

# NORDISKA KOMMISSIONEN FÖR GEODESI

Nordic Geodetic Commission, Working Group of Reference Frames  
Chairman  
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## NKG Working Group of Reference Frames

### Minutes of the working group meeting Reykjavik/online on Mar 13-14, 2024

**Place:** Reykjavik + online (marked with \*)

#### Participants:

EST: Jaanus Metsar, Tarmo Kall\*

DEN: Kristian Evers, Joachim Mortensen, Thomas Knudsen, Mette Weber\*

FIN: Pasi Häkli, Sonja Lahtinen (secretary)

ISS: -

LAT: Aigars Keiselis

LIT: Jokubas Ogintas

NOR: Michael Dähnn, Tobias Arnell, Sveinung Himle\*, Oddvar Tangen\*, Knut Gjerde\*

SWE: Tina Kempe, Lotti Jivall, Martin Lidberg, Tobias Nilsson\*, Per-Anders Olsson\*, Christina Lilje\*, Henrik Bryskhe\*, Tong Ning\*, Rebekka Steffen\*

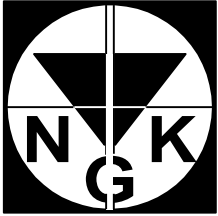
The slides of the presentations will be available at the SDFI's FTP server.

#### Session 1: Workshop feedback

The thoughts about the workshop “Geodesy Redefined? - Quantum & AI Insights” were discussed. The time series analysis may benefit from AI, but there are no activities going on within our group. However, the AI presentation was considered very useful giving useful references to be checked out. We follow the topic. The quantum technology was not seen having a connection to the work of the group.

#### Session 2: NKG GNSS AC

Michael presented the Python tools that NMA has developed to facilitate the high-precision GNSS processing. The Midgard library includes time and position conversions, plate motion calculator, input/output file writers/parsers for Bernese and Gipsy formats. Operax is developed for operationalisation of the GNSS processes. It is currently used operationally for GipsyX. Midgard is freely available as a Python package available at GitHub (<https://github.com/kartverket/midgard>). Operax can be considered for sharing if someone is



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interested. NMA has also developed a timeseries format based on the SINEX format for their internal use, as the EPOS format was not considered flexible enough in all aspects. Kristian encouraged NMA to contact IGS to get an official status for the format, like RINEX and SINEX. It could be useful for the NKG AC project, like in Repro2, but it depends on the software in use etc.

Joachim presented the development done at SDFI to automate the Bernese installation and workflows. The Bernese needs several third-party dependencies, and all the installation steps/scripts do not work as stated in the installation guidelines. SDFI has taken steps to use Docker (kind of virtual environment) into use to isolate and reproduce the Bernese installation on any host architecture and to make it easier to get up and running. They have also developed a tool called AutoBernese that facilitates the Bernese processing. It is available at GitHub (<https://github.com/SDFIdk/AutoBernese>).

Sonja presented the overall status of the NGK AC. All LACs except DK are now routinely submitting their operational solutions. DK has run the benchmark test, but there are still larger than usual differences compared to other AC results. It was concluded that this is probably due to the bug-fixed version in use at DK, which was not available, when other ACs ran the test. Lotti promised to re-run the benchmark test results with current software version. DK will start operational processing when they have AutoBernese ready.

Lotti has combined all available solutions since the switch to IGS20 (GW2238). The results show that the new (IGS20) AC solutions fit significantly better to the combined solution than the earlier operational solutions (IGb14).

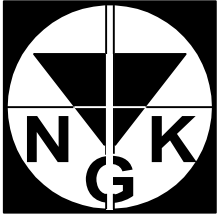
Sonja presented the Repro2 guidelines. NKG-EPN and FGI has already processed most of the data. EST, LAT and ISS have started preparations and/or processing. The rest are encouraged to start as soon as possible. Sonja will share her Repro PCF setup, which can be used to check how to configure e.g. the BIFROST specific solution. Tina presented her experiences with the Repro processing, the slides may help in troubleshooting issues. The Bernese BASTST.PCF can be used to compute GPSEST baseline-by-baseline to find out the problematic station/baseline. After the session it came out the reduced IGS20.SNX on FTP may not include all the available IGS20 stations in our area as they are not part of NKG-EPN subnet. Tina will check this.

Sonja is leaving FGI in April so the project will need a new leader in near future. Everyone is encouraged to use the opportunity to get a nice post.

## **Session 3: Transformations and GNSS positioning**

This session was joint with the GNSS positioning group. Some main points listed here; see the slides for details.

