11. Flight Operations Scenario Group

Flight Operations Segment (FOS) capabilities in Release B are primarily provided to support EOS AM-1 Spacecraft launch and routine on-orbit operations. The Release B system supports: testing of FOS mission critical requirements related to Spacecraft health & safety and system performance; testing of EOC interfaces (including EDOS, NCC, FDF, and the Software Development and Validation Facility (SDVF)); and testing of the Instrument Support Terminal (IST), and the SMC.

Flight Operations Segment (FOS) capabilities in Release B are primarily provided to support: EOC activation including training and development of operational procedures; testing of EOC interfaces (including EDOS, NCC, FDF, and the Software Development and Validation Facility (SDVF)); testing of the Instrument Support Terminal (IST), and the SMC; integration of the EOS AM-1 Spacecraft at the contractor's facility; and launch and routine on-orbit operations.

In order to accomplish these objectives, the following FOS capabilities are included in the Release B: (1) Long term planning and initial and final scheduling for command and control of the AM-1 spacecraft and its complement of instruments; (2) Full capability and connectivity for ISTs; (3) Resource and schedule conflict resolution; (4) Generation of a Detailed Activity Schedule (DAS) and subsequent ground script; (5) Receipt, modification, and processing of late activities and Data Acquisition Requests (DARs); (6) Activity level and command level constraint checking; (7) Uplink of spacecraft and instrument loads and flight software updates; (8) Spacecraft data processing; (9) Health and safety monitoring via telemetry and engineering analysis; and (10) Instrument status, performance and trend analysis.

This scenario group is comprised of the Pre-Contact, Contact, and Post-Contact scenarios (Figure 11-1). The Pre-Contact Scenario tests FOS activities that proceed from FOS initialization, through Pre-Contact Planning and IST Planning activities, achieving a FOS operational state, ready for contacting a simulated on-orbit AM-1 spacecraft. The second scenario, the Contact Scenario, consists of verifying the systems capabilities for performing real-time contacts with the simulated AM-1 spacecraft, confirming the systems capabilities for receiving real-time telemetry and for transmitting manual commands and command loads. The Contact Scenario also verifies FOS capabilities for updating continuous operations plans based on information generated during the Pre-Contact Scenario. The final scenario, the Post-Contact Scenario, verifies FOS analysis capabilities and performance requirements.

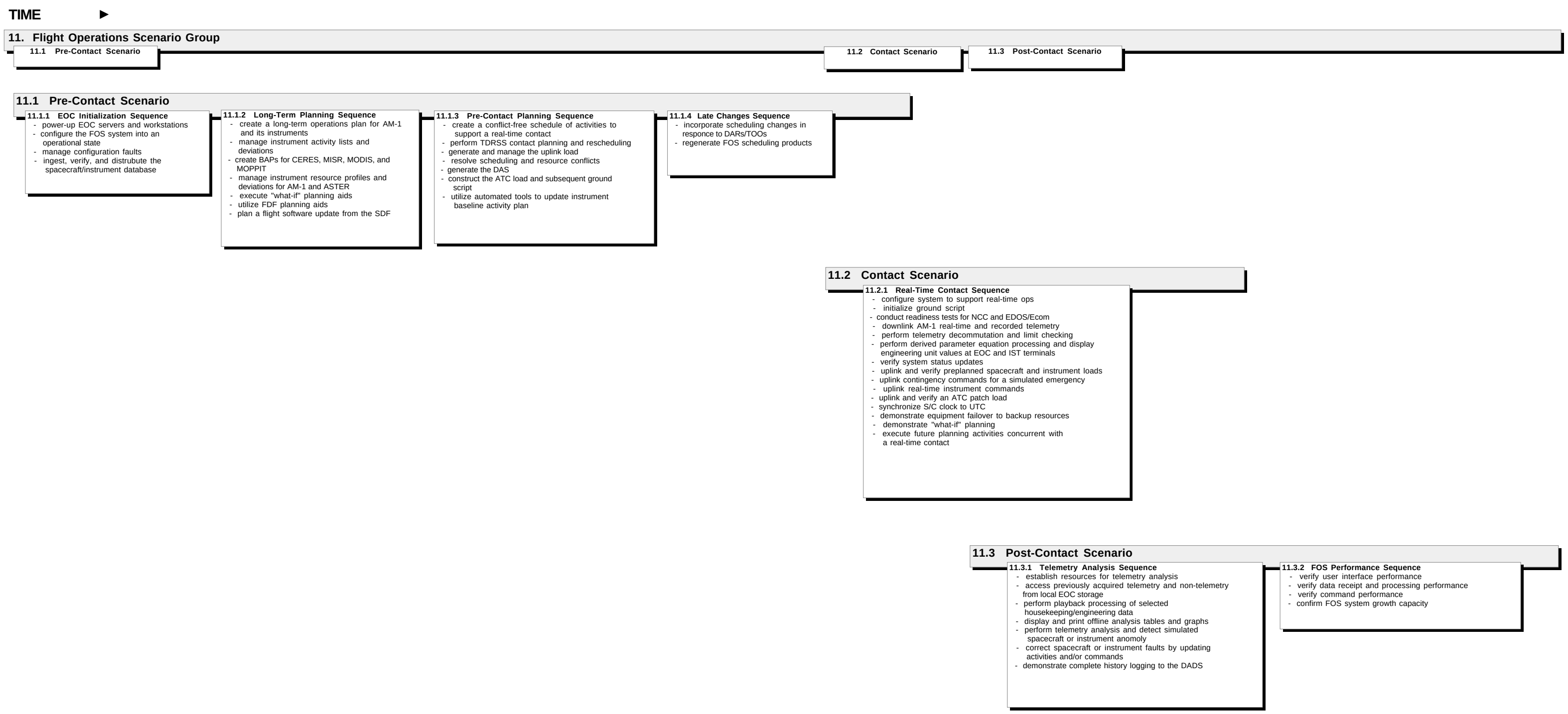

FIGURE 11-1. Flight Operations Segment Acceptance Test Sequencing

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11.1 Pre-Contact Scenario

The Pre-Contact Scenario demonstrates the FOS capability for accomplishing actions that initialize the system resources to an operational state ready for contact with a simulated AM-1 spacecraft.

The first sequence in the group confirms the ability to perform actions that initialize the system resources to support the execution of succeeding test sequences. The following sequences are an initial scheduling exercise, whose purpose is to show how the Release B capabilities provide the scheduling basis for the succeeding scenarios. The scheduling exercise demonstrates the creation of a contact plan with ongoing communications among the ISTs and IP-ICCs.

The Long Term Spacecraft Plan (LTSP) and the Long Term Instrument Plans (LTIPs) are received from the SMC. The EOC scheduler utilizes these long term plans to develop a long term spacecraft operation plan. ISTs for each of the AM-1 instruments have the opportunity to make modifications to the operations plan. A Baseline Activity Profile (BAP) is created for the following AM-1 instruments: CERES, MISR, MODIS, and MOPITT.

Using information from the long term plans and from the FDF, the NCC is contacted to negotiate TDRSS contact times. The scheduler performs resource constraint checking and coordinates the resolution of any activity conflicts with the ISTs and ASTER ICC. Instrument loads and command requests from the ISTs, orbit adjustment data from the FDF, and flight software updates from the SDVF are combined into a deconflicted ground script. Activity deviations are negotiated between the EOC, ASTER ICC and ISTs.

