

Report of Working Group D: Reference Frames, Timing and Applications

1. Introduction

Matt Higgins, co-chair of Working Group D, opened the meeting, welcomed everyone and went through the proposed agenda. Agenda was approved. The meeting listed attendees and noted regrets of those unable to attend. Representatives from all system providers except India were present, although it was noted that India's representative to ICG was Co-Chairing the WG-C meeting and therefore unable to attend this meeting which was in parallel.

2. Review of Minutes from last meeting

The last meeting was held on July 4, 2011 in conjunction with the IUGG General Assembly in Melbourne. Matt went through the action items listed from the Melbourne meeting, many of which would be further covered at this meeting.

3. Task Force on Geodetic References

Zuheir Altamimi, chair of Task Force on Geodetic References, chaired this agenda item.

3.1. Summary by Task Force Chair of Currently Submitted Templates and Planning for their Publication

The current status regarding templates is that China, EU, USA and Japan have delivered their geodetic templates. Russia and India have promised to deliver theirs before end of 2011. The meeting agreed that the templates will be published on the website as they are finalized and then maintained and updated as necessary.

Zuheir presented suggestions on interoperability of geodetic templates. The delivered templates may need minor changes and an agreed action is to work by Zuheir's suggestion.

Also agreed WG-D Recommendation #11 on "Finalization and Publication of templates on Geodetic and Timing References" (See Appendix A)

There was discussion among the participants concerning the use of ISO standard ISO 19111 when describing reference systems. It was agreed that we start by collecting the templates in the format that we currently have agreed on and the next step will be to review them with respect to ISO 19111.

3.2. Presentations on Recent Developments in Geodetic References

From the discussion among the participants at the meeting we can note that:

- USA representative reported that WGS 84 will be updated and will be aligned with ITRF2008. The work is underway and will be finalized in the next couple of months. The result will be published on their website but will also require updating of the ICG template.
- Russia reported that an updated version of PZ-90 is almost finalized and will soon be published and that will be reflected in the ICG template promised later this year.

Resulting from actions at the BIPM, the General Conference of Weights and Measures (CGPM) will adopt in October 2011 a resolution recommending the use of the ITRS for metrological applications. This will make the ITRS the international geodetic reference for metrology.

3.3. Relevant Developments in International Standards Organization (ISO)

Zuheir reported, on behalf of Claude Boucher, that France has decided to submit in September 2011 to ISO a proposal to make ITRS an ISO standard. The preferred path is to go through ISO TC211 and create a permanent working group. France will need support in the process and the member and associate members of ICG are encouraged to give support.

3.4. Recommendations from Task Force on Geodetic References

Recommendations from WG-D can be found in Appendix A.

4. Task Force on Timing References

Felicitas Arias, chair of the Task Force on Timing References, chaired agenda item number 4.

4.1. Summary by Task Force Chair of Currently Submitted Templates and Planning for their Publication

All providers except India had submitted their templates on timing references. Progress has been made during ICG-6 regarding the template from India. The meeting agreed that the templates will be published on the website as they are finalized and then maintained and updated as necessary.

The templates are almost ready for publication but need some minor changes. Time frame for this is about one month. An agreed action is to publish the templates on the ICG website together with the geodetic templates.

Agreed Action: Augmentation systems such as EGNOS and WAAS should also present templates.

4.2. Presentation by Task Force Chair on Developments with UTC

Felicitas reported on the Rapid UTC project at the BIPM (UTCr). A decision will be made before September 2012 about whether this is something that BIPM will provide on a routine basis in the future. The purpose of the project is to provide to users and time laboratories more frequent access to UTC. At present UTC is calculated with one-month data batches and available monthly in BIPM Circular T. This means that laboratories today extrapolate UTC values for the period 10 to 35 days. An advantage of this new approach would be better synchronization of GNSS times to UTC.

The meeting agreed on the importance of the project and discussion took place on how the support should be given. For BIPM it is enough to have recommendations at an appropriate meeting and level and suggested words were... "The system providers note the progress of the experiment and encourage BIPM to carry on with the project".

Felicitas also pointed out that UTC will most probably be modified since a proposal is up for voting at the ITU General Assembly in January 2012.

