HADMÉRNÖK

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Koós Tamás
Zrínyi Miklós Nemzetvédelmi Egyetem
koos.tamas@zmne.hu

EXPERIMENTS IN THE DEVELOPMENT OF THE HUNGARIAN GPS NETWORKS

Abstract

The establishment of the GPS and the large spread of this technique made new, simpler and more accurate adaptation of navigational and positioning methods possible. The geodesic and military- geodesic adaptation of the technique needed new, country-wide geodetic network, defined only by GPS method. The developed networks created the right relationship between the already existing country-wide and the international geodetic networks.

Keywords: *Global Positioning System, European Reference Frame*

THE NEED FOR CREATION THE GPS NETWORK

The use of GPS (Global Positioning System) technology in surveying practice in Hungary started in 1990. The very first results have already made that clear, that - in accordance with our expectations - the accuracy of the GPS measurements exceeds by orders that of the networks determined by traditional surveying methods.

Influenced by the political changes, a new demand has also come to the fore. The closer links with the Western European countries in the field of economy, politics and military affairs required the Hungarian geodetic network be able to connect with the geodetic network of the neighbour countries and the world.

On the strength of these two main factors, a new demand has emerged for creating a new, a GPS network, that should be based on the points of the traditional network, but independent in determining the coordinates.

THE HUNGARIAN GPS FRAME NETWORK

The Hungarian civilian land survey, under the leadership of the Penc Cosmic Geodetic Observatory of the Institute of Geodesy, Cartography and Remote Sensing (Földmérési és Távérzékelési Intézet, Kozmikus Geodéziai Obszervatóriuma, Penc, FÖMI-KGO) started to survey a 24 points national GPS network in 1991 (see figure 1).

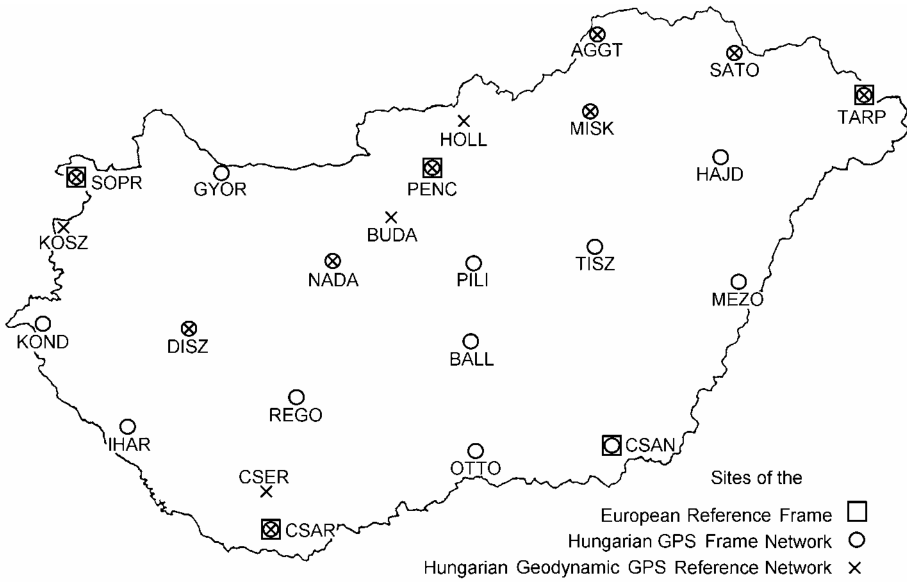

Figure 1. The Hungarian GPS Frame Network[1]

Thirteen points of this network are also included in the Hungarian Geodynamic GPS Reference Network [1], which aim is to implement repeated measurements to show the movements of the related regions from each other.

For the first time, five points in Hungary and six points in the territory of the former Czechoslovakia have been connected to EUREF (European Reference Frame) within the frame of the EUREF CS/H '91 campaign, executed simultaneous measurements in reference points in Austria, Germany and Switzerland in eight sessions.

Later on, based on five EUREF points, the 24 points national GPS network has been established with another 19 points taken in four more sessions. This network will then serve as a base of the future densifications.

