

Meeting of the CCTF GNSS Working group

BIPM, June 6, 2017 14h00

Pascale Defraigne, chair of the WG, opened the meeting and presented the meeting's [agenda](#).

1. Calibration status: Group 1 and Group2; lessons learned

G. Petit indicated the status of the work on calibrations. The second Group 1 trip is nearing completion with the EURAMET-APMP results published and the SIM results now being computed. He presented (see [slides](#)) several items where some questions need to be discussed by the WG, in light of the experience gained over the past two years.

- The reference for Group 1 results is based on the concept of “ensemble average” where the stability of the reference between two consecutive calibration trips is provided by an ensemble of receivers present in the two trips rather than by a single receiver. Based on the EURAMET+APMP results for Group1, where 10 receivers were common to the 2014 and 2016 trips, it is found that an ensemble of 5 receivers provides ~0.3-0.4 ns instability of the reference, while using a single receiver provides ~1.0 ns instability.
- The uncertainty budget developed in Annex 4 of the Guidelines has been used for Group 1 results, and also, with some variations, for most Group 2 reports. Extensive discussion ensued, which is reported later on.

P. Uhrich presented (see [slides](#)) the GNSS calibration activities at the LNE-SYRTE. He included a comparison of all recent calibrations at the LNE-SYRTE in parallel to several long-term comparisons of GPS P3 and TWSTFT links involving UTC(OP). He also presented the new set-up of GNSS receivers at the LNE-SYRTE which is composed of three independent reception chains.

A. Bauch presented (see [slides](#)) the GNSS calibration activities at the PTB, including a comparison of all recent calibrations results of the reference receiver PT02. He presented results from a new study concerning the sensitivity of several antenna cables to temperature, which may explain part of the instability observed in PT02.

N. Kosheliaevskii presented (see [slides](#)) results for absolute calibration of receivers and antennas. They obtained a very good agreement (1.0 ns difference only) between BIPM calibration and their absolute calibration for L1C on a TTS4 receiver. Furthermore they looked at the dependence of the antenna delays as a function of the satellite elevation. The dependence is shown to be light for GPS signals, but more significant (up to 6 ns) for GLONASS, especially in the L2 frequency band. He also shows that using CV when the CGGTTS have been obtained from different SW sources can induce significant noise in the results, due to the possible difference in the navigation message used by the two SW sources.

A discussion on absolute calibration followed. Recent results of absolute calibration of ORB receivers by the CNES led to differences of order 3-4 ns with respect to the values given by a recent Group 2 calibration. It was agreed to gather all existing information on absolute calibration results for future discussion by the WG.

2. Calibration guidelines

A discussion on the uncertainty budget and uncertainty values of calibrations led to the following:

- Several items of the uncertainty budget should be clarified and reviewed, e.g.:
The “misclosure” actually represents the possible instability of the traveling receiver(s), to be evaluated through all possible means including the misclosure, the use of multiple traveling receivers, a comparison with an independent technique like TW, etc..
The “multipath” actually represents all possible environmental effects. It is agreed that a value of 0.2 ns is adequate.
- Using a conventional (conservative) value for the REFPLY uncertainty, based on the specs of the equipment used, is a valid approach. However the WG encourages providing best estimates for each measurement uncertainty, along with a justification, in the aim of promoting the best practices.
- Using conventional uncertainty values in the UTC computation is not disputed. The present conventional values (1.5 ns for G1, 2.5 ns for G2 for P3/PPP links) are still considered valid but should be reviewed in the future if considered too pessimistic.

P. Defraigne reported (see [slides](#)) on the impact of using different P1/P2 antenna phase centers on calibration, as it is known that the antenna phase centers do depend on the frequency. While the effect may reach 0.2 ns for individual codes, it is found that the ionosphere-free combination is not affected.