4.3. Presentations on Other Recent Developments in Timing References

Yuanxi Yang (China) presented on and pointed out that Beidou follows interoperability and compatibility regarding time issues. He showed results describing the stability of Beidou time. He also reported that China will set up a GNSS time monitoring system.

Yuanxi also made a presentation about DOP which questioned whether the current definition of GDOP still works in a multi-GNSS world. He presented suggestions on new ways of calculating GDOP.

Shinichi Hama (Japan) also presented on UTC and QZSS.

4.4. Recommendations from Task Force on Timing References

Recommendations from WG-D can be found in Appendix A.

5. Overarching ICG Activities

5.1. Actions arising from Joint Session between WG-A, WG-B and WG-D during the meeting on the 7th September at ICG

In relation to WG-A Recommendation 4.1 on Open Service Performance Parameters, WG-D sees the value in such parameters and can offer user perspective feedback on a draft set of parameters.

In relation to WG-A Recommendation 4.2 on International GNSS Monitoring and Assessment, WG-D welcomed the amendment to allow for all ICG participants to be involved in the team to progress that issue with no need for a separate recommendation by WG-D.

WG-B and WG-D both have the word *applications* in the name. A suggestion from WG-B to clarify the different focus for the working groups to ICG is that:

- WG-D to focus on surveying/geodetic/precise timing applications and derive from this recommendations on the implementation of time/geodetic reference frames.
- WG-B to “*monitor the techniques of application developers*” (including indoor applications) “*and external augmentation service providers for enhancement of GNSS performance with a view to recommend any required system enhancements or actions that may support the realization of such techniques*”.

The meeting discussed the suggestion and expressed some concerns with the wording above suggested by WG-B. It was decided that the chairs of WG-B and WG-D will continue discussions on this matter.

5.2. Actions arising from consideration of the various roles of System Monitor Stations vs SBAS Stations vs Geodetic CORS

Discussion on GNSS providers delivering data collected at their respective monitor stations to the IGS on a regular basis to facilitate integration and alignment of all GNSS reference frames to the ITRF. The discussion resulted in WG-D Recommendation #12 on “Achieving

Interoperability of Geodetic References Among the Different GNSS systems” (See Appendix A).

5.3. Multi-GNSS Asia and extension to IGS global multi-GNSS experiment

Ruth Neilan presented on IGS Multi-GNSS Experiment (IGS M-GEX). The Call for Participation is out and proposals should be sent in by October 30 and the experiment starts on February 1, 2012. The project was also presented by Chris Rizos during ICG-6 at both the Plenary Session as at the WG-A meeting earlier in the week. WG-D will make a recommendation on IGS M-GEX to the Plenary, see Appendix A.

JAXA presented a draft QZSS extension version of RINEX and RTCM. UNAVCO has updated the BINEX format to include QZSS. Other relevant issues here are progress on extensions for RINEX 2.1.2. and 3.0 and developments with RTCM 3.0. This issue is embedded in the recommendation on IGS M-GEX (see later) and therefore it was decided that WG-D need not put forward a separate recommendation on this.

5.4. Other whole-of-ICG issues such as Joint Workshops, etc.

The need of joint workshops on geodetic and timing reference was brought up. ICG participants are welcome to suggest if they have need in having a specific seminar/workshop. Many of the associate members regularly organize or can organize workshops/seminars etc.

6. Next Steps for Working Group D

6.1. Review of Work Plan and emphasis for the coming year

WG-D has during the last years been focused on collecting the geodetic and timing templates. The meeting discussed what would be the next focus area for the working group.

Barbara Wiley (USA) suggested, and the meeting agreed, that the Providers and IGS need to have a closer cooperation. **Agreed Action** at the meeting is that IGS will discuss this at their IGS Governing Board meeting in December to decide on how IGS can support this. The proposal from ICG WG-D was to have a workshop through ICG WG-D since IGS and all of the System Providers are already members of the WG.

There was also a discussion on the ICG GNSS Glossary of Terms. **Agreed Action** at the meeting was to encourage all WG-D participants to review the Glossary and send in corrections directly to the ICG Secretariat. It was pointed out that if ICG is to have a Glossary then it is important that the Glossary is correct and does not conflict with other authoritative glossaries already in use.

