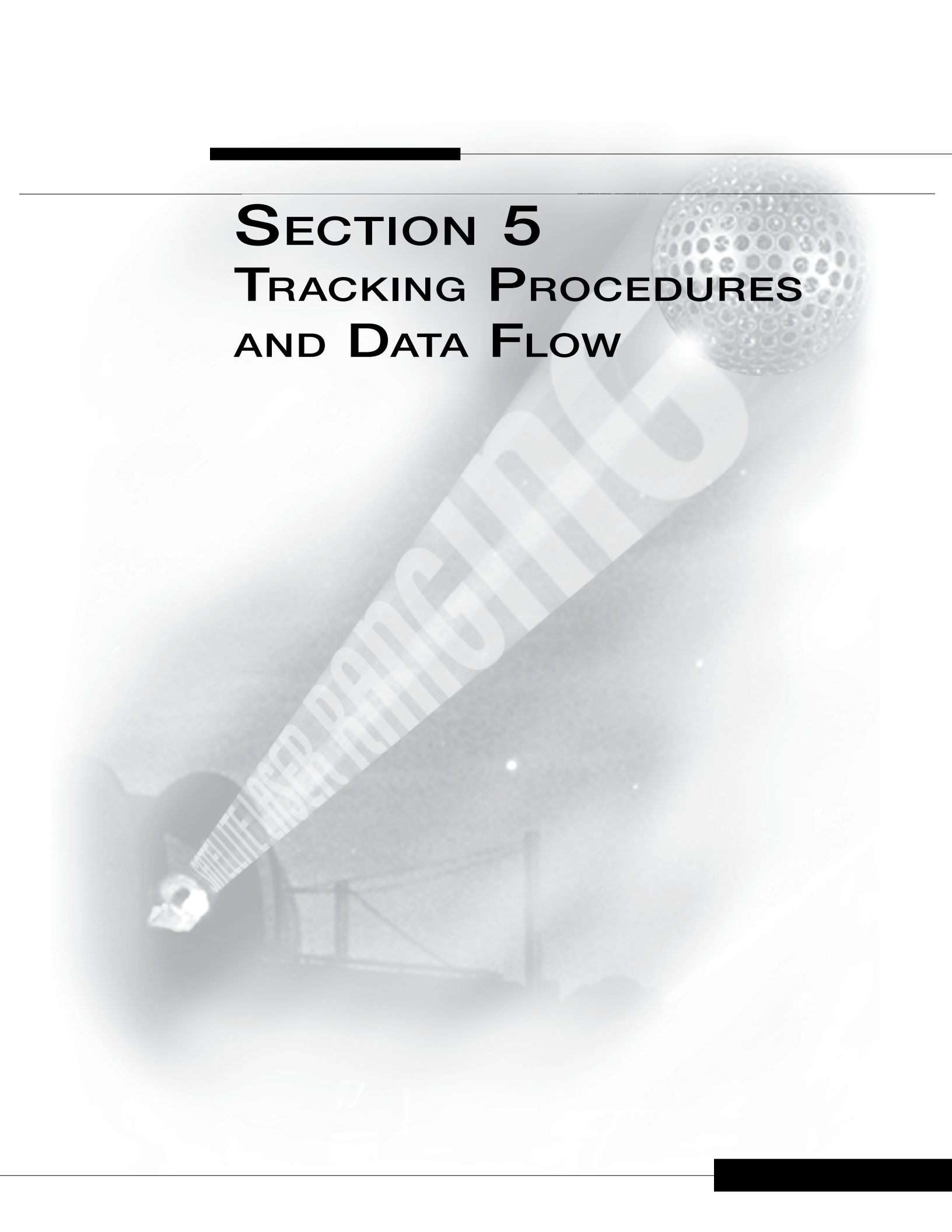
Section 5
Tracking Procedures and Data Flow



Section 5

Tracking Procedures and Data Flow

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Tracking Priorities

The ILRS tries to order its tracking priorities (shown in Table 5-1) to maximize the utility to the users of ILRS data. Nominally tracking priorities decrease with increasing orbital altitude and increasing orbital inclination (at a given altitude). Priorities for some satellites are then increased to intensify support for active missions (such as altimetry), special campaigns (such as satellite in eclipsing orbit), and post-launch intensive tracking campaigns. Some slight reordering may then be given missions with increased importance to the analysis community. Some tandem missions (e.g., GRACE-A and -B) may be tracked on alternate passes at the request of the sponsor. Stations may also adjust priorities to accommodate local conditions such as system capabilities, weather, and special program interests.

