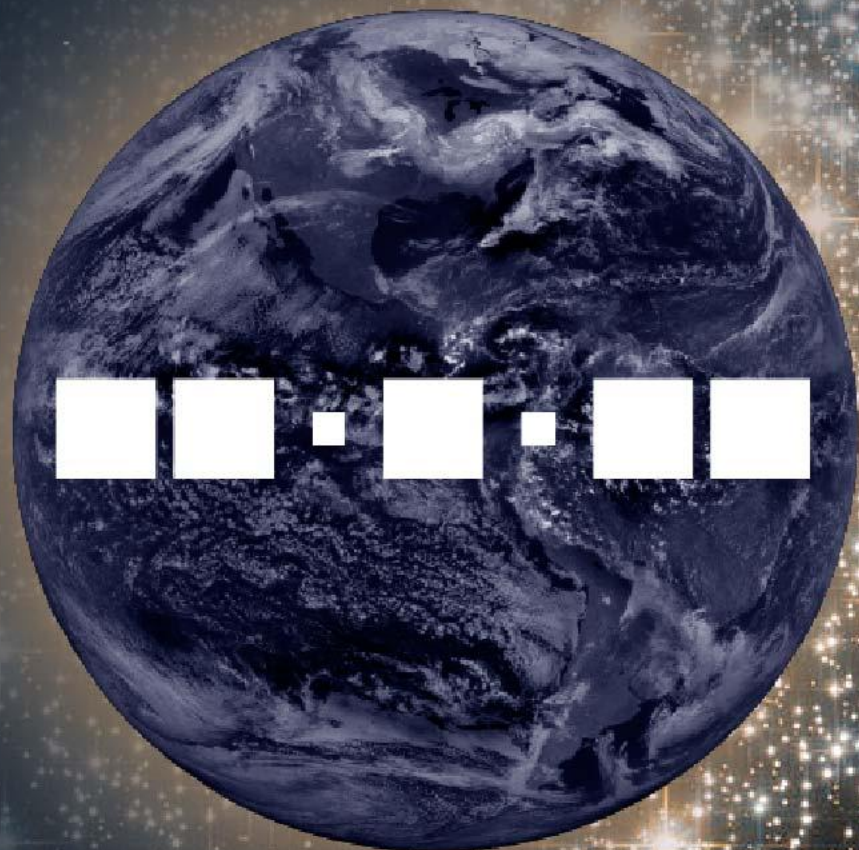




Clock Products WG Summary

Michael J. Coleman,
Chair and Clock Products Coordinator



2022 Virtual Workshop
“Science from Earth to Space”

Session Information

Meeting Time: Monday Morning 13:30 - 14:45 UTC

Rapporteur: Mike Coleman

Participants: Approximately 100 - 110.

Current WG Members:

Administrative

Mike Coleman	Chair
Ken Senior	Previous Chair
G�rard Petit	BIPM Representative
Allison Craddock	CB Representative
Salim Masoumi	ACC

Analysis Center Representatives

Rolf Dach	Tom Herring
Simon Banville	Sharyl Byram
Nacho Romero	Li Min
Pierre Sakic	Sungpil Yoon
Flavien Mercier	
Paul Ries	

