



Content

- Ten years of establishment of **EUPOS** reference stations in Central and Eastern Europe
- Some words about the International GNSS Symposium 2011, Berlin, Germany
- **EUPOS** news from HUNGARY
- **EUPOS** Combination Centre
- **EUPOS** news from POLAND
- **EUPOS** news from ESTONIA
- **EUPOS** news from ROMANIA
- **EUPOS** news from BULGARIA
- **EUPOS** news from SERBIA
- **EUPOS** news from LATVIA
- **EUPOS** news from SLOVAKIA
- Events

Ten years of establishment of **EUPOS** reference stations in Central and Eastern Europe Do you remember the facts from the last ten years?

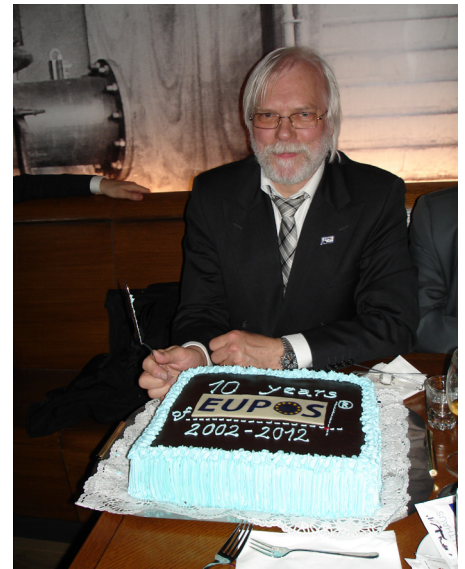
In March 2002 there was organised by the Berlin Senate Department for Urban Development supported by the European Academy of the Urban Development Berlin first conference aimed at the launching of a new European project of establishment of the multifunctional reference station system in Central and Eastern countries consisting of a uniform ground based GNSS augmentation system of multifunctional permanently operating reference satellite system creating a satellite positioning infrastructure in Central and Eastern Europe. This was in fact the founding conference initiating project **EUPOS** (European Position Determination System) accepted enthusiastically by all attending countries. Since that time the established International **EUPOS** Steering Committee (ISC) meet twice a year in order to discuss all problems concerning technical standards, international cooperation and current development matters of **EUPOS**. So our conference in Bratislava in March 2012 is a Ten Years Jubilee ISC conference. The **EUPOS** project was many times presented at different conferences and symposia. Therefore now is the time to only summarise concisely the results and achievements resulting from the huge work done by the **EUPOS** ISC.

- There were prepared very essential fundamental for **EUPOS** development documents:
 - the detailed **EUPOS** Terms of Reference;
 - the **EUPOS** Technical Standards;
 - Guideline for **EUPOS** Reference Frame Fixing;
 - Guideline for Single Site Design;
 - Guideline for Cross-Border Data Exchange.

All these documents are adopted and observed by all **EUPOS** countries.

- The System **EUPOS** is the first satellite navigation system that will use as the basic satellite signal the signal of European system Galileo as soon as this system is available.

- The *EUPOS* System was entirely established in many countries, in some countries is still under construction depending on financial possibilities.
- The number of participating countries is steadily growing from year to year. As in March 2012 the following countries are member of the *EUPOS* family: Bosnia & Herzegovina, Bulgaria, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Latvia, Lithuania, Macedonia (FYROM), Moldova, Montenegro, Poland, Romania, Russian Federation, Serbia, Slovak Republic, Slovenia, Ukraine. Also the German Land Berlin is the member of *EUPOS*. Some more countries like as Azerbaijan be interested in membership of *EUPOS*. So we can say that *EUPOS* in the near future might extend over territory from Baltic Sea to Adriatic and Caspian Sea Regions.
- ISC has established two Working Groups: - *EUPOS* working group on Technical Cooperation with the Industry (TCI) and the *EUPOS* Working Group on System Quality, Integrity and Interference Monitoring (SQII).
- *EUPOS* ISC has established close cooperation links with other organisations, such as: - International Committee on Global Satellite Systems (ICG); - United Nations Office for Outer Space Affairs (UN OOSA); - the EUREF Technical Working Group; - the Radio Technical Commission for Maritime Services Special Committee 104 (RTCM SC 104). The *EUPOS* and EGNOS have agreed to establish close cooperative relations. Another goal of *EUPOS* ISC activities is to bring together the regional reference frames and systems such as the *EUPOS*/European Reference Frame EUREF, the African Reference Frame AFREF, the Geocentric Reference System for the Americas SIRGAS and the Asia-Pacific Reference Frame APREF.
- *EUPOS* has very effective, operative and transparent organisation: International *EUPOS* Steering Committee consisting of representatives of all member countries and its Central Office (ISCO) in Berlin as well as ISC Conferences are the highest authorities of *EUPOS* organisation. In every *EUPOS* member country are active the National *EUPOS* Service Centres (NSC). They deal with the tasks of planning, establishment and maintenance of the national *EUPOS* network.
- Conferences of ISC *EUPOS* that are held twice a year contribute considerably to transfer technologies, development of regional cooperation of neighbouring countries and creation of social friendly bonds among *EUPOS* family members.



