

EUPOS® – An International Initiative towards GNSS-based Positioning Infrastructure for Central and Eastern Europe

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Summary

EUPOS® (European Position Determination System, see www.eupos.org) is an international organization of European public institutions related to the development and maintenance of real-time GNSS services. The most important task of EUPOS® is to support the realization and maintenance of precise national positioning services based on dense national active GNSS networks.

EUPOS® members had elaborated commonly defined standards, which then were offered for implementation in the national positioning services. Those standards are necessary to maintain homogeneous high quality services and seamless cross-border applications. EUPOS® promotes those standards to countries, where the establishment of GNSS production networks is planned or it is on the way.

Another important task of EUPOS® is to represent the members in international bodies and also act for the common interests in international bodies such as RTCM (Radio Technical Commission for Maritime Services) or ICG (International Committee on GNSS). The current EUPOS® members come mainly from Central and Eastern Europe, but EUPOS® has connections to Central Asian countries as well. However EUPOS® is willing to attract more European members and willing to establish a common discussion forum for all GNSS service providers.

Zusammenfassung

EUPOS® (European Position Determination System, siehe www.eupos.org) ist eine internationale Initiative von öffentlichen Vermessungs- und Katasterinstitutionen der Länder Mittel- und Osteuropas, die auf den Aufbau, die Laufendhaltung und die weitere Entwicklung der GNSS-gestützten Echtzeit-Positionierungsdienste gerichtet ist. Die EUPOS®-Mitgliedsstaaten haben gemeinsam die der modernen Echtzeitpositionierungsdienst unterliegenden technischen Standards definiert, ausgearbeitet und in einzelnen Nationalblöcken eingeführt, womit ein homogenes, zusammenhängendes GNSS-Permanenznetz entstand, das sich über einen beträchtlichen Teil Mitteleuropas und die Gebiete einiger Osteuropäischen Staaten ausbreitet. Gemeinsame technische Standards sind wichtig, um die erforderliche Homogenität der Dienste und länderübergreifende nahtlose Anwendungen zu gewährleisten. EUPOS® fördert diese Standards auch in den Ländern, in denen der Aufbau der Positionierungsdienste erst geplant wird oder sich in der Anfangsphase befindet. Eine wichtige Aufgabe von EUPOS® ist es weiterhin, die Mitglieder in den internationalen Organisationen, wie z. B. RTCM (Radio Technical Commission for Maritime Services) oder ICG (International Committee on GNSS), und ihre Interessen in diesen Organisationen zu vertreten. Obwohl die gegenwärtigen EUPOS® Mitglieder meistens aus Mit-

tel- und Osteuropa kommen, erhält EUPOS® auch die Verbindungen mit einigen Ländern der ehemaligen Sowjetunion in Zentralasien aufrecht. Das Ziel von EUPOS® ist, weitere Länder zur Zusammenarbeit einzuladen und ein Diskussionsforum für die Organisationen zu schaffen, die Echtzeit-Positionierungsdienste betreiben.

Keywords: GNSS, positioning, network, cooperation

1 Introduction

The advent of new information and communication technologies about 25 years ago brought about a revolution in geodetic observation techniques and in parallel accelerated the evolution of the human society towards an information society. Such a society is to a large extent based on different kinds of information, the majority of which must be referenced in an appropriate way. This gives rise to the geographic information systems which became an essential tool in state and local administration, in many branches of national economy and also in earth sciences.

It becomes more and more evident that at the time of increasing political and economic integration running in today's Europe a suitable infrastructure for operational positioning and navigation is absolutely necessary. About 80 % of all political decisions made on different levels of the state administration are based on spatial information. Therefore, a decisive aspect is to provide a relevant and efficient spatial information which can only be done if necessary infrastructure is available.

Much of the related responsibility for creating and maintenance of such an infrastructure is on the National Mapping and Cadastral Agencies of individual countries but also many other active subjects are involved in both provider and user spheres. Since georeferencing and/or navigation are essential for spatial information, the corresponding infrastructure is generally based on the services provided by Global Navigation Satellite Systems (GNSS).

Although the applications based on positioning with GNSS have been developed for about 20 years, the first country-wide systems of GNSS reference stations providing positioning services in differential mode (DGNSS – Differential GNSS) on different accuracy levels and with different latencies were in some West European countries set into a routine operation in the second half of 1990's. The contribution of such permanent DGNSS was fasci-

nating, however, the disadvantage was that these systems were mutually non-compatible due to the way they had been built up and operated.

