ILRS Terms of Reference

Last Revised: March 22, 2005

1.0 INTRODUCTION

1.1 Charter and Affiliations

The International Laser Ranging Service (ILRS) is an established Service within Section II, Advanced Space Technology, of the International Association of Geodesy (IAG). The primary objective of the ILRS is to provide a service to support, through Satellite and Lunar Laser Ranging data and related products, geodetic and geophysical research activities as well as International Earth Rotation Service (IERS) products important to the maintenance of an accurate International Terrestrial Reference Frame (ITRF). The service also develops the necessary standards/specifications and encourages international adherence to its conventions.

1.2 Service

The ILRS collects, merges, archives and distributes Satellite Laser Ranging (SLR) and Lunar Laser Ranging (LLR) observation datasets of sufficient accuracy to satisfy the objectives of a wide range of scientific, engineering, and operational applications and experimentation. These data sets are used by the ILRS to generate a number of scientific and operational data products including but not limited to:

- Earth orientation parameters (polar motion and length of day)
- Three-dimensional coordinates and velocities of the ILRS tracking stations
- Time-varying geocenter coordinates
- Static and time-varying coefficients of the Earth's gravity field
- Centimeter accuracy satellite ephemerides
- Fundamental physical constants
- Lunar ephemerides and librations
- Lunar orientation parameters

The accuracy of SLR/LLR data products is sufficient to support a variety of scientific and operational applications including:

- Co-determination, with other space geodetic techniques, of the International Terrestrial Reference Frame (ITRF), especially as it relates to center-of-mass and scale
- Realization of global accessibility to and the improvement of the International Terrestrial Reference Frame (ITRF)
- Monitoring three-dimensional deformations of the solid Earth
- Monitoring Earth rotation and polar motion
- Support the monitoring of variations in the topography and volume of the liquid Earth (ocean circulation, mean sea level, ice sheet thickness, wave heights, etc.)
- Tidally generated variations in atmospheric mass distribution
- Calibration of microwave tracking techniques
- Picosecond global time transfer experiments

- Astrometric observations including determination of the dynamic equinox, obliquity of the ecliptic, and the precession constant
- Gravitational and general relativistic studies including Einstein's Equivalence Principle, the Robertson-Walker b parameter, and time rate of change of the gravitational constant, G
- Lunar physics including the dissipation of rotational energy, shape of the core-mantle boundary (Love Number k2), and free librations and stimulating mechanisms
- Solar System ties to the International Celestial Reference Frame (ICRF)

1.3 Amendments to the ILRS Terms of Reference

A proposal to amend the ILRS Terms of Reference can be made in writing to the Chairperson of the Governing Board (see Section 3.0) by any ILRS Associate Member (see Section 4.1). Proposed amendments will be forwarded by email to all ILRS Associate Members of record for comment and amended as necessary by the Chairperson prior to a Governing Board vote. Associate Members will be given two weeks to comment. Final approval of any such amendment requires a 2/3 affirmative vote of the Governing Board. Proposed amendments to the Terms and subsequent Board actions will be summarized and presented to the Associate Members by the Chairperson at the next General Assembly.

2.0 PERMANENT COMPONENTS OF THE ILRS

The ILRS accomplishes its mission through the following permanent components:

- Tracking Stations and Subnetworks
- Operations Centers
- Global and Regional Data Centers
- Analysis and Associate Analysis Centers
- Central Bureau

The characteristics and responsibilities of these entities are described in the following subsections.

2.1 Tracking Stations and Subnetworks

ILRS Tracking Stations range to a constellation of approved satellites (including the Moon), contained in a list of satellites compiled and approved by the ILRS Governing Board, through the use of state of the art laser tracking equipment and data transmission facilities which allow for a rapid (at least daily) data transmission to one or more Operations and/or Data Centers (see below). Stations will be categorized as "Operational" if they meet data accuracy, data quantity, data delivery and GPS collocation requirements as specified. Stations not yet meeting these requirements will be categorized as "Associate" status. The tracking data produced by the ILRS Operational Stations are regularly and continuously analyzed by at least one ILRS Analysis Center or one mission-specific Associate Analysis Center. Tracking Stations may be organized into regional or institutional subnetworks.

2.2 Operations Centers

The Operational Centers are in direct contact with tracking sites organized in a subnetwork. Their tasks typically include the collection and merging of data from the subnetwork, initial data quality checks, data reformatting into a uniform format, compression of data files if requested, maintenance of a local archive of the tracking data, and the electronic transmission of data to a designated ILRS Data Center. Operational Centers may also provide the tracking sites with sustaining engineering, communications links, and other technical support. In addition, Operational Centers can perform limited services for the entire network. Individual tracking stations can also perform part or all of the tasks of an Operational Center themselves.

