

Draft Charter for the

# **EUREF Working Group on Reprocessing of the EPN**

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prepared by

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## **Goals**

Consistent precise coordinates and velocities as basis for the management of the ETRS

## **Introduction**

During the past years it has been realized that the analysis of the global as well as the regional GNSS networks are affected by different factors like the reference system realization, correction models, analysis strategies and software packages. Therefore products provided by the IGS or the individual analysis centers in the form of precise orbits, ERPs or clocks are dependent on these different factors that were available at the time of generating these products. As a consequence the coordinates estimated by the EPN Local Analysis Centers (LAC) over the past decade are not consistent over the entire period of time. Inconsistencies in the time series of the coordinate appear most frequently whenever models (e.g. antenna PCV) or the reference frame realization were changed.

The appreciation of this problem has been recognized by several groups. As a result the entire IGS network has been reprocessed by the group consisting of the GFZ Potsdam, TU Dresden and TU Munich. This group used identical standards and models, reference frame realization and software package to process the data between 1994 and 2007 homogeneously. In the meantime the different analysis centers of the IGS have started their own reprocessing activities and reprocessed orbits, clocks and ERPs are available to the users. These reprocessing activities are now coordinated within the IGS and consistently derived products are to be expected in the near future. One potential user group of these products is the group of Local Analysis Centers (LACs) of the EPN, which are dependent on these products for the estimation of consistent coordinates.

## **Status**

Reprocessing activities have been started by different LACs of the EPN. Some groups applied the reprocessed products by the Potsdam-Dresden-group (PD), while other groups used the already available final IGS products generated over the past decade to perform their reprocessing. In the later case the products still did not contain the most recent corrections models (e.g. absolute PCVs). The networks were also different in size - varying from parts of the EPN to the entire EPN (as it was carried out by the Military University of Technology, Poland). But all the groups acted



individually and arrangements under the umbrella of EUREF were not made in advance. During the LAC workshop in Frankfurt end of October 2008 there was a general agreement to present to the EUREF TWG a working plan for a coordinated reprocessing of the entire EPN, spanning the period from 1996 until 2009. At least 6 groups announced during the workshop that they would participate in the reprocessing activities. The analysis coordinator (Heinz Habrich, BKG) confirmed to combine the reprocessed solutions of the LACs. A dedicated data center for the reprocessing will be installed by the EPN central bureau, which will provide an on-line copy of all EPN data since the start of the EPN. In a next step, Christof Völksen was appointed to prepare a charter for a working group on “Reprocessing of the EPN” and, if successful, to coordinate the reprocessing activities of the EPN. In the meantime a questionnaire was sent to all the LACs in order to gain information on their participation in the reprocessing activities, different views and to collect ideas. The questionnaires have been returned by now and evaluated. Some of the ideas are presented here.

## Participation

Of the 16 local analysis centers (LAC), 12 centers indicated clearly their participations for the analysis of the GPS data. This very positive response indicates the wish of the LACs to be involved in an official EPN reprocessing under the umbrella of EUREF. The willingness shown by the different LACs offers also the possibility to reprocess the EPN network in a similar manner as it is currently carried out within the EPN organization. Therefore, a distributed processing should be put in the focus again. Even though ROB and WUT are prepared to process the entire EPN it should be emphasized to allow all LACs to participate in the reprocessing activities. Since some LAC will most likely not be involved in the reprocessing activities the questionnaire did also show that most of the LACs are prepared to enlarge their network in order to cover developing gaps by adding stations. It will therefore be necessary to assign additional stations to the LACs in order to have a redundant coordinate estimation. The assignment of these GPS stations shall be governed mainly by the networks processed by each LAC and the special interests of the LAC. The station selection, as also the potential use of globally distributed stations, still needs to be solved in detail.

The EPN regional data centers BKG and OLG are willing to participate in the planned reprocessing activities. The EPN-CB (ROB) will setup an additional data center dedicated to the reprocessing, which will contain an on-line copy of all the EPN data since the start of the EPN. While the data of EPN-CB data center will have corrected header information this will most likely not be the case for the two regional data centers (BKG and OLG). Some LACs are in favor of synchronizing the data centers while others do not mind. It would be very valuable if the missing data could be made available through the regional data centers BKG and OLG. The issue of synchronizing the data centers is still not settled but does not hamper the reprocessing activities. It should be pointed out, that corrected RINEX headers are the best way to avoid inconsistencies in advance.

The analysis coordinator (BKG) is prepared to take over the responsibility to combine the different solutions provided by the LACs.

