# IAG Services in the Current Framework of the International Association of Geodesy (IAG)

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## ABSTRACT

It is generally acknowledged that *services* play an essential role in geodesy and, consequently, in the International Association of Geodesy (IAG). Services are not a recent invention within the IAG. They accompany the Association since its creation.

Services in general (not only within IAG) are (should be) created if a well defined user community can be identified needing well defined products. Recent examples within the IAG are the creation of the International Earth Rotation Service (IERS) in 1987 and the creation of the International GPS Service (IGS) in 1991 (officially approved by IAG in 1994).

The IGS and the IERS are probably the best known IAG services with an impact reaching far beyond geodetic applications. There are many more services within IAG, however.

In our analysis we first characterize a scientific service, then we comment the current situation of IAG(-related) services; as a case study we briefly review the activities of the IERS and the IGS. We conclude with some thoughts concerning the future role of the IAG services.

## 1. Characterization

Let us try to characterize a scientific service with a few keywords:

- The word *Service* implies that there is a well defined *set of products* and a sizeable *user community.*
- Services should be based on a long-term need. Nobody should create a service for just a few years. Decades are the basic time unit.
- *Accuracy, reliability, robustness,* and *timeliness* are the essential characteristics for the *operational aspects* of the service.
- In a scientific services scientists are the most demanding part of the user community. Science is thus an important aspect within the IAG services.
- In a scientific service there must be a clear distinction between *operational* and *research-oriented* aspects in order not to disturb the generation of a well defined set of products.

What makes a scientific service successful? This question is delicate to answer. Let us give a few conditions that have to be met:

- Meeting the user community's requirements has to be the first priority.
- The interactions between the most demanding part of the user community, in the case of the IAG Services the scientific community, and the service must be regular and intensive.
- *Long time series* are of crucial importance in the geosciences. This is why
  - archiving the service's products (raw data also must be considered data in this context),

– providing easy access to the products

must be of primary concern to the services. This may even be the most important aspect of a particular service.

- If the community is broad, the products have to be easily understood and used.
- *Redundancy* is an important keyword for the long lasting success of a service. Redundancy is required on the observational side (to mitigate instrument and operator failures) *but also* on the analysis side.
- Competition between different analysis groups is an essential driver for the quality of the service's product (see also discussion in section 3).

## 2. Status Quo

The structure, tasks, composition and work of the IAG services is documented every four years in the *Geodesist's Handbook* (latest version issued in 1996, new version to be issued in the year 2000) and in the *Travaux de l'Association Internationale de Géodésie*.

It became clear in recent years that the IAG services play an increasingly important role in the IAG framework. This is why Prof. Ivan Mueller was asked to organize a special session at the IAG Scientific Assembly in Rio de Janeiro in July 1997 giving all IAG Services the opportunity to describe their achievement, in particular their products and their "customers". This session is very well documented in Mueller (1998). The booklet gives a concise overview of the current situation.

The IAG Services are very different in nature: They may consist of single institutions, as in the case of the BIPM (Bureau International des Poids et Mesures) or the PSMSL (Permanent Service for Mean Sea Level), or of a loose collaboration of a great manifold of organizations, as in the case of the IGS, the IERS, and the other Space Geodetic Services.

The IAG Services have an impact on a broad user community: Atomic time and frequency, as generated and disseminated by the BIPM, is of greatest importance not only in the geosciences but also in physics and in data transmission. The terrestrial and celestial reference frames, as realized and maintained by the IERS are fundamental in all geosciences, in astronomy, but also for setting up new navigation satellite systems (we think, e.g., of the plans for the European GALILEO system). The technique specific services IGS, ILRS, and IVS are not only of vital importance as suppliers for the IERS but they have greatest impact on navigation, atmosphere sciences, geodynamics, etc. The BGI (Bureau Gravimetrique International) and the IGeS (International Geoid Service) have a major impact on space missions and on industry.

Table 1 lists the currently existing IAG services. The table is taken from Beutler et al. (1999) where the structural aspects of the services are discussed.

