

WG D Task Force on Time references

Update of actions since ICG-13

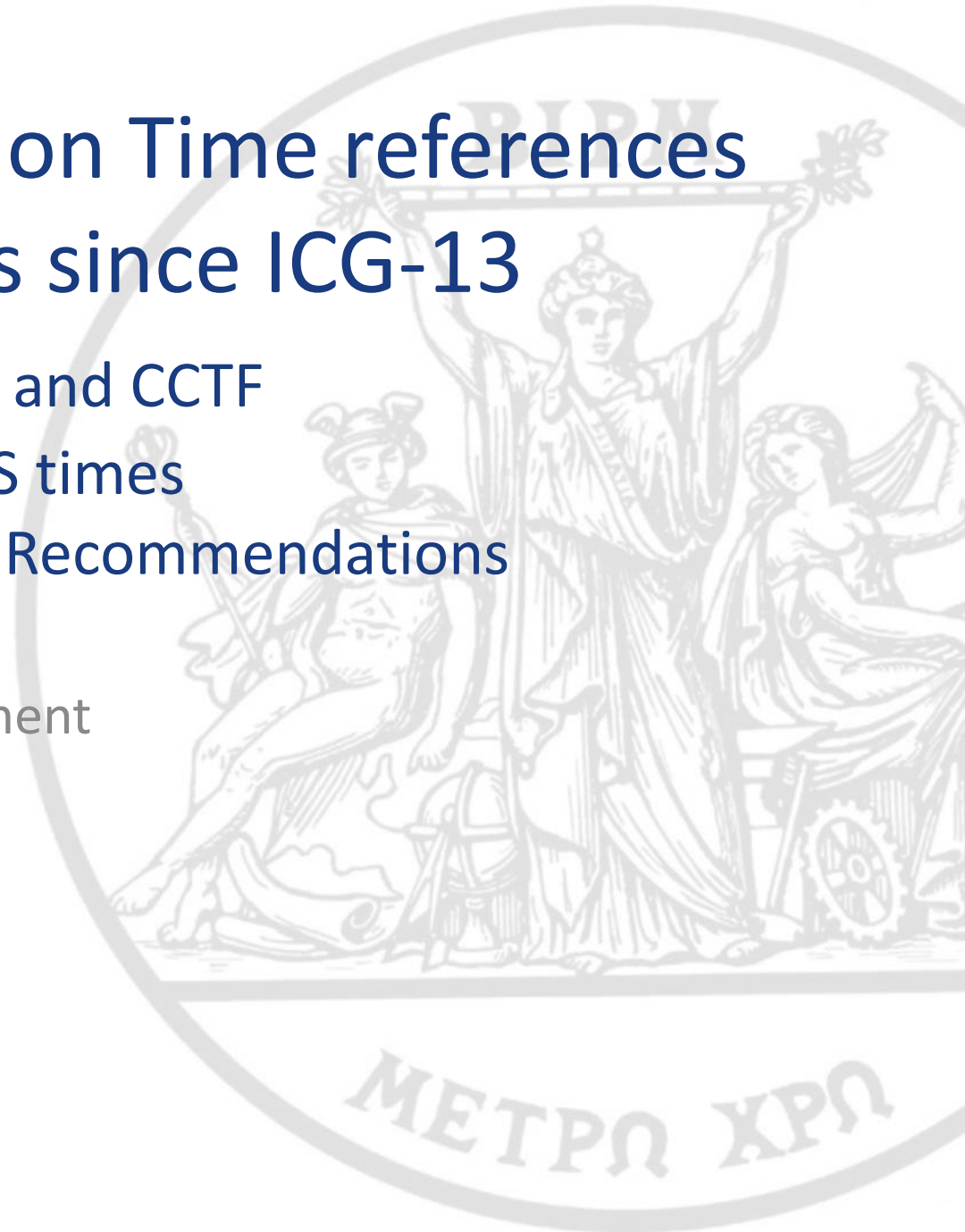
News of the BIPM and CCTF
Templates of GNSS times
Status of past ICG Recommendations

