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ESTABLISHMENT OF ASG/EUPOS – THE POLISH PART OF THE EUROPEAN NETWORK OF EUPOS REFERENCE STATIONS

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Abstract

EUPOS (European Position Determination System) is a new European initiative of establishment of the multifunctional reference station system in Central and Eastern countries. The Project EUPOS was initiated by the Berlin Senate Department for Urban Development and European Academy of the Urban Development Berlin. The project consists in establishment of about 440 multifunctional satellite reference stations in Central and Eastern Europe. Fourteen countries (Bulgaria, Czech Republic, Estonia, Germany, Hungary, Latvia, Lithuania, Macedonia, Poland, Romania, Russian Federation, Serbia & Montenegro, Slovakia and Slovenia) intend to participate in the project. One common project standard set will be observed by all countries, however the project will include the existing or developed infrastructure in participating countries. Experiences of all participating countries in establishing and operating satellite systems will also be used. The system will be compatible with the German network SAPOS and in future will use as main signal the signal of the European system Galileo. The network of reference stations will provide services for both positioning of the geodetic control points and for land, air and marine navigation. Several levels of positioning accuracy will be offered.

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

The project EUPOS was also presented at many international conferences and symposia. .On 12 November 2003 the representatives of the EUPOS International Steering Committee have held consultations in Brussels with Galileo Joint Undertaking and the European Commission EuropeAid Co-operate Office. The objectives of consultations were to inform the EC about the Project EUPOS, its organisation, standards and services, links to the European Project Galileo and expected benefits for all participating countries. As positive aspects there were recognised short time (2,5-3 years) of realisation of the Project and the fact that the organisational structures of the project are already available. It was advised that the attempt could be made to request for financial support from different EU Programmes: ERDF for EU member countries (Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia), ISPA – for EU candidate countries (Bulgaria, Romania), CARDS – for West-Balkan countries (Macedonia, Serbia and Montenegro), TACIS – for the Russian Federation and INTERREG III C – for Germany (Coordinator of the Project).

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

1. INTRODUCTION

The GNSS systems of multifunctional reference stations are nowadays the background for both geodetic precise point positioning and for land, air and marine navigation of all movable objects. Some countries in Central and Eastern Europe endeavour to build their own systems, develop their own networks of permanent satellite stations and set up their own satellite infrastructure. There is no doubt that the most advanced and sophisticated system SAPOS (Satellite Positioning System) was built in Germany. Another completed system that more or less fulfils all geodetic requirements but because of low density of reference stations appears rather insufficient for navigation is the Swedish system SWEPOS (Swedish Positioning System). On the other hand the integration processes in Central Europe and the accession of ten new countries to European Union anticipate the necessity to consider common actions of European countries to build up a unified integrated GNSS system covering the territory of the whole Europe. Such an action will simplify the control of the international road traffic, transport operation, emergency services (police, fire dept., medical operations) as well as urban transport services. The international integrated action is also worth supporting from economical reasons.

2. EUPOS INITIATIVE

In this situation the European countries accepted with satisfaction the initiative of the Berlin Senate Department for Urban Development, supported by the European Academy of the Urban Environment (EA.UE), Berlin, Germany that suggested in March 2002 to organise in Berlin an international workshop/conference with the aim to discuss the possibilities and reality of establishment of the "multifunctional GNSS system of reference stations for Europe" that could be used for both geodetic point positioning and also for land, air and marine navigation. The conference was held in Berlin on 4-5 March 2002 and was attended by representatives of 16 countries of Central and Eastern Europe.

The participants of the conference stated that the existing and already operating German positioning system SAPOS gained in the German regional surveying authorities and also in neighbouring countries extremely positive experience as far as its capacity, effective procedures as a multifunctional DGNSS reference station system and fundamental infrastructure components is concerned.

The participants of the Berlin workshop decided to form a founding/steering committee comprising participants from the countries represented at the workshop, with the goal of drawing up in the near future the basic principles concerning setting up multifunctional DGNSS reference station system in countries expressing an interest. Existing infrastructures and activities of particular countries should be incorporated. They have also decided that these multifunctional DGNSS reference station systems be realised in a short time frame and that the workshops on multi-functional DGNSS reference station systems for Europe are to be held on an annual basis enabling the necessary exchange of experience and information.

Eight working conferences of the Founding (Steering) Committee were held up to now. They are listed in Table 1. The conferences were devoted to discussions on practical aspects of establishment of a multi-functional network of GNSS reference stations in Central and Eastern European countries. It was decided that the Founding Committee would be renamed into the "Steering-Committee" of the unified project called "European Position Determination System (EUPOS)". Next meeting of the International EUPOS Steering Committee will be organised in Warsaw, Poland on 4-5 May 2006.

Table 1. EUPOS Conferences and workshops of the International Steering Committee

No.	Conference/ workshop	Place	Date
1.	First Conference of the ISC	Warsaw, Poland	2 – 3. 07.2002
2.	Second Conference of the ISC	Sofia, Bulgaria	6 – 7. 11.2002
3.	Third Conference of the ISC	Riga, Latvia	10-11.06.2003
4.	Fourth Conference of the ISC	Berlin, Germany	23.11.2003
5.	Fifth Conference of the ISC	Bratislava, Slovakia	18-19.06.2004
6.	Sixth Conference of the ISC	Sofia, Bulgaria	2 - 3.11.2004
7.	Seventh Conference of the ISC	Prague, Czech Rep.	11-12.04.2005
8.	Eighth Conference of the ISC	Berlin, Germany	24-25.11.2005
9.	Ninth Conference of the ISC	Warsaw, Poland	4 – 5.05.2006
10.	1. Conference/workshop	Berlin, Germany	4 – 5.03.2002
11.	2. Conference/workshop	Berlin, Germany	21-22.11.2003
12.	Workshop for decision makers	Berlin, Germany	6-7.12.2004

As a result of the work of the EUPOS Steering Committee one general project has been developed that contains common backgrounds and standards of the Project as well as detail projects for particular countries which take into account the existing or being developed satellite infrastructure in particular countries.

