

# **EUPOS – A NEW EUROPEAN INITIATIVE**

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## **Abstract**

EUPOS (European Position Determination System) is a new European initiative of establishment of the multifunctional reference station system in Central and Eastern countries as an international project to establish a uniform ground based GNSS augmentation system of multifunctional permanently operating reference stations creating a satellite positioning infrastructure in Central and Eastern Europe (CEE). The Project EUPOS 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 800 multifunctional satellite reference stations in Central and Eastern Europe. Fifteen countries (Bulgaria, Czech Republic, Estonia, Germany, Hungary, Latvia, Lithuania, Macedonia, Poland, Romania, Russian Federation, Serbia & Montenegro, Slovakia, Slovenia and Ukraine) 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. Experiences of all participating countries in establishing and operating satellite systems will also be used. The system will be compatible with the German network SAPOS and in future will use as main signal the signal of the European system Galileo. The network of reference stations will provide services for both positioning of the geodetic control points and for land, air and marine navigation. Several levels of positioning accuracy will be offered.

The participating countries decided to form a Steering Committee. Nine working conferences of the Steering Committee were held up to now. The conferences were devoted to discussions on practical aspects of realisation of establishment of the network, the standards and possible sources of financial support for realisation of the Project.

EUPOS is a member of the International Committee on Global Navigation Satellite Systems (ICG) and the Radio Technical Commission for Maritime Services Special Committee 104 (RTCM SC 104).

The project EUPOS was also presented at many international conferences and symposia. 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 there were recognised short time (2,5-3 years) of realisation of the Project and the fact that the organisational structures of the project are already available. It was advised that the attempt could be made to request for financial support from different EU Programmes: ERDF for EU member countries (Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia), ISPA – for EU candidate countries (Bulgaria, Romania), CARDS – for West-Balkan countries (Bosnia and Herzegovina, Macedonia, Serbia and Montenegro) and TACIS – for the Russian Federation. 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 and promotion of the Project particularly by the International EUPOS Steering Committee.

In August 2006 the Head Office of Geodesy and Cartography of Poland has signed with the Polish Ministry of Economy the agreement on financial support for establishment of EUPOS reference stations in Poland. The respective fund as given in the Project EUPOS was accepted and support will be given from structural ERDF EU programme. The detailed technical design of the network is already prepared. In order to cover the whole territory of Poland and to achieve the proper cross-border links there will be finally established 87 reference stations. According to the agreement the establishment of all stations should be concluded by September 2007. The first GPS receivers for some stations will be purchased in 2006.

## **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 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 departments, 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 "multifunctional 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 countries of Central and Eastern Europe.

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 multifunctional DGNSS reference station system and fundamental infrastructure components is concerned.

The participants of the Berlin workshop decided to form a founding/steering 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 multifunctional 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 multifunctional DGNSS reference station systems be realised in a short time frame and that the workshops on multi-functional DGNSS reference station systems for Europe are to be held on an annual basis enabling the necessary exchange of experience and information.

Nine working conferences of the (Founding) Steering Committee were held up to now. The conferences were devoted to discussions on practical aspects 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)". Next (tenth) meeting of the International EUPOS Steering Committee will be organised in Budapest, Hungary on 23-24 November 2006.

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**

The following countries intend to participate in the project EUPOS: Bosnia and Herzegovina, Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Macedonia, Montenegro, Poland, Romania, Russian Federation, Serbia, Slovakia and Slovenia and Ukraine. Also German States Berlin and Hamburg cooperate within the Project. So, it can be said that **EUPOS is an initiative to establish a uniform DGNSS basis infrastructure in Central and Eastern Europe (CEE) for nearly 60 % of the area of the whole Europe.** About 10 million square kilometres will be covered by EUPOS reference stations taking into consideration also the Russian territory in Asia where this infrastructure will be established.

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, that the Project covers in its first version about 25 % of the European territory and the fact that the 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 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 reduced (mainly by reducing the number of planned stations) and was advised that the attempt could be made to request for financial support from different EU Programmes: 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 (Bosnia and Herzegovina, Macedonia, Serbia and Montenegro), TACIS – for the Russian Federation,

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 800 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 and promotion of the Project particularly by the International EUPOS Steering Committee.

