WG-D Task Force on Time references
Status on actions and recommendations

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16th ICG Meeting

9 -14 October 2022

I. Task Force on timing references: ICG-16 agenda

- Tuesday 11 October 2022 (09:00-11:00 and 11:20-12:45)
  - WG-D status on actions and recommendations – J. Delporte (CNES), this presentation
  - GNSS/RNSS report
    - GNSS Timing monitoring with calibrated receivers at ESA (ESA)
    - Galileo timing perfo monitored by the GRC-MS - J. Delporte (CNES)
  - Report from BIPM on UTC, UTCr and update on Circular T - P. Tavella (BIPM)
  - Status on GNSS timing calibration – P. Defraigne (ORB)
  - NavIC: Demonstration of NavIC based timing synchronization for entanglement based quantum communication (SAC/ISRO)
  - Update on indigenous atomic clock development for NavIC (SAC/ISRO)

  Discussion on timing interoperability (in preparation of the joint WG-S+B+D session) and possible way forward

  Review of recommendation list, discussion and summarization of Task Force on Timing References sessions

- Wednesday 12 October 2022 (09:00-10:00)
  - Traceability to UTC from GNSS measurements - P. Defraigne (ORB)
  - GNSS system time scales and assessment of the offsets between them – TBD (RIRT)
  - Summary of time interoperability and way forward - P. Defraigne (ORB)

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	

II. Templates of GNSS times

- Templates can be found on ICG website thru
  Resources/Regional reference systems or WG/WG-D/Templates
- Name of the page is « Regional reference systems »

- Proposal to ask ICG secretariat:
  - To rename the web page into e.g. « Reference Systems »
  - To separate GNSS times from regional/SBAS and others :
    - GNSS time scale description : GPS, GLONASS, Galileo, BDS and Navic (when available)
    - Regional and augmentation systems : QZSS and EGNOS
    - Others : IGST

  Agreement on this proposition ?

Regional Reference Systems

The International Committee on Global Navigation Satellite Systems (ICG) noted a proposal to establish links with national and regional authorities and relevant international organizations, particularly in developing countries. A working group will be established to develop a strategy for support of regional reference systems.

- African Geodetic Reference Frame (AFREF): http://geoinfo.uneca.org/afref/
- Asia and Pacific Regional Geodetic Project (APRGP): http://www.sbsm.gov.cn/pcgiap/98wg/98wg1/aprgp_analysis/aprgp_analysis.htm
- European Position Determination System (EUPOS): http://www.eupos.org
- IAG Reference Frame Sub-Commission for Europe (EUREF) http://www.euref.eu or http://www.euref-iag.net
- Geocentric Reference System for the Americas (SIRGAS): www.sirgas.org

UN-GGIM: SUBCOMMITTEE ON GEODESY - GLOBAL SURVEY ON GEODETIC REFERENCE FRAME COMPETENCY

- Website (External Link): https://bit.ly/3fyNBRT

Templates on Geodetic and Timing References

GLOBAL NAVIGATION SATELLITE SYSTEMS TIMESCALE DESCRIPTIONS

- Global Positioning System (GPS): GPS Time
- GLObal NAvigation Satellite System (GLONASS): GLONASS Time
- GALILEO (satellite navigation): Galileo System Time (GST) - as of January 2016
- European Geostationary Navigation Overlay (EGNOS): SBAS Timescale Description
- International GNSS Service (IGS): IGS Time V1.0
- BeiDou Navigation Satellite System BDS): BeiDou System Time - as of November 2016
- Quazi Zenith Satellite System (QZSS): QZSS Time - as of November 2016

GLOBAL NAVIGATION SATELLITE SYSTEMS REFERENCE FRAMES DESCRIPTIONS

- National Geospatial-Intelligence Agency: World Geodetic System 1984 (WGS84)
- Global Geocentric Coordinate System of the Russian Federation: Earth Parameters (PZ-90) - " Parametry Zemli 1990" (updated as

Our Work
Secretariat of COPUOS
Programme on Space Applications
UN-SPIDER
International Committee on GNSS
Overview
Members
ICG Terms of Reference
Providers' Forum
Working Groups
Working Group S
IDM
Performance Standards
Working Group B
Working Group C
Working Group D
Templates
ICG Annual Meetings
ICG Programme on GNSS Applications
Resources
ICG Documents
Other Events
ICG Timeline
UN-Space
UNISPACE+50
Space Law

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 (UTCr) by the BIPM** »
  - Ongoing, see BIPM presentation
- Rec #20 « **BIPM publication of [*UTC – GNSS times*] and [*UTC – UTC (k)*$_{\text{GNSS}}$]** »
  - 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 (with little involvement of timing experts), 20 June 2018, 14 June 2019

- Joint sessions on GNSS timing interoperability at the ICG-13, ICG-14 and ICG-15 with a total of 15 presentations, mostly from WG-D

- At ICG-15 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, <u>for a ground user</u>:
  - 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

Sesia *et al. GPS Solut* **25,** 61 (2021)
Defraigne *et al. GPS Solut* **25,** 2 (2021)

- 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
- Proposal by WG-S to hold another WG-S+B+D timing workshop, to be discussed in the joint session