

EUPOS - a new European initiative of establishment of the multifunctional reference station system in Central and Eastern European countries.

EUPOS Steering Committee Members contributing to the Project:

**J. Balodis (Latvia), I. Fejes (Hungary), P. Hankemeier (Germany),
K. Leitmannova (Slovakia), G. Milev (Bulgaria), O. Odalovic (Serbia),
G. Rosenthal (Germany), P. Pihlak (Estonia), U. Samratov (Russia),
J. Sledzinski (Poland), D. Ghițău (Romania), G. Wübbena (Germany).**

Paper presented by

Janusz Sledzinski

Warsaw University of Technology

Institute of Geodesy and Geodetic Astronomy

00-661 Warsaw, Pl. Politechniki 1

E-mail: sledzinski@gik.pw.edu.pl

Abstract.

The Project EUPOS (European Position Determination System) was initiated by the Berlin Senate Department for Urban Development and European Academy of the Urban Development Berlin. The project consists in establishment of about 415 multifunctional satellite reference stations in Central and Eastern Europe. Fourteen countries intend to participate in the project. One common project standard set will be observed by all countries, however the project will include the existing or developed infrastructure in participating countries. The system will be compatible with the future European system Galileo. Experiences of establishing and operating satellite systems gained by other countries will also be used. The network of reference stations will provide signal for both positioning of the geodetic control points and for land, air and marine navigation. Several levels of positioning accuracy will be offered. The poster will reflect the newest version of the project including all recommendations resulting from the consultations with the representatives of European Commission.

1. Introduction

The GNSS systems of multifunctional reference stations are nowadays the background for both geodetic precise point positioning and for land, air and marine navigation of all movable objects. Some countries in Central and Eastern Europe endeavour to build their own systems, develop their own networks of permanent satellite stations and set up their own satellite infrastructure. There is no doubt that the most advanced and sophisticated system SAPOS (Satellite Positioning System) was built in Germany. Another completed system that more or less fulfils all geodetic requirements but because of low density of reference stations appears rather insufficient for navigation is the Swedish system SWEPOS (Swedish Positioning System). On the other hand the integration processes in Central Europe and the accession of ten new countries to European Union in the near future anticipate the necessity to consider common actions of European countries to build up a unified integrated GNSS

system covering the territory of the whole Europe. Such an action will simplify the control of the international road traffic, transport operation, emergency services (police, fire dept., medical operations) as well as urban transport services. The international integrated action is also worth supporting from economical reasons.

2. EUPOS Initiative

In this situation the European countries accepted with satisfaction the initiative of the Berlin Senate Department for Urban Development, supported by the European Academy of the Urban Environment (EA.UE), Berlin, Germany that suggested in March 2002 to organise in Berlin an international workshop/conference with the aim to discuss the possibilities and reality of establishment of the "multi-functional GNSS system of reference stations for Europe" that could be used for both geodetic point positioning and also for land, air and marine navigation. The conference was held in Berlin on 4-5 March 2002 and was attended by representatives of 16 European countries from Bulgaria, Croatia, Czech Republic, Estonia, Germany, Hungary, Latvia, Lithuania, Macedonia, Poland, Romania, Russia, Slovakia, Slovenia Switzerland and Yugoslavia.

The participants of the conference stated that the existing and already operating German positioning system SAPOS gained in the German regional surveying authorities and also in neighbouring countries extremely positive experience as far as its capacity, effective procedures as a multi-functional DGNSS reference station system and fundamental infrastructure components is concerned.

The participants of the Berlin workshop decided to form a founding committee comprising participants from the countries represented at the workshop, with the goal of drawing up in the near future the basic principles concerning setting up multi-functional DGNSS reference station system in countries expressing an interest. Existing infrastructures and activities of particular countries should be incorporated. They have also decided that these multi-functional DGNSS reference station systems be realised in a short time frame and that the workshop on multi-functional DGNSS reference station systems for Europe is to be held on an annual basis enabling the necessary exchange of experience and information.

