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THE INTERNATIONAL LASER RANGING SERVICE

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ABSTRACT

The International Laser Ranging Service (ILRS) was established in September 1998 to support programs in geodetic, geophysical, and lunar research activities and to provide the International Earth Rotation Service (IERS) with products important to the maintenance of an accurate International Terrestrial Reference Frame (ITRF). Now in operation for nearly two years, the ILRS develops (1) the standards and specifications necessary for product consistency, and (2) the priorities and tracking strategies required to maximize network efficiency. The Service collects, merges, analyzes, archives and distributes satellite and lunar laser ranging data to satisfy a variety of scientific, engineering, and operational needs and encourages the application of new technologies to enhance the quality, quantity, and cost effectiveness of its data products. The ILRS works with (1) new satellite missions in the design and building of retroreflector targets to maximize data quality and quantity, and (2) science programs to optimize scientific data yield. The ILRS is organized into permanent components: (1) a Governing Board, (2) a Central Bureau, (3) Tracking Stations and Subnetworks, (4) Operations Centers, (5) Global and Regional Data Centers, and (6) Analysis, Lunar Analysis, and Associate Analysis Centers. The Governing Board, with broad representation from the international Satellite Laser Ranging (SLR) and Lunar Laser Ranging (LLR) community, provides overall guidance and defines service policies, while the Central Bureau oversees and coordinates the daily service activities, maintains scientific and technological data bases, and facilitates communications. Active Working Groups in (1) Missions, (2) Networks and Engineering, (3) Data Formats and Procedures, (4) Analysis, and (5) Signal Processing provide key operational and technical expertise to better exploit current capabilities and to challenge the ILRS participants to keep pace with evolving user needs. The ILRS currently includes more than 40 SLR stations, routinely tracking about 20 retroreflector-equipped satellites and the Moon in support of user needs.

ORIGIN AND ESTABLISHMENT OF THE ILRS

For many years, international SLR activities had been organized under the Satellite and Lunar Laser Ranging (SLR/LLR) Subcommission of the International Coordination of Space Techniques for Geodesy and Geodynamics (CSTG). The Subcommission provided a venue for organizing tracking campaigns, adopting data formats, reporting on network status, and sharing technology. However, membership and commitment to the Subcommission were informal, and the main focus was on systems and data acquisition rather than on the production of consistent and high quality data products for end users.

With strong encouragement from Gerhard Beutler, then President of the CSTG, the CSTG SLR/LLR Subcommission Steering Committee undertook the formation of the ILRS. A draft Terms of Reference, detailing the mission and the organization of the new service was written and accepted by the CSTG Executive Board in May 1997. A joint CSTG/IERS Call for Participation in the new ILRS was drafted by the SLR/LLR Subcommission Chairman, John Degnan, and the SLR Representative on the IERS Directing Board, Bob Schutz, and issued on 24 January 1998. Institution proposals in response to the Call were evaluated at a special meeting of the CSTG SLR/LLR Subcommission Steering Committee and subsequently approved by both the CSTG Executive Board and the IERS Directing Board on 18 April 1998. ILRS approval was granted to 46 tracking stations, 4 Operations

Centers, 3 Analysis Centers, 4 Lunar Analysis Centers, 18 Associate Analysis Centers, 2 Global Data Centers and 1 Regional Data Center. The Central Bureau was established at the NASA Goddard Space Flight Center with John Bosworth as Director and Michael Pearlman of the Harvard-Smithsonian Center for Astrophysics as Secretary.

Appointments and elections of Governing Board members were carried out during the summer of 1998. On 22 September 1998, the CSTG SLR/LLR Subcommission was officially disbanded, and replaced by the First ILRS General Assembly, held in conjunction with the 11th International Workshop on Laser Ranging in Deggendorf, Germany. The first ILRS Governing Board meeting was held on 25 September 1998; John Degnan was elected by the Board as Chairperson, and the Coordinators and Deputy Coordinators for the various Working Groups were also selected.