Some words about the International GNSS Symposium 2011, Berlin, Germany, 10 - 12 October 2011

On 10-12 October 2011 there was organised in Berlin, Germany the fourth International Symposium on Global Navigation Systems, Space and Ground-Based Augmentation Systems and Applications. The Symposium was hosted by the Land Berlin, Germany in Rathaus Wilmersdorf and was organised by Berlin Senate Department for Urban Development and the International *EUPOS* Steering Committee coorganised by the United Nations Office for Outer Space Affairs and the International Committee on Global Navigation Satellite Systems. Sixty participants from 27 countries attended the Symposium. The welcome addresses were given by Ms Ingeborg Junge-Reyer, Senator for Urban Development, Berlin, Ms. Sharafat Gadimova, UN OOSA/ICG and Mr. Gerd Rosenthal, *EUPOS* ISCO Berlin. 26 papers were presented in 7 sessions. Current status of development of the Japan satellite system QZSS (Quasi-Zenith Satellite System) and Russian

GLONASS status and main applications in the Russian Federation were presented. Also information on current activities of the UN ICG and Latin America Geocentric Reference System for the America (SIRGAS) were given.

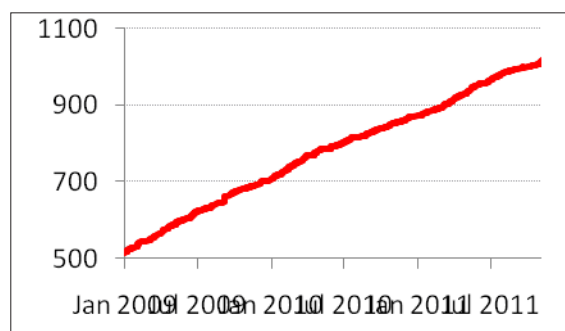
EUPOS news from HUNGARY

The network

The Hungarian nationwide GNSS infrastructure is operated by the Institute of Geodesy, Cartography and Remote Sensing (FÖMI). The network called GNSSnet.hu consists of 54 reference stations, 35 of which are located on Hungarian territory and 19 are integrated from the neighbouring countries. Raw observation data exchange with all of our neighbours is performed on a routine basis. Among the 35 Hungarian stations 1 IGS (PENC) and 4 EPN (PENC, BUTE, OROS, SPRN) sites are operating. In addition to the reference stations two permanent rover stations have been deployed to continuously monitor the quality of GNSSnet.hu real time corrections.



The Hungarian GNSSnet.hu infrastructure



Number of GNSSnet.hu user accounts
(January 2009 – November 2011)

All of the Hungarian reference stations are GPS+GLONASS enabled. In order to minimise site specific effects, such as multipath, the Hungarian stations are equipped with individually absolute PCV calibrated choke ring antennas. The hardware upgrade required for Galileo and GPS L5 signal support have been completed on 5 reference stations. It is planned that all GNSSnet.hu sites will support the new GNSS signals (including modernised GLONASS and COMPASS) by the time the new or modernised satellite constellations will reach an advanced deployment phase.

In February 2011 the antenna of the Nyíregyháza station was relocated to a more stable position on the same building, because time series analysis indicated systematic seasonal coordinate variations in one of the horizontal components. The old station NYLE ceased to exist, the new station ID is NYL2. Early results show that the antenna coordinates are now stable, the 1 cm amplitude movement disappeared.

The antenna of station PENC will also be relocated in the near future to mitigate the effect of increasing signal obstructions caused by growing pine trees near the observatory building. The new antenna location has been selected where test measurements promise a significant improvement in signal quality.

Users and applications

For October 2011 the number of registered user accounts rose above 1000. More than 750 organisations rely on GNSSnet.hu data during their routine operations. Service fee revenues cover all operational costs including hw/sw developments - GNSSnet.hu has become self-financing.