Fig. 1. Logo of the Project EUPOS

In the meantime the project EUPOS was presented at many international conferences (see: References), e.g. to the "UN/USA Expert Meeting on the Use and Application of Global Navigation Systems", Vienna, Austria, 11-15 November 2002, to the "1st Conference 'Galileo' for an enlarged Europe" organised by the European Commission in Warsaw, Poland on 19-20 May 2003, to the "2nd Common Baltic Symposium on the Concept of Digital Height Reference Surface and Related GNSS Topics – GPS Heighting and Nation-wide Permanent GNSS Reference Systems" in Riga, Latvia on 12-13 June 2003, to the EGS/AGU/EUG Symposium G17 in Nice, France, 7-12 April 2003; and to International Symposium on Space Information Technologies, Acquisition, Processing and Effective Application, Sofia, Bulgaria, 7-8 November 2002 and others. The recommendations of all these conferences support the initiative of EUPOS as a common GNSS infrastructure for all kinds and accuracy of on-line and post-processing DGNSS applications based on the standards of multifunctional reference station networks.

On 12 November 2003 the representatives of the EUPOS International Steering Committee have held consultations in Brussels with Galileo Joint Undertaking and the European Commission EuropeAid Co-operate Office. The objectives of consultations were to inform the EC about the Project EUPOS, its organisation, standards and services, links to the European Project Galileo and expected benefits for all participating countries. As positive aspects were recognised short time (2,5-3 years) of realisation of the Project, that the Project covers about 15 % of the European territory and the fact that the organisational structures of the project are already available. As negative were pointed out the high cost of the project and a fact that not all 14 countries participating in the Project can request for financial support from one EU programme. It was recommended that the total cost of the Project should be reduced (mainly by reducing the number of planned stations) and was advised that the attempt could be made to request for financial support from different EU Programmes:

ERDF -	for EU member countries (Czech Rep., Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia),
ISPA –	for EU candidate countries (Bulgaria, Romania),
CARDS –	for West-Balkan countries (Croatia, Macedonia, Serbia and Montenegro),
TACIS –	for the Russian Federation,
INTERREG III C –	for Germany (Coordinator of the Project).

Besides, the financial support for the coordination work of the International Steering Committee could be requested for the non-EU member countries from the programme PHARE. It is planned to build in total up about 440 reference stations in above mentioned countries beyond Germany. Since Germany has complete network of reference stations SAPOS, the financial support for this country will be used only for international co-ordination, organisation, supervising and promotion of the Project particularly by the International EUPOS® Steering Committee.

Next consultations were held in Vienna, Austria at the EU INTERREG IIIC East Joint Technical Secretariat, and at the UN Office of Outer Space Affairs (OOSA), Vienna. As a result EUPOS was presented at the UN/USA Expert Meetings on the Use and Application of GNSS, organised by OOSA Vienna. OOSA supporting the programme EUPOS granted financial support for organisation of the next conferences of the International EUPOS Steering Committee.

3. GENERAL CHARACTERISTICS OF THE EUPOS

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

- The EUPOS stations will be permanently operating, multifunctional DGNSS reference stations.
- The distance between the stations will be 60-70 km dependent on the topography. Higher density may be required in conurbation. Existing reference station systems (e.g. EUREF, IGS) should be connected or incorporated.
- The co-ordinates of the stations will be determined with high precision, both in ETRS 89 and in conventional geodetic reference systems by connecting to EUREF points as well as to the other control networks of the countries.

- EUPOS will use the signals of Galileo as basis standard as soon as it is available and Global Positioning System (NAVSTAR – GPS) as basis standard up to the complete availability of Galileo and as optional additional standard after complete availability of Galileo, also Russian Global Navigation Satellite System (GLONASS) will be used as optional additional standard.
- Only high quality geodetic GNSS dual frequency receivers will be used at EUPOS® reference stations. Positions of reference station antennas will be checked regularly for any displacement
- A common use of reference stations in neighbouring countries close to border areas will be taken into account. The reference stations will be networked with each other, even cross-border.
- All participating countries will observe the unified standards or/and will build up their multi-functional systems fully compatible with future European system GALILEO.
- Generally EUPOS will offer several levels of RTK and post processing services for geodetic positioning and land, air and marine navigation:
    - EUPOS DGNSS for real time or post processing DGNSS applications by code and code-phase measurements with metre up to sub-metre accuracy;
    - EUPOS RTK for real time DGNSS applications by carrier phase measurements with centimetre accuracy;
    - EUPOS Geodetic for DGNSS applications by phase measurements in static or kinematic mode with centimetre up to sub-centimetre accuracy.
- A quality management will guarantee a minimal 99 %-level of security of supply and system integrity of EUPOS®. Malfunctions automatically activate an alarm plan which sets off appropriate corrective measures. Depending on the requirement, data links, computers or transmitters etc. are switched over and different reference stations will temporarily be used as principal reference station for providing the correction data. The system will be designed so that the technology can generally manage itself and the EUPOS® operation will be maintained. All malfunctions etc. will be recorded automatically and evaluated within the framework of the quality control management. Malfunctions, faults and losses of quality are therefore automatically identified in real time.

4. ORGANISATION

The management of the project EUPOS is performed by:

- International EUPOS Steering Committee (ISC),
- National EUPOS Service Centres (NSC),
- Workshops EUPOS® – Multifunctional GNSS Reference Station Systems for Europe".

The International EUPOS Steering Committee and its office were established during the first Workshop „Multifunctional GNSS Reference Station Systems for Europe" held in Berlin in March 2002. The committee will be extended by representatives of all accessing countries. The main tasks of the ISC are: coordination of the project actions and management, agreements with the NSC and manufactures, dissemination of information, organisation of EUPOS workshops and symposia, clarification of technical questions and standardisation, organisation and coordination of software and hardware tests and support of the countries in training the technical staff.

