Co-Location and Local Tie Information at the International Laser Ranging Service (ILRS)

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1 Introduction

The ILRS supports programs in geodesy, geophysics, oceanography, and lunar research by managing a network of over 40 stations (see Figure 1) that routinely track nearly 30 retroreflector-equipped satellites and five retroreflectors on the Moon to support user needs. Data are routinely provided to the ILRS data centers on a daily and hourly basis. ILRS Analysis Centers, university, government, and other users download these data and produce products to support applications in Earth orientation, station positions and velocities, time varying geocenter coordinates, static and time varying components of the Earth's gravity field, precision orbit determination, fundamental physical constants, lunar ephemerides and librations, and lunar orientation.

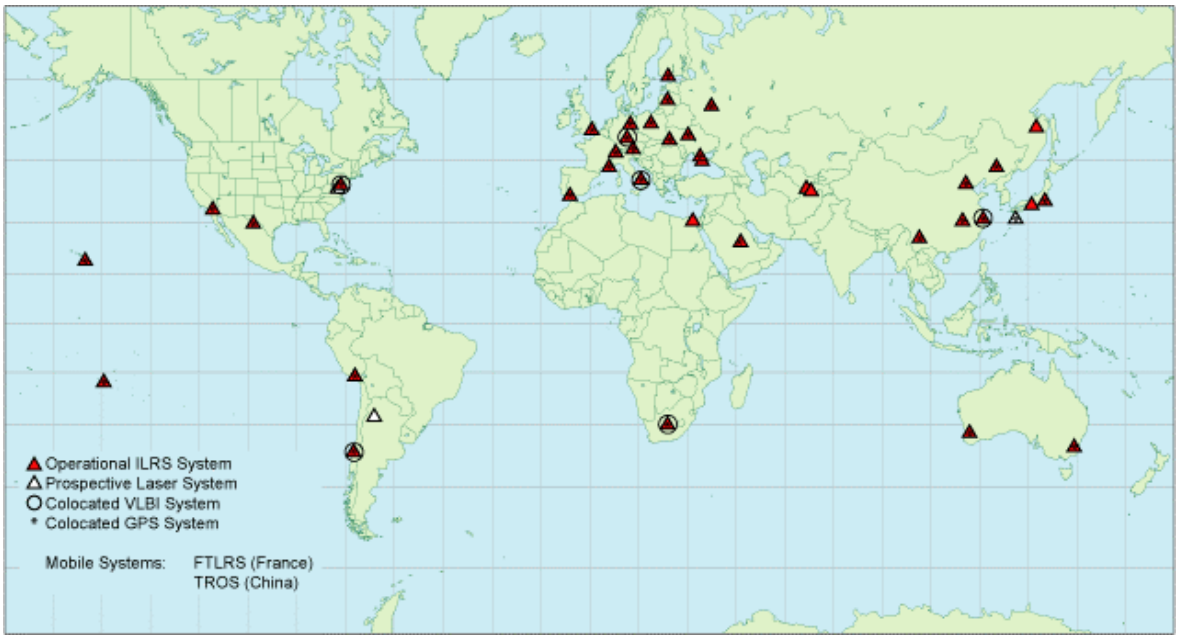

Figure 1: The ILRS network in 2003.

New stations must adhere to ILRS requirements to be accepted into the network. New stations are accepted into the ILRS network in associate status upon submission of a complete site log and associated configuration files. Associate stations become operational by:

- delivering at least 10 passes of satellite data to the CB that pass format and data integrity validation by the CB;
- delivering at least 50 LAGEOS passes to an ILRS Data Center that satisfy rms, short-term stability, and acceptance criteria over a consecutive three-month period during the previous 12 months;
- passing data evaluation by the Analysis Working Group;

- having a collocated GPS receiver that is part of the IGS network;
- receiving approval from the Governing Board.

In 2003, a joint NASA-IGN team surveyed the stations in Shanghai China and Hartebeesthoek South Africa to verify the ground surveys to laser monuments and to collocated instruments. The analysis of these surveys is still underway.