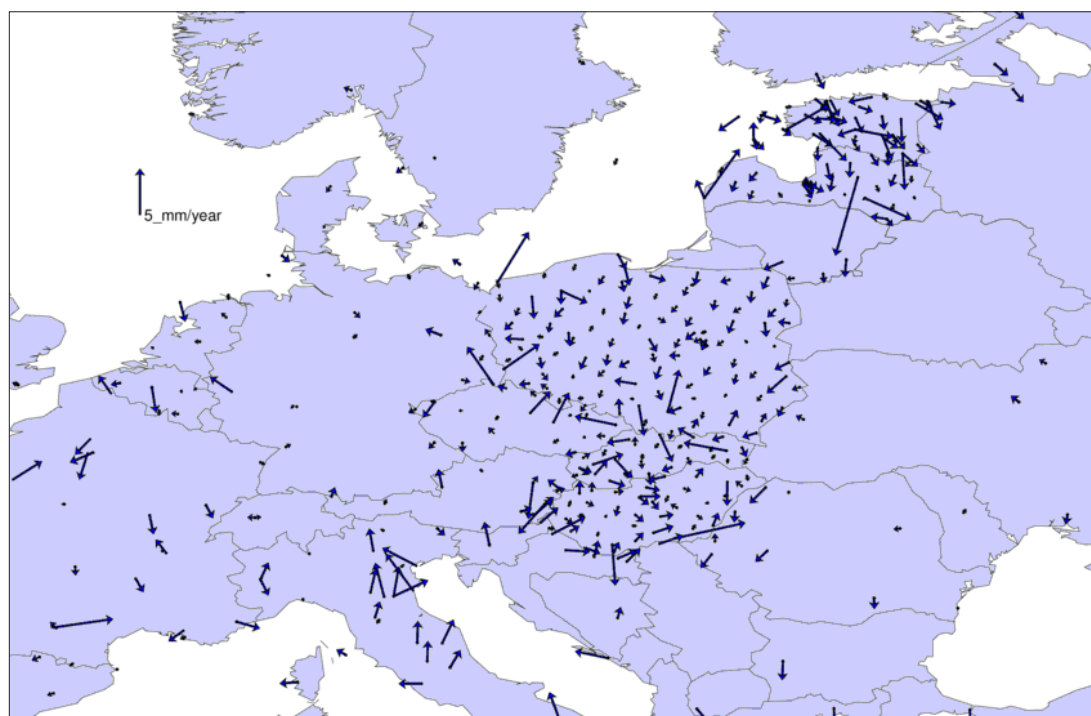
The Hungarian State Railways (MÁV) used GNSSnet.hu real-time corrections to measure the complete 7800 km railway network including all assets between October 2009 and January 2011. The resulting GIS data-

base will help MÁV significantly improve its asset management capabilities.

A yet small but rapidly growing market in Hungary is precision agriculture. Currently 31 tractors equipped with cm accurate auto-steering system use FÖMI's network RTK corrections for field operations.

EUPOS Combination Centre

The EUPOS Combination Centre (ECC) continued its operation at the FÖMI Satellite Geodetic Observatory in Penc. Large amounts of historic SINEX data - back to the start of the operation at each participating network - were submitted and included into the combination. Thanks to the work of the ECC management and the readiness of the network operators most of the stations have got DOMES numbers for better and unique site identification. Now the data coverage in general starts from 2007 and lasts up to mid 2011. At a significant amount of stations the data sets span almost 4 years, which already allows the estimation not only high quality coordinates but also velocities. The first velocity maps were presented in 2011. IAG EUREF are and also interested in starting similar combination of the dense national permanent networks. The two organisations a cooperation to exploit the potential lying in the analysis.



Horizontal station velocities computed by the EUPOS Combination Centre

EUPOS news from POLAND

ASG-EUPOS is a multifunctional satellite positioning augmentation system based on international EUPOS standards, located in the area of Poland and managed by the Head Office of Geodesy and Cartography - the Polish national mapping authority. The system structure is divided into four basic segments: satellite, reference, management and user segment. Those segments working together provide the system for precise positioning in real-time and postprocessing applications.

The main GNSS signals used currently in the ASG-EUPOS system come from GPS (all stations) and GLONASS (total of 39 stations including the foreign ones). With the development of GALILEO system, the network will be remodelled towards multi-constellation, where GALILEO will become the basic system. In addition to GNSS reference stations standard infrastructure, 14 sites are equipped with automated meteorological sensors.



Observation data from reference stations are stored and processed in a Management Centre which is divided into two locations – Warsaw (main centre) and Katowice. This is because of data security and service continuity reasons.

The ASG-EUPOS system has been established to serve the users assisting them in various applications that require precise and reliable positioning or navigation of objects. In order to fulfil the various requirements, concerning precision, usage costs, availability, etc, five standard positioning services have been developed (see Table 1). In addition, a sixth Technical Support service is maintained by the ASG-EUPOS Management Centre.