The Central and East European countries arrived at a decision to build permanent DGNSS arrays a few years later – in the first years of the new millennium. Therefore, there was a chance for them to approach the problem jointly in a cooperated way and to benefit from the experience of the West to avoid some disadvantages associated with the early stage of the Western DGNSS systems. The incentive for such a co-operation came from the Berlin Senate Department for Urban Development in cooperation with the European Academy for Urban Environment (EAUE) Berlin. These two German institutions organized the first international workshop “Multifunctional GNSS Reference Station Systems for Europe”, which was held on 4 to 5 March 2002 at the EAUE in Berlin. Over 60 participants from 16 countries came together to discuss the feasibility of the establishment of compatible DGNSS reference station systems in the countries of Central and Eastern Europe and to initiate necessary coordinated steps towards this goal. The essential idea was that the DGNSS service should be based on international standards and standardized data formats for all types of users (real time and/or post processing), e. g., from navigation, transport, fleet management, security tasks, environmental protection, climate research, disaster management and geoinformation systems.

It is important to note, that the above mentioned workshop was not only an isolated single event but it laid the foundation stone to a new joint initiative of a number of European countries towards building DGNSS services. It was immediately followed by several successive organizational milestones – establishment of the EUPOS® International Steering Committee (ISC) in Warsaw in July 2002 with representatives of the participating countries, the EUPOS® Steering Committee Office (ISCO) in Berlin in 2002, which gave a firm operational background for the management and the administrative framework for EUPOS®, and a series of ISC working meetings, workshops and symposia where many details of the cooperation were discussed and necessary decisions were taken. Very important was also another special workshop destined for decision-makers and stakeholders (mostly officials of the National Mapping and Cadastre Agencies) from the participating countries which was again organized in Berlin in autumn 2002 and hosted by the European Academy for Urban Environment (EAUE) in cooperation with the Berlin Senate Department for Urban development. This workshop was of a significant help in the start-up phase of preparation and realization of the DGNSS projects on the national level.

The initial DGNSS workshop and follow-up actions gave rise to a new international initiative called EUPOS® which was originally formed by 16 Central and Eastern European (CEE) countries. The main goal of this initiative was the establishment and operation of a “full accu-

racy scale” ground based GNSS augmentation system by means of unified multifunctional GNSS reference station systems as a fundamental infrastructure for the interested CEE countries represented at the Berlin workshop as well as for CEE and other countries that would have been interested to join this initiative later.

2 EUPOS® Structure and Membership

EUPOS® should be considered as a mosaic of national segments operating according to common standards under the coordination of the International EUPOS® Steering Committee (ISC). Its organizational structure consists of the International EUPOS® Steering Committee, its Office, National EUPOS® Service Centers and EUPOS® manufacturers and resellers, see Fig. 1. The organizational structure includes international and national levels. The official level consists of the ISC with its working groups and delegated ISC representatives to other organizations, the Office of the ISC (ISCO) and one National Service Centre (NSC) per country. The EUPOS® member countries are free to make independent decisions (EUPOS 2012).

The ISC may establish working groups to investigate specific topics of interest, cooperation and coordination and to report at the ISC conferences. Two working groups, which still continue working, were established in 2006. It is the WG on Technical Cooperation with the Industry (TCI) and the WG on System Quality, Integrity and Interference Monitoring (SQII).

In general, the members of the ISC discuss all relevant questions and make decisions by resolutions. Members of the ISC are:

- one representative of each EUPOS® member country,
- representatives of other states, organizations, institutions, companies etc. that became members of the ISC when it was founded,
- head of the ISC Office.

The ISC mainly pursues the following goals:

- overall coordination, collaboration and management for realization, completion and running of a ground based GNSS augmentation basis infrastructure in the participating European countries,
- support of the representatives from Central and Eastern European (CEE) countries in accomplishing political acceptance, applying for financial support,
- solving the problems related to technical issues, product definition, standardization,
- support of reference station system establishment in the member countries,
- support by providing training of experts and technical staff,
- dissemination of information on EUPOS®, the current status and corresponding items,
- agreements with manufacturers of EUPOS® compatible hardware and software,