Late schedule changes in support of Targets Of Opportunity (TOOs) are initiated for specific instruments and the scheduler merges the new activities into the ground script. Further activity deviations are negotiated with the ISTs and ASTER ICC. The detailed activity history log including all activity changes is forwarded to the GSFC DAAC.

11.1.1 FOS Initialization Sequence

The FOS Initialization Sequence takes the EOC from a powered down state to an operational system ready to support the rest of the activities in the acceptance test. The activities in this sequence verify that the FOS system is initialized and configured into an operational state, capable of establishing and managing multiple logical strings designed to support the operations of the AM-1 spacecraft and its aggregate set of on-board instruments. This sequence first focuses on the configuration of all supported logical strings (i.e. real-time, simulation and replay). Following nominal logical string configuration activity, the focus of the sequence switches to the introduction of configuration faults and the ability of the FOS to flag faults and provide the tools necessary for reconfiguring logical strings around those faults.

Since processing of downlink and historical data by a logical string or set of strings is ultimately controlled by the Project Data Base (PDB), this sequence also includes verification of operational PDB activities performed at the EOC and IST locations. PDB verification activities focus on two specific areas: (1) management of the operational data base files and (2) use of data base files by the various FOS subsystems once the data base becomes operational.

11.1.1.1 Test Case B110110.010 - FOS Initialization & Configuration

The FOS Initialization & Configuration test case verifies the capability of the FOS to initialize, configure and reconfigure its ground system as needed to support concurrent real-time spacecraft operations. The Test, Demonstration, and Inspection test methods are used to verify tested requirements.

The test begins with the initialization of all primary and backup FOS hardware including data management servers, telemetry and command servers, EOC user stations, IST user stations, operational and supporting LANs, printers, and plotters. Following hardware initialization, steps are provided for the configuration of a logical string supporting real-time, simulation, and historical replay operational activities and the initialization of several EOC and IST user stations to support the established logical string activity. Logical string establishment and event/telemetry archiving is initiated via pre-defined ECS Command Language (ECL) procedures (PROCs) manually initiated by the EOC "master" controller. PROCs used for this test are defined to include ECL commands specifying string resources, EOC/IST user station event and status displays, and external interface configuration (i.e. FDF, NCC, EDOS, ASTER, SDVF).

The next set of test steps involves the establishment of a redundant logical string to support training, test, development and software upgrade activities. PROCs entered by the EOC command controller supporting the operational string initiate the establishment and relinquishment of FOS resources, while the EOC command controller supporting the redundant logical string issues PROCs to configure the redundant string and its resources. Examples of activity during this test phase include the relinquishment of NCC external interface support from the operational string and the switching of a backup data management server from the operational to the redundant string configuration.

Following the testing of the FOS string assignment functionality, operational activity is performed on all strings assigned. This is done to verify parallel AM-1 operational and support activity, necessary for the ground system to maintain full functionality despite software and/or hardware fault conditions.

Real-time housekeeping telemetry data is transmitted from previously configured simulators for high-level processing by the appropriate logical string configurations, as well as the initiation of a historical data replay on the operational string configuration. Other EOC Flight Operations Team (FOT) and IST user station engineers initiate PROCs to configure their user stations to specific logical string support, and display event and configuration status page windows.

The remaining test steps deal with the establishment and relinquishment of various sets of functional string activities (i.e. multiple telemetry processing and command uplink setup, request for dedicated replay, request for a mirrored string connection). Functional activities are established via ECL directives and/or ECL command PROCs entered at EOC and IST user stations.

At various points throughout the test, configuration and event page windows are snapped, and information on these snaps reviewed to verify that string configuration activity performed by the software matches ECL command input submitted by the users.

Other operational and event status window prints are taken at various times during the test to ensure that operational activity performs in a nominal manner, is performed by the issuing string, and does not affect the other strings' concurrent operational activity. Test activities also verify that configuration status information is broadcast to the appropriate FOS user stations.

11.1.1.2 Test Case B110110.020 - Spacecraft/Instrument Database

The Spacecraft/Instrument Database test case verifies the capability of the FOS to receive, validate, edit, and update the PDB. This test case also verifies the generation and distribution of spacecraft and instrument Operational Data Base (ODB) files following PDB generation and validation and the operational use of the ODB files following validation. The Test, Demonstration and Inspection test methods are used to verify tested requirements.

Following user authentication and sign-on into the FOS PDB account by the EOC database engineer, the transfer and ingestion of PDB files from the spacecraft contractor's SDVF facility is initiated. Following PDB acceptance by the EOC, the validation of PDB files is performed. All PDB file errors incurred during the validation of the PDB are requested for printing via the PDB validation log. All errors recorded in the log are compared to scripted spacecraft and instrument PDB error listings to ensure complete PDB validation coverage.

Following PDB validation activity, the ability to edit spacecraft and instrument portions of the PDB is performed. Specified spacecraft parameters, instrument telemetry and command parameter changes requested by the CERES and MISR Instrument Operations Team (IOT) engineers, and corrections to errors found during the validation process are input by the EOC data base engineer. The revalidation of the most current PDB is then initiated to ensure all edits pass validation, and that all spacecraft and instrument records necessary to support FOS operations reside in the PDB.

The test continues with the verification of automatic ODB generation and availability of the latest ODB by the FOS real-time and off-line functions. Steps are provided for the configuration of logical strings supporting real-time, simulation, and historical replay activities and for the initialization of several EOC and IST user stations to support the established logical string activity. FOS functions which utilize ODB files for processing (i.e. telemetry decommutation, historical replay, real-time commanding) are performed by various FOS string configurations. For each operational activity specified above, functional display windows and event status messages are printed at specified intervals during the test.

The printed output from each functional area (i.e. telemetry decommutation, historical replay, real-time commanding) is compared against the most current ODB file record reports to verify that all FOS functions requiring ODB access utilize the same and most recent ODB file information.

11.1.2 Long-Term Planning Sequence

The Long-Term Planning Sequence demonstrates the planning and scheduling activities that provide a baseline mission schedule for the AM-1 spacecraft and instruments. The series of test cases in this sequence establish the resource strings required to receive the long-term spacecraft and instrument plans from the SMC, planning aids from the FDF, and flight software updates from the SDVF. Instrument inputs to the mission schedule, including Instrument Activity Lists (IALs), are sent from the ISTs and ASTER ICC. BAPs are defined and scheduled for CERES, MISR, MODIS, and MOPITT. Resource Profiles are generated for the spacecraft and for the ASTER instrument.

At the completion of this sequence, the FOS is ready to perform routine scheduling activities in preparation for a real-time contact.

11.1.2.1 Test Case B110120.010 - Manage/Generate Long-Term Plans

The Manage/Generate Long-Term Plans test case verifies FOS capabilities to receive the LTSP and LTIPs from the CSMS SMC, to receive orbit and attitude data from the FDF, to generate a Long Term Spacecraft Operations Plan, and to provide authorized user access to the various plans. The Test, Demonstration and Inspection test methods are used to verify tested requirements.

This test case begins with the establishment of an operational configuration and AM-1 real-time logical string. The SMC, FDF and ASTER interfaces are initialized into the configuration, along with specified EOC and IST user stations. The FOT scheduler initiates the input of the LTSP data set and LTIP data sets (representing the ASTER, CERES, MISR, MODIS, and MOPPIT instruments) from the SMC to the EOC for storage in the Data Management Server (DMS) archive. FDF orbit and attitude data is transmitted to the EOC, where it is distributed to the ISTs and ASTER ICC. Through the use of the Label Activity Scheduler Tool, the FOT scheduler utilizes the LTSP, LTIP, and FDF data inputs to generate the AM-1 Long Term Spacecraft Operations Plan whose content is generated to mirror the LTIP/LTSP and FDF provided information outlining operations for the AM-1 power subsystem, navigation subsystem, and Solid State Recorder (SSR).

