

## **ILRS Network and Station Assessment Software: Overview**

Justine Woo, Sigma Space Corporation

Evan Hoffman, NASA Goddard Space Flight Center

Mark Torrence, Stinger Ghaffarian Technologies, Inc.

### **Introduction**

The Crustal Dynamics Data Information System (CDDIS), established in 1982, serves as a global data center supporting the space geodesy and geodynamics community as a dedicated archive and distribution center. In its role, CDDIS continues to actively support the International Laser Ranging Service (ILRS) goals through various contributions. The ability to measure network capability and performance has become increasingly critical as the network continues to grow and the number of satellites being tracked increase. A study group formulated by the ILRS Central Bureau has been working to define parameters for assessing network capabilities for altimetry, geodetic, and GNSS satellites. To better understand the parameters, visualizations were created at CDDIS which evolved into the prototype ILRS Network and Station Assessment Software. In addition to its original intent, the software has also grown to include assessments of individual station performance to allow stations to determine steps for improvement to support network goals.

### **Parameters and Software**

The 2015 ILRS System Performance Standards provide guidelines on the number of passes required, data quality, and operational compliance for stations. Current system performance standards are based on a combination of inputs from analysts and estimated operational capacity of the global network. For geodetic targets such as LAGEOS, a goal for total number of passes per week and per year are set to ensure sufficient coverage to determine the reference frame. For many other targets, specific requirements are not given by the mission, and a goal is set based on past performance of the network as a whole. Data quality standards are set to move the network towards millimeter level precision in accordance with the Global Geodetic Observing System (GGOS) reference frame goals.

System performance and data quality standard requirements are a subset of the metrics used in the assessment software. These requirements are not station specific and applied to all station equally. However, this may change if ILRS resources permit and there is interest. This assessment software is a small step towards individuating stations for fair assessment. For example, a station that was not designed to track High Earth Orbit (HEO) targets should not be shown to be an underperformer based on that metric. Many other metrics are extracted from suggestions given at the Riga conference and are used to show the different capabilities of the network.

The metrics that will be included in this release are as follows:

General Metrics:

1. Comprehensive Score
2. Number of Lunar Passes Tracked (Note: this is not a requirement, it only shows who participates in LLR tracking)
3. Total Number of Passes: 3500 Minimum
4. Total Normal Points per Pass: 3 Minimum

#### Priority List Adherence Metrics:

- Minimum of 1% of Passes Tracked are from the Top 10 Satellites on the Priority List: 1% Minimum
- Minimum of 15% of Passes Tracked are from the Top 20 Satellites on the Priority List: 15% Minimum
- Percentage of Satellites Tracked not on the Priority List: 35% Maximum
- Percentage of Distinct Satellites on the Priority List Tracked: 25% Minimum

#### Altimetry:

- Total Number of LEO Passes: 2300 Minimum
- Total Number of LEO Passes: 2300 Minimum - Percentage of ILRS standard
- LEO Number of NPT per Pass: 8 Minimum

#### Geodetic

- Tracked all LAGEOS and LARES
- Total Number of LAGEOS Passes: 600 Minimum
- Total Number of LAGEOS-1 Passes: 200 Minimum
- Total Number of LAGEOS-2 Passes: 200 Minimum
- Total Number of LARES Passes: 200 Minimum

#### Etalon

- Tracked all Etalon
- Total Number of Etalon Passes: 50 Minimum
- Etalon Number of NPT per Pass: 3 Minimum

#### GNSS

- Tracked All GNSS Constellations: Compass, Galileo, GLONASS
- GNSS Number of NPT per Pass: 3 Minimum

Tools were built to provide insight into core parameters including the global report cards, station information plots, and ground tracking maps. The quarterly and monthly report cards, available from 1997, provide a review of the data volume and quality by station over the previous twelve month period

([https://ilrs.cddis.eosdis.nasa.gov/network/system\\_performance/global\\_report\\_cards/monthly/index.html](https://ilrs.cddis.eosdis.nasa.gov/network/system_performance/global_report_cards/monthly/index.html)). The station information plots summarize the data quality and environmental parameters for LAGEOS satellites by station over the previous twelve month period ([https://ilrs.cddis.eosdis.nasa.gov/network/stations/station\\_info\\_plots\\_past\\_12\\_months.html](https://ilrs.cddis.eosdis.nasa.gov/network/stations/station_info_plots_past_12_months.html)).

