Certification of Non-EUREF Permanent Stations

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ABSTRACT

As a first approach to the certification of GNSS stations belonging to local networks but not included in the EUREF Permanent Network (EPN), the methodology of the 'ISO19100 – Geographic Information' family of standards was used, in order to identify the procedures to be applied in this activity.

Now, the follow-up of this work is presented. The main topics are the identification of the different types and categories of stations, the respective product specifications and a proposal for the procedures to be followed by EUREF for each of the identified types of stations.

There are still remaining questions to be solved, in particular the identification of the workload's amount that this activity represents for the TWG and how to interact with the National Mapping Agencies (NMA), who have an important role in this process.

1. Introduction

At the EUREF Technical Working Group (TWG) meeting held in Paris, March 2003, it was presented for discussion (Caporali, A., 2003) the question of certification by EUREF of GNSS permanent stations not integrated in the EUREF Permanent Network (EPN).

Later on, at the EUREF Symposium held in Toledo, June, 2003, this subject was presented and discussed (Torres, 2003), using the *International Standards ISO 19113 Geographic Information – Quality principles* (ISO/TC211, 2001A) and *ISO 19114 Geographic Information – Quality evaluation procedures* (ISO/TC211, 2001B), that are part of the 19100 family of standards addressed by *ISO/TC 211 – Geographic Information; Geomatics,* as a guidance to identify the items to be addressed.

In this paper the different aspects are concretized, starting, in chapter 2, with a review of the product specifications. Next, in chapters 3 and 4, the different types of stations and requirements for compliance are identified, as well as the respective items for quality evaluation and the procedures to be followed. Finally, a summary of the tasks to be developed by the Technical Working Group (TWG) is presented, as well as the identification of some remaining questions to be solved. The example of the procedure followed by the Netherlands is also presented.

2. Product Specification

From the practical point of view, it is important to identify different product components. This approach has the advantages of allowing to define different levels of conformance and also to divide the responsibility of quality evaluation among the different entities that may be involved in this process. The EPN guidelines (EPNCB, 2004) are the main references to establish conformance.

As previously defined, the product has the following components:

a) coordinates
b) data
c) station

The specifications with respect to these components, which are also the items for quality evaluation, can be summarized as follows:

coordinates

- the coordinates of a station are expressed in ETRS89
- the accuracy is within class A or B, as defined by EUREF

data

- the data must be at least similar to the data of the EPN stations
- there is the guarantee of free access

station
The *station* component contains 3 sub-components:

site
- 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

equipment
- the receiving equipment and the complementary equipment have the quality requested by the EPN

purpose
- there is the guarantee of operation for at least 3 years
- the purpose of the station doesn't collide with the EUREF Terms of Reference

These specifications are used for the general case and for the upper level of conformance. However, different levels of conformance may be established, according to the compliance with the different components of the product specifications; this topic will be addressed in the next chapter.

3. Types and categories of stations; compliance
EUREF has defined the ETRS89 as a geodetic reference system to be adopted and used Europe-wide as the backbone for the geo-referencing activities. Consequently, the certification activity must be as wide as possible, in order to increase the number of organizations that use this system, so that it will be a *'de facto'* standard.

This aspect has been taken into account in the identification of the potential types of stations to be included in the certification process, and is also related to the level of conformance with respect to the requirements.

3.1 Types of stations
The GNSS stations continuously operating nowadays in Europe serve different purposes.

In one hand, there are stations operated by public institutions (NMA, Universities, Research Centres, etc.) used for local, regional or global programmes on reference systems' maintenance, geodynamics, sea level monitoring, meteorology, etc., whose data are publicly available and processed in a regular basis. There is a great number of these stations not included in the EPN, but routinely processed by a EPN Local Analysis Center (LAC).

On the other hand, there are the reference stations operated by private companies for commercial purposes, providing differential corrections, RTK services, support to navigation, etc., whose data are neither available free of charge nor monitored by an official entity.

There are still the cases of public institutions who commercialise the data and, in the opposite side, private companies who deliver the data freely.