THE MILITARY GPS NETWORK

Simultaneously with the development of the Hungarian GPS Network the elaboration of the Military GPS Network has also been started. The Hungarian GPS Network consists of 5 absolute and 33 relative stations (see figure 2).

The survey production of the Military GPS Network was completed in two phases. The absolute stations were surveyed from 19 – 21 October 1992 and the relative stations were surveyed from 26 October – 10 November 1992 [2].

The absolute stations were to be surveyed jointly by the Defense Mapping Agency Department of Defense, United States of America (DMA) and the Tóth Ágoston Mapping Institute of the Hungarian Defence Forces (Magyar Honvédség Tóth Ágoston Térképészeti Intézet, MH TÁTI) personnel and the relative stations were to be surveyed by the surveyors of the MH TÁTI.

[1] FÖMI.

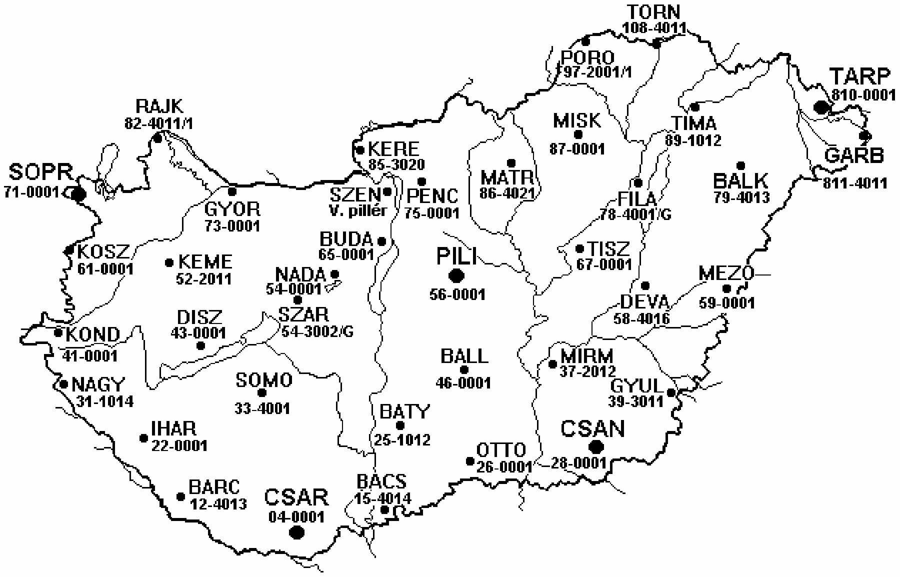

Figure 2. The Military GPS Network

All surveys were to be conducted with Astech MD-XII dual frequency C/A-code GPS satellite receivers, owned by DMA.

All absolute stations were occupied simultaneously, i.e. all five at the same time, for 3 satellite tracking session. Each satellite tracking session was 5 hours in length and the recording (epoch) interval was 30 second. The relative network was divided into small sections and a "leapfrog" technique was implemented to tie each day's survey to a previous one. Station PILI 56-0001 were held as a fixed base station and, a second absolute station was occupied each session, while 6 other receivers occupied the relative stations.

Each relative station was occupied for at least 2 satellite tracking. Each satellite tracking session was 3 hours in length and the recording (epoch) interval was 20 second.

Due to the effects of Selective Availability[2] (SA), validation of the computed absolute positions was not possible in the field. The relative computations were validated in the field using transformed WGS 84[3] coordinates of the absolute stations provided by the MH TÁTI. The post-processing of the data obtained was done by the experts of Geodetic Surveys Division of the DMA Aerospace Center, Department of Geodesy and Geophysics (DMAAC/GGB).

The coordinate determination error for all three components of the so elaborated KGPSH datum points, are less than one metre. The relative errors of the network to the datum point in all cases are less than 0.015 metre, except one point, where it is 0.037 metre. 557 of the 583 vectors between observed stations, have accuracies of 0,3 ppm (pars per million) or better and the remaining 6 vectors have accuracies of 0,4 ppm or better.

THE "ONE-THOUSAND-POINT" NATIONAL GPS NETWORK

The density of the GPS networks, 40 to 50 kilometers, does not meet the requirements of executing practical surveying tasks [3].

In order to carry out a densification two methods can be considered:

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[2] The Selective Availability is turn off in 2000.

