II INTERNATIONAL CONFERENCE
TRANSPORT SYSTEMS TELEMATICS TST`02

ZESZYTY NAUKOWE
POLITECHNIKI ŚLĄSKIEJ 2002
TRANSPORT z.45, nr kol. 1570

intelligent transport systems,
Galileo system,
positioning systems

Dušan KEVICKÝ[1]
Alica KALAŠOVÁ[2]
Ján DÚHA[3]

CONTRIBUTION OF A NEW EUROPEAN POSITIONING SYSTEM TO DEVELOPMENT OF TRANSPORT SAFETY

Modern technology of ITS is navigation and surveillance of vehicles. Information and surveillance of vehicles. Information about position is important for driver himself, who wants to know where he is and if he follows his particular route and if he follows his particular route and if he has right direction to the destination on the other hand the operator- controller can determine position of each vehicle and can optimize service of vehicle fleet. In the next part we describe used navigation systems and newly developed european system Galileo.

WKŁAD NOWEGO EUROPEJSKIEGO SYSTEMU POZYCJONOWANIA W ROZWÓJ BEZPIECZEŃSTWA TRANSPORTU

Nowoczesne technologie inteligentnych systemów transportowych (ITS) służą nawigacji i nadzorowi pojazdów. Informacja o miejscu jest ważna dla samego kierowcy, który chce wiedzieć gdzie jest i czy stosuje się do wyznaczonej wcześniej trasy oraz czy jedzie we właściwym kierunku, a z drugiej strony chodzi oto czy operator może określić miejsce, w którym znajduje się każdy pojazd i może zoptymalizować usługi serwisowe. W dalszej części opisano użycie systemów nawigacyjnych i nowo rozwinięty europejski system – Galileo.

One possibility of safety is to provide the participants in transport with information in advance. Conditions for steady and safe traffic are made this way. Intelligent transport systems - ITS are able to give us this possibility. Basic aim of ITS is to: [1]

- ✓ Increase safety of road transport
- ✓ Increase efficiency of transport represented by cut down transport time
- ✓ Increase quality of environment
- ✓ Improve commercial productivity of a company.

ITS are systems which help to make efficient use of road and urban communication network, using information, communication and directing technologies. They make basic

[1] Faculty of Operation and Economics of Transport and Communication, University of Žilina, Moyzesova 20, 010 26 Žilina, kevicky@fpedas.utc.sk
[2] Faculty of Operation and Economics of Transport and Communication, University of Žilina, Moyzesova 20, 010 26 Žilina, kalasova@fpedas.utc.sk
[3] Faculty of Electrical Engineering, University of Žilina, Moyzesova 20, 010 26 Žilina, duha@fel.utc.sk

conditions for high quality communication and information society that we are approaching also in our conditions.

ITS:

- ✓ Make possible efficient connection of source and destination,
- ✓ Provide with transport information,
- ✓ Integrate several types of transport into uniform system.

From the point of view of ITS applications, positioning systems are among leading systems and deserve close attention. Considerable time and financial cut down should be pointed out. In this connection we should emphasize the necessity of creating a uniform infrastructure of data gathering and distribution, creating a central system providing with current data from given length of communications. This should be remembered while implementing master systems. In the next part of our contribution we describe possibilities of satellite navigation in our conditions.

Global navigation satellite systems (GNSS) nowadays are something that is known not only in aviation but also affect many human activities.

After abolition of intentional accuracy decrease of GPS, real accuracy of the system is within 10-15m. GPS is not suitable for aviation for several reasons. Accuracy of global satellite systems can be increased by so called differential methods. Differential beacons whose accurate position is known, make possible the accuracy increase of the system, its integrity and availability. That is why in 1992 FAA (Federal Aviation Administration USA) presented wide area system WAAS (Wide Area Augmentation System) [2] based on differential GPS. In [3] horizontal and vertical accuracy of WAAS are stated 4m.

WAAS provides accuracy, availability and integrity of GPS system, including differential corrections. It consists of 25 ground referential beacons covering the whole territory of the USA. Each of these, with exactly fixed position, receives GPS signals and gives all variations and is a part of the network, sending data to master station (WMS – Wide Area Master Station), where information about corrections is processed. It is sent via geostationary satellite back to users who are within the reach of WAAS.

Development of global navigation satellite systems – GNSS is still in the phase of constructing. Europe joined GNSS constructing by project EGNOS (European Geostationary Navigation Overlay System) which is augmentation navigation system in Europe. This project started in 1996 by borrowing first two transmitters, placed in two satellites INMARSAT III (International Telecommunications Satellite Organization). They provide wide area differential services over all Europe, Africa, South America and greater part of Asia. [3,4].

