

## **Report of Working Group D: Interactions with National and Regional Authorities and International Organizations (in Monitoring, Networks and Reference Frames)**

1. Working Group D (WG-D) met on three occasions throughout the week of the Fourth Meeting of the International Committee on Global Navigation Satellite Systems (ICG-4) on 15, 16 and 17 September 2009 to discuss the WG activities, review the recommendations from the Third Meeting of ICG (ICG-3) and to have the first full meetings of the new Task Forces.
2. The primary focus of the meetings was on the work of the Task Forces on Geodetic References and Timing. Those two Task Forces were established at ICG-3, December 2008, following the ICG's endorsement of Recommendations 1 and 2 of Working Group D. Task Force D1 is on Geodetic References and Task Force D2 is on Time References. The Working Group had a combined meeting with the existing Associate Members already involved in WG-D and the representatives of the GNSS System Providers who have now been appointed to both of the Task Forces, although noting that not all Providers had designated their representatives.
3. The working Group adopted the following meeting agenda:
  - Introductions
  - Review WG-D work plan and action list from ICG-3
  - Review Recommendations from ICG-3
  - Progress on Task Forces
    - a. Geodetic References
    - b. Time References
  - Two New Items:
    - a. Consider the recommendation of Consultative Committee on Time and Frequency (CCTF) as presented by International Bureau of Weights and Measures (BIPM) (Lewandowski) on Monday, September 14
    - b. Discuss the proposed steps for the International Terrestrial Reference Frame (ITRF) as an International Organization for Standardization (ISO) standard as presented by the International Earth Rotation and Reference Systems Service (IERS) (Boucher)

### **Introductions**

4. Introductions were made and the chairs welcomed the new representatives. A list of participants at the various WG-D meetings is in Attachment D.
5. It was noted that only China, Japan and the United States of America have officially nominated expert representatives to both of the Task Forces. However, there were unofficial representatives from the European Union and Russia for both Task Force topics. Unfortunately, India was the only one of the six major Provider Forum members without any representation at the WG-D meetings at ICG-4. There was also discussion of the need for a level of continuity in membership to enable significant progress in the work of the Task Forces.

### **Review WG-D work plan and action list from ICG-3**

6. The chairs noted that several actions for WG D are on-going as cited in the WG-D report from ICG-3. It was also noted that two of the original actions in the ICG November 2006 Work Plan had been transferred to WG-A leadership, specifically:

Action D2: ICG to establish a working group focused on Site Quality, Integrity and Interference Monitoring (SQII);

Action D4: Establish a working group to develop a strategy for ICG support of mechanisms to detect and mitigate sources of electromagnetic interference, taking existing regulatory mechanisms into consideration.

7. For Action D2 – it was noted that WG-D can continue to address issues related to Site Quality and have noted resources available. The other activities are reflected in the Working Group A Draft Work Plan made available to WG-D at ICG-4.
8. In reviewing the WG-D work plan, a number of overlapping areas with the 3 other working groups were noted. However, at this stage of the development of the ICG, there is not yet a clear mechanism for inter-working group activities and coordination. It was further discussed that close coordination with WG-A is important since fundamental interoperability relies heavily on common geodetic and timing references. WG-A as the key working group for the providers is concerned about integrity of the *provision* of the GNSS service, WG-D is concerned about the integrity of GNSS systems from the *user* point of view.

**Review of the list of Recommendations from ICG-3 was considered later**

9. These were considered later in the agenda after discussions about the Task Forces (TF).

**Task Force D1 on Geodetic References**

10. The following is a summary of the issues discussed in relation to Task Force D1 at the various meetings during the week. It should be noted that several presentations during the week (especially at the technical session devoted to WG-D topics) helped to inform discussion at the various WG-D meetings. Those presentations will be made freely available on the ICG Information Portal managed by the United Nations Office for Outer Space Affairs (UN OOSA).
11. It was noted that a description from the providers of the current situation with each system would be useful and documentation of their reference system/reference frame should be encouraged. It was suggested that the WG-A template for system providers to describe their ‘open service’ should include elements that WG-D could develop to assist in documenting that information and making it available to users. This was seen as a useful starting activity in the work plan of Task Force D1.
12. At ICG-3, WG-D made Recommendation #3 about alignment of Geodetic References and synchronization of Time References to international standards. A round table of the GNSS geodetic representatives initiated the discussion on how each System Provider currently approaches realizing the reference system used in their GNSS. It was suggested that WG-D should work to prepare a ‘best practices’ methodology for alignment to ITRF. This may not need to specify how to do, but may be useful to assess level of consistency with ITRF. External comparisons for providers could be a type of ‘validation’. e.g., BIPM publishes the difference between GLObal Navigation Satellite System (GLONASS) and Global Positioning System (GPS) system time.
13. A lengthy discussion at the opening meeting of WG-D also revealed different understandings of what ‘standard’ means.
14. For example, there were initially differences in understanding among Task Force members of the term “alignment to ITRF”. That led to concern from some System Provider representatives that the Associate Members in WG-D were advocating that