National EUPOS Service Centre (NSC) will be established in every EUPOS country. They will deal with the tasks of planning, establishment and maintenance of the national EUPOS network. Beyond these activities, the most important tasks of the EUPOS Service Centre are: contact with the International EUPOS Steering Committee and its office, coordination of the interests and the activities of the national authorities and other governmental bodies, checking the integrity of the network, testing software and hardware in agreement with the International EUPOS Steering Committee and their own interests, providing adequate information for the users about the status of the network, organisation of educational and training courses for the technical staff and the users, transferring the international development trends and contributes to the EUPOS developments.
The National EUPOS Service Centres will have adequate communication links to the EUPOS reference stations and the necessary computing power and equipment. It should dispose the highly qualified, competent and motivated manpower.

Workshops EUPOS® – Multifunctional GNSS Reference Station Systems for Europe" will be organised once a year as an information platform on a broader base, thus to enable the participating countries the necessary exchange of experiences and information, to discuss and create further developments of EUPOS® and to increase the identification with the system. The workshops will be organised by the International EUPOS® Steering Committee.

5. 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; more than 430 reference stations in 14 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 will establish close cooperation links with the IAG (EUREF) Sub-Commission for Europe of the IAG Commission X on Global and Regional Geodetic Networks.

6. EUPOS IN EUROPEAN COUNTRIES

Fifteen countries intend to participate in the project: Bosnia and Herzegovina, Bulgaria, the Czech Republic, Estonia, Germany, Hungary, Latvia, Lithuania, Macedonia, Poland, Romania, Russian Federation, Serbia and Montenegro, Slovak Republic and Slovenia. They are listed in Table 2. Number of planned EUPOS reference stations in particular countries are also given in the Table. All countries are now preparing their draft designs of distribution of reference stations and search for funds indispensable for establishment of the stations and other required infrastructure for the network. The general draft designs of the EUPOS in European countries and in Russia are shown in Fig.2 and Fig.3. The design of the Polish part of the network EUPOS will be discussed in the next sections of this paper.

Table 2. Number of planned EUPOS reference stations

Country	Area [km^2]	Number of planned EUPOS reference stations	Average distance between stations [km]
EU member countries			
Czech Rep.	78 870	16	70
Estonia	45 220	13	60
Hungary	93 030	19	70
Latvia	64 600	14	70
Lithuania	65 300	13	70
Poland	312 680	87	70
Slovak Rep.	49 035	12	65
Slovenia	20 270	8	50
EU candidate countries			
Bulgaria	110 950	23	70
Romania	237 500	48	70
West Balkan States			
Bosnia and Herzeg.	51 000	12	65
Macedonia (FYROM)	25 330	8	60
Serbia and Montenegro	88 360	18	70
Russian Federation			
Russian Fed.	17 075 000	150 stations at all (in 7 federal districts, will cover not whole area)	30 - 100