In July 1999, the Directing Board of the International Association of Geodesy (IAG), meeting at the IUGG Conference in Birmingham, UK, established the ILRS as an official Service of the IAG, on an equal par with the other three IAG Services - the International Earth Rotation Service (IERS), the International GPS Service (IGS), and the newly established International VLBI Service (IVS).

CONTRIBUTIONS OF THE ILRS

The ILRS collects, merges, analyzes, archives and distributes Satellite Laser Ranging (SLR) and Lunar Laser Ranging (LLR) observation data sets of sufficient accuracy to satisfy the objectives of a wide range of scientific, engineering, and operational applications and experimentation. The basic observable is the precise time-of-flight of an ultrashort laser pulse to and from a satellite, corrected for atmospheric delays. These data sets are used by the ILRS to generate a number of fundamental data products, including:

- Centimeter accuracy satellite ephemerides
- 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
- Fundamental physical constants
- Lunar ephemerides and librations
- Lunar orientation parameters

ORGANIZATION AND ROLE OF THE ILRS

The ILRS organization is shown in Figure 1. ILRS Tracking Stations range to a constellation of approved satellites (including the Moon), compiled and approved by the Governing Board, with state-of-the-art laser ranging systems and transmit their data on a rapid basis (at least daily) to an Operations or Data Center. Stations are expected to meet ILRS data accuracy, quantity, and timeliness requirements, and their data must be regularly and continuously analyzed by at least one Analysis or mission-specific Associate Analysis Center. Each Tracking Station is typically associated with one of the three regional subnetworks (National Aeronautics and Space Administration (NASA), EUROpean LASer Network (EUROLAS), or the Western Pacific Laser Tracking Network (WPLTN)).

Operations Centers collect and merge the data from the tracking sites, provide initial quality checks, reformat and compress the data if necessary, maintain a local archive of the tracking data, and relay the data to a Data Center. Operational Centers may also provide the Tracking Stations with sustaining engineering, communications links, and other technical support. Tracking Stations may perform part or all of the tasks of an Operational Center themselves.

Global Data Centers are the primary interfaces between the Analysis Centers and the outside users. They receive and archive ranging data and supporting information from the Operations and Regional Data Centers, and provide this data on-line to the Analysis Centers. They also receive and archive ILRS scientific data products from the

Analysis Centers and provide these products on-line to the users. Regional Data Centers reduce and consolidate traffic on electronic networks and maintain a local data archive.

Analysis Centers receive and process tracking data to produce ILRS data products. They are committed to produce the products on a routine basis for delivery to the Global Data Centers and the IERS using designated standards. Full Analysis Centers routinely process the global LAGEOS-1 and LAGEOS-2 data and provide Earth orientation parameters on a weekly or sub-weekly basis. They also produce other products such as station coordinates and velocities and geocenter coordinates on a schedule consistent with IERS requirements and provide a second level of data quality assurance in the network. Associate Analysis Centers produce specialized products, such as time-varying gravity field measurements, fundamental constants, satellite predictions, precision orbits for special-purpose satellites, regional geodetic measurements, and data products of a mission-specific nature. Associate Analysis Centers are also encouraged to perform quality control functions through the direct comparison of Analysis Center products and the creation of "combined" solutions using data from other space geodetic techniques. Lunar Analysis Centers produce LLR products such as lunar ephemeris, lunar libration, and Earth rotation (UT0 - UT1). In the field of relativity, LLR is used for the verification of the equivalence principle, estimation of geodetic precession, and examination of the relative change in G.

