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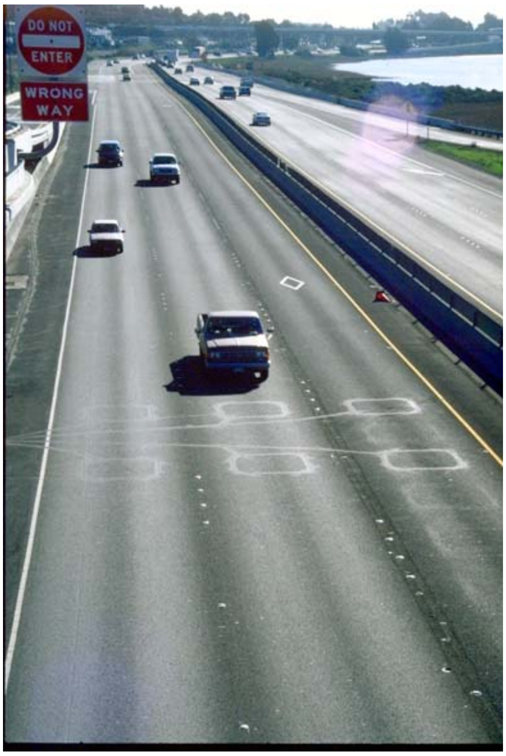
Networks for Transportation:

Case Studies in Traffic Management & Applied Information Systems for Transportation



Τιμονίδου Βασιλική

Καρακουγιουμτζής Γεώργιος

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Summary

The first part of this paper deals with networks in transportation, and more specifically their use for (urban) traffic management. Six case studies of different cities/areas are presented and the methods used in each are described. The technology used in this field varies, and the choice of which to employ depends largely on the needs and resources of the interested region.
In the second part of this paper we examine various applied technological solutions. Information systems are widely used in the transportation section. The first case study discusses the e-navigation vision -especially the communication subsystem between ships- and presents a delphi-based program to fulfil its needs. The second case study analyzes a different subject-the standardization and interoperability problems of the European Electronic Toll System. The next project applies a technical solution for visually impaired and blind people, while the fourth one- a rather expensive one I would say- deploys morphological based analysis on digital satellite images for monitoring the traffic. The 5th case study examines a solution for the Rail Transport service Information system and finally the 6th project is about a client-server architecture software for generating personalized tourist routes, taking into account public transportation means.

Περίληψη

Το πρώτο μέρος της εργασίας αυτής ασχολείται με τη χρήση των δικτύων στις μεταφορές και συγκεκριμένα για τη διαχείριση της (αστικής) κίνησης. Παρουσιάζονται έξι περιπτώσεις και περιγράφονται οι μέθοδοι που χρησιμοποιούνται σε κάθε μία. Η τεχνολογία που είναι διαθέσιμη σε αυτόν τον τομέα ποικίλει, και η επιλογή για το τι θα επιλέξει κάθε περιοχή εξαρτάται από τις συγκεκριμένες ανάγκες της και τις δυνατότητές της.

Στο δεύτερο μέρος της εργασίας εξετάζουμε διάφορες εφαρμοσμένες τεχνολογικές λύσεις. Τα πληροφοριακά συστήματα χρησιμοποιούνται ευρέως στο τομέα των μεταφορών. Η πρώτη υπόθεση εργασίας αφορά στο όραμα για την ηλε-πλοήγηση (e-navigation) συγκεκριμένα στο σύστημα επικοινωνίας πλοίων και παρουσιάζει ένα πρόγραμμα φτιαγμένο σε Delphi για να εκπληρώσει τις ανάγκες του οράματος. Η δεύτερη υπόθεση εργασίας αναλύει ένα διαφορετικό θέμα -τα προβλήματα προτυποποίησης και διαλειτουργικότητας στο Ευρωπαϊκό Ηλεκτρονικό Σύστημα Διοδίων. Στο επόμενο πρότζεκτ εφαρμόζεται τεχνολογική λύση για άτομα με προβλήματα όρασης, ενώ στο τέταρτο- μια μάλλον ακριβή λύση- υλοποιείται μορφολογική ανάλυση σε δορυφορικές φωτογραφίες για τον εντοπισμό και την επίβλεψη της κίνησης. Το 5ο θέμα εξετάζει μια λύση για το τηλεματικό σύστημα πληροφόρησης των σιδηροδρόμων, ενώ τέλος το 6ο πρότζεκτ αφορά σε μιά υλοποίηση ενός προγράμματος αρχιτεκτονικής client-server για τη δημιουργία προσωπικών τουριστικών διαδρομών λαμβάνοντας υπόψη τα δρομολόγια των δημόσιων μεταφορικών μέσων.

Presentation of the Problem

The issue/problem that is dealt with in the first part of the paper is the following:
In our days, ever larger portions of the population in most countries have gathered in big cities. The number of car owners is now greater than ever in the past. This means more and more traffic and especially in big cities. However, the existing road infrastructure in cities cannot always expand to accommodate the greater number of cars. This is true especially in city centres. Therefore, taking the existing infrastructure as given, any improvements in traffic flow must be made through managing traffic in a better way. The first thing that the authorities responsible for transportation need to know is the **actual amount of traffic** in a specific location at a certain time. **Traffic detection** methods include for instance the use of loop detectors, cameras and satellite images. Once the traffic load is known, alternative routes can be suggested, so as to relieve congested areas. This information is communicated to drivers e.g. via **VMS**s (Variable Message Signs). Alternative sources of traffic information for drivers (either from their internet connection at home or in their car via a mobile phone) are websites, possibly managed by transport authorities, where information about traffic is available on-line, real-time. So, even before the set off, drivers know if there is a problem on their intended route and maybe choose a different one, or decide to travel at a later time altogether. The six case studies that follow will give us some examples of what systems are used to address these problems in six different parts of the world today.
On the second part of this paper:
The first project deploys a solution for e-navigation. Windows environment and Delphi programming language are used to create a one-window communication sub-system between ships and between ships and meteorological stations and vessel terminal stations. This project was developed on the basis of Maritime International Organization and International Association of Marine Aids to navigation and Lighthouse Authorities working papers, by Polish researchers of Gdynia Maritime Studies University.
The 2nd case study examines the architecture of the Polish National Automatic Toll Collect System Pilot Project in order to create a similar interface for the European Electronic Toll System standardization and interoperability issues. The 3rd project integrates GPS based technology and mobile connectivity with servers in data centres in order to provide public transportation information and delay timetables to the mobile phones of visual impaired and blind people, who have dedicated software installed.

The fourth project describes a new method for traffic analysis and monitoring on non-urban areas using morphology algorithms the so called "immunization" technique. With this method vehicles and roads are extracted from high definition satellite images . The fifth project is about a new telematic information service platform for the rail transportation information system. The Sitkol system is developed in order to provide access to the system to passengers and all the other participants of the railway system so as to give and receive data upon ticket ordering, travel payment system, freight and carriers information.

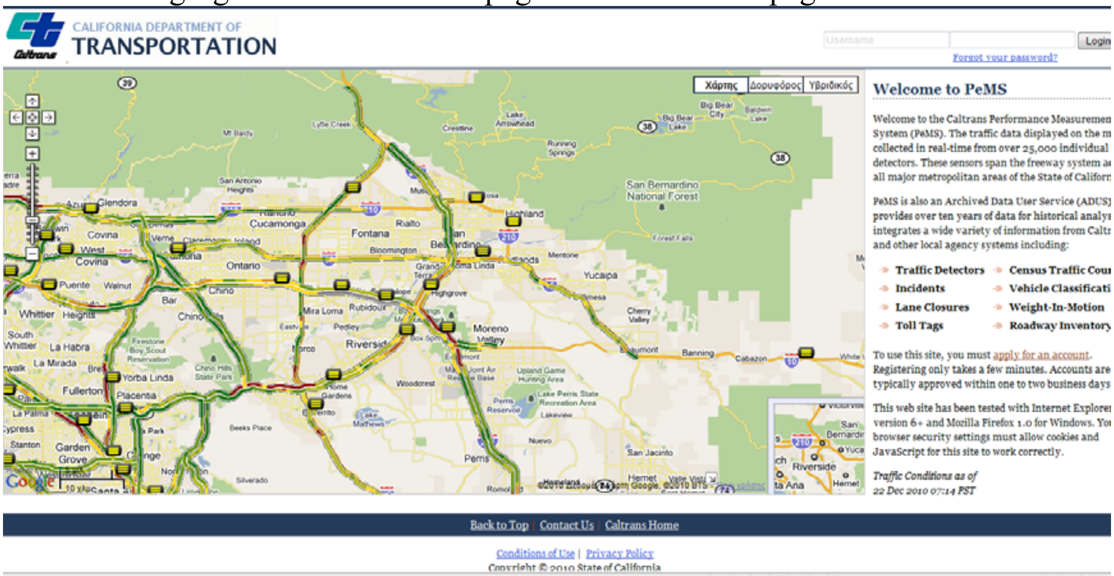
The sixth project analyzes a special algorithm for personalized tourists' route generations. The team involved in the project presents a heuristic able to solve the tourist planning problem. The proposed software was developed with Google Web

Toolkit Framework. It is based on a client -server architecture and has both a desktop computer and a mobile client graphical user interface. The software was tested at the city of San Sebastian of Spain with good results.

1. California

The California Freeway Performance Measurement System (PeMS) is a freeway performance measurement system for all California. It is is a joint effort by Caltrans (the California transportation department), the University of California, Berkeley, and PATH, the Partnership for Advanced Technology on the Highways It processes data in real – time and produces information that can be used by interested parties. Traffic engineers can take decisions knowing the exact state of the traffic in the entire network. Drivers can consider different route or time options knowing where there may be a congestion, on at what time of the day a certair road is usually overburdened. PeMS can be accessed over the World Wide Web. In order to get access to the website users need only apply for an account and wait for their application to be processed (this took only one day for the authors' application) after which they get a password and they can fully make use of the information provided. No fee is required, the information is totally free. The PeMS software architecture is open.

The following figure shows the main page of the PeMs webpage



screenshot of: http://pems.dot.ca.gov

Measurements are collected by over 30.000 sensors and detectors placed all over the state. Measurements are reported every 30 seconds. The data are transferred through the Caltrans wide area network (WAN) to which all districts are connected. The 30-second data received by PeMS consist of counts (number of vehicles crossing the loop), and occupancy (the average fraction of time a vehicle is present over the loop) (PeMs website). The system covers 164 Freeways and includes 6.328 Vehicle Detector Stations and 3.470 Ramp Detectors (Lippi et.al, 2010).