G. Petit, BIPM Time Department

J. Delporte, CNES

14th ICG Meeting

9-13 December 2019

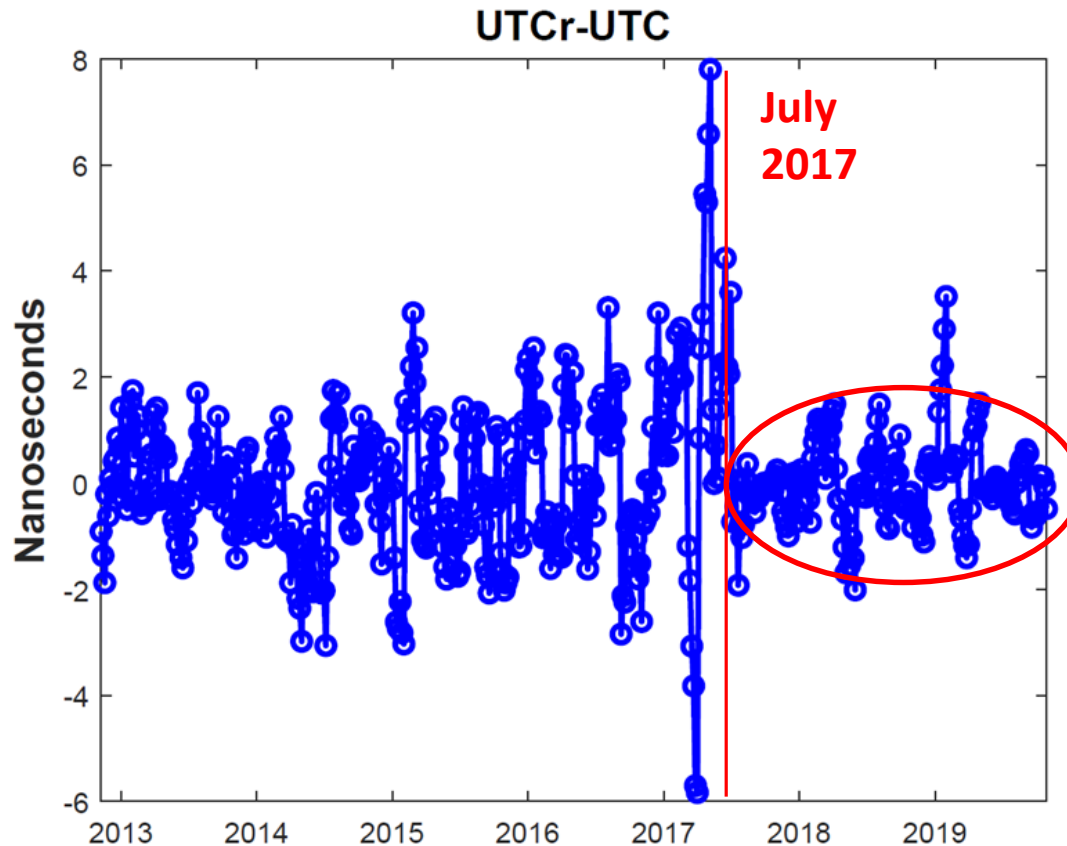


I. News of the BIPM and CCTF

This is not a full presentation of BIPM/CCTF work, only in relation to ICG work and Recommendations (**items in red in next slides**)

- ◆ Production of UTC and **UTCr** continues regularly
 - UTC:~85 labs, UTCr:~60 labs).
- ◆ Extended access to the information on data and products through the database <http://webtai.bipm.org/database/>
- ◆ Calibrations for UTC continue.
 - New effort on **absolute calibrations and comparisons**
- ◆ Preparation of an **update to Circular T section 4** (Predictions of UTC as broadcast by GNSS), to include all GNSS.
 - Link to the ICG discussions on interoperability
- ◆ Participation to the ITU discussions on the future of UTC.
- ◆ Next CCTF is October 2020.