Throughout the test, the LTIP, LTSP, and Long Term Spacecraft Operations Plan are displayed and printed at configured EOC, ASTER and IST user stations to verify accurate textual and graphical visualization of information in the plans and the ability to broadcast these plans to configured user stations upon generation. At the end of the test, all long-term plans are printed at the EOC to verify archiving at the DMS archive.

11.1.2.2 Test Case B110120.020 - Instrument BAP Generation/ Scheduling

The Instrument BAP Generation/Scheduling test case verifies the FOS capability to define CERES, MISR, MODIS and MOPPIT activities and BAPs and to schedule BAP activities at the EOC and/or IST user stations. The Test, Demonstration and Inspection test methods are used to verify tested requirements.

Using the previously initialized FOS configuration, a combination of EOC and IST schedulers access the Activity Definer, BAP Definer, BAP Scheduler and Planning Permission Tools. Through the use of these tools, a series of operational activities and BAPs specifying daily activities for the AM-1 spacecraft and CERES, MODIS, MISR and MOPPIT are created using input data from the LTIPs, LTSP and Spacecraft Operations Plan received earlier in this sequence. Each activity defined includes one or more commands, and parameters required for modeling spacecraft or instrument characteristics (i.e. power and data rate requirements). Each instrument BAP defined includes specified instrument activities and trigger events for those activities. Once generated, the BAPs are transmitted to the EOC and the activities are scheduled by the EOC scheduler, via the BAP Scheduler Tool. Through coordination with the EOC, the MISR IOT engineer creates a set of MISR BAPs at the MISR IST and performs scheduling of the activities through use of the BAP Scheduler and Planning Permission Tools. By accessing, displaying, and utilizing the various FOS planning & scheduling tools throughout this test, the generation of spacecraft and instrument BAPS and corresponding activities, and accurate scheduling of BAPs is verified.

An oversubscription of TDRSS activities is purposely introduced during the initial BAP scheduling process to verify the flagging through event status and Resource Timeline display of oversubscribed instrument activities. Through coordination with the EOC and cognizant IOT schedulers, the oversubscribed activities are rescheduled by the EOC scheduler.

Throughout the test, the Resource Timeline is displayed and printed from "single instrument" and "multiple instrument" viewpoints to verify accurate BAP activity scheduling. The rescheduling of BAP activities due to oversubscription is verified using the Resource Timeline Tool and event message status displays.

11.1.2.3 Test Case B110120.030 - ASTER IRP/IRDL Generation & Scheduling

The ASTER Instrument Resource Profile (IRP)/Instrument Resource Deviation List (IRDL) Generation & Scheduling test case verifies the FOS capability to receive the IRP from the ASTER ICC, and to reserve resources based on pre-determined profile content. This test case also verifies the EOC ability to reject profile activities based on conflicts and to merge updated ASTER profile activities into the Mission Plan upon receipt by the EOC. The Test, Demonstration and Inspection test methods are used to verify tested requirements.

Using the previously initialized configuration, ASTER IRP data sets are transmitted to the EOC from the ASTER ICC. The automatic entry of IRP activities into the AM-1 mission plan is verified by reviewing the Mission Timeline display and comparing the updated resource model (as seen on the Mission Timeline) to the aggregate set of ASTER IRP activities and other scheduled instrument activities. Examples of comparison activity include comparing the predicted ASTER-dedicated SSR data volume (as shown in the AM-1 resource model) against the combined SSR data volume needs of each scheduled ASTER profile activity. Since the comparison is made both before and after ASTER profile activity scheduling, automatic IRP activity entry into the mission plan is confirmed.

The test case continues with the transmission of an updated resource profile, also referred to as an IRDL, to the EOC, resulting in an oversubscription of TDRSS services. Through coordination with the EOC and ASTER schedulers, the oversubscribed activity is rescheduled by the EOC scheduler using the resubmitted IRDL whose content includes the updated TDRSS resource requirements.

Following the reservation of resources specified in the IRP and IRDL, the Resource Timeline is viewed from "single instrument" and "multiple instrument" viewpoints, at both EOC and IST user stations in order to verify accurate rescheduling of updated activities.

11.1.2.4 Test Case B110120.040 - FDF Planning Aids

The FDF Planning Aids test case verifies FOS capabilities to receive spacecraft navigational and TDRSS tracking data from the FDF, and to provide the FDF with a subset of real-time and back-orbit spacecraft telemetry parameters, and notification of quality indicators performed on telemetry. The Test, Demonstration and Inspection test methods are used to verify tested requirements.

The test begins with the FOS configuration of a logical string supporting real-time operational activities, the initialization of the EOC-FDF and EOC-DAAC interfaces, and the initialization of several EOC and IST user stations to support established logical string activity.

At the EOC user station, the FOT engineer requests a replay of telemetry data stored at the EDOS. During the telemetry replay, the EOC forwards telemetry containing navigational data to the FDF while performing quality checks on predetermined telemetry parameters. When the telemetry replay is complete, the FOT engineer sends a notification of orbit and attitude quality checks to the FDF. As a follow-on to this activity, an EOC request for updated orbit/attitude data is transmitted to the FDF and an updated data set containing forecasted AM-1 orbit data is transmitted to the EOC for formatting and storage in the DMS archive. The IST and ASTER ICC engineers then verify the automatic reception of the forecasted orbit data and the subsequent update to the AM-1 Spacecraft and TDRSS State Models following the reception of TDRSS availability and navigational data.

The test continues with the transmission of real-time housekeeping telemetry processing by the EOC, and the subsequent subsetting and transmission of selected parameters to the FDF. Following the verification of proper subsetting and transmission, updated spacecraft ephemeris data is requested from the FDF by the FOT scheduler for use in building an FDF table load. Verification activities performed at this point include accurate storage of the updated FDF orbital, navigational, and ephemeris data in the DMS archive; the ability to select the various FDF-generated products for delivery; and transmission of the selected FDF-generated products to the GSFC DAAC upon request by the FOT scheduler.

11.1.3 Pre-Contact Planning Sequence

The Pre-Contact Planning Sequence demonstrates use of the FOS capabilities necessary to provide a conflict free schedule of activities to support the Real-Time Contact Sequence that follows. In other words, it demonstrates the type of day-to-day scheduling that is necessary to perform both science data collection activities and health and safety functions for the EOS spacecraft and the aggregate set of on-board instruments. The focus of this sequence is the FOS functional operations necessary for the creation of the final DAS including the acceptance of uplink products from the ISTs, schedule conflict resolution, rescheduling of TDRSS contacts, and the construction of the Absolute Time Command (ATC) load and subsequent ground script.

Also included is the update of the CERES BAP and the rescheduling of the BAP in concurrence with other pre-contact planning activities.

11.1.3.1 Test Case B110130.010 - TDRSS Contact Planning

The TDRSS Contact Planning test case verifies the FOS capabilities of scheduling TDRSS real-time contacts with the AM-1 spacecraft. The Test, Demonstration and Inspection test methods are used to verify tested requirements.