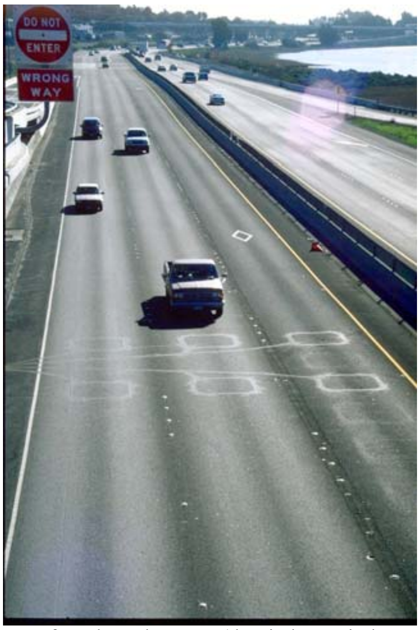
State Attributes	
Freeway Miles (directional)	30,571
Controllers	5,805
Stations	12,473
Detectors	32,176

source: PeMs website

Loop detector data is collected in real-time from all of the sensors. The data passes from the local collection machine, over the network and then into PeMS (PeMS website).

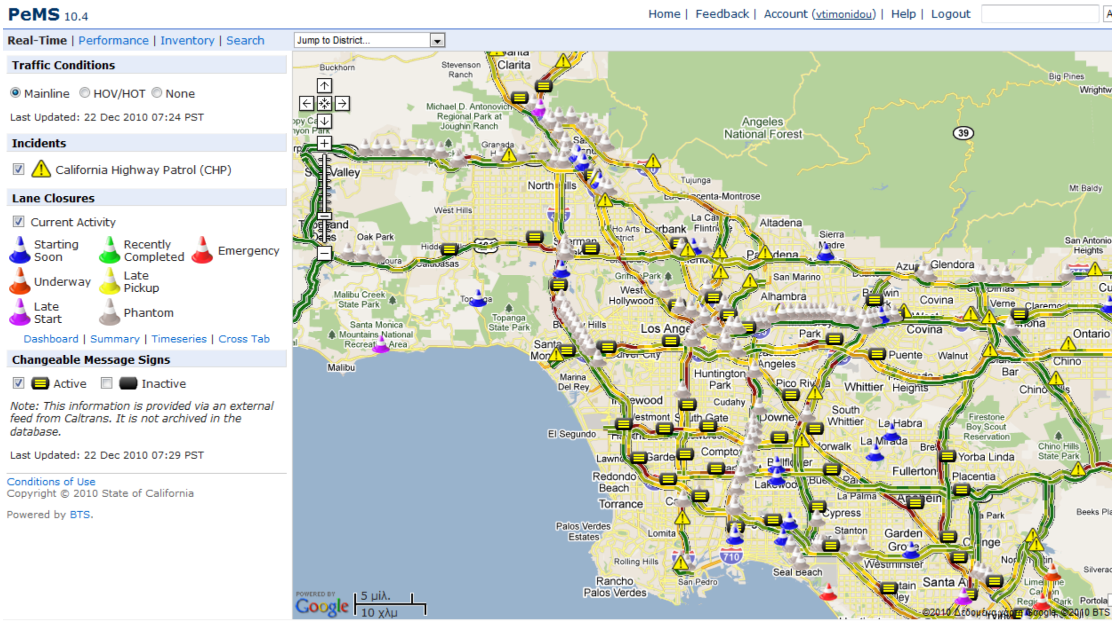
Lippi et.al. describe PeMS as follows: “The loop detectors used within the PeMS are frequently deployed as single detectors, one loop per lane per detector station. The raw single loop signal is noisy and can be used directly to obtain only the raw count (traffic flow) and the occupancy (lapse of time the loop detector is active) but cannot measure the speed of the vehicles. The PeMS infrastructure collects filtered and aggregated flow and occupancy from single loop detectors, and provides an estimate of the speed and other derived quantities. In some locations, a double loop detector is used to directly measure the instantaneous speed of the vehicles.” (2010, p.264). Occasionally, sensor faults occur and then a large part of the data can be unavailable for forecasting applications, until the sensor recovers(ibid.).

7 measurement stations placed on three different Highways in the area of East Los Angeles
source: (Lippi et.al., 2010, p.265)



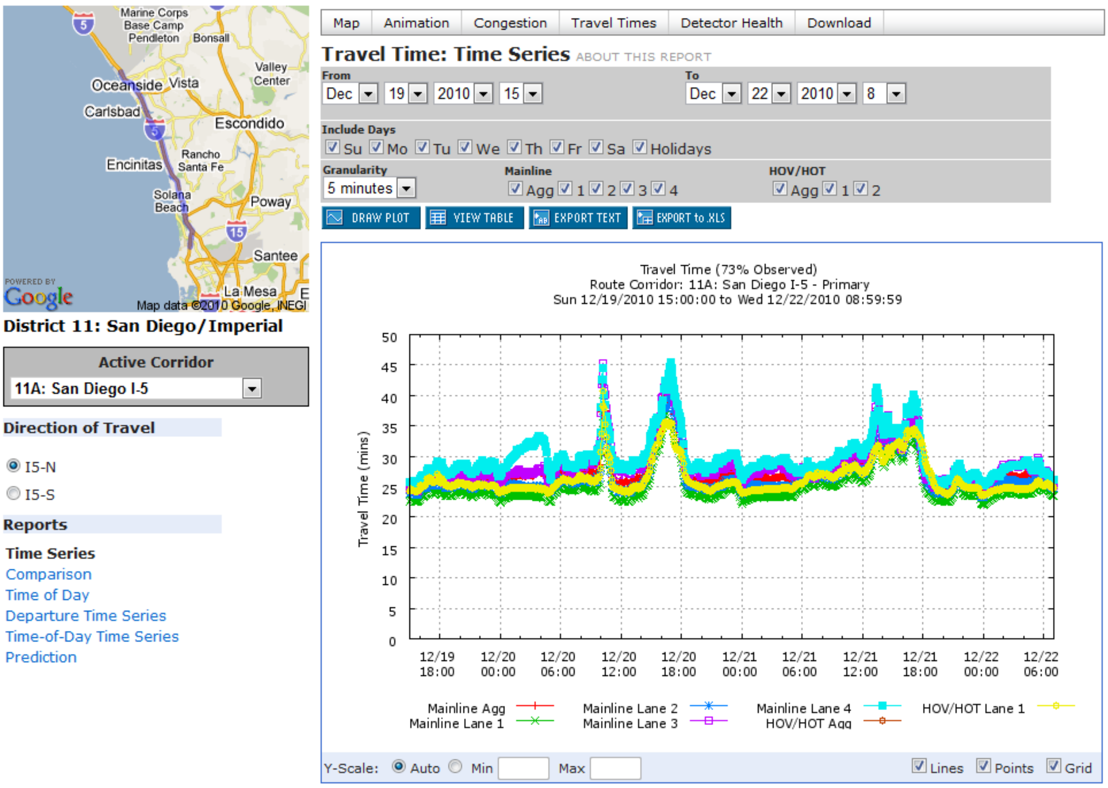
Data from loop detectors (the six large circles on the road) in the San Francisco Bay Area
Source: http://coe.berkeley.edu/labnotes/0801ontheroad.html

PeMS uses Google Maps™ to “provide real-time and historical performance measures superimposed on maps. Alternate views show device configuration or allow users to search for specific field elements and see results on the map. Maps are linked to detailed tabular reports.” (PeMS website)



screenshot from PeMS website

The PeMS website has a Corridor Module™ that animates congestion on the freeways showing how bottlenecks grow and diminish over time.



screenshot from PeMS website

According to the PeMS website, PeMS, by offering real-time information as well as historical data and presenting it in various forms, it can assist managers, traffic engineers, planners, freeway users, researchers, and traveler information service providers (value added resellers or VARs).

“With PeMS, Caltrans managers can instantaneously obtain a uniform, and comprehensive assessment of the performance of their freeways. Traffic engineers can base their operational decisions on knowledge of the current state of the freeway network. Planners can determine whether congestion bottlenecks can be alleviated by improving operations or by minor capital improvements. Traffic control equipment (ramp-metering and changeable message signs) can be optimally placed and evaluated. In short, PeMS can serve to guide and assess the deployment of intelligent transportation systems (ITS).” (PeMS website)

For further reading, a list of research papers on PeMs can be accessed at: http://pems.eecs.berkeley.edu/?dnode=Public&view=resources

2. Beijing

The Capital city of China, Beijing, has about 1000 cameras to monitor traffic on almost all the main arteries and ring roads (Jianming et.al, 2008), which is a closed circuit television (CCTV) system. Video images are transmitted to a traffic management centre via optical fiber networks. The information that is retrieved is real-time and it helps identigy traffic incidents in order to issue the appropriate traffic control instructions (ibid). There are, however, shortcomings in the above-described circuit, such as (ibid):

- The cameras are not densely enough placed throughout the city. Smaller roads are not monitored. Adding more cameras to reach sufficient density would mean very high costs.
- The data communication costs are extremely high. The optical fibre networks, via which the video is transmitted, incur huge communication and maintenance costs.
- Most of the video information is wasted. Video is transmitted all the time, which is unnecessary, since most of the time the traffic is flowing normally.

Therefore, Jianming et.al (2008), suggest that a new method is needed, that could efficiently cover all the roads in the network and provide real-time traffic-flow infromation.

Beijing's traffic flow detection system includes MTFDs (Microwave Traffic Flow Detectors) and travel time detectors (Li & Jia, 2009). The fixed traffic flow detector system has been installed on the Beijing transportation network as shown in the following Figures (ibid., pp10-11).

Travel time detection system installed in Beijing.
*the roads marked by the heavy thread denote that they are installed the travel time detector by the distance of 1–10 km between two detectors.
(source: Li & Jia, 2009, p.10)

Microwave traffic flow detection system installed in Beijing.
*the roads marked by the heavy thread denote that they are installed the MTFDs by the distance of 400–1,000 m between two detectors.
(source: Li & Jia, 2009)

Loop lines are the important roads of Beijing Transportation network, where MTFDs are deployed with density of two detectors per 1.4 km. They collect traffic flow information such as speed, density, volume etc. Based on this information, travel time information can be estimated. But according to Li and Jia (2009) there can be errors because of using the point speed provided by MTFDs to calculate average speed between two detectors.

Li & Jia (2009) note that the MTFDs are installed at intervals of about 700 m which they consider a reasonable distance, however, they argue that in urban arteries, the number of MTFD is inadequate and many important roads have no detectors installed.

Li and Jia (2009) highlight the main problems (which lead to an absence of effective data) of the travel time detection system built on Beijing transportation network as being the following:

1) Some crucial roads in which travel time information
need by ATIS (Advanced Traceler Information System) have no detectors installed, such as the fourth loop line and the third loop line.
2) The distance between two travel time detectors is too long to supply exact travel time information, such as the fifth loop line, the largest distance between two detectors is 10.1 km (from JinYuanQiao to XiangQuanQiao).

