

# **ASG-EUPOS - a Multifunctional Precise Satellite Positioning System in Poland**

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**ABSTRACT:** With the beginning of January 2007 the realisation of the ASG-EUPOS multifunctional precise satellite positioning system in Poland has begun. The system founded in Poland is a part of a larger project EUPOS®, involving the countries of the Central and Eastern Europe. The ASG-EUPOS system will consist of 86 reference stations placed evenly on the area of the country in distances around 70 km and two management centres located in Warsaw and Katowice. The system will render three real-time services (NAVGeo, NAVGIS and CODGIS) and two postprocessing-mode services accessible (POSGEO and POSGEO D). It's planned to organise a technical service and supply the geodesy and cartography documentation centres with GNSS equipment. The whole system is to be built by the end of 2007 and will go into use with the beginning of 2008. The ASG-EUPOS system is realised utilising the resources of the European Regional Development Fund.

## **1 INTRODUCTION**

On the 2nd of January 2007 the Head Office of Geodesy and Cartography (GUGiK), the consortium: WASKO S.A., Geotronics Poland S.A. and Trimble Europe BV have signed a contract for building the ASG-EUPOS multifunctional precise satellite positioning system in Poland. The goal of building this system is to web-enable corrections for GNSS observations for satellite receivers and enabling the precise positioning and navigation in Poland. The network of ground reference stations ASG-EUPOS receiving signals from global navigation systems NAVSTAR GPS, GALILEO and GLONASS will constitute a system of spatial references in Poland (*ASG-PL/EUPOS, 2004; ASG-PL/EUPOS, 2005*). The reference points of the ASG-EUPOS System's reference stations will create the geodetic control network according to the regulations of the act from May 17th 1989. Geodetic and cartographic law. The ASG-EUPOS multifunctional precise positioning system project is realised utilising the resources of

the European Regional Development Fund within the Sectoral Operational Programme „Improvement of the Competitiveness of Enterprises”. The contract for project subsidising was signed on the 2nd of August 2005. The Ministry of Regional Development is the Managing Authority, while Department of European Funds acting within the Ministry of Science and Higher Education is the Implementing Authority and the General Surveyor of Poland is the Final Beneficiary.

The ASG-EUPOS multifunctional system for precise satellite positioning is part of project EUPOS® involving the countries of Central and Eastern Europe. The EUPOS System is to constitute a unified system for precise positioning in 16 Central and East European countries. All in all around 450 / 900 reference stations will have been added into the system. The International Steering Committee in Berlin is in charge of the coordination. Important to highlight is the fact, that the system is built according to a unified standard. The launch of the EUPOS System is anticipated for 2008. The

coordinates will be in ETRS89 system and then recalculated to national coordinate systems. Participating countries will apply a unified technical standard and will render the data accessible from the border reference stations (*ASG-PL/EUPOS, 2004; Graszka, 2007*).

## 2 THE DESCRIPTION OF THE ASG-EUPOS SYSTEM

The ASG-EUPOS System is composed of three essential segments: the segment of reference stations, the segment of managing and the segment of users. Enabling of differential corrections in real-time is designed in the system (NAVGeo, NAVGIS and CODGIS services), rendering data accessible and calculating in postprocessing-mode (services: POSGEO and POSGEO D), arranging of the technical service and also supplying the geodesy and cartography documentation centres with GNSS equipment. Enabling of corrections will take place on the Internet and GSM (GPRS). With the increasing number of users it's planned to implement other transmission channels (UMTS, radio systems and others). Enabling the observations and postprocessing calculations' results will be realised by the Internet and on CDROM (*ASG-PL/EUPOS, 2005; Graszka, 2007*). Figure 1 introduces schematic segments of the system and services with information on the accuracy of measurements carried out in respective services.

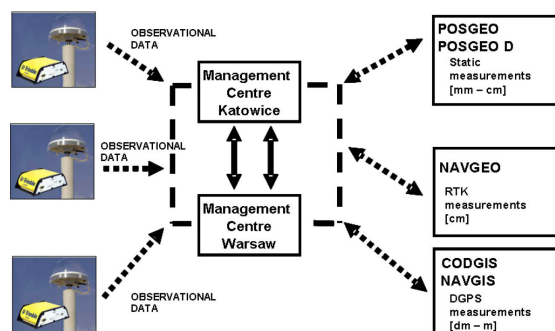


Fig. 1. The chart of ASG-EUPOS System segments and services

The distribution of the stations is introduced on figure 2.

Circles denote existing stations, planned for admission into the system. Triangles denote stations planned for establishing (including reserves). Squares denote stations which will be admitted into the EUREF Permanent Network (EPN). Localisations of the designed stations are presently (April, 2007) in verification. The verification concerns the possibility of installing the GNSS antenna, installation of the 19-inch Rack with

modules: receiving, primary and emergency power, steering and communication and of the possibility to establish communication connections (*ASG-PL/EUPOS, 2005, WASKO, 2007*).