Table 1. Positioning services of the ASG-EUPOS system

General division	Service name	Measurements method	Data transmission	Estimated precision	Minimum hardware requirements
Real-time services	NAWGIS	Kinematic (DGNSS)	Internet/GSM	1.0 - 3.0 m	L1 GPS receiver, communication module
	KODGIS			0.2 – 0.5 m	L1 GPS receiver, communication module
	NAWGEO	Kinematic (RTK)		0.03 m (horiz.) 0.05 m (vert.)	L1/L2 GPS receiver, communication module
Postprocessing services	POZGEO	Static/kinematic (postprocessing)	Internet/hardcopy	0.01-0.10 m	L1 GPS receiver
	POZGEO D				

Since June 2, 2008 the precise satellite positioning system ASG-EUPOS has been running at full operability. Until today, all services remain free of charge for the registered users.

The ASG-EUPOS project was co-funded from the resources of the Sectoral Operational Programme „Improvement of the Competitiveness of Enterprises 2004—2006” (SOP ICE), Measure 1.5: Development of a system of entrepreneurs’ access to information and public services on-line. The overall budget for the ASG-EUPOS System equals 28 921 165 PLN including the qualified expenses equal 27 946 121 PLN wherein 75% of qualified expenses comes from subsidisation from the European Regional Development in total the sum 20 959 590 PLN (€5,239,898).

In 2011 a major development in ASG-EUPOS network management was made - a new Trimble VRS3Net v. 1.4.1 software was introduced and replaced the previous Trimble GPSNet/RTKNet software. Additionally, due to software limitations, several reference station changes occurred:

- 5 stations were excluded from the network RTK solution: CBKA (Warszawa), ELBL (Elbląg), OLST (Olsztyn), POZN (Poznań), WLAD (Władysławowo) due to obsolete hardware,
- a new station KRA1 (Kraków) appeared – EPN G2 station that replaced KRAW in ASG-EUPOS network,
- a new station KROL (Olsztyn) appeared – new G3 station replacing the old OLST station in network RTK solution,

- on 4 stations equipment was replaced with new G2 receivers: NWSC (Nowy Sacz), NWTG (Nowy Targ), PROS (Proszowice), TRNW (Tarnów).

A total number of 100 reference stations with 24 GPS+GLONASS stations work now in the Polish territory within the ASG-EUPOS framework. All stations are kept up to date in ESDB.

The present distribution of the ASG-EUPOS reference stations is shown on Fig. 1. The plans for the nearest future include modernization of ELBL station towards G3 capability