Table 5-1. Satellite and Lunar Tracking Priorities (as of December 2008)

Satellite Priorities					
Priority	**Satellite**	**Sponsor**	**Altitude (km)**	**Inclination (degrees)**	**Comments**
1	GRACE-A/B	GFZ, JPL	485-500	89	Tandem mission
2	CHAMP	GFZ	429-474	87.3	
3	TerraSAR-X	Infoterra/DLR/GFZ/ CSR	514	87.27	
4	Envisat	ESA	796	98.6	Tandem mission with ERS-2
5	ERS-2	ESA	800	98.6	Tandem mission with Envisat
6	Jason-1	NASA, CNES	1,350	66.0	Tandem mission with Jason-2
7	Jason-2	NASA, CNES, Eumetsat, NOAA	1,336	66.0	Tandem mission with Jason-1
8	OICETS	JAXA	610	97.83	
	Larets	IPIE	691	98.2	
10	Starlette	CNES	815-1,100	49.8	
11	Stella	CNES	815	98.6	
12	Ajisai	JAXA	1,485	50	
13	LAGEOS-2	ASI, NASA	5,625	52.6	
14	LAGEOS-1	NASA	5,850	109.8	
15	BE-C	NASA	950-1,300	41	
16	Etalon-1	Russian Federation	19,100	65.3	
17	Etalon-2	Russian Federation	19,100	65.2	

18	Compass-M1	China	21,500	55.5	
19	GLONASS-99	Russian Federation	19,400	65	Replaced GLONASS-87 (12-Jan-2007)
20	GLONASS-109	Russian Federation	19,400	65	Replaced GLONASS-95 (28-May-2008)
21	GLONASS-102	Russian Federation	19,400	65	Replaced GLONASS-89 (04-May-2007)
22	GPS-35	U.S. DoD	20,100	54.2	
23	GPS-36	U.S. DoD	20,100	55.0	
24	GIOVE-B	ESA	23,916	56	
25	GIOVE-A	ESA	29,601	56	

Lunar Priorities

Priority	Retroreflector Array	Sponsor	Altitude (km)
1	Apollo 15	NASA	356,400
2	Apollo 11	NASA	356,400
3	Apollo 14	NASA	356,400
4	Luna 21	Russian Federation	356,400
5	Luna 17	Russian Federation	356,400

Tracking priorities are formally reviewed semi-annually by the ILRS Governing Board. Updates are made as necessary. The Central Bureau communicates these updates to the ILRS stations.

Predictions

Current Status

There are now ten centers that provide SLR predictions on a regular basis (see Table 5-2).
The consolidated laser ranging prediction format (see below) is now operational within the ILRS. This format can be used for ranging to near Earth satellites and the Moon, and for transponder ranging to planets and interplanetary spacecraft. Also included are options for standardizing prediction interpolators used at the stations. In 2006, the tracking of very low Earth orbit satellites increased significantly with sub-daily distribution of the new, higher quality CPF predictions.

The ILRS is encouraging stations to use the mission provided or sanctioned predictions for these satellites where they are available. Some of the recent missions have periodic maneuvers or drag compensation capability, and some also have GPS data to enhance the SLR predictions. Since the missions have the most up-to-date information of this type, they are in the best position to keep predictions current.

