Executive Reports

The Development of the IGS in 1997 - The Governing Board's Perspective

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1 Overview

It was stated many times that the IGS, as a very active service in support of Earth Sciences and Astronomy, is in continuous development. Many changes have occurred recently.

One of these recent changes concerns the format of the IGS annual reports. The first IGS annual report was written in 1994 (although IGS activities started as early as 1992), and the annual reports for 1995 and 1996 followed. The 1994 Annual Report contains 330 pages, the 1995 Volume 282 pages (using a more dense format than the 1994 report), and the 1996 report contains 446 pages (using essentially the same format as in 1995). On one hand, this increase in size was viewed as a positive development which highlighted and documented many new activities (e.g., the work performed in the context of the densification of the ITRF). On the other hand, it became increasingly difficult for non-IGS-experts to get a concise overview of IGS activities.

This was why the IGS Governing Board, at its 1998 Darmstadt Business Meeting on Sunday, February 8 1998, decided to produce the IGS Annual Report for 1997 in two corresponding volumes. Volume 1 would contain the top level information (CB report, IGS Analysis Center Coordinator report, report about current projects, etc.), and Volume 2 would contain the technical reports (analysis center reports, the station reports, etc.).

As a matter of fact, Volume 1 has been completed and should be distributed in summer 1998. Volume 2 is being finalized in September 1998. Volume 1 was edited by the Central Bureau much the way the 1996 Annual Report was done, and Volume 2 will be published to closely resemble "camera ready manuscripts." Volume 1 contains about TBD pages and will be broadly distributed (approximately 1500 copies) inside and outside the IGS. Volume 2 is primarily designed for internal IGS use and will be distributed to the IGS participants, associates, and libraries. Both reports will be made available in electronic form.

The Table of Contents of Volume 2 indicates the high documentary value of Volume 2: Here, the IGS Analysis Center Coordinator and all IGS Analysis Centers and Associate Analysis Centers summarize their latest and greatest improvements and changes, the IERS (Rapid Service and Predictions and Central Bureau) provide technical

feedback and comments to the IGS. This again underlines the excellent relationship between the two services in support of science. In subsequent sections, the Data centers discuss the issues of data handling, and an overview is provided concerning the state of the IGS network.

The development of the IGS in size and quality since 1992 is remarkable. Crucial to this development are its pilot projects, working groups, and committees. The final section of Volume 2 gives an overview of these IGS components that are currently active. The topic is also addressed in the next subsection of this report.

Volume 2 contains another first; an executive chapter. Initially, it was important that the topic of this new section does not restate that which is contained in Volume 1 of the 1997 Annual Report. I was therefore initially reticent to write a new contribution for Volume 2. However, after some reflection, I found that the Governing Board clearly states that the Technical Reports volume of the 1997 Annual Report was different in content but of equal importance as Volume 1.

So that I do not repeat that which is in Volume 1, the development of the IGS as an IAG- and a FAGS-Service, the essential IGS Events in 1997, and a few remarks concerning the IGS Retreat 1997 may be found in my report in the first part of the 1997 IGS Annual Report.

Let me address here two topics which kept the Governing Board (and others) quite busy in 1997 and 1998. (As opposed to the first part of the annual report, I am thus also addressing events which took place in 1998 – a practice which was always followed in the IGS Analysis Center Reports). The first topic addresses the future IGS policy regarding pilot projects and working groups, the second the IGS retreat -- which will then be handled in detail in the second contribution to this introductory chapter.

2 IGS Policy for the Establishment of IGS Projects and Working Groups

As one may conclude from Section 5 (Pilot Projects/Committees) of this report there are quite a few pilot projects or working groups active within the IGS. These working groups were set up in the past by the Governing Board on a more or less spontaneous "ad hoc" basis, where the goals and responsibilities were not always clearly defined. When the Governing Board saw the smooth development of the ambitious "IGS/BIPM Pilot Project to Study Accurate Time and Frequency Comparisons" it became obvious that the IGS needed well-defined rules for how to set up pilot projects and working groups.

