Meeting of the CCTF GNSS Working group
Sèvres, September 14, 2015 14h30

Pascale Defraigne, chair of the WG, opened the meeting and presented the meeting's agenda.

1. Introduction, summary of items in the WG report to the CCTF

P. Defraigne presented a summary of the activity of the WG over the triennium 2012-2015 (see slides).

She first had the WG confirmation that the terms of reference of the group were still adapted.
A discussion arose whether the activities of the group (and its membership) should be managed in a much more formal way. E.g. whether the group could hold specifically called meetings instead of the present form of holding meetings associated with the main T/F gatherings. It was generally felt that the present manner was adequate.

She announced the incoming publication of the CGGTTS V2E format in Metrologia 2015 52 G1. She reminded the main features of the extended format and the changes with respect to V02.
She briefly presented the outcome of the BIPM's work with the WG on the Calibration Guidelines, with laboratories divided in two groups: Group 1, selected by the RMOs, for which the calibration is performed by the BIPM and from which the calibration of Group 2 labs is performed.
P. Uhrich questioned the repartition of the tasks and the inferred costs between RMOs and G1 labs. It was noted that this should have been discussed when applying for G1.
D. Matsakis asked whether a database, maintained by the BIPM, will be open to all TAI labs. This is indeed the BIPM's plan in the future.
She reminded the proposed Calex format to store all calibration information in a single file and briefly outlined the progresses of the Precise Point Positioning technique in recent years.
Finally she presented the proposed Recommendations, see a summary in section 9

2. Group 1-2 calibration : update on results and plans for changes in Circular T

G. Petit presented (see slides) an update of the work carried out since the last meeting of the WG (13 April 2015). He indicated that, after the version 3.0 of the "BIPM guidelines for GNSS calibration" had been placed on the web in April, only minor changes occurred in an update 3.1 (see ftp://tai.bipm.org/TFG/GNSS-Calibration-Results/Guidelines/).
He mentioned that Annex 1 (Operational procedures for a visit of the traveling equipment) should be completed as needed to cover some new types of receivers. S. Römisch agreed that the Task group which she is leading should write sections on GTR51 and JAVAD.
When reviewing Annex 4 (Template of calibration report) he asked several questions:

- How to take into account the uncertainty from the instability of the traveling receiver? The misclosure gives one estimate but is not quite sufficient. D. Rovera proposed that, when two receivers are traveling, an estimate can be obtained from the deviation between the results obtained from the two receivers (SYRTE uses the maximum of this deviation among all visited laboratories).
- The choice has been made to use default values for several components of the uncertainty budget, aiming at simplifying the computation of standard uncertainty and to account for the fact that, if an optimal uncertainty was calculated, it would likely be valid only for the period of

calibration while the goal of the standard uncertainty is to provide an estimate of UTC link accuracy valid for 2-3 years. Nevertheless the choice of default values may be discussed, particularly when no reliable estimate is available e.g. for multipath where the value chosen (0.3 ns) has been taken from an actual experiment while visiting USNO.

- The uncertainty applied to UTC links (typically 1.7 ns for G1, 2.5 ns conventional value for G2) is a transitory situation while PTB is a unique pivot; the true uncertainties coming from the calibration reports should be used in the future when the UTC software allows. However, presently a higher uncertainty can be used if warranted, e.g. in case one visited lab had specifically bad behaviour. For G2 trips, the computation of the uncertainty budget may presently not be the same by all the Group 1 labs, it should be standardized in the future.

He mentioned that C/A only receivers, which still concern nearly 30 UTC laboratories, will be addressed, basing the calibration of C/A receivers on the same ensemble of Group 1 systems that serve as references for P1/P2.
Finally he mentioned that the results of the initial Group 1 trip were about complete, only SU results still to be completed. It is planned to implement the new results, along with a significant change in the report of information on time links in Circular T, in the next monthly UTC computation.

