STEREO MOC Status Report
Time Period: 2016:074 – 2016:080

STEREO Ahead (STA) Status:

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

   • On day 078, during the DSS-26 support, turbo decoder lock
     was lost briefly at 079-0012z. This anomaly resulted in
     the loss of one frame of SSR data.

   • On day 079, during the DSS-55 support, turbo decoder lock
     was lost briefly at 1227z. This anomaly resulted in the
     loss of 10 frames of real-time and SSR data.

   • On day 080, during the DSS-25 support, turbo decoder lock
     was lost briefly at 1811z. This anomaly resulted in the
     loss of one frame of SSR data.

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 110 degrees C and decreasing with the HGA
   angle at 8.9 degrees and increasing, with respect to the
   spacecraft-Sun line.

   • On day 077, the Ahead observatory was used to phase
     calibrate the 1st uplink array, using DSS-24, 25, and 26 for
     1.25 hours, to support the array use for STEREO Behind
     recovery. As the transponder data is required to do this,
     the space weather broadcast was delayed after the DSS-63
     support by 4.25 hours and resumed at 2225z.

   • The average daily science data return for Ahead was 5.3
     Gbits during this week.

STEREO Behind (STB) Status:

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

   • On day 077, the 1st uplink array for STEREO Behind recovery
     was conducted using DSS-24, 25, and 26. The uplink array

was phase calibrated using the Ahead observatory first for 1.25 hours then the arrayed stations were switched to point to the Behind observatory. The configuration consisted of with the three 34m stations at the Goldstone complex using the 80 kW and two 20 kW transmitters incorporating the frequency segmented acquisition sequence with the MOC sending commands for battery recovery. At 2005z, due to all 3 stations being scheduled with the same SOA, the MOC automation software selected both DSS-25 and DSS-26 for commanding. This issue was corrected in real-time, but caused an hour delay in commanding. 174 commands were sent for battery state of charge recovery. Due to the MOC automation anomaly and the duration of the support, only 19 of the 36 frequency segments were commanded.

- On day 078, during the DSS-26 34m support, the 80 kW transmitter tripped off-line at 1908z and remained off-line for the final 9 minutes of the track. 256 commands were sent for battery state of charge recovery. This anomaly resulted in the loss of commanding one frequency segment. See DR# G117009 for more information.

- On day 079, 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 080, during the DSS-63 70m support, some station monitor data was unavailable for the duration of the support due to a receiver controller software issue. 380 commands were sent for transmitter carrier recovery. No downlink signal was detected by the DSN. Due to the duration of the support, only 19 of the 36 frequency segments were commanded. Three commands must be received sequentially to power on the transmitter. See DR# M109260 for more information.

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. Recovery operations resumed on November 30, 2015.

- 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. 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 not in view until April 2016.

- 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 17th. The uplink array capability will provide 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.

- 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.