2.3 Data Centers

2.3.1 Regional Data Centers

The Regional Data Centers reduce traffic on electronic networks. They collect reformatted tracking data from Operational Data Centers and/or individual tracking stations, maintain a local archive of the data received and, in some cases, transmit these data to the Global Data Centers. Regional Data Centers may also meet the requirements for Operational Centers and Global Data Centers (as defined in the previous and following paragraphs) of strictly regional network operations and duplicate activities of Global Data Centers to facilitate easy access to the information and products.

2.3.2 Global Data Centers

The Global Data Centers are the primary 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, meteorological data, site-specific engineering data, etc.,
- Receive/retrieve, archive and provide on-line access to ILRS scientific data products received from the Analysis Centers
- Backup and secure ILRS data and products

2.4 Analysis Centers

The analysis centers fall into three categories: Analysis Centers, Lunar Analysis Centers, and Associate Analysis Centers.

2.4.1 Analysis Centers

The Analysis Centers receive and process tracking data from one or more data centers for the purpose of producing ILRS products. The Analysis Centers are committed to produce the products, without interruption, at an interval and with a time lag specified by the Governing Board to meet ILRS requirements. The products are delivered to the Global Data Centers, to the IERS (as per bilateral agreements), and to other bodies, using designated standards. At a minimum, the Analysis Centers must process the global LAGEOS-1 and LAGEOS-2 data sets and are encouraged to include other geodetic satellites in their solutions.

The Analysis Centers provide, as a minimum, Earth orientation parameters on a weekly or sub-weekly basis, as well as other products, such as station coordinates, on a yearly basis or as otherwise required by the IERS. The Analysis Centers also provide a second level of quality assurance on the global data set by monitoring individual station range and time biases via the fitted orbits (primarily the LAGEOS 1 and 2 satellites) used in generating the quick-look science results.

2.4.2 Associate Analysis Centers

Associate Analysis Centers are organizations that produce special products, such as satellite predictions, time bias information, precise orbits for special-purpose satellites, station coordinates and velocities within a certain geographic region, or scientific data products of a mission-specific nature. Associate Analysis Centers are encouraged to perform additional quality control functions through the direct comparison of individual Analysis Center products and/or the creation of "combined" solutions, perhaps in combination with data from other space geodetic techniques (e.g., VLBI, GPS, GLONASS, DORIS, PRARE, etc.), in support of the IERS International Terrestrial Reference Frame (ITRF) or precise orbit determination. Organizations with the desire of eventually becoming Analysis Centers may also be designated as Associate Analysis Centers by the Governing Board until they are ready for full-scale operation.

2.4.3 Lunar Analysis Centers

Lunar Analysis Centers process normal point data from the Lunar Laser Ranging (LLR) stations and generate a variety of scientific products including precise lunar ephemerides, librations, and orientation parameters which provide insights into the composition and internal makeup of the Moon, its interaction with the Earth, tests of General Relativity, and Solar System ties to the International Celestial Reference Frame.

2.5 Central Bureau

The Central Bureau (CB) is responsible for the daily coordination and management of the ILRS in a manner consistent with the directives and policies established by the Governing Board. The primary functions of the CB are to facilitate communications and information transfer within the ILRS and between the ILRS and the external scientific community, coordinate ILRS activities, maintain a list of satellites approved for tracking support and their priorities, promote compliance to ILRS network standards, monitor network operations and quality assurance of data, maintain ILRS documentation and databases, produce reports as required, and organize meetings and workshops.

Although the Chairperson of the Governing Board is the official representative of the ILRS to 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 ILRS. It produces and/or maintains a hierarchy of documents and reports, in both hard copy and electronic form, including network information, standards, newsletters, electronic bulletin board, directories, summaries of ILRS performance and products, and an Annual Report.

The Central Bureau may propose to the Governing Board names of individuals to be considered by the ILRS Associates for election as members at large to help ensure the proper representation of important contributing organizations.

The responsibilities and activities of the Central Bureau may be distributed between different groups and organizations according to written agreements and charters.

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

The Central Bureau is headed by a Central Bureau Director, who is an ex-officio member of the ILRS Governing Board. The Secretary of the GB is also provided by the Central Bureau.

