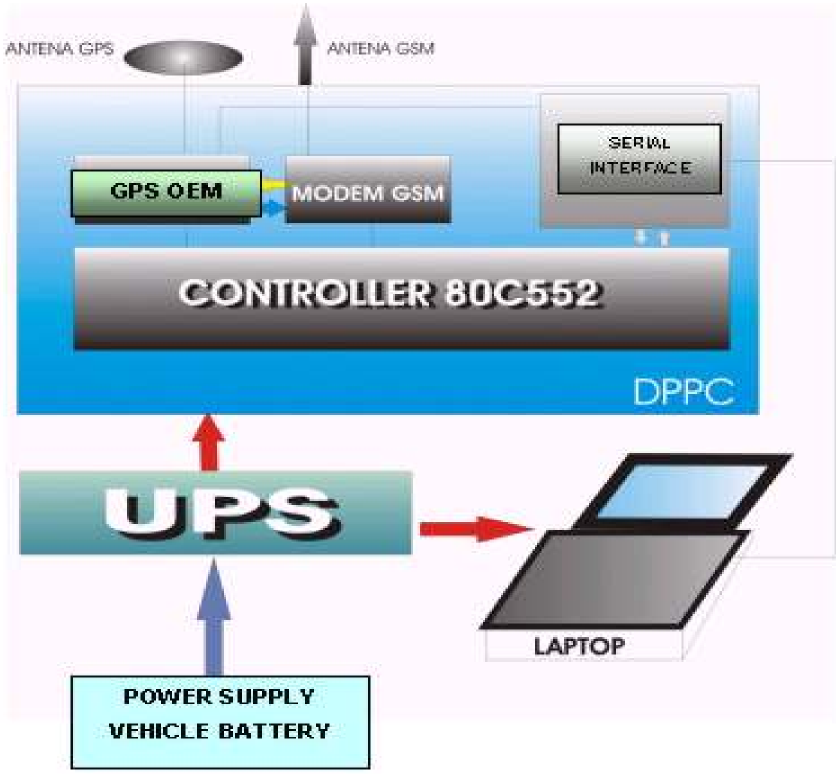


Fig. 2 Test equipment

Tests were concerned on:

- GSM coverage;
- Map precision;
- Mobile equipment reliability;
- Communications reliability.

A tele-recording of a position and other vehicle's parameters consists of a string of alpha-numeric characters, which are transmitted by a single SMS, as shown in figure 3. This is also a part of the string of characters that represent a record on the local PC.

GpsTime	Speed (cm/s)	Heading	DopType	SatsVis	SatsTrack	GpsStatus
13:07:17	0	0	1	8	0	8

No.	Type Msg	Code	Phone	Lat	Long	Alt (m)	GpsDate
1	POS	255	0722792787	159821759	93983348	154	7/12/2002

Figure 3: First section of the SMS position message transmitted by the mobile equipment