Table 1 illustrates that the bandwidth of IAG services is broad indeed, covering pure documentation (e.g., the IIS and the IBS) and services dealing with almost the entire range of geodesy and geodynamics (like *IERS, IGS, IGeS, BGI, and ICET*). Services, like, e.g., the PSMSL are truly interdisciplinary in nature.

| **Service/Section** | **Short Title** |
|---|---|
| IGS/II | Intl. GPS Service |
| IVS/II | Intl. VLBI Service |
| ILRS/II | Intl. Laser Ranging Service |
| BGI/III | Intl. Gravimetric Bureau |
| IGeS/III | Intl. Geoid Service |
| IERS/V | Intl. Earth Rot. Service |
| BIPM/V | Intl. Bureau of Weights and Measures |
| ICET/V | Intl. Centre for Earth Tides |
| PSMSL/V | Permanent Service for Mean Sea Level |
| IBS/— | IAG Bibliographic Service |
| IIS/— | IAG Information Service |

Table 1: The Current IAG Services

In Table 1 the services are arranged according to the IAG Sections. It is immediately clear that this principle of ordering is not a very logical one. The technique-oriented services associated to Section II are in practice very closely related to the IERS in Section V.

# 3. Two Case Studies: The IERS and the IGS

Modern services go far beyond the *product/-customer*-driven concept. Let us try to explain briefly the principles underlying the *IERS (International Earth Rotation Service)* and the *IGS (International GPS Service)* in order to understand their success.

Both services have clear and relatively simple mission statements. They take a very broad a view when trying to accomplish their mission. The IERS mission is to establish and maintain the ICRF (International Celestial Reference Frame), the ITRF (International Terrestrial Reference Frame), and to determine the best possible time series of transformation parameters between the two frames. These transformation parameters are called Earth Rotation/Orientation Parameters (ERPs). The frames and the transformation parameters are meant to have state-of-the-art accuracies. This demand implies that the observation techniques may change in order to always use the most promising observation techniques. In 1987 the IERS started with VLBI (Very Long Baseline Interferometry), SLR (Satellite Laser Ranging), and LLR (Lunar Laser Ranging) as primary observation techniques. Later on GPS (Global Positioning System) and DORIS observations were accepted as official IERS observation techniques. It is of vital importance for the IERS that different observation techniques are used.

The IERS generates combined products from the technique specific series of coordinates, transformation parameters, etc. This very ambitious task can only be addressed through an intensive collaboration of all relevant scientific organizations. Regular workshops organized by the IERS, technical and annual reports, the maintenance of a set of IERS analysis conventions document the work performed within the service and the progress made.

Through the creation of the IERS Bureau of Atmospheric Angular Momentum (AAM) and the recently created Global Geodynamic Fluids Center the IERS documents that it wants to take into account all geodynamical aspects related to Earth rotation. It is this holistic approach which guarantees the success of the service and the value of the IERS products.

The mission statement of the IGS is simple, as well. As opposed to the IERS the IGS is based on a single technique, namely Global Positioning System (GPS). Archiving and making available raw observations from its global network, generating and making available products like satellite ephemerides, station coordinates, etc., are primary duties of the IGS.

It is again the holistic approach centered around the primary mission which guarantees the value of the service: After having accomplished its primary duties (making available raw observations and highly accurate orbits) the IGS soon started exploiting all scientific aspects inherent in the GPS observations. Contributions to the IERS through high resolution ERP series and through sets of station coordinates and velocities, but also ionosphere mapping, GPS meteorology, time and frequency transfer, and spaceborne applications of the GPS are but a few keywords indicating the broad field of science and application covered today by the IGS.

The reliability and robustness of IGS products is based on a global tacking network sponsored by many international agencies (a fair degree of redundancy proved to be very useful in the past when instrument or data transfer failures related to single contributors occurred), on a fair number of IGS Analysis Centers (a friendly competition between these centers was and is extremely beneficial for the quality of IGS products), and last but not least on the generation of official IGS products based on the individual contributions of the IGS Analysis Centers.

The IGS makes a clear distinction between service-related aspects (documented by regular reports in the electronic IGS report series) and scientific aspects dealt with in working groups or pilot projects.

Annual reports, technical reports, proceedings of workshops document the work of the service and the progress made on the operational and scientific side.

Let us try to summarize the essential characteristics of services of the kind of the IERS and the IGS:

- Clear mission statements and a broad and holistic approach to accomplish the mission are mandatory.

- *Reliability, robustness, timeliness, proper interfacing with the user community, optimization of the performance* are essential for

the service-oriented activities within the service.