This issue was addressed at the Business Meeting of the IGS Governing in Darmstadt because of the request to create an IGS ionosphere working group. It was decided that John Dow and the IGS Chairman should

- draft a general "charter" for setting up Working Groups or Pilot Projects within the IGS, and to circulate this draft within the Governing Board, and

- develop, in close cooperation with the "ionosphere club," the charter for the ionosphere working group and circulate this draft within the "ionosphere group."

Such general rules and a draft charter for the ionosphere working group were actually set up and presented to the Governing Board at its ninth meeting in Boston, Mass, at the end of May 1998. The outcome may be found in IGS Mail Message No. 1916: The rules were accepted by the Board and will be applied whenever new IGS working groups or pilot projects are created. Moreover, the ionosphere working group was created with Dr. Joachim Feltens from ESA as chairman.

It is the explicit wish of the Board that existing IGS Working Groups, Pilot Projects, etc., should follow the same rules in the future. This process will be invoked soon and will eventually lead to a clearer and better structure of the IGS. The accepted rules are stated in a special document which will have the status of a "by-law" of the IGS. The document will be referred to in the new Terms of Reference (to be adapted by the end of 1998). Some of the essential points of the document are:

- An IGS Working Group deals with a particular topic related to the IGS components. An IGS Pilot Project aims at the development of one or more particular IGS product(s) using data from the IGS network.

- Working groups and projects are operating autonomously under the leadership of the chairperson.

- The IGS Governing Board regularly organizes special meetings, where IGS projects and working groups are reviewed. Such meetings may be special sessions at IGS Workshops.

- IGS Working Groups and IGS Pilot Projects are set up by the IGS Governing Board at one of its regular meetings. At such a "constitutional meeting" the IGS Governing Board

    - approves the draft Working Group Charter
    - appoints the chair of the Working Group or Project for two years.

- Proposals to terminate the work, to essentially change the Charter, to (re-)appoint chairpersons are made at these meetings. These proposals are presented to the IGS Governing Board at its next regular Meeting.

3 The IGS Retreat in December 1998

At the seventh IGS Governing Board Meeting in Rio de Janeiro it was decided to organize an "IGS Retreat" in December 1997 with the IGS Governing Board Members

and a very limited group of IGS Associates with the goal to come up with a plan for the future development of the IGS which then should be discussed by the entire IGS community and the Board (IGS Mail Message No. 1683).

The retreat actually took place in Napa Valley, December 12-14, 1997. Recommendations and action items were presented at the Business Meeting of the IGS Governing Board in Darmstadt. The report was prepared by Ivan I. Mueller, who was also the program chair of the retreat. The recommendations and action items will be discussed in the next section of this introductory chapter by the same author. The report could only be discussed at the business meeting, decisions on this matter were taken at the 9th IGS Governing Board Meeting on 28 May, 1998 in Boston. Many of the proposed action items were already properly addressed at the 1998 IGS Analysis Center Workshop, others require adaptations in the Terms of Reference, a work which is underway right now.

The Governing Board considers the "recommendations and action items" of the IGS Governing Board retreat in Napa Valley, December 12-14, 1997 (as prepared by Ivan I. Mueller) as an extremely useful document defining the development of the IGS at least till the end of the millennium..

4 Acknowledgments

We should keep in mind that the IGS is based on a voluntary collaboration of a large number of scientific and survey institutions. It is also worth pointing out that the contributing organizations are not funded by the IGS, but have to raise funds for their IGS-related activities. Thus, an organization like the IGS only works properly if all contributing institutions are dedicated to the IGS mission and its performance, and if the benefit from IGS activities justifies the investments.

