



## **ICG WORKING GROUP D REFERENCE FRAMES, TIMING AND APPLICATIONS**

### **Ninth Meeting of the International Committee on GNSS (ICG), Prague, Czech Republic**

#### **WG D MEETING NOTES Tuesday 11 November 2014 Wednesday 12 November 2014**

Co-Chairs: Zuheir Altamimi, Mikael Lilje, Ruth Neilan, Chris Rizos

#### **1. INTRODUCTION**

The Co-Chairs welcomed all to the meeting. Unfortunately Matt Higgins could not attend ICG-9 and Mikael acted on behalf of FIG. Zuheir acted as chair of the meeting and Ruth and Mikael as secretaries. The participants can be found in appendix A. The meeting was split into two days where discussion devoted to Geodetic References were held on Tuesday, Nov 11 and Timing References on Wednesday Nov 12.

#### **2. REVIEW OF MINUTES FROM ICG-8 MEETING**

The minutes from the working group meeting at ICG-8 in Dubai were reviewed. Round-table discussion of the representatives of Providers on the minutes concerning the templates and comments can be found in the meeting notes.

#### **3. TASK FORCE ON GEODETIC REFERENCES**

Discussion on progress with WG-D Recommendations:

##### **Recommendation 13 – International GNSS Service Multi-GNSS Global Experiment – IGS M-GEX**

- ESA - has upgraded their IGS stations to multi-GNSS and support M-GEX.
- BKG - also upgrading HW & SW to manage multi-GNSS analysis
- China – Wuhan, computing orbits for Beidou since 1.5 years
- Russia – no update
- USA/GPS – NGA not involved in M-GEX
- India – no representative at this part of the meeting

##### **Recommendation 15 – Improving the GNSS contribution to the ITRF defining parameters.**

###### Calibrating each satellite antenna before launch

Clarification, the measurements of the phase center of the antenna to center of mass of the satellite. And compare to the estimated values from post-launch orbits.

- Galileo – was requested and is under review.
- GPS – Future GPS will have SLR retro reflectors due to efforts of NGA and NASA and other US agencies.

- GLONASS – Calibrate antennas during factory tests. WG-D requests that the information be made available
- China – Antennas are measured and will continue.
- Japan – no update
- India – no representative

#### Adding retro-reflectors to GNSS satellites

- GPS – will be on GPS III on SV 9, can also estimate on orbit
- Galileo – will be on all Galileo satellites
- GLONASS – already installed.
- China – every satellite carries retro, 14 on orbit each installed.
- India – no representative

#### Studying the possibility and utility of adding an accelerometer to new satellites

GPS – not clear why is needed, as contributions from VLBI, SLR are valued (Malys).

Accelerometer would help to determine geo-center motions (ZA)

#### **Presentations on Recent Developments in Geodetic References;**

The following presentations were made. They are all available on the ICG-9 webpage.

- Transformation to Classical Horizontal Mapping Datums, by S Malys (US)
- System of Geodetic Parameters "Parametry Zemli 1990" (PZ-90.11), by A. Zueva, E. Novikov, D. Pleshakov, I. Gusev (RU)
- Update on Galileo Geodetic Reference Frame, by W Enderle(ESA)
- Study on updating the BDS Terrestrial Reference Frame using BDS observations, by Q Zhao (China)
- Positioning by MultiGNSS: the user point of view based on processing of real data, by A Caporali, (Italy)
- India- quick update by A Banik (India),

During his presentations, Malys proposed a possible recommendation for WG-D to develop and maintain a multi-national authoritative list of horizontal mapping and charting datums that is still in use and that may be encountered by a GNSS user. The decision at the meeting was that ICG WG D is not the correct place for such a list but it should be of interest for others as e.g. ISO, UN GGIM/GGRF.

Discussion of the need for more comprehensive information about new GNSS satellites to improve orbit modeling (Altamimi for M. Ziebart);

Notes need for improved information needed for satellite orbit dynamics modeling. This will comprise a new recommendation from WG-D. The meta data should cover;

- Surface geometry and dimensions
- Surface optical properties
- Nominal attitude model
- Transmitted power in all signals
- Solar panel constructions information
- Position and power of output radiators
- Thermal properties of multi-layered insulations....

The group agreed to formulate a recommendation on these aspects.

