

## **The IGS GNSS Working Group – Charter and Plans**

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### **Introduction**

With the imminent introduction of new civilian signals in GPS, the development of the GALILEO system, and the modernization of GLONASS the IGS is facing a changing situation. It is essential that the implications for the service are fully analyzed and that the new factors affecting its operations are duly taken into account in IGS strategic planning. In this context an IGS GNSS Working Group has been created begin of 2003 to explore potential contributions to IGS products through the use of GALILEO, modernized GPS and modernized GLONASS Signals. Moreover the WG should prepare a consolidated feedback to GALILEO developments based on relevant IGS experience in specific areas such as receiver site selection, installation and maintenance. A stated goal is to pave the way for fully integrated GNSS data products, comprising orbits, clock offsets, stations coordinates and tropospheric delays available very close to real time.

### **Principal Objectives**

The list of overall objectives of the WG comprises:

- Bring knowledge about the developments of GALILEO and GPS to the attention of the various participating elements of the IGS through reports and dedicated sessions in IGS workshops (GLONASS is the concern of a dedicated IGS Pilot Project).
- Prepare a consolidated feedback to GNSS system engineering based on relevant IGS experience of providing highest accuracy products for the existing systems, with some emphasis on calibration characterisation issues such as the role of SLR, estimation of inter-frequency biases, and timing.
- Prepare a consolidated feedback to GALILEO developments based on relevant IGS experience in specific areas such as receiver site selection, installation and maintenance.
- Document the potential contributions of the IGS to reference frame establishment and maintenance for GALILEO (e.g. interface to a GALILEO “Geodetic Reference Service Provider”) and actual/potential contributions for GPS.
- Assess how the IGS infrastructure could be harnessed to participate in the validation of the new systems, for example by receiver deployments and data analysis in the early phases, in line with the Galileo System Test Bed GSTB activities conducted by ESA.
- Contribute to standardisation of products (orbits, clocks, other corrections) and coordination of extensions to existing exchange formats (RINEX, ...).
- Prepare a plan for these activities and a strategy for possible IGS participation in the longer term exploitation of the next generation of GNSS.

### **How to accomplish these goals**

To accomplish these goals two studies are in preparation which focus on the benefits and problems IGS Analysts have to deal with when processing dual or triple system GNSS data in parallel. Topics of this studies are ‘**Anticipated Improvements in IGS Products**’ (impact study based on interoperable systems, additional signals, future services) and, on the other hand,

**‘Standardization Issues’** investigating if currently used formats are applicable for post-processing and real-time distribution of IGS products based on interoperable systems and additional signals. In this context the WG should coordinate closely with, and seek inputs from other relevant IGS WG’s (in particular the Ionosphere, Troposphere, Timing and IGLOS groups/pilot projects) as appropriate.

A major field of activity, if not to say the primary field, is to establish information exchange and stimulate cooperation between IGS and entities involved in the administration and technical set up of GALILEO as well as modernization of GPS and GLONASS. Information exchange can be performed at regular meetings with system administration entities, via presentations at scientific meetings or via the Web-Page of the WG. A first step in this direction has been done by preparing a list of recommendations to GALILEO System Design based on relevant IGS experience. The list points to various fields like orbit determination or reference frame alignment. The introductory statement and some topics are briefly highlighted below, a complete version can be obtained from the WG’s Web-Page:

There is a strong interest in the IGS community in ensuring that the GALILEO system is able to make a major contribution to scientific and other applications requiring very high positioning accuracy. In this context interoperability between GPS, GLONASS and GALILEO is a key issue.

#### **Reference Frame**

The GALILEO Reference Frame (GRF) should be as close as possible to the most recent realization of ITRS. In order to collocate the GRF to ITRF the IGS asks for a proper calibration of GRF Reference Station Antennas and for providing that data to the scientific community.

#### **Orbit Determination**

The IGS asks for a proper calibration of GALILEO and modernized GPS satellite antennas (before launch) and for providing that data to the scientific community.

Provide information to determine reliable a priori radiation pressure models for all types of test- and operational GALILEO space vehicles.