The meeting discussed the need for a common internet-based work space where we can share and store documents. We need to decide on who will be the official keeper of the final version of a document, e.g. the templates. **Agreed Action** was for Felicitas Arias to ask UNOOSA about document management conventions and the possible creation of a common work space.

6.2. Recommendations to Plenary of ICG-6

Matt went through the current version of the presentation to the Plenary meeting later in the afternoon. Discussion took place as each was presented and it was agreed that the involved officers will improve the report summary ready for the presentation to the Plenary at 3.15 pm.

All the recommendations can be found in Appendix A:

1. Recommendation #11: Finalization and Publication of Templates on Geodetic and Timing References;
2. Recommendation #12: Achieving Interoperability of Geodetic References Among the Different GNSS Systems;
3. Recommendation #13: Multi-GNSS Experiment of the IGS.

6.3. WG-D paragraph as input to the Joint Statement at the conclusion of ICG-6

It was agreed that the WG-D paragraph in the Joint Statement should concentrate on the content of the three new recommendations. The text drafted by the Co-Chairs and included in the final Joint Statement was as follows:

Working Group D on Reference Frames, Timing and Applications completed development of templates describing the geodetic and timing references for the 4 GNSS and 2 RNSS currently represented in the ICG. The WG also proposed that the templates be published on the ICG website. ICG also welcomed progress by BIPM work towards production of “Rapid UTC” as a more immediately accessible time reference that could be used to better harmonise the UTC broadcast by each GNSS. The WG recommended that System Providers supply data from their respective Monitor Stations for inclusion in regular processing with the International GNSS Service network of reference stations. Such inclusion is aimed at improving the alignment of the various GNSS reference frames with each other and with the International Terrestrial Reference Frame. An important new development was the endorsement by the ICG of the IGS Multi-GNSS Experiment, which follows on from the ICG’s previous endorsement of the Multi-GNSS campaign in Asia and Oceania.

6.4. Next meeting

The next meeting will be held at the IGS workshop in Poland in July, 2012. The WG-D meeting to follow that will be at the next ICG (ICG-7), which will take place in Beijing from 4 to 9 November 2012.

APPENDIX A**WG-D Recommendation 11 for Committee Decision****Prepared by:** Working Group D**Date of Submission:** 08/09/2011**Issue Title:** Finalization and Publication of Templates on Geodetic and Timing References**Background/Brief Description of the Issue:**

ICG WG-D notes:

- progress at ICG-6 with submission of the remaining templates on geodetic references and timing prepared by System Providers;
- assessment by Task Force Chairs of the suitability and consistency of these templates, and;
- expresses appreciation to System Providers for providing this information.

Discussion/Analyses:

Templates are now complete it is timely and appropriate that these be made available to ICG and the community in general. It is recognized that these may be updated as necessary to reflect system changes.

Recommendation of Committee Action:

ICG WG-D Recommends that, following minor amendments based on discussions at ICG-6, all templates for Geodetic and Timing References be published on the ICG website and that any future updates or improvements to templates also be published as they become available.

WG-D Recommendation 12 for Committee Decision

Prepared by: Working Group D

Date of Submission: 08/09/2011

Issue Title: Interoperability of geodetic references among the different GNSS systems

Background/Brief Description of the Issue:

It is essential for multi-GNSS positioning users to be able to position precisely their locations in a unique terrestrial reference frame. Given the fact that each GNSS system has its own reference frame, e.g. WGS84 for GPS, PZ-90 for GLONASS, CGCS2000 for COMPASS, GTRF for Galileo, etc., it is desirable, from the user point of view, to relate or align these different frames to the International Terrestrial Reference Frame (ITRF).

Discussion/Analyses:

The individual GNSS reference frames are materialized through the provision/computation of the coordinates using data collected at the ground control stations.

The International GNSS Service (IGS) is providing in a weekly basis the coordinates of its global network consisting of more than 300 stations, expressed in the ITRF. Time series of IGS weekly station positions are used in the construction of the ITRF.

