



NKG, Working Group: Reference Frames, Positioning and Navigation

March 15–16, 2011, FGI, Masala, Finland

Minutes of the meeting

Participants:

Denmark: Mette Weber
Estonia: Karin Kollo
Finland: Pasi Häkli (Chairman of the WG)
Sonja Nyberg (secretary of the meeting)
Markku Poutanen
Iceland: Þórarinn Sigurðsson
Norway: Torbjørn Nørbech
Matthew Simpson
Oddvar Tangen
Sweden: Lotti Jivall
Christina Lilje

1. Welcome + practical information

Pasi welcomed everybody and informed the schedule of the meeting and other practical issues.

2. Agenda/minutes

The minutes of the previous meeting were not found and notes from the previous meeting were not considered necessary to go through. The agenda of the meeting was approved.

3. Brief national reports

- **Finland (Markku, Pasi & Sonja)**

Risto Kuittinen has retired as the director general of Finnish Geodetic Institute in February 2011. The new director general will be nominated until the end of the May.

The GPS antenna change operation of Metsähovi IGS station (METS) has taken a lot of effort. The antenna broke down during summer 2010 and was replaced by a new one. The tie between the old and the new antenna have been determined with tacheometric measurements. So far, the vertical shift has been determined. The plan is to continue the tie determination as soon as possible: measure the horizontal displacement and compute the difference relative to the other antenna (METZ) in the same mast from GNSS observations as well.

The work for the automating of the FinnRef data processing is going on. The first aim is to reprocess the FinnRef data history (during this year), and later carry on with the routine processing of the data. Also the data archiving system will be developed for the needs of the routine processing.

- **Denmark (Mette)**

Denmark is preparing a new strategy for reference network, which will be based on GNSS, leveling and tide gauge observations (5D).

In the Faroe Islands, a new reference frame based on GPS and leveling is established. A new geoid model will also be determined and transformations between the old and new systems.

The national network, REFDK, has been remeasured and recalculated for stability check (first measurement 15-20 years ago). The measurement campaign consisted of roughly 100 benchmarks (~40 km baselines), which were observed in 24h sessions. The maximum coordinate differences were about 3-4 cm compared to the first measurement. Coordinates of benchmarks will be updated.

Two new GNSS stations will be established during this year.

- **Estonia (Karin)**

The national GPS network together with private stations is computed in routine processing. Some problems exist especially in height component.

New legislation (INSPIRE) is under implementing that caused extra work to get everything working according to law.

The re-computation of the 1st order network (measured in 2008) has been finalized and the report is ready.

- **Iceland (Þórarinn)**

New height system will be published this month and report later this year. The height system was established in co-operation with FGI.

Next the work for building up permanent GNSS station network will be started. There are currently five stations working and nine new stations planned. Receivers will be bought from Norwegian colleagues. The establishment of the new stations will be carried out in co-operation with geophysicists, university and the meteorological institute aiming at in total of 20-30 stations. Private RTK service companies are establishing stations, too. Services have access to state-owned data.

Ref-93 (ISN93) network was remeasured in 2004. In the near future, the need for new (semi-dynamic) datum is crucial for maintaining stable coordinates in current reference epoch (2004.6). The static reference system approach does not work, because land is deforming quickly, but people are not either willing to adopt new datum every 10 year. When new semi-dynamic datum is established, the software/service for transformations is also needed.

- **Norway (Torbjørn, Matthew)**

The first national ETRS89 realization (in ETRF93) is not accurate enough especially in height (1-sigma about 15 mm). The new reference system will be established based on time series of permanent stations. New stations have been built and the connection to the previous system is determined by densification of

the network. Observing time in the densifications has been 5-7 days. A remarkable improvement in height (1-sigma 3mm) has been achieved.

The way to establish a new datum is under investigation, but any principle decisions are not yet done. It will probably be established through transformation.

The work for renewing Ny Ålesund VLBI station is going on. The old antenna is from 1993, now two smaller antennas are in target. The optical cable is ready to use. The funding is not yet confirmed.