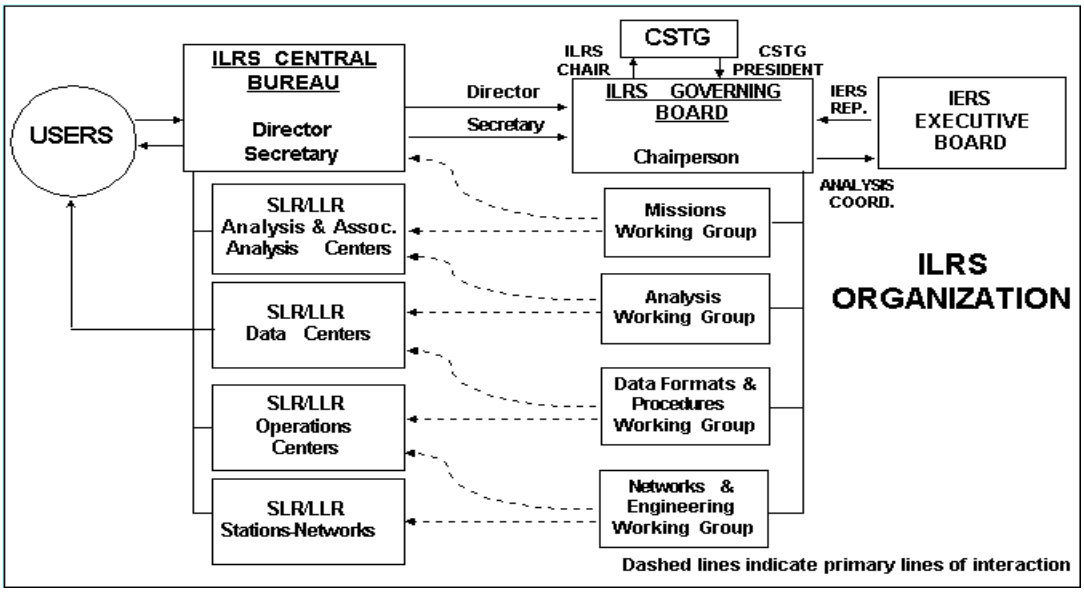

Figure 1. ILRS Organization

The Central Bureau (CB) is responsible for the daily coordination and management of ILRS activities. It facilitates communications and information transfer and promotes compliance with ILRS network standards. The CB monitors network operations and quality assurance of the data, maintains all ILRS documentation and databases, and organizes meetings and workshops. In order to strengthen the ILRS interface with the scientific community, a Science Coordinator and an Analysis Specialist within the CB take a proactive role to enhance dialogue, to promote SLR goals and capabilities, and to educate and advise the ILRS entities on current and future science requirements related to SLR. The Science Coordinator leads efforts to ensure that ILRS data products meet the needs of the scientific community and there is easy online access to all published material (via Abstracts) relevant to SLR science and technology objectives.

The Governing Board (GB) is responsible for the general direction of the service. It defines official ILRS policy and products, determines satellite tracking priorities, develops standards and procedures, and interacts with other services and organizations. There are 16 members of the Governing Board (GB) - three are ex-officio, seven are appointed, and six are elected by their peer groups (see Table 2).

Within the GB, permanent (Standing) or temporary (Ad-Hoc) Working Groups carry out the business of the ILRS. At its creation, the ILRS established four Standing Working Groups: (1) Missions, (2) Data Formats and

Procedures, (3) Networks and Engineering, and (4) Analysis. In 1999, an Ad-Hoc Signal Processing Working Group was organized to provide improved satellite range correction models to the analysts. The Working Groups are intended to provide the expertise to make technical decisions and to plan programmatic courses of action and are responsible for reviewing and approving the content of technical and scientific databases maintained by the Central Bureau. All GB members serve on at least one of four Standing Working Groups, led by a Coordinator and Deputy Coordinator. Table 1 lists the current GB membership, their nationality, and special function (if any) on the Governing Board.