providers needed to adopt ITRF specifically in their system. It was agreed that WG-D should recognize that system providers need to maintain, strengthen and retain their specific reference frames (such as Parametri Zemli (PZ-90), World Geodetic System (WGS84), the China Geodetic Coordinate System (CGCS2000), the Galileo Terrestrial Reference Frame (GTRF)), while also explaining how their geodetic reference is related to ITRF and thus also to the geodetic references of other global navigation satellite systems (GNSS).

15. There were some specific comments made by the representative of the Russian Federation on this and other matters of relevance in WG-D (included as Attachment I).
16. There was also discussion later in the week about the need to not only document each realization of the reference system but how the resulting reference frame is maintained over time, e.g. to account for relative movements of Monitor Stations that might be located on different tectonic plates around the globe.
17. There was discussion of the Global Geodetic Observing System (GGOS) and the need to recognize that while GNSS is important for the realization of ITRF, it also requires other non-GNSS space techniques; including Very Long Baseline Interferometry (VLBI) and Satellite Laser Ranging (SLR). The importance of SLR is linked to the WG-D Recommendation to ICG-3 on the desirability of placing retro-reflectors on GNSS satellites.
18. Another topic of discussion was the value of co-location and/or integration of GNSS Monitor Stations with IGS stations. Co-location has been flagged by WG-A as a possibility for consideration in discussions around interoperability. It was noted that fully integrated co-location of multiple systems at a single site might be difficult due to security and independence requirements of individual systems. However, even an improved level of sharing of data from GNSS Monitor Stations to be matched with data from IGS stations could significantly improve integration of geodetic references.

#### **Task Force D2 on Time References**

19. The following is a summary of the issues discussed in relation to Task Force D2 at the various meetings during the week. Again it should be noted that several presentations during the week helped to inform discussion in this agenda item.
20. The first meeting allowed introductions of the Task Force members as well as a general discussion of time references as currently used in GNSS.
21. There was considerable discussion on alternative means of aligning GNSS system times, including discussion of topics such as “near real time Coordinate Universal Time (UTC)”. The various alternatives will be considered in detail as the work of the Task Force progresses.
22. There was also discussion of the need to recognize the interdependence between geodetic and timing references and especially the need to consider Earth Orientation Parameters and their prediction. This highlights the value of having both of the Task Forces operating under the same Working Group.
23. As with the other Task Force, it was felt that it would be useful for Task Force D2 to compile descriptions from the providers of the current situation with the Time Reference used in each system and to add to the WG-A template where system providers describe their ‘open service’. This was seen as a useful starting activity in the work plan of Task Force D2.

#### **Recommendations of the Consultative Committee on Time and Frequency (CCTF)**

24. Lewandowski (BIPM) drew on his presentation to the ICG on Monday 14 September and summarized the recommendations of the CCTF. The CCTF recommendations are listed below (with responsibility as allocated in WG-D):

- CCTF Recommendation #3 On the Weakness of the Present Definition of UTC (Leap Second) (*To be addressed by ICG TF D2 on Time References*);
  - CCTF Recommendation #4 Concerning adoption of a common terrestrial reference system by CGPM (*To be addressed by ICG TF D1 on Geodetic References*);
  - CCTF Recommendation #5 Alignment of Geodetic References and Synchronization of Time references to International Standards (This is similar to ICG WG-D Recommendations at the second meeting of the ICG (ICG-2) and ICG-3 and will need to be addressed by both Task Forces of ICG WG-D).
25. There was considerable discussion of the fact that all member nations of the ICG are signatories to the Metre Convention, which has international treaty status and gives the CCTF its head of power. A presentation on the relevant issues was made by Felicitas Aria of BIPM during the WG-D report to the final plenary of ICG-4 and that presentation will be made available on the ICG Information Portal.
26. The key point is that there is a need for the ICG to consider and respond to these recommendations from the CCTF. Accordingly, WG-D and its Task Forces will consider these CCTF Recommendations with a view to developing a suitable recommendation to the ICG so it can officially respond to these recommendations by the CCTF.

