STEREO MOC Status Report
Time Period: 2016:144 - 2016:150

STEREO Ahead (STA) Status:

1. The following Ground System anomalies/events occurred during
   this reporting period:

   • On day 144, during the DSS-55 support, turbo decoder lock
     was lost briefly at 1734z. This anomaly resulted in the
     loss of 1 frame of SSR data.

   • On day 147, before the DSS-25 support began, at 1230z, it
     was noticed that the SLE telemetry binds were lost on all
     command workstations. While this should have been due to
     the scheduled JPL to GSFC RIONet circuit switching
     maintenance, this maintenance had been postponed. After
     several failed re-attempts, the binds were successfully
     acquired before the track started. Also, the Ahead voice
     box was not functioning properly prior to the DSS-25 track,
     i.e., JPL could hear us, but we could not hear them (the
     Behind voice box was working nominally). The fault was
     isolated to a misconfiguration at NASCOM to rectified and
     two-way voice communications with JPL. Later in the
     support, turbo decoder lock was lost intermittently between
     1655z and 148-0045z. These anomalies resulted in the loss
     of 11 frames of SSR data.

   • On day 148, during the DSS-55 support, turbo decoder lock
     was lost briefly at 1142z. This anomaly resulted in the
     loss of 5 frames of SSR data.

   • On day 150, during the DSS-55 support, telemetry lock was
     lost intermittently between 1556z and 1729z due to heavy
     rain at the Madrid complex. This anomaly resulted in the
     loss of 12,406 frames of real-time telemetry and SSR data.
     See DR #M109390 for more information.

2. The following spacecraft/instrument events occurred during
   this week. The Ahead observatory operated nominally during
   this week on the center of the HGA main lobe. The HGA feed
   assembly was at 94 degrees C and decreasing with the HGA angle
   at 11.4 degrees and increasing, with respect to the
   spacecraft-Sun line.

- On day 145, the G&C wheel speed avoidance (CTL_WHLBADOFFSET) parameter for increasing the band about zero speed to 30.79 rads/second was adjusted in RAM at 1602z. This update is attempting to minimize the increase in fine pointing losses from wheel 2 stiction when it passes through zero speed.

- On day 147, during the DSS-25 support, PLASTIC real-time commanding was conducted to switch geometric factors from the main channel to the small channel to improve science data return.

- The average daily science data return for Ahead was 5.7 Gbits during this week.

STEREO Behind (STB) Status:

1. The following Ground System anomalies/events occurred during this reporting period:

   - On day 148, during the DSS-26 34m support, using the 80 kW transmitter to minimize 70m contentions, 270 commands were sent for battery state of charge recovery.

   - On day 149, during the DSS-26 34m support, using the 80 kW transmitter to minimize 70m contentions, 351 commands were sent for battery state of charge recovery.

   - On day 150, during the DSS-14 70m support, 500 commands were sent for transmitter carrier recovery. The Allen Telescope Array observed concurrently, however, no downlink signal was detected by them or the DSN. Due to the duration of the support and the increased commands for each step, only 25 of the 36 frequency segments were commanded. Three commands must be received sequentially to power on the transmitter.

2. Detailed status of the recovery activities to restore operations from the Behind loss of communication anomaly, which occurred on October 1, 2014, are listed below.

   - The Behind observatory entered superior solar conjunction at the 2.0 degree SPE angle on January 22, 2015. Recovery efforts resumed post solar conjunction on May 4th through June 27, 2015, as the spacecraft had cleared solar interference for LGA communications. The Failure Review

Board recommendations were implemented consisting of battery state of charge recovery and powering on the downlink carrier. The Green Bank Radio Telescope and the Arecibo Observatory also observed the carrier recovery tracks. No downlink signal has been detected. Due to Behind's retrograde motion causing it to re-enter the region of solar interference, recovery operations were suspended from June 28th through November 29, 2015. Weekly recovery operations resumed on November 30, 2015. The Green Bank Radio Telescope and the Allen Telescope Array will also observe the carrier recovery tracks depending on availability. While the Arecibo Observatory is willing also assist, the Behind observatory is only in view mid-April through mid-September. Recovery operations were reduced to every other week beginning on March 21, 2016 to minimize the impact on DSN resources.

- The Failure Review Board's recommended faster frequency segmented acquisition sequence was tested with the Ahead observatory on September 29, 2015. All 18 one kHz frequency steps were tested twice. While stepping down through the 1 kHz segments, on segment #9 going down in frequency, the transponder locked to the BLF and accepted 9 no-op commands as expected. An interesting finding, but not unexpected, was that the transponder continued to follow the moving carrier and accept all commands sent for the remaining 27 segments.

- As commands must be received to recover the Behind observatory, the first use of the newly developed DSN uplink arraying capability for Behind recovery operations occurred on March 17, 2016. The uplink array capability provides four times the uplink received power as a 70m station. The uplink array consists of using an 80 kW and two 20 kW transmitters from three 34m Goldstone stations, DSS-24, 25, and 26, with each uplink being precisely phase shifted to create a constructive interference. From testing with STEREO Ahead, an approximate 12 dBm increase in received uplink power, as compared to a single 34m, has been successfully demonstrated each time. As the Behind observatory may be rotating, a frequency segmented acquisition sequence will be used with the uplink array. For each use of the uplink array, as transponder feedback is required, the Ahead observatory is first used to calibrate the phased uplink array then the three stations are switched to point to the Behind observatory sending commands for recovery. The uplink array will be used twice

monthly within a three day period, once for battery recovery and again for carrier recovery. The next use of the uplink array is scheduled for June 11th and 12th.

- As time goes by, the ephemeris error increases degrading DSN antenna pointing. However, with time the spacecraft range also decreases improving RF communications and the ability for other assets to acquire data on Behind. Analysis indicates that the total RF gain change is significant and the probability of command success increases with time.

Significant findings to date:

1. Analysis of the three DSN extracted telemetry frames from the carrier signal just before the planned observatory reset/anomaly occurred on October 1, 2014 showed nominal performance of the spacecraft, i.e., no anomalies, IMU off, and the star tracker providing an attitude solution.

2. Post reset, from the very limited telemetry, three packets, extracted from the carrier signal by the DSN, the X-axis gyro on IMU-A had failed. Unfortunately, this telemetry contained only G&C anomaly data and no spacecraft summary data, i.e., the state of the RF, G&C, fault protection and other subsystems is not known at the time of the anomaly. With a failed IMU and the star tracker being off-line for an undetermined duration, the sun sensors will keep the observatory pointed at the Sun, though the G&C will not have any roll knowledge, and cannot roll the observatory as part of the safing configuration to re-establish communications on the LGAs. From analysis of this telemetry and initial G&C simulations, it is highly suspected that the observatory is rotating about the principal axis of inertia due to an autonomous momentum dump initiated by highly biased gyro data flagged good by the IMU, but this has not yet been confirmed.

3. At least two anomalies occurred post reset, the star tracker not promoting to AAD mode and the X-axis gyro failure. Unfortunately, due to the number of possible combinations, the STEREO fault protection system is not designed for simultaneous failures.

Once communications are restored and the anomaly resolved, the Behind observatory will be returned to nominal science data collection as soon as it is safely possible.