Hermann Drewes	Ex-Officio, CSTG President	Germany
John Bosworth	Ex-Officio, Director ILRS Central Bureau	USA
Michael Pearlman	Ex-Officio, Secretary, ILRS Central Bureau	USA
Werner Gurtner	Appointed, EUROLAS , Networks & Eng. WG Coordinator	Switzerland
Wolfgang Schlueter	Appointed, EUROLAS, Networks & Eng. WG Deputy Coord.	Germany
David Carter	Appointed, NASA	USA
John Degnan	Appointed, NASA, Governing Board Chairperson	USA
Yang FuMin	Appointed, WPLTN	PRC
Hiroo Kunimori	Appointed, WPLTN, Missions WG Coordinator	Japan
Bob Schutz	Appointed, IERS Representative to ILRS	USA
Graham Appleby	Elected, Analysis Rep.	UK
Ron Noomen	Elected, Analysis Rep. , Analysis WG Coordinator	Netherlands
Wolfgang Seemueller	Elected, Data Centers Rep. , Data Formats & Procedures WG Deputy Coordinator	Germany
Peter Shelus	Elected, Lunar Rep., Analysis WG Deputy Coordinator	USA
Georg Kirchner	Elected, At-Large, Missions WG Deputy Coordinator	Austria
John Luck	Elected, At-Large, Data Formats & Procedures WG Coordinator	Australia

Table 1. ILRS Governing Board (as of April 2001)

ILRS Web Site

The Central Bureau maintains a comprehensive web site as the primary vehicle for the distribution of information within the ILRS community. The site, which can be accessed at:

http://ilrs.gsfc.nasa.gov

includes the following major topic titles: About the ILRS, Current Events, Working Groups, Satellite Missions, Network Stations, Data Products, Science/Analysis, Engineering/Technology, Reports, Frequently Asked Questions (FAQs), and Links. Mirrored sites are also available at the Communications Research Laboratory (CRL) in Tokyo and the European Data Center (EDC) in Munich. The site also includes SLR related bibliographies, Earth science links, historical information, collocation histories, and mail exploders. An on-line brochure provides charts for SLR presentations. A hard copy library of early documentation has been assembled and is listed in the on-line bibliography.

A new ILRS Reference Card was recently developed to provide easy online access to much of this material and to targeted email exploders.

ILRS NETWORK

The ILRS Network is shown in Figure 2. Traditionally the network has been strong in the US, Europe, and Australia. Through international partnerships, the global distribution of SLR stations is now improving, especially in the Southern Hemisphere. NASA, working in cooperation with CNES and the University of French Polynesia has established SLR operations on the island of Tahiti with MOBLAS-8. In cooperation with the South African Foundation for Research Development (FDR), NASA has relocated MOBLAS-6 to Hartebeesthoek (which already

has VLBI, GPS, and DORIS facilities) to create the first permanent Fundamental Station on the African continent. Negotiations between NASA and the University of La Plata are underway to establish a new co-sponsored site in Argentina using the TLRS-4.

A Chinese-Argentine SLR station at the San Juan Observatory in western Argentina, is in preparation with SLR equipment furnished by the Beijing Astronomical Observatory. Another site in South America, at Concepcion, Chile, has been selected by the BKG for its multi-technique Totally Integrated Geodetic Observatory (TIGO). The TIGO, with SLR, VLBI, GPS and absolute gravimetry techniques will provide a Fundamental Station in South America when it becomes operational in late 2001. Operations at the new Australian station on Mt. Stromlo, which replaced the older Orroral site near Canberra, are going extremely well in terms of both data quantity and quality. Autonomous operations at the stations have been very successful. Thus, considerable effort is being made to fill the long-standing Southern Hemisphere weakness in the SLR network.