The other pillar of the IGS success is the personal engagement of many individuals who devote their time to the IGS. Prior to my involvement with the IGS, I was not aware of the large number of enthusiasts willing to cooperate on a voluntary basis for the benefit for the scientific community. I am convinced that most IGS associates share these feelings. On behalf of the IGS Governing Board, I would like to cordially thank all institutions and individuals devoting time and funds to the success of the IGS.

Many of us contributing to the 1997 IGS Annual Report found it difficult to submit manuscripts on time. The fact that delays stayed within "reasonable limits" is due to Prof. Ivan Mueller. His help in the editorial process allowed the Central Bureau to produce the Annual Reports in a timely manner -- which is of greatest importance for such a document. In this context I also would like to congratulate Dr. John Dow from ESA for his very efficient production and distribution of the Proceedings of the 1998 IGS Workshop in Darmstadt.

Activities of the IGS Central Bureau in 1997

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1 Overview

The end of 1997 marks a 'rite of passage' for the IGS, the first four year period devoted to nurturing this fledgling scientific service based on the Global Positioning System (GPS). The past four years have resulted in solidifying this now well known international activity and reinforcing its importance for scientific and research applications. During this time period, the IGS has become the fundamental supporting infrastructure for numerous geodetic, geophysical and geodynamic applications that depend on the utilization of GPS technology. The IGS also advocates standards and specifications for achieving excellence in precision use aspects of GPS from network operations through GPS analysis and applications, so that users worldwide can make use of the wealth of data and products afforded by the IGS.

It is quite clear that the strength of the IGS is directly due to the many participating individuals and their sponsoring agencies as noted by Gerhard Beutler above. The achievement of the IGS is something that each can lay claim to and it is the recognition that through mutual cooperation much greater benefit is realized by all.

2 Network Status and Update

The IGS network consists of precision, geodetic dual-frequency GPS stations that observe the GPS satellites on a continuous, 24-hour basis. These globally distributed stations are funded, implemented and operated by one of the IGS participating. At the end of 1997, nearly 200 stations were listed as part of the IGS network, an increase of nearly 70 stations registering with the IGS in 1997. Currently, the data files from each station span a 24-hour period, although the IGS is planing sub-daily data retrievals in the future, on an hourly or four to six hour basis. A Network Workshop is planned in November 1998 to address the current and future operations of the network, and many new requirements that affect these operations. This is in response to increasing demands on the infrastructure.

3 IGS / CB Activities in 1997

The IGS Terms of Reference, the relations by which the IGS is governed (i.e., by-laws) were established at the beginning of the service in 1994. These terms state that the "Central Bureau of the International GPS Service is responsible for the overall coordination and management of the Service". In order to fulfill this role, the CB has been be actively engaged in the many activities of the IGS. Given the current scope of IGS activities, the on-going fundamental processes and the new projects and directions of related GPS applications, the personnel of the CB must have a number of different talents to collectively perform the necessary tasks in order to coordinate with the various components of the service.

The CB is in the process of reorganizing the office based on the recommendations of the Napa Retreat in December 1997, see Ivan Mueller, this volume. One of the most noticeable results will be a nearly full-time Director and a full-time position of a Deputy Director. These staffing allocations are appropriate given the necessity of the CB to assume more of the daily coordination of the IGS, especially with regard to the robust performance of the ~200 station network, and the need to assume the role of the Executive arm of the Governing Board. In the first year or two of IGS operations the contributing agencies were all working to achieve their objectives as part of the IGS, in the spirit of the IGS mission statement. During this period, it took time to develop and solidify the working relationships internal to the IGS. Today, we are increasingly aware that additional effort is warranted in two areas: sustaining the fundamental IGS and providing interface to users, both internal and external

The Central Bureau has been actively working to completely upgrade the Central Bureau Information System (CBIS) which was made active in June of 1998. This web site and FTP server contain all of the fundamental information of the IGS. All IGS products are held here, as well as at the Global Data Centers (GDC). Most external users access the CBIS, while internal IGS users generally access the GDCs of choice. The CBIS will continue to evolve so that information is easily accessible and web based tutorials on the use of IGS products will be developed.