- Research-oriented activities *within* the service primarily address the following areas:
  - Improvement of the *classical products* of the service, optimization of the production of these products,
  - exploitation of the full potential of the *raw material (input)* the service is dealing with, and, if appropriate
  - establishment of *new sets* of products.
- *Originality, openness for scientific collaboration* with other IAG entities (currently other IAG services, commissions, study groups, etc.) proved to be essential in this context.

Opportunities for collaboration in research were sought by both IAG entities. Let us mention the establishment of the AAM Bureau and the creation of the Global Geodynamic Fluids Center as excellent examples for such research-oriented activities within the IERS. The establishment of the IGS/BIPM Working Group on Time and Frequency Transfer using GPS and the organization of the *IGEX-98*, the first global GLONASS observation and analysis campaign, by CSTG, IGS, ION, and IERS are excellent examples for IGS-related activities with a heavy involvement of external collaboration.

The success of the IGS was, as a matter of fact, so convincing, that two new services, the *ILRS (International Laser Ranging Service)* and the *IVS (International VLBI Service for Geodesy and Astrometry)* emerged recently from the corresponding CSTG Subcommissions in Section II.

# 4. Potential Role of the Services in the New IAG Structure

There are many relations and interactions between the IAG services. The three services of Section II are, e.g., closely cooperating with the IERS in Section V. Also, there are often bilateral relationships between services and/or commissions in the context of projects or working groups. The project of the IGS and the BIPM (Bureau International des Poids et Mesures), the IGS/BIPM Pilot Project on time and frequency transfer, or the organization of the GLONASS tracking and analysis experiment IGEX-98 by CSTG, IGS, IERS and ION (Institute of Navigation) were already mentioned above.

There are, at times, topics of common interest to a number of services. Let us mention the ongoing activity of creating the International Space Geodetic Network (ISGN) by the services IGS, ILRS, and IVS in Section II, the IERS and (possibly) the BIPM and PSMSL in Section V.

The examples show that attractive geodetic activities are taking place in the services without having a serious influence on the conventional IAG structure because the IAG Services are rather independent and not well embedded in the "normal" IAG structure (Sections, Commissions, Executive). The chairpersons of the services are *not* assigned by either the IAG Sections or the IAG Executive Committee. The IAG thus has very limited influence on the Services.

On the other hand the Services are represented neither in the IAG Executive Committee nor in the IAG Sections' Steering Committees. The services thus have a very limited influence on the higher IAG levels.

What can be done to improve the situation? It seems clear to us that the relationship between the upper IAG levels and the services has to be improved. This means in particular that (some of) the services have to be represented in the IAG Executive. It is completely impossible, on the other hand, to ask for service representatives for each of the services in the IAG Executive. It seems therefore necessary to form groups of services which are logically related and to assign 1-2 representatives to each of the groups.

In Table 2 we formed three such groups. The first group is geometry and time related, the second one gravity and ocean related, whereas the third one is purely administrative in nature.

Let us also mention Commission X (Networks), Commission VIII (CSTG), Commission VII (RCM), and Special Commission 8 (Sea Level&Ice Sheet) are linked to the first group, Commission III, Commission XII (Gravity and Geoid) and CV (Tides) are more linked to the second group.

We do not pursue these relationships any further here. This must be one of the topics of the IAG Retreat early in 2000 (see Beutler et al., (1999)). It is, however, good to keep in mind that such relations exist and that there are options to

give the Services a more pronounced role in the new IAG structure.

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Table 2: Logical Groups of the Current IAG Services

## 5. Summary and Wishes

It seems clear that the services must play an important role in the IAG structure being developed right now. It is also clear, on the other hand, that IAG cannot uniquely rely on services. Many of geodesy-relevant research-oriented activities must be dealt with in other parts of the IAG structure.

Let us conclude this review of the role of the IAG services within the current and the future IAG structure with two wishes:

- **Wish, addressed to the Service:** Maintain or develop a high level of "open mindedness" regarding the scientific collaboration with other parts of IAG, with sister unions, IAU, etc., and try to incorporate young scientists into the services' work a soon as feasible.
- **Wish, addressed to the IAG:** Perform the review and restructuring process of the IAG in the spirit alive in (at least some of) the IAG services, important elements of which are respect for everybody's contribution to IAG, respect for minorities, taking the other (geo-)sciences and their requirements serious.

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