3.0 Governing Board

3.1 Roles and Responsibilities

The Governing Board is responsible for the general directions in which the ILRS is providing its services. It defines the official ILRS products, decides upon the satellites to be included in the ILRS tracking list, accepts standards and procedures prepared and proposed by the individual bodies of the ILRS and ensures, through its chairperson, the contact to other services and organizations.

The GB exercises general control over the activities of the Service including modifications to the organization that would be appropriate to maintain efficiency and reliability, while taking full advantage of the advances in technology and theory.

Most GB decisions are to be made by consensus or by a simple majority vote of the members, provided that there is a quorum consisting of at least ten members of the GB. In case of lack of a quorum the voting is by mail or email. Changes in Terms of References and the Chairperson of the GB can be made by a 2/3 majority of the members of the GB, i.e., by twelve or more votes.

3.2 Membership

The Governing Board consists of both appointed and elected members. The appointed members include:

Director of the Central Bureau	1
Secretary of the Central Bureau	1
President of IAG Sect. I (Reference Systems)	1
Members elected by their peers within the ILRS Associates include:	
NASA SLR Network Representatives	2
EUROLAS Network Representatives	2
WPLTN Network Representatives	2
Analysis and Associate Analysis Centers' Representatives	2
Data centers' Representative	1
LLR Representative	1
At-Large Members	2
IERS Representative	1
Total:	16

The appointed members are considered ex-officio and are not subject to institutional restrictions. The elected board positions are nominated and elected by members of the ILRS components they represent for a two-year term. The At-Large members are intended to compensate for under-representation among the various components of the ILRS or to provide additional skills or knowledge of use to the Board in carrying out its duties. At-Large members are elected by the entire body of ILRS Associates. The total GB membership should be properly balanced in all respects with regard to supporting organizations, skill mix, geography, etc.

3.3 Nomination and Election of Members

ILRS Associate Members (see Section 4.1), together with the GB, may nominate and vote for the elected members of the GB. The Call for Nominations and GB Elections will be conducted by the Central Bureau via official email lists and will be held approximately every two years prior to the International Workshop on Laser Ranging. Newly elected GB members will be installed at the next meeting. With the exception of At-Large members, GB nominees must be associated with the relevant ILRS component (e.g. Analysis, Data Centers, Lunar, etc.), and only ILRS Associate Members officially associated with that component, as determined by the official email lists maintained by the CB, may participate in the election of their representative. The full ILRS membership can vote for At-Large members. The GB will be final arbiter on an individual's qualifications for a particular elected post on the Board. Election is by a simple majority of votes received. In the unlikely event of a tie vote, the GB will make the final selection in Executive Session.

3.4 Election and Role of Chairperson

The GB Chairperson is elected by the Board from among its members for a term of two years, renewable for three terms. Nomination and selection of the Chairperson is carried out in GB Executive Session during the biannual Workshop Meeting. The Chairperson does not vote, except in case of a tie. He/she is the official representative of the ILRS to external organizations.

3.5 Frequency of Governing Board Meetings and ILRS General Assemblies

The Board shall endeavor to meet annually and at such other times as shall be considered appropriate or opportune by the Chairperson or at the request of at least eight Governing Board members. Whenever possible and appropriate, the GB and CB will jointly sponsor a General Assembly at least once per year for the benefit of the ILRS Associates. The logistics (schedule, location, advertising, etc.) for the General Assembly are the responsibility of the CB.

3.6 Rights and Privileges of GB Members

Members of the GB shall become IAG Fellows with the appropriate rights and privileges following two years of recognized service.

3.7 Analysis and Lunar Coordinators

The laser ranging technique is a broad based one. As an observational technique, the division between lunar laser ranging and artificial satellite laser ranging has become largely a historical one. However, present differences in many areas related to observations (e.g., predictions and data formats) are still being reconciled. It must also be recognized that the major data analysis packages that are presently used for artificial satellite analysis are not yet equipped to deal with lunar laser ranging observations and most of the LLR analysis packages are equally not yet compatible with SLR observations. Thus, it is prudent to maintain separate LLR and SLR coordinators for an, as yet, undefined time into the future. The SLR and LLR coordinators must work within their own disciplines to maintain observational and data integrities. However, they must also work together in an effort to unify both techniques, bringing together the best of both, and, when possible, learning from the other.

The Analysis and Lunar Coordinators are elected by the GB from its own membership and serve as the two voting ILRS representatives on the IERS Directing Board. The IERS in turn designates a representative to serve as an ex-officio voting member of the ILRS Governing Board.