Japan creates geostationary augmentation of covering with differential signal by system called MTSAT Satellite Based Augmentation System (MSAS). The first satellite MTSAT-1 was launched in 1999; in 2005, two satellites MTSAT-1 and MTSAT-2 are expected to operate. MSAS consists of two master beacons (Kobe and Ibaraki) and four ground monitoring beacons (Naha, Fukuoka, Tokyo and Sapporo). In the territory of Czech and Slovak Republics a pilot transmitting of differential data was carried out at ČVUT in Prague (Faculty of electrotechnics – Department of radioelectronics, lead by prof. Ing. František

Vejrážka, Csc). Transmitter in Poděbrady distributes the data. The whole territory of Czech Republic and Slovakia is covered and partly Poland, Germany and Austria (see picture 1).

Differential data provide 5m accuracy in position in the territory of Czech and Slovak Republics. While transmitting differential data on LW, it would not be necessary to use expensive radio modems for DGPS systems, which would lead to costs reduction of systems using DGPS. Correction data DGPS are transmitted in Slovakia by standard network of radio USW FM transmitters. Referential station is in Bratislava. [5].

DV signal covering of Central Europe territory.

Fig.1. Differential signal covering on LW

Further modernization GPS resides in a progressive completing of cosmic segment with latest generation satellites – Block II F. Financing (originally 17 mil USD) by ministries of transport and defense has been stopped.

Supporters of both GPS and Galileo systems try as much as possible to introduce their systems into work at the same time (that is to say while observing strict civil service requirements!). European Union will try to get system Galileo into operation before launching next generation GPS satellites (Block II F), because it is supposed that if system Galileo is not in operation by the time, there will be loss of competition advantages.

Ultimate decision that European GPS Galileo will be built up was made at summit of EU countries' prime ministers in Spain (Barcelona) 13th – 14th March 2002. Project Galileo originated from two parallel studies. One, financed by EU, involved all Galileo project including infrastructure and management. The other called GalileoSat financed by European space association ESA solved cosmic and master segment.

Cosmic segment of Galileo will consist of 27 satellites and 3 active reserve satellites, which will be placed on three orbits. Satellites will circle round the Earth on MEOs (Medium Earth Orbit) at the altitude of 23 000km. 30 ground beacons placed on the Earth surface will be needed to monitor the quality of the signals transmitted by the satellites.

In 1999 limited costs specification for Galileo was fixed for less than 3 billion EUR, which is comparable to construction of high speed 100km long railway line in open terrain.

Unlike NASA (National Aeronautics and Space Administration) in the USA, ESA contributes towards these programs in the form of dues of ESA members, who take part in the program financially in accordance with their interest and according to this, they expect contracts and job opportunities that will flow back to the participating countries in percent dependence on particular contribution. E.g. some European countries participated in program EGNOS, which is the first step towards the system Galileo, in percentage as follows in picture 2.

Others:

Austria1 %

The Netherlands1 %

Norway2 %

Portugal2 %

Sweden2 %

Undefined4 %

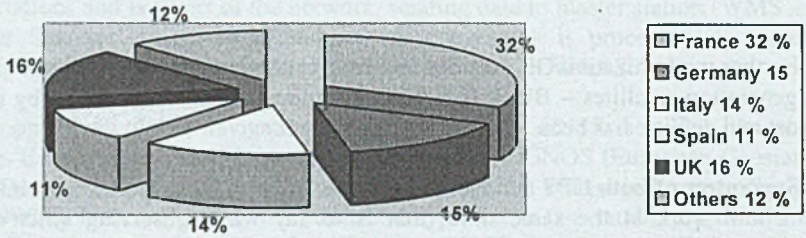

Fig.2. EGNOS project financing in percentage

Besides defining basic requirements for the system in EU study, and GalileoSat too, requirements for four broadcasting frequencies of the satellites appeared. Frequency proposition is shown in table 1. These frequencies were to be agreed at WRC (World Radio Conference) in Istanbul, Turkey, in May 2000.

Galileo users will be able to determine their position with radius under 10m in 95% time, every second. Time accuracy guarantee is 33 nanoseconds.

Table1

Four possible frequencies of system Galileo

Frequence	Alternative 1	Alternative 2
1	1 561,052 MHz (E2)	1 575,420 Mhz (L1)
2	1 202,025 MHz (E 5)	1 176,450 MHz (L5)
3	1 589,742 MHz (E 1)	1 595,880 MHz (G1)
4	1 278,750 MHz (E 6)	1 248,060 MHz (G2)

Worldwide availability of the system will be continuous in 99,7% of time. European Integrity Determination Service will develop broadcasting series and Almanac news via GalileoSat satellites. At this early stage, integrity service will cover only Europe. This service will possibly be widened and integrity signals will be distributed into other regions too. Galileo satellites are designed so that there is space for 50kg useful (paid) load, which can be used for various purposes, e.g. communication. Galileo will also be able to mediate (transmit) other data: bad weather warnings, traffic information, prevention of road accidents, etc.

