NASA SLR Network Status

- All NASA SLR stations are currently operational (MOBLAS-4, 5, 6, 7, 8, & MLRS)
- Single shift operations at MOBLAS-7
- Multiple shift operations at MOBLAS-4, 5, 6, 8 & MLRS
- Increase SLR network infrastructure by several engineers
- Re-open Arequipa (TLRS-3) site in March 2005
- Re-open Hawaii site using TLRS-4 in August 2005
- Continue SLR2000 prototype development

NASA Network Replacement Status: Dec 2004

➢ SLR2000 prototype development

- **Upgraded receiver optics installed and aligned**.
  New optics optimize focus & provide adjustable field of view stop.
- **Replaced original detector with off-the-shelf spare**. New detector appears to have a factor of 3 - 4 improvement in sensitivity. Unclear why original detector sensitivity degraded.
- **Much improved tracking performance with new receiver optics and new detector**.
  Now getting > 50% return to fire ratio on TOPEX when pointing optimized - using 60 microJoule transmit energy and > 75 microradian divergence. Expect 100% return to fire ratio on TOPEX in future.
- **Point-ahead and closed-loop tracking software installed and in testing**.
- **New laser due in by end of December**.

➢ Network replacement effort

- **NASA/HQ Review on July 26, 2004**. Action items in progress (7 out of 9 completed).
- **Positive preliminary feedback**:
  Awaiting final review comments and future plans from NASA/HQ on Review.
- **Team consists of D. Carter, T. Zagwodzki, J.McGarry.**
- **RFI for replacement effort released on November 23, 2004.**

ILRS Ranging to ICESat

- There have been identified 3 types of restrictions with respect to the ILRS's tracking of vulnerable targets:
  - An angle restriction (for example, ICESat's 70-degree elevation cutoff);
  - A "go/no-go" restriction (gives a mission control center the ability to enact a global restriction on ranging to its target);
  - A pass-segment restriction (for example, ALOS's requirements for its multiple sensor satellite).
- Some targets will require none, one, two or all three of the above.

“Restrictions” File

- Individual ” restriction” files will be maintained at the mission control center of each target that desires ILRS tracking, when that target is defined to be vulnerable.
- Pass segment files (not relevant to ICESat) will be available, together with the predictions at some time in advance of the actual passes, allowing stations ample time to schedule time and personnel.
- Only authorized stations will be able to access the restrictions and predictions files.

Present Situation

- At the GSFC meeting, we agreed to only consider the implementation of a “go/no-go” restriction.
- At the MLRS, we are actually looking at both the angle and go/no restrictions since we need that for ICEsat at the MOBLAS and MLRS sites.
- We will keep “pass segments” in mind, but on the “back burner”, so as not to preclude action at a future time.

Implementation (Part 1)

- A participating station, for any given target. will have a "cron" task that copies this target's "restrictions" file from the mission control center's ftp/scp site every "n" minutes, n usually being 5-15 minutes.
- We discussed whether "n" should be an interval established by the ILRS, or an interval controlled by the particular mission control center (McGarry suggested that it should be both, with the minimum period of the two being used).
- The date of file creation, when the file is copied, becomes the "copy time".

Implementation (Part 2)

- When a station is ready to range to any target, the target ID is checked to see if there are restrictions associated with that target.
- With a “no restrictions” target, ranging proceeds normally.
- If the target has restrictions, the local “restrictions file” is queried as to the nature of the restriction.
- If a “no-go” is returned, ranging is disallowed and the operator proceeds to the next target.

Implementation (Part 2) - con't

- If a "go" is obtained, the "creation time" is checked.
- If the difference between the current time and the creation time is greater than "n", ranging is disallowed and the operator proceeds to the next target. This will usually imply that a "connect" to the target's "restrictions file" was not successful and ranging will not be performed
- If a "go" is obtained and the difference between the current time and the creation time is less than "n", ranging proceeds normally.
- The "go/no-go" file is rechecked every "n" minutes (during ranging to the target) in the event there is a change of status.

Additional Comments

As already mentioned, the angle restrictions should be added to the above, if possible, in the first MLRS implementation. The current MLRS angle restriction is specifically "hard-wired" for the ICESat target

- The software should inform the operator, on-screen, whenever the target is not to be tracked, or when lasing has been suspended but tracking continues.
- Randy is to consider all of the above and proceed to implementation of the "go/no go" (and possibly, the angle restriction) scenario at the MLRS.
- He will stay in touch with Tony Mann at HTSI, to assure that similar implementations may be made at the MOBLAS systems.

