IGS INTERNATIONAL GNSS SERVICE

Analysis Center Coordinator

Call for Participation

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Background

The IGS analysis products are formed from a combination of the results submitted by the IGS Analysis Centers (ACs). The role of the Analysis Center Coordinator (ACC) is to perform these combinations of different products generated by the ACs and to disseminate and evaluate the combined products. To the extent that the effect of data and mis-modeling among different ACs are independent, properly weighted combinations of results can be superior. In this way, the IGS products benefit in precision, accuracy, stability, reliability, and robustness compared to the results of any individual AC.

The IGS Analysis Center Coordinator (ACC) is responsible for monitoring the quality of products submitted by individual analysis centers and combining them to produce the publicly well-established combined IGS products, as well as providing coordination and governance for the provision of the products in an operational framework. The IGS ACC also has the overall responsibility for coordinating the changes, developments, and improvements within the contributing analysis centers to produce the IGS products using the latest models and standards. The IGS products continue to perform at a consistent level, and in general, the solutions submitted by the analysis centers maintain a consistent level of performance.

The current call for ACC preproposal and the transition to a new ACC consists of two distinct but interrelated efforts: transfer of responsibility from GA and MIT to the new host(s) and transition of the ACC software and analysis products. This transition will provide the opportunity to introduce a multiple (multi) GNSS combination for orbit and clock products because first, since November 2022, a number of triple system solutions have been provided by a number of analysis centers in the legacy final series, and second several software candidates for this purpose have been developed within the last years.

The IGS ACC is responsible for product generation on a variety of latencies, with the shortest being a few hours to the operational Final Product processing with a latency of about two weeks. In addition, the combination of products spanning over two decades is needed every few years after major reprocessing campaigns. The IGS final and reprocessed products are particularly important because their results are essential for the formation and maintenance of a highly accurate and consistent IGS Reference Frame, and hence the contribution of the IGS to the International Terrestrial Reference Frame (ITRF). For many geophysical studies, the models used in the finals processing (atmospheric delay propagation models and higher-order ionospheric correction) are necessary to avoid artifacts in the geophysical interpretation. Also, since the final products use a minimum constraint system, site position estimates in the network are not affected by non-modeled motions at individual sites.

Since combination strategies normally assume that the weighted average result is preferred, it is important for the IGS and the ACs to be aware of potential common mode errors, which can

degrade the accuracy of the IGS combined products compared to those of an individual AC. For this reason, the IGS must continuously encourage efforts to calibrate and test the absolute performance of its products.

Core Products

For the new ACC, the IGS products will be multi-GNSS with initially GPS, Galileo and GLONASS included. When metadata for the Beidou system is determined to be accurate, it will be included also.

The IGS core products currently consist of:

Weekly Final products, which are:

a. GNSS satellite ephemerides and clock values, tabulated at specified intervals for each day (in standard formats)

b. Earth orientation parameters (polar motion, polar motion rate, and length-of-day), estimated at daily intervals (in standard format)

c. Station clock values, tabulated at specified intervals for each day (in standard format)

d. Station coordinate and velocity values for the global tracking network from a combination of weekly data sets (SINEX format)

Final Products are determined for each GPS week of data and delivered to the IGS within a specified deadline (currently 13 days after the end of that week). The Final products are reprocessed every several years (most recently 2008, 2014, and 2020) based on the most up-to-date models and analysis strategies. Significant commitments of resources by the IGS ACs and ACC are needed at the times of reprocessing campaigns.

Daily Rapid products, which are:

a. GNSS satellite ephemerides and clock values, tabulated at specified intervals for each day (in standard formats)

b. Earth orientation parameters (polar motion, polar motion rate, and length-of-day), estimated at specified intervals (in standard format)

c. Station clock values, tabulated at specified intervals for each day (in standard format)

Rapid products are determined for each day of data and delivered to the IGS within a specified deadline (currently 17 hours after the end of that day). Finite constraints are applied to station position estimates for the IGS core sites.

Ultra-rapid products, which are:

a. GNSS satellite ephemerides and clock values, tabulated at specified intervals (in standard format)

b. Earth orientation parameters (polar motion, polar motion rate, and length-of-day, in standard format)

Ultra-rapid products are determined several times per day (currently four times per day) and delivered to the IGS within a specified deadline (currently 3 hours after the last epoch of the adjusted time interval). They include a 24-hour adjusted and a 24-hour predicted part. Station position constraints are the same as rapid solutions.

Product Requirements

The Final Products from each AC must be fully self-consistent. The Analysis Center Coordinator establishes the detailed specifications for the Final products in consultation with the ACs and the IGS Reference Frame Coordinator. The Final products, when combined with proper weighting, allow for the definition and maintenance of the IGS Reference Frame.

The Rapid and Ultra-rapid products from each AC must apply the current IGS Reference Frame. The Analysis Center Coordinator establishes the detailed specifications for the Rapid and Ultra-rapid products in consultation with the ACs and the IGS Reference Frame Coordinator.

Other Products

In addition to the Core Products listed above, the IGS generates other analysis products such as tropospheric zenith delay and ionospheric products, IGS time scale, satellite and receiver differential code biases, satellite antenna offsets, and phase center calibrations. Other entities in the IGS generate these products and they are not the responsibility of the ACC. However, the ACC works closely with the relevant product coordinators.

Summary of Resources and Commitments

Key Knowledge Holders, Training, and Skills

Commitment and support of a minimum of 1.5 FTE (likely 2 FTE while training and transitioning) during regular working hours (with additional system monitoring on weekends and non-working days, such as public holidays and closedown periods), with the following skills and experience:

a. Background in GNSS processing or analysis, with a particular focus on clock and orbit combinations;

b. Experience in cloud computing environments and programming, including information and cyber security;

c. Experience or ability to provide leadership, coordination, and stakeholder engagement in an international context.

d. Commitment and ability to respond to major incidents during non-working hours.