Rapid UTC (UTCr)



- Uninterrupted weekly publication since July 2013
- ~60 participants
- ~75% of the clocks in UTC

Since Summer 2017

UTCr-UTC well below 1 ns RMS,
Tdev ~0.4 ns, +/-2 ns p-p.

One problem with clock data in
January 2019

UTCr easier to extrapolate

Absolute calibration of GNSS receivers (CCTF WG on GNSS)

Aims at gathering all existing information on absolute calibration of GNSS receivers and to compare the results.

- ◆ Calibrations done in recent years, already published, e.g. by ESA, CNES (GPS+GAL)
- ◆ Calibrations performed for the BIPM
 - VNIIFTRI (GPS+GLO); CNES (GPS+BDS); ESA (GPS+GLO+GAL+BDS)
- ◆ Other calibrations performed for UTC laboratories, e.g. JPL for USNO
- ◆ Comparisons between absolute calibrations can be
 - direct : same receiver absolutely calibrated by two institutes
 - indirect : compare two receivers , each one calibrated by a different institute, or by one institute at different epochs, or ...
- ◆ Initial results will be presented at EFTF'2020

Update of section 4 of Circular T

- ◆ GNSS disseminate access to a prediction of a UTC(k) or another proxy of UTC through the navigation message. When UTC is computed, section 4 of Circular T compares these predictions to UTC, presently for GPS and GLONASS.

④ 4 - Relations of UTC and TAI with predictions of UTC(k) disseminated by GNSS.

$$[\text{UTC}-\text{UTC}(\text{USNO})_{\text{GPS}}] = C_0', [\text{TAI}-\text{UTC}(\text{USNO})_{\text{GPS}}] = 37 \text{ s} + C_0'$$

$$[\text{UTC}-\text{UTC}(\text{SU})_{\text{GLONASS}}] = C_1', [\text{TAI}-\text{UTC}(\text{SU})_{\text{GLONASS}}] = 37 \text{ s} + C_1'$$

For this edition of *Circular T*, $\sigma_0' = 0.8 \text{ ns}$, $\sigma_1' = 6.7 \text{ ns}$

2019	0h	UTC	MJD	C_0'/ns	N_0	C_1'/ns	N_1'
	MAR 27		58569	-4.8	89	10.1	80
	MAR 28		58570	-0.6	72	10.3	88
	MAR 29		58571	4.2	90	9.8	89
	MAR 30		58572	3.4	89	8.7	77
	MAR 31		58573	2.5	88	11.0	86

- ◆ Goal is to provide similar information for all GNSS. Will be based on absolute calibrations (see previous slide).

II. Templates of GNSS times

- ◆ Recommendation 11 (2011) on « Finalization and publication of templates on geodetic and timing references »
 - Ongoing, most templates have been published between 2012 and 2016
 - Some templates still need updating; e.g. to be independent of leap second insertion
 - No progress in 2019

- ◆ Templates available at <http://www.unoosa.org/oosa/en/ourwork/icg/resources/Regl-ref.html>

Present status of Time templates

GNSS time	Published/updated	Update needed
GPS time	2012	Leap second
GLONASS time	2014	Under way
Galileo System time	Updated 2016	-
EGNOS	2015	-
IGS time	2012	V2 Leap second
BeiDou System time	2016	
QZSS time	2016	
Navic		For 2019

Provision of templates and updates as of 6 December 2019

III. Status of past WG D Recommendations

- ◆ **Rec #11 « Finalization and publication of templates on geodetic and timing references »**
 - Status of templates given above in Part II
- ◆ **Rec #16-A « Information on the works related to the proposed redefinition of UTC »**
 - See above in Part I. Also contribution to the ITU meeting May 2019.
- ◆ **Rec #19 « Official provision of a rapid UTC (UTC_r) by the BIPM »**
 - See above in Part I
- ◆ **Rec #20 « BIPM publication of [UTC – GNSS times] and [UTC – UTC(k)_{GNSS}] »**
 - The BIPM Time Dpt is starting studies to incorporate Galileo and BeiDou data in its analysis for UTC computation. This includes the provision of [UTC – GNSS times] and [UTC – UTC(k)_{GNSS}] for these GNSS.
 - See above in Part I
- ◆ **Rec #21 « On the monitoring of offsets between GNSS times »**
 - See below discussion on GNSS time offsets