The test begins with the FOS configuration of a logical string supporting real-time operational activities, including several EOC and IST user stations to support established logical string activity. The EOC Scheduler displays the TDRSS Activity Scheduler Tool and enters requested contact times based on TDRSS availability periods supplied by the FDF and data rate profiles for the instruments and spacecraft subsystems. To verify TDRSS schedule request generation, including rejections and updates, a TDRSS schedule request is constructed with a contact that cannot be satisfied due to either lack of TDRSS resources or a violation of spacecraft visibility constraint. The EOC scheduler then verifies that the schedule request transmitted to the NCC is rejected and the details of the rejection are resident in the TDRSS contact rejection notification message. The EOC scheduler modifies the rejected TDRSS contact using the Activity Scheduler Tool and transmits the updated schedule request to the NCC.

Following acceptance of the preliminary TDRSS contact request, the EOC scheduler and IST engineers verify that the contacts are merged into the mission schedule, SSR resource states are updated to reflect the most current contacts, and the timeline is updated to reflect the most current state changes.

The results of this test case are the successful generation of initial and modified TDRSS contact requests by the EOC and the incorporation of the TDRSS contact requests into the mission schedule, viewable by both EOC and IST schedulers/engineers.

11.1.3.2 Test Case B110130.020 - Load Generation/Management

The Load Generation/Management test case verifies FOS capabilities to receive, store, and schedule preplanned spacecraft and instrument command groups, flight software loads, instrument loads, and SCC-stored instrument commands/tables for real-time execution, relative-time execution, and for use in emergency or contingency situations. The Test, Demonstration, Inspection and Analysis test methods are used to verify tested requirements.

The test case begins with the FOS configuration of a logical string supporting real-time operational activities, initialization of the EOC-ASTER ICC interface, and initialization of several EOC and IST user stations to support established logical string activity.

The EOC Scheduler, via the Relative Time Sequence (RTS) Builder and RTS Scheduler Tools, generates a set of spacecraft RTS loads containing sets of command mnemonics and relative time tags and schedules each load's uplink time. At the IST user stations, IOT engineers generate and schedule additional instrument RTS loads, instrument table loads, and/or instrument microprocessor loads and transmit the loads/tables to the EOC via the Load Scheduler Tool for uplink schedule validation performed at the EOC. At the MISR IST, the uplink window for a table load is input for a time period which is not supported by a scheduled TDRSS contact. The MISR scheduler verifies load schedule conflict message receipt by viewing event message display windows for status. Concurrent to this activity, the EOC scheduler generates, validates and schedules an updated ephemeris table load using FDF provided ephemeris data resident in the DMS archive.

The test case continues with a flight software uplink load generated at the SDVF and transmitted to the EOC. At the EOC user station, the EOC scheduler, via mission timeline and event message display windows, verifies receipt and validation of the flight software load, and subsequent update to the mission timeline.

Throughout the test, EOC and IST schedulers constantly scan the updated timeline, load report, spacecraft state, and event message display windows to verify accurate load generation, scheduling, contact constraint checking, and load rescheduling activity. At the end of the test, a load report for each load generated and scheduled is compared to the ending mission timeline and event history report to ensure all loads are scheduled for uplink, scheduling times are accurate, and rescheduling of loads failing contact constraint checking is complete.

11.1.3.3 Test Case B110130.030 - Activity/Command Constraint Resolution

The Activity/Command Constraint Resolution test case verifies FOS capabilities for the identification and resolution of spacecraft and instrument activity and command level constraints residing in the mission schedule. The Test and Demonstration test methods are used to verify tested requirements.

This test case begins at the EOC, where the EOC scheduler, via the Activity Scheduler Tool, chooses specified start/stop times for scheduling spacecraft and instrument activities. Since specified activities are predefined to contain violations, the activities chosen result in the flagging of one or more constraint violations. Examples of constraint violations encountered include MODIS calibration activity attempted during MODIS yaw maneuver, CERES scan activity during sun intrusion period, and attempting a High Gain Antenna (HGA) maneuver exceeding HGA gimbal limit. Each conflict flagged is investigated by the EOC scheduler and resolved by modifying all offending plan activities and updating the mission schedule.

The automatic flagging of hard and soft constraints and the resolution of each constraint is verified by the display and print of the mission schedule, activity lists, and event message displays before, during and after the resolution of each constraint.

Following activity level constraint resolution, the EOC scheduler, via the Activity Scheduler Tool, expands each activity into directives to allow for command level constraint checking. Several command-level constraints are purposely introduced in order to verify the automatic flagging and display of those constraints. Examples of constraints introduced include an excessive number of commands timed for uplink per time period, and violation of rule based sequences (i.e. MODIS-DOOR-CLOSED command followed by MODIS-IMAGE-ON command). Each conflict flagged is investigated by the EOC scheduler and resolved by modifying all activities to include updated commands.

The automatic flagging of each command constraint and the resolution of the aggregate set of command constraints for each scheduled activity is verified by the display and print of the ATC schedule and event message displays at various times throughout the test.

11.1.3.4 Test Case B110130.040 - DAS Generation

The DAS Generation test case verifies the FOS capability to generate the DAS to include spacecraft and instrument activities for a specified time period. The Test, Demonstration, Inspection and Analysis test methods are used to verify tested requirements.

The test begins with the EOC scheduler, via the Daily Plan Tool, releasing the DAS by specifying DAS start and stop time relating to a specific target day. At this point, the EOC scheduler verifies all activities scheduled during the activity scheduling phase which violate hard constraints are deleted from the schedule and that protections on scheduled activities are set to disallow further scheduling for the specified target day. DAS, timeline schedule and event page displays are viewed at EOC, ASTER ICC, and IST user stations in order to verify transmission of the DAS and event messages identifying deleted/protected activities.

In response to a deleted activity, an activity update is initiated at an IST user station. At the EOC, the updated activity is inserted into the mission schedule and checked for resource, activity, and command level constraints. Following constraint checking, the updated DAS is then distributed to the ISTs, ASTER ICC, and the GSFC DAAC, where it is accessed, printed and compared to the EOC's DAS printout to verify accurate transmission, storage and display.

11.1.3.5 Test Case B110130.050 - ATC Load/ Ground Script Generation

The ATC Load/Ground Script Generation test case verifies FOS capabilities to generate ATC loads and ground scripts from the DAS. The Test and Demonstration test methods are used to verify tested requirements.

Previously generated and tested activities for the upcoming TDRSS contact are now ready for conversion into spacecraft, instrument, and ground commands. The first set of steps involves the generation of the ATC load by the FOT scheduler via ATC scheduling tools. The ATC load is printed and reviewed to verify that it includes the commands scheduled for execution during the target day, and activities scheduled to start on the target day and end on the next target day.

The next set of steps involves the generation of the ground script by the EOC scheduler, based on the ground schedule and start/stop times matching the ATC load created earlier. Following generation of the ground script, it is printed and reviewed to verify that it includes all commands scheduled for execution during the target day and commands scheduled for execution during the last 3 hours of the previous target day.

The final steps involve printing the expected state tables and integrated load report, and verifying, via off-line analysis, that both the state tables and load reports mirror the information residing in the ATC load, DAS and corresponding ground script.

11.1.3.6 Test Case B110130.060 - CERES BAP Update

The CERES BAP Update test case verifies the FOS capability to update BAP activities while concurrently performing other pre-contact planning activities. The Test, Demonstration and Inspection test methods are used to verify tested requirements.