Equip GALILEO space vehicles with adequate sized retro-reflectors used for a system independent orbit determination.

#### **GALILEO System Test Bed**

Involve IGS in the early evaluation of SIS and prototype Receivers in GSTB V2.

#### **Interface to IAG Commissions and Services**

The new structure of IAG, implemented at the past IUGG General Assembly in August 2003 (Sapporo), provides that Services and Commissions at the same level within the IAG-hierarchy. Furthermore it allows Working Groups (respectively Study Groups) to belong to an IAG-Commission as well as to a special Service in case the goals of the WG are of interest to both bodies. In this context the IGS GNSS Working Group has been closely linked to (joint with) the IAG IC Study Group 1.2 on the **‘Use of GNSS for Reference Frames’**. This implies that a branch of the WG belongs to IAG Commission I aiming at the use of Global Navigation Satellite Systems for the definition and densification of the global International Terrestrial Reference Frame (ITRF). The topics to be studied by this group are:

- Document the potential contributions of Global Navigation Satellite Systems to reference frame establishment and maintenance.
- Investigate the ties and their time evolution between GNSS Broadcast Frames like WGS84, PZ-90 and the upcoming GALILEO Reference Frame, and the ITRF.
- Examine deficiencies in the stability of the global GNSS station network, especially focusing on stations contributing to the ITRF2000 catalogue.
- Prepare a consolidated feedback concerning GPS, GLONASS and GALILEO frame establishment and improvement based on relevant experience in areas such as receiver site selection, installation and maintenance.
- Investigate the individual strengths and shortcomings of GPS, GLONASS and GALILEO for Reference System Realisation and work out synergies.
- Study the ties of regional and local frames realized by a permanently increasing number of active real-time GNSS networks.

Besides Commission I also IAG Commission 4 on 'Positioning and Applications' is interested in the WG's activities. Therefore the IAG SG 1.2 has been setup as an Inter-Commission (IC) Study Group. Further links to Commission 4 were established, in special to Sub-Commission 4.5 on 'Next Generation RTK' and to WG 4.5.3 on 'Carrier Phase Based Precise Point Positioning'.

## **Conclusion**

From 2005/2006 the GPS constellation will comprise a gradually changing mix of satellites transmitting the standard and the new signals. Also GLONASS upgrades the orbit constellation both in number and type of satellites. The implications for the ground infrastructure have to be properly assessed. New receiver types will have to be introduced into the IGS network and there will be new requirements on software for handling the data in the Analysis Centres.

Similarly the signals to be generated by GALILEO will need new developments in ground and space receivers and modified algorithms for data processing. The IGS experience of the International Glonass Experiment IGEX and the IGLOS (International GLONASS Service) Pilot Project will assist in minimizing the impact of these changes on the service operations and in integrating the new features into the IGS infrastructure to the advantage of users of the IGS products.

The design of the GALILEO system and its specifications are not yet finalised, and both the accuracy and long-term stability of the system can still be improved. The IGS GNSS WG can be one means to transfer IGS knowledge concerning high accuracy applications into the decision process for the GALILEO specifications and system design.

Up to now the operating satellite navigation systems allow a huge user community an easy access to reference frames very close to the most recent realization of the ITRS. The IAG Services IERS (International Earth Rotation and Reference Systems Service) and IGS (International GPS Service) provide the necessary products to tie these frames to the ITRF, which is based upon a set of estimated coordinates and velocities of stable stations observed by all space techniques. The design of the upcoming GALILEO system, its envisaged accuracy and the long-term stability implies, that also GALILEO will become a highly valuable technique for the ITRF. Therefore another (clearly overlapping) subgroup of the WG will look at the IGS product suite for research topics related to the use of Global Navigation Satellite Systems for the definition and densification of the International Terrestrial Reference Frame (ITRF).

The Working Group Web-site can be accessed via

[http://www.hg.tuwien.ac.at/forschung/satellitenverfahren/GNSS\\_WG\\_IGS/GNSS\\_WG\\_IGS.htm](http://www.hg.tuwien.ac.at/forschung/satellitenverfahren/GNSS_WG_IGS/GNSS_WG_IGS.htm)