One of the other duties of the Central Bureau is to organize workshops and meetings, much effort was devoted to the first joint workshop between the Permanent Service for Mean Sea Level (PSMSL) and the IGS, the Workshop on Methods for Monitoring Sea Level and Altimeter Calibration, a joint IGS and Permanent Service for Mean Sea Level (PSMSL) workshop. This resulted in proceedings that are very valuable for these applications . Other workshops include supporting the 1997 Analysis Center workshop convened by Mike Watkins and Yehuda Bock. All meetings of the Governing Board are arranged by the CB, this year in held in Pasadena, Rio de Janeiro, San Francisco and the IGS Retreat in Napa Valley.

The Central Bureau managed six IGS exhibits at various international locations this year in order to promote information and use of data and products from the IGS. These exhibits include a computer slide show, back-drop of information, publications for pick-up or order and people stationed at the booth to answer questions.

The Central Bureau has devoted a great deal of time and resources to publications, which include 1996 IGS Annual Report, IGS Directory 1997, and IGS Resource Packets, updated quarterly. The IGS brochure was completely redesigned and rewritten:
IGS Brochure Monitoring Global change with Satellite Tracking, this brochure is also available in Spanish and future revisions will be available in other languages also.

The direction of the Central Bureau in the future will be to shift the focus somewhat from publications, exhibits, and meeting organization, and move to coordinate the Service in a more active fashion, as recommended by the Governing Board. To achieve this objective, the current reorganization of the CB will result in closer working relations with the various IGS components, including the Analysis Center Coordinator, the IGS working groups and committees. .

Recommendations and Action Items - IGS Governing Board Retreat Napa Valley, December 12-14, 1997

Ivan I Mueller

1 Overview

One of the conclusions reached at the Retreat was that the IGS Terms of Reference (January 1996 version), with some "fine tuning", still reflects the current needs of the IGS. For this reason, and also to provide a framework for the Retreat's Recommendations (Rs) and Action Items (**A**s), relevant portions of the terms are reproduced below, in **bold** letters between dotted lines, with the Rs and **A**s inserted at the appropriate locations.

In order to keep the Retreat as conducive to open discussion as possible, formal Minutes were not kept. A "short hand"/informal record, suitable to jag the memories of the participants, is available from the Central Bureau.

The Recommendations/Action Items and the explanatory text as presented below are based on the final summary discussion of the Retreat Coordinators on December 14, 1998, and on correspondence and conversations held after the Retreat.

2 International GPS Service for Geodynamics - Terms of Reference

The term "Geodynamics" within the name IGS, at its inception, was meant to indicate that the primary users of the service are scientists involved in geodynamics, specifically using GPS for determining and/or monitoring positions on the surface of the Earth with the highest accuracy. Since other types of users (especially from the atmospheric and oceanic science communities) are appearing on the horizon, the suggestion was made to eliminate the term "Geodynamics" from the title of IGS.

- R1: The name of the Service be the "International GPS Service".

- **A1**: Governing Board (GB) needs to consider R1 and vote.

The primary objective of the IGS is to provide a service to support, through GPS data products, geodetic and geophysical research activities. Cognizant of the immense growth in GPS applications the secondary objective of the IGS is to support a broad spectrum of operational activities performed by governmental or selected commercial organizations. The Service also develops the necessary

standards/specifications and encourages international adherence to its conventions.