Pasi introduced the NKG2020 transformation that is available in PROJ. He also presented a pilot project DynPos carried out at FGI, in which the use of dynamic reference frame was tested in FINPOS positioning service. Almost the same accuracies were achieved using different setups: dynamic, semi-dynamic and static.



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Kristian presented his ideas about simplifying transformation parameter derivation. He had drafted architecture of transformation parameter derivation program. This could be the architectural foundation in next generation of the software behind the NKG transformations.

Christian Brönnum (WGGP) presented the ongoing development of SDFI's new GNSS data management tool. The new system will be based on Python as it enables concurrency. Tools from the GeoRust ecosystem was evaluated as replacements for existing tools. The GeoRust includes tools to work with RINEX and also quality checking of the data. The evaluation showed that the RINEX tools from GeoRust are not yet mature for production use at SDFI.

Kibrom Abraha (WGGP) presented the fully re-written Swepos post-processing service developed at Lantmäteriet. A user can submit his/her RINEX data and get the SWEREF99 coordinates as a result. The processing is done using Bernese, and the input RINEX data is validated before processing to avoid errors in later phase.

Michael introduced the Galileo High Accuracy Service (HAS), which aims to bring the positioning accuracy to 20/40 cm level by providing correction data to the user via satellites or internet. NMA is part of the GEMOP project, in which they have studied the ranging and positioning performance using the HAS corrections. The target levels have not yet been met.

Kent Ohlsson (WGGP) presented DINPAS project, in which Lantmäteriet has generated SSR corrections for positioning using GNSMART software. The static test showed 10/15 cm accuracy in horizontal/vertical. Dynamic test has been done on car and drone. Railbased test in realistic user environment is coming.

Magdalena Golofit (WGGP) presented Danish National Galileo Overlay (DANGO), which motivation is to deliver Galileo services to the Danish user. The project will still last until autumn this year.

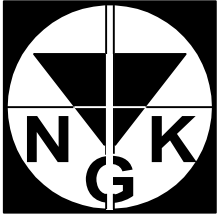
Discussion: Casper Jepsen will arrange a study group related to Galileo HAS. A study group for SSR will be set up within WGGP as well. The benefit of having joint sessions was discussed. It was concluded that there is no interest to have joint sessions every year. They can however be successful during the NKG Science Weeks, as all participants are anyway in the same place.

## Session 4: National reports

Some main points listed here; for all project and details, see the slides.

### Denmark

- SDFI has moved to a new office close by the old one in Copenhagen.
- GNSS real-time data: a next generation real time caster has been developed based on BKG's software
- New guidelines prepared for the private network operators providing positioning services
- Work on geodetic standardisation has continued



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- GNSS jamming test carried out, and purchased a HAS receiver
- Activity in Greenland: new stations, GNSS-IR receiver installed and start link connections tested

## Estonia

- ESTPOS includes 28 stations. The upgrade of the hardware is under tender. There will be about 40 stations in future. Quality check has been developed using Anubis.
- There are 4+1 commercial RTK networks, of which coordinates are monitored. Official legislation change is underway.
- Estonian Land Board is under a new ministry: Regional affairs and agriculture. A new department has been formed by merging two, the new one is called Geodesy and Aerial survey.

## Finland

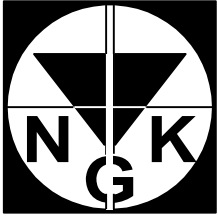
- Reference frame related work done in NKG projects: NKG GNSS AC and NKG transformations.
- Finnref network is the backbone for the national coordinate, height, and gravity reference systems. Precise levellings and terrestrial measurements of the GNSS stations has continued and will be finished by about 2025. Twenty stations are re-measured in three-year cycle using absolute gravimeter. Furthermore, SAR reflectors have been installed at sites.
- FINPOS network includes about 100 own stations. It is used in NLS's internal operational use. Raw data streams are sold to five customers. Ionospheric activity monitoring has been developed. No significant interference has been detected.
- A new EGNOS/RIMS station in Kuusamo has been taken into use in Dec 2023.

## Iceland

- ICECORS network: upgrade of the receivers in the network is going on.
- Maintenance of the geodetic network in the Reykjanes peninsula, where the volcanic activity has destroyed the infrastructure, is going on. In near future ISN2016 in this area will be redefined.

## Latvia

- LatPos network includes 26 stations. The service is free of charge.
- Planning to use Anubis for the RINEX quality control.



