Certification of Non-EUREF Permanent Stations

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ABSTRACT

The EUREF Permanent Network (EPN) is an array of GPS stations operating continuously, submitted to a set of standards, close to the IGS ones, that guarantee its performance and reliability for the maintenance of the European Terrestrial Reference Frame (ETRF).

On the other hand, there is an increasing number of GNSS stations not included in the EPN, belonging to local networks, that may have the same level of performance and reliability and would like to be recognized as having the same kind of quality as the EPN stations.

The question how to certify these stations has been raised within the EUEREF community, since they are also important for a certain number of EUREF and non-EUREF projects.

This paper represents a first approach to the methodology to can followed by EUREF in the certification of non-EPN stations. For this purpose the 'ISO19100 – Geographic Information' family of standards is reviewed, in order to identify the procedures to may be applied in this certification activity.

1. Introduction

In a working paper (Caporali, A., 2003) presented at the EUREF Technical Working Group (TWG) meeting held in Paris, March 2003, it was presented for discussion the question of certification by EUREF of GNSS permanent stations that cannot be integrated in the EUREF Permanent Network (EPN) because of the density threshold stipulated by EUREF but fulfill, in principle, all the other requirements.

This paper deals with the aspects concerning the decision to formulate guidelines on this subject. Since the certification is mostly related with quality evaluation and assessment, it may be important to try to follow some of the principles already established and approved as International Standards for this kind of information, like the 19100 family of standards addressed by *ISO/TC 211 – Geographic Information; Geomatics*.

The part 2 is dedicated to frame the certification of non-EUREF GPS permanent stations in the principles of the *International Standards ISO 19113 Geographic Information – Quality principles* and *ISO 19114 Geographic Information – Quality evaluation procedures*, that may be applicable in this case, as well as other related standards.

In the part 3 the meaning of the certification is presented.

Finally, a summary of the items for the guidelines is listed, based in the standard's principles.

2. International Standards on quality of geographic information. Basic principles

The International Standards ISO 19113 Geographic Information – Quality principles (ISO/TC211, 2001A) and ISO 19114 Geographic Information – Quality evaluation procedures (ISO/TC211, 2001B) are related with providing quality information on how well a dataset conforms to product specification.

The classes of conformance defined by the ISO 19114 standard are: quality evaluation procedures, evaluation of data quality and reporting quality information.

According also to ISO 19114, the actions within the flow related to the quality evaluation process are the following:

- 1. Identify an applicable data quality element and data quality scope, based on the specified data set and product specification;
- 2. Identify a data quality measure;
- 3. Select and apply a data quality evaluation method;
- 4. Determine the data quality result;
- 5. Determine conformance.

A data quality evaluation procedure is accomplished through the application of two methods: direct (comparison with internal or external information) or indirect (using information on the data).

The reporting of data quality evaluation information can be done using metadata, a quality evaluation report or both.

For the certification of products by EUREF, it's necessary to

- a) Identify the products available for certification
- b) Define the product specification for each potential certified product
- c) Concretise the items for the quality evaluation process
- d) Determine how data quality evaluation information is reported

2.1 Identification of the product to be certified and the product specification

Following the standard's approach, what is needed in the first place is to identify the product for certification. In this case, the product has the following components:

- a) the coordinates
- b) the data
- c) the station itself

The specification of these components can be summarized as follows:

The coordinates

The coordinates of a station must be expressed in ETRS89 with an accuracy within class A or B, as defined by EUREF.

The data

The data must be at least similar to the data of the EPN stations and have the guarantee of free access.

The station

The concept of station contains, at least, the following items:

- site installation (location, stability, guarantee of access);
- equipment (GPS equipment, complementary equipment);
- guarantee of operation for a certain time.

2.2 Identification of items for the quality evaluation process

The choice of items for the quality evaluation process must be made taking into consideration that their evaluation is enough and sufficient to qualify a permanent GNSS station as EUREF-compliant. So, at least the following items must be analyzed and subject to some kind of evaluation:

The coordinates

The values of coordinates, their accuracy and the associated reference system.

The data

The available GPS data and respective accessibility.

The station

The station's location, information about stability, accessibility, equipment, expected time of operation and purpose.

2.3 Quality evaluation procedure and reporting

Considering the nature of the items involved in the process of quality evaluation, both the direct and indirect methods are applied in the quality evaluation procedure.

In fact, the coordinates and respective accuracy, the associated reference system and the GNSS data are evaluated by a direct method, using internal information. On the other hand, the remaining items can only be evaluated through the application of the indirect method, using information that must be requested. As a result of the evaluation, a report seems to be adequate, instead of metadata.

3. EUREF-compliant: the meaning of the certification

Any GNSS permanent station not included in the EUREF Permanent Network (EPN) may apply for a certification by EUREF.