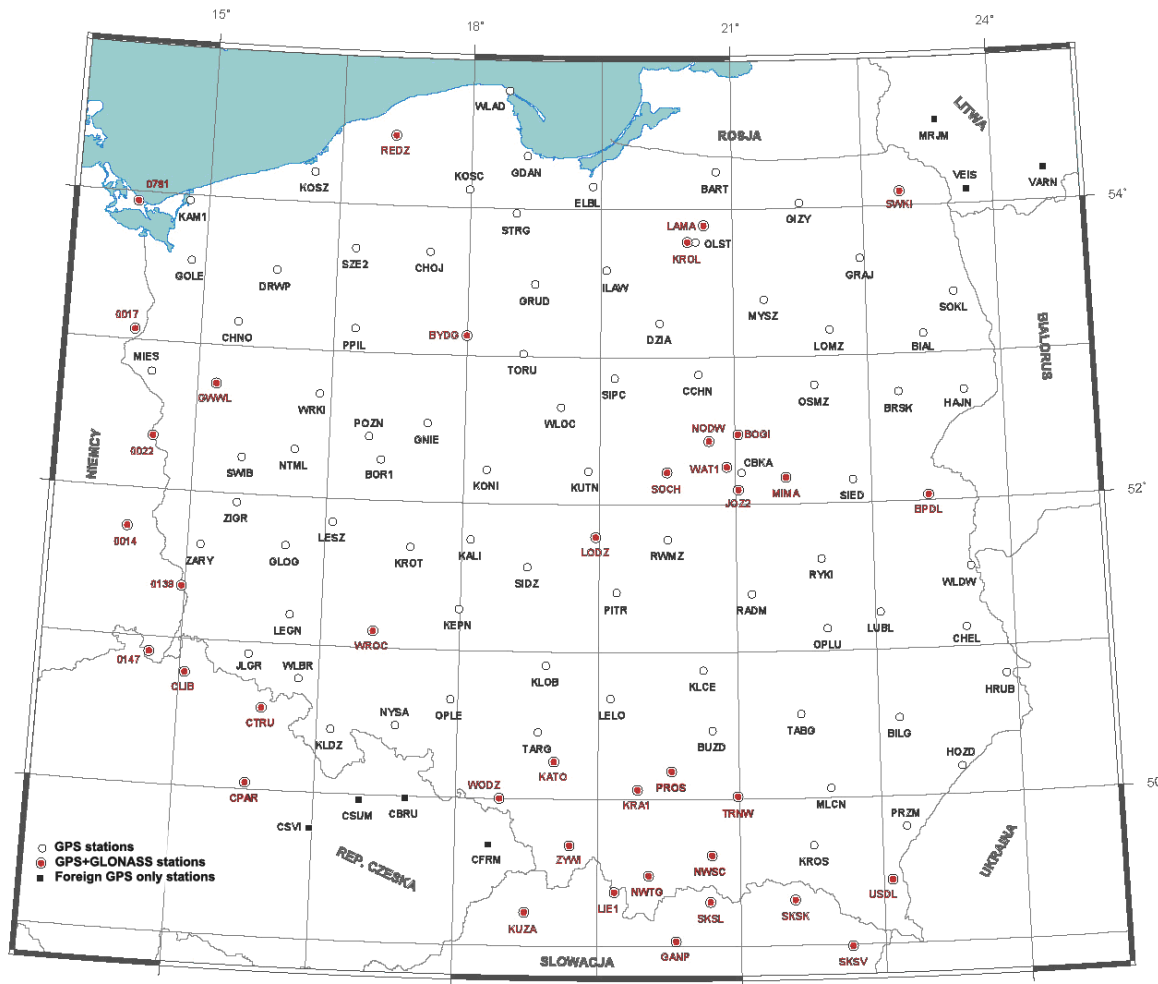


Figure 1. Distribution of the ASG-EUPOS system reference stations on Dec. 1, 2011.

2 Ukrainian stations are being still tested for performance: SHAZ (Shatsk) and VBER (V. Berezniy). Another, earlier planned SULP (Lviv) station does not fulfill Trimble VRS3Net minimum requirements and until the equipment modernization it will not be included in the ASG-EUPOS network.

Due to the appearance of GPS+GLONASS sub networks, ASG-EUPOS system started to provide Network RTK VRS corrections for the area of Warsaw (6 stations) and Silesia-Małopolska (total 13 stations including 5 SKPOS stations).

Current main ASG-EUPOS usage statistics show, that the system is growing constantly from the very beginning of its official operation. The number of registered users exceeds now 5200 and the most popular real-time service NAWGEO (RTK) sums up to 650 simultaneous connections in the peak hours every day.

It is worth mentioning that a second step of the ASG-EUPOS calibration campaign was also finished and

the stations were processed along with almost 500 ground control points to create a uniform reference system in Poland. Until the end of 2011 the review and an independent calculation are being performed in order to confirm the results of the campaign. Finally since Jan. 1, 2012 new coordinates of reference stations in ETRF2000 are going to be introduced into ASG-EUPOS system.

EUPOS news from ESTONIA

The Estonian Land Board has 9 EUPOS stations, including 4 EPN stations. Plans exist to build 8 stations more and to establish networked RTK services. Additionally several private companies in Estonia have 39 GNSS stations and these are providing RTK services also. Weekly calculations for 48 Estonian GNSS stations are started.

EUPOS news from ROMANIA

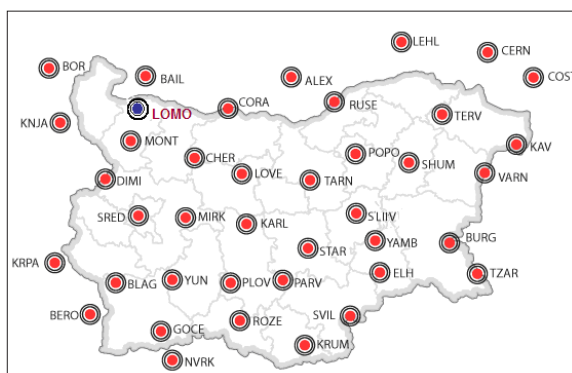
The most important objectives that will be touch in 2012 are:

- the acquisition of 30 supplementary licences for the Leica GNSS Spider software. These will allow to integrate the GNSS stations from neighbouring countries in our network and consequently improving the quality of the network products;
- our National GNSS Permanent Network will be complete by reaching the number of 75 permanent stations (EUPOS recommendation for Romania is 73). Please consider also the following issues concerning the present situation of ROMPOS:
- in June 2011 our Leica GNSS Spider software suffered a major up-grade operation which implied changing of the users' data base, improvement of the real time services and so on;
- in Romania the real time services are still free of charge, users paying only the post-processing products (RINEX files)
- the number of users increased exponentially this year: while in January 2011 we counted about 850 users, now we have about 1400 users.

EUPOS news from BULGARIA

Present status of BULiPOS-Leica Network

The national segment of EUPOS in Bulgaria is now the integrated network BULiPOS – Leica, which is enlarged with one more station (SLIV) in Sliven town and a second additional station will be installed soon in Lom town.