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- Geomagnetic measurements were continued for mapping and heliport purposes.
- LatRef network will be densified by the Great network with 62 benchmarks. The Great network will serve for datum maintenance. The new benchmarks are concrete pillars and include levelling benchmark, and possibly passive SAR reflectors as well.

## Lithuania

- LITPOS service includes total of 44 stations and is free-of-charge. Trimble hardware are used.
- LITPOS stations are contributing to the NGK GNSS AC. The processing in IGS20 is up to date.

## Norway

- NMA's positioning service CPOS has about 5000 unique users and other private services (based on CPOS) have more than 15000 unique users. CPOS utilises about 300 stations.
- MODI project is related to test highly automated driving features: NMA is providing a reference.
- NMA is part of the EUSPA funded GEMOP project. They contribute to several work packages.
- HyPos project is related to testing of the SSR correction in positioning.
- A new coordinate transformation platform will be released in summer.
- NYAL: The scale issue in VLBI in ITRF2020 has partly been explained by the melting glacier in the region.

## Sweden

- Swepos: automated and simplified subscription of orders has been taken in to use. Prices has been reduced for the RTK users.
- Antenna heating system has been installed at two station to get rid of the snow accumulation during wintertime. The system looks promising, but some fine-tuning of the radome and/or heating system is under development to get the snow sliding totally away.
- Installation of InSAR corner reflectors has continued. Five more reflectors will be installed every year in 2024.
- RINEX data has been restored from tapes to disks due to change in IT systems.
- GNSS analysis: Bernese 5.4 has been tested and taken into use in 2023. LM is processing the NKG contribution to the EPN Repro3, and it has progressed well.



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## Session 5: Git and GitHub

This session focused on the possibilities to utilise Git and GitHub within the AC and transformation projects. Joachim gave a thorough introduction to Git followed by Kristian's introduction to GitHub. Git is a version control system and GitHub used for sharing the code and interacting.

The possibilities with AC were discussed. Joachim had a thought about a common GPSUSER setups, which could be just easily copied to get correct settings with little effort. Sonja pointed out that there are differences in AC setups and preferences, and fully identical setups may not work for all. The Bernese updates should be possible to handle as different branches. It was decided that Joachim makes an example of how the things could work using a private GitHub repository. He can utilise Lotti's example on FTP. NKG AC has also some additional tools/scripts/guidelines/stationlist currently saved on FTP, which might be useful to maintain in the GitHub in future for better version control.

The use of Git/GitHub is more straightforward in the transformation project. Kristian invites an online meeting about this latest in month or two.

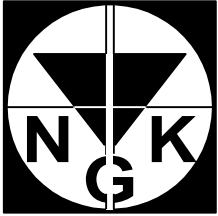
## Session 6: NKG Transformations

Pasi presented the status of the NKG\_RF17vel model. He has got all necessary information now, but he had not time to finish the work for this meeting. He has started to make the manuscript of the model, but the results part is still missing. It will be finished within a month and shared with the co-authors.

Henrik presented a GTRANS coordinate transformation program developed at Lantmäteriet. It is available free of charge at LM's webpage. It includes a graphical user interface and a software library. It can currently be used for creation of two-dimensional transformations by fitting, but three-dimensional transformations can be performed. It is not tied to Sweden, but it can be adopted to different countries/coordinate systems. It has also a multilanguage and PROJ support, and it can be extended using Lua programming language.

Thomas talked about geodetic registers and registries, and how important the registers are to get the coordinate systems into the users' hands. The two important registers are ISO and EPSG. The current registries may not include all features needed to present e.g. NKG transformations. Thomas et al. are working hard to get the NKG transformation into ISO. In ISO term, NKG transformations can be considered as a concatenated operation, but the ISO does not understand observation epoch. ISO is a purely abstract presentation and the implementation in software like PROJ is still needed.

It was discussed that it could be beneficial if each country communicates the same message to ISO via its national representative of the standardisation organisation. Thomas will prepare a memorandum for comments and further to be communicated to the national representatives.



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Sveinung talked about EPSG registry. PROJ database is actually a subset of the EPSG database. The NKG transformations are implemented in PROJ but not in the EPSG registry. He had been thinking of reducing steps in NKG transformation.

It was decided to arrange a study group on registers. Thomas will chair the group and invite a meeting. As the work in ISO is likely not progressing quickly, the focus will be on EPSG.

## **Session 7: Business matters**

Pasi has started to update our products to the NKG webpage.

The next meeting will be hosted by Lantmäteriet in Gävle in spring 2025.