UTC(k) Representatives

Pascale Defraigne
Ilaria Sesia
Shinn-Yan Lin
Stephen Mitchell

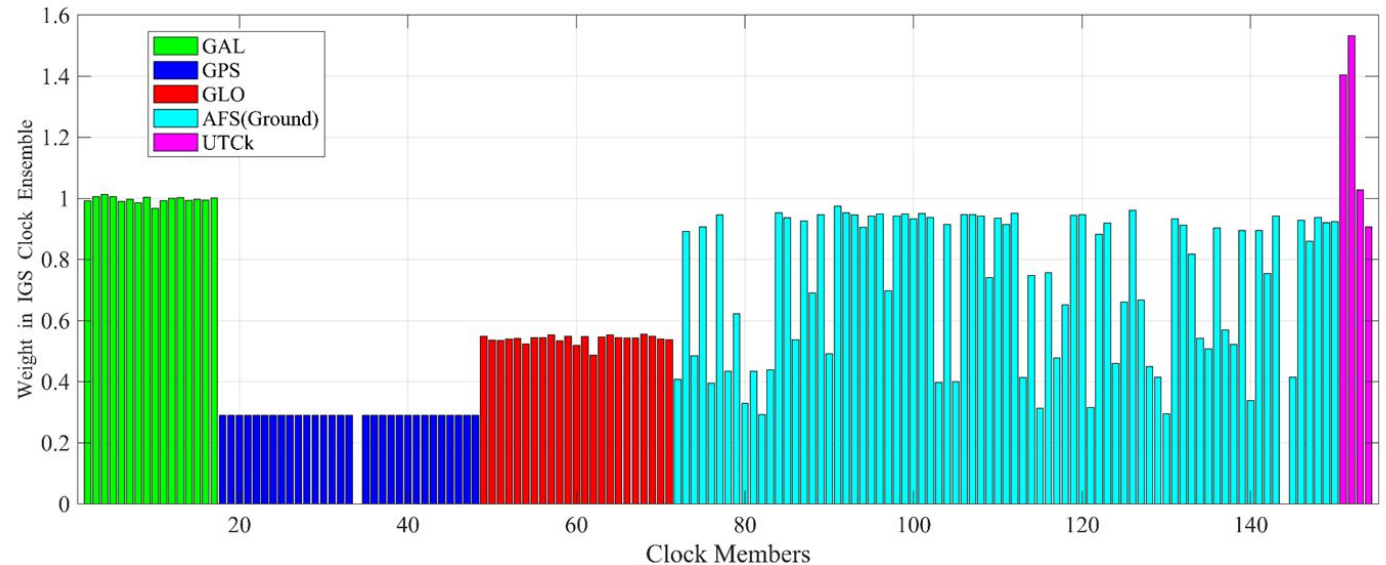
Discussion Highlights

- **Multi - GNSS Clock Combination**
 - Currently contains GAL, GPS, GLO.
 - For BDS: more AC clock solutions and updated antenna maps needed.
 - Product Precision ~20-25 ps.
- **Clock Rinex File Format Update – Changing to ClockEx File**
 - New documentation underway for this format.
 - Opportunities to use this format in disseminating additional information types.
 - Clock solutions, predictions, day boundary discontinuities, etc.
 - Header field updates.
- **IGS Statement on Leap Second**
 - Final statement on continuous UTC was approved at the GB in May.
 - Recommend no additional leap seconds in UTC.
 - Future of this topic remains open in ITU-R and other groups.

Major Accomplishments

Clock Combination Completion (really an accomplishment of PPP-AR)

- Utilizing work from PPP-AR WG / NRCAn.
- Generates multiple products:
 - OSB.BIA: Bias SINEX file with signal biases
 - CLK.CLK: Clock Rinex file with satellite and station clock bias
 - CLS.CLS: Combination summary (mean and std of combined biases).
- Approximate number of clock members
 - 260 ground station clocks
 - 84 atomic standards
 - 4 UTC(k) sites).
 - 77 satellite clocks
- Final step is completion of IGST timescale and clock exchange.



Major Accomplishments

Finalization of Leap Second Statement

- **Although the IGS has methods and architectures to handle and document leap seconds, discontinuities in UTC – GNSST are undesirable. The IGS therefore recommends that additional leap seconds not be added to UTC.**
 - References to UTC and leap seconds are common in several file formats including: RINEX, SINEX, Clock Rinex (soon to change) in order to clarify system time integer offsets. These may require updating as leap seconds are declared and added.
 - With a greater number of multi-GNSS products and differing implementations of leap seconds between GNSS providers, the possibility of confusion between timescales has grown
 - Changing discrepancies between the IGS's time tags and UTC, the internationally recognized timescale, is not desirable. Further, the boundaries of a GNSS-based day versus a UTC-based day differ. Additional leap seconds will cause a greater number of records in a typical IGS daily product file to belong to the previous UTC day.
 - Discontinuities in UTC can affect firmware performance in GNSS receiving equipment and/or timing systems which may add maintenance load at IGS sites.

Emerging Ideas

- **File updates:**
 - Consider linking files for consistency – should discuss at the Infrastructure Committee.
 - Update units of station APC positions to meters.
- **New topics for improved products and book-keeping:**
 - Study the possibility of reducing the day boundary discontinuities.
 - Discuss whether multiple clock solutions are appropriate if both L1/L2 and L1/L5 solution combinations are published. Would require additional input from Analysis Centers and ACC.
 - Multi-GNSS: maintain pace to bring multi-constellation clock products to core IGS products.

Recommendations for Future Work

- **Collaborate with WG on Bias & Calibration and PPP-AR on:**
 - publication of multiple clock solutions owing to different signal frequency combination.
 - linking files among different products for consistency.
- **Collaborate with PPP-AR on:**
 - evaluation and possible reduction of clock day boundary discontinuities
 - present proposal for publication of that additional product.
- **Collaborate with Multi-GNSS on:**
 - ensuring clock products ultimately contain solutions from all four global GNSS.