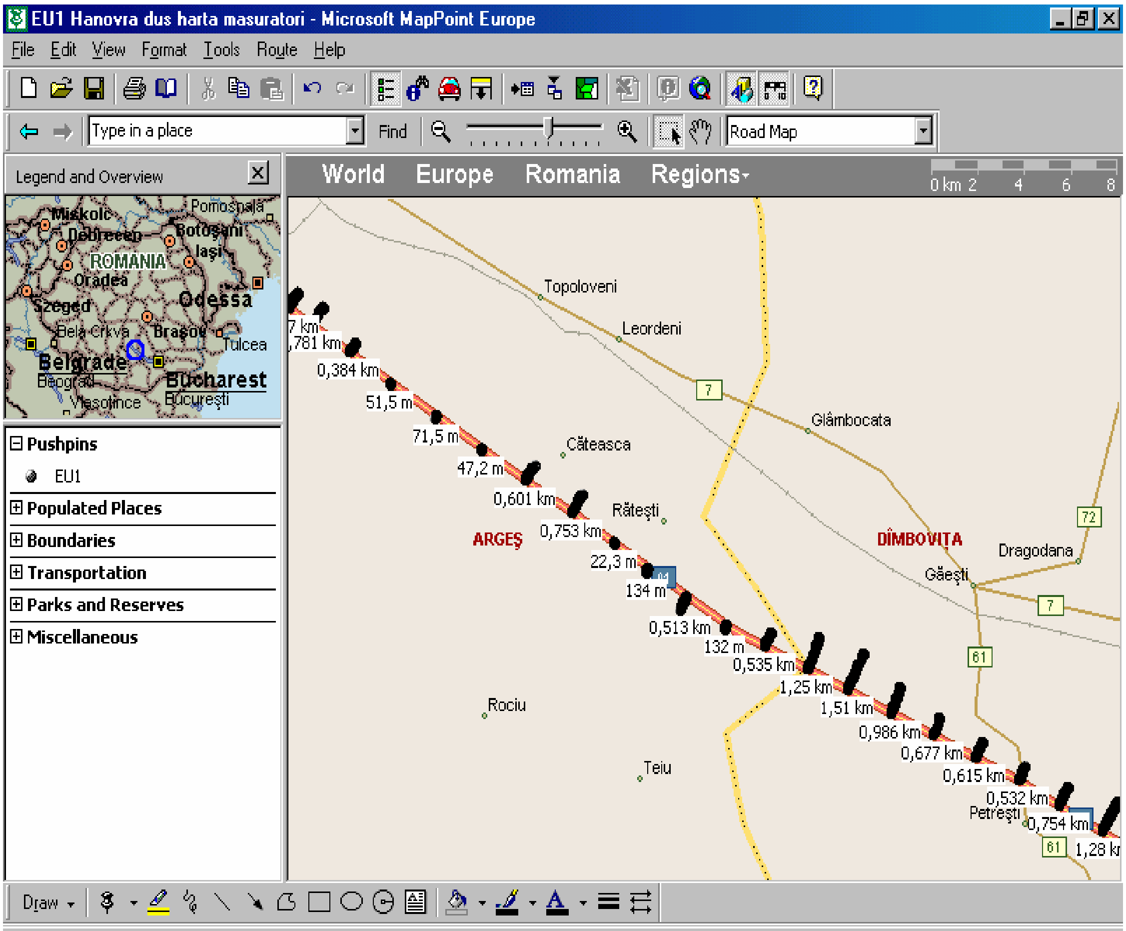


Figure 4: Second section of the SMS position message transmitted by the mobile equipment

The fields in this message format are:

- *Type Msg*: type of message transmitted / recorded (possibilities are: POS – position message, SYS – system configuration);
- *Code* – a special code for the message (default is 255);
- *Phone* – Phone number (GSM international format) of the mobile equipment;
- *Lat.* – latitude in per tens of thousand of degree;
- *Long.* – longitude per tens of thousand of degree;
- *Alt.* – altitude in meters;
- *GPSDate* – date in GPS format;
- *GPSTime* – time in GPS format;
- *Speed* – speed, in centimeters per second;
- *Heading* – direction of the vehicle displacement;
- *DOPType* – type of Dillution of Precision, a GPS feature that indicates the degree of error due to space vehicles' position;
- *SatsVis* – number of visible space vehicles (satellites);
- *SatsTrak* – number of tracked space vehicles;
- *GPS Status* - error message that indicates health of GPS receiver.

5. Test Results and Conclusions

For GSM coverage there almost were no problems. In Romania, especially in the mountain area there were sporadic signal losses, but for very short moments. By the other side, the use of SMS technique in information transmission ensures a "buffering" in the SMS centre of the GSM network so, even if the signal is lost for a while, only the moment of data reception is delayed, and no data is lost. But in the sense vehicle-dispatcher transmission, the data could be lost if no coverage is present. The software employed ensures a "track & trace" function, for best results in monitoring a vehicle. The global coverage of GSM network achieved in Romania is 96,8 % from the time used to transmit / receive messages (the system was set to transmit each half-hour the data and to locally record each minute). The coverage in Hungary and Austria was about 98,9 % and for Germany 99,3 %. As before mentioned, few mountain areas were considered with problems. The GPS precision is generally affected by some factors. GPS errors are a combination of noise, bias, blunders.