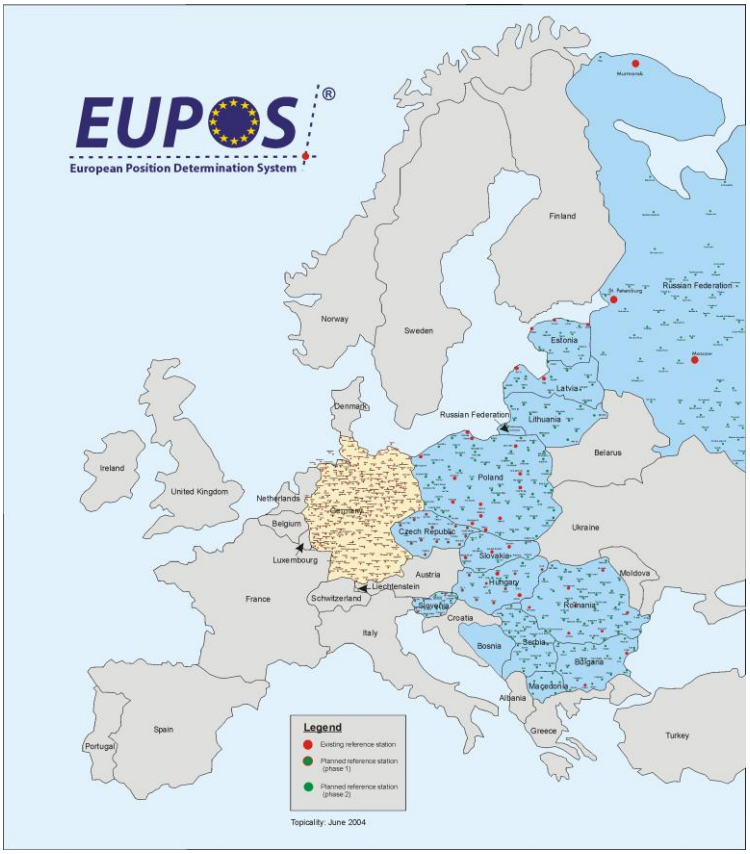

Fig. 2. Planned and existing EUPOS stations

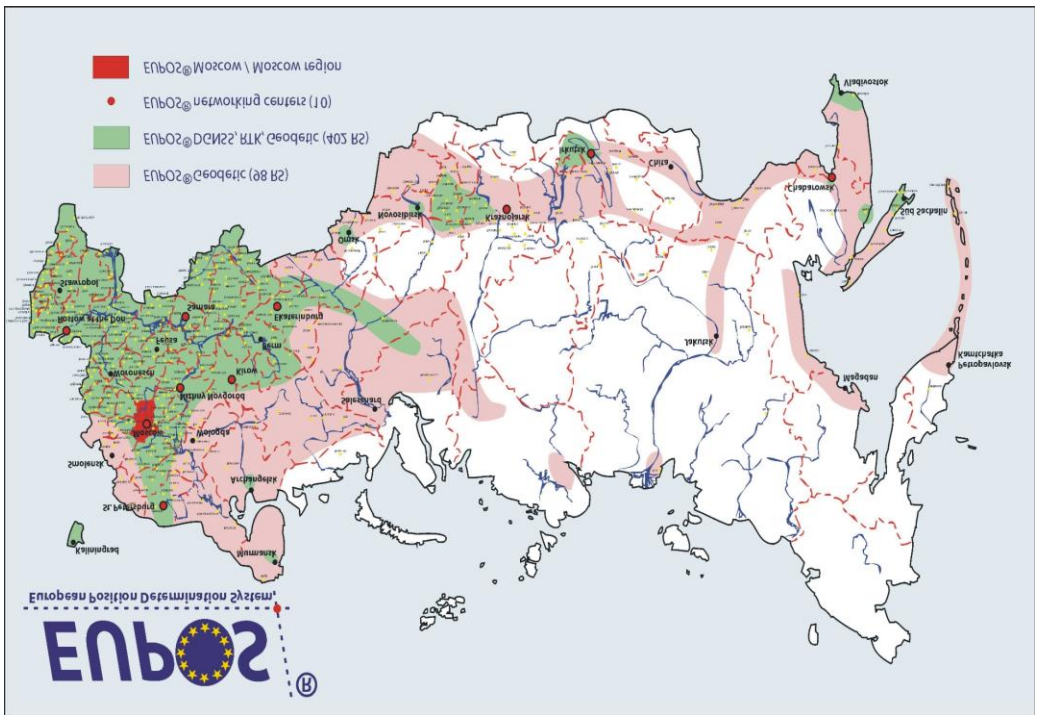

Fig. 3. Russian stations of the project EUPOS

7. POLISH PART OF THE EUROPEAN NETWORK EUPOS

The Polish part of EUPOS, named ***Active Geodetic Network (Aktywna Siec Geodezyjna)*** ASG/EUPOS, will contain 87 permanent reference stations. The National Network Management Centre (NMC) and one Regional Management Centres (RMC) will manage whole system under general control of the Head Office of Geodesy and Cartography. Data transmission between reference stations and management centres shall be realised using secure dedicated links. The services to the end-users will be offered through standard public communication systems: the internet, cellular networks (GSM/GPRS and UMTS in future), and optionally – radio broadcasting (depending on the project's available budget and users specific requirements).

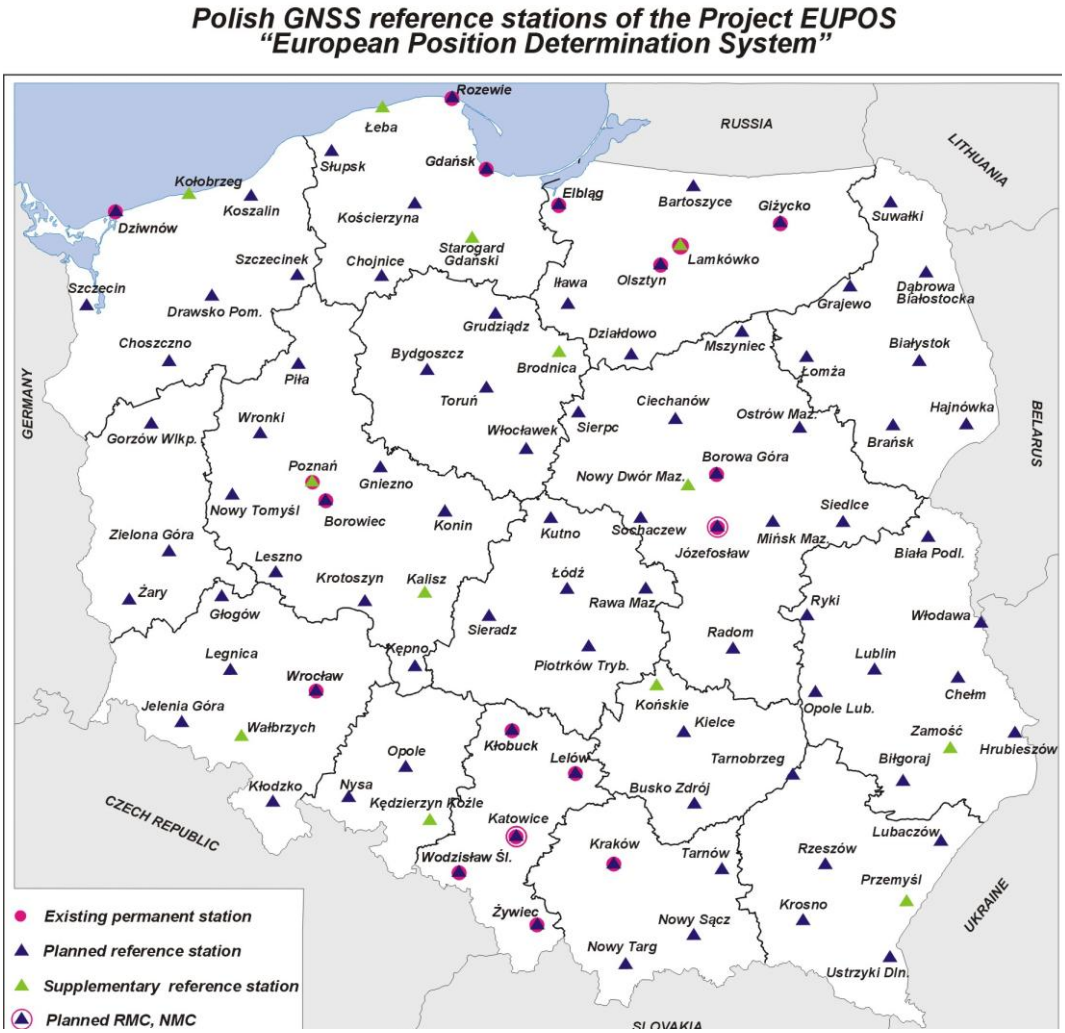

Fig. 4. Reference stations of the Polish part of the network EUPOS

The Polish part of the EUPOS system – ASG/EUPOS will consist of at least 87 reference stations. To achieve desired quality of services and to comply with general EUPOS requirements, the distance between individual stations will be 70-80 km. Planned locations of 87 reference stations, which have already been decided, are given in Fig. 4 and listed in Table 3. Red circles denote locations of the existing permanent stations, while black triangles – these of planned ASG/EUPOS stations.