3. P. Uhrich: some comments on the Calibrations guidelines

P. Uhrich presented some comments by the SYRTE group on the Calibration guidelines (see slides). He reminded the consideration that the goal of calibration is to determine hardware delays of the receivers, even though the results are used by the BIPM to form links.
He commented that the Guidelines, notably Annex 4 on the calibration, report) should include all equations, even basic ones, and that he had trouble trying to adapt results of previous calibrations to the proposed form of report.
To the specific point of reporting results and statistics of raw code differences, G. Petit stated that it was OK to report any equivalent information, e.g. values differing from the raw differences by a constant.
He stressed the importance of proposing a validation of the calibration results by presenting time transfer links for data obtained during the calibration trip using the final calibration.
He questioned the computation of calibration uncertainty (k=1 or 2) and the link between the BIPM Cal_Id and other external identification (e.g. in EURAMET projects).
He also reminded that basic hardware measurements should be documented as well, which was followed by a discussion involving W. Walls, D. Rovera, S. Römisch on the definition of the trigger, and on the procedure for TIC measurements.
Finally he noted that in some RMOs like EURAMET the number of G2 to be covered by each G1 lab may be too large.

4. Calibration campaign between NIST, OP and PTB

S. Römisch presented a calibration campaign (see slides) that is starting between NIST, OP and PTB. The results will be communicated to the BIPM and will help obtaining information on the calibration performance and the long-term instability in time link, however will not be explicitly included in the Group 1 results.

5. Receiver P1-P2 stability analysis and comparison with calibration results

P. Defraigne presented some results (see slides) of a study that computes the P1-P2 delay from direct measurements of the receivers, assuming that the satellite TGDs and the ionosphere models from the IGS are both accurate, and compares these delays to those obtained from BIPM calibrations. The agreement with the recent 1001-2014 G1 trip is below 0.5 ns, while it is of order 1 ns with BIPM calibrations from the past decade. It is to be noted that, for some receivers, the instability of the P1-P2 delay over the years reaches several ns.

6. A low cost GPS calibrator for the G2 calibrations

Z. Jiang presented a proposal (see slides), with co-authors in the 3 G1 labs in APMP, that aims at replacing, for some of the G2 trips, the standard traveling receiver by a small and low-cost receiver to be designed. That would help reduce the shipping costs and eventually facilitate repeated calibrations. He also considered that RMOs may wish to include in such trips, in addition to some G2 laboratories, other laboratories that don't yet contribute to UTC.

7. A low-cost time-transfer system to support dissemination of national standards

M. Wouters presented a proposal (see slides) with other APMP laboratories to develop a low-cost reference platform, based on an existing system, which would include a GPS Disciplined Oscillator, a time interval measurement, and would provide CGGTTS data.

8. Carrier Phase frequency biases in receivers used for UTC-generation

D. Matsakis presented results of a study on code-phase biases in receivers used for UTC (see slides). He pointed out that this effect, long noticed but only recently identified (also by P. Defraigne), creates discontinuities in phase solutions with respect to code, and can yield significant frequency biases. This supports the submission of a Recommendation to the CCTF (see below).

9. Discussion of Recommendations to the CCTF

P. Defraigne presented three draft recommendations for the coming CCTF, the first two of which had been previously sent to the WG members. They recommend that:
(Rec 1) the BIPM Calibration guidelines be applied and Group 2 calibration be organized;
(Rec 2) receiver manufacturer implement the extended CGGTTS format V2E in their new issues;
Recommendation 3 has been presented during this meeting to recommend that receivers be designed with no significant latching time offset between code and carrier phase measurements (see item 8 above).
A. Bauch noted that it would be more efficient to specify that the WG should contact directly the manufacturers (Rec 2-3).
The final form of the Recommendations, which were passed by the CCTF on 18 September, may be found in the report of the CCTF meeting.

10. Any other business

N. Koshelyaevsky presented excerpts from the report of VNIIFTRI to the CCTF, where he mentioned recent work on GLONASS and GPS calibration. Absolute calibration has been performed on the VNIIFTRI receiver and on the BIPM receiver presently in Russia for the G1 trip.

The meeting was closed at 18h30.

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List of participants

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