ICESat Observations

(through 2004 November 30)

Station	Pad ID	Passes	Normal Points	rms (cm)
Zimmerwald (blue)	6810	10	102	0.0
McDonald (green)	7080	27	251	0.0
Greenbelt (green)	7105	14	458	0.0
Zimmerwald (red)	7810	12	124	0.0
Aggregate		63	935	0.0

Tracking Restrictions/Limitations

- Geometric limitations (no damages)
- Destruction of nadir-looking sensors
- Destruction of off-nadir looking sensors

Corner cube position
Satellite orientation

- Corner cubes not pointing to observer
- Line of sight between corner cubes and observing site obstructed by parts of spacecraft
- Pass partly or fully eliminated
- Need spacecraft attitude and geometry to compute actual tracking segments
- Cannot be done by stations
- Need station-dependent pass segment list

- Example: Gravity Probe B

Destruction of nadir-looking sensors

- Sensitive optical sensors on board can be destroyed by laser beam
- Avoid firing if site is in field of view of the sensor
  - Can be dealt with by the station
  - Tracking below maximum elevation
- Example: ICESat

Destruction of off-nadir looking sensors

- Intentional or unintentional change in attitude / pointing direction of sensor
- Need spacecraft attitude and geometry to compute actual tracking segments
- Cannot be done by stations
- Could be on short notice
  - Enforcement problem in case of unscheduled attitude changes
- Near-real time authorization for each pass

- Example: ALOS (Japan, end of 2005)

Maximum Elevation: ICESat

- Usually nadir pointing. Occasional tilts < 7 deg
- Maximum Elevation: 70 degrees
- Stations individually divide high-elevation passes into two segments ending/starting at 70 degrees elevation
- Currently tracking stations:
  McDonald, Zimmerwald, Graz
- Rather informal agreement (e-mail)

Pass Segment List

- Mission control generates station-dependent pass lists
  - Satellite and Station names
  - Start and End times of tracking segments
  - More than one segment per pass possible
- Distribution
  - Similar to predictions: One global file
  - Individual distribution of station-dependent files
- Used for Gravity Probe B, planned for ALOS

Pass List: Used for GP-B

Satellite : GP-B
Generation Date : 2004-05-18 21:21:48 [UTC]
Generated by : GP-B Mission Operations / Stanford University
Minimum Elevation : 0 deg

ID	SAT	Start Date/Time [UTC]	End Date/Time [UTC]	MaxEl [deg]	Durtn [min]
1884	GP-B	2004-05-02 00:45:31	2004-05-02 00:56:00	23	10.5
1884	GP-B	2004-05-02 02:23:08	2004-05-02 02:32:23	16	9.2
1884	GP-B	2004-05-02 03:59:37	2004-05-02 04:09:51	21	10.2
1884	GP-B	2004-05-02 05:36:13	2004-05-02 05:48:13	47	12.0
1884	GP-B	2004-05-02 07:14:32	2004-05-02 07:26:40	48	12.1
1884	GP-B	2004-05-02 08:56:19	2004-05-02 09:03:51	10	7.5
1884	GP-B	2004-05-02 20:58:28	2004-05-02 21:09:21	24	10.9
1884	GP-B	2004-05-02 22:36:36	2004-05-02 22:49:00	84	12.4

ID	SAT	Start Date/Time [UTC]	End Date/Time [UTC]	MaxEl [deg]	Durtn [min]
7080	GP-B	2004-05-02 04:22:01	2004-05-02 04:29:53	11	7.9
7080	GP-B	2004-05-02 05:58:25	2004-05-02 06:10:38	67	12.2
7080	GP-B	2004-05-02 07:39:29	2004-05-02 07:44:25	7	4.9
7080	GP-B	2004-05-02 15:32:06	2004-05-02 15:43:20	31	11.2
7080	GP-B	2004-05-02 17:10:26	2004-05-02 17:21:28	27	11.0

Pass-By-Pass Authorization

- ICESat: Few-days-by-few-days authorization (IRVs for a few days only)
- Development of a Go-No-go flag file at mission sponsor's server
- Check flag immediately before start of tracking
- Mission control can modify authorization anytime before the pass begins
- Safe in case of communication problems

"Hardware" Solution

- Proposal by Ulrich Schreiber
- Development of a black box, connected to the internet at the station
- Pass segment list downloaded by mission control
- Automatically generates inhibit signal for the laser. Needs to know currently tracked satellite

- JAXA does not intend to develop such a box for ALOS

Tests and Acceptance Procedures

- Stations tracking vulnerable satellites have to perform tests beforehand:
- Tracking of a test satellite under simulated tracking restrictions
  - Checks of forbidden intervals in the ranging data (normal point or full rate)
- “Dry” tracking of vulnerable satellite
- Description of procedures to handle such satellites
- Permission to track only after successful tests

Tracking of sensitive targets

- Liability
  - What happens in case of sensors damaged by SLR?
  - Do we need legal contracts denying all liability?

The Present Structure of GGOS