Considering the importance of including as much GNSS stations as possible in the 'EUREF system', and given the different purposes and characteristics of the continuously operating GNSS stations, a first distinction of the station type is defined as follows, independently of the station owner's statute:

- *Public station:* data freely available
- *Private station:* data not freely available

Taking this distinction into account, 3 categories of stations are defined as follows:

- *Category A:* Public stations routinely processed by a LAC
  These stations may be considered as a densification of the EPN
- *Category B:* Public stations not routinely processed by a LAC
  These stations may be considered as a campaign type, for ETRS89 densification
- *Category C:* Private stations

3.2 Compliance

For certification purposes there is the need to check the compliance of the product specification with the requirements.

The items to be considered for quality evaluation and the respective requirements for each type of station and corresponding category are summarized in Table 1.

Type of station	Category	Items for quality evaluation	Requirements
Public station A	**A**	coordinates	- coordinates expressed in ETRS89 - accuracy within class A as defined by EUREF
		data	- data at least similar to the data of the EPN stations routinely processed by a LAC - guarantee of free access to data
		site	- station installed in a place with good stability, homologous to the EPN stations - guarantee of access to the station for checking purposes, if needed
		equipment	- receiving and complementary equipments have the quality requested by the EPN
		purpose	- guarantee of operation for at least 3 years - the purpose of the station doesn't collide with the EUREF Terms of Reference
Public station B	**B**	coordinates	- coordinates expressed in ETRS89 - accuracy within class B as defined by EUREF
		data	- data at least similar to the data of the EPN stations - guarantee of free access to data
		site	- station installed in a place with good stability, homologous to the EPN stations - guarantee of access to the station for checking purposes, if needed
		equipment	- receiving and complementary equipments have the quality requested by the EPN
		purpose	- guarantee of operation for at least 3 years - the purpose of the station doesn't collide with the EUREF Terms of Reference
Private station	**C**	coordinates	- coordinates expressed in ETRS89 - accuracy within class B as defined by EUREF
		site	- guarantee of access to the station for checking purposes, if needed
		purpose	- the purpose of the station doesn't collide with the EUREF Terms of Reference

Table 1

4. Procedures

Given the characteristics of the stations in category C, most of the proposed procedures related with the EUREF structure concern only the stations in categories A and B.

For stations in category C, the NMA of the country where the station is installed is responsible for all the process. The EUREF responsibility with these stations is only to produce a set of guidelines to be followed by the interested NMA to guarantee that the coordinates have been computed in ETRS89 within class B accuracy. In change, EUREF must be informed by the NMA on the stations certified.

A summary of the certification procedures is presented in table 2.

Type of station	Category	Responsible entity	Procedure
Public station A	**A**	NMA	- application containing • information about the station, associated LDC and LAC • declarations about accessibility to station and data, period of operation • supporting letters from NMA, LDC and LAC
		EPNCB	- analysis of pre-requirements • purpose and location • stability • equipment • completeness of the documentation - reporting on preliminary acceptance or rejection
		Station manager	- data submission to the associated LDC according to EPN standards, in case of preliminary acceptance
		LAC	- data analysis - computation of ETRS89 coordinates to guarantee Class A accuracy (EPN densification)
		EPNCB	- reporting on data accessibility, data quality, station performance, accuracy - proposal for acceptance or rejection
		TWG	- decision on acceptance
		EPNCB	- registry as densification station
Public station B	**B**	NMA	- collection of information on station owner, manager, location, monumentation, equipment - optional inspection - data analysis and computation of ETRS89 coordinates to guarantee Class B accuracy (campaign type) - reporting to the TWG on the station information, computation procedure and results
		TWG	- analysis of the report - preparation of resolution
		Plenary	- decision on acceptance
		TWG	- registry in the data base of campaigns
Private station	**C**	NMA	- collection of information on station owner, manager, location, monumentation, equipment - optional inspection - data analysis and computation of ETRS89 coordinates to guarantee Class B accuracy - decision on acceptance - issue of certificate
		TWG	- registry of the information on the certification

Table 2

If a station in category A shows a potential interest for EUREF (a special project, possible replacement of an existing EPN station, or other pertinent reason) and if the associated LAC agrees, then the time series should be maintained.

