

Meeting of the CCTF GNSS Working group

Zoom, June 3, 2020 12h00 UTC

The meeting was held as a videoconference, due to the COVID19 crisis.

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

1. GNSS Calibrations

G. Petit (GP) and P. Defraigne (PD) presented the status of calibrations (see [slides](#)). GP indicated the page of the BIPM Time department database that provides the best access to the list of calibration trips (https://webtai.bipm.org/database/calid_gnss.html). PD presented a table with the status of the G1/G2 calibration in time laboratories that she established from the content of the database. In the discussion it was recognized that a target for repeated calibration should be of order 3 years rather than 2 years as anticipated. GP indicated that Group 1 trips would remain at 2-year intervals and that the 2020 G1 trip is about to start providing GPS and Galileo results (see further below)

Representatives of the G1 laboratories presented a summary of their activities.

- R. Ichikawa for NICT (see [slides](#)) indicated a problem with the traveling receiver and that commissioning a new one is under consideration.
- B. Patla for NIST (see [slides](#)) indicated that one G2 trip is under way in South America and one is planned.
- P. Urich (PU) for OP (see [slides](#)) reported good results for G2 calibrations but indicated mixed consistency with BIPM results when visiting G1 labs.
- A. Bauch (AB) for PTB (see [slides](#)) reported a sustained program of G2 trips, that is ongoing.
- H. Esteban for ROA (see [slides](#)) reported recent calibration trips for G2 and other projects.
- C. Lin for TL (see [slides](#)) reported no current trip but a number are to be planned within APMP.
- N. Koshelyaevsky for SU indicated no progress, noting problems because some countries envision this activity as a bilateral collaboration which should provide some official certificate.
- K. Liang for NIM indicated that he intends to carry out one or two of the trips requested by APMP.
- J. Hanssen for USNO indicated some lack of manpower and envisioned possibly one exercise at one laboratory close by.

GP presented “Evolution of the GPS reference for G1G2” (see [slides](#)). He first showed that all comparisons between current G1-G2 results and absolute calibration indicate consistency within 4 ns p-p. He concluded that the current realization of the G1 reference should be kept as no alternate method would warrant a better realization. He also showed that the comparison of INTDLY values for the same receivers at 2-year (resp. 4-year) intervals was typically within 0.7 ns (resp. 1.3 ns) RMS. This is an indication that the uncertainty due to ageing, as presently used in Circular T, is too pessimistic and should be corrected. After some discussion it was agreed to lower the “ageing constant” to $0.4 \text{ ns/yr}^{1/2}$ for all GNSS links.

GP presented “Update of calibration Guidelines” (see [slides](#)). He reminded the rules for a Transfer of Calibration within a laboratory. Several items were open for discussion in the WG and the main outcomes are as follows:

- No change is planned for the standard G1 and G2 trips.
- The category of calibrations carried out by “authorized third parties” can be extended by the BIPM and an uncertainty down to 5 ns can be assigned. All decisions should be based on a documented report from the candidate party that it can link to, or reproduce, the G1/G2 reference to this level.
- The category envisioned as “Calibration through GNSS time” should not be introduced. No new such calibration should be accepted. Such existing calibrations should be assigned larger uncertainty (value TBD).
- Discussions on specific points of the calibration reports (e.g. uncertainty related to mis-closure) were inconclusive and too time consuming for such a remote meeting. Further discussion is expected to take place via e-mail.

PD presented a synthesis of absolute calibration comparisons (see [slides](#)). Based on some ten documented absolute calibration results from four different institutes, she showed that the consistency is typically within 2.5 ns to 4 ns peak-peak for any given code, thus may be larger for ionosphere-free combinations. These results provide some insight in all cases when absolute calibration is considered (see e.g. G1-G2 reference and Revised Section 4 below).

P. Waller presented “Update on ESTEC absolute calibration” (see [slides](#)). He mentioned the recent changes in the calibration procedures and their estimated impact. He presented results of common clock common antenna comparisons of receivers with real signals showing consistency below 1 ns for similar receivers and up to 1.5 ns for different types.

J Delporte presented “Absolute calibration activities at CNES” (see [slides](#)), reminding the recent publications of the CNES team on the topic. Based on CNES absolute calibrations, he reported monitoring of GNSS times and the activity as coordinator of the Galileo Reference Center to monitor and assess the quality of Galileo services (GRC-MS).

GP presented the method proposed to define a reference for Galileo G1/G2 (see [slides](#)). Reminding that all possible comparisons between Galileo absolute calibrations have shown consistency at the level of 1 ns or better, it is proposed to use one absolute calibration as reference, namely that of the BIPM receiver BP21 performed by ESTEC (see above). The reference will first be applied retrospectively to provide Galileo results for the 2018 Group 1 trip, then it will be propagated to the 2020 Group 1 in the same way as the GPS reference.