However, the errors of the GPS receiver does not affect much precision at the large scales that the AVL system operates. Thus, tests were concerned especially on the electronic maps. There were over 2,800 recordings to evaluate. First estimations of map positioning were made on MapPoint Europe 2001, for the A1 motorway in Romania, where the speed of the vehicle was relatively constant, and distances between marks quasi-equal. Absolute maximum error for this road section was 1493 m, and average error on the whole motorway length was 67,11346 m, an acceptable value for international transports monitoring purposes. To estimate this error, a simple formula was employed:

$$E_d = \frac{d_1 + d_2 + \ldots + d_n}{n} \qquad (1)$$

where: E_d stands for medium distance error and d_1, d_2, …, d_n represent perpendicularly distances from estimated point to motorway, where the vehicle was really positioned; n is the current number of the recording.

Figure 5 depicts one section of A1 motorway with positions determined by the system. Figure 6 presents absolute errors to the motorway represented on the map (very poor map precision).

The map precision is crucial especially for small area monitored transports (such as public transportation in cities), but of less importance in case of large coverage area, where positions of the vehicles are refreshed at rare intervals of time. The conclusion in this case is that the precision which affects more is the map precision and not the GPS precision, because an average accuracy of about 10 meters is enough in the case of international transports.

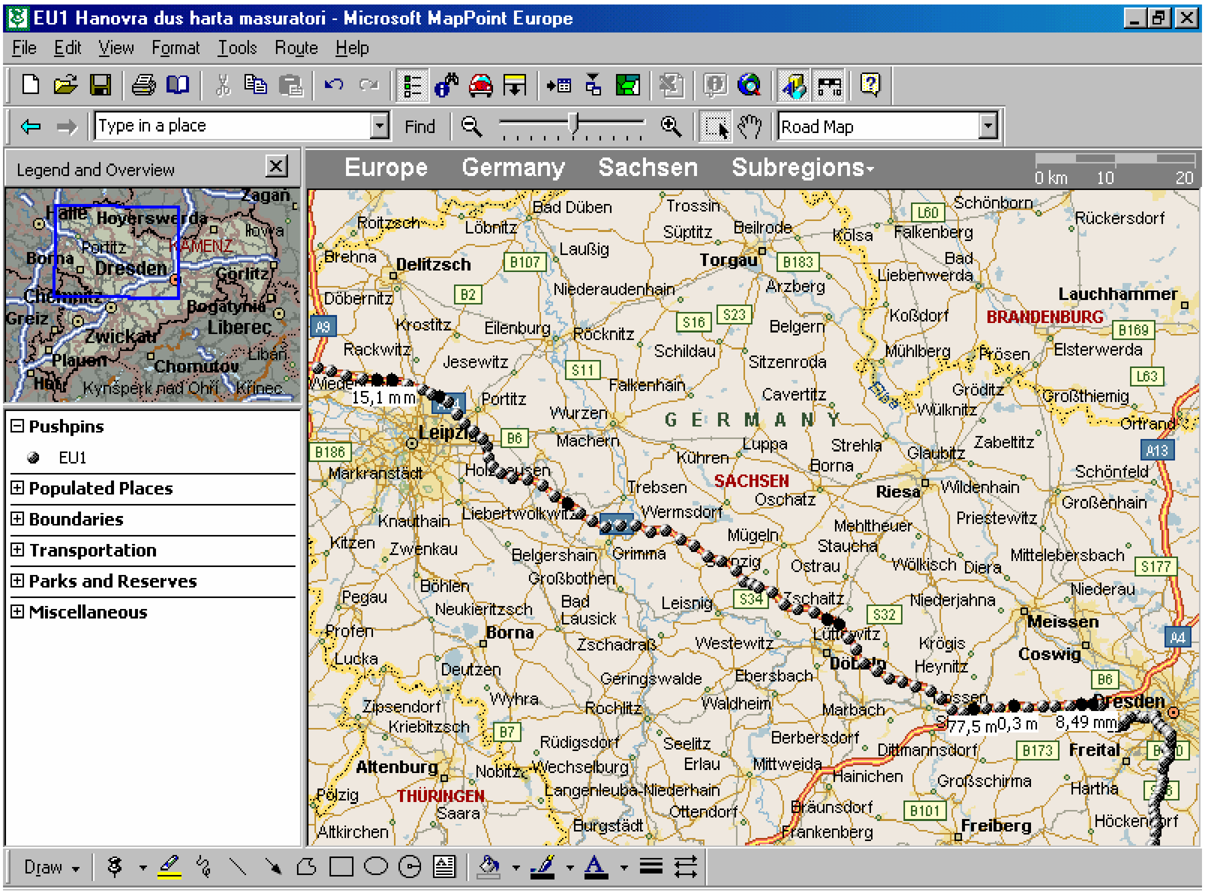
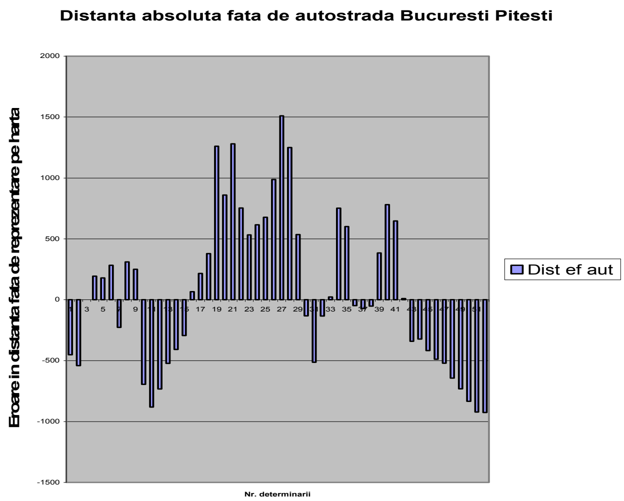


