

TEN YEARS OF ESTABLISHMENT OF THE SATELLITE REFERENCE STATION SYSTEM EUPOS IN CENTRAL AND EASTERN EUROPE

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The European Project EUPOS (European Position Determination System) was successfully initiated ten years ago, in March 2002, at the Berlin conference organised by the Berlin Senate Department of Urban Development. The project consists in establishment of multifunctional satellite reference stations in Central and Eastern European countries. As in April 2012 20 European and West Asiatic countries intend to participate in the project. One common project standard set is observed by all countries. The system will use as main satellite signal the signal of the system Galileo as soon as this system is available. The network of reference stations provides signals for both positioning of the geodetic control points and for land, air and marine navigation. Several levels of positioning accuracy are offered. In the presentation there will given some details concerning organisation of the project, up to now gained experiences and cooperation with other scientific organisations.



Fig.1. Participants of the EUPOS Foundation Conference in Berlin 2-3 March 2002 (foto ISCO Berlin)



Fig.2. Foundation Workshop In Berlin 2-3 March 2002 (foto ISCO Berlin)

1. General information on EUPOS project

EUPOS (European Position Determination System) is a new European initiative of establishment of the multifunctional uniform permanently operating reference ground based GNSS augmentation station system in Central and Eastern countries creating a satellite positioning infrastructure in Central and Eastern Europe (CEE). The Project 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 one thousand multifunctional satellite reference stations in Central and Eastern Europe. Twenty countries: Bosnia & Herzegovina, Bulgaria, Czech Republic, Estonia, Hungary, Kazakhstan, Latvia, Lithuania, Macedonia (FYROM), Moldova, Montenegro, Poland, Romania, Russian Federation, Serbia, Slovak Republic, Slovenia, Ukraine intend to participate in the project. Also the German Stadt Berlin is the member of EUPOS. Lately applied for the EUPOS membership: Azerbaijan, Georgia and Kirghiz Republic. One common project standard set is 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 are also used. The system is 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. Twenty one working conferences of the International Steering Committee were held up to now. The conferences were devoted to discussions on practical aspects of realisation and establishment of the network, the standards and possible sources of financial support for realisation of the Project.

The project EUPOS was 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, ISPA – for EU candidate countries, CARDS – for West-Balkan countries and TACIS – for the Russian Federation. Since Germany has complete network of reference stations SAPOS, the financial support for this country will be used mainly only for international co-ordination, organisation, supervising and promotion of the Project particularly by the International **EUPOS** Steering Committee

Table 1. Conferences of the EUPOS International Steering Committee (ISC)

No.	Conference	Place	Date
	Foundation Conference	Berlin, Germany	2 -- 3. 03.2002
1.	1. Conference ISC	Warsaw, Poland	2 – 3. 07.2002
2.	2. Conference ISC	Sofia, Bulgaria	6 – 7. 11.2002
3.	3. Conference ISC	Riga, Latvia	10-11.06.2003
4.	4. Conference ISC	Berlin, Germany	23.11.2003
5.	5. Conference ISC	Bratislava, Slovakia	18-19.06.2004
6.	6. Conference ISC	Sofia, Bulgaria	2 - 3.11.2004
7.	7. Conference ISC	Prague, Czech Rep.	11-12.04.2005
8.	8. Conference ISC	Berlin, Germany	24-25.11.2005
9.	9. Conference ISC	Warsaw, Poland	4 – 5.05.2006
10.	10. Conference ISC	Budapest, Hungary	22-24.11. 2006
11.	11. Conference ISC	Riga, Latvia	29-30.03.2007
12.	12. Conference ISC	Vilnius, Lithuania	20-21.09.2007
13.	13. Conference ISC	Bucharest, Romania	23-24.04.2008
14.	14. Conference ISC	Berlin, Germany	25-26.10.2008
15.	15. Conference ISC	Tallinn, Estonia	28-30.04.2009
16.	10. Conference ISC	Berlin, Germany	30.11-3,12.2009
17.	17. Conference ISC	Novi Sad, Serbia	27-28.05.2010
18.	18. Conference ISC	Warsaw, Poland	26-27.10.2010
19.	19. Conference ISC	Budapest, Hungary	14-15.04.2011
20.	20. Conference ISC	Berlin, Germany	12-13.10.2011
21.	21. Conference ISC	Bratislava, Slovakia	26-27.03.2012
22.	22. Conference ISC	Bucharest, Romania	26-27.04.2012
Next Conferences: Tbilisi, Georgia ? spring 2013			

The European Position Determination System EUPOS is both an international initiative and a project to establish and to provide a basis infrastructure particularly for positioning and navigation in Central and Eastern Europe (CEE) realised by ground based multifunctional DGNSS reference station systems and services in the participating countries, which use agreed uniform standards. The EUPOS ground-based GNSS augmentation system covers about 25% of the European Union territory and more than 60% of the area of the whole Europe. Taking into consideration also the Russian territory in Asia where this infrastructure will be established EUPOS will be realised for an area of about 10 million square kilometres.