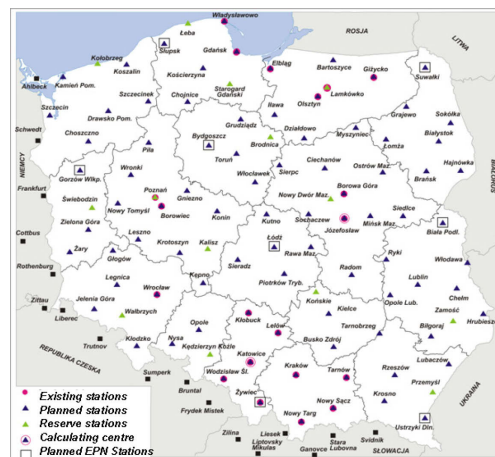


Fig. 2. The designed distribution of ASG-EUPOS system reference stations

According to figure 2, the segment of the ASG-EUPOS reference stations will consist of (Graszka, 2007):

- 67 RTK reference stations (GPS module) built within the realised project
- 8 stations (GPS/GLONASS module) built within the realised project
- 15 existing RTK reference stations (GPS module) situated in Poland
- 3 existing RTK/DGPS reference stations (GPS/GLONASS module) admissiomed into the system, situated in Poland
- not more than 30 foreign reference stations situated in the border zone, working within EUPOS System

Every reference station will consist of the following modules: receiving (GPS or GPS/GLONASS), primary and emergency power, steering and communication.

Managing of the ASG-EUPOS System will be carried out by the management centres: in Warsaw and in Katowice. The management centres will be equipped in application software enabling the realisation of the full extent of services. The reference stations will communicate with the management centres using the TCP/IP protocol. Every station will send data with the sample frequency of 1Hz (every 1 second) parallel to the both centres. The managing of reference stations will be realised from the level of management centre. Access to the system's services and postprocessing module will be assured 24 hours a day, 7 days in a week. The overall characteristic of the real-time services offered in ASG-EUPOS System is introduced in table 1.

Table 1. Real-time services in the ASG-EUPOS System

Service	Method	Transmission	Accuracy	Format	Receiver
NAVGeo	RTK	GSM/GPRS/EDGE/UMTS, Internet,	0,03m horizontal, 0,05m vertical	RTCM SC-104 version 2.3 and 3.0	L1/L2
CODGIS	DGPS	GSM/GPRS/EDGE/UMTS, Internet	up to 0,5m	RTCM SC-104 version 2.1	L1
NAVGIS	DGPS	GSM/GPRS/EDGE/UMTS, Internet, FM(optional)	1m - 3m	RTCM SC-104 version 2.1	L1

The calculation module of the system will assure the generating of RTK/DGPS corrections, enabling users, equipped with GPS/GNSS receivers and GSM/GPRS (UMTS) communication module to calculate the position of a point in real-time.

The calculation module for realising services of precise positioning in postprocessing mode will be installed in management centres and web-enabled to users ([www.asg-eupos.gov.pl](http://www.asg-eupos.gov.pl)). Within the same login session the user will be allowed to send his GPS observational files (in RINEX format) for processing. This module will work in automatic mode, with the possibility of the operators' intervention in case of a need for manual calculations. The data necessary for calculations (RINEX files from the nearest reference stations or virtual reference stations) within POSGEO D service will be available the same way.

The maintenance of reference system and the control of correctness of its realisation is to be provided in ASG-EUPOS system. For that purpose an autonomous calculating system based on the Bernese GNSS Software v. 5.x is expected to be launched. The task of this service will be to make calculations of the whole ASG-EUPOS reference stations network according to the calculation standards applied by the EPN network's centres of analyses. The results of these analyses will enable the control of the reference stations' coordinates stability and will constitute the base to carry out actions in case of occurrences of essential transitions in antennas' phase centres position.

The user segment will comprise of mobile receivers equipped with GSM/GPRS module. Such a configuration will enable direct use of real-time services (NAVGeo, NAVGIS and CODGIS) of the ASG-EUPOS System. The software of the mobile receivers' is to make possible the direct determination of point coordinates in terrain in the national spatial reference system: EUREF 89, 1992, 2000 and 1965, and also the normal heights in Kronstadt 86 system. The user will have access to the postprocessing mode calculation services (POSGEO and POSGEO D) through the system's web page.

### 3 THE REALISATION OF ASG-EUPOS SYSTEM

On the 2<sup>nd</sup> of August 2005 a contract was signed for subsidizing of the construction of the ASG-EUPOS precise satellite positioning system utilizing the resources of the European Regional Development Fund within the Sectoral Operational Programme "Improvement of the Competitiveness of Enterprises" 2004-2006 (SOP-ICE). The project has been realised within Priority 1 – Enhancement of knowledge based economy business environment, Task 1.5. Development of a system of entrepreneurs' access to information and public services on-line. The Ministry of Regional Development is the Management Authority, the Department of European Funds acting within the Ministry of Science and Higher Education is the Implementing Authority. The General Surveyor of Poland is the Final Beneficiary, who, in order to support the project, established the Project Steering Committee and two counselling bodies: the Programme Council of the Project and the Team of Experts. The management structure of the ASG-EUPOS System is introduced on figure 3.