If a station is certified by EUREF, it has the label EUREF-compliant. This label means that:

- the station is installed in a place with good stability, homologous to the EPN stations;
- there is the guarantee of access to the station for checking purposes, if needed;
- the receiving equipment and the complementary equipment have the quality requested by the EPN;
- there is the guarantee of operation for at least 3 years;
- the GNSS data have a quality similar to the majority of the EPN stations;
- there is free access at least to the GNSS data similar to the data used in the EPN processing during the operation period;
- the coordinates are expressed in ETRS89;
- the accuracy of the coordinates complies with class B as defined by EUREF.

If a station is certified by EUREF, it will be registered as EUREF-compliant and is submitted to continuous (data, for example) or periodical (site installation, for example) quality checks.

4. Guidelines: a summary

The summary of the guidelines is presented according to the methodology expressed before.

At first, some pre-requirements are listed, concerning general aspects that must be taken into consideration by EUREF, considering its nature and the principles that have been followed so far, especially those concerned with the responsibilities that must be maintained at national level.

Then, the aspects related with the information about the station are listed. These are mostly related with the indirect method of quality evaluation.

Afterwards, the items concerning the data and the computation of the coordinates are summarized; these are related with the direct method of quality evaluation.

Finally, some ideas about the development of the process inside EUREF are presented.

4.1 Pre-requirements

The responsible for a GNSS continuously operating station not included in the EUREF Permanent Network (EPN) interested in a certification by EUREF must apply for the certification through the National Mapping Agency of the country where it is installed.

The application must contain information about:

- the purpose and location of the station;
- the place and installation stability;
- the GNSS equipment and the complementary equipment;
- the associated local network and Operational Center (old or new);
- the associated Local Data Center (LDC) and Analysis Center (AC).

The application must contain a declaration of the responsible person saying that:

- there is free of access to the station for checking purposes, if needed;
- there is the guarantee of operation for at least 3 years;
- there is free access at least to the GPS data similar to the data used in the EPN processing during the operation period.

The application must contain letters expressing the support from the responsible persons of:

- the National Mapping Agency;
- the Local Data Center (LDC);
- the Analysis Center (AC).

4.2 Information about the station

A report will be produced based on the pertinent station's information and the EPN standards (EPN, 2003), expressing the preliminary acceptance or rejection. The pertinent information concerns:

- the purpose and location of the station;
- the place and installation stability (if necessary, checked by the NMA);
- the GNSS equipment and the complementary equipment;
- the completeness of the documentation.

If the conclusion of the preliminary report is acceptance, then the responsible for the station is asked to announce the starting date of data delivery.

4.3 Data and computation of coordinates

The data is submitted to the associated LDC according to the EPN standards. The data quality is evaluated and reported by the associated AC.

The ETRS89 coordinates and accuracy are computed according to the EPN standards.

A report will be produced based on the data accessibility and evaluation and the accuracy results, expressing the acceptance or rejection.

If the computation is performed at a certain epoch, the results are classified as class B and communicated to the station and to the NMA.

4.4 Validity of the certification

The certification has a validity of a certain period of time. If the station wants to maintain its register as EUREF-compliant, must be submitted to periodical checks. The items to be rechecked have to be defined.

If a station shows a potential interest for EUREF (a special project, possible replacement of an existing EPN station, or other pertinent reason) and if the associated AC agrees, then the time series should be maintained and the certification automatically revalidated if the basic conditions are still fulfilled.

4.5 The process flow

A small group of persons 'certification group?' within the TWG must take care of the certification process, with the following tasks:

- to analyze the pre-requirements and produce a preliminary report;
- to present the conclusions of the preliminary report to the TWG members (by e-mail);
- to inform the station about the preliminary acceptance or rejection;
- to receive the report of the AC about the data quality and results of the computations;
- to present the complete report to the TWG in a meeting for formal approval;
- to send the necessary information to the registry.

A possible sequence is the following:

- 1 Application of the station through the NMA
- 2 Analysis of the pre-requirements
- 3 Preliminary acceptance or rejection
- 4 Communication of the decision to the station
- 5 Computation of the coordinates
- 6 Final decision at the TWG meeting
- 7 Register the station, if certified

The reports and the information must be built mainly in templates, to make the work easier and not bring much workload to the TWG and to the persons directly involved in this task.

5. Final notes

The first note concerns the connection between EUREF and EuroGeographics. It may be interesting to develop this project in liaison with both organizations, with two main advantages. The first one, for EUREF, is to enlarge the manpower possibilities; the other one, for EuroGeographics, is the starting of

the involvement in certification activities in a very concrete subject, perhaps within the frame of the Inspire initiative.

The second note concerns this paper, whose main purpose is to present a first approach to the subject of certification of non-EUREF permanent stations. Therefore, the guidelines have been presented as a summary, and must be developed into more complete documents.

References

- Caporali, A. (2003): *ETRS89-Certification of Non-EUREF Permanent Stations: a task for the TWG?* Presented at the EUREF TWG meeting held in Paris, 6-7 March 2003
- EPN Coordination Group and EPNCB (2003): *Procedures for Becoming an EPN Station*. (http://www.epncb.oma.be)

ISO/TC 211 (2001A): ISO/DIS 19113 Geographic Information - Quality principles

ISO/TC 211 (2001B): ISO/DIS 19114 Geographic Information – Quality evaluation procedures