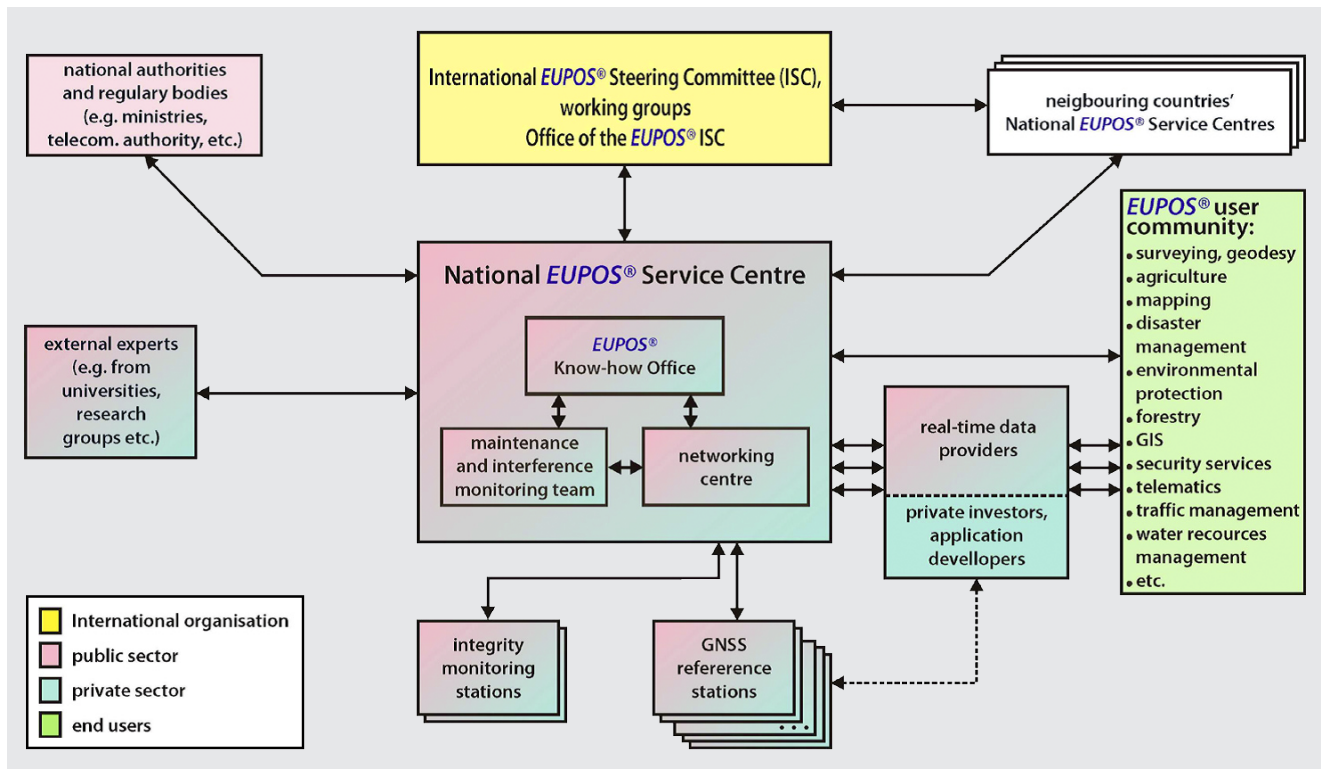


Fig. 1: Organizational Structure of EUPOS® initiative

- organization and coordination of software and hardware tests in cases of new developments,
- support of the EUPOS® initiative as uniform basic infrastructure for Europe going beyond the EUPOS® project of the involved CEE countries.

The Office of the International EUPOS® Steering Committee (ISCO) is the central point of contact for matters of international importance. The main task of the ISCO is to prepare conferences of the ISC and to represent the ISC in international organizations. From the very beginning of the EUPOS®' existence until May 2013 the Office was headed by Gerd Rosenthal of the Senate Department for Urban Development, Berlin, Germany. After that, the duty was transferred to Artur Oruba, Head Office of Geodesy and Cartography, ASG-EUPOS® Management Centre, Warsaw, Poland.

In each member country a National Service Centre (NSC) is established. It is usually associated with a National Mapping Agency's organization. The NSC is managed by the national administrator of the national EUPOS® segment. It is basically responsible for the tasks of planning, establishment, operation and maintenance of the national EUPOS® network.