2 Site Metadata in the ILRS

The format for the ILRS site log was based upon the successful site log used by the IGS, which was then modified to include laser-system specific parameters. Each site log also contains information about the location of the site and any co-located systems. The ILRS site reference point is assigned a unique four-digit station number and a DOMES number. The DOMES numbering system was developed in the early 1980s as a way to assign an unambiguous identifier to instrument reference points and ground markers; more information about the DOMES numbering system can be found at the ITRF website http://itrf.ensg.ign.fr/domes_desc.php. The ILRS site logs are accessible through the ILRS website[1]

The major categories contained the ILRS site log are:

1. System Reference Point (SRP) identification
   - DOMES number
   - monument number
2. Site location information
   - city, country
   - approximate position
3. General system information
   - ILRS code
   - monument and site occupation designator
   - eccentricities
4. Telescope information
5. Laser system information
6. Receiver system
   - primary chain
   - secondary chain
7. Tracking capabilities
8. Calibration
9. Time and frequency standards
   - Frequency standard type
   - GPS timing receiver
10. Preprocessing information
11. Aircraft detection
12. Meteorological instrumentation
13. Local ties, eccentricities, and co-location information
    - Collocated permanent geodetic systems (GPS, GLONASS, DORIS, PRARE, VLBI, gravimeter)
    - local ties from the SRP to other monuments or systems on site
    - eccentricities between other monuments on site
14. Local events possibly affecting computed position
15. On-site, point of contact agency information
16. Responsible agency (if different from 15.)
17. More information

[1] ftp://cddis.gsfc.nasa.gov/pub/reports/slrlog/

Station operators are asked to issue updates to their site log whenever major changes occur; old logs are archived. Co-location information, in particular, the three dimensional vectors between the reference points of different space geodetic instruments, is included in the ILRS site log (as it is included in the IGS and IVS site logs). Unfortunately, at this time there is no method (other than human perusal of all logs) for coordinating these entries to ensure they are consistent across the services.

SLR eccentricity information, the three-dimensional vector from the SLR measurement point to a reference marker, is of critical importance to SLR analysis. Eccentricities are measured for both mobile occupations and fixed systems.

Mobile ILRS systems usually occupy and are referenced to a physical ground monument/mark and have an associated set of non-zero eccentricities. System eccentricities are defined as the offsets (usually less than 15 meters) from the ground monument/mark to the optical reference point of the system (i.e., the intersection of the telescope axes). A given monument may be occupied by more than one system or may be occupied by the same system multiple times, but never during the same time period. Therefore, for a given monument and time period, there will be a unique set of eccentricities. A monument is assigned both a station number and DOMES number.

Permanent or fixed systems were designed to remain in one place and usually do not occupy a ground monument/mark. In this case, the reference point is the intersection of the horizontal and vertical axes of the telescope. The system eccentricities are by definition zero. In the rare occasion that a permanent system or its intersection of axes is relocated, new occupation information is recorded (i.e., a new station number and DOMES number).

The ILRS sites are responsible for providing system eccentricity in the site log. The ILRS Central Bureau maintains two SINEX files that contain site eccentricities in North, East, Up and X, Y, Z formats. In these files, each eccentricity set has a unique station number and time frame. These files are available at ftp://cddis.gsfc.nasa.gov/pub/slrocc.

3 Site Guidelines

ILRS site guidelines are also documented on the ILRS website. ILRS stations must adhere to the following requirements:

- Register with the ILRS (new stations)
- Request identifiers (new stations):
  - Site occupation designator (station number, system number, and occupation number) from the ILRS Central Bureau
  - DOMES number (IERS)
- Deliver data on a hourly/daily basis to ILRS data centers:
  - Normal point
  - Full-rate
- Maintain site files and forward updates to the ILRS Central Bureau for posting on the website:
  - Site log
  - Configuration files
  - System eccentricities
- Maintain station qualification following ILRS criteria

4 Conclusions

The ultimate capability of the integrated geodetic networks can only be realized if the local inter-technique ground surveys are accurately performed, reported, and maintained. Every effort should be made by all IAG services to coordinate these efforts.

5 Acknowledgements

We wish to thank the ILRS stations, operations centers, data centers, and analysis centers for their strong participation toward the continued success of the ILRS.