Table 3. ASG/EUPOS permanent stations in Poland

No.	Station	Code	Latitude	Longitude	Station's status
1	Bartoszyce	BART	54 15 03.2	20 48 55.6	planned
2	Biala Podlaska	BPDL	52 02 06.8	23 07 39.0	planned
3	Bialystok	BIAL	53 07 55.7	23 08 19.4	planned
4	Bilgoraj	BILG	50 31 53.8	22 43 06.8	planned
5	Borowa Góra	BOGO	52 28 29.9	21 02 06.8	EPN
6	Borowiec	BOR1	52 16 37.0	17 04 24.4	IGS, EPN, CERGOP
7	Bransk	BRAN	52 44 28.1	22 50 19.3	planned
8	Busko Zdrój	BUZD	50 27 58.3	20 43 08.2	planned
9	Bydgoszcz	BYDG	53 07 26.7	18 00 19.9	planned
10	Chelm	CHEL	51 07 47.9	23 28 49.7	planned
11	Chojnice	CHOJ	53 41 42.5	17 33 08.2	planned
12	Choszczno	CHOS	53 09 50.6	15 24 50.6	planned
13	Ciechanów	CCHN	52 52 57.8	20 35 52.5	planned
14	Dabrowa Bialost.	DBBS	53 39 17.9	23 20 45.0	planned
15	Drawsko Pom.	DRAW	53 31 34.8	15 49 02.9	planned
16	Dzialdowo	DZIA	53 14 02.2	20 10 40.3	planned
17	Dziwnów	DZIW	54 01 19.2	14 43 50.0	marine station
18	Elblag	ELBL	54 01 19.2	19 24 01.3	RTK
19	Gdansk	GDAN	54 21 16.3	18 38 33.0	RTK
20	Gizycko	GIZY	54 02 08.8	21 46 04.0	RTK
21	Glogów	GLOG	51 39 55.1	16 04 26.4	planned
22	Gniezno	GNIE	52 31 57.6	17 34 58.5	planned
23	Gorzów Wlkp.	GWWL	52 44 16.5	15 12 18.5	planned
24	Grajewo	GRAJ	53 39 03.8	22 27 08.3	planned
25	Grudziadz	GRUD	53 29 19.0	18 45 16.8	planned
26	Hajnówka	HAJN	52 44 27.4	23 33 57.3	planned
27	Hrubieszów	HRUB	50 48 17.3	23 53 11.1	planned
28	Ilawa	ILAW	53 35 13.4	19 34 05.1	planned
29	Jelenia Góra	JLGR	50 55 09.2	15 43 59,7	planned
30	Józefoslaw	JOZ3	52 05 52.1	21 01 56.5	IGS, EPN, CERGOP
31	Katowice	KATO	50 15 11.8	19 02 08.3	EPN, RTK
32	Kepno	KEPN	51 16 48.4	17 59 01.0	planned
33	Kielce	KLCE	50 52 30.1	20 37 44.9	planned
34	Klobuck	KLOB	50 54 19,9	18 56 12.8	RTK
35	Klodzko	KLDZ	50 26 08.1	16 39 06.5	planned
36	Konin	KONI	52 13 39.9	18 15 13.5	planned
37	Koszalin	KOSZ	54 11 17.5	16 11 36.1	planned
38	Koscierzyna	KOSC	54 07 24.0	17 58 55.7	planned
39	Kraków	KRAW	50 03 57.9	19 55 13.5	EPN, CERGOP
40	Krosno	KROS	49 40 43.1	21 46 28.5	planned
41	Krotoszyn	KROT	51 41 31.2	17 26 17.0	planned
42	Kutno	KUTN	52 14 19.4	19 22 22.2	planned
43	Legnica	LEGN	51 11 59.8	16 09 18.2	planned
44	Lelów	LELO	50 40 58.4	19 37 44.0	RTK
45	Leszno	LESZ	51 50 25.3	16 34 42.3	planned
46	Lubaczów	LUBA	50 09 29.4	23 07 41.8	planned
47	Lublin	LUBL	51 14 59.1	22 33 05.3	planned

Table 3. ASG/EUPOS permanent stations in Poland (cont)