IGS collects, archives and distributes GPS observation data sets of sufficient accuracy to satisfy the objectives of a wide range of applications and experimentation. These data sets are used by the IGS to generate the following data products:

- **high accuracy GPS satellite ephemerides**
- **earth rotation parameters**
- **coordinates and velocities of the IGS tracking stations**
- **GPS satellite and tracking station clock information**
- **ionospheric information**
- **tropospheric information.**

The accuracies of these products are sufficient to support current scientific objectives including:

- **realization of global accessibility to and the improvement of the International Terrestrial Reference Frame (ITRF)**
- **monitoring deformations of the solid earth**
- **monitoring earth rotation**
- **monitoring variations in the liquid earth (sea level, ice- sheets, etc.)**
- **scientific satellite orbit determinations**
- **ionosphere monitoring**
- **climatological research, eventually weather prediction.**

In the past, the IGS combined products used primarily have been those related to the **IGS Reference Frames**, both terrestrial and inertial, recommended for GPS users. These are the station coordinates with their variations in time (defining the terrestrial frame) and the orbits of GPS satellites (defining the inertial frame), and the transformation parameters relating the two (the earth-rotation parameters). There have been some questions as to the internal consistencies of the above products.

Due to user requirements for using the GPS signals in various efficient modes and/or leading to more accurate results, it appears necessary for IGS to produce combined, timely, and consistent additional products. Specifically, this includes GPS clock corrections (possibly an IGS time scale), tropospheric zenith biases and global and/or regional ionosphere models. These, together with the reference frames (all based on the IERS Conventions, 1996), constitute the **IGS Reference System**, assuring consistency for all GPS users of positioning in all modes.

Although non-positioning GPS user requirements are not clear at this time, it appears that there is (or will be in the near future) an increasing demand for rapid (real-

time) and more accurate GPS orbits, as well as the inclusion of other non-GPS satellites in the IGS framework (primarily the GLONASS and LEO satellites).

- R2: IGS is to produce combined, internally consistent, global products based on GPS observations as follows (several of these to a fair extent are already accomplished):
  a) station coordinates and velocities (incl. IGS SINEX products)
  b) orbital parameters
  c) earth rotation parameters
  d) GPS clock corrections
  e) IGS time scale
  f) tropospheric zenith delays
  g) ionosphere models

- **A2.1**: The Analysis Center Workshop in Darmstadt should address the issues a) - d) and f) and g) and make recommendations.

- **A2.2**: The recently established IGS-BIPM Pilot Project should address issues as already decided by the GB.

- R3: IGS should continue producing accurate orbits based on rapid and/or high rate data, investigate new requirements (e.g., for real time meteorology forecasting a twenty-station network providing 30s data down loaded every 6-12 hours is suggested. For LEO see A4.2 below) and suggest and implement improvements in availability (IGR) and precision (IGP).

- **A3**: The Analysis Center Workshop in Darmstadt should address this issue and make recommendations.

- R4: IGS should support the tracking of GLONASS and LEO satellites.

- **A4.1**: The GB should support tracking of GLONASS satellites by actively promoting within IGS the International GLONASS Experiment (IGEX), currently scheduled Sep.-Dec.,1998, pending on the discussion on GLONASS at the GB business meeting in Darmstadt.
- **A4.2**: The LEO Working Group should continue its work (in collaboration with various groups involved in the use of LEOs for atmospheric science). Specific recommendations are to be made on the appropriate number of tracking stations and sampling rate (1-5s?) and on the feasibility of IGS processing of occultation and/or other flight data.

The IGS accomplishes its mission through the following components:

networks of tracking stations

- **data centers**
- **Analysis and Associate Analysis Centers**
- **Analysis Coordinator**
- **Central Bureau**
- **Governing Board**

NETWORKS OF TRACKING STATIONS

IGS Stations provide continuous tracking using high accuracy receivers and have data transmission facilities allowing for a rapid (at least daily) data transmission to the data centers (see below). The stations have to meet requirements which are specified in a separate document. The tracking data of IGS stations are regularly and continuously analyzed by at least one IGS Analysis Center or IGS Associate Analysis Center....

IGS Stations which are analyzed by at least three IGS Analysis Centers for the purpose of orbit generation, where at least one of the Analysis Centers lies on a different continent than the station considered, are in addition called IGS Global Stations.

All IGS stations are qualified as reference stations for regional GPS analyses. The ensemble of the IGS stations forms the IGS network (polyhedron).