3. Hangzou

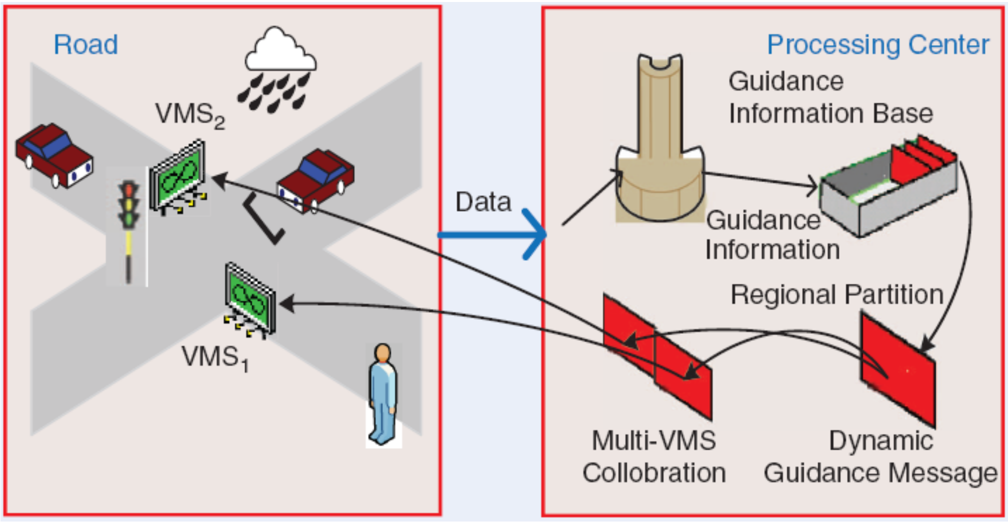
In Hangzou, southeastern China, Variable Message Signs (VMS) provide traffic information in the road network. Traffic guidance information is produced based on traffic conditions of the roads downstream to the VMS - located road.

The traffic road network in Hangzou is shown in the following figure:

source: Shi et.al., 2009.

In the above figure, the numbers with circles represent intersections. The line arrows indicate the direction of each road and lane. The number pairs in brackets indicate the max flux capability and the average travel time of each road and lane. The blue squares label the location of VMS.

The figure below shows the application of the VMS-based dynamic regional traffic guidance system.



The application scene of VMS-based dynamic regional traffic guidance system
source: Shi et.al., 2009.

As Shi et.al. (2009) explain, the underground induction loop sensors or video detection devices over ground collect the real-time traffic data, and transfer these data to the traffic data processing center. Then the center analyzes the traffic data to dynamically partition traffic regions affected by each VMS and construct various traffic guidance messages. The collaboration mechanism among the distributed VMS can ensure that the VMS can coordinate with each other to keep on balancing the traffic flow while the city is faced with emergency events or large-scale disasters. That is, even if such a disaster may destroy the connection among some VMS, and the management centre cannot send the overall-communication order to the affected VMS, the collaboration mechanism can ensure that even those VMS will coordinate with each other to keep the balance (Wei Shi, email on January 4, 2011). However, as Shi et. al. (2009) point out, VMS are handled manually by traffic administrators, something that makes the system inefficient and not very effective. Some VMS are even designated only for advertisements!

4. Singapore

Singapore is a small island city-state in southeast Asia, with a population of 5 million living in an area of 710sq.km. It is one of the the world's most densely populated coutnries. Therefore, land is sparse in Singapore, and the use of private cars is highly problematic. The country has tried several methods in the past to contain traffic. Measures included vey high car prices, high car taxes, car-sharing schemes, as well as road-usage related taxes.

The Land Transport Authority (LTA) of Singapore is the authority that is responsible for the management and administration of the transport sector in the country. It monitors the traffic of expressways using overhead sky-cameras, which overlook traffic. However, as Cho et.al. point out, upon detection of vehicle breakdowns, slow traffic, accidents or other factors that impair the regular traffic flow, it is the personnel working for the authority that have to type relevant warning messages, such as "vehicle breakdown on Lane1", and display them on the board of the "Expressway Monitoring Advisory System (EMAS)" to inform drivers.

At present, the majority of traffic sensors used in Singapore are based on detector coil burried under the surface of the road (Cho et.al., 2009). These types of sensors are accurate but would incur high cost for long term maintenance, therefore according to Cho et.al. (2009) new methodologies should be employed, something that the authors do in their article.

ERP, Electronic Road Pricing.is a scheme of electronic toll collection implemented since 1998. The purpose is to reduce traffic in congested areas by imposing a toll on all the vehicles that use the specific area according to the time they spend in it. The system consists of ERP gantries (see picture below) which is actually a system of sensors on 2 gantries, one in front of the other. Cameras are also attached to the gantries to capture the rear license plate numbers of vehicles. Currently, there are 80 ERP gantries in Singapore.

ERP gantry at North Bridge Road
source: http://en.wikipedia.org/wiki/Electronic_Road_Pricing
Here we can see how drivers are warned that they are entering an area where ERP is in operation.

A device known as an In-vehicle Unit (IU) is affixed on the lower right corner of the front windscreen within sight of the driver, in which a stored-value card, the CashCard, is inserted for payment of the road usage charges. It is mandatory for all Singapore-registered vehicles to be fitted with an IU if they wish to use the priced roads. When a vehicle equipped with an IU passes under an ERP gantry, a road usage charge is deducted from the CashCard in the IU. Sensors installed on the gantries communicate with the IU via a dedicated short-range communication system, and the deducted amount is displayed to the driver on an LCD screen of the IU.

The Land Transport Authority has been testing a system based on the Global Positioning System that may eventually replace the current Electronic Road Pricing system. The proposed system overcomes the inflexibility of having physical gantries, which "are not so flexible when it comes to re-locating them". This system has been copied in other places of the world. For instance, London officials visited Singapore to study the ERP system, after which the London Congestion Charge was introduced on 17 February 2003.

The LTA provides a webpage (whose screenshot can be seen in the picture below), which offers data taken from the EMAS system with real-time camera images. As we can read on the site: "EMAS *is an intelligent incident management system that monitors and manages traffic along expressways, including the CTE tunnels. It deters congestion and implements appropriate action plans.* EMAS *provides motorists with updated traffic information on incidents so as to mitigate its effects. By providing real-time traffic alerts,* EMAS *allows early detection and quick clearance of accidents and breakdown vehicles. The overall result is a safer and more pleasant journey for motorists"*

screenshot of http://www.onemotoring.com.sg/publish/onemotoring/en/on_the_roads/traffic_cameras0.html
accessed on 18/12/2010 at 13:08 CET

Users of the website can have real-time image of the traffic on the specific location that interests them. The locations for which images are available, can be seen on the map of the country above, taken from the same website. By clicking on each of the points seen on the map, a smaller map of the specific area requested appears, with more than one choices, that the user can further on click on, to get the image from the specific camera. (as below).

selection from screenshot from the same website.

Further on, after clicking for example on "Near Woodlands Checkpoint", the following image appears (see below), showing the traffic on the specific segment in real-time:

screenshot of search on the EMAS website for traffic on one of the areas (Woodlands Checkpoint)

This can be useful for someone wanting to check out the traffic in a specific road before setting off. It is also helpful to the authorities, if there is congestion or if a road is totally blocked, so that they can monitor all the roads and take action.

The site provides more useful information about the country's policies on traffic.
As seen below, the same site provides features such as "Travel Time Calculator". The user can click on two points and the system should calculate how much time it would take to travel from one to the other on that specific moment. However, when attempted (18/12/2010) this feature didn't work ("error on page"message). Other systems that can be seen and are worth mentioning include the "Parking Parking Guidance System" that offers information about the available parking spaces, something of great importance for a big city, as parking is a great problem.
All the available options that someone can read about on this site can be seen on the screenshot below:

screenshot of sub-menu of the same site, with information about other systems in use in Singapore that facilitate traffic management and the life of road users.

5. Prague

In Prague, the capital city of the Czech Republic, traffic has grown by 36% between 2000 and 2010 and there is nowadays 1 car per every 1.8 citizen, which is a number among the highest in Europe (Tichý & Krajčir, 2010).

Prague has a central system that controls traffic lights, called "SITRAFFIC SYSTEM". "SITRAFFIC" is a solution provided by SIEMENS AG, a private company that offeres traffic solutions to cities worldwide with many possible mixes of attributes[1]. For a city or country that doesn't possess the "know-how" itself to develop its own system, solutions like this are an option. SITRAFFIC is a distributed system between traffic control units and a central controlling system. Its structure is such that it can work even if there are communication problems between its components. The system includes the following functions: visualisation, processing of measured values, archiving and report. Another tool used is the "SITRAFFIC SCALA", which works with a GIS application on which traffic management can be done. The figure below shows an example of a GIS application from Prague.

A GIS application from the SITRAFFIC SCALA system
Source: Tichý & Krajčir, 2010.

SITRAFFIC SCALA enables intervention to control traffic in the area of Prague. It also has an open interface for cooperation with new models of control and other systems (e.g. VMS, cameras, etc.).

According to Tichý & Krajčir (2010), a long term objective for Prague is to replace technologically old and defective equipment in order to reduce the intervention necessary and to increase the system's reliability. This translates to new control units and LED technology signal device installation, new detectors, cables and poles. The failure that is reported most frequently is broken lightbulbs, which are gradually replaced by LED technology.

Tichy & Krajcir suggest the adoption of MOTION, TASS and STRAMO systems (all of them products provided by SIEMENS), for better control. They point out that MOTION and TASS can "apply higher control algorithms for network automatic traffic control by using the traffic lights in intersection points" (ibid, p.415). They note that STRAMO integrates heterogeneous data from detectors and other sources of telematics systems. Further on, they explain that STRAMO is a strategy module that uses logic conditions and ensures strategic control at the city level and that it supports and extends the two previously mentioned systems rather than being a substitute for them. Last, they stress the need for a global traffic control system in Prague, which could connect the telematics system to the traffic centre.

[1] For more information: http://www.siemens.com/traffic

6. Poland

The trend in polish cities is towards more private ublic transport, a fact that is expected to burden the country's network even more in the future. In Poland, coordinated adaptive road traffic control systems have been deployed since the 1990s and most of them are based on SCATS (Sydney Coordinated Adaptive Traffic System[2]) (Żochowska et.al., 2010). SCATS is one of the two most popular systems and is mostly used in Asia and Oceania. It controls and coordinates traffic signals. The other system, SCOOT, is used in large scale in the UK and the cities of Beijing and Bangkok. The two systems employ different methods in the control algorithms they use, however, they only differ by 11% when it comes to the basic traffic characteristics they form (Żochowska et.al., 2010). By 2010 SCATS systems operated on about 33200 intersections in 144 cities in 24 countries all over the world, according to the SCATS website. In Poland SCATS systems were first used in Crakow, Poznan, Rzezow and Warsaw, i.e. the biggest cities.

The coordinated adaptive road traffic control system in Poland has been applied to:

City	Number of intersections
Wrocław	180
Warsaw	160
Poznań	112
Cracow	80
Lódź	61
Olsztyn	33
Gdynia	33
Rzeszów	5

Source: (Żochowska et.al., 2010, p.365)

The road networks within the urban areas of Poland are managed by local authorities. Traffic surveys are run independently by each local authority and are often out of date (authorities cannot afford such surveys) or inaccurate, thus the information they provide cannot be of much use. Another problem is that the percentage of intersections without traffic lights in the urban road network in Poland is high. These intersections, however, should also be taken into account when deploying a traffic control system.