There is a long lasting cooperation of the EUPOS ISC and the United Nations Office of Outer Space Affairs (UN-OOSA). The UN-OOSA has been organising, since the year 2001 in co-sponsorship with the Government of the USA, a series of regional workshops and international meetings of experts on the use and applications of GNSS. The latest one of this series was held in Vienna, Austria in 2003. The International Workshop reviewed the implementation of project proposals from the series of GNSS meetings with a view to prioritising the projects for support by the UN-OOSA. EUPOS was identified as one of the priority projects that were provided. Among other things it was stressed by the UN-OOSA that EUPOS significantly enhance the scope of use and applications of GNSS as well as their scientific, social and economic benefits. It was pointed out, too, that **EUPOS would serve as a good model for the other regions to follow in the development of their GNSS infrastructure**. Following the recommendations of the Action Team on GNSS, that was established by the UN Committee on the Peaceful Uses of Outer Space (COPUOS), EUPOS will participate in the UN/Zambia/ESA Regional Workshop on the Application of Global Navigation Satellite System Technologies in Sub-Saharan Africa that will be held end of June 2006 in Lusaka. Thus the exchange of experiences and knowledge from both projects the European EUPOS and the African AFREF could serve a good basis for cooperation and interoperability of these regional ground based DGNSS augmentation systems.

The Action Team on GNSS recommended also that an International Committee on GNSS (ICG) should be established to promote the use of GNSS infrastructure on a global basis and to facilitate exchange of information. COPUOS included this recommendation in the Plan of Action proposed in its report to the General Assembly on the review of the implementation of the recommendations of UNISPACE III. In 2004, in its resolution 59/2, the General Assembly endorsed the Plan of Action. In the same resolution, the General Assembly invited GNSS and augmentation system providers to consider establishing an ICG in order to maximize the benefits of the use and applications of GNSS to support sustainable development (cf. UN General Assembly ‘Report on the United Nations/United States of America International Meeting on the Use and Application of Global Navigation Satellite Systems’, Vienna, 13-17 December 2004, A/AC.105/846).

At the ‘UN International Meeting for the Establishment of the International Committee on Global Navigation Satellite Systems (ICG)’ held on 1-2 December 2005 in Vienna, Austria, the ICG was established on a voluntary basis as an informal body for the purpose of promoting cooperation, as appropriate, on matters of mutual interest related to civil satellite-based positioning, navigation, timing, and value-added services, as well as compatibility and interoperability among the GNSS systems, while increasing their use to support sustainable development, particularly in the developing countries. The participants in the meeting agreed on an establishment of the ICG information portal, to be hosted by UN-OOSA, as a portal for users of GNSS services. **Among others EUPOS is a member the ICG** (cf. <http://www.unoosa.org/oosa/SAP/gnss/icg/html>).

### 3. GENERAL CHARACTERISTICS OF THE EUPOS

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

- **The EUPOS is an international project to establish a uniform ground based GNSS augmentation system of multifunctional permanently operating reference stations creating a satellite positioning infrastructure in Central and Eastern Europe (CEE).**
- The distance between the stations will be 60-70 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 multi-functional systems fully compatible with future European system GALILEO.
- Generally EUPOS will offer several levels of RTK and post processing services for geodetic positioning and land, air and marine navigation:
  - 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.
- 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.

#### 4. ORGANISATION

The management of the project EUPOS is performed mainly by:

- International EUPOS Steering Committee (ISC),
- National EUPOS Service Centres (NSC),

**The International EUPOS Steering Committee (ISC)** and its office (ISCO) 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, organisation of educational and training courses for the technical staff and the users, transferring the international development trends and contributes to the EUPOS developments.

#### 5. EUPOS IN EUROPEAN COUNTRIES

Number of planned EUPOS reference stations in particular countries is given in Table 1. All countries are now preparing their draft designs of distribution of reference stations and search for funds indispensable for establishment of the stations and other required infrastructure for the network.

Table 1. Number of planned EUPOS reference stations

Country	Area [km <sup>2</sup> ]	Number of EUPOS reference stations	Average distance between stations [km]
<b>EU member countries</b>			
Czech Rep.	78 870	26	70
Estonia	45 220	13	60
Hungary	93 030	36	70
Latvia	64 600	24	70
Lithuania	65 300	13	70
Poland	312 680	87	70
Slovak Rep.	49 035	21	65
Slovenia (observer status)	20 270	15	50
<b>EU candidate countries</b>			
Bulgaria	110 950	23	70
Romania	237 500	48	70
<b>West Balkan States</b>			
Bosnia and Herzegovina	51 000	30	65
Macedonia	25 330	15	60
Serbia and Montenegro	88 360	32	70
<b>Russian Federation</b>			
Russian Fed.	17 075 000	500 stations (in 7 federal districts, will cover not whole area)	30 – 100
<b>Ukraine</b>			
Ukraine	603 700	?	
<b>T o t a l</b>		<b>879</b>	