EUPOS provides DGNSS correction data for real-time positioning and navigation as well as GNSS observation data for post-processing position determination. EUPOS is able to support precise positioning and navigation with high accuracy (metre,

decimetre, centimetre in real-time and centimetre and sub-centimetre in post-processing) and with guaranteed availability and quality. EUPOS is independent of private company solutions and uses only international open standards.

At last almost one thousand EUPOS reference stations are planned currently in all countries. The progress of the EUPOS system realisation in the participating member countries is different since it depends on the financial possibilities of particular countries.

The vision of such a uniform DGNSS infrastructure in CEE was born in the nineties of the last century. EUPOS itself presented this aim to 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 (OOSA) has organising since 2001 in co-sponsorship with the Government of the United States. The international workshops reviewed the implementation of project proposals from the series of GNSS meetings with a view to prioritizing the projects for support by the OOSA. EUPOS was identified as one of the priority projects that were provided. The OOSA noted with satisfaction that EUPOS would be the first ground-based GNSS infrastructure of its kind with regional reach and 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.

To enlarge the EUPOS activities transcending technical realisations the project EUPOS – Interregional Cooperation (EUPOS - IRC) was launched in October 2006, since it is accepted as a European Union INTERREG IIIC Programme operation. Main aims of this operation are to identify, point out and enable possibilities and benefits of the use and application of GNSS technology in the field of regional development, to establish long lasting cross-border cooperation between experts in the field of GNSS and geoinformation on the one hand and on the other hand regional policy experts and stakeholders.

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 organized the establishment of a EUPOS working group on Technical Cooperation with the Industry (TCI). EUPOS also became member of the Radio Technical Commission for Maritime Services (RTCM) in 2006 and contributes to the Special Committee 104 (RTCM SC 104), which sets guidelines in the field of real-time DGNSS. Among other issues EUPOS is interested in an international standard for RTCM data encryption against manipulation and unauthorized use, but also for deduction of fees, especially if data are broadcasted.

Furthermore the EUPOS Working Group on System Quality, Integrity and Interference Monitoring (SQII) was established by the ISC in 2006. The SQII is responsible for ensuring high quality operation and services of EUPOS on an international level, works out technical quality guidelines and standards and supervises their implementation in the national EUPOS segments, documents network and station configurations and status. Following recommendations of the UN

Action Team on GNSS the SQII supports the development of methodology and software for efficient quality, interference and integrity monitoring. Such as the TCI the SQII presents its results to the ISC.

Table 2. Number of planned EUPOS reference stations

Country	Area [km ²]	Number of EUPOS reference stations	Average distance between stations [km]
EU member countries			
1	Bulgaria	110 950	29
2	Czech Republic	78 870	26
3	Estonia	45 220	48
4	German Stadt Berlin	892	4
5	Hungary	93 030	35
6	Latvia	64 600	24
7	Lithuania	65 300	25
8	Poland	312 680	100
9	Romania	237 500	75
10	Slovak Rep	49 035	26
11	Slovenia	20 270	15
Balkan countries			
1	Bosnia and Herzegowina	51 000	30
2	Macedonia	25 330	15
3	Serbia	74 549	32
4	Montenegro	13 812	?
Other countries			
1	Russian Federation	17 075 000	?
2	Ukraine	603 700	?
3	Kazakhstan	2 700 000	?
4	Moldova	33 700	?
5	Azerbaijan	86 600	?
6	Georgia	69 700	?
7	Kirghiz Republic	198 500	?
Total			484 + ?