According to Żochowska et.al. (2010), when a city is selecting which system to implement, one should also carefully select the additional technical solutions that each of them offers (e.g. Scheduling & Dispatch which is a vehicle positioning system for public transport, GIS, VMS, AVL (automatic vehicle location), Electronic Fare Collection, etc.). This choice should be determined according to the needs of the area.

In Warsaw the traffic control centre only monitors 37 out of 660 electrically signalled intersections (World Bank, Project Information Document, 2009). According to the "on-line Warsaw Voice" (20/05/2009), no city in Poland has a proper traffic management system. The road safatey in Poland appears to be pretty bad, as made explicit by the following statement from the "Economist": "In Poland the roads are

2 http://www.scats.com.au

many times more deadly than Islamist terrorism and mysterious Russian plane crashes put together."[3]

3 http://www.economist.com/blogs/easternapproaches/2010/10/polands_dangerous_roads (12-10-2010)

China - Location of Vehicle Licence Plates

High-definition industrial CCD cameras are popular in China, according to Sheng et.al. (2009), because they provide higher image quality, greater resolution and clearer information, and because they have a wider observation range and include more legible image details than ordinary cameras. They note, however, that most existing approaches to licence plate location are insufficient for real-time detection in high definition images. Another difficutly they highlight is that higher resolution also increases the computational load of graphical analysis and background interference.

Real-time location of VLP over HD video.
Source: Sheng et.al., 2009

Vehicle detection and locating
Source: Sheng et.al., 20

<u>Second Part: 1.Concept of "One Window" Data Exchange System Fulfilling the Recommendation for e-Navigation System</u>

"E-navigation is the harmonised creation, collection, integration, exchange and presentation of maritime information onboard and ashore by electronic means to enhance berth to berth navigation and related services, for safety and security at sea and pro-

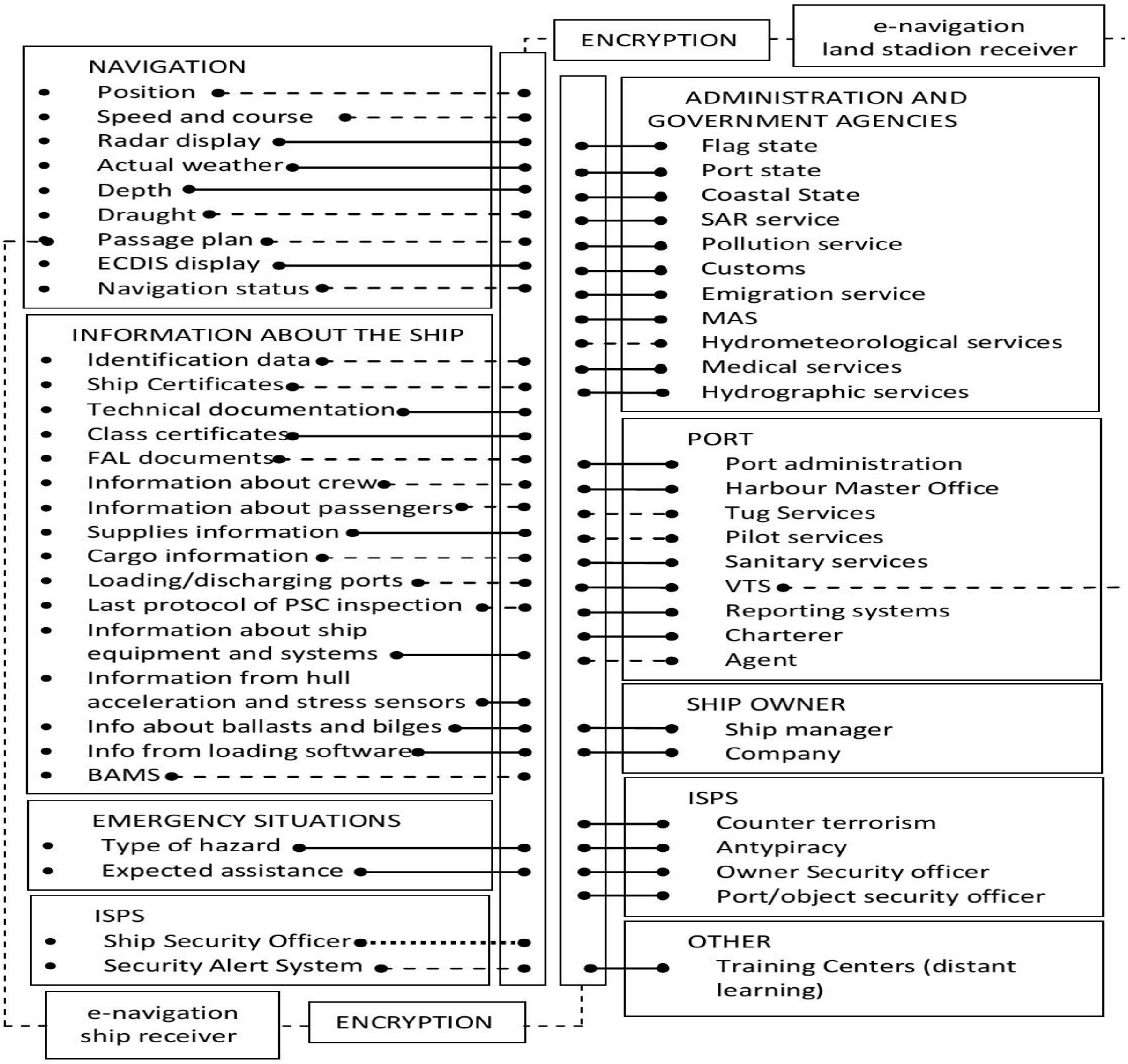


Fig.1 presents data flow between ship and vessel terminal station, source: fig.2 in J. Mikulski (Ed.): TST 2010, CCIS 104, page 88

tection of the marine environment."There are 2 types of architectures:1) e-navigation between ships and 2) e-navigation between ship and meteorological station or other building.

Project one window was developed by the laboratory of Gdynia maritime studies of Poland, in order to fulfill the commitment for better marine and maritime services and therefore for further development of e-navigation. Some basic standards that the projects has to assure are:

Increasing the safety and security of the ship, Streamlining and automation of ship-to-ship, ship-shore and shore-ship data exchange, More effective vessel traffic observation (Committee on Safety of Navigation, 2007).
(Weintrit, A., Wawruch, R., Specht, C., Gucma, L., Pietrzykowski, Z, 2007)
A radio communication subsystem has to fullfill some basic radio needs and provide access to the following services: (Czajkowski, J., 2002), (Korcz, 2007) Transmission of electronic mail (e-mail), Automatic updating of the navigational charts and publications in electronic form, Receiving of weather information,
Access to web pages and intranet (e.g. master using company extranet), Secured communication,
Transfer of large files over the Internet (e.g. pictures, video files etc.), Routine communications on the Internet and telephone, Transmission of SMS in relation ship to ship and ship to shore to ship (SMSs
sent from mobile phones to vessel radio station).
For the development of the project windows enviroment was choosed(as the easiest to work in) and Delphi programming language was used
There is a main menu within the window and 5 tabs. User has access access to five tabs, each representing a different range of data presented to the user,and all together form an integrated whole:
HOME tab - presents data that the user of an integrated navigation bridge can get and is presented on the main panel of IBS, **RADAR DISPLAY tab** - simulates the radar equipment installed on board
together with the information it gives, **ECDIS tab** - presents data available for the user through the electronic chart navigation system IENC, **INFORMATION tab** - allows to present implementation of so called "One window concept" for exchange of data between ship and port and coastal
state authorities and requires designation of one contact point on shore for
these purposes; and **COMMUNICATION tab** – allows the user to simulate the process of
establishing and proceeding radio-communication.

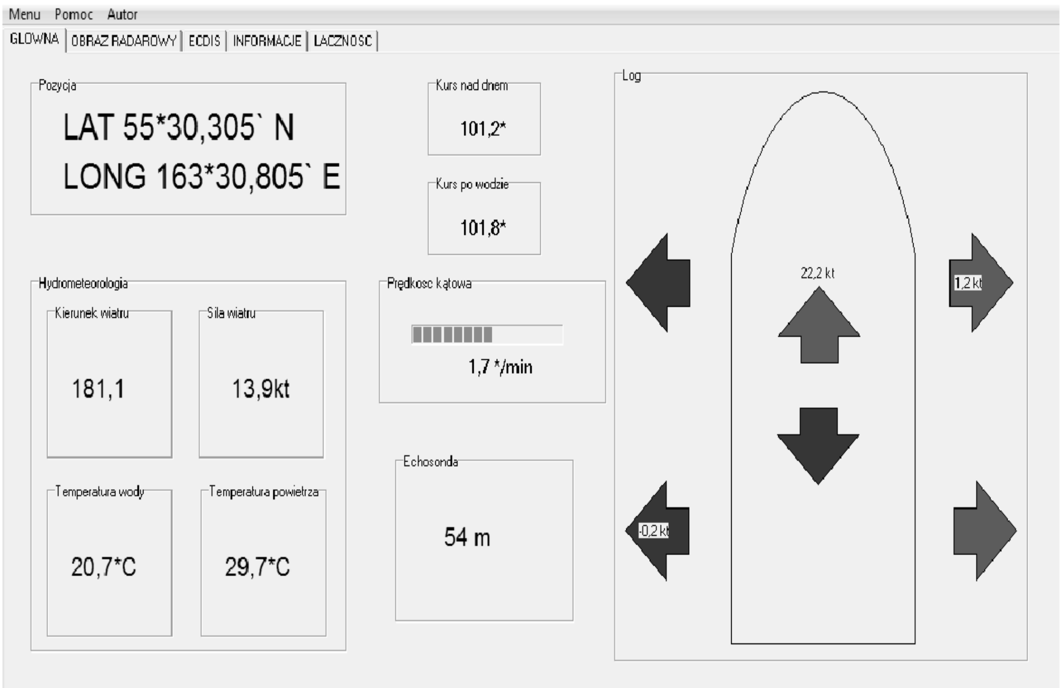


Fig.2 illustrates the one window delphi program, source: fig.5 in J. Mikulski (Ed.): TST 2010, CCIS 104, page 94

2.Standardization and Interoperability Problems of European Electronic Tolling Service (EETS)

The electronic Toll charging system in E.U wasn't interoperable due to differences in the pricing policy, legislation and technology. The European Commission decided to make some bold steps to address this issue. First one was with the 2004/52/EC directive, 2^{nd} one was with the 6^{th} October Decision and the definition of the European Electronic Toll Service and its technical elements. There are 2 types of EETS: 1)The DSRC (Dedicated Short Range Connectivity) and 2) the GPS/GSM based