Using the previously initialized FOS configuration, a combination of EOC and IST schedulers access the Activity Definer, BAP Scheduler, and Planning Permission Tools. Through the use of these tools, a series of operational activities and BAPs specifying daily activities for the CERES, MODIS, MISR and MOPPIT instruments are created at the respective instrument's IST user station. At the CERES IST user station, the IOT scheduler views the mission schedule to determine the CERES activities at the time of an upcoming contact. It is determined that a CERES BAP previously scheduled must be modified in order to relinquish resources due to AM-1 health and safety concerns. The Activity Scheduler is invoked at the CERES IST in order to view, delete, and modify the CERES activities defined in the specified BAP. Several activities are replaced, new activities are added, and several activities are deleted from the CERES BAP. Those activities remaining from the original BAP are modified to include different start/stop times. When the updates are complete, a report for the updated BAP is generated and printed. The activities within the BAP are then rescheduled via the Activity Scheduler Tool.

Throughout the test, the Resource Timeline and AM-1 Mission Schedule is displayed and printed at configured EOC and IST user stations from both "single instrument" and "multiple instrument" viewpoints to verify accurate CERES BAP activity rescheduling. At the end of the test, activity list reports are printed at the EOC to verify MISR, MODIS, MOPPIT, and CERES activity definitions created during this test are resident in the DMS archive.

11.1.4 Late Changes Sequence

The Late Changes Sequence demonstrates the submission, scheduling and management of spacecraft/instrument late changes, including ASTER Detailed Activity Requests (DARs) and instrument Targets of Opportunity (TOOs). This sequence also demonstrates the ability to regenerate FOS scheduling products (i.e. DAS updates, IAL updates, ATC load updates, ground script updates and ATC patch loads) based on approved DARs and TOOs submitted at the ASTER ICC and/or instrument ISTs.

In order to demonstrate late change scheduling, ASTER DARs and instrument TOOs are submitted for scheduling at selected time intervals (i.e. from three weeks to less than 3 hours) from the spacecraft/instrument event(s) affected by the change(s). Depending on the timing of the DAR/TOO submittal, steps are taken to ensure proper rescheduling of resources and ultimately the regeneration of the DAS, ATC load, and ground script when necessary. Secondly, selected DARs and TOOs are submitted following the uplink of the ATC load in order to verify ATC patch load generation and its patch or replacement ground script. DARs and TOOs that require a patch load are demonstrated during the Real-Time Contact Sequence.

11.1.4.1 Test Case B110140.010 - Early DAR Scheduling

The Early DAR Scheduling test case verifies the ability of FOS to schedule spacecraft and instrument DAR activities and TOO observations for time periods covered in the existing DAS, and to update the ATC load, DAS and corresponding ground script to reflect all scheduled late changes. A secondary objective of this test case is to verify FOS' ability to resolve instrument and spacecraft DAR scheduling conflicts which arise during early DAR scheduling. The Test, Demonstration and Inspection test methods are used to verify tested requirements.

The test begins by initializing the FOS ground system, including the configuration of the ASTER ICC. Several instrument microprocessor loads and SCC table loads are requested for uplink during the next available contact by cognizant EOC/IST schedulers (this includes at least two DARs or TOOs for each AM-1 instrument and several database defined spacecraft tables). The EOC scheduler, following the prioritization of all DARs received, begins by sequentially scheduling the DAR activities for the next available contact using various load scheduling tools. Due to various constraints (i.e. specific spacecraft health and safety constraints, power, and TDRSS contact time), several DAR activities are denied scheduling. By viewing the activity timeline and event message display windows at EOC, IST and ASTER-ICC user stations, the iterative steps of DAR scheduling, rescheduling, and conflict resolution activities performed by EOC/IST schedulers are confirmed.

Following scheduling of DARs and conflict resolution activities, the EOC scheduler updates the ATC load, regenerates the DAS and corresponding ground script via the Daily Plan Tool. The DAS, ATC and ground script windows are then displayed at configured EOC, IST and ASTER ICC user stations. By viewing the displays, accurate updating and distribution of the DAS, ground script, and ATC load is confirmed. To further ensure ATC load regeneration accuracy, ATC load reports are printed before and after DAR scheduling activities at all configured user stations, and compared post-test to each scheduled activity.

Throughout the test, EOC, IST and ASTER ICC schedulers verify all DAR scheduling activities and monitor performance, regardless of processing location (i.e. EOC, IST, ASTER ICC). This is accomplished by continually monitoring DAS, ground script and event message display windows at all configured EOC, ASTER ICC and IST user stations. For example, the ASTER ICC controller, via the event display, monitors the transmission of the updated DAS to ensure it includes scheduled ASTER-ICC DAR activities and that the DAS is delivered at least 6 hours prior to the rescheduled activity.

To further ensure all scheduling changes made as a result of DAR scheduling are accurate, and scheduling events are broadcast to all configured user stations, event history reports are printed post-test and compared to information contained in the updated ATC load, DAS and corresponding ground script.

11.2 Contact Scenario

The Contact Scenario demonstrates the FOS capability to perform the activities associated with the (simulated) on-orbit AM-1 spacecraft including initialization of and control of FOS ground support with external interface functionality. Ground script control is performed to demonstrate the automated progress of scheduled contact activities. The ability to establish spacecraft contact, and to initialize reception of telemetry data is confirmed. Pre-planned instrument and spacecraft loads generated during the pre-contact scenario are uplinked, and uplink status is monitored. Late change scheduling requiring patch load uplink is performed concurrently with on-going real-time operations. Simulated real-time telemetry data is downlinked, full data decommutation is performed, and telemetry quality is determined. During the real-time contact, instrument command requests from instrument planners are received, commands are validated and generated, and the instrument commands are manually uplinked and verified via telemetry. Microprocessor dumps from the spacecraft and instruments are downlinked, and best estimates are generated for specified microprocessor word locations.

Additionally, real-time and scheduling functions are performed using a combination of EOC and IST user positions to demonstrate IST-EOC interaction. These interactions are demonstrated during real-time activities, with coordination and shared functionality utilized during the reporting, analysis, and resolution of a simulated spacecraft emergency.

11.2.1 Real-Time Contact Sequence

The Real-Time Contact Sequence demonstrates both nominal and emergency related activities that take place during contact with the AM-1 spacecraft. Contact with the spacecraft is initialized and backup support capabilities are verified. Late changes to the mission schedule are generated. Real-time telemetry, command and archiving functions are performed concurrent to planning and scheduling activities. Telemetry is downlinked, decommutation and limit checking is performed on downlinked data and data is archived for analysis processing activities performed in the post-contact sequence. Preplanned spacecraft and instrument loads and real-time commands are uplinked and verified. Also demonstrated are the execution and performance of instrument contingency commands in response to a simulated emergency, with command notification sent to the appropriate ICC/IST location(s) and appropriate schedules updated. Finally, simulated failures in the FOS operational hardware configuration are used to demonstrate equipment failover to backup resources which are configured for operational support.

11.2.1.1 Test Case B110210.010 - Contact and Ground Script Initialization

The Contact and Ground Script Initialization test case verifies the FOS capabilities to configure resources in preparation for a real-time contact with the AM-1 spacecraft, and demonstrates the initialization and utilization of the FOS ground script previously generated in the Planning Sequences and Early DAR Processing test. The Test, Demonstration and Inspection test methods are used to verify tested requirements.