G. Cerretto reported (see [slides](#)) on work performed at INRIM using Vector Network Analyzers to measure the properties and propagation delays of splitters and long cables, and show that «active» power splitters induce some reflections on L1 and L2 frequencies and hence recommend the use of passive splitters.

3. Calibration results

G. Petit presented (see [slides](#)) the present archive of calibrations results and the different methods to access them through the BIPM web site or through the Time Department database. He mentioned some practical questions that need to be clarified, e.g.

- the distinction between the date of calibration and the date of application of results which should be more emphasized;
- the fact that, when two calibration results become available in a short time, the general rule should be that the result corresponding to the most recent calibration period should take precedence;
- the special case of receivers which include the calibration results in their raw data, for which the values of the true calibration delays should be retained in addition to the changes with respect to past values;

All these issues are also related to the evolution of the Calex file which gathers the history of calibration results, see below.

P. Defraigne presented a new version of the [Calex file](#), which has been assembled at ORB. Some items to consider:

- The “valid from” date should be the date of application of results as specified in the calibration summary on the BIPM web pages;
- The case of receivers which include calibration results in their raw data should be clarified

- It has been suggested to provide the sub-blocs related to a given Calibration identifier for a given receiver with the most recent first. In each sub-block, the information would still be provided in chronological order, though.

It is proposed that the CALEX file be sent to the labs for verification and to be completed with missing information.

4. CGGTTS format V2E: managing non-healthy satellites

On a suggestion by J. Delporte, P. Defraigne introduced (see [slides](#)) the question of whether the CGGTTS files should continue reporting results from satellites declared as non-healthy in the Navigation message. In the ensuing discussion, it was recognized that there was no strong case for a change.

5. RINEX 3 clock format

M. Coleman presented the new Rinex clock format (v 3.04) which is to be proposed to the IGS Governing Board this July. Changes are relatively minor and mostly related to the new IGS coding of station names allowing 9-character. Comments are to be sent to M. Coleman.

6. Use of “new” GNSS constellations for UTC

P. Defraigne presented (see [slides](#)) some evolutions concerning the “new” constellations, namely Galileo and BeiDou.

Galileo: CGGTTS files are now available for Galileo either from receivers or using the R2CGGTTS SW delivered by ORB. Before Galileo can be integrated in UTC, a calibration procedure should be determined. Currently only Galileo calibration based on GPS calibration and satellite broadcast group delays can be realized. This method should be in the near future cross-checked with the output of some ongoing studies of absolute calibration for Galileo signals.

BeiDou: Many satellites are to date available, but these are mostly IGSO and GEO, not visible from every place and apparently subject to higher noise. Seven MEOs are available, however the problem of elevation-dependent biases is documented and should be accounted for in time transfer use. It was reported that many groups investigate the use of BeiDou for time and frequency comparisons and a Pilot Project could be considered to gather these forces.

7. Recommendation “On the utilization and monitoring of redundant time transfer equipment in the timing laboratories contributing to UTC”

P. Defraigne presented the draft recommendation “On the utilization and monitoring of redundant time transfer equipment in the timing laboratories contributing to UTC” presented to the CCTF by the WG on GNSS together with the WG on TWSTFT. Extensive discussion had taken place beforehand and only a few very minor changes were discussed¹.

8. Any other business

¹ The Recommendation was adopted by the CCTF at its meeting on June 9, 2017 and may be found (after final edition is done) at <http://www.bipm.org/en/committees/cc/ctf/publications-cc.html> .

P. Urich and D. Rovera mentioned present and future work for comparison to other techniques: A comparison of GPS to T2L2 in non-common view mode is under way with apparently good results. The launch of the ACES mission next year should also provide opportunities for comparisons between techniques.

The meeting was closed at 18h00.

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List of participants

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Gérard Petit	BIPM (WG secretary)
Maurizio Lopez	CINVESTAV/CENAM
Jérôme Delporte	CNES
Michael Coleman	IGS
Guilherme Garcia	INMETRO
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Victor Zhang	NIST
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