Characterization	Austria [4]	Czech [1]	Germany[1]
Introduction date	01.01.2004	01.01.2007	01.01.2005
Admissible weight (2010)	> 3,5 ton	> 3,5 ton	> 12 ton
System cost (Government contracts)	750 M€[2]	780 M€[3]	1240 M€[4]
Technology	DSRC	DSRC	GPS/GSM
Average charge	0,26 €	0,15 €	0,17 €
Budget revenues (2008)	1,026 B€	236 M€	3,5 B€
Operational and control costs	12 %	10 %	11,2 %

Fig.1 depicts a comparative analysis in various E.U member states, source: table1 in J. Mikulski (Ed.): TST 2010, CCIS 104, page127.
The costs are almost equal for both roads from 0- 1000 kilometers but for longer distances the GPS module based model is more efficient. **The EETS** was originaly based on the RCI project architecture.
(Schwarz-Herda, F., 2006), (Springer, J.2008)

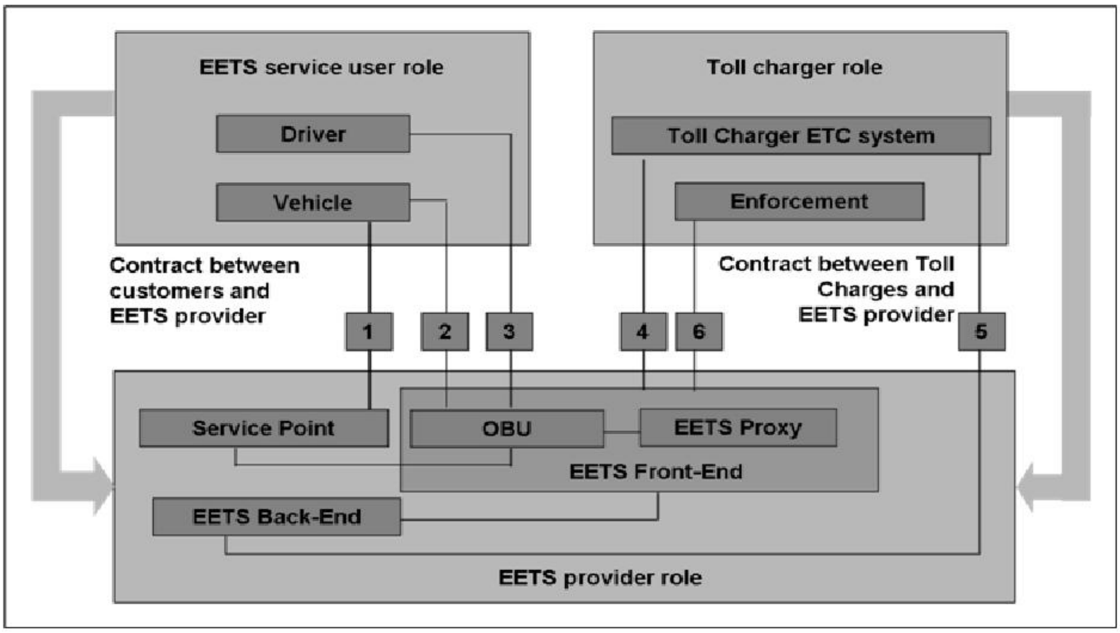


fig.2 EETS architecture, source: fig.1 in J. Mikulski (Ed.): TST 2010, CCIS 104, page 128

EETS Provider means a legal entity fulfilling the requirements and registered in a Member State where it is established, which grants access to EETS to an EETS User. **Toll Charger** means a public or private organization which levies tolls for the circulation of vehicles in an **EETS domain**. **EETS User** means a (natural or legal) person who subscribes a contract with an EETS Provider in order to have access to EETS. **On-board equipment** means the complete set of hardware and software components required for providing EETS which is installed on board a vehicle in order to collect, store, process and remotely receive/transmit data. **Interoperability constituents** means any elementary component, group of components, subassembly or complete assembly of equipment incorporated or intended to be incorporated into EETS upon which the interoperability of the service depends directly or indirectly, including both tangible objects and intangible objects, such as software. As a minimum, the following standardized back office interfaces must be implemented by all EETS Providers. Toll Chargers must implement each interface, but can choose only to support either the GNSS or DSRC charging process. Also EETS providers must agree in data exchange, Exchange of EETS blacklists and trust objects, Sending of Toll Context Data(= the information defined by the responsible Toll Charger necessary to establish the toll due for circulating a vehicle on a particular toll domain and conclude the toll transaction) from Toll Chargers to EETS Providers.

The National Automatic Toll Collect System Pilot Project of Poland was an implementation of the Motor Transport Institute:

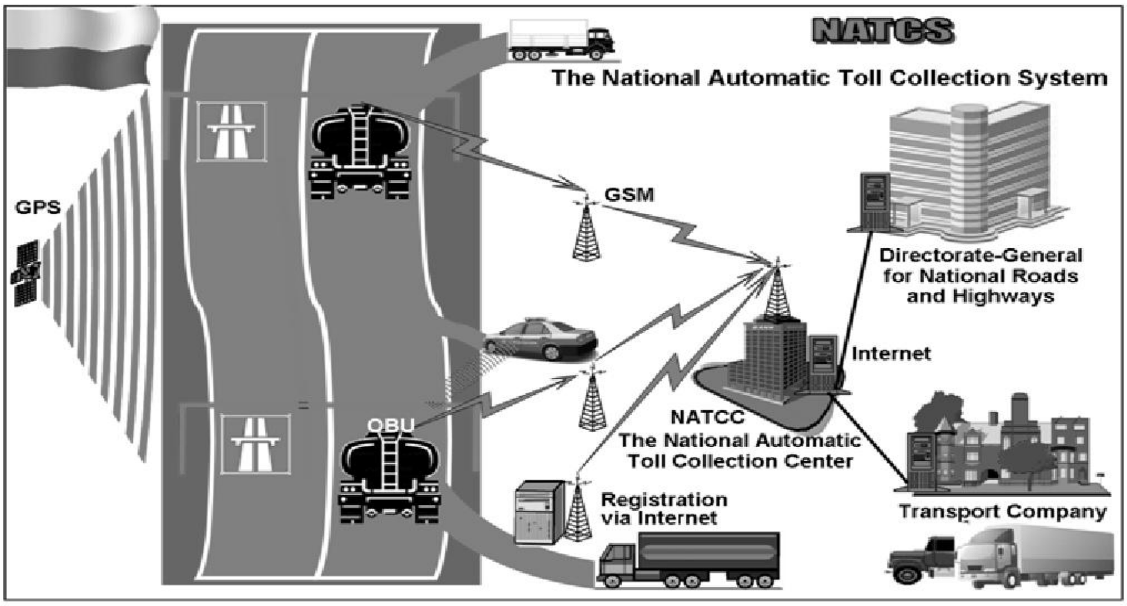


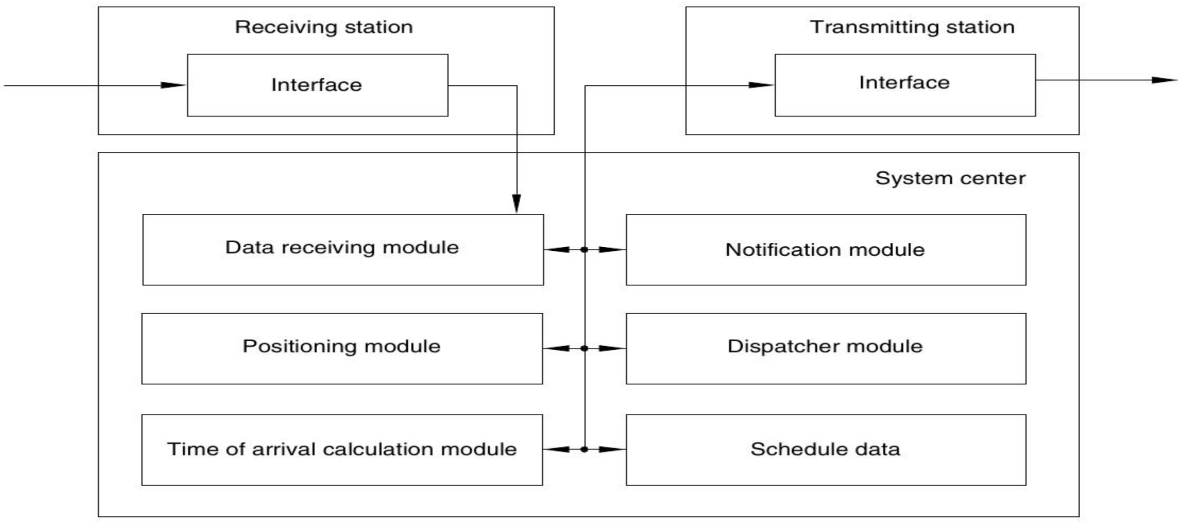
fig.3 shows the NATCS data flow and architecture, source fig.2 in J. Mikulski (Ed.): TST 2010, CCIS 104, page 130

Consists of: ***a)the NATCC*** (telematics system center) which has the following elements:Redundancy servers, Applications and system software, Databases, Interfaces: (between NATCC and OBU, between NATCC and control gates, between NATCC and external systems), User interface – www Internet service, Call Center, SMS gate, automatic telephone service,Data transmission nets (WAN, LAN) ***b) the OBU*** (a GNSS/GPS HYBRID MODULE) which with the aid of GPS satellite signals and other positioning sensors, automatically determines how many kilometers have already been driven on the toll route, calculates the toll based on the vehicle and toll rate information that has been entered, and transmits this information to the NATCS computer centre for further processing. Software will be supported with electronic road maps and data of users registered as well as data charges of highways and expressways. Charge counting will start after highway entrance gate and finished after highway exit gate. Data on vehicle position will be additionally approved by GPS system and delivered to NATCC by GSM net. The toll amount is based on the truck's emission category and number of axles, as well as on the length of the toll route and finally **c)the control system which** consists of permanently installed enforcement control gates and mobile/patrol teams that are used to ensure toll requirements are met without interrupting traffic flow.

3.Public Transport Information System for Visually Impaired and Blind People

This type of system should meet some requirements like: provide on time precise information about arriving vehicles, give access to the timetable and current delays, give access to the online route planner, inform the driver about a disabled person waiting, use standard devices which are in mass production, namely mobile phones as communication devices for the blind people and PDAs as the terminals for the bus drivers. Opposite to the existing solutions, the proposed system uses a central server to mediate between the public transport vehicles and the users and does

not rely on the proximity detection. This is because the team responsible for the project has used the most common communication devices in the world – mobile phones – which are typically not equipped with proximity sensors that could be useful for this purpose. Therefore, the user has to provide the information about his location. Stop codes are short (four digits) and unique, so it is easy to remember the codes of a few most visited stops (near home and office, for example).
Vehicle equipment, which allows the driver to receive notifications of awaiting disabled passengers, is a terminal with built-in GPS receiver and the module which provides wireless communication with the central server. The terminal is continuously sending the information about vehicle's position on the route to the central server. After the reception of the information, that the distance to the next stop on route is less than the predefined threshold, the information about arriving vehicle is relayed to all passengers waiting on the stop (and who gave this information to the system by typing stop code or by allowing the built-in GPS to send coordinates of their position). As a result passenger's mobile phone vibrates, and emits an appropriate communication messages (which can be different according to the personalized setting such as



preferred language).