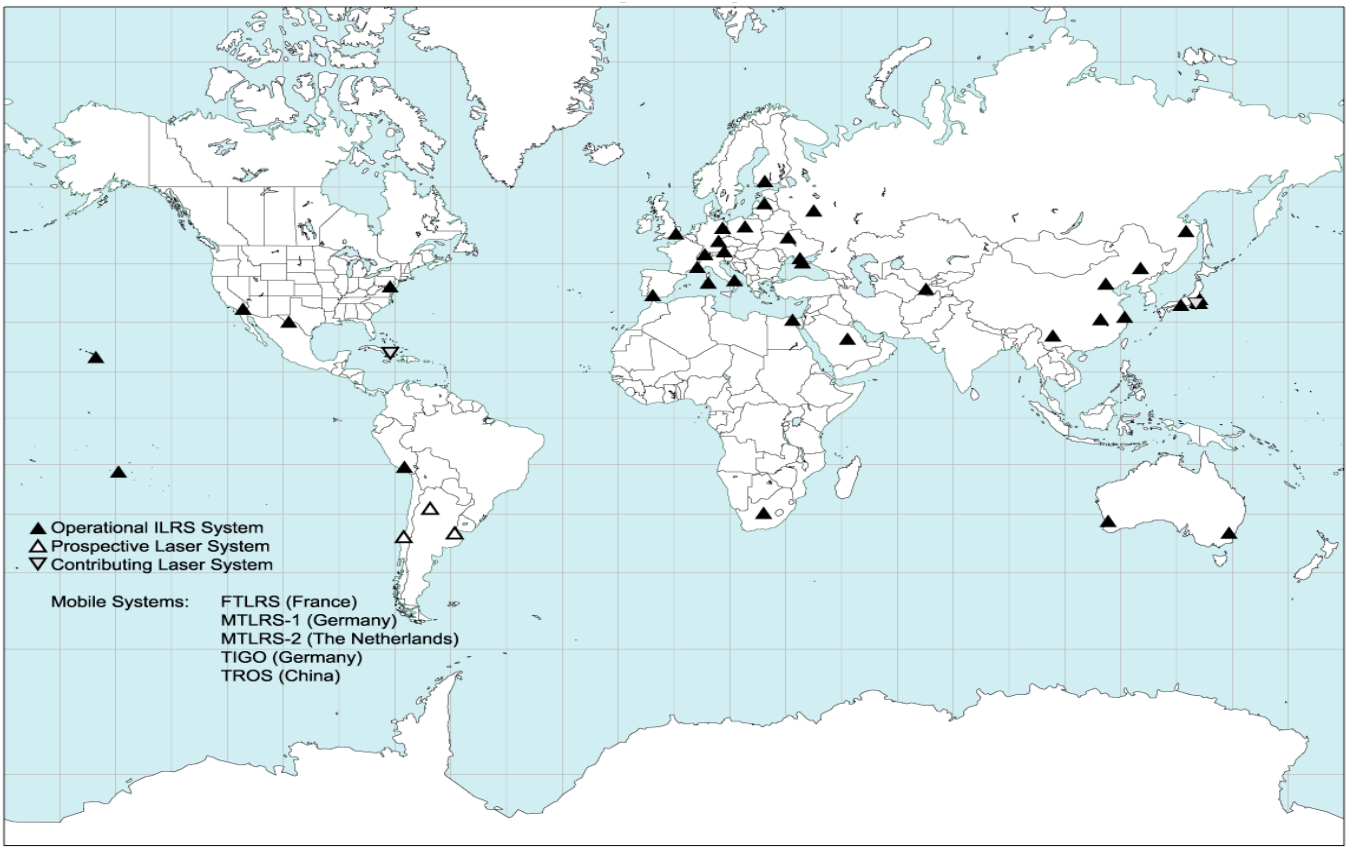

Figure 2. ILRS Network

The Peoples' Republic of China has made substantial investment in SLR stations and technology over the past two years. The SLR station in Kunming was recently re-established, bringing the total number of Chinese permanent sites to five (Shanghai, Changchun, Wuhan, Beijing, and Kunming). The data quality and quantity from the Chinese stations continue to improve, most notably at Changchun. The Wuhan SLR station has been recently moved to a site outside the city where there is significantly better atmospheric seeing, and construction is nearing completion on two mobile Chinese SLR stations which will occupy additional sites within China, as part of a national geodetic program. The new Russian SLR station started operations near Moscow in 1999, and permission is being requested from the Russian government to integrate it into SLR operations. A second new Russian SLR station is under construction in the Altay region.

In Japan, The Communications Research Laboratory (CRL) in Tokyo continues to operate two of its Keystone sites at Kashima and Tateyama in the Tokyo area. The two stations at Koganei and Miura are not operational. The future of these sites however is unclear. The Simosato site, operated by the Japanese Hydrographic Institute, will continue to provide data in this technically highly interesting region.