Work on timing interoperability at the ICG

WG D Rec #21-B: On the monitoring of offsets of GNSS times

- 2017 wording of Recommends 4:

“In order to promote GNSS compatibility and interoperability, GNSS providers and time relevant organizations, including the BIPM, actively develop methods to monitor the offsets between GNSS times, share the monitoring data and relevant research results and actively collaborate with the relevant experts in WG D and S.”

- 2nd Joint timing workshop of WG S and WG D: 20 June 2018 (Vienna)
 - No clear consensus emerging: Additional work is necessary to assess the accuracy goals for the GNSS time offsets, and consequently the methods to determine them;
- Joint session on GNSS interoperability at the ICG-13 (6 Nov 2018)
 - <http://www.unoosa.org/oosa/en/ourwork/icg/meetings/icg-13/d2018.html>
- 3rd Joint timing workshop of WG S and WG D: 14 June 2019 (Vienna)
 - <http://www.unoosa.org/oosa/en/ourwork/icg/activities/2019/time2019.html>

WG S and D Third joint timing workshop (14 June 2019)

- ◆ Attendance ~30 from close to 20 institutions

- ◆ Presentations see <http://www.unoosa.org/oosa/en/ourwork/icg/activities/2019/time2019.html>
 - GLONASS time and GNSS time interoperability (Russia)
 - Interoperability through accurate prediction of [GNSS time - UTC] (BIPM)
 - Different ways of estimating the GGTO, and their impact on the position accuracy (ORB)
 - Progress on Multi-GNSS Timing Offsets: XGTO, MGET (ESA)
 - The new results of GNSS Time Offsets Monitoring and the Opinion about MGET and xGTO (China)
 - Considerations on GNSS Timescale Offsets (IGS)

WG S and D Third joint timing workshop : Discussions

- ◆ Discussion of three options
 1. Do nothing. There is no real need for G2GTOs anyway
 2. All G2GTOs should be broadcasted. But not all GNSS can do this
 3. A common reference is needed to broadcast offsets
 - ◆ Proposals for xGTO claim that it is simpler to implement.
 - ◆ Proposals for MGET claim the existence of high-accuracy users that would need a broadcast access to a high accuracy offset.
 - ◆ UTC may continue to be used as a common reference.
- ◆ Presentations at the workshop show
 - that proposals requiring changes in broadcast info are not encouraged by providers;
 - that studies still need to be carried out to evaluate the feasibility of the proposed solutions xGTO and MGET;
 - that a user has always advantage to solve for GGTOs. If this is not possible, a broadcast GGTO is of little help;
 - that if using broadcast offsets to a common reference scale, the scale is not the limiting factor in the accuracy of positioning and timing in case of multi system solutions. Thus UTC may continue to be used.

WG S and D Third joint timing workshop : Conclusions

- ◆ Providers should indicate in the ICD that GGTOs should be used only when users have no other choice (Action by providers).
- ◆ No consensus on the need and feasibility of a Multi-GNSS Ensemble Time. Consensus to NOT create a specific task force to study the proposal. Possibly such studies could be considered within the IGMA.
- ◆ The recommendation presented by the IGS WG on clock products, with the BIPM, should be discussed at the 14th ICG meeting.

Recommendation still under discussion. CIPM supports IGS and ICG efforts
- ◆ The ICG WG S-D would also welcome a presentation on the IGS clock products and timing activities at the 14th meeting.

IGS presentation will be on Tuesday 10, at 16h30