Four working conferences of the Founding (Steering) Committee were held up to now. The first one in Warsaw, Poland on 2-3 July 2002 (organised by the Institute of Geodesy and Geodetic Astronomy of the Warsaw University), the second one in Sofia, Bulgaria on 6-7 November 2002 (organised by the Union of Surveyors and Land Managers in Bulgaria), third conference in Riga, Latvia on 10-11 June 2003 (organised by the State Land Service of Latvia) and the fourth conference was held in Berlin on 23 November 2003 (organised by the Berlin Senate Department for Urban Development and the European Academy of the Urban Environment (EA.UE), Berlin). The conferences were devoted to discussions on practical aspects of realisation of establishment of a multi-functional network of GNSS reference stations in Central and Eastern European countries. It was decided that the Founding Committee would be renamed into the "Steering-Committee" of the unified project called "European Position Determination System (EUPOS)". Second Workshop on "EUPOS - Multifunctional GNSS Reference Station Systems for Europe" was held on 21-22 November 2003 in Berlin, Germany. Next meeting of the International EUPOS Steering Committee will be organised by Slovak colleagues in Bratislava in June 2004.

Fifteen countries intend to participate in the project: Bulgaria, Croatia, Czech Republic, Estonia, Germany, Hungary, Latvia, Lithuania, Macedonia, Poland, Romania, Russian Federation, Serbia and Montenegro, Slovak Republic and Slovenia. All countries are now preparing their draft designs of distribution of reference stations and other particular requirements specific for the area of the countries.

As a result of the work of the EUPOS Steering Committee one general project has been developed that contains common backgrounds and standards of the Project as well as detail projects for particular countries which take into account the existing or being developed satellite infrastructure in particular countries.



Fig. 1. Logo of the Project EUPOS

In the meantime the project EUPOS was presented at many international conferences (see: References), e.g. to the “UN/USA Expert Meeting on the Use and Application of Global Navigation Systems”, Vienna, Austria, 11-15 November 2002, to the “1st Conference ‘Galileo’ for an enlarged Europe” organised by the European Commission in Warsaw, Poland on 19-20 May 2003, to the “2nd Common Baltic Symposium on the Concept of Digital Height Reference Surface and Related GNSS Topics – GPS Heighting and Nation-wide Permanent GNSS Reference Systems” in Riga, Latvia on 12-13 June 2003, to the EGS/AGU/EUG Symposium G17 in Nice, France, 7-12 April 2003; and to International Symposium on Space Information Technologies, Acquisition, Processing and Effective Application, Sofia, Bulgaria, 7-8 November 2003 and others. The recommendations of all these conferences support the initiative of EUPOS as a common GNSS infrastructure for all kinds and accuracies of on-line and post-processing DGNSS applications based on the standards of multifunctional reference station networks.

On 12 November 2003 the representatives of the EUPOS International Steering Committee have held consultations in Brussels with Galileo Joint Undertaking and the European Commission EuropeAid Co-operate Office. The objectives of consultations were to inform the EC about the Project EUPOS, its organisation, standards and services, links to the European Project Galileo and expected benefits for all participating countries. As positive aspects were recognised short time (2,5-3 years) of realisation of the Project and the fact that the first organisational structures of the project are already available. As negative were pointed out the high cost of the project and a fact that not all 14 countries participating in the Project can request for financial support from one EU programme. It was recommended that the total cost of the Project should be decreased (mainly by decreasing the number of planned stations) and was advised that the attempt could be made to request for financial support from different EU Programmes:

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| ERDF - | for EU member countries (Czech Rep., Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia), |
| ISPA – | for EU candidate countries (Bulgaria, Romania), |
| CARDS – | for West-Balkan countries (Croatia, Macedonia, Serbia and Montenegro), |
| TACIS – | for the Russian Federation, |
| INTERREG III C – | for Germany (Coordinator of the Project), |

Besides, the financial support for the coordination work of the International Steering Committee could be requested for the non-EU member countries from the programme PHARE. It is planned to build in total up about 420 reference stations in above mentioned countries beyond Germany. Since Germany has complete network of reference stations (SAPOS[®]) the financial support for this country will be used only for international co-ordination, organisation, supervising, promotion of the Project particularly by the International EUPOS[®] Steering Committee.

3. General characteristics of the EUPOS

To characterise shortly and very generally the Project EUPOS the following should be said:

- The EUPOS stations will be permanently operating, multifunctional DGNSS reference stations.
- The distance between the stations will be about 70 km dependent on the topography. Higher density may be required in conurbation. Existing reference station systems (e.g. EUREF, IGS) should be connected or incorporated.
- The co-ordinates of the stations will be determined with high precision, both in ETRS 89 and in conventional geodetic reference systems by connecting to EUREF points as well as to the other control networks of the countries.
- **EUPOS** will use the signals of Galileo as basis standard as soon as it is available and Global Positioning System (NAVSTAR – GPS) as basis standard up to the complete availability of Galileo and as optional additional standard after complete availability of Galileo, also Russian Global Navigation Satellite System (GLONASS) will be used as optional additional standard.
- Only high quality geodetic GNSS dual frequency receivers will be used at **EUPOS**[®] reference stations. Positions of reference station antennas will be checked regularly for any displacement
- A common use of reference stations in neighbouring countries close to border areas will be taken into account. The reference stations will be networked with each other, even cross-border.
- All participating countries will observe the unified standards or/and will build up their multifunctional systems. fully compatible with future European system Galileo.
- Several levels of RTK and post processing services for geodetic positioning and land, air and marine navigation will be offered. The multifunctional permanent DGNSS service EUPOS will maintain the following sub-services:
 - EUPOS DGNSS for real time or post processing DGNSS applications by code and code-phase measurements with metre up to sub-metre accuracy;
 - EUPOS RTK for real time DGNSS applications by carrier phase measurements with centimetre accuracy;
 - EUPOS Geodetic for DGNSS applications by phase measurements in static or kinematic mode with centimetre up to sub-centimetre accuracy.

General block-diagrams are shown in the Figs. 2-4.

- A quality management will guarantee a minimal 99%-level of security of supply and system integrity of **EUPOS**[®]. Malfunctions automatically activate an alarm plan which sets off appropriate corrective measures. Depending on the requirement, data links, computers or transmitters etc. are switched over and different reference stations will temporarily be used as principal reference station for providing the correction data. The system will be designed so that the technology can generally manage itself and the **EUPOS**[®] operation will be maintained. All malfunctions etc. will be recorded automatically and evaluated within the framework of the quality control management. Malfunctions, faults and losses of quality are therefore automatically identified in real time.

All details on the project EUPOS will be available in the Web Pages (www.eupos.org) that will be installed at the Warsaw University of Technology in April 2004.

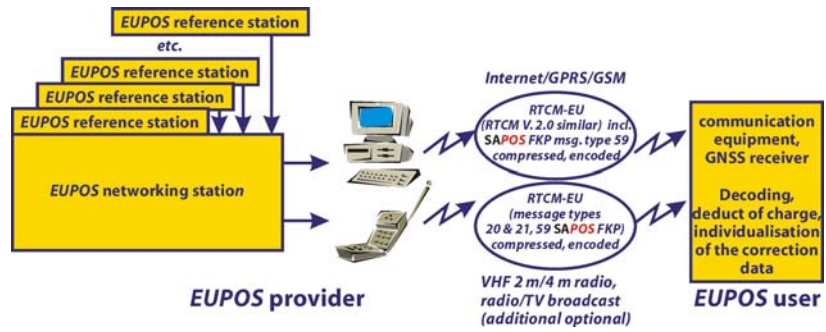


Fig. 2. *EUPOS* DGNSS. (Correction data for real time or post processing DGNSS applications by code and code-phase measurements with an accuracy of 3 m up to 0.5 m, dependent from the user rover equipment).

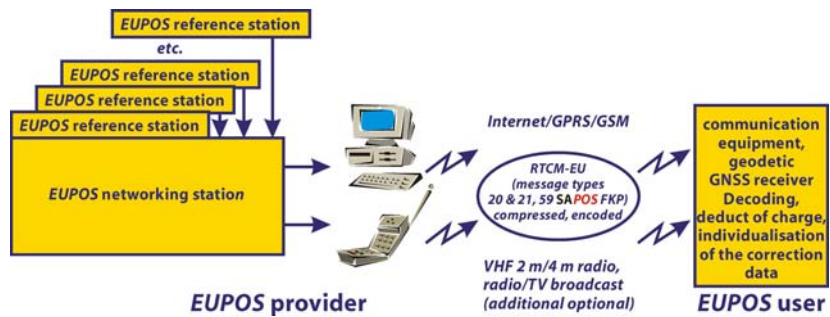


Fig.3. *EUPOS* Network RTK. Correction data for real time applications by carrier phase measurements with an accuracy of ≤ 2 cm

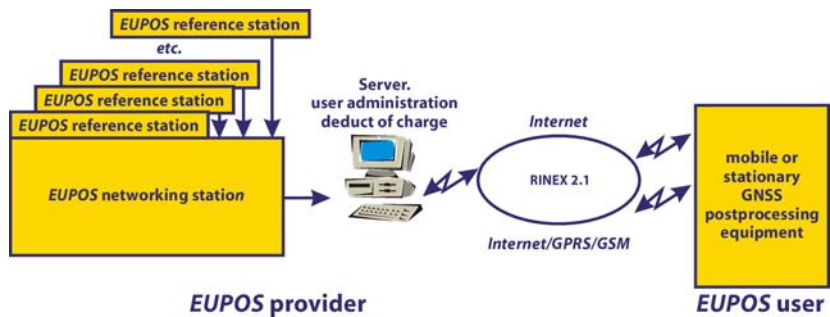


Fig. 4. *EUPOS* Geodetic. Observation data for DGNSS post processing applications by phase measurements in static or kinematics with centimetre up to sub-centimetre accuracy

Table 1. Number of planned reference stations.