Present status of BULiPOS-Leica Network

In this way the total number of DGNSS stations on territory of Bulgaria is increased to 29 as the network is connected to 12 more *EUPOS* stations on the territory of the neighboring countries. The network operates successfully and it is one of the most used DGNSS networks in Bulgaria.

Applications

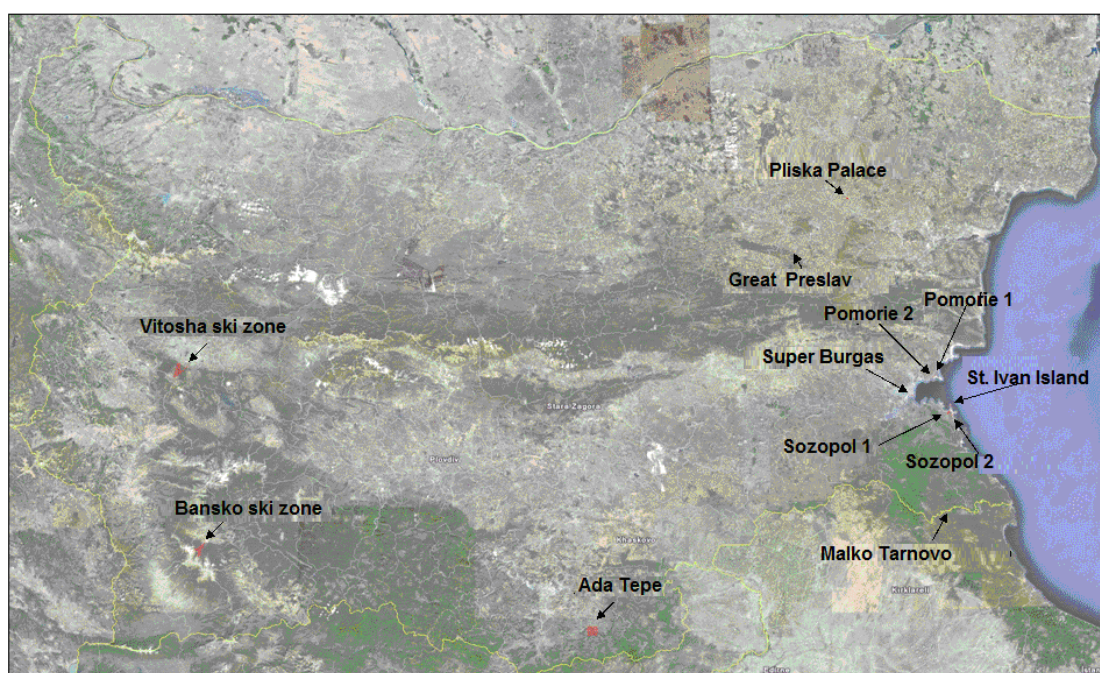
The advanced geodetic technologies: spaced and aerial – (remote sensing, GNSS), photogrammetric, laser and other sensor systems and technologies for air shots, including photometry, air laser scanning of land and under-water surfaces etc. aerial digital cameras and scanners are used and GNSS receivers and inertial systems for navigation), and terrestrial technologies are used more widely in Bulgaria in different fields like protection and monitoring of the environment, security, engineering objects and their complexes, urban territories, forests, agriculture, flooding, archeology and many others.

In the process of aerial survey or scanning the navigation of the plane or helicopter is carried out by using active permanent GNSS stations and inertial systems. GNSS coordinates of the front nodal point of the objective of the digital camera, respective of the scanner are determined at the moment of exposing. According to the purpose and the accuracy of the respective application it is necessary or not necessary to be used additional geodetic (GNSS) determined points or group of points. Further they are used as control points in the aerial triangulation, in photogrammetry or as group of terrestrial control points in aerial laser scanning.

Except the mentioned applications the geodetic networks and systems are a base for so called “georeferencing”, i.e. reducing the data and results to defined coordinate system and for respective coordinate transformations as well.

In November 2009 BLOM Group carried out laser scanning of the land and under-water relief section of 100 km² of the Black Sea coast between Lozenec and Primorsko by Hawk Eye laser system. The parameters of the survey of the land (topographic – red laser) and the under-water relief (hydrographic – blue laser) are established. For archeological purposes it was developed GIS.

In December 2010 BLOM Group carried out laser scanning of 10 objects on the territory of Bulgaria. The objects covered archeological and mining objects, port and areas for ski racing track in Vitosha and Pirin mountains (Figure).