The test case begins with user authentication and establishment of operational and backup logical strings necessary to support real-time command and telemetry operations. In order to ensure availability of the necessary uplink/downlink communications paths, prepass operational messages are transmitted from the NCC for processing and display by the FOS. This is followed by the establishment of "master" control authority by the EOC command controller and initiation of the AM-1 ground script. At this point, steps are provided to verify that all uplink/downlink activity specified in the current ground script is "kicked-off" at absolute or relative times specified in the script. This verification is accomplished by viewing the mission timeline and event message displays at configured EOC and IST user stations in real-time, and post-test, by comparing ground event messages in the DMS archive with printouts of the AM-1 ground script.

Real-time telemetry data coinciding with the ground script is then transmitted and broadcast to all configured EOC/IST user stations. Concurrent to this activity, AM-1 real-time commands are uplinked by the EOC command controller, also coinciding with the current ground script. Accurate uplink/downlink activities are verified by viewing the event display windows during string initialization and ground script execution.

11.2.1.2 Test Case B110210.020 - Late DAR Scheduling

The Late DAR Scheduling test case verifies the ability of FOS to schedule DAR activities which require the generation of an ATC patch load, patch DAS and corresponding ground script. A secondary objective of this test case is to verify FOS' ability to resolve instrument and spacecraft scheduling conflicts which arise during late DAR scheduling. The Test, Demonstration and Inspection test methods are used to verify tested requirements.

The test begins with the EOC receiving late arriving ASTER instrument scheduling requests initiated by the ASTER ICC for inclusion into the latest schedule. Since the late request requires an update to a previously uplinked ATC load, the next set of steps involve the construction of an ATC patch load, patch DAS and corresponding ground script by the EOC scheduler using FOS provided scheduling tools. During this activity, the DAS, ATC and ground script windows are displayed and printed at configured EOC, ASTER, and IST user stations. By viewing the displays, accurate regeneration and distribution of the ATC patch load, DAS and ground script is confirmed. To further ensure ATC patch load generation accuracy, ATC load reports are printed before and after late DAR scheduling activities at configured user stations, and compared post-test to each scheduled activity. Finally, steps are provided to verify the smooth transition from the previous ground script to the most current patch ground script, accurate scheduling of the ATC patch load, and ATC patch load uplink via telemetry.

Throughout the test, EOC, ASTER and IST schedulers verify patch load scheduling, generation and uplink by continually monitoring the DAS, ground script, and event page display windows. For example, the ASTER ICC scheduler verifies the transmission of the updated patch load by viewing event messages regarding the uplink which are automatically broadcast from the EOC and displayed at the ASTER-ICC user station event display window. ATC load reports are printed and analyzed post-test to ensure that the ATC patch load includes all commands from the scheduled time of change to the end of the target day, as well as commands for those activities still scheduled. Likewise, the updated DAS and corresponding patch ground script are printed to ensure the DAS includes the latest ASTER scheduled activity, and that the patch ground script includes all commands from three hours before the ASTER change to the end of the target day. To ensure all scheduling changes made as a result of late DAR scheduling are accurate, and DAR scheduling events are broadcast to all configured EOC, ASTER, and IST user stations, event history reports are printed post-test and compared to information contained in the updated ATC load, DAS and corresponding ground script.

11.2.1.3 Test Case B110210.030 - FOS Ground Support

The FOS Ground Support test case verifies the FOS capabilities to configure resources in preparation for a real-time contact with the AM-1 spacecraft, including the reconfiguration of the FOS ground system to support backup capabilities at Deep Space Network (DSN), Ground Network (GN) stations, and Wallops Orbital Tracking Station (WOTS). A secondary objective is the transmission and processing of operational contact support messages between the EOC and NCC. The Test, Demonstration, Inspection and Analysis test methods are used to verify tested requirements.

The test case begins with user authentication and establishment of operational and backup logical strings necessary to support real-time command and telemetry operations. In order to ensure availability of the necessary uplink/downlink communications paths, prepass operational messages are transmitted from the NCC for processing and display by the FOS. This is followed by the establishment of "master" control authority by the EOC command controller and initiation of the AM-1 ground script. The next set of steps involves the sequential transmission, receipt, and broadcast of each real-time telemetry format and monitor blocks from the simulated DSN. Concurrent to this activity, real-time commands are uplinked and verified to ensure FOS support of command uplink via the DSN network. The above uplink/downlink test activities are repeated for WOTS and each GN station.

By viewing telemetry and event window displays during telemetry receipt and command uplink activity, the ability to receive telemetry from the various sites and broadcast telemetry packets in real-time to configured EOC and IST user stations is verified. At various points throughout the test, telemetry, event and command uplink display windows are printed and analyzed post-test to ensure that telemetry packets and monitor blocks, regardless of site source, are broadcast in real-time to configured EOC and IST users. The event displays are also used to verify command uplink transmission capabilities to the various sites, and ground support status messages received from the NCC.

11.2.1.4 Test Case B110210.040 - Telemetry Processing

The Telemetry Processing test case verifies the FOS capabilities for the receipt, broadcast, and processing of AM-1 data, including real-time housekeeping telemetry, health and safety telemetry and SSR dump data. A secondary objective is the verification of telemetry subsetting and transmission of subsets to the FDF. The Test, Demonstration, Inspection and Analysis test methods are used to verify tested requirements.

The test begins with the initialization of a second real-time string coinciding with the real-time string previously established. Following string and telemetry archive initialization, two scripted real-time telemetry streams are enabled simultaneously, with telemetry processing of both streams split between several EOC and IST user station positions. For example, several EOC user stations are configured to process health and safety telemetry received on the "I" channel, while other EOC user stations process housekeeping telemetry received on the "Q" channel. All telemetry stream data is scripted to ensure engineering unit (EU) conversions based on non-static raw values, limit violations for specified parameters, quality violations for specified packets, and data dropout periods.

For those user stations supporting "I" channel telemetry receipt, derived parameter, limit value, and limit value context switching is enabled at the EOC master user station via ECL directives. For those user stations supporting "Q" channel telemetry receipt, derived parameter rates, limit context switches, and limit value adjusting is enabled at the EOC master user station. Subsetting and telemetry subset transmission is enabled to the FDF. A combination of real-time telemetry displays, strip chart displays, spreadsheets, and schematics are displayed, viewed and printed at specified times throughout the test. The displays are used to monitor real-time telemetry processing capabilities and analyzed post-test against issued ECL directives to assure accurate and separate telemetry processing configurations. For example, by comparing telemetry displays from the same time period (one each from "I" and "Q" channel support), an EU conversion change directive issued at a user station supporting the "Q" channel is verified that the change did not affect "I" channel processing.

The next set of steps involves the configuration of the EOC to support the receipt, ingest and processing of SSR dump data. Event and SSR display windows are used to monitor SSR broadcast, processing and ingestion into the DMS archive during SSR receipt by the FOS. SSR data packets residing in the archive are used as input for specific reports generated during the Analysis Reports Test Case. The reports are compared post-test to the simulated SSR packet word location raw values to ensure accurate processing and storage of the SSR packets.

11.2.1.5 Test Case B110210.050 - Real-time Commanding

The Real-time Commanding test case verifies the FOS capabilities for building, validating and uplinking commands and loads for the AM-1 spacecraft and its complement of instruments. A secondary test objective is to verify prerequisite state checking, command receipt/command execution verification, and memory load uplink verification. The Test, Demonstration, Inspection and Analysis test methods are used to verify tested requirements.