- **Sweden (Lotti)**

A new strategy plan for years 2011-2020 (Geodesi 2010) and its complement (Report on future geodetic infrastructure in Sweden) was recently published.

Currently 45 municipalities have adopted the new height system (RH2000), while the SWEREF99 is already used in more than 200 municipalities.

The further development of the SWEPOS network is going on. The network currently consists of 218 (RTK) stations. Annually 40 stations will be established during next 6 years leading up to 400 stations (station separation ~ 30-35 km). Lantmäteriet has agreed with Leica and Trimble for delivering GNSS data in order to avoid multiple GNSS networks. The densification aims at increasing positioning accuracy, especially in height. The target is to achieve height accuracy of 10-15 mm (1-sigma) while it is currently about 20-25 mm.

Almost all SWEPOS RTK stations are GPS+GLONASS+Galileo ready (still 30-40 uses old Ashtech antennas). New monuments will be established for the permanent stations to get them all capable for all signals, too.

Also more accurate geoid computation has been considered.

Handbook for surveyors is under updating process (current version from 1993).

4. New NKG structure (Pasi)

Pasi introduced shortly the new structure of the NKG (approved in previous general assembly). Working groups (WG) are like study groups for discussion, information exchange and preparing project proposals. Actual work approved by the presidium (decision of resources) will be carried out in projects (groups). New project can be proposed whenever needed. Time span of a project can vary in time, also inter-WG projects and sub-projects will work fine.

The four NKG WGs are now Geodynamics (WGG), Geoid and Height System (WGGHS), Reference Frame, Positioning and Navigation (WGRFPN) and Geodetic Infrastructure (WGGI).

WG discussed about the keywords connected to the WGRFPN (set at the NKG General Assembly). These were considered relevant and well-suited to the scope of the WG but there is also some overlapping with other WGs.

Pasi reminded WG about NKG General Assembly resolutions. The resolution of making NKG more visible should be kept in mind when proposing projects. More visibility could be achieved by delivering products (e.g. transformations, time series).

5. Work of the previous WG 2006-2010

Lotti presented the computation of NKG2008 measurement campaign of Nordic and arctic areas. Major challenges were related to the connection to the ITRF: which ITRF to choose and how to align the network? It was discovered that the choice depends on the use of the reference frame. With NKG2008 campaign the WG ended up to a conclusion that the main solution should be regionally constrained in order to get consistent coordinates with respect to the official ITRF in the Nordic area. The ITRF2005 coordinates from EPN cumulative solution were chosen to be used for fiducial stations and several methods were tested to align the solution. The final solution was constrained with minimum constraints with NNR+NNT conditions. As a result of the processing good internal precision of the network and good compatibility with EPN solution was achieved. The largest uncertainties were related to the connection to the ITRF but in the final solution these were mostly below 5 mm. The final solution also fulfills the criteria given in the EPN guidelines.

The coordinates from the final solution were used to determine transformations from ITRF2005 to national ETRS89 realizations. The results of the transformations and their residual tests were also shortly presented by Lotti (Martin's slides) and Pasi. The results were not considered as final and it was concluded that this part should be studied further (e.g. new velocity models, new realizations of ITRS etc).

6. Discussion of possible projects

The project topics were discussed based on the previous work of the WG and the NKG General Assembly resolutions. Especially the resolution no. 8 about NKG GNSS analysis centre was considered directly linked to this WG. The WGRFPN may contribute also to the resolution no. 3 about model of crustal deformations and possibly indirectly to the resolution no. 4 about sea level change.

- **NKG GNSS Analysis Center (NKG AC)**

Pasi presented the ideas of NKG GNSS Analysis Center, which could produce as an end product NKG GNSS time series for maintaining reference systems and for geodynamical studies. The NKG GNSS Analysis Center is a wide and work-demanding topic, but if all countries are anyway processing their time series, it would not be impossible to combine them to an official NKG ITRF solution.