Fig.1 The systems architecture, source: fig.1 in J. Mikulski (Ed.): TST 2010, CCIS 104, page 274

The software part can be divided into three applications, which are running on mobile phones, PDAs and on the central server:
The application for mobile phones, which has a form of MIDlet that after start up connects to the central server, and then plays sequences of messages notifying of events, for example "The bus number 139 is arriving.". **The application for drivers**, which continuously sends the geographical coordinates of the vehicle to the central server and displays notifications to the driver. **The central application** responsible for routing messages coming from devices installed in the vehicles to the mobile devices owned by passengers.(Michał Markiewicz and Marek Skomorowski, 2010)

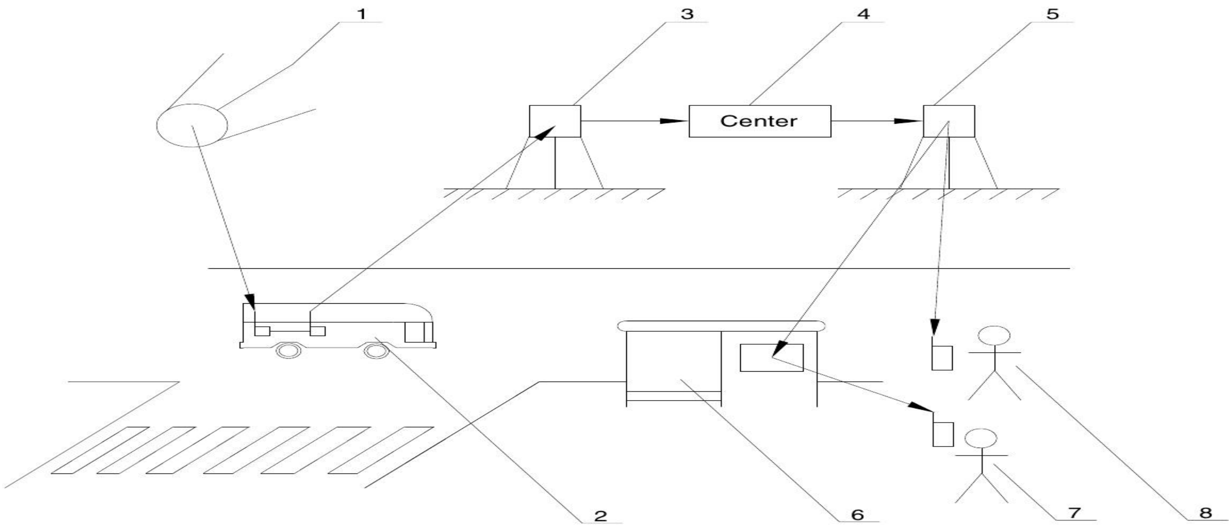


Fig.2 illustrates the data flow between satellite-bus-intermediate station- main central server- bluetooth bus stop device-end-users device, source: fig.2 in J. Mikulski (Ed.): TST 2010, CCIS 104, page 275

The project was deployed in the underground station of trains of Warsaw and in the public transport of Noby Saz in Poland. Certain disadvantages that emerged were the cost of transmission of data in the end users even if some GSM providers decreased their dues for these particular individuals, the need for connection on the internet for the mobile users in order to receive the latest information on the arrivals and difficulties in discovering the bus and train stops from the individuals with infirmities. For this reason there were bluetooth devices installed as intermediary between the central transporter and mobile (with bluetooth activated).

4.Automatic Traffic Monitoring from Satellite Images Using Artificial Immune System

A new method of recognition of streets and vehicles is presented here for non- urban regions via analysis of high resolution satellite photographs. The techniques that are used are: hough transform and thresholding operation, morphology transform. The photos were taken by xerographic satellites of IKONOS and NAVTEQ type with precision of analysis from 0.6 to 1 metres and specialized aircrafts. The data of the project were retrieved from the webpage space imaging inc and include different pictures of cities, 6 different streets and were concretely exported with the particular method above 200 vehicles. Most vehicles were roughly from 3 until 5 pixel in width and from 8-10 in length. The export results had a 94% rate of success.

Fig.1 below shows the projects results, source:table in E.R. Hancock et al. (Eds.): SSPR & SPR 2010, LNCS 6218, page 177

	No. of vehicles	No. of detected vehicles	No. of missing vehicles	No. of false alarm	Missing detection rate %	False detection rate %
Road1	5	5	0	0	0	0
Road2	8	8	0	0	0	0
Road3	10	10	0	1	0	10
Road4	15	15	0	1	0	6
Road5	19	17	1	1	5.3	5.2
Road6	16	15	1	0	6.2	0
Road7	23	23	2	2	8	8
Road8	60	56	6	5	10	8.3
Road9	52	47	5	4	11.5	7.6

The system is divided in 2 phases: Road recognition and vehicle recognition. In the first phase the road is being recognized by applying some special processing filters in order to sharpen the photograph and make it more clear and vivid. Then the road is being isolated from the rest of the image among with its edges and is defined as a separate line with a different color. In the processed results the road lanes are also presented.

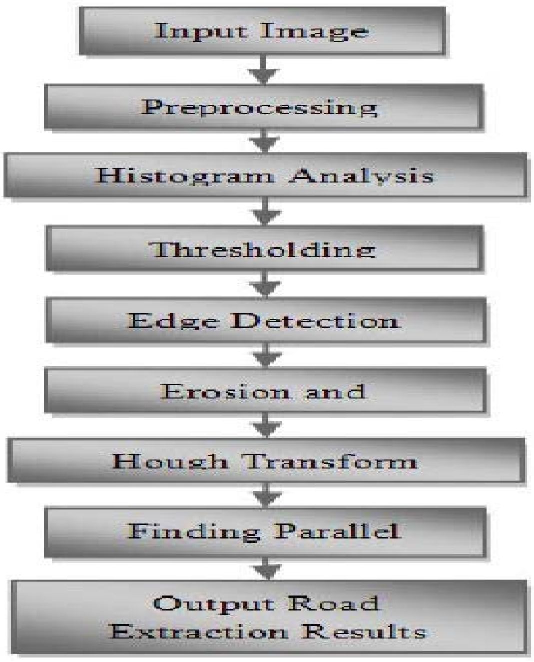


fig.2 The road recognition procedure presented as a logical diagram ,source: fig.1 in E.R. Hancock et al. (Eds.): SSPR & SPR 2010, LNCS 6218, page 172

fig.3 A Satellite image before processing source: fig.2 in E.R. Hancock et al. (Eds.): SSPR & SPR 2010, LNCS 6218, page 172

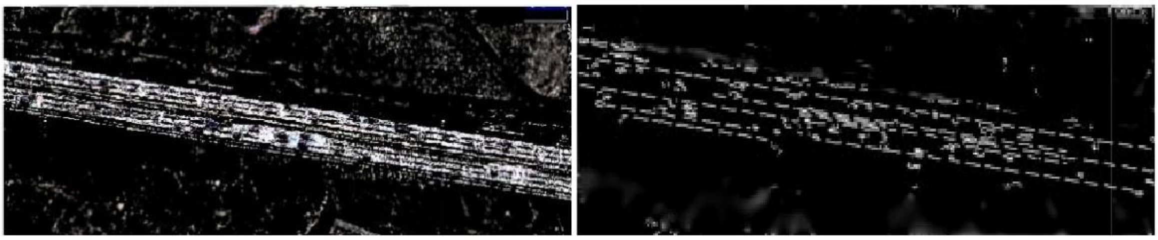


fig.4 The same image after 2 processing stages, source fig.3 in E.R. Hancock et al. (Eds.): SSPR & SPR 2010, LNCS 6218, page 173

After the completion of the road recognition phase, the vehicle recognition procedure is being initialized. This stage is separated in 2 phases. The learning and discovery of antibodies and the strategy of detection. Vehicle recognition phase constitutes of algorithms that integrate morphology operations in the analysis and the processing method that aim at the final extraction of the detected vehicles.

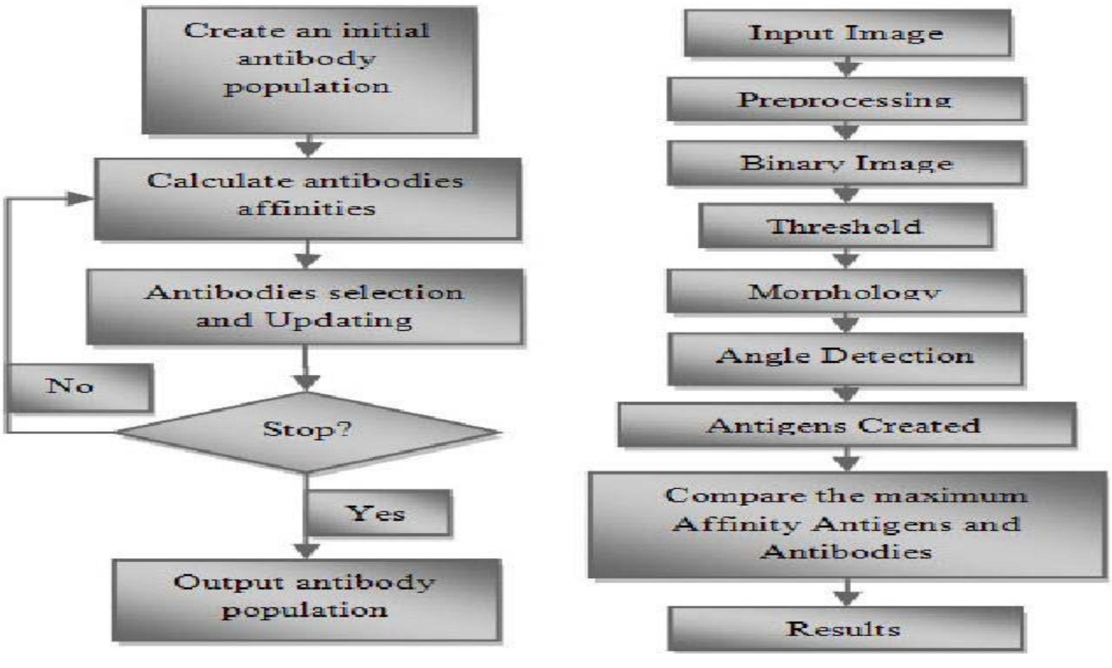


Fig.5 illustrates the flow chart for the antibody learning technique(on the left side) and the detection technique on the right side, source:fig 1 in E.R. Hancock et al. (Eds.): SSPR & SPR 2010, LNCS 6218, page 172

The immunological terms are defined in the following manner: **Antigen**: Vehicle targets, **Antibody**: Vehicle template images extracted from processed images by the morphology transform and are already stored in the database. **Affinity**: Matching index. It is inspired from image correlation concept. In order to store a sample into the database there has to be a matching affinity below 0.6 points.