The IGS global network needs an overall enhancement. The IGS Infrastructure Committee is involved considering issues related to the existing network e.g., instrumentation, monumentation, reporting, performance, data communication and flow, quality control, archiving, site and RINEX standards. Plans for a coordinated systematic effort to expand/densify the network to the proposed (about 200 stations) Polyhedron are still lacking. On the other hand, the regional densification efforts are progressing, and limits are to be set up as to the inclusion of the regional stations into the IGS Polyhedron (being pro-active at the same time). Use of the network for climatology would also require the installation of high stability accurate barometers.

- R5: The global IGS Network should be enhanced in the overall sense.

- **A5.1**: The IGS Infrastructure Committee is to continue its work and report to the GB at its next regular meeting in Boston.
- **A5.2**: The GB should consider appointing a Network Manager/ Coordinator, within or outside the CB, to coordinate a systematic effort to complete the IGS Polyhedron. The responsibility would include the formulation of network standards and checking performance.
- **A5.3**: The CB/GB should make a systematic and concerted effort to request stations to install high stability/accuracy barometers (the alternative of using routinely produced atmospheric pressure grids should be explored, although their availability in near real time might be a challenge).
- **A5.4**: The GB should consider organizing an IGS Network Workshop to have an open discussion on network/station issues and to develop a direct interaction between the GB and the stations, upon which rest all IGS activities.

DATA CENTERS

The data centers required fall into three categories: Operational, Regional, and Global Data Centers.

The Global Data Centers are the main interfaces to the Analysis Centers and the outside user community. Their primary tasks include the following:

- **receive/retrieve, archive and provide on line access to tracking data received from the Operational/Regional Data Centers**
- **provide on-line access to ancillary information, such as site information, occupation histories, etc.,**
- **receive/retrieve, archive and provide on-line access to IGS products received from the Analysis Centers**
- **backup and secure IGS data and products.**

It was noted that, with the exception of CDDIS (which is doing an admirable job), not all Global Data Centers are regularly producing their Access Reports. In view of the importance of keeping track of the users of IGS products, it is recommended that such reports be published on a regular basis.

- R6: It is recommended that all Global Data Centers publish Access Reports on a monthly basis.

- **A6**: The CB is to contact the relevant Global Data Centers and encourage them to comply with R6.

ANALYSIS CENTERS

The analysis centers fall into two categories: Analysis Centers and Associate Analysis Centers.

The Analysis Centers receive and process tracking data from one or more data centers for the purpose of producing IGS products. The Analysis Centers are committed to produce daily products, without interruption, and at a specified time lag to meet IGS requirements. The products are delivered to the Global Data

Centers and to the IERS (as per bilateral agreements), and to other bodies, using designated standards.

The Analysis Centers provide as a minimum, ephemeris information and earth rotation parameters on a weekly basis, as well as other products, such as coordinates, on a quarterly basis. The Analysis Centers forward their products to the Global Data Centers.

Associate Analysis Centers are organizations that produce unique products, e.g., ionospheric information or Fiducial Station coordinates and velocities within a certain geographic region. Organizations with the desire of becoming Analysis Centers may also be designated as Associate Analysis Centers by the Governing Board until they are ready for full scale operation.

- R7: Depending on the outcome of the Analysis Center Workshop in Darmstadt the above descriptions of the Analysis and Associate Analysis Centers should be reviewed. The GB decisions in San Francisco/Napa Valley re. the GNAACs/RNAACs, may also have an effect.

- **A7**: The AC Coordinator together with the Chair of the Densification Project recommend the necessary changes to the Terms of Reference as per R7, if necessary.

ANALYSIS COORDINATOR

The Analysis Centers are assisted by the Analysis Coordinator.