Laser scanning objects in December, 2010

EUPOS news from SERBIA

Automatic data post processing

In addition to the default service that provides a software package GPSNet, a control center of a national network of GNSS stations of Serbia is, in cooperation with colleagues from Sweden, correctly their national network of SWEPOS implemented the service of automatically post processing. In locations where there is no signal by the mobile operators user collecting data in static mode outside of AGROS. After coming to office sends its data by (in RINEX format) e-mail to agros@rgz.gov.rs where the data checked, tested and sent to Bernese software package for processing. Application by defined values using 5 nearest stations of AGROS system from which calculate the position of the receiver. In this way the user is confident in the quality of the result obtained within defined date in AGROS system.

Quality Control

For the needs of daily activities and obligations control center of national network of GNSS stations of Republic of Serbia has developed a several applications for control of the work of permanent station, whose reports on a daily basis are used to control the operation of the AGROS system itself. One of these applications is a quality control of permanent stations. The application is built in Java and provides information in alphanumeric form on the status of an antenna and receiver as well as on the environment in which equipment is installed. Information on the environment include insight into the effects of reflection, radiation, frequency interference, etc. Visualization of the alphanumeric data was done in MatLab program. Graphical views are generates for the amplitude of the L1 and L2 frequencies, reflections on the same frequencies, the availability of satellite, ionospheric delays on both frequencies, azimuths and elevation of satellites and so on. The same application with less information is designed for users of the system AGROS. It is free and can be downloaded at www.rgz.gov.rs/agros. On the address, given above, is also made a technical user guide with main purpose to help users to understand the report which is generated on the server of AGROS system.

Alarm service

The following service which is designed for user needs is named the alarm service. The idea for the development of this service came from colleagues from the Swedish national network SWEPOS. Use of this service is free. Alarm service works by sending information of the work of a national network of permanent stations of Republic of Serbia by text message and viewing the station at the web address www.rgz.gov.rs/agros.

Monitoring service

Development of a new service that will provide even greater transparency of the control center of a national network of GNSS stations of Republic of Serbia, as well as the possibility of insight into the work of system to each user in real time. In this way the user will be able to see if it is a problem that occurs on the field related to AGROS system or something else. New service called monitoring service will be developed in cooperation with colleagues from the Swedish national GNSS network SWEPOS. For purposes of this service it initially appears will be established a rover station. The stations will simulate the work of the rover (user) in the field. The service will be free and will work through the internet web page on which at any moment will be able to see and monitor the rover station, the time of initialization, the positional and vertical accuracy and so on.

Development of backup center

By signing the contract of business and technical cooperation between the Republic Geodetic Authority and private company Vekom began the period of development back up center of a national network of GNSS stations in Serbia. The first step after signing the contract on business and technical collaboration has been implementation of the stations of previously private network VekomNet in the system of national

GNSS network of the Republic of Serbia - AGROS. Implementation required the deployment of stations to locations designated by the Republic Geodetic Authority, redirecting all data from permanent stations of Republic of Serbia on the backup server and shutting down some specific stations at locations that were not included in the system of national GNSS network of Republic of Serbia. After these operations have been completed a unique system named AGROS. In this way, users will have the opportunity to work on two servers, to use a single tariff system according to the official price list of the Republic Geodetic Authority, and also increased reliability and safety when working in the field

Development of local analysis center in the EPN network

The Republic Geodetic Authority and its activities during the previous year, he proved that he can join the community and applied to, within its scope, structure such a local computer center EPN. Candidature of the Republic Geodetic Authority has received and granted him the subnet that the future will be processed in the Republic Geodetic Authority. This network consists of 19 EPN stations that were the definition of geodetic datum EUREF campaigns in Serbia 2010, when he realized ETRF frame of reference in the Republic of Serbia. Furthermore, this network has entered the 25 EPN stations in the immediate environment, which have been addressed in only three local data center. It will also enter into this subnet and 4 (four) points out AGROS network Plandište, Dimitrovgrad, Novi Pazar and Sabac, which are nominated and are currently in the process of becoming permanent stations of the European Network (EPN). Currently the local computer center EPN in RGA, in the test phase, and official results will be the local data center start to produce from the 1640th GPS week.

Cooperation with neighboring networks

In accordance with the recommendations *EUPOS*, a national network of the Republic of Serbia signed an agreement to exchange data with the Hungarian national network. With national networks of Romania, Macedonia, the exchanges of data, and is soon expected to sign the contract. It also performs the data exchange with colleagues from Bulgaria networks.

Implementation of coordinate reference system ETRF2000

According to the legal provisions Republic Geodetic Authority has been obliged to of the first January 2011 switch to a new coordinate system ETRF2000. For this purpose, the control center of a national network has taken a number of activities. The local computer center EPN in the Republic Geodetic Authority will work within AGROS control center.