The EUPOS® membership is voluntary. The members are obliged to observe the adopted unified technical standards and the terms of reference of the EUPOS® initiative. Countries willing to join EUPOS® are asked to contact the ISC or the ISCO. The admission of a new member to the organization is confirmed by the resolution of the ISC. In exceptional cases the ISC has the freedom to decide whether to accept non-country members as well. The

present EUPOS® members come from Bosnia and Herzegovina, Bulgaria, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Latvia, Lithuania, Macedonia, Moldova, Montenegro, Poland, Romania, Russian Federation, Serbia, Slovak Republic, Ukraine and advisory the Capital City of Berlin, Federal Republic of Germany. The FRG state Hamburg was a EUPOS® member until the end of 2007. The Republic of Slovenia has an observer status.

3 EUPOS® Observational Segment

The EUPOS® observational segment is a mosaic of national segments consisting of a number of permanent GNSS reference stations with spacing of about 70 to 100 km which is built and operated according to uniform technical standards. The first design of the entire EUPOS® network had been created on the basis of national contributions submitted at the 3rd EUPOS® ISC meeting held in Berlin in November 2003 and later modified in accordance with the development of national concepts and realization conditions. The overview of the stations that are actively maintained in the EUPOS® network and provide up-to-date technical information is represented in Fig. 2 (EUPOS-ESDB 2014).

Considering the current state, the EUPOS® ground based GNSS augmentation system will cover about 25 % of the EU territory, a large part of Europe and a part of the territory of South-West Asia. Almost all stations, which are being currently operated in the EUPOS® national segments, are GPS/GLONASS capable and a majority of them is equipped with a multi-GNSS oriented hardware.