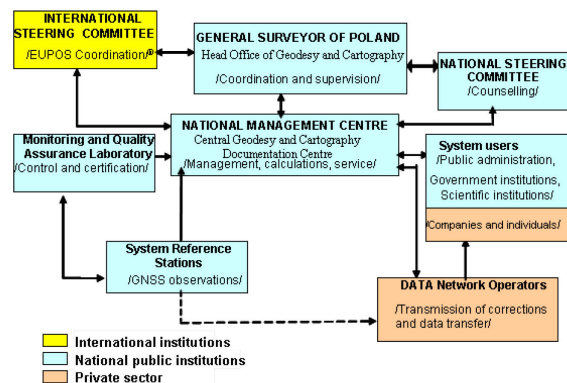


Fig. 3. Target Structure of the ASG-EUPOS System

The practical realisation of the ASG-EUPOS System has begun with the beginning of 2007 after signing the 2nd of January contract for founding the consortium: WASKO S.A, Geotronics Poland S.A. and Trimble Europe BV. The realisation of the contract has been divided, from technical reasons, into three stages (*WASKO, 2007, Graszka, 2007*):

**Stage 1** – consisting of: the delivery of 30 dual-frequency GPS receivers with the equipment and software of the reference stations, the delivery of servers, computer and telecommunication equipment, system and application software, as well as the delivery of 15 dual-frequency GPS receivers with equipment and software for RTK/DGPS field measurements;

**Stage 2** – consisting of: delivery of 40 dual-frequency GPS receivers and 8 dual-frequency GPS/GLONASS receivers with the equipment and software for the reference station, mounting of reference stations in 75 locations, delivery and installation of supplementary equipment, installation of servers, computer and telecommunication equipment, system and application software in Management Centres, connecting all the system elements and training of the personnel operating the stations and positioning services. 50 dual-frequency GPS receivers will also be provided, with equipment and software for RTK/DGPS field measurements and a training of operating personnel will be conducted;

**Stage 3** – consisting of: launching of real-time and postprocessing precise positioning services, plugging the border stations in and connecting the National Management Centre with National Management Centres in neighbouring countries, and also the training of the staff, testing and authorisation of the precise positioning system in Poland.

According to the accepted schedule Stage 1 has been finished in March, Stage 2 in June and Stage 3 by the 15th of December 2007. The ASG-EUPOS System after the audit completion should be available to the users with the beginning of 2008.

#### 4 THE INFRASTRUCTURE OF THE ASG-EUPOS SYSTEM

The reference stations with GPS receiving module will be equipped with Trimble NetRS receivers with Zephyr I antenna (TRM41249.00) and the stations with the GPS/GLONASS receiving module with NetR5 receivers with Zephyr II antenna (TRM55971.00) (*WASKO, 2006*).

The registration of the NAVSTAR GPS and GLONASS signal in reference stations will be within 1Hz interval in the receivers' cache. The communication servers in Management Centres will connect to the TCP/IP ports of the receiver and download RAW type data. For this purpose Trimble GPSBase software will be installed on existing stations which are equipped with control computers. Every station will send data with sample frequency of 1Hz (every second) using two distinct ports. The data from the first port will be sent to the Management Centre in Warsaw and its replica from the second port to the Management Centre in Katowice (*WASKO, 2007*).

The calculation segment of the ASG-EUPOS system for real-time services (NAVGeo, NAVGIS and CODGIS) will be realised based on software by Trimble Infrastructure Software™ that is installed in

both Management Centres. The primary task of the system is to generate real-time corrections. This task will be realised by GPSNet and RTKNet modules as well as the NTRIP application (*WASKO, 2006, 2007*).

The calculation segment of the ASG-EUPOS System for postprocessing mode (POSGEO) will be installed in Management Centres, available to users through the web page and based on Trimble TTC software. Through the web page service the user will also be given the possibility to download observation data from given stations in RINEX format and virtual station's position (POSGEO D) (*WASKO, 2006, 2007*).

#### 5 CONCLUSIONS

The ASG-EUPOS system will ensure a stable and uniform reference system in Poland. The system accessibility and the realisation of precise positioning and navigation service will be carried out in real time. According to the assumptions, the ASG-EUPOS system may constitute a base for building own systems (applications) for users utilising the positioning or navigation function. The implementing and effective functioning of the system is possible only in cooperation with the public administrative boards, scientific institutions and entrepreneurs. The Head Office for Geodesy and Cartography coordinates the founding of the system on the area of the country, basing on the experiences of other European countries, also having in regard the high requirements that have been set up to the reference system by the geodesic-measurement works contractors. The realisation of the ASG-EUPOS system also requires the coordination of operations with the neighbouring countries, especially in the scope of common technical standards and the exchange of observational data from border stations.

#### REFERENCES

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