5. Summary of tasks

In order to give an idea of the amount of workload to EUREF, the tasks to be undertaken by the EUREF structure are summarized in table 3.

Type of station	Category	Entity	Task
Public station A	**A**	EPNCB	- analysis of the pre-requirements - reporting - registry
		LAC	- data analysis and computation
		TWG	- decision on acceptance
Public station B	**B**	TWG	- analysis of the computation report - preparation of resolution
		Plenary	- decision on acceptance
		TWG	- registry
Private station	**C**	TWG	- development of guidelines - tracking of the process

Table 3

The development of guidelines to be followed by the interested NMA to guarantee that the coordinates of the stations in category C have been computed in ETRS89, within class B accuracy, is a task that must be finished before the adoption of this (or a similar one) certification process. In a first and simple approach, the guidelines should address the following topics:

- what is the minimum accepted type of monumentation and equipment
- which data is delivered and how
- how long is the data set
- how many and which kind of fiducial stations are used
- which computation techniques must be used
- how is the reference system (ETRS89) fixed

For this case there are already experiences in some countries in the certification of private stations, and the guidelines to be developed must be adapted to them. The example of the Netherlands is presented here.

In 2001, then NMA in the Netherlands, i.e. the Kadaster, Triangulation Department and Rijkswaterstaat, Geo-Information and ICT Department (AGI), developed a certification procedure for external GPS infrastructure, with the aim to control the integrity of the national Geometric Infrastructure.

The appearance of two commercial RTK-GPS service providers on the market of precise positioning was the main reason for developing such a certificate.

The certificate consists of two parts:

1. information of the provider and the RTK network
2. information on each station in the network

Ad 1: the RTK-GPS service provider should deliver general information on its enterprise and network. Further conditions for certification are:

- coordinates within ETRS89 to be determined with an accuracy of 1 cm horizontal and 3 cm vertical
- data of 3 consecutive 24 hour periods of recent date available for each station in RINEX format maximum data interval 30 sec; no data cleaning or filtering
- immediate notification of any relevant changes to the network or the stations

The station will be officially mentioned as 'part of the Netherlands Geometric Infrastructure' and mentioned as such in communication if the following additional conditions are met:

- data of the reference stations are public, regardless any charges
- the stations will be active for at least one year
- agreement with publication of relevant information on Internet

Ad 2: for each reference station, the station manager should provide general information on the reference station, its approximate location and receiver/antenna equipment. Further conditions are:

- location of the antenna should not be accessible to unauthorized persons
- no obstruction above 15 degrees
- possible movement of the antenna not larger than 1 cm
- elevation dependant phase centre model of the antenna is available (IGS standards)
- dual frequency receivers, at least 8 channels
- drawings and digital photographs of site and antenna construction should be available

Since the end of 2003, computation of ETRS89 coordinates of external GPS infrastructure is in accordance with EUREF standards. This implies the use of Bernese Software, version 4.2. Data of external stations are processed in the same computation run as part of the zero order GPS network (AGRS.NL). The total network includes a total of eight IGS stations.

At this moment, first a (daily) free network solution is computed in ITRF2000. Then the free network is constrained to the eight IGS fiducial stations, with 4 week coordinates of fiducials. Daily solutions are merged with ADDNEQ and the result is transformed to ETRS89 (Altamimi and Boucher, 2001).

6. Final notes

First, it is important to note that this activity depends very much on the NMA and how the process is coordinated with EUREF, and the ExG-G (EuroGeographics Expert Group on Geodesy) has an important role to play on this issue.

Secondly, it must be pointed out that all the proposed procedures have the intention to start the process as soon as possible with a minimum of guaranties of success; however, it must be kept in mind that a further step in this activity should be done, which is to upgrade the certification process in order to comply with the pertinent standards of the ISO 19100 family. This will, certainly, take considerable time and resources, and may also be a task to be developed in close cooperation between the ExG-G and EUREF.

References

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