Sites in the United States and Europe have been relatively stable over the past several years, with efforts continuing to improve overall performance or reducing the cost of SLR operations. The new state-of-the-art Matera Laser Ranging Observatory (MLRO) with both SLR and lunar ranging capability has now been installed at Matera and is presently undergoing acceptance testing. The new French Transportable Laser Ranging System (FTLRS) is undergoing checkout in preparation for tracking support of JASON and other active satellite missions from a site in the Mediterranean region. The automated SLR 2000 is under development at NASA.

TRACKING PRIORITIES AND CAMPAIGNS

The ILRS is currently tracking about two dozen targets including passive geodetic (geodynamics) satellites, Earth sensing satellites, navigation satellites, experimental missions, and lunar reflectors (see Table 2).

Priority	**Satellite**	**Sponsor**	**Altitude (Km)**	**Inclination**	**Campaign Ends**
1	CHAMP	GFZ	470	87.3	
2	GFO-1	US Navy	790	108.0	
3	ERS-2	ESA	800	98.6	
4	TOPEX/Poseidon	NASA.CNES	1,350	66.0	
5	Starlette	CNES	815 – 1,100	49.8	
6	WESTPAC	WPLTN	835	98	
7	Stella	CNES	815	98.6	
8	Beacon-C	NASA	950 – 1,300	41	31 December 2001
9	Ajisai	NASDA	1,485	50	
10	LAGEOS-2	ASI/NASA	5,625	52.6	
11	LAGEOS-1	NASA	5,850	109.8	
12	Etalon 1	RSA	19,100	65.3	
13	Etalon 2	RSA	19,100	65.2	
14	GLONASS 80	RSA/IGLOS	19,100	65	
15	GLONASS 72	RSA/IGLOS	19,100	65	
16	GLONASS 79	RSA/IGLOS	19,100	65	
17	GPS 35	US Air Force	20,100	54.2	
18	GPS 36	US Air Force	20,100	55.0	
	Lunar Targets	**Sponsor**			
1	Apollo 15	NASA			
2	Apollo 11	NASA			
3	Apollo 14	NASA			
4	Luna 21	RSA			

Table 2. ILRS Tracking Priorities (as of April 2001)

The ILRS assigns satellite priorities in an attempt to maximize data yield on the full satellite complex while at the same time placing greatest emphasis on the most immediate data needs. Priorities provide guidelines for the network stations, but stations may occasionally deviate from the priorities to support regional activities or national initiatives and to expand tracking coverage in regions with multiple stations. Tracking priorities are set by the Governing Board, based on application to the Central Bureau and recommendation of the Missions Working Group.

Priorities typically decrease with increasing orbital altitude and orbital inclination (at a given altitude). Priorities may be adjusted by the Board to intensify support for (1) active remote sensing missions such as altimetry, (2)

special campaigns (such as IGEX 98), (3) post-launch intensive tracking phases, and (4) missions of greatest importance to the scientific and analysis communities.

During the past year, tracking campaigns have included: (1) ERS-1 to support tandem Synthetic Aperture Radar (SAR) experiments with ERS-2; (2) the GEOSAT Follow-on (GFO-1) altimetric mission, (3) the South African SUNSAT remote sensing satellite, and (4) revived GEOS-3 and Beacon-C tracking for gravity field improvement .

Since several remote sensing missions have suffered failures in their active tracking systems or have required in-flight recalibration, the ILRS has encouraged new missions with high precision orbit requirements to include retroreflectors as a fail-safe backup tracking system, to improve or strengthen overall orbit precision, and to provide important intercomparison and calibration data with onboard microwave navigation systems.

UPCOMING MISSIONS

At one time, the main task of the international SLR Network was the tracking of dedicated geodetic satellites (LAGEOS, Starlette, etc.). Although we have had requests to revive tracking on older satellites already in orbit (e.g. Beacon-C) to further refine the gravity field with improved accuracy laser data, new requests for tracking are now coming mainly for active satellites. A list of upcoming space missions that have requested or are expected to request SLR tracking is summarized in Table 3 along with their sponsors, intended application, and projected launch dates. The tracking approval process begins with the submission of a Missions Support Request Form, which is accessible through the ILRS web site. The form provides the ILRS with the following information: a description of the mission objectives; mission requirements; responsible individuals, organizations, and contact information; timeline; satellite subsystems; and details of the retroreflector array and its placement on the satellite. This form also outlines the early stages of intensive support that may be required during the initial orbital acquisition and stabilization and spacecraft checkout phases.

