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GGOS Bureau of Networks and Observations

Director: **Michael Pearlman** (USA)

The Bureau of Networks and Observations develops a strategy to design, integrate and maintain the fundamental infrastructure in a sustainable way to satisfy the long-term (10-20 years) requirements identified by the GGOS Science Panel. Primary emphasis must be on sustaining the infrastructure needed to maintain the evolving global reference frames, while at the same time ensuring the broader support of the scientific applications of the collected data. Coordinating and implementing the GGOS co-located station network is a key focus for the Bureau.

GGOS Bureau of Networks & Observations

- IAG Service Network Representatives
- Committee on Performance Simulations and Architectural Trade-offs
- Committee on Data and Information
- Committee on Satellite Missions

Structure

Director: *Michael Pearlman* (USA);
Secretary: *Carey Noll* (USA)
Analysis Representative: *Erricos Pavlis* (USA)

Members:

PLATO Committee:	*Daniela Thaller* (Germany) *Benjamin Männel* (Germany)
Missions Committee:	*Roland Pail* (Germany) *C.K. Shum* (USA)
Data and Information:	*Nicholas Brown* (Australia) *Carey Noll* (USA)
IGFS:	*Riccardo Barzaghi* (Italy) *George Vergos* (Greece)
IVS:	*Hayo Hase* (Germany) *Dirk Behrend* (USA)
ILRS:	*Toshi Otsubo* (Japan) *Jean-Marie Torre* (France)
IGS:	*Allison Craddock* (USA) *Gary Johnston* (Australia)
IDS:	*Jérôme Saunier* (France) *Guilhem Moreaux* (France)
Tide Gauges:	*Elizabeth Bradshaw* (UK) *Lesley Rickards* (UK) *Richard Gross* (USA)

In addition, the IERS Working Group on Site Survey and Co-location also participates in the BN&O activities; this Working group is now in the process of reorganization with *Ryan Hippenstiel* / NOAA as Chair.

Objectives

The Bureau of Networks and Observations (BNO) supports the networks capability available to the IAG in its goal to provide geodetic data products of sufficient quantity, quality and temporal and spatial resolution to improve our understanding of the dynamic Earth for both scientific understanding and societal needs. Fundamental to achieving reaching this goal is the maintenance and further development of the globally available terrestrial and celestial reference frames, which are the basis for our metric measurements over space, time, and evolving technology.

The BN&O advocates for implementation of the global space geodesy network of sufficient capability and geographic coverage to achieve data products essential for

GGOS and serves as a coordinating point for the Services to meet, discuss status and plans, and examine common paths for meeting GGOS requirements. Committees and working groups are included in the Bureau in recognition of their synergistic role with Bureau activities.

The role of the BNO is to:

- Advocate for the expansion and upgrade of the space geodesy network for the maintenance and improvement of the reference frame and other GGOS priorities; Main focus will be on the Reference Frame; but the other applications need to be accommodated;
- Encourage partnerships to build and upgrade network infrastructure
- Organize and expand the GGOS affiliated network;
- Monitor network status; projected network evolution based on input from current and expected future participants, estimate performance capability 5 and 10 years ahead;
- Conduct simulation studies and analyses to assess impact on reference frame products of: network configuration, system performance, technique and technology mix, co-location conditions, site ties, and network trade of options (PLATO);
- Develop Metadata Systems for a wide range of users including GGOS; near term strategy for data products (Carey Noll at GSFC) and a more comprehensive longer-term plan for an all-inclusive system (Nick Brown at GA) (Committee on Data and Information);
- Provide the opportunity for representatives from the Services and the Standing Committees to meet and share progress and plans; discuss issues of common interest; meetings at EGU, AGU, GGOS Days, etc.;
- Talks and posters on the Bureau at EGU, AGU, JPGU-AGU, AOGS meetings, etc.;
- Letters/documentation to support stations, current/ new missions, and analysis centers;