#### **Proposal for ITRF as an ISO Standard**

27. IERS (Boucher) described the concept and process for the International Terrestrial Reference System (ITRS) as de-facto global standard to become an ISO standard noting:
- ITRS has been established for more than 25 years;
  - Currently ITRF is an internationally accepted convention, specification;
  - It is adopted by both the International Union of Geodesy and Geophysics (IUGG) and the International Astronomical Union (IAU), formally described in an IUGG resolution 2007, fully accepted for scientific use, and needs to go beyond this to practical users, extend the adoption beyond science
  - ITRS is included by the Group on Earth Observations (GEO) in its Global Earth Observation System of Systems (GEOSS) in task DA-09-02;
  - ITRS is recognized within the CGPM – General Conference on Weights and Measures, and Consultative Committee for Time and Frequency (CCTF), BIPM.
28. The following objectives can be accomplished to establish an ISO standard:
- Document basic recommended terminology in regard to ITRS/ITRF for greater understanding and communications;
  - Provide a definition of ITRS in agreement with IUGG, IAU;
  - Describe the ways ITRS is realized;
  - Describe the primary realization by IERS (ITRF);
  - Document specific realizations by GNSS providers;
  - Regional and national realizations by geodetic and mapping agencies.
29. The procedure within ISO is to establish a Project Committee (PC) for this purpose and to meet these objectives. France is ready to fund the secretariat of this PC. The project committee is inclusive and will be comprised of:

- Country representatives, through their national standardization agency, which can settle its own national mirror committee to collect input from all interested organizations from the country;
  - Representatives of ISO Technical Committees (TC) (e.g. TC20 on aerospace or TC211 on geographical information);
  - Representatives from international organizations (IUGG, IAU, International Association of Geodesy (IAG), IERS, International GNSS Service (formerly the International GPS Service) (IGS), BIPM, International Civil Aviation Organization (ICAO), International Maritime Organization (IMO), International Cartographic Association (ICA), Centre for Earth Observation Science (CEOS), etc.)
30. It was noted that IAG/GGOS plan to pursue this issue of an ISO Standard on ITRS in their own right. Therefore, it was agreed that while Task Force D1 is just only beginning its deliberations on possible alignment of GNSS Geodetic References to ITRF, WG-D needs to monitor the developments in ISO and to get involved as appropriate.

#### **Progress with Existing Recommendations from WG-D to the ICG**

31. **Recommendations 1 and 2** of WG-D to ICG-3 can now be considered as **complete** with the establishment of Task Forces D1 and D2.
32. **Recommendation 3** of WG-D to ICG-3 should be considered **commenced and ongoing** with responses being developed as a key focus of the work of Task Forces D1 and D2.
33. **Recommendation 4** of WG-D to ICG-3 in relation to the placement of Retro-reflectors on GNSS satellites to enable Laser Ranging **still stands**. As this is primarily an issue for the System Providers to implement, WG-D agreed to:
1. Reaffirm the same Recommendation to ICG-4;
  2. Commend to all Providers the standard developed by the International Laser Ranging Service; available at:  
[HTTP://ILRS.GSFC.NASA.GOV/DOCS/RETROREFLECTOR\\_SPECIFICATION\\_070416.PDF](http://ilrs.gsfc.nasa.gov/docs/retroreflector_specification_070416.pdf) and;
  3. Note and commend the progress made by the Russian Federation on the placement of retro-reflectors to enable laser ranging to GLONASS satellites. (Specifically, this is as in the Presentation by Shargorodsky at ICG-4, which will be made available on the ICG web site).
34. In addition to these recommendations, it was noted that the activities of WG-D are aligned with recommendations stemming from the International Symposium on Global Navigation Satellite Systems, Space-Based and Ground-Based Augmentation Systems and Applications in Berlin, Germany, 11-14 November 2008. Those recommendations from Berlin are in Attachment II and are considered to be consistent with the goals of the broader ICG.

#### **New Recommendation on Multi-GNSS Demonstration Project for Asia and Oceania**

35. The only recommendation from WG-D at ICG-4 in relation to new initiatives was to support Japan's proposal for a Multi-GNSS Demonstration Project in Asia and Oceania.
36. In the Asia and Oceania region there will be signals available from Regional Navigation Satellite Systems, notably those planned by India and Japan, in addition to signals from the GNSS with global coverage. Therefore, Japan (through JAXA) proposed that the

ICG should endorse a project to track as many of the systems as possible and to demonstrate the utility of the extra satellites and their signals. WG-D agreed to support Japan's proposal, which is especially important given the key role to be played by the International GNSS Service (IGS – represented through two of the WG-D Co-Chairs).

