



## **NAVITEQ NETWORK**

### ***General description***

Following the world experience in establishing and operating networks of permanent stations, NAVITEQ started to build the first GNSS network in Bulgaria. This is a private project initiated at the end of 2004. First, the project started with installing 5 stations in the most economically developed region. Currently, the number of the stations is 15.

### ***Manager(s)/Organisation(s)***

NAVITEQ is a trade mark of "SB Group" Corporation. The company has three main divisions: providing GNSS services for professionals, developing digital maps and distributing GPS devices.

NAVITEQ has established close cooperation with the Central Laboratory of Geodesy (CLG) at the Bulgarian Academy of Science for use of existing academic buildings and infrastructure wherever possible. Specialists from CLG calculate the coordinates of the stations with the Bernese software, version 5.0 and monitor the reference station stability by the velocities computed by GAMIT/GLOBE-K software. The analyses of trails show good stability of the chosen reference sites.

NAVITEQ provides the academic society with 30 second RINEX files for geotectonic applications. Annually, NAVITEQ supports the University of Civil Engineering and Geodesy in Sofia with practical training in GNSS services and their applications.

### ***Type of equipment, description of a "typical" station***

NAVITEQ reference stations are equipped with Topcon receivers and choke ring antennas. The antennas are absolutely calibrated by a robot at Geo++ GmbH and are used together with radomes against icing, snow and rain. There are two



types of antennas – nine are CR-3 and six are CR-G3 model.

All antennas are mounted on the roofs of existing buildings. Masts of 10 centimeters in diameter are used to ensure stability against wind load. The mast elevation is minimum 0,5 m above the roof surface.

The indoor equipment of each NAVITEQ reference station is situated in a rack for ensuring normal operating temperature for all devices inside: a GNSS receiver, a UPS device, telecommunication devices for the primary and the backup lines to the control centre. These racks are situated in rooms with restricted access.

### ***Description of Control Centre***

The NAVITEQ control centre is situated in a special room in the main corporate office in Sofia. The reference stations are connected to the control centre using leased lines. GSM connections are used as backup lines.

At the beginning, the communication server capacity at the control centre enabled connection of up to six users simultaneously. This number has been increased by specific solution with a local communication operator for adding more communication lines. This solution also improves the reliability of the mobile data connection, and provides for improved service monitoring capability.

On request, NAVITEQ offers its users GNSS data for post-processing. These are RINEX or Compact RINEX data at user specified observation rates, from either the reference stations or a VRS (virtual reference station) at any required location within the area of the NAVITEQ network.

For real-time applications, RTK and DGNSS are supported, whilst for network RTK VRS, FKP and MAC techniques are used. Real – time data are transmitted in RTCM 2.3 and 3.0 formats, as well as in the CMR+ format.

NAVITEQ runs the GNSMART system of Geo++ GmbH.

### ***Stations***

The NAVITEQ reference stations positions are determined in the EUREF based National Reference Frame realized by the Bulgarian National GPS Network. [1]

Currently, the NAVITEQ network consists of 15 reference stations. All are



observing GPS and GLONASS, one is observing GPS only.

The calculated number of reference stations is between 21 and 25 by applying the hexagonal puzzle technique [2] for the 110993 km<sup>2</sup> area of Bulgaria and 70-100 km project interstation distance.

Another 10 stations are under construction and will be operational by 2010.

## **Services**

NAVITEQ offers two services in post processing and two in real time.

The post processing data are available in RINEX format to subscribers upon request. These data are provided through the Naviteq Post Processing and Naviteq VRS services. The achievable accuracy is 1 cm.

The real time kinematic service, called Naviteq RTK is a networked service. It gives all users the opportunity to measure in the entire coverage of the network with accuracy of 2 cm. The correction data for network-RTK are transmitted to the users by RTCM 2.3 protocol by GSM network via CSD protocol. Currently, the network solution is established by FKP concept. The correction data acquisition for RTK service is also available by Internet via NTRIP protocol.

Another service in real time is Naviteq DGNSS. It provides users with differential corrections by improving the precision up to 0,5m. Naviteq DGNSS is provided to the users free of charge. Users receive the correction data via NTRIP protocol, and can select the most suitable amongst the available reference stations.

## **Users**

NAVITEQ services meet different application requirements in surveying, cadastre, GIS and utility fields, photogrammetry, agriculture and any other field where the user needs high accuracy and efficiency.

As of June 2009, there are 30 users of the network. All of the users are private companies working in cadastre, photogrammetry and surveying as well as utilities.

RINEX files from the real reference stations are used for tectonic plate monitoring by the Central Laboratory of Geodesy at the Bulgarian Academy of Science.



## ***Issues to Resolve***

This project has always been challenged by poor customer's demand on GNSS services because of the lack of regulation document and limited funding.

The main problem in providing GNSS services in Bulgaria is the out-of-date legislation documents for using GNSS methods and GNSS networks in surveying. Since 2007, there have been significant efforts to update legislation in order to give the opportunity and freedom to Bulgarian surveyors to choose the most effective and suitable technique for GNSS observations.

## ***Future plans***

The first and main perspective of NAVITEQ is to complete the realization of the GNSS network in Bulgaria. The complete NAVITEQ network development is planned to be finalized next year. Then the NAVITEQ services will be available from any site of Bulgaria and Bulgarian surveyors will be up to date with the newest GNSS techniques.

## **References:**

1. Georgiev, I., et all., National GPS Network, Geodesy, special issue 18, 2006
2. Minchev, M., Establishing 3D Reference Frame in Bulgaria, Partnership in Mapping, Charting and Geodesy '97, Bucharest, Romania 3-4 September 1997

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