Tasks

- Continue recruiting station membership in the GGOS Network through the CfP; issue membership certificates (great response);
- Continue monitoring network status and plans; develop next network projection status for 5 and 10 years ahead;
- Provide next update of the "Guideline for GGOS Core Sites and Co-locations Sites" document;
- Work with the IGFS and IHRF, the PSMSL and the other services to integrate relevant parameters from other ground networks (gravity field, tide gauges, etc.) into the GGOS network to support GGOS requirements including the reference frame, a unified height system, etc.; advocate for installation of GNSS receivers at appropriate tide gauges; Global Geodetic Observing System (GGOS)
- Support the technique Services on the promotion of recommended technologies/configurations and procedures in the establishment of new sites and the upgrading of current sites, and in the evaluation of performance of new stations and new capabilities after they become operational;
- Continue simulation and trade-off studies for network options (PLATO Committee)
- Continue metadata systems development; target phase 1 (data products) for 2020 (Committee on Data and Information)
- Improve communication and information exchange and coordination with the space missions; (Committee on Satellite Missions)
- Work with the IERS Working Group on Site Survey and Co-location to improve the quality of site ties and instrument reference points:
- Continue BNO meetings to meet, discuss status and plans, and examine common interests and requirements;
- Continue presentation at international meetings in BNO activities and plans;
- Continue providing letters and documentation support
- Update the Bureau web pages for public use (to be compatible with the new GGOS website in process;

Committees of the Bureau of Networks and Observations

BNO C1: Committee on Performance Simulations and Architectural Trade-Offs

(joint with IAG Sub-Commission 1.1)

Chair: *Daniela Thaller* (Germany)
Vice-Chair: *Benjamin Maennel* (Germany)

Objective

The PLATO Committee / Working Group has currently 12-member groups working on simulations and data analysis covering the full range of existing ground and space assets, including VLBI, SLR, GNSS, and DORIS. The main focus is on how do we use existing observation capabilities (stations, observation concepts, tracking performance, etc.) including co-location in space with existing and new dedicated satellites to best support GGOS planning and implementation.

Project future network capability and examine trade-off options for station deployment and closure, technology upgrades, the impact of site ties, additional space missions, etc. to maximize the utility of the GGOS assets:

- Use simulation techniques to assess the impact on reference frame products of network configuration, system performance, technique and technology mix, colocation conditions, site ties, space ties (added spacecraft, etc.), analysis and modeling techniques, etc.;
- Use and developing improved analysis methods for reference frame products by including all existing data and available co-locations (i.e., include all satellites and use all data types on all satellites);
- Make recommendations on network configuration and strategies based on the simulation and trade-off studies.

Investigations that are being included in the PLATO activity include studying the impact of:

- The full range of existing ground and space assets:
  - GNSS assets (ground and space)
  - SLR (beyond Lageos-1 and -2) including ranging to GNSS satellites;
  - LLR assets
  - VLBI assets including tracking of GNSS satellites;
  - Co-located assets in space (e.g. GRACE, OSTM/Jason-2)
  - Mixture of existing legacy stations and simulated next generation stations
  - Improved GNSS antenna calibrations and clock estimation strategies (GNSS alone or when in combination with SLR, VLBI, and DORIS)
- Anticipated improved performance of current systems:
  - Simulate the impact of upgrading existing stations and their procedures
  - Simulate the impact of additional ground surveys at colocation sites (site ties)
- Potential future space assets: - Co-locate all four techniques in space on a dedicated satellite

Tasks

- Examining trade-off options for station deployment and closure, technology upgrades, the impact of site ties, etc. and project future network capability based on network configuration projected by the BNO or relevant IAG services (IGS, ILRS, IVS, IDS);
- Investigating the impact of improved SLR tracking scenarios including spherical satellites, LEOs, and GNSS satellites and VLBI satellite tracking on reference frame products;
- Identifying technique systematics by analyzing short baselines, data from new observation concepts, and available co-locations (e.g., consistent processing of LEO and ground-based observations);
- Investigating the best-practice methods for co-location in space and assessing the impact of co-location in space on reference frame products based on existing satellites and by simulation studies for proposed missions.

BNO C2: Committee on Data and Information

Chair: *Nicholas Brown* (Austria)
Vice-Chair: *Carey Noll* (USA)

Objectives

The Committee on Data and Information had two GGOS objective areas:

- Development and implementation of a portal;
- Development and implementation of a metadata scheme

Initial work on the portal was done by *Bernd Richter*. When he retired, the task was transferred to the GGOS Coordinating Office.

Near term Metadata activity (Carey Noll/CDDIS)

CDDIS is implementing collection-level metadata through the Earth Observation System Data and Information System (EOSDIS) Common Metadata Repository (CMR). CDDIS is an EOSDIS Distributed Active Archive Centers (DAACs) and thus utilizes the EOSDIS infrastructure to manage collection and granule level metadata describing CDDIS archive holdings; these metadata include DOIs associated with the CDDIS archive contents. The CMR is accessible through APIs and can be used in the future by GGOS to find geodetic data and products available through the CDDIS.