Figure 5: Map precisions in Romania (A1, left) and Germany – between Dresden and Leipzig (right) The max. absolute error was 78,2 m (a single recording) and the average error was only 1,42 m.



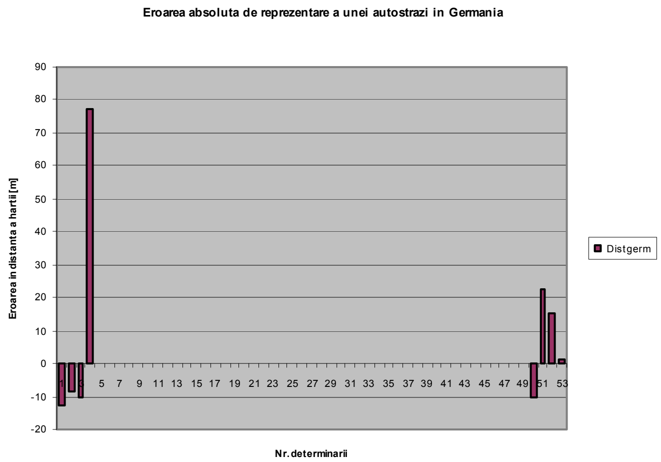


Figure 6: Comparison Between Absolute GPS and Map Errors of the System in Romania (left) and Germany (right)

All measurements indicate availability of the system in more than 98% of time and good flow of information between vehicles and central (dispatching) point. Future use of GALILEO system is expected to produce more accuracy in positioning. The use of a more precise map for Eastern Europe will increase appliance area of the system in urban public/commercial transportation. Systems as the presented above will become more and more spread across Europe and interconnected thru satellite systems, making possible borderless actions for safety and security of transports.

In conclusion, we can say that in our country, as in major economically developed nations, ITS technologies have to be more and more incident, in order to make from the national road transportation network a performant means for displacement of people and freight in safer conditions.

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