Mission Name	Support Requester	Mission Type	Planned Launch Date	Mission Duration	Altitude (km)	Inclination (deg)	Mission Request Form Received
Envisat-1	ESA Europe	Oceans, Atmosphere	June 2001	5 years	800	98.5	yes
Starshine 3	NRL/USA	Atmosphere, Educational	August 2001	3-5 years	470	67	yes
JASON-1	CNES/NASA France/USA	Oceans, Atmosphere	October 2001	5 years	1336	66	yes
Starshine 2	NRL/USA	Atmosphere, Educational	December 2001	3-5 years	360	39	yes
Icesat (GLAS)	NASA USA	Ice Balance, Oceans	January 2002	3-5 years	600	94	yes
ADEOS-II	NASDA Japan	Oceans, Atmosphere	February 2002	3 years	803	98.6	yes
GP-B	NASA-JPL USA	Relativity	October 2002	1-2 years	400	90	yes

Table 3. Upcoming Missions (as of April 2001)

Once tracking support is approved by the Governing Board, the Central Bureau works with the new missions to develop a Mission Support Plan detailing the level of tracking, the schedule, the points of contact, and the channels of communication. New missions normally receive very high priority during the acquisition and checkout phases and are then placed at a routine priority based on the satellite category and orbital parameters. After launch, New Mission Reports with network tracking statistics and operational comments are issued weekly. The Central Bureau monitors progress to determine if adequate support is being provided. New mission sponsors (users) are requested

to report at the ILRS Plenary meetings on the status of ongoing campaigns, including the responsiveness of the ILRS to their needs and on progress towards achieving the desired science or engineering results.

PERFORMANCE EVALUATION

ILRS Analysis Center reports and inputs are used by the Central Bureau for weekly review of station performance and feedback to the stations when necessary. Special weekly reports on on-going campaigns are issued by email. The Central Bureau generates Quarterly Performance Report Cards and posts them on the ILRS web site. The Report Cards evaluate data quantity, data quality, and operational compliance for each tracking station relative to ILRS minimum performance standards. A catalogue of diagnostic methods, for use along the entire data chain starting with data collection at the stations, has emerged from this process and will be made available on the ILRS web site. The evaluation process has been helpful in comparing results from different Analysis and Associate Analysis Centers, a role soon to be assumed by the Analysis Working Group.

INTERFACES WITH OTHER ORGANIZATIONS

Although the ILRS is no longer a sub-Commission of the CSTG, the ILRS continues to maintain close ties with its former parent organization. Hermann Drewes has recently replaced Gerhard Beutler as CSTG President following Professor Beutler's elevation to the position of IAG Vice-President. The chairpersons of the three IAG space geodetic services - IGS, ILRS, and IVS - all serve on the CSTG Executive Board. This enhances the coordination and cooperation between the various space geodetic communities.

The ILRS also maintains close ties with the International Earth Rotation Service (IERS), which is a prime user of laser ranging data in maintaining the Terrestrial Reference Frame. The Analysis Coordinator (Ron Noomen) on the ILRS Governing Board is a voting member of the IERS Directing Board, and an SLR Representative (Bob Schutz) is appointed by the IERS to serve as a voting member of the ILRS Governing Board. The Lunar Representative (Peter Shelus), who also serves as the Deputy Coordinator of the Analysis WG, is an invited attendee at IERS Directing Board meetings and can vote in the Analysis Coordinator's absence.

MEETINGS

The ILRS organizes an open General Assembly Meeting and a Governing Board Meeting twice a year. The spring meetings have been held in conjunction with the EGS General Assembly. The fall meetings have been held in conjunction with ILRS-sponsored technical meetings or workshops, such as the Colloquium on SLR System Calibration (SPIE Colloquium in Florence, Italy, in September, 1999) and the International Workshop on Laser Ranging (Matera, Italy, in November 2000). Reports on these meetings can be found at the ILRS web site.