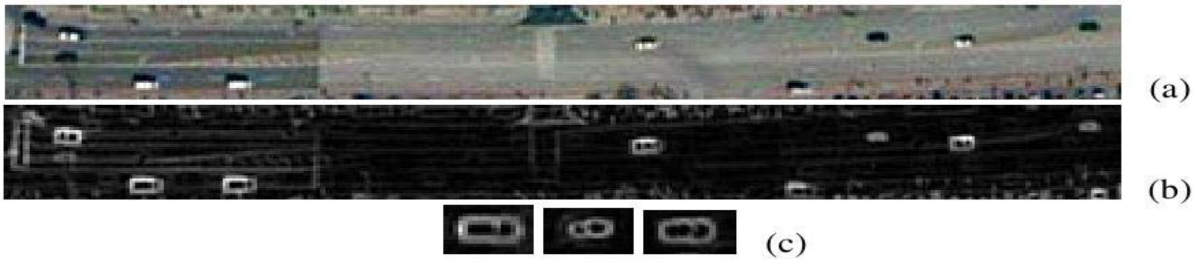


Fig 6. An example of antibodies detection and extraction, source: fig 6 in E.R. Hancock et al. (Eds.): SSPR & SPR 2010, LNCS 6218, page 174

Finally, after the antibodies learning operation, the vehicle extraction procedure is being processed.

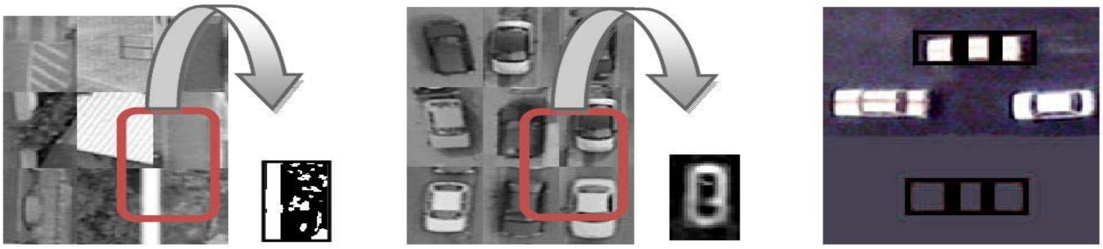


Fig 7 .An example of vehicles extraction, source: fig.7 in E.R. Hancock et al. (Eds.): SSPR & SPR 2010, LNCS 6218, page 176

The resulting image after the morphology transform analysis is being presented in the following picture. We can clearly focus on the immunated antibodies(second picture)

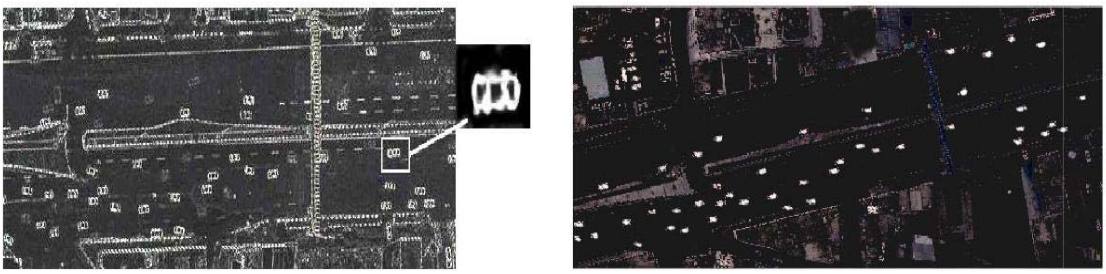


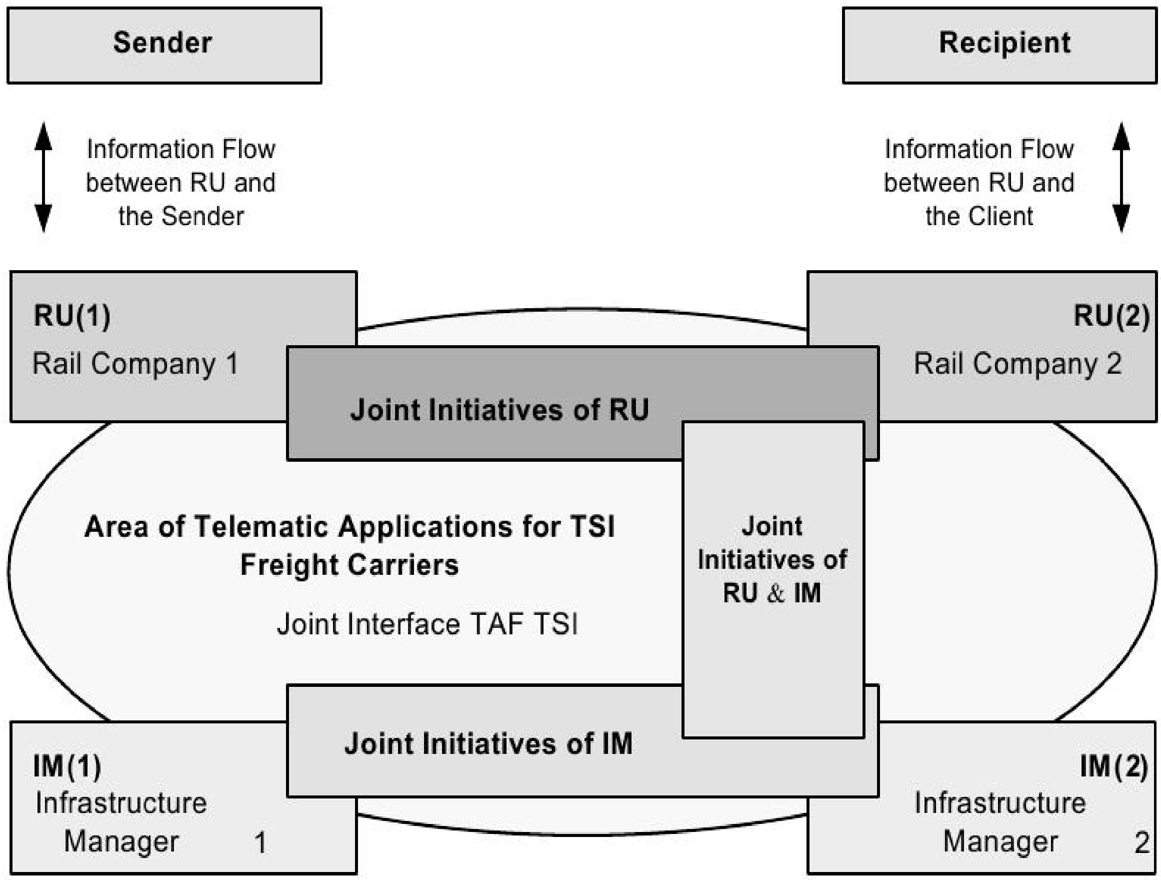
Fig 8. The final image, source: fig.8 in E.R. Hancock et al. (Eds.): SSPR & SPR 2010, LNCS 6218, page 176

5.Concept of Integrated Information Systems of Rail Transport

The SEDP defines the target system, which is to be achieved through the implementation of the TSI. The SEDP sets out the way of TAF TSI implementation (The TAF TSI is focused on providing IT support for business processes in rail freight transport, which may lead to a substantial increase in the quality of transport services. Because of its nature, the TSI shall materially affect the business and operational processes throughout the European rail industry. In addition, a continuous growth in international freight traffic requires a European perspective of information management. Those facts together require defining a coherent trans-European implementation plan for the TSI.). It creates a possibility to control the project implementation at the European level. The Strategic European Deployment Plan (SEDP) supports:

− coordination, synchronisation, and prioritisation in the European rail transport,
− allocation of limited resources and budgets to meet business requirements,
− optimisation of the overall costs/benefits,
− protection for shareholders' investments during the implementation phase,
− monitoring the work progress at a company level and at the European one.(Mirosław Siergiejczyk and Stanisław Gago, 2010)

Fig.1 below represents the transport process in taf tsi approach, source: fig.2 in J. Mikulski (Ed.): TST 2010, CCIS 104, page 303



Rail Transport Service Information System

The European Commission had decided to grant the EU financial assistance to the Ministry of Transport (now Ministry of Infrastructure) of the Republic of Poland for the implementation of R&D project – "Feasibility Study for Railway Transport Service Information System – SITKol." The project consists of three substantive phases: Feasibility Study, Project Study, Pilot Implementation

The beneficiary (MT) has appointed the Railway Telecommunication „Telekomunikacja Kolejowa" company for the project implementation. According to the assumptions, the SITKol is to become a system to inform the public about rail transport services and that shall allow, inter alia, for obtaining current information about transportation capacities of rail operators, about decisions (licenses, certificates, etc.) issued, and that will be able to become a tool to monitor traffic. The system is to develop tools to provide equal access of the carriers to the railway transport market in Poland, and to facilitate alignment with the EU legislation for this market. The system should also ensure direct access to information from fixed and mobile terminals and allow for electronic information flow between railway companies, offices, and railway clients.

It is assumed that the exchange of data between participants in the SITKol system will be based on the network of the Railway Telecommunication frameworkcompany. The SITKol system is a multi-service platform and its users will be able to enjoy the exchange of data or information through the use of e-mail, websites, WAP, SMS, Contact Centre and telephony services. The data obtained will be made available to authorised users by using commonly applicable protocols such as GSM /GSM-R (SMS, WAP), GPRS, EDGE, UMTS, Wi-Fi and WAN, LAN, WLAN.

The main objectives behind the implementation of the SITKol System are to:gain knowledge about the existing information systems related to the SITKol system, review the SITKol system architecture,

verify the demand for information and its impact on the infrastructural costs of the system, verify the feasibility and costs of the SITKol project. This system, by direct access to fixed and mobile terminals, should allow for exchange of and sharing information between the Ministry of Infrastructure (MI), the Rail Transport Office (UTK), the rail transport participants, and the direct users of the rail transport.