The ground tracking maps provide a visualization of network tracking over the past week ([https://ilrs.cddis.eosdis.nasa.gov/network/system\\_performance/recent\\_groundtrack.html](https://ilrs.cddis.eosdis.nasa.gov/network/system_performance/recent_groundtrack.html)).

The ILRS Network and Station Assessment Software is a supplement, not a replacement, for these tools and works to fill in some gaps. The existing tools do not provide a comprehensive understand of performance across multiple parameters, nor do they aid stations in determining next steps. The ILRS Network and Station Assessment Software works to address this need alongside addressing the individual needs of each satellite type.

## Uses

For each parameter, an individual map was created to visualize the network capabilities. Maps may be used individually or combined to provide a narrative to better understand the extent to which the network supports different goals and to identify gaps. In addition, they allow for parameter reassessment. The overall network performance for individual stations may be utilized to determine how well stations are performing based on quantitative metrics. Qualitative metrics will be added in the future.

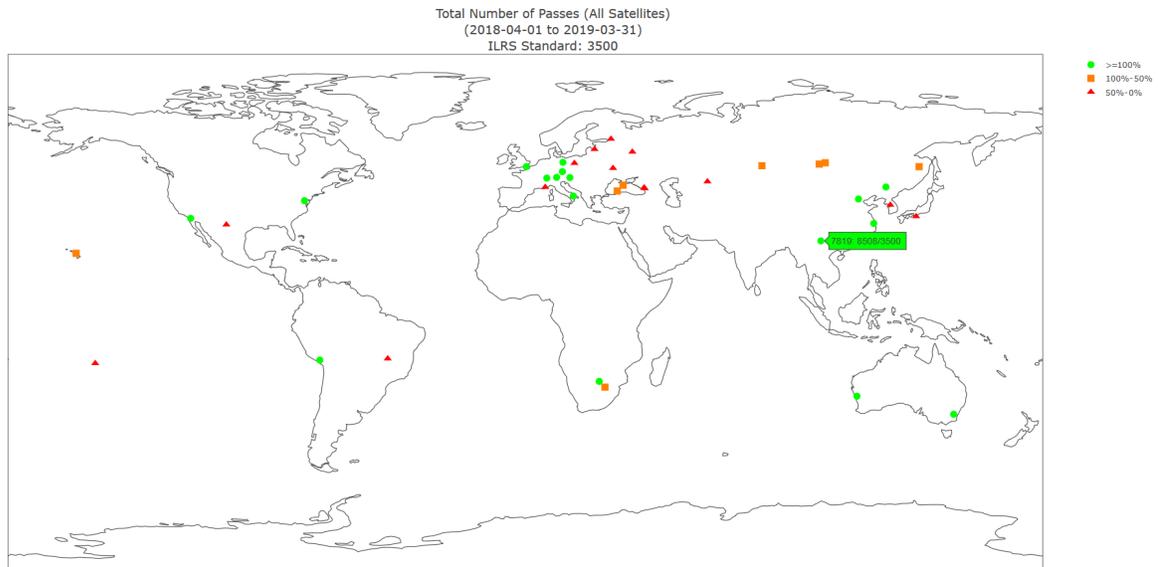


Figure 1: Example Map of the Total Number of Passes (All Satellites) Tracked

Figure 1 is an example of the plots created by the software and presents the network capability for meeting the total number of passes set in the 2015 ILRS System Performance Standards. For more information about a specific station, hovering over the station will show the number of passes taken. The website will contain information on additional functions.

## Future Work

The ILRS Network and Station Assessment Software will incorporate changes based on inputs from station clinic attendees for its initial release. Due to limitations based on the software packages used to build these maps, CDDIS is not able to incorporate all features at this time. The maps will be available on the ILRS website within the System Performance section. Additional releases will become available as additional parameters are defined.