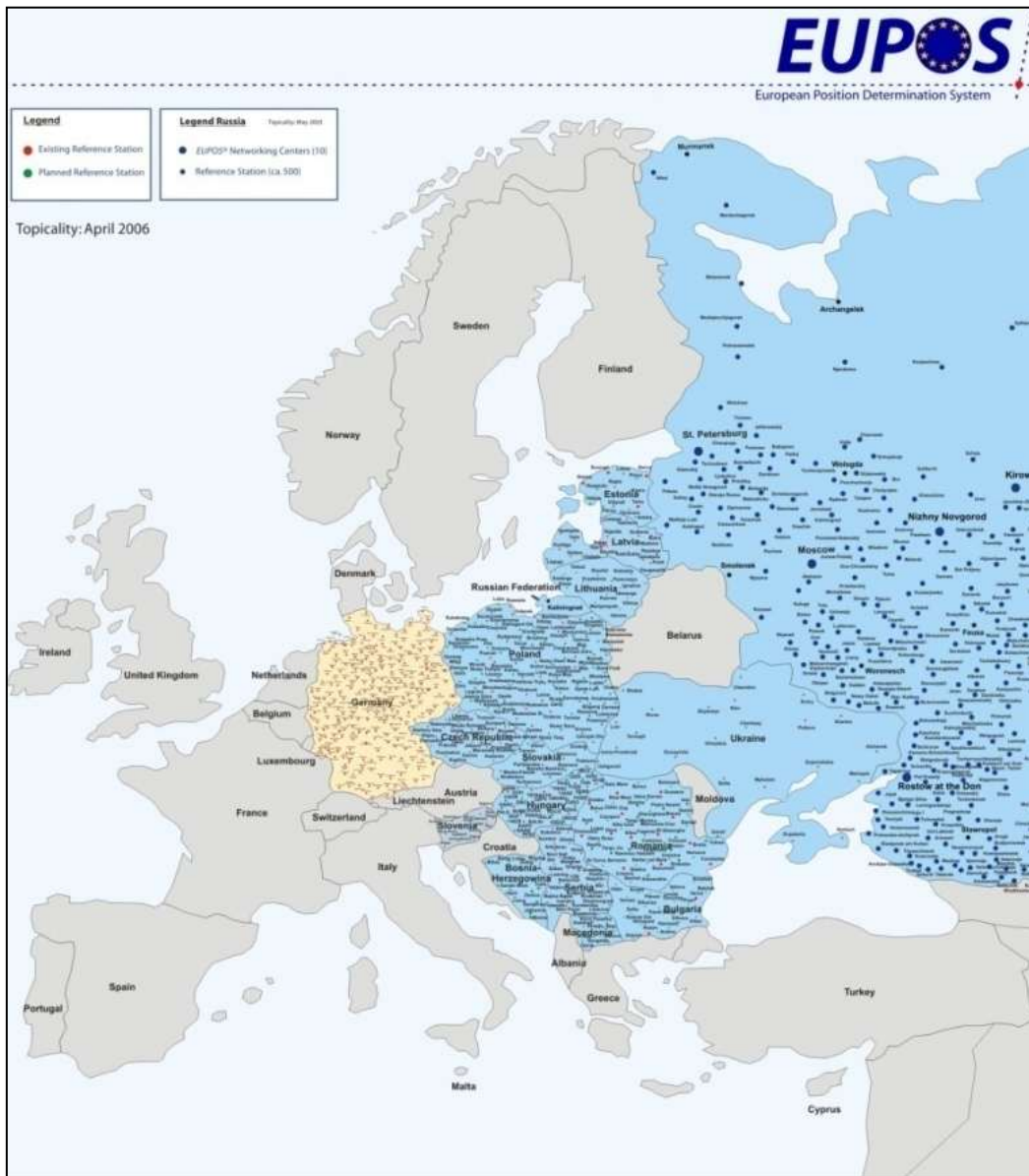


Fig. 3: Planned and existing EUPOS reference stations (Western part of the network)

2. Relation links of EUPOS to GALILEO system and EUREF

The Galileo signals will be the basis standard for the EUPOS stations as soon as the system Galileo is available. Systems GPS and GLONASS will be additional optional elements. Evident interrelations between the system Galileo and the EUPOS network can be noted as follows:

- Galileo gains a huge number of new users; about 900 reference stations in 20 countries will work permanently using the Galileo system;

- By EUPOS Galileo will transfer the reference system to all users in Central and Eastern Europe;
- EUPOS will offer and guarantee the services of proper accuracy as recommended by the Galileo programme;
- EUPOS stations could be integrated into Galileo programme. Some selected EUPOS stations could be incorporated to the Galileo ground control segment.

System of EUPOS stations will be related to the European EUREF Permanent Network EPN the main objectives of which is to monitor and maintain the European Terrestrial Reference Frame ETRF. In particular the following can be said:

- EUPOS reference stations will be connected to the EUREF EPN;
- The EUPOS stations will be related to the ETRF system and will transfer the ETRF to all Central and Eastern European countries;
- Some selected EUPOS Processing Centres could serve as EPN Local Analysis Centres; International EUPOS Steering Committee has established close cooperation links with the IAG Sub-Commission S.C.1.3a for Europe "Regional Reference Frame (EUREF)" of the Commission 1 "Reference Frames".

3. Summary of ten years achievements and experiences

Our last conference in Bratislava in March 2012 was 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 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 April 2012 the following countries are member of the EUPOS family: Bosnia &

Herzegovina, Bulgaria, Czech Republic, Estonia, Hungary, Kazakhstan, Latvia,, Lithuania, Macedonia (FYROM), Moldova, Montenegro, Poland, Romania, Russian Federation, Serbia, Slovak Republic, Slovenia, Ukraine. Also the German Stadt Berlin is the member of EUPOS. Some more countries – Azerbaijan, Georgia, Kirghiz Republic applied lately for the membership of EUPOS. So we can say that EUPOS in the near future will 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:
 - UN 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 there 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 of technologies,
 - development of regional cooperation of neighbouring countries and
 - creation of social friendly bonds among EUPOS family members.



Fig.4. Ten years after the Foundation Berlin Conference, at the Jubilee “Ten Years EUPOS Birthday” Conference in Bratislava, two Senior Members of the ISC shared-out the Jubilee Birthday fancy-cake prepared by the Slovak organizers of the Conference

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Further details on the project EUPOS are available in the Web Pages
www.eupos.org