The responsibility of the Analysis Coordinator is to monitor the Analysis Centers activities to ensure that the IGS objectives are carried out. Specific expectations include quality control, performance evaluation, and continued development of appropriate analysis standards. The Analysis Coordinator is also responsible for the appropriate combination of the Analysis Centers products into a single set of products. As a minimum a single IGS ephemeris for each GPS satellite is to be produced. In addition, IERS will produce ITRF station coordinates/velocities and earth rotation parameters to be used with the IGS orbits.

The Analysis Coordinator is to fully interact with the Central Bureau and the IERS. Generally the responsibilities for the Analysis Coordinator shall rotate between the Analysis Centers with appointments and terms specified by the Governing Board.

In view of R2 above, the present Analysis Coordinator's role will be significantly expanded and it is unlikely that a single person (or organization) will be able to handle the responsibilities related to all the different combined global products now contemplated. There is also a question of coordinating the regional densification projects (connected to the Polyhedron) in some central way.One of the responsibilities here would also be the education of users on how to use IGS products.

- R8: It is recommended that Working Groups be appointed for **Tropospheric Products**, for **Ionospheric Products**, for ITRF **Densification** and possibly others (pending on the recommendations of the Analysis Center Workshop in Darmstadt). The Analysis Center Coordinator should be an ex-officio member of all Working Groups. The alternative of appointing individual "Coordinators" for each application (instead of the Working Groups) may also be considered.

- **A8.1**: Based on the recommendations of the Darmstadt Analysis Workshop, the GB should appoint new Working Groups or Coordinators as per R8 and clarify their relationship/interaction (reporting requirements, etc.) with the CB and the GB.
- **A8.2:** The concept of Working Groups or additional Coordinators, together with their responsibilities and reporting/interaction requirements should be incorporated in the Terms of Reference.

CENTRAL BUREAU

The Central Bureau (CB) is responsible for the general management of the IGS consistent with the directives and policies set by the Governing Board. The primary functions of the CB are to facilitate communications, coordinate IGS activities, establish and promote compliance to IGS network standards, monitor network operations and quality assurance of data, maintain documentation, and organize reports, meetings and workshops, and insure the compatibility of IGS and IERS by continuous interfacing with the IERS. To accomplish these tasks the CB fully interacts with the independent Analysis Coordinator described above.

Although the Chairperson of the Governing Board is the official representative of the IGS at external organizations, the CB, consonant with the directives established by the Governing Board, is responsible for the day-to-day liaison with such organizations....

The CB coordinates and publishes all documents required for the satisfactory planning and operation of the Service, including standards/specifications regarding the performance, functionality and configuration requirements of all elements of the Service including user interface functions.

The CB operates the communication center for the IGS. It maintains a hierarchy of documents and reports, both hard copy and electronic, including network information, standards, newsletters, electronic bulletin board, directories, summaries of IGS performance and products, and an Annual Report.

In summary, the Central Bureau performs primarily a long term coordination and communication role to ensure that IGS participants contribute to the Service in a consistent and continuous manner and adhere to IGS standards.

The Central Bureau has performed well, especially in the areas of coordinating the network and communication. However, due in part to the rapid expansion of IGS over the past several years, other CB tasks described in the Terms of Reference either had to be farmed out to persons (usually volunteers) outside the CB, contracted to other organizations (e.g., UNAVCO), or neglected.

In addition to the rapid expansion of IGS, the other major difficulty faced by the CB is in trying to fulfill its responsibilities which are primarily structural and organizational in nature. Although it is difficult to assess the situation from the outside, it seems evident that because no single person has full time responsibility within the CB, every one is "spread too thin" and fragmented. The Director of the CB has at least three jobs and it appears that only one person reports to her (the liaison to UNAVCO). The UNAVCO contract to help with the network involves one staff position spread out over six persons. Others working for the CB, instead of reporting to the Director, in fact report to one of JPL's Group Supervisors, who in turn reports to certain Section/Division heads, and is not directly in charge of the Director of the CB. It appears that such a structure (although maybe efficient for other purposes), combined with the fragmentation of individual responsibilities, lead to difficulties in meeting JPL's original commitment to IGS and in some cases even to conflicts of interests within JPL.