48	Lomza	LOMZ	53 10 26.5	22 04 49.4	planned
49	Lódz	LODZ	51 46 44.0	19 27 33.8	planned
50	Minsk Maz.	MIMA	52 10 53.0	21 33 33.3	planned
51	Myszyniec	MYSZ	53 23 03.7	21 20 29.9	planned
52	Nowy Sacz	NWSC	49 37 06.4	20 41 24.1	CERGOP
53	Nowy Targ	NWTG	49 28 39.7	20 03 00.2	planned
54	Nowy Tomysl	NTML	52 19 14.5	16 07 05.0	planned
55	Nysa	NYSA	50 28 39.6	17 20 01.4	planned
56	Olsztyn	OLSZ	53 46 39.2	20 29 13.7	RTK
57	Opole	OPLE	50 40 04.2	17 55 08.5	planned
58	Opole Lubelskie	OPLU	51 08 57.5	21 58 32.7	planned
59	Ostrów Maz.	OSMZ	52 48 02.5	21 53 29.7	planned
60	Pila	PILA	52 16 37.0	17 04 24.4	planned
61	Piotrków Tryb.	PITR	51 24 27.2	19 41 07.0	planned
62	Radom	RADM	51 23 29.1	21 09 49.7	planned
63	Rawa Maz.	RWMZ	51 46 39.2	20 15 01.6	planned
64	Rozewie	ROZE	54 49 50.2	18 20 07.6	marine station
65	Ryki	RYKI	51 37 29.2	21 55 39.1	planned
66	Rzeszów	RZES	50 01 45.0	22 02 03.1	working
67	Siedlce	SIED	52 09 26.7	22 17 39.2	planned
68	Sieradz	SIER	51 36 24.6	18 42 47.4	planned
69	Sierpc	SIER	52 51 10.4	19 40 02.0	planned
70	Slupsk	SLUP	54 27 45.9	17 01 47.6	planned
71	Sochaczew	SOCH	52 13 21.1	20 14 20.6	planned
72	Suwalki	SWKI	54 05 55.0	22 55 41.6	planned
73	Szczecin	SZIN	53 25 20.0	14 33 09.6	planned
74	Szczecinek	SZEK	53 41 10.3	16 42 24.9	planned
75	Swiebodzin	SWIB	52 14 52.5	15 32 10.6	planned
76	Tarnobrzeg	TABG	50 34 15.2	21 40 16.4	planned
77	Tarnów	TRNW	50 00 52.7	20 59 27.5	planned
78	Torun	TORU	53 02 00.4	18 37 50.5	planned
79	Ustrzyki Dolne	USDL	49 25 58.4	22 35 08.4	planned
80	Wloclawek	WLOC	52 39 31.6	19 04 00.5	planned
81	Wlodawa	WLDW	51 32 43.3	23 33 25.9	planned
82	Wodzislaw Sl.	WODZ	50 00 00.6	18 27 30.3	RTK
83	Wroclaw	WROC	51 06 47.7	17 03 43.3	EPN, CERGOP
84	Wronki	WRKI	52 42 23.9	16 23 10.2	planned
85	Zary	ZARY	51 38 23.6	15 08 46.4	planned
86	Zielona Góra	ZIGR	51 56 24.8	15 30 52.0	planned
87	Zywiec	ZYWI	49 41 12.1	19 12 21.4	EPN, RTK

The total number of station may increase to 90-95 if some areas are not to be covered well by RTK corrections when the system is working. Also, some already existing stations in Poland are going to be included in ASG/EUPOS. Upon inclusion of these stations the existing infrastructure will be upgraded or replaced with equipment compliant with the EUPOS standard. Each station will consist at least of one GPS receiver, a computer with dedicated software, as well as supplementary power supply and alarm systems.

8. MANAGEMENT/PROCESSING CENTRES

The ASG/EUPOS system will include two management centres:

a) National Network Management Centre (NMC), located in Warsaw;
b) Regional Management Centres (RMC), located in Katowice.

The National Network Management Centre will maintain general planning and control of ASG/EUPOS operation. It will also be responsible for provision of real-time corrections and data for post-processing to end-users and maintenance of the central archival database for ASG/EUPOS. Following the international trends, NMC will carry out software and hardware tests according to the EUPOS International Steering Committee (ISC) recommendations, monitor integrity and assure quality of the system. The NMC is going to increase the knowledge about GNSS among potential users through organising educational and training courses, and contribute to GNSS application development in Poland. Finally it will liaison and co-ordinate activities with the EUPOS ISC (through ISC office in Berlin), as well as with other EUPOS members and relevant national or international bodies.

RMC will be responsible for pre-processing of GNSS data for the purposes of geodetic positioning and convey results to the NMC, being the main processing centre. All necessary computations, stations' activity control and provision of user information will be done incessantly round-the-clock. RMC will also contribute to the storing archival data and security back-ups. RMC will also encompass its individual responsibility for allocated group of reference stations.

The overall scheme of ASG/EUPOS infrastructure and the role of the management centres are presented in Fig.5.