37. The full text of the WG-D recommendation is given at Attachment C. It was noted that a similar Recommendation of support was made by Working Group A. The Working Group took note of the information provided by the United States that the Asia Pacific Economic Cooperation (APEC) GNSS Implementation Group (APEC GIT) met in Singapore in 2009. In that regard, the Working Group noted with appreciation of the indication of interest of APEC GIT in establishing a working relation with the ICG, particularly in the area of transportation applications in the Asia Pacific Region. The Working Group further noted that the 14<sup>th</sup> Meeting of the APEC GIT would be held on 21 – 24 June 2010, in Seattle, Washington and that the ICG was invited to present the ICG activities.

#### **Additional Issues**

38. The group discussed additional issues and actions:

##### Accomplished actions:

1. Promote use of IGS guidelines for reference frame requirements, station installation and operation. (<http://igs.org>)
2. Promote use of the University NAVSTAR Consortium (UNAVCO) website for detailed information on GNSS station installation and operation. ([www.unavco.org](http://www.unavco.org))
3. Use existing mechanisms to disseminate information on ICG and its work, e.g., IGS, the International Federation of Surveyors (FIG), European Position Determination Systems (EUPOS) (Joint with WG-C).

##### Ongoing:

4. Consider for future discussion: how geodesy and geodetic observations could be placed on a more legal basis. (See Ihde presentation at ICG-3);
  5. Continue support to realize African Geodetic Reference Frame (AFREF) (See Wonnacott presentation, ICG-3);
  6. Begin support to plans by IAG for a new project on Asia Pacific Reference Frame (AP-REF). This will comment at the FIG Regional Conference in Vietnam in October 2009. This also needs to be linked to the recommendation above on the Multi-GNSS Demonstration Experiment in Asia Pacific area;
  7. Discuss plans for incorporating evolving GNSS and communications, standards and technology;
  8. Discussions with BIPM (Arias and Lewandowski) demonstrate that many are unaware of the treaties that are agreed to by governments with regard to the Convention of the Meter and how this affects ICG and GNSS. (See [www.bipm.org](http://www.bipm.org))
39. At each ICG meeting a Joint Statement is released to summarize the outcomes of the meeting in a statement suitable for use in press releases. The following is the final wording from Working Group D:

*The Working Group D (WG D) on interaction with national and regional authorities and relevant international organizations successfully initiated the work of its Task Forces to develop processes to align and maintain Geodetic and Timing references, which are fundamental to interoperability of GNSS for users.*

*It was also agreed to hold additional workshops in between the annual ICG meetings.*

40. It can be seen that the overall focus of WG-D at ICG-4 was to have the first substantive meetings of the Task Forces D1 and D2 and as such there were not many concrete new outcomes. However, there was a very good spirit of cooperation among all Task Force members allowing open and frank discussion about issues. This is seen as a good sign that these Task Forces will be able to do good work in bringing a new level of cooperation and coordination among the Geodetic and Time References of the GNSS systems, with consequent benefits for all GNSS users.

#### **Next Meetings**

41. It was decided to aim to have future WG-D meetings or follow-on discussions in conjunction with the Munich SATNAV Summit, in early March 2010 and possibly at the European Geosciences Union (EGU) in Vienna, late April 2010, date to be decided.

#### **Updates to WG-D Work Plan and Development of Task Force Work Plans**

42. It was agreed that preparations for coming meetings need to include development of first drafts of Work Plans for the Task Forces to flesh out their Terms of Reference as set out in the Recommendations that established them.
43. There is also a need to incorporate those Task Force Work Plans into an updated overall Work Plan for WG-D.

**ATTACHMENT 1****Input to Working Group D from ROSCOSMOS (Yury Pushkarev)**

In preparation for the ICG meeting the Russian delegation has carefully studied the recommendation drafts prepared for the WG-D meeting. These recommendations were related to international ITRF recognition as an international standard for ground reference frames (including those used by GNSS).

In our view, all geodetic reference frames (including PZ-90.02 which is the one most used by GLONASS) should be coordinated.

In the case of GLONASS it means that PZ-90.02 as a national reference frame will continue to get more accurate and to be further improved.

We consider recognition of ITRF as a specific practical realization of ITRS inexpedient.

Definitions in previous WG-D presentations on ITRF recognition as the only preferred reference frame for geodesy cannot be accepted.

We consider \_\_\_\_\_ collocation (their placement in the same points) expedient for reference frames and time scales interoperability principles fulfillment.