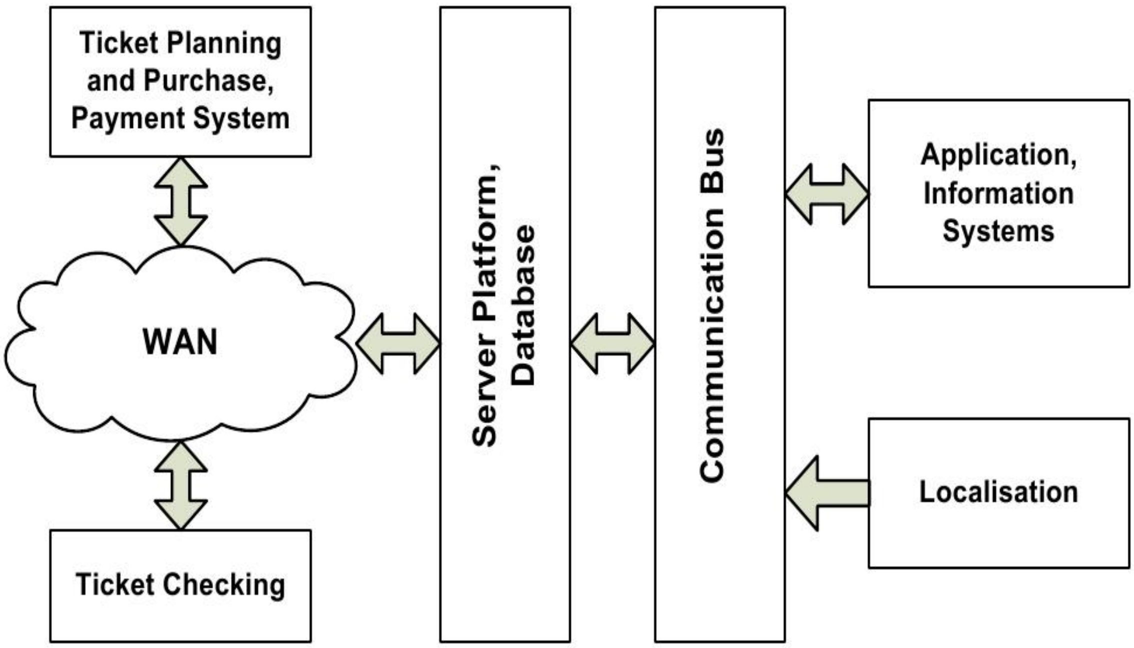


Fig.2 logical architecture of rail transport information system, source:fig.4 in J. Mikulski (Ed.): TST 2010, CCIS 104, page 306

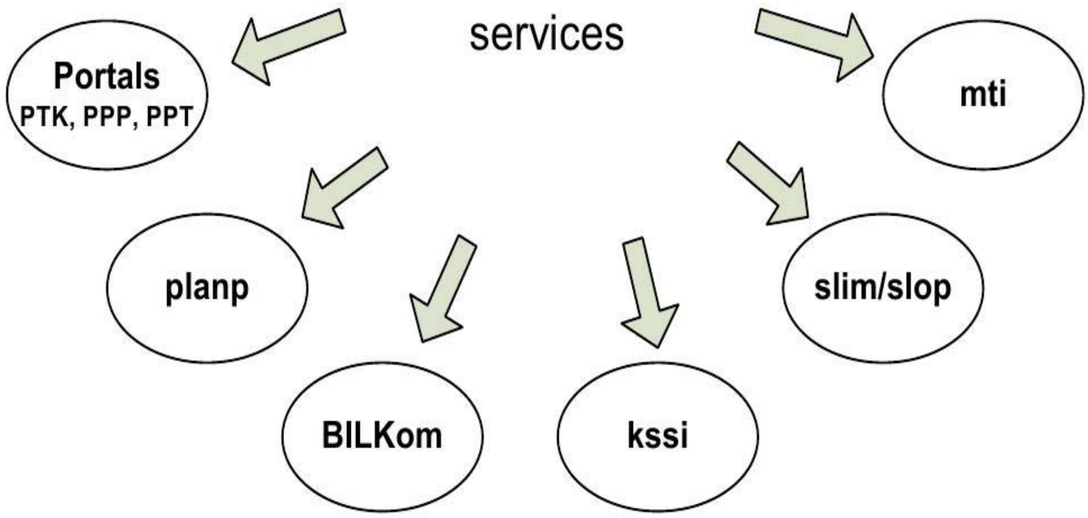


Fig.4 Diagram and services provided by the rail transport service information system, source:fig. 3 in J. Mikulski (Ed.): TST 2010, CCIS 104, ppage 305

6.PERSONALIZED TOURIST ROUTE GENERATION

In this project the team has presented an intelligent routing system able to generate and customize personalized tourist routes in real-time and taking into account public transportation. Although the whole process is divided in three steps, the team has

focused only on the last two: route generation and route customization. They have modeled the tourist planning problem, integrating public transportation, as the Time Dependent Team Orienteering Problem with Time Windows (TDTOPTW). The team has designed a heuristic able to solve it in real-time, precalculating the average travel times between each pair of POIs (Points Of Interest) in a preprocessing step. Moreover, the system includes the basic functionalities required to customize the generated route. They allow to move, add and remove visits in a route.
Personalized Tourist Route Guide :
– Recommendation. Combining the tourist information of the destination with the tourist profile, the system has to create a list of recommended POIs. As a result, POIs will have a di□erent score and visit duration for di□erent tourists.A deep review on tourist recommendation systems lies on the recent paper from Kabassi (Kabassi, K., 2010).
– Route Generation. Once the system knows which are the most appealing POIs for the tourist, an intelligent routing engine can combine this information with tourist's restrictions (available time, number of days of the route, maximum budget, starting POI . . .), POI data (location, opening hours, ticket price . . .) and transportation data (traveling times, public transportation network data . . .) to generate personalized tourist routes. This intelligent routing engine has to apply advanced algorithms from the field of Operations Research (OR) in order to generate routes in real-time.
– Customization. Finally, tourists appreciate to have the opportunity to customize the proposed personalized route to better fit their needs. Inserting new visits to the route, removing visits or reordering them are the basic functionalities of a customization engine.

Route Generation:

The team has modeled the problem of generating personalized tourist routes with public transportation as a TDTOPTW (Time Dependent Team Orientereeing Problem with Time Windows). After analyzing di□erent approaches, the team finally designed a heuristic able to solve it in real-time (Garcia, A., Arbelaitz, O., Vansteenwegen, P., Sou□riau, W., Linaza, M.2010), based on a fast heuristic for the TOPTW, (Garcia, A., Vansteenwegen, P., Arbelaitz, O., Sou□riau, W., Linaza, M.,2010). The inclusion of public transportation makes the process of building a solution much more complex: each distance calculation between two POIs becomes a Time Dependent Shortest Path problem (TDSP). Thus, in order to handle the di□culty of the TDTOPTW, the team applies a hybrid approach combining two di□erent heuristics. Each of them focuses on a di□erent aspect of the problem.

Route Customization:

The customization is based on six basic operations a PET should provide plus 2 alerts.
1) Add a visit 2)Remove a visit 3) Move a visit towards the beginning of the route 4) Move a visit towards the end of the route 5) Move a visit to the previous/next day 6) Customization exception.
• Maximum travel time/ budget exceed alert. This alert notifies that the maximum values introduces as restrictions have been exceeded.
• High wait/travel alert. This alert is launched if the proportion between visiting time and wait/travel time is high (higher than 40%).

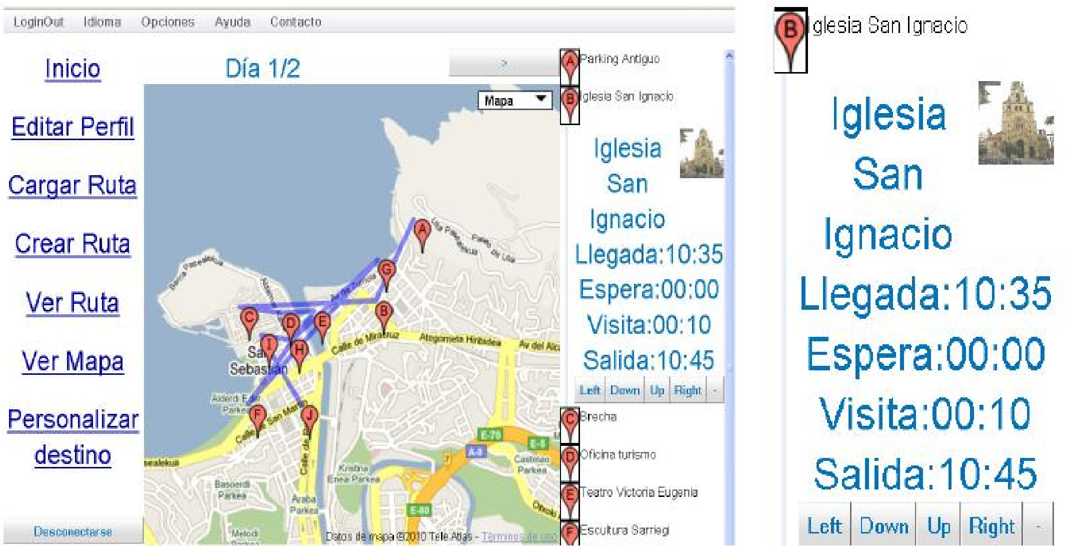
Architecture:

The team has designed and implemented a client server architecture. The client consists on a thick client executed on a Web browser. The server is constituted by a database (MySql), and an application Server (Apache Tomcat). The client is a Web client based on Google Web Toolkit (GWT). GWT is a framework from Google allowing to develop a Web application on Java. GWT's compiler transforms the Java code on the corresponding HTML and JavaScript code compatible with main browsers (including iPhone's and Android's browsers).

Evaluation:

The team has evaluated the performance of their approach against test instances for the city of San Sebastian. Results are able to obtain routes in real time (worst case of 0.2 seconds for a 2 day 8 hour per day route) in a scenario with 50 POIs, 26 public transportation lines and 467 stops, and are comparable to the best results available on the literature.

Fig.1 below depicts details of the desktop prototype, source: fig .2 in F. Daniel and F.M. Facca (Eds.): ICWE 2010 Workshops, LNCS 6385, page 494



(a) A route

(b) Details of a visit

Fig .2 above shows the gui of the mobile client, source: fig.3 in F. Daniel and F.M. Facca (Eds.): ICWE 2010 Workshops, LNCS 6385, page 494

Conclusions

As we have seen in the preceding case studies about traffic management networks, some areas have more advanced systems to monitor and manage traffic than others, who are taking the first steps in the field. Intelligent Transport Systems (ITS) will be used more and more in the future, as they offer a solution to a big problem: Since, in most parts of the world, the existing road network cannot grow, due to lack of space, the same one will have to be used more efficiently, more “intelligently”. Some cities/countries are using tailor-made systems, developed for themselves (e.g. California), yet everyone uses some common technology (loops, cameras). It is how the collected information is used afterwards that can make the difference. There are also some off-the-shelf solutions, such as traffic lights control systems, which are provided by commercial companies. In this case, the area’s specific needs must be satisfied by the specific characteristics of the “product mix” they choose. For the time being not all parts of the world have the means (know-how and financial) to employ sophisticated technology, that would yield the best results. There is certainly room for development in the field of ITS. As technology advances, new possibiliteis are expected to make traffic management much easier and the exchange of information a lot faster, and therefore more effective.

In the 2nd part of the paper, we have presented case studies and already built software projects that signal a new era for the transportation sector. Information systems are being applied in order to help the correspondent clerks, the drivers, the passengers and all the participants in transportation transactions to have up to date information about all kinds of itineraries, delay timetables, ticket checkings, traffic monitoring and management, tourist routes, etc. Some projects rely on simple web based software and require commonly used devices such as mobile phones and pda's. Others only need a windows compatible computer, which means that the communication subsystem that is developed depends on a logical amount of money for the dedicated software. The philosophy of this paper was to present information systems for communicating in the transportation area that provide real time information about the events occurring and are of a low budget.

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