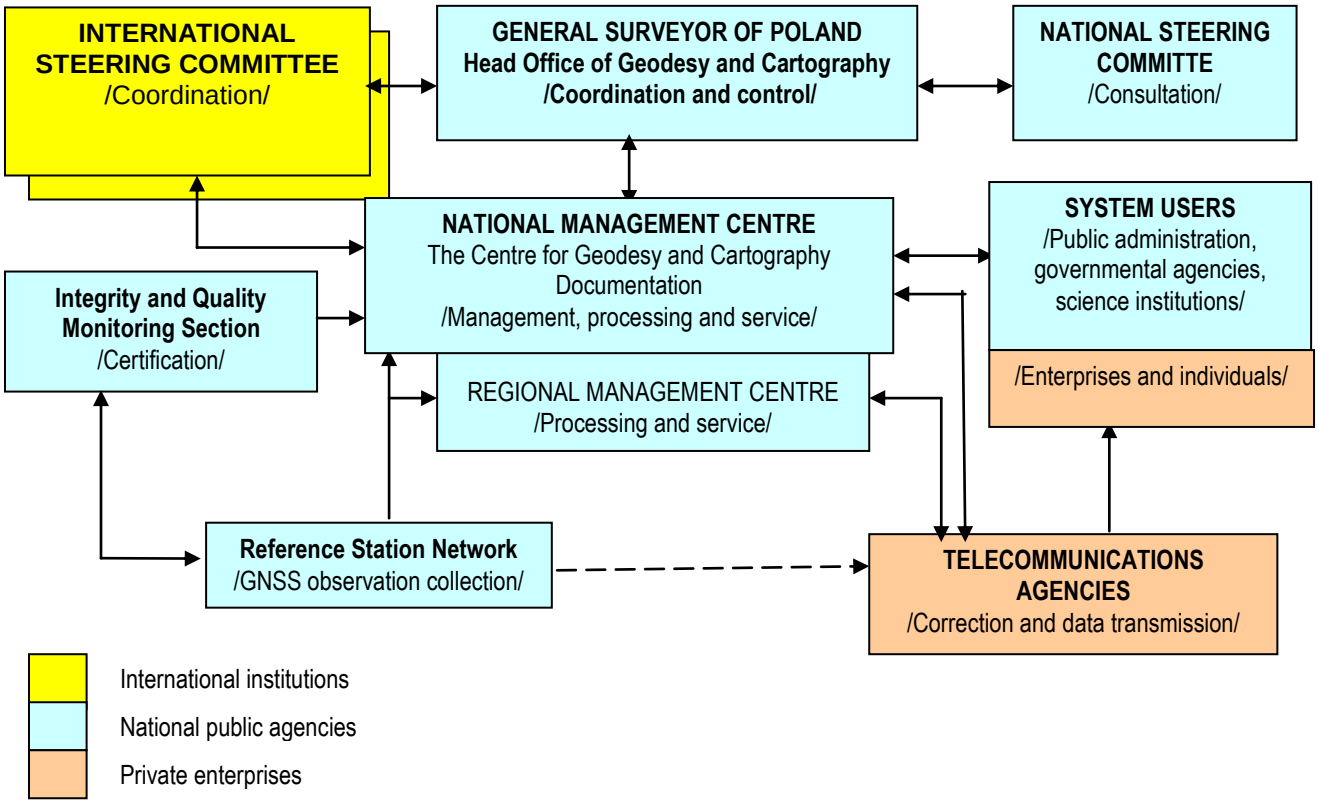

Fig. 5. The ASG/EUPOS organisational and management structure

9. SERVICES OFFERED FOR END USERS BY ASG/EUPOS

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

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

They are summarised in Table 4.

NAVGIS (network RTK for real time kinematic DGNSS applications)

For navigation and real time position determination with accuracy of 3 metres up to 0.5 metre, depend on the used rover equipment, ASG/EUPOS will provide compressed and encoded DGNSS correction data via Internet/GPRS as a basic standard. The authenticity of the official NAVGIS GNSS correction data provided via Internet will be ensured. It is an essential advantage of Internet/GPRS transmission that the corrections can be broadcasted to unlimited number of users simultaneously. The international standard data format "Radio Technical Commission for Maritime Services, Special Committee 104 version 2.x" (RTCM SC 104 V. 2.x) is going to be used for DGNSS correction transmission.

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

Table 4. Services planned to be offered by ASG/EUPOS

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

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

NAVGEO (network RTK for precise real time kinematic DGNSS applications)

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

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

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

POSGEO DGNSS for precise DGNSS post processing applications

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

10. TARGET USERS.

The ASG/EUPOS can be developed as a precise and effective tool for many branches of industry, national security and rescue services, as well as land and engineering surveying. The system is dedicated to companies and entrepreneurs offering precise positioning services and individuals in sport, tourist and leisure activities. The potential target users of the ASG/EUPOS services will include (however, will not be limited to) administrative institutions, companies and person working in the following fields:

a) agriculture and forestry – gathering information about parcels, agriculture, wood stock and condition registration,
b) aviation and airport emergency services – precise landing, airport transport management,
c) geodesy and cartography – all-classes geodetic control network establishing, satellite levelling, GIS and cadastre measurements, precise real-time and post-processing positioning, large scale maps updating, GCP co-ordinates determination,
d) hydrography and hydrology – coast line measurements, sea and lake-bottom maps preparation, pollution registration,
e) industrial architecture – building displacements and deformations monitoring, precise real-time surveying, stake-out,
f) meteorology – ionosphere condition research,
g) rescue – accidents localisation, search and rescue actions remote steering,
h) road and rail route construction and exploitation – road and railway surveying, surface condition registration, train and vehicle movement registration,

11. STATUS OF REALISATION OF THE ASG/EUPOS PROJECT

The ASG/EUPOS system is going to be developed with financial support from European Regional Development Fund. Four institutions are involved in project realisation: Finance Ministry, Regional Development Ministry, Education and Science Ministry and finally the Head Office of Geodesy and Cartography which will be the main beneficiary of the project. Whole project will be carried out in 2006-2007. Since beginning 2006 the realisation team has been established and National Management Centre has been established. In 2006 the public

tender procedures are going to be launched and DGPS/RTK services will be activated and tested over chosen areas of Poland. Also, the intensive information and advertising campaigns will be prepared and initiated in 2006. The reference stations are going to be established beginning from region with existing telecommunication infrastructure and where big industrial and road investments are planned. A completion of whole project is planned by end 2007 and since 2008 system ASG/EUPOS is to be offered to the users. The milestones of the ASG/EUPOS system realisation in Poland are presented bellow in Table5.

Table 5. ASG/EUPOS organisational milestones

2005	May	– development of ASG/EUPOS technical specification;
	September	– start of realisation of the project
2006	March	– establishment of National Management Centre
	August	– delivery of the first part of GPS receivers and software
	December	– activation of DGPS/RTK applications
2007	April	– delivery of the last part of receivers
	May	– starting technical and operational tests
	September	– completion and assessment of the project
	December	– authorisation of ASG/EUPOS system

The above presented programme is very tight and its realisation may request some correction due to some bureaucratic barriers and non predictable result of tender trial. Base on the experience gained during a pilot project realisation the fierce competition among potential contractors may adversely impact on attainment of the project goals.

12. ASG-PL IN SILESIA PROVINCE AS A PILOT PROJECT

The Active Geodetic Network (Aktywna Siec Geodezyjna – ASG-PL) is a common project being realised by the General Surveyor of Poland and the authorities of the Silesia Province in Poland. ASG-PL is a multifunctional service providing an official, space-oriented data, for all satellite-supported positioning and navigation applications over the Silesia region. In this sense ASG-PL could be regarded as a pilot project providing important infrastructure and experience for Polish part of the Project EUPOS. The region was chosen due to high population density and influence of negative effects of heavy industry on human living conditions. The system uses open standards, employs highly automated computational processes and control procedures of GPS stations.

The ASG-PL consists of three main segments: a set of permanent GPS reference stations, user receivers and the Management and Processing Centre (MPC). Since February 2003 the GPS observation has been releasing to all users free-of-charge.

Permanent stations

ASG-PL comprises two kinds of permanent stations:

- basic stations located in the Silesia region,
- scientific, permanent stations located outside Silesia and available at the ASG-PL homepage, which link the ASG-PL with the Polish state reference system.