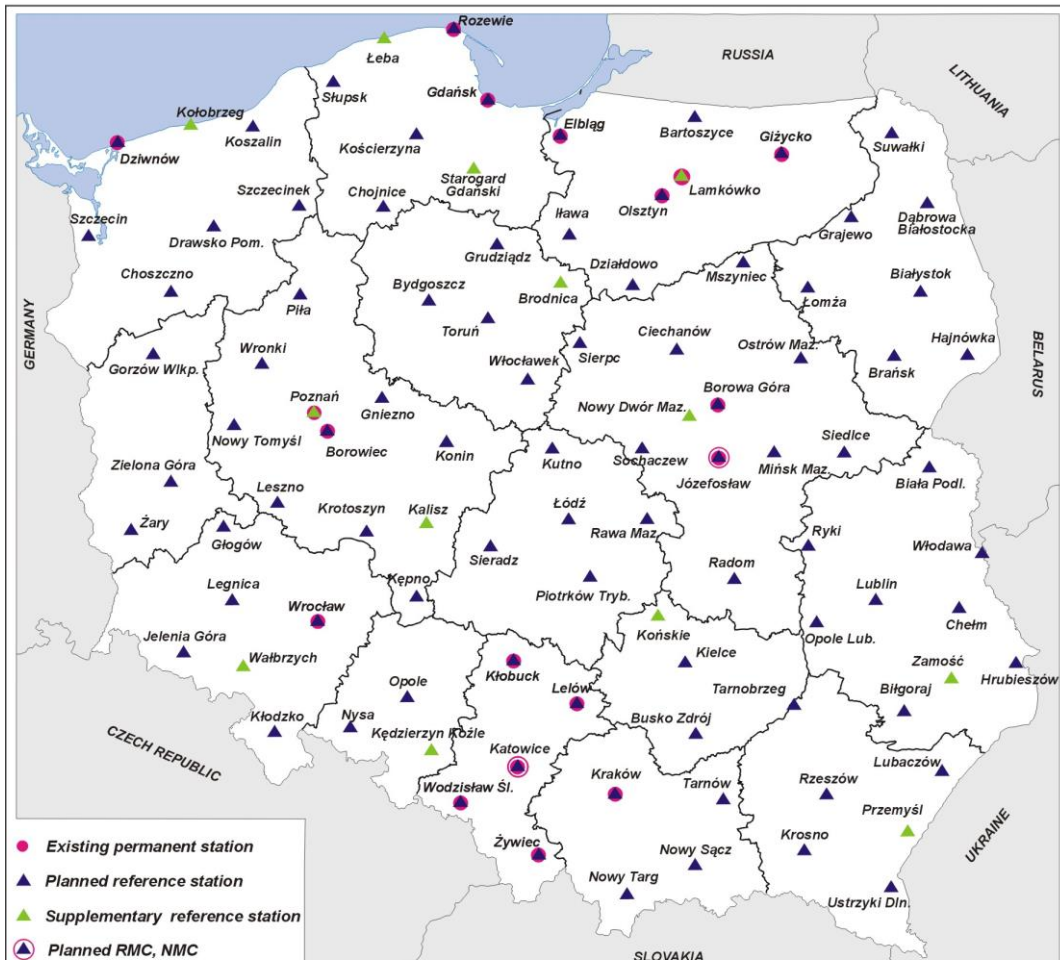
## 6. POLISH PART OF THE EUROPEAN NETWORK EUPOS

The Polish part of EUPOS, named *Active Geodetic Network (Aktywna Siec Geodezyjna) ASG/EUPOS*, will contain **87 permanent reference stations**. To achieve desired quality of services and to comply with general EUPOS requirements, the distance between individual stations will be 70-80 km. Planned locations of 87 reference stations, which have already been decided, are given in Fig. 2.

The National Network Management Centre (NMC) and one Regional Management Centres (RMC) will manage whole system under general control of the Head Office of Geodesy and Cartography. Data transmission between reference stations and management centres shall be realised using secure dedicated links. The services to the end-users will be offered through standard public communication systems: the internet, cellular networks (GSM/GPRS and UMTS in future), and optionally – radio broadcasting (depending on the project's available budget and users specific requirements).



