

WG-D Task Force on Time references

Status on actions and recommendations

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I. Task Force on timing references: ICG-17 agenda

- **Tuesday 17 October 2022 (09:00-11:00) : WG-D session**
 - *Status on Timing Task Force Actions and Recommendations*, Jérôme DELPORTE (CNES) – this presentation
 - *Next BIPM Publication of (UTC - bUTC_GNSS)*, Giulio TAGLIAFERRO, F. MEYNADIER (BIPM)
 - *Towards a Continuous UTC*, Giulio TAGLIAFERRO (BIPM)
 - *Traceability to UTC from GNSS*, Pascale DEFRAIGNE (ORB)
 - *Status of GNSS Calibrations*, Pascale DEFRAIGNE (ORB), Giulio TAGLIAFERRO (BIPM)
 - *GNSS Timing Monitoring with Calibrated Receivers at ESA*, Pierre WALLER (ESA)
 - *ISRO Installation of a NavIC Timing Receiver at PTB and Characterisation of [UTC(PTB) - NavIC time]*, Subramanya GANESH (ISRO)
 - *Performance of IRAFS on-board NVS-01 NavIC Satellite*, Maulik BHAVSAR, Sarthi MANDAL (ISRO, SAC)
 - *Continuous UTC and its Impact from the NavIC Perspective*, Kalasagarvarma KANDUKURI (URSC/ISRO)
 - *Comparative Experiment and Analysis of Different GNSS Time Offset Monitoring Method*, Haibo YUAN (NTSC)
 - *Draft Recommendation on Timing Interoperability*, Jérôme DELPORTE (CNES), Pascale DEFRAIGNE (ORB)
 - Summary of key discussion points/actions/possible recommendations, summary of points to be brought to the joint sessions
 - Review of recommendation list, discussion and summarization of Task Force on Timing References sessions
- ~~Wednesday 18 October 2022 (09:30-10:00)~~ **Tuesday (15:00-16:00) : Joint session on timing interoperability**
 - Review of 2 recommendations

II. Templates of GNSS times

- ◆ Follows from Recommendation 11 (2011)
 - Ongoing, most templates have been published between 2012 and 2016
 - They provide a rapid and clear information on the timing system and the related timing services
 - Many templates still need updating, little progress in recent years
 - See status at

<https://www.unoosa.org/oosa/en/ourwork/icg/resources/Regl-ref.html>

GNSS time	Published/updated	Update needed
GPS time	2012	Leap second
GLONASS time	Updated 2017	
Galileo System time	Updated 2016	
EGNOS	2015	
IGS time	2012	Leap second
BeiDou System time	2016	
QZSS time	2016	
Navic	Planned	

Please verify whether the timing template of your GNSS need an update

II. Templates of GNSS times

- ◆ Templates can be now found on ICG website thru
Resources/Reference systems or WG/WG-D/Templates
- ◆ Name of the page is now « Reference systems »
- ◆ Timing templates have been separated into:
 - ◆ GNSS time scale description : GPS, GLONASS, Galileo and BDS
 - ◆ Regional and augmentation systems : QZSS and EGNOS
 - ◆ Others : IGST

III. Status of past WG-D Recommendations

- ◆ Rec #11 « Finalization and publication of templates on geodetic and timing references »
 - Ongoing, status of templates given in Part II
- ◆ Rec #16-A « Information on the works related to the proposed redefinition of UTC »
 - CGPM 2022 draft resolution E, see BIPM presentation
- ◆ Rec #19 « Official provision of a rapid UTC (UTC_r) by the BIPM »
 - Ongoing
- ◆ Rec #20 « BIPM publication of [UTC – GNSS times] and [UTC – UTC(*k*)_{GNSS}] »
 - Ongoing, see BIPM presentation
- ◆ Rec #21-B « On the monitoring of offsets between GNSS times »
 - See below discussion on timing interoperability + joint session with WG-S and B

IV. Discussion on timing interoperability

WG-D Rec #21-B: On the monitoring of offsets between 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.”
- Joint timing workshops of WG-S and WG-D: 7 July 2017, 20 June 2018, 14 June 2019, 28 August 2023
- Joint sessions on GNSS timing interoperability at the ICG-13, ICG-14, ICG-15 and ICG-16 with a total of 18 presentations, mostly from WG-D
- At ICG-16 last year, the 2021 CCTF Recommendation “On the use of existing time scales to generate GNSS inter-system information” was discussed but no consensus reached

IV. Discussion on timing interoperability

- Wording of the 2021 CCTF Recommendation “On the use of existing time scales to generate GNSS inter-system information” :

recommends that

GNSS providers consider the benefit of using the predictions of (UTC-GNSStime) as reference for computing the inter-system biases, which avoids the need to create an ad-hoc common reference time scale,

GNSS providers continue their efforts to improve the prediction of (UTC-GNSStime) with the help of time laboratories,

and further recommends that

Multi-GNSS receiver manufacturers explore the possibility to obtain the GNSS inter-system biases from these predictions of (UTC-GNSStime),

The International Committee on GNSS of United Nations supports this recommendation.