The Analysis Coordinator is a voting member of the ILRS Governing Board and is elected by the Governing Board as the ILRS representative to the IERS Directing Board. Under a reciprocal arrangement, the IERS designates a representative to serve as a voting member on the ILRS Governing Board. The Lunar Coordinator may represent the ILRS as a deputy voting member on the IERS Directing Board in the Analysis Coordinator's absence and may otherwise attend IERS Board meetings at their discretion in a non-voting advisory capacity.

The Analysis Coordinator chairs the Analysis Working Group, which includes, at a minimum, the Lunar Coordinator, one representative from each of the Global Analysis Centers and may contain representatives of Associate Analysis Centers as well.

The responsibility of the Analysis Coordinator is to monitor the Analysis Centers' activities to ensure that the ILRS objectives are carried out. Specific expectations include global data quality control, station performance evaluation and reporting, and continued development of appropriate analysis standards and formats for the final science products. The Analysis Coordinator is also

responsible for the appropriate combination of designated Analysis Centers products into a single and coherent set of products.

The Analysis Coordinator ensures that the ILRS products produced by the ILRS Analysis and Associate Analysis Centers conform to IERS requirements and standards.

3.8 Working Groups

The Governing Board, at its discretion, can create or disband Working Groups. A Working Group (WG) may be either permanent (Standing) or temporary (Ad-Hoc) in nature. Standing Working Groups are created by the GB to carry out continuously evolving business of the ILRS. Occasionally, Ad-Hoc Working Groups are appointed to carry out special investigations or tasks of a temporary or interdisciplinary nature.

The valid activities for the various Working Groups are defined by their Charters. Modifications to the charters of existing WGs can be submitted by the corresponding Coordinator for approval by the Governing Board. In order to create a new WG, the sponsor must submit a proposed charter, which clearly states the goals and responsibilities of the new group, for approval by the GB.

The Coordinator of each Standing WG is selected by the GB from amongst its members for a period of two years to ensure close coupling of the WG with the GB and its goals. WG Coordinators may serve a total of four consecutive two-year terms on a specific Standing WG, starting from January 1, 2005. Once a Coordinator has served four consecutive terms on a WG, he or she may again serve as Coordinator of that WG after a hiatus of at least two terms. Past Coordinators on one WG may serve as Coordinators on other WG's without hiatus restrictions. The WG Coordinator can independently appoint additional members to the WG from among the other GB members, ILRS Associate Members or ILRS Correspondents (see below). The WG Coordinator may also designate a Deputy to act on his/her behalf in his/her absence. All GB members, with the exception of the ex-officio members and the Chairperson, are required to serve on at least one of the Standing Working Groups.

The Coordinator for Ad-Hoc Working Groups may be chosen, at the discretion of the Board, from outside its membership in order to best fulfill the goals of that WG.
Currently, the Standing Working Groups are:

- Missions
- Data Formats and Procedures
- Networks and Engineering
- Analysis

4.0 DEFINITIONS

4.1 ILRS Associate Members

Persons affiliated with recognized ILRS institutions and who routinely participate in any of the ILRS activities (management, missions, tracking, engineering, operations, data analysis, archiving, etc.) are eligible to be ILRS Associate Members. To gain official membership in the ILRS, an

approved ILRS institution must submit the person's name, email, and primary ILRS function in the organization to the Central Bureau. ILRS Associate Members do not have to be employed by their institution sponsor; they merely need to provide a recognized ILRS-related service to the sponsoring institution under a contractual or cooperative arrangement. The Associate's stated function will determine his/her eligibility to nominate and/or vote for specific GB representatives as described in Section 3.3.

Associate Members may attend open (non-executive) ILRS meetings, which are announced to the general community by the CB, place nominations for elected GB posts, vote in ILRS elections, and serve on the Governing Board if appointed or elected. A directory, electronic and/or hard copy, of ILRS Associate Members, and their approved association with a particular component of the ILRS, is maintained by the CB.

ILRS Associate Members are considered IAG Affiliates with the corresponding rights and privileges.

4.2 ILRS Correspondents

ILRS Correspondents are persons on a mailing list maintained by the Central Bureau, who do not actively participate in the ILRS but who either express interest in receiving ILRS publications, wish to participate in workshops or scientific meetings organized by the ILRS, or generally are interested in ILRS activities. Ex-officio ILRS Correspondents are the following persons:

- IAG General Secretary
- President of IAG Section 3 (Geodynamics and Earth Rotation)