The 2017 Tracking Data Use Questionnaire Summary

M. Pearlman, M. Kuzmicz-Cieslak, and E. C. Pavlis

The network stations have a wide spectrum of performance, some are oversubscribed, while others are producing very little data (see M. Pearlman and C. Noll, "*A View of ILRS Station Performance*"; see below). We need to work the deficiency from both station performance and the satellite workload points of view.

The ILRS issued a User Survey to better understand the needs of the users, and where we might make some changes in tracking strategy to increase the overall value of the data. Underlying this of course is the tracking requirement for the reference frame.

As of the Riga Workshop, we have received 66 replies, of which eight were on behalf of specific missions/entities: GRACE, TerraSAR-X, TanDEM-X, KOMPSAT, LARES, ILRS for ITRF, Sentinel-3A and GLONASS. Additional responses will be incorporated into the results as they are received.

For the sake of categorization, Satellites were classified into
- Geodetic spheres – AJISAI, Etalon, LAGEOS, LARES, Starlette, Stella, Larets;
- Altimetry Missions – Cryosat, HY-2A, Jason, SARAL, Sentinel-3;
- GNSS Constellations – GPS, GLONASS, Galileo, BeiDou, IRNSS, QZS;
- Remote Sensing Missions (LEOs) – GRACE, Beacon-C, KOMPSAT-5, PN-1A, STSAT-2C, Swarm; and
- Lunar reflectors, RadioAstron/Spektr-R, LRO/LR

Application categories were:
- Science Products;
- Precision Orbit Determination;
- Calibration and Instrument Validation;
- Engineering Applications or Demonstrations;
- Other applications

Questions asked were:
- Do you use ILRS data from any of the targets in each group?
- How many passes on each satellite do you require per week?
- Any special characteristics/conditions for the data that you need?
- What data accuracy do you require?
- Can your work be done with periodic campaigns instead of continuous tracking?
- What products do you generate with the data?
- Are those data products made public?
- General comments

User Interest

In general (either through the survey or verbal contact) all the satellites on the ILRS tracking roster are important to some investigators. We are not tracking anything that nobody wants. Some investigators "need everything they can get". Others would be satisfied with a geographic and/or temporal sampling.

In the Geodetic Spherescategory, twelve of the responders use LAGEOS; 46 use at least one of these satellites (See Fig. 1). Applications include Reference Frame, gravity field, long period perturbations, etc.
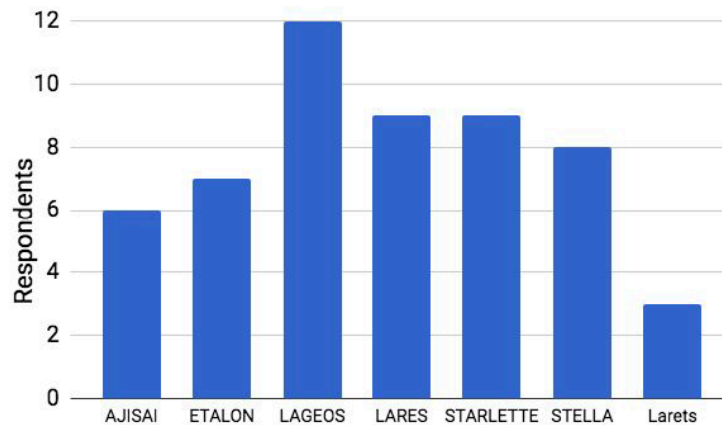

Fig 1. Distribution of data usage for the Geodetic Spheres category

Twenty-seven of the responders use ILRS data from all the altimeter satellites. Two of them requested the we try to get continuous data from low to high elevations.