CURRENT STATUS AND FUTURE PROSPECTS

The first two-year period of the ILRS has been an active one. While all of the ILRS institutions have worked hard to meet the demanding new requirements, the ILRS is particularly pleased with the success of the Working Groups (WG's) The WG's were originally created to serve as the primary foci for Governing Board activities. Coordinators and Deputy Coordinators for the four Standing Working Groups were chosen from among the Governing Board members at their first meeting. At the Second General Assembly, the first Ad-Hoc (temporary) Working Group on Signal Processing was created. All of the WG's have attracted talented people from the general ILRS membership who have contributed greatly to the success of these efforts. To date:

- The Missions Working Group under the coordination of Hiroo Kunimori, from the Communications Research Laboratory (CRL) in Japan, has formalized and standardized the mission documentation required to obtain ILRS approval for new missions and campaigns. They continue to work with new missions and campaign sponsors to develop and finalize tracking plans and to establish recommended tracking priorities.

- The Data Formats and Procedures under the coordination of John Luck, from the Australian Land Information Group (AUSLIG), has been tightening up existing formats and procedures, rectifying anomalies,

providing standardized documentation through the web site, and setting up study subgroups and teams to deal with more complicated issues. This group also recommended the establishment of the Ad-Hoc Signal Analysis Working Group.

- The Networks and Engineering Working Group, under the coordination of Werner Gurtner from the University of Berne, Switzerland, has (1) developed the new ILRS Site and System Information Form which is being distributed to the stations to keep the engineering database current, (2) provided a new online satellite-link analysis capability for system design and performance evaluation, and (3) initiated the development of the ILRS technology database.

- The Analysis Working Group under the coordination of Ron Noomen, from the Delft Institute for Earth-Oriented Space Research (DEOS) in the Netherlands, has been working with the ILRS Analysis Centers to develop a unified set of analysis products presented in the internationally accepted SINEX format. Three associated pilot programs are underway to assess differences among analysis products from the different centers.

- The Signal Processing Ad-Hoc Working Group under the coordination of Graham Appleby, from ITE Monks Wood, United Kingdom, is working on improved center-of-mass corrections and signal processing techniques for SLR satellites.

The Central Bureau (CB) has also been very active. In addition to providing effective communications to, and coordinating the various activities of, the various elements of the ILRS, the CB has been actively providing new conveniences (such as targeted email exploders) and adding to the technical and scientific database. The information available via the ILRS Web Site has grown enormously since its inception, and many new links to related organizations and sites have been established. The site provides details and photographic material on the ILRS, the satellites and campaigns, individual SLR station characteristics, a scientific and technical bibliography on SLR and its applications, current activities of the Governing Board Working Groups and Central Bureau, meeting minutes and reports (including annual reports), tracking plans, etc. In coming months and years, much more technical material and reports is expected to be made available online with an enhanced search capability to quickly isolate specific material of interest.

FUTURE CHALLENGES

Some of the important challenges for the future include**:**

1. strengthening ILRS liaison with the scientific community;

2. maintaining the momentum of the working groups in identifying, studying, and recommending solutions to problems in their respective areas of responsibility;

3. improving our ability to track “very” low earth orbiting satellites through improved coordination and predictions in preparation for missions such as CHAMP and GRACE;

4. encouraging and helping tracking stations and analysis centers meet their minimum performance criteria;

5. developing an ILRS "standard" global solution for submission to the IERS and maintenance of the International Terrestrial Reference Frame (ITRF);

6. adopting a global analysis results format (such as a modified SINEX) to further encourage the use of different data types (e.g., SLR, VLBI, GPS, GLONASS, DORIS, etc.) in combined solutions by the geodetic community; and

7. continuing the development of the ILRS Web Site and database, especially in the areas of technology, science and applications, and formalizing the process by which updates are approved.