Infrastructure and Information Technology Resources

Operations in a cloud environment (currently AWS). For the current ACC based at Geoscience Australia, the AWS costs total approximately AUD$70K annually in AWS storage and compute costs. There would be an increase in the computing/storage costs during reprocessing efforts and test campaigns. Similar costs are expected for the new ACC.

Estimated Summary of Resources

The IGS final, rapid and ultra-rapid combinations currently run using automated pieces of software/scripts at pre-scheduled times of the day. Automated scripts also create statistical summaries and plots on a constant basis that are used to monitor the quality of the products. For the final products, which are released on a weekly basis, an analyst manually checks the quality of products and carries out manual interventions if required, before distributing the products to the global data centers. Currently, only one facility operates the combinations, even with four releases per day for the ultra-rapid combinations. With a cloud-based implementation of the ACC combination, it would be feasible to have operators in different time zones monitor the delivery and quality of the combinations. Delivery of Rapid and Ultra-Rapid products needs to be constantly monitored even after business hours and the weekends/holiday periods (once daily for Rapid and ideally four times per day for the Ultra-Rapid). Final products are always

carefully checked for quality before release, but since these are released weekly, this task can be performed during normal working hours.

Minimum and Preferred Expectations for the new ACC Entity

The new ACC is expected to:

1. As a minimum, directly take over the GPS-only combinations and coordination activities from the current ACC for at least a four-year term, with a plan forward for the extension towards multi-GNSS combined products;
2. Preferably generate new multi-GNSS orbit and clock products, with the current ACCcontinuing to generate GPS-only combinations while the new multi-GNSS combinations are validated.The new ACC may use either a combination sofware developed by their own - given an open access to the source code or one of the currently available multi-GNSS software packages can be incorporated in collaboration with the original authors.

The new ACC combination software is expected to be open-source and run in an open cloud-based environment, so the next ACC transition should be a straightforward switch of the cloud-based operator.

Current Status of Multi-GNSS ACC Capabilities

Geoscience Australia has developed an in-house multi-GNSS orbit combination capability, which was used for the Repro3 orbit combinations. The same software is now capable of performing multi-GNSS orbit combinations on an operational basis. This has allowed the current ACC to produce ultra-rapid multi-GNSS (GPS+Galileo+GLONASS) orbits on an operational basis since July 2023, which have been stored on a non-public AWS cloud storage. These combined ultra-rapid orbits are planned to be published on global data centers as demonstration products, with an expected release window of late 2023 to early 2024. The orbit combination software developed at Geoscience Australia is also planned to be released as open-source software with a similar expected timeframe of late 2023 to early 2024. The limitation of the multi-GNSS capability of the current ACC is that it only covers the orbit combinations and does not include clock combinations. It also currently does not have an ERP combination and a PPP component, with these components currently being sourced from the legacy combination software.

Timeline

The following timeline shows the expected activities over the next two years in the transitions from the current ACC based at Geoscience Australia to a new multi-GNSS ACC.

February 2024

Call for Participation to serve as the new ACC (this document) is finalized and presented to the Governing Board as part of a formal plan to transition the ACC role. More information will be made available in the Transition Roadmap document.

February-March 2024

Consultation period for organizations considering responding to the Call for Participation. Current ACC organizations will be available to answer any questions not addressed in the Call for Participation.

Document key information and best practices and create an accessible knowledge repository (as far as not done so far).

Middle of April 2024

- Proposals shall be submitted to the CB.

April to May 2024

- Proposals are reviewed by the Governing Board and discussed at a special virtual meeting.
- The Governing Board selects the new ACC in May 2024.

July 2024

- Prior to the IGS Workshop in Bern, Switzerland, the successful candidate(s) are confirmed, and the transition process begins.

May-September 2024

- Training and skills transfer, mentoring new people, and identifying backup personnel as part of a risk reduction strategy.
- Review the download and initial content-checking environment.
- Implementation of the new combination of software.

- Review and update the existing quality assurance environment.

October 2024-May 2025

- Parallel operation of the cloud environment at the new ACC and on the existing GA/MIT facilities with comparisons and validation of the combination results.

June 2025

- Switch of the operational environment to the new facility.
- (GA/MIT may run their environment for one month as a backup)

July 2025

- Geoscience Australia and MIT step back completely from the ACC role.

July-September 2025

- New ACC completes documentation of key information and best practices and creates an accessible knowledge repository.
- Feedback and iteration of work from new ACC.
- Document challenges encountered and solutions developed during the transition process.

Instructions for Submitting a Proposal

Proposals submitted in response to this Call for Participation should contain:

1. A cover letter signed by an official representative of the organization affirming that sufficient resources will be available to carry out the responsibilities of the ACC. Key personnel and the person who will be the ACC should be named in the cover letter.
2. A detailed plan describing how the combined IGS [multi-GNSS] products will be generated. This plan should include details of

a. The cloud-based environment to be used with details of the operating system, proposed architecture of the system (e,g, CPU, Disk storage).

b. The software to be used and the details of the licenses associated with the software, e.g., which open-source license is being used.

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c. Validation tests to be carried out to demonstrate the consistency between the multi-GNSS orbits and clocks and existing IGS products.

d. Approaches to be used to ensure the quality of IGS products during operational processing.

e. Contingency plans that demonstrate the IGS combinations should be robust in the event of disruptions at the main processing facility, e.g., these plans could include multiple Cloud installations in different geographical regions.

It is recommended that the above details be consulted with the current ACC organizations (Geoscience Australia and MIT) prior to submission of the proposals.