IGS 2021+ Strategic Plan Goals and Objectives



GOAL 1 **Achieve Multi-GNSS Technical Excellence**
 Increase organizational capability by identifying barriers to multi-GNSS success throughout the IGS, supporting solutions to key challenges, and reinforcing the importance of continuous technical evolution.

The present goal of this WG is the development and publication of multi-GNSS clock products in combination with combined bias products. This group will continue to advise relevant IGS subgroups on the interests of clock product users and clock solutions so that the most appropriate products are ultimately generated and disseminated.



GOAL 2 **Strengthen Outreach and Engagement**
 Advocate for open access geodetic and GNSS data and products that facilitate collaborations, standardization, and inclusivity.

The effect of clock biases on several different methods and measurements makes this group’s subject area an important intersection for discussion and planning. Because there are several stakeholders, there is a need to collaborate across working groups that is not ordinarily done at any IGS meeting or workshop.



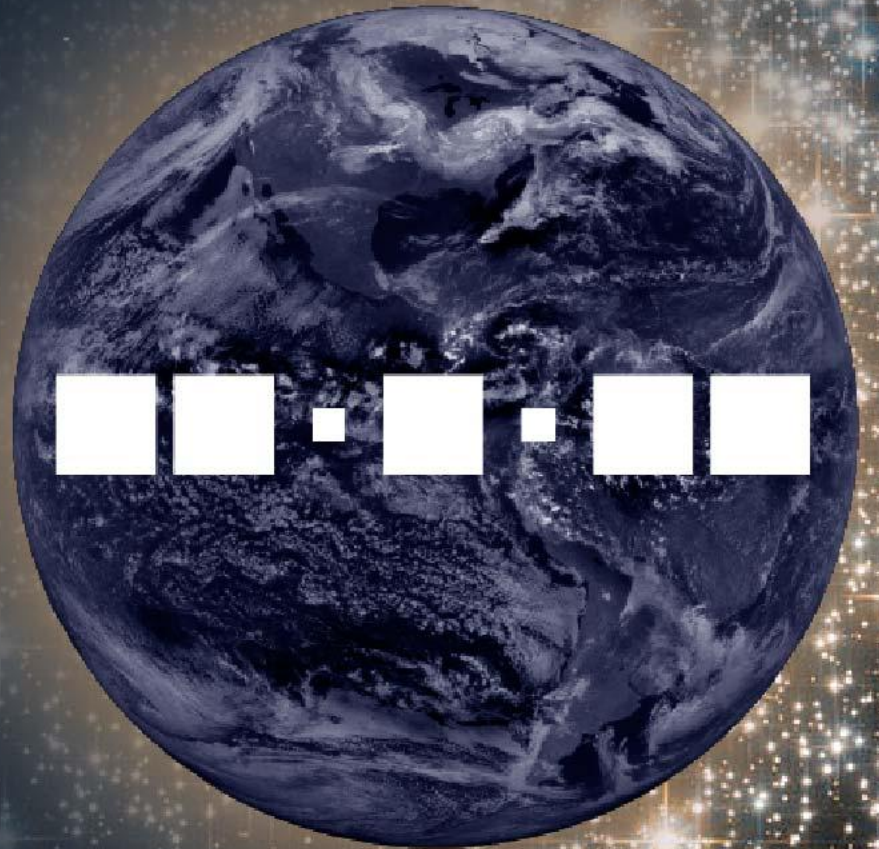
GOAL 3 **Build Sustainability and Resilience**
 Foster a resilient, sustainable, and effective organization to support an expanding and evolving IGS community.

Nothing specific being done in this area presently.



Clock Products WG Meeting

Michael J. Coleman,
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Meeting Agenda

- **Multi-GNSS Clock Combination**
 - Discussion of combination completed
 - Product flow with IGS Clock Ensemble (ICE)
 - Clock Ensemble/Timescale reprocessing
- **Clock Rinex Format Update**
 - Removal from rinex file group
 - Version and naming conventions
- **IGS Statement on Leap Second**
 - Background
 - Current discussion and effort
 - IGS relevant points
- **Goals // Other Business**

Clock Combination Info

- **Developed by Wuhan University.**
 - Utilizing work from PPP-AR WG / NRCAn.
 - Generates multiple products:
 - OSB.BIA: Bias SINEX file with signal biases
 - CLK.CLK: Clock Rinex file with satellite and station clock bias
 - CLS.CLS: Combination summary (mean and std of combined biases).
- **Current combination includes: GPS, GAL, GLO**
 - Station receiver clocks (based on AC network selections)
 - GPS satellite clocks (all PRN in service)
 - GAL satellite clocks (16 satellites as of 2018)
 - GLO satellite clocks (23 satellites as of 2018)
- **BDS not yet included due to antenna map corrections that are needed as well as additional AC solutions.**