- R9: It is recommended that the tasks of the CB as described in the Terms of Reference be reviewed and the future tasks of the CB clearly defined, with the "left-over" responsibilities appropriately assigned to organizations or individuals outside the CB, which will closely interact with the CB.

- R10: It is recommended that the host organization of the CB review and streamline the CB organization, with fragmentation reduced to a minimum and lines of reporting and responsibilities clearly defined.

- R11: It is also recommended that at least two persons should be given full time responsibility within the CB. One of these should be the Director, the other may be the Network Coordinator (see A5.2 above).

- R12: It is recommended that, provided that the recommendation for the additional Coordinators are adopted (see R8 above), their interaction with the CB be clearly defined.

- **A**9: The Director of the CB should discuss R9-11 with the appropriate officials of the host organization and present a plan to eliminate the above difficulties to the GB and the progress at its next regular meeting in Boston.

- **A**10: **A**10: The GB should appoint a sub-committee to work with the Infrastructure Committee and the Director of the CB to accomplish R9 and R12.

- **A**11: The Central Bureau section of the Terms of Reference will have to be modified after the fact.

GOVERNING BOARD

The Governing Board (GB) consists of fifteen members. They are distributed as follows:

Elected by IGS Associates (see below):

Analysis Centers' representatives	**3**
Data centers' representative	**1**
Networks' representatives	**2**

Elected by the Governing Board upon recommendations from the Central Bureau, for the next term:

Representatives of Analysis, Data Centers or Networks	**2**
Members at large	**2**

Appointed members:

Director of the Central Bureau	**1**
Representative of the IERS	**1**
IGS representative to the IERS	**1**
IAG/FAGS representative	**1**
President of IAG Sect. II or Com.VIII (CSTG	**1**
Total	**15**

The appointed members are considered ex officio and are not subject to institutional restrictions. The other ten persons must be members of different organizations and are nominated for each position by the IGS components they

represent as listed above (six persons) , or by the Central Bureau (four persons) for a staggered four year term renewable once. The GB membership should be properly balanced with regard to supporting organizations as well as to geography.

The election for each position is by the number of nominations received from the relevant IGS component, i.e., from the networks (for this purpose organizations operating two or more Global Stations are considered a network), from the Analysis Centers and from the Data Centers. In case of a tie, the election is by the members of the Governing Board and the IGS Associate Members (see below) by a simple majority of votes received. The election will be conducted by a nominating committee of three members, the chair of which will be appointed by the Chair of the IGS Governing Board...

The IAG / FAGS representative is appointed by the IAG Bureau (or by FAGS) for a maximum of two four-year terms...

The secretariat of the GB is provided by the Central Bureau...

The experiences of the past several years indicate that the nomination procedure for both groups of elected GB members (i.e., those nominated by the IGS Associates and those by the CB), may be improved to assure wider participation in the nomination process. In addition, it has been suggested to include all (or most) Coordinators in the deliberations of the GB. The appointed representation of IAG and FAGS on the GB needs clarification as well.

- **A**12: The GB should appoint a sub-committee to review the current nomination/appointment procedures for GB membership and to recommend improvements by the end of 1998.

Additional Recommendations/Action Items:

- **A**13: Periodic performance review requirement for each IGS component be incorporated in the Terms of Reference. The GB is to set up procedures for such regular reviews (how often and how?) and for the follow up of the recommendations (whether positive or negative).

- R13: The GB should consider forming an Advisory Committee for Commercialization of IGS products. The Committee should include representatives of organizations experienced in such ventures, e.g., WMO, UCAR/NCAR, IRIS, ESA (its business arm).

- R14: The GB should consider forming a committee, with external participation, with the task to prepare the IGS Long Range and Strategic Plan. Reporting should be at the IAG General Assembly in 1999.

(January 31, 1998)

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