

# National Report of Germany to EUREF 2001

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On behalf of the European Commission a Spatial Reference Workshop took place in Paris at the end of 1999 to recommend to the European Union uniform reference systems for the referencing of geo-data. For spatial positioning the ETRS89 was proposed. The IAG Subcommission for Europe (EUREF) was asked to compile in cooperation with the National Mapping Agencies a catalogue with information for describing the national reference systems which are valid in Europe and their relations to the ETRS89. The BKG - assisted by EUREF and CERCO WG VIII - developed an information system considering the demand of ISO 19111 Spatial referencing by coordinates and will put it into the web at the beginning of 2001 (<http://crs.ifag.de/>).

In addition to that EUREF was asked to develop a definition for a European height reference system on the basis of the European height projects United European Levelling Network (UELN) and European Vertical Reference Network (EUVN). On the basis of the above mentioned projects the BKG prepared respective documentations which were adopted by EUREF (<http://evrs.leipzig.ifag.de/>).

The height data base for the European projects UELN, EUVN and European Vertical Systems (EVS) maintained by BKG was developed further and extended by the Baltic countries (see Figure 1). In 2001 Bulgaria shall be included.

In the scope of EUREF the European GPS Permanent Network EPN is maintained for the realisation of the

uniform geodetic spatial reference. The BKG runs among others for the collection and supply of observations of this network a data centre (<http://igs.ifag.de>) which today receives continuously the data of altogether 160 connected permanent stations. Thirteen states of the continent contribute at the moment to the evaluation of the observations of their share of the EPN which comprises about 120 stations. The BKG combines the results of the national partial solutions weekly to an overall solution which covers the continent cohesively. The resulting high-precision coordinates serve to maintain the connected national geodetic reference systems. In addition they are delivered to the International GPS Service (IGS) as contribution to the maintenance of the International Terrestrial Reference System (ITRS) and for estimating Earth rotation parameters. The GLONASS data which are also recorded in the EPN are weekly processed together with further data of the International GLONASS Service Pilot Project (IGLOS) to precise orbits for the satellites of the Russian GLONASS system at the BKG.

With the operation of the Fundamental Station Wettzell the BKG contributed considerably to the realisation of the global reference systems ITRS and ICRS which are kept up-to-date by the international cooperation within the frame of the services of the International Association for Geodesy (IAG) and of the International Astronomical Union (IAU). The BKG is involved by the recording of observations

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(VLBI, SLR und GPS) and by the analysis of measurements in the International VLBI Service for Geodesy and Astrometry (IVS), in the International Laser Ranging Service (ILRS), and in the International GPS Service (IGS). With the construction of the Transportable Integrated Geodetic Observatory TIGO the BKG enables the operation of a further fundamental station in the southern hemisphere. The BKG signed a cooperative agreement with the University Concepcion in Chile to operate the system on the university grounds in Concepcion. With that the distribution of stations in the International Space Geodetic Network (ISGN) especially in the southern hemisphere has improved considerably and it is contributed substantially to the ITRS.

By international cooperation in the "International Earth Rotation Service (IERS)" a global reference frame is created which ensures continuity and consistency of all geodetic measurement series in space and time. This reference frame forms the basis for geographic information systems (GIS), for the navigation tasks of all transport modes and for an integrated scientific viewing of the "System Earth". The global reference frame realised with the IERS products is important for the national reference systems which on their part densify the global reference system. The BKG is entrusted with the running of the Central Bureau of IERS. The IERS Central Bureau establishes an information and data system which as interface between a highly sophisticated system of measurement and evaluation procedures and the user transfers the IERS product information appropriately and timely.

The Surveying Authorities of the States and the BKG have been working for several years on the realisation of a satellite-geodetic quasigeoid which allows the transition from GPS heights in the ETRS89 to heights of the German primary levelling network 1992 (DHHN 92) on the federal territory with centimetre accuracy. To this end, for about 800 points GPS coordinates (2 x 24 h measuring time) and normal heights are determined with precise levelling. The measurements will be completed in 2001. The satellite-geodetic levelling quasigeoidal heights are modelled together with about 150 000 point gravity data to a quasigeoid. The computations with various model approaches shall be available in 2002. Test computations so far prove an accuracy of better than 1 cm in plain and hilly ground.

#### **Satellite Positioning Service of the German National Survey SAPOS**

The build-up of the Satellite Positioning Service SAPOS of the German National Survey is advancing

further. To this end, a network of multifunctional permanent GPS reference stations is established (see Figure 2) with the aim to provide data for Differential GPS (DGPS) in uniform formats for users in all fields of application. The position of SAPOS reference stations is determined with high precision in the European Terrestrial Reference System 1989 (ETRS 89). Therefore, the results of SAPOS at the user refer directly to the uniform European reference system ETRS89.

After the stop of the intentional degradation of GPS signals (Selective Availability, SA) in May 2000 GPS provides for civilian users an absolute accuracy of about 15 meters. With the service area EPS (Real Time Positioning Service) a positioning accuracy of about 0.5 to 3 meters can be achieved which is suitable for many applications of georeferencing. The user gets the correction data in real time. Country-wide, there are two methods available for whole Germany: The method ALF (Accurate Positioning by Low Frequency) for which the correction data are transmitted via a long waves transmitter in cooperation between the BKG and the Deutsche Telekom AG, and the method RASANT (Radio Aided Satellite Navigation Technique) which uses for the correction data the Radio Data System (RDS) of the public VHF radio stations.

The service area HEPS (High-Precision Real Time Positioning Service) offers a positioning accuracy of 1 to 5 cm. For this, a network of GPS reference stations at a distance of about 50 to 60 km is necessary. The correction data are transmitted in the 2 m band via the National Survey's own VHF transmitters or can be called by mobile phone. The station network is being extended at the moment. In most of the Federal States the final stage of completion is already achieved. Currently about 85 % of the planned reference stations are already in operation in Germany.

In several States an on-line networking of reference stations is being built up. Position-dependent corrections allow real-time positioning with homogeneous accuracies of about 2 cm and of high reliability.

With the service GPPS (Geodetic High-Precision Positioning Service) the data of the reference stations are available to the user for post-processing or "near online" immediately after the recording in the RINEX format via telephone or internet.

In the Technical Committee SAPOS representatives of the Adv and of GPS hardware and software producers as well as those of communication technology work together to coordinate standards and the further development of SAPOS.

# Referenzstationen

**SAPOS®**

**Satellitenpositionierungsdienst  
der deutschen Landesvermessung**  
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