The test case begins with the establishment of an operational logical string by the FOT scheduler. This string activity is established to support real-time commanding, ASTER and SDVF interfaces. EOC and IST user positions are initialized into the string in support of real-time activities. This is followed by the establishment of "master" control authority by the EOC command controller and initiation of the AM-1 ground script at a specified start/stop time. Telemetry verification and prerequisite state checking capabilities are enabled via ECL PROCs, and real-time housekeeping telemetry is transmitted for processing by the FOS. Real-time spacecraft and instrument commands, spacecraft memory loads, instrument software table loads, and flight software loads are uplinked based on the current ground script.

Via telemetry and event message display at EOC, IST, SDVF and ASTER user positions, accurate command uplink and prerequisite state checking capabilities are verified. Command notification event messages for ASTER command uplink activity are verified at the ASTER ICC via event and command display windows. Flight software uplink notification event messages are verified at the SDVF via IST event message display.

The ground script is paused while the EOC controller attempts to uplink real-time commands and loads which are scripted to fail either state checking, command uplink or command receipt verification. For example, a table load uplink fails receipt by the spacecraft; an uplinked real-time command fails telemetry verification; or a command attempted for uplink fails prerequisite state checking. For each command/load failing state checking or uplink/receipt verification, procedures are performed to correct the failed state, and the commands/loads which previously failed are uplinked.

An example of test activity performed at this point includes a command requested for uplink but failing a prerequisite state check. State check override is enabled and the command is uplinked and verified via telemetry. The ground script is resumed, and various uplink failures are scripted to occur, with the emphasis at this point on the ability of the ground script to pause upon uplink failure, and to resume smoothly upon uplink resolution. An example of an uplink failure at this point is the attempt of uplinking a non-existent command (i.e. command definition not in operational database).

At various points throughout the test, command uplink and event display windows are printed and analyzed post-test to ensure that real-time commands and command loads are constructed based on the 1553b construct. The printouts are also used to verify command and load uplink activity is accurate and based solely on the ground script or ECL command directives entered by the FOT command controller.

11.2.1.6 Test Case B110210.060 - Spacecraft/Instrument Failure

The Spacecraft/Instrument Failure test case verifies the ability of the FOS to detect, report and analyze failure conditions onboard the AM-1 spacecraft, and the ability to provide software tools necessary for recovering from spacecraft and instrument failures. The simulated failures in this case represent an AM-1 spacecraft propellant tank pressure loss and MISR Aft Camera shutdown, with each failure generated sequentially by the Spacecraft Simulator (SSIM). The Test, Demonstration, Inspection and Analysis test methods are used to verify tested requirements.

The test begins with the initialization of the FOS operational string, transmission of real-time housekeeping telemetry, and the start of the ground script for the current day. A propellant tank pressure loss aboard the spacecraft is initiated at the SSIM, resulting in out of limits tank pressure parameter values in the downlinked telemetry stream. Flagged out of limits conditions and alarm messages reporting the pressure problems are verified at the EOC by viewing telemetry and event windows.

At the EOC, emergency command PROCs are generated using the PROC Builder tool and scheduled for uplink in the current contact. The ground script is paused, emergency commands are uplinked, and the ground script is resumed by the EOC scheduler. Schedule timeline displays are viewed at EOC and IST user stations to verify ground script control during failure conditions, while event message displays provide verification of emergency command uplink activity. Following verification of emergency command uplink, telemetry display windows are viewed in order to verify propellant tank pressure/pressurant parameters are back in bounds, and event messages report the "back-in-bound" states for those propellant-related parameters.

During resumption of the ground script, a MISR aft camera failure is simulated, resulting in out of limits camera parameter values. As in the previous failure scenario above, telemetry and event window displays aid in verifying the flagging of out of limits conditions for respective aft camera telemetry values and alarm message reporting of the camera failure.

Steps are provided for the MISR IST to analyze the problem, prepare individual commands, and transmit command requests to the EOC for the next scheduled contact. Command generation and subsequent command uplink start/stop time requests are made by the MISR IST scheduler via the PROC Builder tool. The EOC scheduler, via the Command Request Evaluator Tool, browses available command requests, chooses and validates the MISR IST commands, and schedules the requested command uplink at the previously entered start/stop times. By viewing the ground script and timeline, scheduling changes made to the ground script as a result of MISR IST command scheduling is verified.

11.2.1.7 Test Case B110210.070 - Dump Processing and Best Estimate Determination

The Dump Processing and Best Estimate Determination test case verifies the ability of the FOS to command Spacecraft Computer (SCC) and instrument microprocessor dumps, report status on dump activity at the EOC and IST user stations, and compare current computer/microprocessor address values with previously uplinked address values. The Test, Demonstration and Inspection test methods are used to verify tested requirements.

The test begins with the initialization of the FOS operational string, and the enabling of the ground script for the current day. A partial SCC memory dump is initiated, resulting in the receipt and storage of the SCC memory dump contents into the DMS archive. Steps are provided for the FOT engineer to compare the uplinked SCC load image for specified address locations to the "best estimate" of the memory dump for those same locations. Results of the comparison and status message reporting is verified by monitoring event and SCC window displays at the EOC and IST user stations.

The ground script is paused, and a MISR instrument microprocessor dump for specified microprocessor address locations is commanded by the FOT scheduler via ECL directives. The entire MISR load (i.e. all addresses) is compared to the "best estimate" of several copies of the downlinked microprocessor dump address values via user interface provided tools at the EOC. Status monitoring of the MISR microprocessor dump activity, dump address location value display, and "best-estimate" address value comparison capabilities at the EOC and MISR IST is verified by monitoring event and MISR display windows at the EOC and MISR IST user stations.

Status event messages produced from instrument memory dump commands, ground comparison, comparison reporting and subsequent transmission of these messages to/from appropriate FOS element user stations are tested as part of this test suite.

11.2.1.8 Test Case B110210.080 - FOS Fault Processing/Equipment Failover

The FOS Fault Processing/Equipment Failover test case is designed to verify the FOS capability to configure and/or reconfigure its ground system to work around hardware and software faults, and to provide the capabilities for "failing over" to backup equipment. The Test, Demonstration and Inspection test methods are used to verify tested requirements.

The test starts with the establishment of operational and redundant FOS string configurations, initiated by the EOC master controller. String establishment is initiated via pre-defined ECL command PROCs and manual ECL directives initiated by the EOC FOT master controller. PROCs and manual directives used for this test are defined to include ECL commands specifying string resources, EOC/IST user station event and status displays, and external interface configuration.

Following configuration of FOS resources, real-time housekeeping telemetry data is transmitted for processing by the EOC FOT and IST IOT engineers at their respective user stations concurrently with the processing of historical replay data by specific EOC FOT engineers. Steps are provided to introduce both software and hardware fault conditions with each fault introduced sequentially in order to verify proper and timely fault recovery. Examples of software faults introduced include real-time telemetry process crash and data management process time-out. Examples of hardware faults introduced include FOS LAN failure, real-time data server failure, network failure (i.e. hub, router, EBnet), and EOC/IST user station failure.

Following the introduction of each fault, steps are performed by the EOC FOT and/or IST IOT engineers to reconfigure around the fault, to a point where both real-time, off-line, and external interface functionality is returned to the same operational state as that before the fault occurred (i.e. real-time telemetry processed by EOC/IST engineers, replay data processed by EOC/IST off-line engineers).

At points both before and after fault introduction, configuration and event display windows are snapped at EOC and IST user stations. Configuration, event and alarm status information from these snaps is reviewed to verify that software and/or hardware reconfiguration activity carried out by the software matches reconfiguration requests submitted by the FOT and IOT engineers. Configuration event messages, telemetry displays, and configuration status windows are also reviewed to verify the return of the FOS to an operational state able to support previously established real-time, off-line, and external interface functionality.