#### **Relevant Developments in International Standards Organization (ISO);**

L Hothem reported that ISO TC 211 on Geographic Information are the standards that are relevant for ICG WG-D. The members of the TC 211 are representatives from 36 countries. All the provider nations, and also other organizations as IAG, FIG are members. The ISO Geodetic Registry would become a common source for 'meta-data'. The TS 19127 Geodetic Codes and parameters is currently under review, and in compliance with TS 9111. Technical report due in 2015. Control Body had a number of permanent members, Australia just named John Dawson to the Body and it is chaired by Hothem (USA) and Craymer (Canada).

#### **4. TASK FORCE ON TIMING REFERENCES**

Discussion on progress with WG-D Recommendations:

##### **Recommendation 11 on "Finalization and Publication of Templates on Geodetic and Timing References";**

- GPS: on the web. No update
- Galileo: on the web. No update
- IGS: on the web
- Glonass: The template will be sent to ICG-secretariat in due time for publication
- Beidou: Not ready for publication yet
- QZSS: Not ready yet but will be sent to ICG-secretariat in due time for publication
- India: No representative at the meeting

The following presentations were made. They are all available on the ICG-9 webpage.

- Storage effects on space borne Rubidium Atomic Clocks, by A Binak (India)
- Absolute calibration of GNSS time transfer equipment at CNES, by J Delporte, (EU)
- GLONASS time and UTC, actions for decreasing their offset observed with GNSS receivers, by F Arias, G Petit; (BIPM)
- Progress on works related to the proposed redefinition of UTC, by F Arias , G Petit (BIPM)
- New level of development for the National time scale of Russia, V Palchikov; (RU)
- Improvement of GLONASS Time Synchronization with other GNSS Time, by A. Druzhin, A. Pokhaznikov, A. Tiuliakov; (RU)
- GLONASS Time. A. Druzhin, A. Pokhaznikov, A. Tiuliakov, (RU)
- Progress of BDT and its relationship with UTC/UTCr – H Chunhao, (China)

The Russian delegation noticed that the values published from October and forward are the correct ones concerning the UTC-Glonass Time offset. They presented the correct values later on during the meeting and propose a mechanism to make sure that correct values are presented at the meetings.

#### **5. NEXT STEPS FOR WORKING GROUP D**

Agreement on Recommendations to Plenary of ICG-9.

There will be two recommendations from the Working Group D regarding reference frame (see appendix B);

- ICG support to the UN General Assembly Resolution on the Global Geodetic Reference Frame

- Improving the accuracy of multi-GNSS orbit determination by the IGS, via detailed satellite information

The Working group discussed several opportunities for meetings during 2015 as for example during or in conjunction with.

- ICG planning meetings, February and June, Vienna
- COPOUS, Vienna, UN OOSA, Feb 2-13
- Munich Satellite Navigation Summit, March 24-26
- IGMA Task Force meeting, Xian, May 11-12 (In conjunction with China Satellite Summit Conference)
- ICG-10, Boulder, US

## APPENDIX 1: ATTENDANCE LIST

### Tuesday meeting

Mr Qile Zhao	China
Mr Alak Banik	India
Mr Alessandro Avanzi	Italy
Mr Alessandro Caporali	Italy
Mr Antonio Paolozzi	Italy
Mr Ryuichi Ichikawa	Japan
Mr Ryoichi Kojiroi	Japan
Ms Anna Dorofeeva	Russia
Mr Igor Gusev	Russia
Mr Vitaly Palchikov	Russia
Mr Larry Hothem	US
Mr Stephan Malys	US
Ms Linda Rowan	US
Mr Werner Enderle	ESA
Mr Artur Oruba	EUPOS
Mr Jaroslav Simek	EUPOS
Mr Johannes Ihde	EUREF
Mr Mikael Lilje	FIG
Mr Zuheir Altamimi	IERS
Ms Ruth Neilan	IGS
Mr Chris Rizos	IAG

**Wednesday meeting**

Mr Chunhai Han	China
Mr Wenjun Zhao	China
Mr Alak Banik	India
Mr Alessandro Caporali	Italy
Mr Ryuichi Ichikawa	Japan
Mr Ryoichi Kojiroi	Japan
Ms Anna Dorofeeva	Russia
Mr Andrei Druzhin	Russia
Mr Alexander Grechkoseev	Russia
Ms. Natalia Basha	Russia
Mr Igor Gusev	Russia
Mr Vitaly Palchikov	Russia
Mr Arkadii Tiuliakov	Russia
Mr Larry Hothem	US
Mr Stephen Mitchell	US
Mr Stephan Malys	US
Ms Linda Rowan	US
Mr Alberto Madrazo	GSA
Mr Werner Enderle	ESA
Mr Artur Oruba	EUPOS
Mr Jaroslav Simek	EUPOS
Mr Johannes Ihde	EUREF
Mr Mikael Lilje	FIG
Mr Zuheir Altamimi	IERS
Mr Chris Rizos	IAG
Mr Gerard Petit	BIPM