Galileo project follows in detail three levels of services. Basic level is OAS (Open Access Services). CAS (Controlled Access Services) have two levels. While users can subscribe to the first CAS 1, the second level CAS 2 will serve exclusively to government purposes - police activities, etc.

OAS will not guarantee services and similarly it will not be responsible for quality. OAS will then be compatible with GPS of Block IIF for users with dual receivers.

It is supposed that in road transport, especially in automobile, millions of users will potentially demand Galileo. This market may make the level of OAS services competitive to GPS services. Higher level of autonomous navigation services, as emergency calls by pressing the button in the vehicle, or other elements connected with life security, can be beneficial for CAS with some responsibility for provided services.

GNSS technologies become integrated with other services, as e.g. communication, navigation information via satellite and equipment becomes more and more available for users. If particular vehicle equipment producers decide which receiver they will build in, future service Galileo will help to choose from the variety of offers. Crucial clue for the success of Galileo is to establish cooperation between vehicle and electronic companies.

As global satellite navigation system Galileo is designed to be compatible with present GPS and GLONASS, after having been completed, its availability, accuracy, integrity and

demanded navigation efficiency of GNSS will increase several times. For example, number of visible satellites will increase up to 15 in any location in the world (see picture 3), [7].

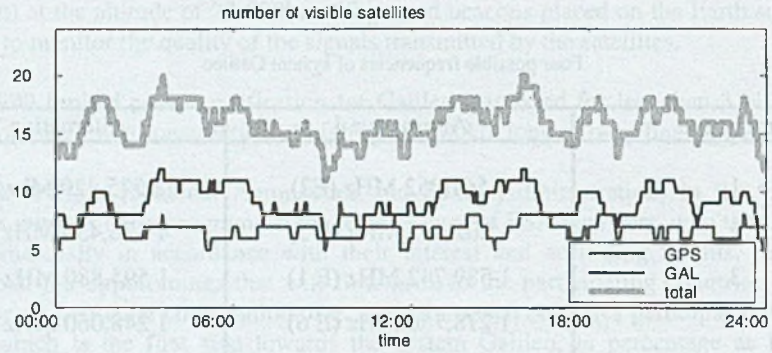

Fig.3. Number of visible satellites

The above accuracies were impossible a few years ago but in many cases they are not suitable for fixing exact position anyway (e.g. for automatic landing of planes and many other applications). That is why a new differential beacon network is being built which will make the differential signal more exact only in particular areas where high accuracy is demanded. This is called LAAS (Local Area Augmentation System) and it will provide with sub meter accuracies.

Galileo will not be exclusively new satellite navigation system. It also follows the intentions to increase advantages of synergy, based on interconnecting with existing navigation infrastructures, that is to say that there will be possibility of its implementing as master element into European radio navigation plan.

There will be two important steps in future to approach European part of GNSS:

- ✓ GNSS 1 it is WAAS, MSAS and EGNOS,
- ✓ GNSS 2 is GNSS 1 and GALILEO.

An important part of current European industry, which has high technological level and is in the beginning of exponential development, is employment raise. Application of satellite navigation structures brings about 20 000 job opportunities and service will create 2 000 permanent job opportunities with considerable increase of opportunities in many branches (hardware and services).

Regulatory issues

Increasingly, European regulatory requirements coul envisage the use of information systems – relying on positioning and/or timing signals. This could, for example, be the case in the future for electronic fee collection, in the environmental field or in agricultural or fisheries surveillance. A Galileo would allow for the necessary certification to take place (something which is not possible with current systems), thus ensuring regulators´and users´confidence in the adequacy of such systems. Regulatory action could thus underpin Community objectives.

BIBLIOGRAPHY

[1] SCHLOSSER T., Inteligentné dopravné systémy, Jaga group, Bratislava, 2001
[2] EUROCONTROL: Satellite Navigation Education and Awareness Training Package, Strasbourgh 1997
[3] www.esa.int./EGNOS/
[4] www. Esa.int./export/esa SA/navigation
[5] http://www. mobil.cz
[6] DEE ANN DIVIS: Galileo Enthusiasm and Honey Propel Europés GNSS, GPS World, XI, 1999
[7] http://www.galileo-pgm.org/
[8] TRESTOUR J., Úvodný referát " The EUROCONTROL GNSS seminar in Praque", 5.-6.10. 2000, Praha
[9] PŘIBYL P.,SVÍTEK M., Inteligentní dopravní systémy, Technická literatúra BEN, Praha 2001

Reviewer: Prof. Romuald Szopa