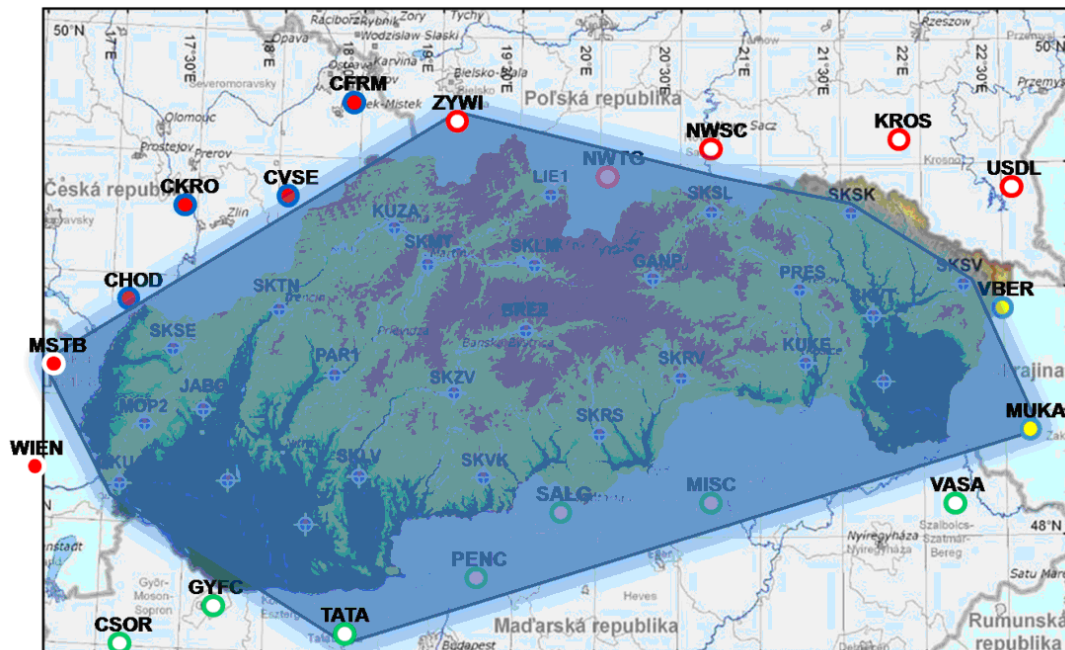
EUPOS news from LATVIA

LatPos in Year 2011 has finished system improving and optimization. In two year period ten antennas has been moved to better sites. Three new stations Mazsalaca, Dagda and Palsmane have been established. Total of 23 stations are up and running. To improve network preciseness, recalculation of all station coordinates will be performed. Data collection was done in October 2011. This year one new station will be purchased to improve overlay.

EUPOS news from SLOVAKIA

SKPOS service as an integral part of *EUPOS* is running well from its beginning which is considerable to November 2006. Actual service infrastructure consists of 26 permanent stations and all station devices observed both GPS and GLONASS satellite systems. Service control software was recently changed from Trimble GPSNet to Trimble VRS3Net and first four foreign border permanent stations (TATA, MSTB, ZYWI and MUKA)

were introduced to SKPOS for enhanced RTK performance and quality in border regions.



Registration to service is charged for RTK users and for post-processing purposes with flat rate 90,- EUR per technical year (365 from the date of registration). SKPOS service supports just VRS (virtual reference station) concept for network RTK measurements and provides corrections only in RTCM formats. RTCM 3.1 format contains also message types 1021 (7-Helmert transformation parameters) and 1023 (geoid undulation corrections) which assures for users correct transformation from ETRS89 to national geodetic and vertical datum. SKPOS service is available on <http://www.skpos.gku.sk>.

Events

- 22-27.04.2012 - General Assembly of the European Geosciences Union, Vienna, Austria. www.meetings.copernicus.org/egu2012
- 14-18.05.2012 - United Nations/Latvia Workshop on the Applications of Global Navigation Satellite Systems, Riga, Latvia
- 20-31.08.2012 – General Assembly of the International Astronomical Union, Beijing, China. www.astronomy2012.org
- 23-27.07.2012 - IGS Analysis Center Workshop 2012, Olsztyn, Poland. lgs.cb.jpl.nasa.gov/pipermail/igsmail2011/006436
- 16-20.09.2012 GNSS2012 ION Technical Meeting, Nashville, Tennessee, USA.

The EUPOS Newsletter is prepared by:

Gerd Rosenthal, Senate Department for Urban Development and the Environment, Berlin, Germany
gerd.rosenthal@senstadtum.berlin.de, gerd.rosenthal@eu-pos-isco.org

Gabriele Wolter, Senate Department for Urban Development and the Environment, Berlin, Germany
gabriele.wolter@senstadtum.berlin.de

Janusz Sledzinski, Warsaw University of Technology, Poland
jsledzinski@gik.pw.edu.pl