The set of reference stations located in Silesia encompasses six fully automatic stations, distribution of which is presented in Fig. 6 below. The stations are situated either in local Repositories of Geodetic and Cartographic Documentation or on buildings housing municipal

authorities. All reference stations located in the Silesia Province are equipped with multifunctional Ashtech μZ receivers and choke ring antennas. Each GPS receiver is connected to a local server (with MS Windows 2000 operating system), placed in a dedicated container with an independent energy supply system. Antennas are installed on roofs in a stable way using observation pillars or on masts in case of steep roofs. The reference stations are remotely controlled from the Management and Processing Centre in Katowice using dedicated secure lines provided by Telekomunikacja Polska. Each station is additionally equipped with a backup ISDN link.

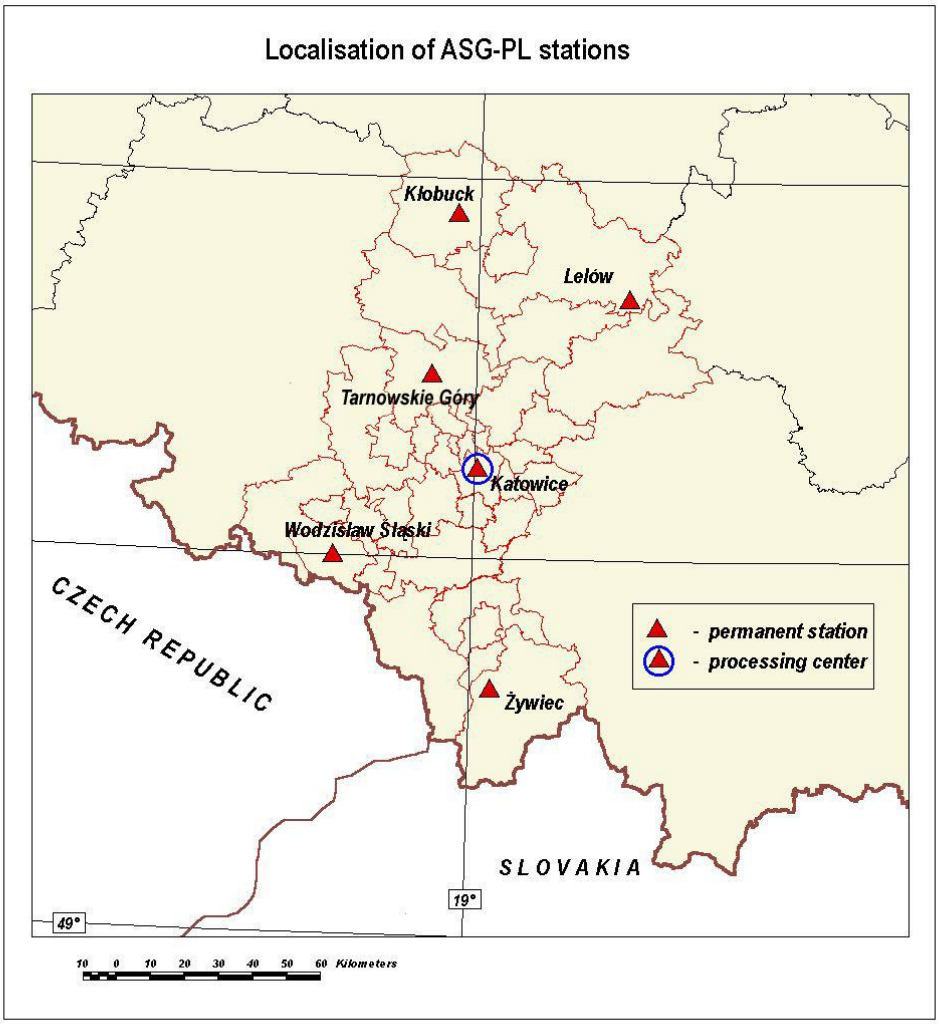

Fig. 6. Location of the ASG-PL permanent stations

Every reference stations records satellite data as 1-hour segments with 1-second sampling rate. However, the data available through the internet are released with 5-second resolution either in 1-hour or 1-day segments. Raw data is stored in the RINEX2 format in local data repository.

As the system is still being tested and modified, the geodetic institutions and surveying companies are the main users. Also, private surveyors possessing either dual- or single-frequency GPS receivers may download data from the website or contract calculation through

MPC. The operational readiness of the system has been reached end of 2005 and the public institutions, both governmental and municipal, are encouraged to use the ASG-PL in their statutory tasks in addition to horizontal geodetic control points.

The management and processing centre (MPC), located in Katowice, controls, processes and disseminates data and RTK corrections. All download or upload operations are performed automatically and continuously in 1-hour periods. All data (observation data from reference stations and users' data) must be encoded in the RINEX2 format.
The MPC employs a system of servers for computations, www home page and data storage, based on the Linux OS (Red Hat 7.0), MS Windows 2000 and Oracle. The operational system uses the Bernese GPS Software v. 4.2, with additional applications which enable its fully automatic operation. The system offers an internet-based user interface (available daily at http://www.asg-pl.pl). Results are presented as EUREF'89 and/or in three official Polish co-ordinate systems. The website additionally enables downloading free-of-charge observation data from reference stations, information on availability of GPS stations, measurement conditions, equipment and methods as well.
Recently, the operating RTK method has been implemented for navigation, traffic management and engineering surveying purposes. The technical tests performed so far and preliminary evaluation of the AGS-PL operation have confirmed its functionality as precise measurement supporting system. Its open structure enables co-operation/incorporation with/into other similar navigation systems, and adding new applications. Practical experience which has been gained throughout the development period will be taken into consideration by the Head Office of Geodesy and Cartography during the planned implementation of the Polish part of the EUPOS system and AGS-PL is going to be included in ASG/EUPOS system.

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

www.eupos.org

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