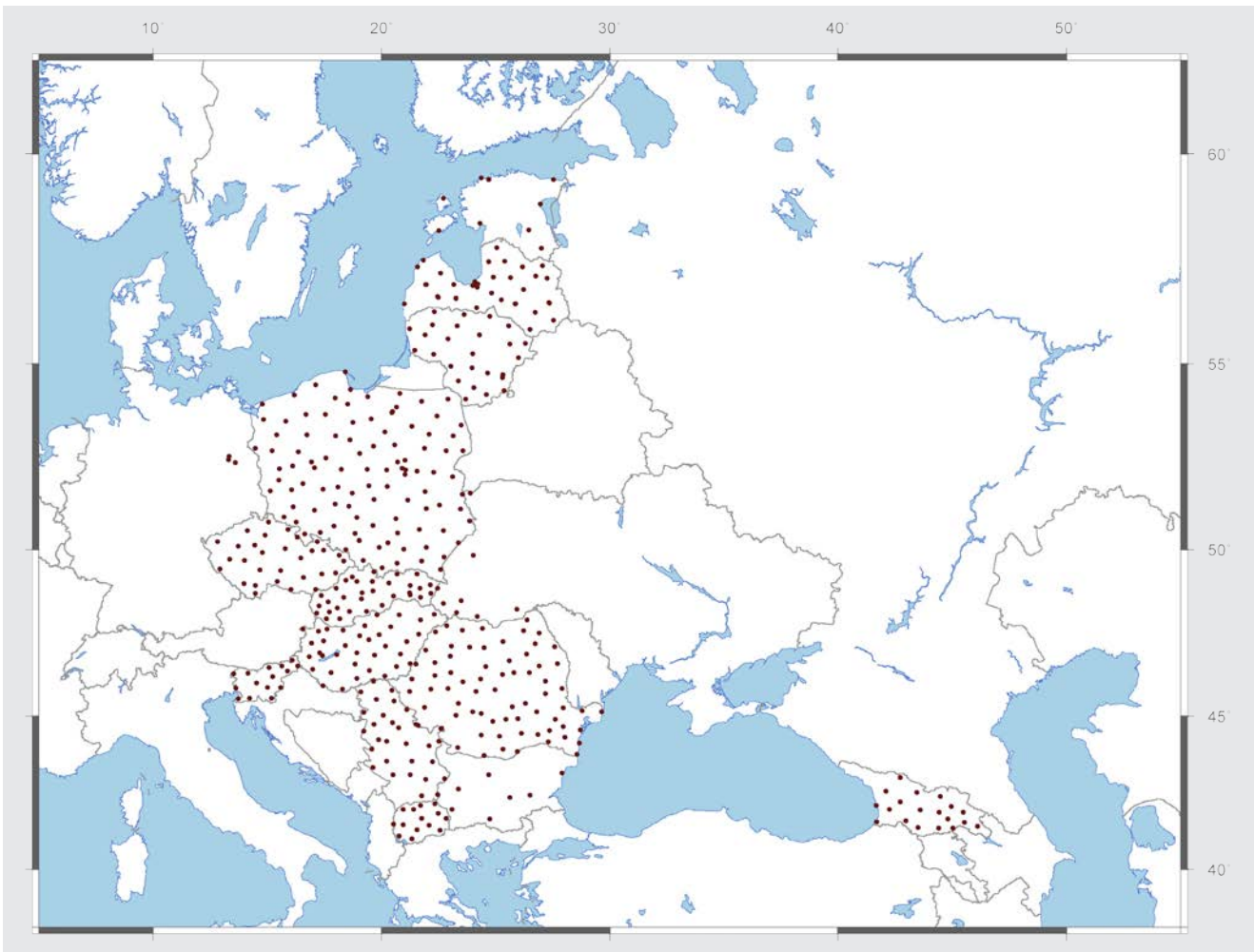


Fig. 2: Distribution of the EUPOS® reference stations contributing actively to the EUPOS® Station DataBase (ESDB)

A review of the current status of the EUPOS® reference station system realization is given in Tab. 1. The technical specifications of the EUPOS® system and of its components are presented in more detail in the next section.

4 EUPOS® Technical Specifications and Data Policy

An essential idea of EUPOS® is to deploy unified standards and communication lines to achieve a full interoperability and compatibility. For this purpose, a special working group elaborated the EUPOS® Technical Standards (EUPOS® ISC 2013) as a basic document for the EUPOS® system function and three guidelines:

- EUPOS® guidelines for single site design (EUPOS® ISC 2008),
- EUPOS® guidelines for cross-border data exchange (EUPOS® ISC 2006),
- EUPOS® guidelines for reference frame fixing (EUPOS® ISC 2007).

From the very beginning of its operation, EUPOS® was designed to support multi-constellation GNSS, providing various signals to the users, ensuring that the widest pos-

sible variety of end-user equipment supports services offered by EUPOS. Taking into account political and geographical aspects, EUPOS® promotes the European system Galileo. To enhance the performance, robustness and availability of position solutions in GNSS-challenged environments (urban canyons, tree canopies), it is recommended to develop EUPOS® as a multi-GNSS oriented system supporting all available GNSSs.

EUPOS® also aims at ensuring compatibility and interoperability between the EUPOS® members (providers), which means that EUPOS® users who meet the EUPOS® technical standards could use the EUPOS® services anywhere within the EUPOS® network. The following GNSS are used/foreseen:

- European Galileo as basic standard when Galileo Full Operational Capability is declared,
- U. S. Global Positioning System (NAVSTAR GPS) as basic standard,
- Russian Global Navigation Satellite System (GLONASS) as optional standard,
- Chinese BeiDou as optional standard.

A necessary prerequisite for compatibility and interoperability is also the implementation of a uniform reference frame throughout the EUPOS® network. The official

Tab. 1: Operational EUPOS® stations – status April 2014

EUPOS® member	Area [km ²]	Number of realized EUPOS® or compatible reference stations
Berlin, Germany (DE)	–	4
Bosnia and Hercegovina (BA)	51.000	36
Bulgaria (BG)	110.950	7
Czech Republic (CZ)	78.870	28
Estonia (EE)	45.220	9
Hungary (HU)	93.030	36
Kazakhstan (KZ)	2.717.300	30
Latvia (LV)	64.600	29 ¹
Lithuania (LT)	65.300	26
Macedonia (MK)	25.330	14
Moldova (MD)	33.846	2
Montenegro (ME)	13.812	?
Poland (PL)	323.520	101
Romania (RO)	237.500	75
Russian Federation (RU)	17.075.000	31 ²
Serbia (RS)	88.360	32
Slovak Republic (SK)	49.035	29
Slovenia (SI) (observer)	20.270	15
Ukraine (UA)	603.700	13

1 including six stations of the Riga City region network

2 stations distributed in seven districts

geodetic terrestrial reference system for EUPOS® is the European Terrestrial Reference System 1989 (ETRS89). If the participating country uses other official national reference system than ETRS89, the EUPOS® National Service Centre shall provide the EUPOS® users with the official precise transformation parameters between ETRS89 and the official national reference system.

EUPOS® ensures the annual system and services availability of at least 99 %, guaranteed by appropriate technical and organizational measures.

The EUPOS® reference stations are linked within a network and transfer the GNSS information to a networking center. This networking center computes highly precise information on troposphere, ionosphere and GNSS satellite orbits, which helps to mitigate the disturbing effects and biases depending on the current GNSS rover position in real-time. Particularly, this procedure enables a very high accuracy of positioning up to one centimeter in real-time.