In course of actions of the WG7 International Telecommunication Union (ITU) is to develop recommendations on new UTC time scale definition. Agreement on this subject has not been reached at the last meeting.

Russian delegation considers maximum possible coordination of all national and system UTC realizations (including the time scale used in GLONASS) with the international standard expedient. It is expedient to use the UTC scale developed by BIPM as the international standard in question.

In the case of GLONASS it means that its system time scale will continue to be further improved and will approach UTC with maximum practically possible accuracy in real time.

We consider the suggestion to switch UTC time scale to continuous scale untimely. This subject could be studied in detail no earlier than in 2020.

In connection with this we suggest to continue studying the matters of recommendation drafts of the geodetic reference frames subgroup D1 and system time scales subgroup D2.



## ATTACHMENT II

### **International Symposium on Global Navigation Satellite Systems, Space-Based and Ground-Based Augmentation Systems and Applications, Berlin, Germany, 11-14 November 2008: Recommendations**

#### **Recommendation 1**

**Recognizing** the present status of Global Navigation Satellite Systems (GNSS) and the prospects for continued development of a wide variety of applications critical to science, commerce, and infrastructure, the Symposium participants recommend:

The continuation of forums such as this one; bringing together system providers, geodetic infrastructure providers, end users, and industry.

Furthermore, these forums should be encouraged to discuss and propose specific recommendations for consideration by the International Committee on GNSS (ICG)

#### **Recommendation 2**

**Recognizing** the densification of the ground-based GNSS infrastructure by the EUPOS initiative on the basis of IAG services and Sub-Commissions,

**considering** the varied degree of GNSS ground-based reference infrastructure development among different regions of the world,

**noting** the need to support the effort of African countries to implement a continental geodetic reference frame,

the Symposium participants

**recommend** that the ICG support the development of GNSS ground-based infrastructure in all regions of the world, taking into account the unique conditions present in each

## **Recommendation for Committee Decision**

**Prepared by:** Working Group D

**Date of Submission:** 09/17/09

**Issue Title:** Multi-GNSS Demonstration Project for Asia and Oceania

### **Background/Brief Description of the Issue:**

In Asia Oceania region there are three major global systems:

- Global Positioning System (GPS) (24 SVs in nominal constellation, currently 32 SVs);
- GLObal NAVigation Satellite System (GLONASS) (24 SVs).

And in the future:

- COMPASS (10 => 35);
- Galileo (27 + spare 3 = 30 SVs);

Plus three regional satellite PNT systems:

- Quasi-Zenith Satellite System (QZSS) (3);
- Indian Regional Navigation Satellite System (IRNSS) (7).

New modernized global navigation satellite system (GNSS) signals, multi-frequency and multi-GNSS signals can be utilized earlier here than in other regions in the world

### **Discussion/Analyses:**

Main objectives of the project are to:

- Encourage and promote the introduction and utilization of satellite positioning, navigation and timing services in the Asia and Oceania region through assistance with the integration of GNSS services into their infrastructures;
- Promote new multi-GNSS utilization and applications in the region and feedback needs and requirements related to interoperability from user communities to GNSS providers
- Encourage GNSS provider and users in Asia Oceania region to develop new applications and carry out experiment or demonstration jointly.

Project Description:

The proposed Multi-GNSS observation network has the following features:

- Generate precise orbit and clock offset estimation and prediction, time offset bias among multi-GNSS systems, ionospheric, tropospheric delay, and other beneficial information for experiments
- Provision of multi-frequency, multi-GNSS receivers for the above purposes is being considered by the Japan Aerospace Exploration Agency (JAXA);

- Provides the opportunity to experiment using first QZSS satellite LEX and L1-SAIF signals;
- Requires collaboration with International GNSS Service (IGS) and related organizations, which will also promote the project concept within their communities;
- Requests contributions from other GNSS providers such as provision of receivers and co-locations with monitor stations sites.

**Recommendation of Committee Action:**

It is therefore recommended that the ICG support and endorse the Multi-GNSS Demonstration Project and actively encourage participation and contributions from:

- GNSS providers
- International organization, and particularly ICG Associate Members related to GNSS utilization: IGS, the International Federation of Surveyors (FIG), the International Association of Geodesy (IAG);
- Government agencies and international organizations related to GNSS utilization in Asia Oceania region: Mapping, Transportation, Geographic Information System (GIS), Tourism, and relevant fields in each country, and United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), Asian Development Bank (ADB), etc.;
- Industries: Receiver manufacturer, service providers;
- Universities and research institutes.