Eleven WGS84 control stations operated by the National Geospatial-Intelligence Agency (NGA) are delivering data to IGS. Station positions and velocities of these NGA 11 stations are now available in the latest ITRF solution, namely the ITRF2008. The inclusion of these NGA 11 stations greatly facilitates in an optimal way the alignment of WGS84 to the ITRF.

Recommendation of Committee Action:

The ICG WG-D recommends that as GNSS Ground Control Segments become operational, the interested GNSS providers deliver the data collected at a globally representative subset of their respective monitoring control stations to the IGS on a regular basis to facilitate the alignment of all GNSS reference frames to the ITRF.

WG-D Recommendation 13 for Committee Decision

Prepared by: Working Group D

Date of Submission: 08/09/2011

Issue Title: International GNSS Service Multi-GNSS Global Experiment – IGS M-GEX

Background/Brief Description of the Issue:

The IGS recently released a Call for Participation (CfP) for the IGS Multi-GNSS Experiment – IGS M-GEX. This CfP focuses on the availability of new additional GNSS signals on the horizon that are globally accessible. The IGS, through this CfP, is preparing for its next evolutionary phase to track, perform signal analysis, collect and analyze global GNSS data from these multi-GNSS constellations through an international tracking network experiment.

The objective is to eventually generate consistent, reliable and robust products for all GNSS available, in a fully interoperable manner, to benefit high-precision users, the scientific community, understanding inter-constellation biases, system monitoring and timing applications. IGS M-GEX will lay the groundwork for strengthening of the International Terrestrial Reference Frame (ITRF) by having contributions from all GNSS. The IGS M-GEX CfP is located at <http://igs.org> (see the ‘What’s New’ box).

It is important to note that the IGS is simultaneously harmonizing the IGS M-GEX in support of the JAXA CfP titled ‘**Multi-GNSS Demonstration Project for Asia and Oceania**’, endorsed by the ICG-4 in St. Petersburg in 2009.

In addition, the IGS is a component of the Global Geodetic Observing System (GGOS). GGOS recently released a separate CfP that should be of interest to ICG members. GGOS is soliciting proposals for a core network of multi-technique, state-of-the-art geodetic sites (co-located VLBI, SLR, GNSS, DORIS, etc.) to define and improve the Terrestrial Reference Frame and provide essential data for fundamental space geodesy requirements. Please access this companion CfP at <http://www.ggos.org>

Discussion/Analyses:

Main objectives of the IGS M-GEX are to:

- Encourage and promote the international utilization of the available GNSS systems to observe, collect and analyze the collection of signals;
- Provide an international framework within the well established organization of IGS to operate an experimental network for multi-GNSS;
- Stipulate that a common format is needed for all experiment data, hence, RINEX 3.01 (or the most current update) will be the agreed upon format;
- Promote engineering analysis of inter-constellation signals as a key focus, as well as classic orbit and position determination based on the new signals, and comparison to current IGS products;
- Present and discuss interim results at the IGS 2012 Workshop in Poland, July 23-27, 2012;
- Ultimately explore capabilities of IGS towards monitoring multi-GNSS performance.

And in WG-D discussions in support of Multi-GNSS Asia and IGS M-GEX to:

- Emphasize to receiver manufacturers the importance of implementation of SW for standard format exchange of data (RIINEX and Real-time formats);

- Note that this would further the goals of WG-D ICG-5 Recommendation 9

Experiment Description:

IGS M-GEX will operate February through August 2012. The experiment calls for participating:

- Multi-GNSS Observing Sites
- Multi-GNSS Data Centers
- Multi-GNSS Experiment Analysis Centers and/or Engineering Analysis Centers
- Multi-GNSS Collaborating Organizations and Networks

Detailed information is included in the Cfp.

Recommendation of Committee Action:

It is therefore recommended that the ICG support and endorse the IGS Multi-GNSS Global Experiment (IGS M-GEX) and actively encourage participation and/or contributions from:

- GNSS providers
- Governments, government agencies and international organizations related to GNSS utilization, including National Mapping Agencies (NMOs), timing, navigation, aviation, transportation, GIS, and relevant fields as appropriate in each country
- Appropriate UN bodies
- International organizations, and particularly ICG Associate Members and Observers
- Industries: receiver manufacturer, service providers
- Space Agencies
- Universities and research institutions