**Polish GNSS reference stations of the Project EUPOS  
“European Position Determination System”**



**Fig. 2. Reference stations of the Polish part of the network EUPOS**

## 7. SERVICES OFFERED FOR END USERS BY ASG/EUPOS

The ASG-EUPOS system will offer the standard services, as required by the general EUPOS assumptions including the following sub-services:

- NAVGIS (network RTK for real time kinematic DGNSD applications)
- NAVGEO (network RTK for precise real time kinematic DGNSD applications)
- POSGEO DGNSD for precise DGNSD post processing applications

They are summarised in Table 2.

### NAVGIS (network RTK for real time kinematic DGNSD applications)

For navigation and real time position determination with accuracy of 3 metres up to 0.5 metre, depend on the used rover equipment, ASG/EUPOS will provide compressed and encoded DGNSD correction data via Internet/GPRS as a basic standard. The authenticity of the official NAVGIS GNSS correction data provided via Internet will be ensured. It is an essential advantage of Internet/GPRS transmission that the corrections can be broadcasted to unlimited number of users simultaneously. The international standard data format “Radio

Technical Commission for Maritime Services, Special Committee 104 version 2.x” (RTCM SC 104 V. 2.x) is going to be used for DGNS correction transmission.

As an optional standard a radio broadcasting FM/RDS or LW/RDS is considered. However, due to limitations resulting from the current situation on the Polish telecommunications market, the provision of RTK data using radio broadcasting will have to be realised only using FM/RDS transmission. Therefore, for the project budget calculation it is assumed that the most effective (both technically and economically) solution is FM/RDS transmission based on an agreement with a national-wide radio station.

**Table 2. Services planned to be offered by ASG/EUPOS**

Service	RTK/ Post-processing	Transmission of corrections/ data	Frequency	Accuracy	Format
NAVGIS/ CODGIS Real Time Positioning Service	DGNSS	Internet/ FM/RDS	5 sec.	1 - 3 m	RTCM 2.0*
	RTK	GSM	1 sec.	0.2–0.5 m	RTCM 2.0*
NAVGE0 High Precision Real Time Positioning Service	RTK	GSM/ GPRS	1 sec.	≤ 0.02 m	RTCM 2.3* NMEA
POSGEO D Geodetic Precision Positioning Service	quasi-RTK	Internet/ GPRS	1 (5) sec.	≤ 0.01 m	RINEX 2*
POSGEO High Precision Geodetic Positioning Service	post-processing	Internet, CDROM	1 (5) sec.	< 0.01 m	RINEX 2*

\* a standard version is to be determined once the project will start

#### **NAVGE0 (network RTK for precise real time kinematic DGNS applications)**

For precise real time position determination with accuracy of at least 0.05 m ASG/EUPOS will provide compressed and encoded RTCM RTK correction data via:

- a) Internet/ GPRS as a basic standard;
- b) GSM – as an optional standard.

The international standard data format RTCM SC 104 V. 2.3 or 3.0 is going to be the main format used for RTK correction transmission. Depend on availability of technically advanced receivers the standard RTCM-EU will also be encouraged during ASG/EUPOS realisation.

#### **POSGEO DGNS for precise DGNS post processing applications**

For precise DGNS post-processing applications ASG/EUPOS will provide observation data of the reference stations via Internet. The user interface for GNSS observation data uses international standard data format “Receiver Independent Exchange Format version 2.1” (RINEX 2.1).

### **8. STATUS OF REALISATION OF THE ASG/EUPOS PROJECT**

The ASG/EUPOS system is going to be developed with financial support from European Regional Development Fund. Four institutions are involved in project realisation: Finance Ministry, Regional Development Ministry, Education and Science Ministry and finally the Head Office of Geodesy and Cartography which will be the main beneficiary of the project. Whole project will be carried out in 2006-2007. Since beginning 2006 the realisation team has been established and National Management Centre has been established. In 2006 the public tender procedures are going to be launched and DGPS/RTK services will be activated and tested over chosen areas of Poland. Also, the intensive information and advertising campaigns will be prepared and initiated in 2006. The

reference stations are going to be established beginning from region with existing telecommunication infrastructure and where big industrial and road investments are planned. A completion of whole project is planned by the end 2007 and from 2008 system ASG/EUPOS will be offered to the users.

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Further details on the project EUPOS are available in the Web Pages installed at the Warsaw University of Technology as:

**[www.eupos.org](http://www.eupos.org)**