EUPOS® provides the following services for Differential GNSS applications utilizing Internet as the medium for data transmission:

- EUPOS® DGNSS for real-time applications by single-frequency pseudorange or pseudorange and carrier-

phase measurements with sub-meter to decimeter level accuracy,

- EUPOS® Network RTK (Real-Time Kinematic) for real-time applications by multi-frequency carrier phase measurements with centimeter accuracy,
- EUPOS® Geodetic for post processing applications by code and carrier-phase measurements in static or kinematic mode with decimeter up to sub-centimeter accuracy.

The specification of the user interface and technical requirements concerning both services and infrastructure of EUPOS® is standardized in the EUPOS® Technical Standards (EUPOS 2013) document.

In order to provide up-to-date and coherent description of the EUPOS® reference stations for the purpose of cross-border data exchange, all EUPOS® reference stations are documented and described in detail by EUPOS® NSCs.

For this purpose the EUPOS® Station Database (ESDB) is maintained. The ESDB stores and provides to EUPOS® National Service Centres at least the information identical to IGS (International GNSS Service) site log contents (EUPOS-ESDB 2014).

Even though all EUPOS® members provide the services based on common standards, thus compatible in the technical way as seen from the user's perspective, the legal differences between the countries currently prevent EUPOS® from creating one common data policy for all

the products. These limitations lead to differences in the pricing schemes and the possibilities to use the EUPOS® data in scientific applications. The EUPOS® ISC acts to promote the free use of GNSS observation data for research purposes. While the EUPOS® services are not fully harmonized in terms of data and payment policy, a potential user should approach every National Service Centre directly. Here the EUPOS® ISCO assists the future users in establishing proper contacts.

5 EUPOS® Outreach Activities

After the EUPOS® ISC had been established, many activities have been concentrated to the preparation and implementation of EUPOS® as well as to its publicity and anchoring to the current international political background. Besides presentations at several symposia, expert meetings, conferences, etc. some negotiations and contacts are particularly worth mentioning.

The EUPOS® Project was presented by the ISC and discussed at the Galileo Joint Undertaking (GJU), which was the top authority in the Galileo development at that time, and EC EuropeAid offices in Brussels, Belgium on No-

vember 12th, 2003. GJU accepted the necessity of reference station systems enabling the user to obtain accuracies higher than are provided by Galileo, emphasized that EUPOS® included many European countries and noted as a very positive aspect that EUPOS® would provide signals for both precise geodetic position determination and for land, air and marine navigation. The EuropeAid was interested to know why Ukraine and Belarus are not included in the initiative. Ukraine then became a member of the EUPOS® in 2005. The information exchange between GJU (later GSA) and EUPOS® management continued for several years.

Since the beginning EUPOS® has been keeping an information exchange with the International Association of Geodesy (IAG) Subcommittee for Europe "EUREF", and the EUREF Technical Working Group delegates its representative to the EUPOS® ISC. A Memorandum of Understanding concerning the cooperation between EUPOS® and EUREF should be already available at the moment when this article is published (EUPOS 2014).

The vision of a uniform European DGNSS infrastructure was born in the late nineties. EUPOS® itself presented this idea at a series of regional workshops and international meetings of experts on the use and applications of GNSS, which the United Nations Office for Outer Space Affairs (UN OOSA) has been organizing since 2001 in co-sponsorship with the Government of the United States of America. The International Workshop reviewed the implementation of project proposals from the series of GNSS meetings with a view to prioritizing the projects for support by the UN OOSA. EUPOS® was identified as one of the priority projects that were submitted. The UN OOSA noted with satisfaction that EUPOS® would be the first ground-based GNSS infrastructure of its kind with a regional extension and that EUPOS® significantly enhance the scope of use and applications of GNSS as well as their scientific, social and economic benefits. It was also pointed out 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, which was established by the UN Committee on the Peaceful Uses of Outer Space (COPUOS), EUPOS® participated in the UN/Zambia/ESA Regional Workshop on the Application of Global Navigation Satellite System Technologies in Sub-Saharan Africa held in 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. A successful participation of EUPOS® in this regional workshop then continued with the participation in regional workshops on multifunctional GNSS systems and applications held in 2010 in Chisinau, Moldova and in 2012 in Riga, Latvia.