IV. Discussion on timing interoperability

- Recent research showed that, for a ground user:
 - Performances of using Broadcast_UTC_{GNSS} as pivot:
Max 20 ns error on inter-system bias so-obtained, because of differences in Broadcast_UTC_{GNSS} (can be improved)
 - Impact of an error on the inter-system bias from broadcast information:
For mass-market receivers, an error of 20 ns has no impact on positioning/timing
- This shows that the use of UTC as a pivot to determine the GNSS inter-system biases is a viable method (and it makes use of already-existing broadcast messages)
- The needs of space users may lead to other requirements and conclusions, but they are not known to us at this stage
- New proposed recommendation that eliminates the creation of an ad hoc time scale to be used as pivot has been presented to WG-B and WG-S

Sesia et al. *GPS Solut* **25**, 61 (2021)

Defraigne et al. *GPS Solut* **25**, 2 (2021)

IV. Proposed recommendation [1/2]

Recommendation for Committee Decision

Prepared by: Working Group D

Issue Title: On the use of the broadcast prediction of UTC to determine the offsets between GNSS times for ground/air users

Background/Brief Description of the Issue:

Multi-GNSS is more and more used in a variety of applications. Multi-GNSS users need to know the timing offsets between the individual GNSS, also called inter-system timing biases.

In ICG 2017, a discussion was raised on the possibility to use a single pivot time scale as reference to estimate the different GNSS time offsets, so that each GNSS would need to broadcast only one parameter. In recent years, the use of the prediction of UTC already broadcast by the GNSS as this single pivot has proved to be a viable solution, without the need to create a new time scale. On this topic the Consultative Committee for Time and Frequency of the BIPM issued a Recommendation in 2021 “On the use of existing time scales to generate GNSS inter-system information” recommending to avoid the proliferation of unnecessary time scales.

Discussion/Analyses:

The inter-system time biases can be determined by three different approaches:

- determination at user level when a sufficient number of GNSS satellites are in view
- use of direct broadcast information (GNSS-to-GNSS time offset) when available
- use of the prediction of UTC (called $bUTC_{GNSS}$) that each GNSS currently broadcasts through the message (GNSStime - $bUTC_{GNSS}$) as a pivot to determine related inter-system time biases

IV. Proposed recommendation [2/2]

Even if the $bUTC_{GNSS}$ is not the same for the different GNSS (different UTC(k) are used by the GNSS as intermediate references), they are sufficiently close to one another for that purpose. Recent studies have confirmed that with the current differences between the $bUTC_{GNSS}$ broadcast by the different GNSS, the resulting error on the inter-system time bias has no significant impact on positioning and timing in situations where ground mass-market receivers cannot determine the inter-system bias directly from the measurements.

The prediction of UTC broadcast by the GNSS is expected to improve in the future, which will benefit to GNSS interoperability and to time dissemination accuracy.

The feasibility/performance of the three approaches depend on many factors such as the number of GNSS satellites in view, the noise level of the receiver and the accuracy of the broadcast messages.

Continuous effort in monitoring and validating all GNSS-to-GNSS time offset is to be pursued also promoting the collaboration among the different involved groups.

The needs of space users may lead to different conclusions that might lead to revisit this recommendation.

Recommendation of Committee Action:

- 1. If a common pivot method is chosen to provide the user with GNSS inter-system time biases, GNSS Providers and multi-GNSS receiver manufacturers consider the benefit of using the common pivot $bUTC_{GNSS}$ contained in the GNSS navigation message. This approach comes in addition to the two other existing methods (estimation at user level or use of broadcast GNSS-to-GNSS time offset). For standard ground/air users, this eliminates the need to create an ad hoc time scale as common pivot.*
- 2. GNSS providers continue their efforts to improve the prediction of UTC broadcast in the navigation message with the help of time laboratories, with the aim to improve their time dissemination service and also the GNSS interoperability.*