Table 5-2. Satellite Prediction Providers

Center	Interval	Satellites
CNES	Daily	Jason
CODE	Daily	GLONASS, GPS
ESOC	Daily	Envisat, ERS-2, GIOVE
GFZ	Sub-daily	GRACE, CHAMP, TerraSAR-X
HTSI	Daily	Ajisai, BE-C, Compass-M1, Envisat, ERS-2, Etalon, GIOVE, GLONASS, GPS, Jason, LAGEOS, Larets, Starlette, Stella
JAXA	Daily	Ajisai, ALOS LAGEOS, OICETS, ETS-8
MCC	Daily	Larets
NSGF	Daily	Ajisai, BE-C, Envisat, ERS-2, Etalon, Jason, LAGEOS, Larets, Starlette, Stella
NRL	Sub-daily	ANDE-RR
SAO	Sub-weekly	Compass-M1
UTX	Daily	ICESat, Moon

Consolidated Prediction Format (CPF)

Randy Ricklefs/University of Texas at Austin, CSR

The ILRS Governing Board approved the new Consolidated Prediction Format (CPF) in October 2005, and since then all operating stations have been converted to use this new format. There is also an ongoing effort to implement the CPF for laser ranging support of the first transponder mission to the Moon, the Lunar Reconnaissance Orbiter (LRO).

Restricted Tracking on Vulnerable Satellites

Michael Pearlman/CfA, Randy Ricklefs/University of Texas at Austin, CSR, Julie Horvath/HTSI

During the last two years, network procedures have been implemented to protect satellites that are vulnerable to laser radiation. Satellites such as ICESat and ALOS have optical sensors aboard that could be damaged. Restricted satellite missions may opt to request one, two, or all of the possible restrictions for their mission, but the numbers 1 and 5 below are required procedures. The procedures include:

1. Predictions are sent to only participating (qualified) stations;
2. Stations are restricted to a maximum ranging elevation to protect fixed nadir pointing sensor(s);
3. Missions provide allowable pass segment files to carefully define tracking and non-tracking periods;
4. Stations are constrained by a mission provided, Web accessible GO/NO-GO flag which allows immediate (within 5 minutes) cessation of all network tracking of target;
5. Stations can also be constrained to a mission-defined maximum power delivered to the spacecraft; and
6. Participation is limited to trusted stations that have demonstrated ability to handle the pass segment file and GO/NO-GO flag.

Among the ILRS stations that have implemented these procedures include: Mt. Stromlo, Riga, Koganei, Monument Peak, Hartebeesthoek, Yarragadee, Tanegashima, Zimmerwald, Herstmonceux, Greenbelt, and TLRS-4 (Haleakala). A questionnaire is being developed to learn which stations have implemented which restrictions. ICESat is presently operating under restricted tracking conditions.

Data Transmission

The ILRS continues to improve data throughput. Data from the field stations are now submitted hourly and made available immediately through the data centers for rapid access by the user community and prediction providers. With this faster submission of data, better quality predictions are available more frequently and prediction quality assessment is available in near real-time.

Consolidated Laser Ranging Data Format (CRD)

Randy Ricklefs/University of Texas at Austin, CSR

Due to the one-way laser ranging support of the Lunar Reconnaissance Orbiter (LRO) mission, and the growing number of stations with lasers firing at a kilohertz rate, the Data Formats and Procedures Working Group has re-written the formats for the ILRS full-rate, normal point, and sampled engineering data types. The older formats do not allow for many of the fields or field sizes required for ranging to transponders. In addition, the current full-rate format is too cumbersome for the amount of data produced by kilohertz laser ranging. The new format encompasses all three data types for SLR, LLR, and transponder targets. The Consolidated Laser Ranging Data (CRD) format uses the same building block approach as the Consolidated Prediction Format (CPF), which allows modularity, flexibility, and expandability. Since the CRD format is considerably more complicated than the old formats, a process was developed by which the ILRS Operations Centers (OCs) at EDC and NASA/HTSI and the AWG would validate CRD normal points from each station. Once a station's data are validated, the station will submit data only in the CRD format. As of the end of 2008, at least MLRS, Mt. Stromlo, Changchun, Wettzell, Matera, and Herstmonceux were providing normal points to the ILRS in CRD format (as well as the old format), and the process of validating the stations had begun. At the same time, many of these stations, plus Zimmerwald and Grasse were producing full-rate data in CRD format, primarily for support of the T2L2 experiment on Jason-2.