In 2004 the COPUOS Action Team on GNSS recommended 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 (UN GA 2004).

At the UN International Meeting held on 1 to 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. Along with a number of international institutions, EUPOS® was an associated founding member of the ICG (UN GA 2006).

Since the existing international technical standards on DGNSS do not fulfill all demands of the EUPOS® community the ISC followed the requests of the international GNSS equipment industry and initiated the establishment of a EUPOS® working group on Technical Cooperation with the Industry (TCI) and became also a member of the US Radio Technical Commission for Maritime Services (RTCM). In June 2006 EUPOS® was represented for the first time at the meeting of the RTCM Special Committee 104 (SC 104), which set guidelines particularly in the field of the real-time DGNSS. Among other issues EUPOS® is interested in an international standard of RTCM data encryption against manipulation and unauthorized use but also for deduction of charges particularly when broadcast media are used. The RTCM SC-104 established a special working group that is chaired by the EUPOS® representative.

The EUPOS® ISCO organized several international symposia in Berlin and in Brussels which contributed in enormous way to the EUPOS® publicity and to propagation of the GNSS related topics and applications among professionals from different application fields. In 2002 it was the initial symposium on the multifunctional DGNSS systems in Berlin, in 2008 a large International Symposium on Global Navigation Satellite Systems – Space-Based and Ground-Based Augmentation Systems and Applications with more than 200 participants from 28 countries of four continents (with UN OOSA), in 2009 the next international symposium on DGNSS in Berlin with about 80 participants, in 2010 it was the international symposium in Brussels intended mainly for EU officials and for

international organizations from the field of surveying and mapping and in 2011 again the international symposium on DGNSS in Berlin. In addition to it, the EUPOS® ISCO was co-convenor of several regional workshops on GNSS applications organized by UN OOSA in Africa and in several European countries and published also the proceedings of these workshops (EUPOS 2014a).

Currently EUPOS® is actively involved in establishing a cooperation platform for GNSS positioning services together with EuroGeographics, EUREF and CLGE (The Council of European Geodetic Surveyors). The main purpose of this cooperation is to facilitate the creation of a uniform pan-European GNSS infrastructure, improve communication between European decision- and policy makers, GNSS service providers and users, including the popularization of ETRS89 as a reference system for all GNSS applications. In this cooperation also the development of common data policy for all European DGNSS service providers is foreseen, which would make the large-scale use of DGNSS services much easier than today.

6 EUPOS® and European Programs and Projects

The INTERREG IIIC Program was one of the three strands of the European Community Initiative INTERREG III, which was designed to strengthen economic and social cohesion in the European Union by promoting cross-border (A), trans-national (B) and interregional (C) cooperations. In this context nine institutions from eight countries coming from the EUPOS® initiative have decided to go beyond the technical aims of the EUPOS® initiative and to promote the use of the EUPOS® services for the benefit of regional development in the framework of an interregional cooperation. They have formed a consortium under the leadership of the Berlin Senate Department for Urban Development and submitted the application for “EUPOS-Interregional Co-operation (EUPOS-IRC)”. The idea of a joint operation was discussed with and agreed by all partners and received a positive response from both the full EUPOS® partnership and the UN OOSA. The added value of the operation for the EUPOS® initiative was the integration of the EUPOS® services into regional decision processes and activities.

The project was successfully realized in 2006 to 2008 by a consortium of eight EUPOS® partners – Berlin, Hungary, Poland, Latvia (University of Latvia and Riga Geometers), Lithuania, Serbia, Bulgaria, Romania (EUPOS® IRC 2007).

As a part of the Living Planet Program realized by the European Space Agency (ESA), the Gravity field and Steady-state Ocean Circulation Explorer (GOCE) satellite mission was in orbit from March 2009 to November 2013. Under the action “GOCE Data Announcement of Opportunity” released by the ESA at the end of 2006 and aimed at projects benefiting from GOCE data, the EUPOS® group submitted a project, which was accepted by ESA (EUPOS®

Contribution to GOCE Mission, ID 4307). The project pursued two goals:

- testing GOCE based Earth’s gravity field models with the help of very precise terrestrial data coming from the EUPOS® reference stations (height components combined with geodetic levelling),
- testing a feasibility of orbit determination of the low orbiter by the RTK positioning based on a regional terrestrial GNSS array.

A few years ago it was recognized that the observation data produced by the EUPOS® network can benefit not only EUPOS main user groups but also a number of other projects beyond traditional application fields.