Country	Area [km ²]	Number of planned reference stations	Density of stations [s/10 000km ²]	Average distance between stations [km]
Bulgaria	110 990	23	2,1	70
Croatia	56 540	11	2,0	70
Czech Republic	78 870	16	2,0	70
Estonia	45 100	10	2,2	70
Hungary	93 030	19	2,0	70
Latvia	64 500	13	2,0	70
Lithuania	65 200	13	2,0	70
Macedonia	25 710	8	2,0	70
Poland	312 680	75	2,3	66
Romania	237 500	48	2,0	70
Russian Federation	17 075 000 from it: EUPOS DGNSS, Network RTK, Geodetic: 2 999 100 EUPOS Geodetic: 6 287 400	150 will cover only some main regions	-	70-100
Serbia and Montenegro	88 360	18	2,0	70
Slovakia	49 040	10	2,0	70
Slovenia	20 250	8	2,0	70
Total/average	1 247 770 (without Russia)	422	-	-

4. Organisation

The management of the project *EUPOS* is performed by:

- International *EUPOS* Steering Committee (ISC),
- National *EUPOS* Service Centres (NSC),
- Workshops *EUPOS*[®] – Multifunctional GNSS Reference Station Systems for Europe”.

The International *EUPOS* Steering Committee and its office were established during the first Workshop „Multifunctional GNSS Reference Station Systems for Europe“ held in Berlin in March 2002. The committee will be extended by representatives of all accessing countries. The main tasks of the ISC are: coordination of the project actions and management, agreements with the NSC and

manufactures, dissemination of information, organisation of *EUPOS* workshops and symposia, clarification of technical questions and standardisation, organisation and coordination of software and hardware tests and support of the countries in training the technical staff

National *EUPOS* Service Centre (NSC) will be established in every *EUPOS* country. They will deal with the tasks of planning, establishment and maintenance of the national *EUPOS* network. Beyond these activities, the most important tasks of the *EUPOS* Service Centre are: contact with the International *EUPOS* Steering Committee and its office, coordination of the interests and the activities of the national authorities and other governmental bodies, checking the integrity of the network, testing software and hardware in agreement with the International *EUPOS* Steering Committee and their own interests, providing adequate information for the users about the status of the network, organisation of educational and training courses for the technical staff and the users, transferring the international development trends and contributes to the *EUPOS* developments.

The National *EUPOS* Service Centres will have adequate communication links to the *EUPOS* reference stations and the necessary computing power and equipment. It should dispose the highly qualified, competent and motivated manpower.

Workshops *EUPOS*[®] – Multifunctional GNSS Reference Station Systems for Europe will be organised once a year as an information platform on a broader base, thus to enable the participating countries the necessary exchange of experiences and information, to discuss and create further developments of *EUPOS*[®] and to increase the identification with the system. The workshops will be organised by the International *EUPOS*[®] Steering Committee.

5. Conclusions

The technical possibilities offered by the Global Navigation Satellite Systems (GNSS) give the national and state survey departments the chance to fulfil their mission of supplying geodetic reference systems efficiently and largely in accordance to their requirements. The availability of two systems in parallel at the moment, NAVSTAR GPS from the United States of America and GLONASS from the Russian Federation, offers the necessary safeguards, taking into consideration the official statements relating to their continued usability and future development. Finally, these systems will be supplemented by the European development of EGNOS and Galileo, the first civilian GNSS. As soon as Galileo will be available, it will be the main standard for *EUPOS*.

The DGNSS reference station systems already existing in Western Europe are frequently not compatible since the developments were not done cross-border. High-profile experts from the CEE states have seen the historical chance to avoid these difficulties in Central and Eastern Europe. The CEE countries are doing now the first steps to build up GNSS reference stations. The initiative to establish compatible DGNSS reference station systems was started by the over 50 participants from 16 countries of the workshop on "Multifunctional GNSS Reference Station Systems for Europe", in March 2002, Berlin, Germany. The *EUPOS* Steering Committee was founded with the aim to draw up in the near future basic concepts concerning setting up multi-functional DGNSS reference station systems in countries expressing an interest and to outline financing models.

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