PU presented work carried out at the LNE-SYRTE (see [slides](#)) to establish a facility for Galileo receiver relative calibration. He mentioned some observed non white noise on the E5a signals, which was confirmed by PD as observed in BRUX in particular in case of snow on the antenna.

AB presented GNSS-related activities at the PTB (see [slides](#)) based on some ten GNSS receivers, several of them on loan or under contract. He outlined some improvements with the change of the reference receiver PTBB and presented the new traveling station for G2 calibrations, PTBM, that recently completed its first trip.

2. Revised section 4 of Circular T

P. Defraigne presented “Revised section 4 of Circular T” (see [slides](#)) listing the issues to be solved in the aim of extending section 4 to all GNS, namely: 1. A naming convention; 2. the choice of the UTC(k) stations used as pivots; 3. the determination of uncertainties; 4. the processing choices e.g. single-frequency / dual-frequency solution, iono&orbits broadcast/IGS; 5. the report interval (1 pt/day or 1pt/ 5 days as UTC). She stressed the role of receiver calibration and the need for Timing Group Delays (TGDs) to identify single frequency and dual frequency results.

In discussing the lack of GLONASS TGDs, A. Karaush indicated that they exist in the navigation message, as described in the original Russian ICD but not in the English translation. It should thus be possible to obtain them from the received signals.

In the ensuing exchanges, the following conclusions were drawn for a future section 4 expanded to the four main GNSS:

- Naming convention still to be chosen among either Brdc_UTC_{XXX} or Broadcast_UTC_{XXX} or UTC_Brdc_{XXX} where XXX is the acronym of the GNSS;
- Dual frequency measurements to be used;
- 1-day sampling to be maintained;
- Uncertainties to be determined based on the uncertainty budget developed in the talk.

3. BeiDou 2/3 evolution in CGGTTS

D. Guo presented “Performance of BeiDou-3 common-view link between TP and NTSC (see [slides](#)). He notably studied the performance of two possible ionosphere-free combinations for BDS-3 and concluded that B1C-B2A (similar to Galileo) provides better results than B1I-B3I, which would allow some continuity with BeiDou 2.

E. Pinat presented “BeiDou3 preliminary CGGTTS analysis” (see [slides](#)). She outlined that TGDs were necessary for advanced methods of time transfer using precise clock products. However BDS-3 TGDs are presently not available from the usual RINEX 3 files, even though the values are broadcast in CNAV messages.

In the ensuing exchanges, the following conclusions were drawn

- The use of the combination B1c B2a is preferred, receiver manufacturer can retrieve the TGDs from the CNAV messages
- Some alternative should be found for Rinex-to-CGGTTS until TGDs are available in a future RINEX version.

4. Task Force on traceability from GNSS measurements

P. Defraigne presented the proposal for a Task Force “Traceability to UTC from GNSS measurements” (see [slides](#)) of the WG on GNSS with the help of the WG on the MRA. A. Bauch accepted to chair the Task Force and a number of members have been approached. The Task Force is expected to hold its kick-off meeting soon and to present its report at the CCTF 2022.

The meeting was closed at 16h00 UTC.

Published 24 June 2020 (P. Defraigne, G. Petit)

List of participants

Pascale Defraigne	Chair, ORB
G�rard Petit	Secretary, BIPM

WG Members

Group 1 representatives:

Andreas Bauch	PTB	
Nikolai Koshelyaevsky	VNIIFTRI	
Yi-Jiun Huang	TL	(attended partly)
Pierre Uhrich	OP	
Hector Esteban	ROA	
Jay Hanssen	USNO	(by phone)
Ryuichi Ichikawa	NICT	
Kun Liang	NIM	
Bijunath Patla	NIST	

Giancarlo Cerretto	INRIM	
Jerome Delporte	CNES	
Jerzy Nawrocki	AOS	
Calvin Lin	TL	
Michael Wouters	NMIA	
Daniele Rovera	OP	
Mike Coleman	NRL	
Paul Koppang	USNO	(by phone)
Wenjun Wu	NTSC	
Marina Gertsvolf	NRC	
Judah Levine	NIST	
Pierre Waller	ESTEC	
Alexander Kuna	TP	

Invited

Pawel Nogas	AOS	
Dmitry Aronov	VNIIFTRI	
Artem Karaush	VNIFTRI	
Andrey Naumov	VNIIFTRI	
Igor Silvestrov	VNIIFTRI	(attended partly)
Bruno Bertrand	ORB	
Elisa Pinat	ORB	
Giovanna Signorile	INRIM	
Ilaria Sesia	INRIM	
Dong Guo	NTSC	
Tetsuya Ido	NICT	
Bin Jian	NRC	
Fr�d�ric Meynadier	BIPM	(attended partly)