## Software

The questionnaire has shown that most of the LACs are going to use the BERNESE 5.0 for the reprocessing of the EPN data. But there are also plans to use MicroCosm 2007, GIPSY/OASIS and GAMIT. This variety of candidate software packages will enrich the discussion of the best possible analysis of the data and give the opportunity to test different strategies and models. Using several software packages will add quality assurance to the final result of the EPN reprocessing result. Linked to the question of software packages is indirectly the integration of GLONASS into the analysis of the data. Of all the mentioned packages only BERNESE and MicroCosm can process the



GLONASS data. Still, ambiguity fixing is not yet possible. On the other hand GLONASS has become an issue only for the last few years and does play only a minor role in the total EPN data set.

## Standards

An important issue concerning the processing of the data is, which standards should be used. Since the planned EPN reprocessing activity is strongly linked to the reprocessing of IGS, there are good arguments to use identical standards as the IGS ones. On the other hand, the EPN is a provider of coordinates to Europe concerning the ETRS. Problems arise most likely with the application of antenna correction models. Many survey agencies in Europe (e.g. SAPOS and ASCOS in Germany, APOS in Austria) and many research institution are already using individual antenna calibration models. A part of these stations are also EPN sites. In order to keep consistency with the IGS standards one has to use type dependent correction models only. The EPN itself is already using individually calibrated correction models for several sites in its recent analysis.

It is therefore necessary to agree on the standards to be used for the reprocessing. Most likely this has to be done within the LACs and a binding agreement has to be established. It is also possible to create different solutions according to the standards in order to analyze best possible strategies. A very critical issue is certainly the application of the antenna PCV model. Here, one has to balance between the best possible antenna model and the consistency to the IGS reprocessing activity.

For the start it should be recommended to use the standard EPN analysis strategy. Fine tuning of the analysis strategy shall be developed while the project evolves.

## Input-Products

The usual EPN analysis is based on precise orbits and ERPs provided by the IGS or in some cases by CODE (recent CODE products also provide GLONASS orbits and clocks). The planned EPN reprocessing activity requires reprocessed orbits and ERPs. For the entire time span of the EPN reprocessed orbits and ERPs are still not available. The largest consistent product line has been computed by the Potsdam-Dresden group (1994-2007) as already mentioned. Within the IGS reprocessing activities, the individual IGS analysis centers have to a large extent finished the reprocessing of the 2007. Still, a combined final IGS reprocessed product line is not yet established. The combined product cannot be expected before the release of the ITRF2008. The drawback of all these reprocessed products is that GLONASS orbits are still not included.

With all these restrictions in mind it is still worth the effort to begin with the EPN reprocessing activities soon. Starting with year 2007 it is possible to use orbits and ERPs of one specific analysis center (e.g. CODE or PDR) only. If the release of the combined reprocessed products would be delayed further, one could use the products from the Potsdam-Dresden Group (PDR) for the previous years too.

## Working plan

For the implementation of the reprocessing activities several steps have to be taken. Some of these steps are briefly outlined:

- Establishment of a working group “Reprocessing” that coordinates the multiple task of this project. Will discuss detailed problems in connection with the LACs.
- Redistribution of the EPN sites with the focus on redundancy (preferred 3 LACs for each



site).

- Selection of suitable sets of reprocessed products as input for the first analysis of the 2007 data (pilot phase).
- Each participating LAC shall setup the facilities for the reprocessing of the 2007 data.
- Development of a common strategy to be used by all participating LACs.
- Analysis of the daily/weekly coordinates by the participating LACs and supplying the results to the analysis coordinator.
- Combination of the different solutions by the analysis coordinator, reports and feedback to the working group and the LACs.
- Development and study of new strategies for the analysis of the entire EPN data set (1996-200x).
- Analysis of the complete EPN data set by the participating LACs.
- Estimation of reprocessed coordinates and velocities for the entire EUREF permanent network.

It is worth to be noted that this project would not only allow a coordinate reprocessing of the EPN but it also creates reprocessing capabilities at the different LACs of the EPN. It is most likely that reprocessing will become an important issue for the analysis centers. Possibly each new release of the ITRF and the introduction of new correction models will require the homogeneous analysis of all the available data. It is therefore not unlikely that this is just a first step into a continuous task in order to improve the existing reference system realization and to apply it for geodynamic studies. As usual the first step is the most awkward one. Apart from the main goal to get improved results, standardization of basic (RINEX) data and detection of discontinuities and other problems will remain useful for future, probably even more refined, reprocessing steps.