Longer-Term Metadata activity (Nick Brown / Geoscience Australia)

Development of a Geodesy Markup Language (GeodesyML), for the GNSS community; potential for expansion to the other space geodesy techniques and GGOS. The current study is identifying metadata standards and requirements, assessing critical gaps and the how these might be filled, what changes are needed in the current standards, and who are the key people who should work on it (more comprehensive scheme). The schema that would be used by its elements for standardized metadata communication, archiving, and retrieval. First applications would be the automated distribution of up-to-date station configuration and operational information, data archives and catalogues, and procedures and central bureau communication. One particular plan of great interest is a site metadata schema underway within the IGS Data Center Working Group. This work is being done in collaboration with the IGS, UNAVCO, SIO, CDDIS, and other GNSS data centers. The current activity is toward a means of exchange of IGS site log metadata utilizing machine-to-machine methods, such as XML and web services, but it is expected that this will be expanded to the other Services to help manage site related metadata and to other data related products and information. Schema for the metadata should follow international standards, like ISO 19xxx or DIF, but should be extendable for technique-specific information, which would then be accessible through the GGOS Portal.

Tasks:

Activities underway at CDDIS:

1. Complete collection level metadata related to CDDIS data and product holdings in the EOSDIS Common Metadata Repository (CMR)
2. Re-ingest CDDIS data holdings in order to extract granule level metadata linked to new collection level records

Activities underway in Geodesy Markup Language (GeodesyML) System

1. Review and document the metadata and standards requirements of precise positioning users in expected high use sectors (e.g. precision agriculture, intelligent transport, marine, location-based services etc.).
2. Assess and document the critical gaps in standards which restrict how Findable Accessible Interoperable and Reusable (FAIR) precise positioning data is for the expected high use sectors.
3. Record use cases of standards being applied well and the benefits it provides to users.
4. Review the "use cases" of geodetic data developed by Geoscience Australia and the IGS Data Center Working Group and document what work and time would be required to ensure these use cases can be met in international standards. This could be:
   - Identify which gaps can be filled by GeodesyML
   - Identify which components of GeodesyML would be better, handled by / integrated with, existing standards (such as TimeSeriesML, SensorML, Observations and Measurements) where possible.
   - Identify which components of already existing international geospatial infrastructure can be approached (such as the European Inspire initiative)
   - Advise on who we should engage with from the OGC/ISO community to facilitate a change to a standard to meet our requirements.
5. Work with Project Partners to develop and test other use cases (e.g. integration of geodetic data with geophysics data (e.g. tilt meters), Intelligent Transport Sector data, mobile applications). Then, document what work and time would be required to ensure these use cases can be met in international standards.
6. Provide advice on how to best engage with the right communities to learn from their experiences, test their tools and influence the development of required standards.

BNO C3: Committee on Satellite Missions

Chair: *Roland Pail* (Germany)
Vice-Chair: *C.K. Shum* (USA)

Objectives

Improve coordination and information exchange with the missions for better ground-based network response to mission requirements and space-segment adequacy for the realization of GGOS goals

- Advocate, coordinate, and exchange information with satellite missions as part of the GGOS space infrastructure, for a better ground-based network response to mission requirements and space-segment adequacy for the realization of the GGOS goals.
- Assess current and near-future satellite infrastructure and their compliance with GGOS 2020 goals;
- Support proposals for new mission concepts and advocate for needed missions;
- Interfacing and outreach with other components of the Bureau; especially the ground networks component, the simulation activity (PLATO), as well as the Bureau of Standards and Products.

Tasks

- Continue the regular activities, i.e. updating the two central lists, supporting future satellite missions, etc.
- Work with the Coordinating Office to set up and maintain a Satellite Missions Committee section on the GGOS website;
- Evaluate the contribution of current and near-term satellite missions to the GGOS 2020 goals;
- Work with GGOS Executive Committee, Focus Areas, and data product development activities (e.g., ITRF) to advocate for new missions to support GGOS goals;
- Support the Executive Committee and the Science Committee in the GGOS Interface with space agencies;
- Finalize and publish (outreach) of Science and User Requirements Document for future gravity field missions.
- Increase the exchange and collaboration with PLATO; set up a more formal procedure of collaboration; discuss needs and run simulations to study the impact of future satellite missions, identify gaps for fulfilling the GGOS goals, etc.