The first step was made in 2010 when the EUPOS® Combination Center (ECC) was established. This computing center, which is operated by the Satellite Geodetic Observatory Penc, Hungary, serves for the densification and maintenance of the European Terrestrial Reference Frame (ETRF) realized by the EUREF Permanent Network (EPN). The input data entering a combined solution are time series of GNSS observations which are processed following the topical EPN strategy for the densification of the ETRF. The processed data are in the form of weekly SINEX observation files of EUPOS® stations. The results provide a homogeneous reference frame for all EUPOS® countries which is closer to EPN, enables a feedback with respect to quality check and homogeneity. This forms a good basis for many scientific applications and supports interdisciplinary aspects of permanent GNSS networks. The pilot phase of the ECC has been running since 2010, currently the ECC has been expanding to cover the whole territory of Europe (Kenyeres et al. 2013).

An interdisciplinary approach of EUPOS® manifested itself also in formulating the Memorandum of Understanding between the EUPOS® and EUMETNET. EUMETNET is a grouping of 31 European National Meteorological Services that provides a framework to organize co-operative programs between its members in the various fields of basic meteorological activities. These activities include observing systems, data processing, basic forecasting products, research and development and training. It has been well known for nearly two decades that the zenith troposphere delays derived in processing of GNSS data from permanent stations can be converted into integrated water content in a column above the GNSS station (or along the connecting line station-satellite) and as such strengthen numerical models of the weather prediction. The data from dense GNSS permanent networks like EUPOS® are especially suitable for that purpose. According to the EUPOS/EUMETNET (Network of European national meteorological services) Memorandum of Understanding, EUPOS® will provide the zenith tropospheric delays (ZTDs) derived from its data for the projects of GNSS-ground based meteorology running under the umbrella of EUMETNET, namely for currently running E-GVAP-III and GNSS4SWEC projects (EUPOS 2013).

7 EUPOS® in Transition and New Challenges

A look back upon twelve-year activities of the international initiative EUPOS® shows that the main goals set up at the beginning were achieved. Continuously operated permanent GNSS networks were established in several countries of Central and Eastern Europe and their services and products became an indispensable part of national infrastructures supporting many fields of national economies – transport, agriculture, surveying and mapping, state and local administration based on information systems, geoinformation systems etc. EUPOS® has also been well established on the international floor through links to several important international organizations. Much merit in achieving these results belongs to the Berlin Senate Department for Urban Development that was all the time keeping the EUPOS® ISC Office and ensured the function of the EUPOS® ISC Chair. It is especially necessary to remind the great work done in making EUPOS® publicity, its editorial and publishing activities, organizing many professional workshops and symposia and in supporting participants from non-EUPOS® countries in these events. All this has prepared a platform for extension of EUPOS® from the point of view of both its geographical side and its mission. In 2013 the Berlin Senate Department for Urban Development ceased operating ISCO and performing function of ISC chair. The responsibilities were transferred to the EUPOS® Vice Chairman Artur Oruba of the Head Office of Geodesy and Cartography, Warsaw, Poland and necessary measures were taken for moving the ISCO to the new place of work.

At the same time, new challenges emerged as a result of new EUPOS® related activities started in recent years and also of increasing interest of new – also non-European – countries in the EUPOS® business. Let us remind a big EUPOS® potential not only for today already traditional applications in surveying and mapping, navigation, transport, agriculture, GIS, etc., but also for science, like for example:

- densification of the velocity field in Europe (cooperation with EUREF),
- other applications in geodynamics,
- GNSS ground-based meteorology (cooperation with EUMETNET),
- modeling Earth's gravity field,
- establishing and maintenance of the vertical reference system,
- upper atmosphere studies, space weather applications (UN OOSA programs).

All these facts led to the necessity to make essential revision and changes of the EUPOS® Terms of Reference mainly concerning EUPOS® mission and membership. These changes should transform the hitherto initiative to an international organization with a firm legal basis making it more flexible and open being able to face new challenges brought about by present-day society and pre-

sent-day earth science. Those challenges can be grouped into three main goals that EUPOS® currently focuses on (EUPOS 2014b):

- acting as a European-wide DGNSS service providers branch organization, representing the interest of its members – the service providers – towards other players and interest groups on the market,
- collaborating with international organizations and bodies to represent European DGNSS service providers, in both political and technical aspects of their activity,
- collaborating with scientific institutions and promote scientific use of EUPOS® data.

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