[3] World Geodetic System 84

– transformation the points of the old networks by means of the already established GPS networks, or
– densification the established GPS network by measurements.

The residual errors of transformation between the old and the established GPS networks can be as much as 25 to 35 centimeters [4]. This value demonstrates the satisfying character of transformation for military use, however, this standard does not fit the demands of cadastral surveying.

Thus, civilian surveying authorities have chosen to support the implementation by densification method (see figure 3).

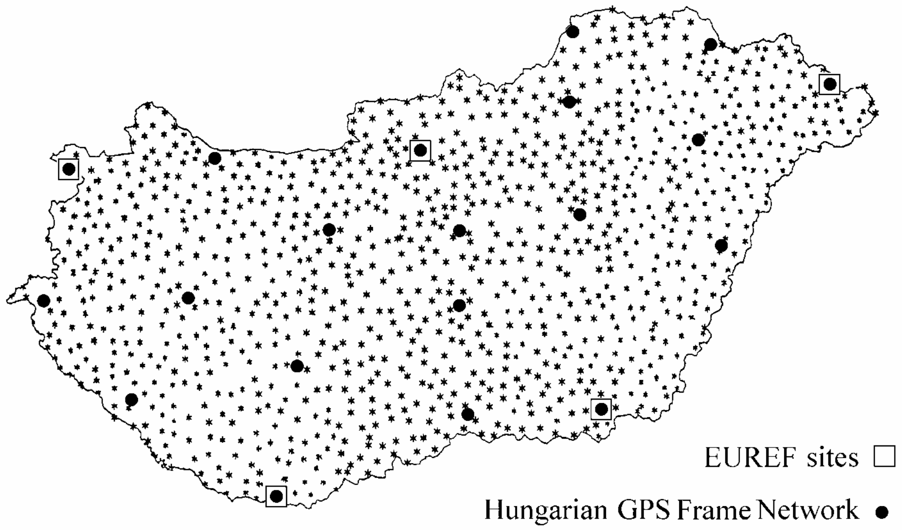

Figure 3. The "one-thousand-point" Hungarian GPS Network[4]

The homogeneity of the network is provided by a 44 point '0' order network, using the points of the Hungarian GPS Network and the Military GPS Network.

Due to financial reasons as well as taking into consideration the geographic structure the country the network measurement was planned to be completed in the course of three years. The preparation of the network development started in 1993. The selected points were reconnaissanced, maintained and, differently from the surveying practice, supplemented with some textual description.

When selecting the points the primary considerations were to have the points of the GPS network be the same as those of the already existing one and that the access of them by car should not be a problem even is the case of unfair weather.

Since the preparation of the EUREF coordinates of the selected points were made by transformation these points could have been used for instrumental GPS navigation at point searching.

The measurements are implemented by the simultaneous observation of 10 pcs. of two-frequency receivers, with 4 tied points. Each point has observed two sessions, with repeated occupation between the sessions in order to minimize the error arising from occupation.

The pre-processing the observed data was already implemented on the field, in the intervals between the measurements, while the final data process was carried out with 'BERNESE' software, developed by the Bern University, Switzerland.

[4] FÖMI

In contrast with the '0' level network determination meteorological data measured were not embraced in the schedule of the sessions so in order to make ionospheric corrections the Hopfield model was selected.

The assigned, consist of overall 1153 observed stations, 3 to 5 kilometers density of this new network will make render to carry out geodetic measurements based on GPS network of great accuracy.

SUMMARY

The density (40 to 50 kilometers) and the accuracy (less then 30 centimeters) of the Hungarian GPS Frame Network and the Military GPS Network, meet the requirements of military task. The homogeneity and the authenticity of the new networks exceed the character of the old ones.

The everyday cadastral surveying requires materially denser network. The “one-thousand-point” Hungarian GPS Network satisfies these requirements, so it can

The developed two Hungarian GPS networks are (the Military GPS Network and the “one-thousand-point” national GPS network) connected with the already existing Hungarian geodetic networks, as well as linked to each other by their 18 common points.

These networks assure right relationship between the Hungarian and the international geodetic networks, so with their assistance come into geodetic connection towards the European and world coordinate systems.

References

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