Thirty-eight responders use the GNSS data (see Fig 2); each of the GNSS constellations has 5-6 users. Twenty-four responders are using the data from the Remote Sensing LEO satellites (see Fig. 3). A few of these satellites had no users among the responders, but some users that we are aware of, did not respond in written form (shame on them). We will probe the data users that we know of.
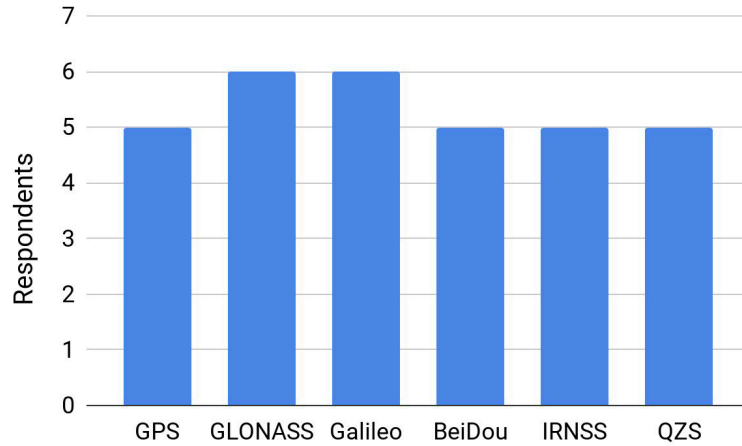
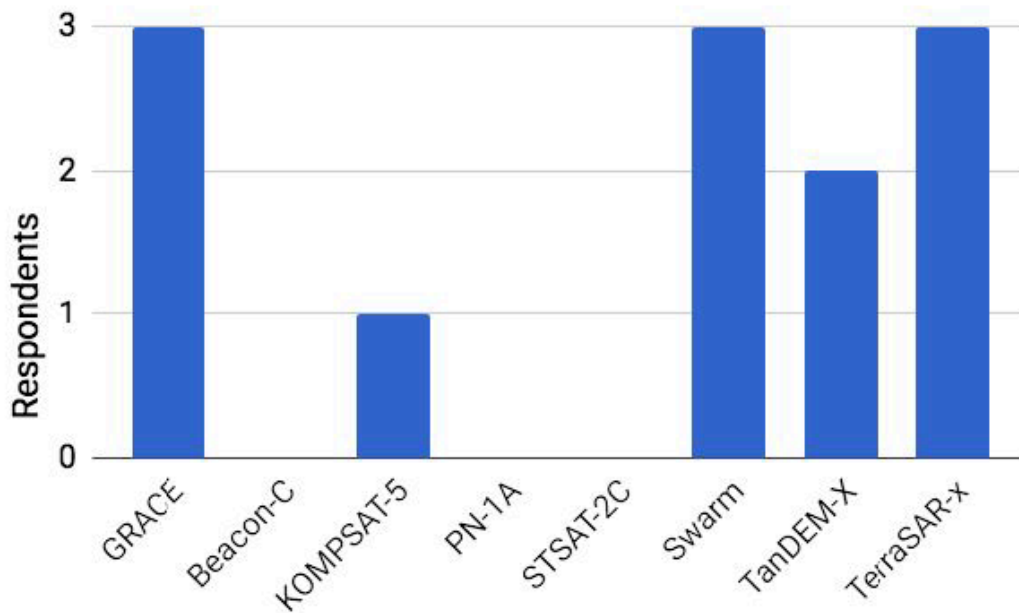Fig. 2. Distribution of data usage for GNSS Constellations

Fig 3. Distribution of data usage for Remote Sensing Satellites

Eight responded positively on the use of the High Targets (Lunar reflectors, RadioAstron/Spektr-R, LRO/LR).

Data Volume

There was a wide variation in the requested data volume. For the Geodetic spheres: two-thirds of the responders wanted more that 100 passes per week; a third would be satisfied with 50. For reference, the simulations conducted to date were based on 200 passes/year on each of LAGEOS, LAGEOS-2, and LARES (averaging 4 passes per week per station on each).

For altimeter missions, again, two-thirds of the responders wanted at least 100 passes per week and one-third would be satisfied with 50.

For the GNSS constellations, 45% wanted greater than 100 passes per week, the rest were split evenly between 1-20 passes and 21-50 passes. Our current operation is certainly below all but the minimum performance. The difference in requirements is probably a reflection of use in different applications.

For the LEO remote sensing satellites, fifty percent asked for more than 100 passes per week for GRACE, Beacon-C, KOMPSAT-5, Swarm, TanDEM-X, TerraSAR-x; seventy-five percent asked for 1-20 passes for PN-1A, STSAT-2C; 25% would be satisfied with 21-50 passes per week.

On Lunar Targets, sixty percent of the responders asked for 6-10 data sequences on each lunar reflector; 30 percent would be satisfied with 1-5 sequences on each.

Data Quality

Sixty percent of the responders asked for millimeter or better accuracy data; 30% were satisfied with a centimeter. A similar percentage of respondents asked for NP, day and night-time data, and low and high elevation data. A much smaller percentage asked for Full Rate data as well. There was no interest expressed for only day time or only night time data. A small percentage (15%) were willing to restrict their data to periodic campaigns. However, for GNSS and Lunar Ranging, the users were split 50-50.

Some Observations:

1. The data requirements for the reference frame have been specified; a dozen or so stations are already meeting the reference framer requirements; another 4-6 stations should be operating in robust mode within the next year. The real problem will be achieving a balanced global distribution.
2. There is a spread in the data requirements for the altimeter satellites; many weeks the network achieves or comes close to the 100 passes per week level for some of the satellites;
3. We do not come close to 100 passes per week on any of the GNSS satellites; This is partly due to GNSS-target saturation of the network.
4. The most stringent accuracy requests are 1 mm, a performance that we will need to meet for the future reference frame development.

Those interested in the results of the survey in more detail, can visit the associated poster in this session: *"ILRS Tracking Data Requirements Survey 2017", Magdalena Kuzmicz-Cieslak and Erricos C. Pavlis.*

Some thoughts that came to mind from the survey results:

- In places where we have a high concentration of stations (at the moment only over Europe), we should try dynamic priorities and tasking to provide a better spread of coverage among the satellites on the roster; this would be a combination of spatial and temporal variation in priorities among the stations; some real-time communication and coordination of scheduling will be required in order to make this work;
- We should run more LARGE Campaigns to focus the GNSS tracking to smaller sets of satellites in each constellation;
- We should try to organize campaigns for those satellites that the users need only periodic sampling;