## Recommendation for Committee Decision (WG-D # 22)

**Prepared by:** ICG WG-D

**Date of Submission:** November 13, 2014

**Issue Title:** ICG support to the UN General Assembly Resolution on the Global Geodetic Reference Frame

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

Considering

- The importance of geodesy and the global geodetic reference frame for scientific and societal applications;
- The important contribution of GNSS to location-based services in general and to the International Terrestrial Reference Frame in particular;
- The ICG mission and vision;

### **Discussion/Analyses:**

The Committee of Experts of the United Nation Global Geospatial Information Management (UN-GGIM) has established a Working Group on the Global Geodetic Reference Frame (GGRF), tasked to draft (1) a text of a UN General Assembly Resolution, (2) an associated Concept Note, (3) Terms of Reference of the WG, and (4) establish a geodetic roadmap. At its 4<sup>th</sup> session held in New York in August 2014, the UN-GGIM Committee of Experts has adopted the draft text of the resolution prepared by the WG on GGRF and submitted it to ECOSOC for further referral to the General Assembly of the United Nation for adoption.

### **Recommendation of Committee Action:**

The ICG WG-D recommends that the ICG Providers' Forum consider supporting the approval by the UN-GGIM Committee of Experts of the draft resolution on Global Geodetic Reference Frame for Sustainable Development and its submission to the UN General Assembly.

**Members Consensus Reached** \_\_\_\_\_ ; **No Consensus Reached** \_\_\_\_\_

**Chairperson Signature:** \_\_\_\_\_ **Date:** \_\_\_\_\_

## Recommendation for Committee Decision (WG-D # 23)

**Prepared by:** ICG WG-D

**Date of Submission:** November 13, 2014

**Issue Title:** Improving the accuracy of multi-GNSS orbits determination by the IGS

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

Considering

- several global navigation satellite systems (GNSS) exist and that each is continuously expanding and improving,
- the importance of improving the ITRF defining parameters for earth science and positioning applications
- the importance of the GNSS contribution to the ITRF from the IGS,
- the importance of the accuracy of the GNSS orbits determined by the IGS and their impact on the IGS products, and subsequently on the ITRF;
- the necessity of improving the orbit dynamics modelling of GNSS satellites by the IGS

### **Discussion/Analyses:**

The knowledge of GNSS satellite structure, geometry, dimensions, among other satellite data is fundamental to improving orbit modeling and accuracy.

### **Recommendation of Committee Action:**

The ICG WG-D recommends that the GNSS Providers consider the possibility of making available the following list (or a sub-set) of satellite data for better orbit dynamics modeling:

#### **Primary list:**

- Surface geometry and dimensions
- Surface optical properties (or material types)
- Nominal attitude model
- Transmitted power in all signals (and direction if relevant)
- Solar panel construction information (thickness, conductivity, power draw)
- Position and power output of radiators
- Thermal properties of multi-layered insulation

#### **More detailed list:**

- Structural data/drawings of the satellite, with dimensions (surface only – we don't need the internals)
- Optical properties (reflectivity, specularity) of the surface materials



- Identification of what is covered in multi-layered insulation (MLI) or ‘thermal blankets’
- Attitude model of the satellite
- Power of all transmitted signals (note we don’t need to know anything about function of the signals, only which way they are pointed, and how much power is transmitted)
- Construction data of the solar panel (material types, thickness, conductivity, surface properties – reflectivity, specularity, emissivity, power draw from the panel)

**Other necessary information:**

- Centre of mass location
- Change of centre of mass over time (manoeuvres)
- Location of antenna reference point
- Phase centre offset for all frequencies w.r.t. antenna reference point
- Phase centre variation as function of azimuth and elevation
- Knowledge about the epoch of change of the attitude mode (e.g. for QZSS and BeiDou that switch from Yaw-steering to normal-mode)
- Attitude of the satellite as measured/computed on board (i.e. those values used by the attitude control system)
- Differential group delays between the different signals (on board of the satellite): can be measured pre-launch

**Members Consensus Reached** \_\_\_\_\_; **No Consensus Reached** \_\_\_\_\_

**Chairperson Signature:** \_\_\_\_\_ **Date:** \_\_\_\_\_