Lotti presented the basics of the routine processing of the NKG LAC as a part of the combined EPN solution (slides available). In addition to GPS processing, also GPS+GLONASS processing is requested by EPN. Routine processing takes roughly 2-3 h per week manpower. Rapid (daily) processing would need more resources.

Different aspects related to the potential analysis center were shortly discussed. More detailed planning is essential if project proposal will be accepted.

The workload was one of the major concerns. Therefore it is reasonable to go step-by-step. In the first step, we could

- study the possibilities to combine existing solutions from each country: are they consistent enough or not? In this approach each country processes its own stations (sub-networks) and combination is done with common backbone of fiducial stations (EPN stations). Here data policy is not

necessary because combination is done with freely available data of EPN stations.

After that, the project could carry on with

- harmonizing of data processing (if needed) and reprocess the data history.
- aiming at the continuous routine (daily) processing.
- agreeing flexible data policy between the participating institutes. This would enable optimizing of sub-networks (each station could be processed by more than one institute/country, cf. EPN LACs). The station selection for NKG solution is one thing to be considered. Are the core stations enough or should the network-RTK stations also be included? In this approach data center would probably be necessary. In this context the WG discussed also about the current status of the BIFROST project. Considering the GNSS data (policy) and processing part in BIFROST, maybe NKG AC project could be something similar to that (or even inherit these actions from BIFROST)?

The product availability and policy are also important issues. Products should be available at NKG webpage to increase the visibility of NKG. Product policy (i.e. what given outside NKG community: data, NEQs, Sinex,...?) should be carefully considered. Related to this topic it was mentioned the resolution at EUREF 2010 symposium regarding to request of contributions to IAG WG of dense velocity field.

- **Transformations ITRF \leftrightarrow ETRS89 with velocity models (Pasi)**

The transformation project was not fully finalized during the last WG period. On the other hand new ITRF's are coming (how to handle these) and new velocity models would be useful (current model is aligned to ITRF2000 and is based on GNSS data up to 2004). Thus, the meeting concluded that the work should be finalized and models further developed.

- **Geodetic infrastructures (in Sweden)**

Lotti presented SWEREF99 and their publication "Report on future geodetic infrastructure in Sweden" (slides available). The work was considered important for all other countries dealing with the same issues. At the moment other countries use passive networks.

Future goals within this WG are to exchange information and knowledge and give support for each other. Later it may be useful to arrange e.g. workshop for more intensive co-operation. This was proposed also a potential topic for the NKG summer school 2012.

- **Modernization of permanent GNSS stations**

Many countries are modernizing their GNSS stations and densifying their existing networks (as mentioned during national reports). Related issues to be considered are monumentation of the stations, dual sites, local ties, site dependent effects etc.

Sweden has already decided how to build new monuments, but other countries do not have exact plans yet. This topic was considered to belong better to the scope of the WG of Geodetic Infrastructures.

- Following project ideas were shortly introduced and considered less important at the moment, but to be potential projects later.
 - GNSS antenna calibrations: individual vs. type calibrations
 - Ionosphere and troposphere modelling in Nordic area
 - Nordic Positioning Service
 - Navigation related projects

As a conclusion from the discussions, the WG decided to propose NKG GNSS Analysis Center and ITRS-ETRS89 transformations as (the first) projects for coming years. Preliminary project proposals/plans documents were prepared. Geodetic Infrastructures was considered an important topic to be discussed in the WG meetings.

7. AOB

Oddvar showed the Metsähovi time series, where the shift due to the antenna changes and the effect of introducing individual antenna calibrations were clearly visible. His Gnu Plot -scripts are available also for other group members.

Slides of the meeting will be available at KMS-ftp server and documents at the WG-NKG webpage

8. Next meeting

WG will meet regularly (once a year) as before, next meeting will be held tentatively in Iceland (or otherwise in Norway)

9. End of meeting

The meeting was ended at 11:30 on 16th March, 2011.