11.2.1.9 Test Case B110210.090 - Planning Update

The Planning Update test case is designed to demonstrate future planning activities simultaneously with real-time contact activities taking place at various EOC and IST user stations. Several simplifications from the Pre-Contact Planning Sequence have been made here. First, it is assumed that the orbit/attitude data obtained includes the predictive information needed for the planning. Second, fewer changes to the plan are being demonstrated here. This is probably more typical of a normal day's activity. The major steps of gathering, combining and finalizing of the plan are included. The Test, Demonstration and Inspection test methods are used to verify tested requirements.

This test case begins with the initialization of a logical string to support real-time, off-line and planning activity, including EOC and IST user stations to support established logical string activity. Real-time telemetry is broadcast onto the FOS LAN and processed by EOC and IST user stations and processing continues throughout the duration of this test.

For the upcoming contact period, the FOT scheduler accesses scheduling tools to merge the planned activities in the mission schedule. Resource conflicts are flagged for resolution by the FOT scheduler who investigates each of the conflicts and resolves them by modifying the offending plan component. The mission timeline display is viewed at this point to insure the presence of expected instrument activities and resource requirements including SSR and TONS requirements.

The FOT scheduler next brings up the TDRSS Activity Scheduler Tool and constructs a TDRSS schedule request. The resulting request is sent to the NCC and any conflicts with the request are resolved through the negotiation process. Following acceptance of the TDRSS contact request, FOT and IOT engineers verify that the contacts are merged into the mission schedule, SSR and TDRSS On-board Navigational System (TONS) resource states are updated, and the timeline is updated to reflect the current state changes.

With the TDRSS contact scheduled, the FOT scheduler validates staged table loads and merges the loads into the mission plan utilizing the Load Scheduler Tool. The mission plan is analyzed for activity and command-level constraint violations. Using the Activity Scheduler Tool, start and stop times are selected for scheduling spacecraft and instrument activities. The FOT scheduler resolves hard and soft activity constraint violations that are automatically flagged. Activities are expanded into directives to allow for command-level constraint checking. Again, flagged conflicts are investigated and resolved by the FOT scheduler.

The next step in this test case generates the DAS for the contact. The FOT scheduler activates the Daily Plan Tool, enters the time boundaries, and allows the tool to process the request. Final constraint checking takes place to detect any remaining constraint violations. Any hard constraints are removed and any soft constraints are acknowledged via the tool. When the process is complete, the DAS is distributed to the ISTs, ASTER ICC, and the GSFC DAAC. DAS, timeline schedule and event page displays are verified at the EOC, ISTs, and ASTER ICC.

The final step for this test case generates the Absolute Time Commands for the target day. The FOT scheduler activates ATC scheduling tools to initiate ATC generation and the generation of the ground script, real-time expected state tables, and the integrated load report. Final verification activities involve printing the expected state tables and integrated load report and analyzing these against the information residing in the DAS, ATC Load and ground script.

11.3 Post-Contact Scenario

The Post-Contact Scenario demonstrates the FOS capability to perform post-contact actions leading to an orderly return of FOS resources. Complete historical reports are prepared, and the capability to send complete or selected history data to the GSFC DAAC is demonstrated. Telemetry analysis is performed for telemetry received during the real-time contact, and for spacecraft recorder data not received in real-time. Trend analysis is performed for spacecraft and instrument housekeeping and engineering parameters. Specified data parameters are examined for EU values and limit violations. Selected statistical reports are generated at the EOC and

ISTs. Also, FOS performance tests are performed to verify user interface, data receipt, data processing, and commanding performance.

At the conclusion of this scenario, the systems ability to return FOS resources is confirmed by inspection of the post contact configuration, archives and reports.

11.3.1 Telemetry Analysis Sequence

The Telemetry Analysis Sequence demonstrates the off-line telemetry capabilities of the EOC and IST user stations. First, the ability to access previously acquired telemetry and non-telemetry data from the local EOC storage is demonstrated. A playback of specified housekeeping/engineering data is then performed, with analysis tables and graphs displayed at the EOC/IST user stations and printed at dedicated line printers. Subsequent reporting of analyzed data requested through the telemetry analysis function flags a simulated instrument or spacecraft anomaly. Actions to correct the failure are made by updating the appropriate instrument or spacecraft activity plans and/or updating contingency commands as necessary. This sequence also demonstrates complete history logging functionality, including the transmission of telemetry and non-telemetry data to the GSFC DAAC, and reception of requested data from the DAAC.

11.3.1.1 Test Case B110310.010 - Historical Telemetry Playback

The Historical Telemetry Playback test case verifies the FOS capabilities for requesting a playback of historical telemetry data residing in the DMS archive, and for the processing and subsequent display of telemetry replay processing information at the EOC and IST user stations. The Test method is used to verify tested requirements.

The test begins with the initialization of the FOS, including IST user station positions. To set up for data replay, pre-defined data sets are loaded into the DMS archive. This data includes non-static raw values and periods of limit and noise violations for specified parameters. DMS archive data consists of sets of housekeeping, health and safety, and SSR EDOS Data Units (EDUs) containing housekeeping and instrument engineering CCSDS telemetry packets.

Via analysis and user interface tools, the FOT engineer specifies the start/stop times for each replay. Each replay requested is selected at variable rates up to 150 Kbps with the FOT engineer pausing and resuming specified replays via ECL directives. During the playback, to verify telemetry processing accuracy (i.e. decommutation, EU conversion, flag processing), printouts of playback telemetry windows, graphs and strip chart displays are generated and compared post-test with telemetry data residing in the DMS archive. This is accomplished by utilizing the Analysis Request and Display Builder tools to generate and display historical datasets for the time periods which match the replay start/stop times. Once the datasets are generated, the telemetry information in the dataset report is compared to the telemetry information residing on the telemetry window/graph/strip chart printouts for the same time periods.

11.3.1.2 Test Case B110310.020 - History Log

The History Log test case verifies the ability of FOS to ingest and archive FOS telemetry and non-telemetry files into the DMS archive, and to provide the tools necessary for accessing and displaying information pertaining to all subsystem data files residing in the archive. A secondary objective of the test is to verify the transmission of datasets to the GSFC DAAC, and receive data from the DAAC in response to historical data requests. The Test and Demonstration test methods are used to verify tested requirements.

The test begins with the initialization of an operational logical string configuration. The configuration includes the EOC/GSFC DAAC interface, ASTER ICC, EOC and IST user positions. The next set of steps provides for the initialization and display of user interface tools at the EOC, IST and ASTER ICC. These FOS User Interface (FUI) tools are used to access, display and print subsystem reports based on information residing in the DMS archive. Following initialization and display of FUI tools, steps are provided for the access, display and printouts of subsystem reports at specified EOC, IST and ASTER ICC user stations. For example, a DAS report for a specified start/stop time is requested at the ASTER ICC, while the MISR IST engineer requests a MISR load report, and the MOPITT IST engineer requests MOPITT activity list reports. Many iterations of report requests (i.e. reports from all FOS subsystems) are made in order to verify access to DMS information by all authorized FOS users.

During the above activity, an analysis request is made which requires data previously archived at the GSFC DAAC. A listing of the report following data transmission and subsequent processing by the FOS is used to verify transmission of data from the DAAC, and accurate processing of the data following transmission. Historical telemetry is then transmitted to the GSFC DAAC for long term storage. Event message windows are displayed at the EOC to verify EOC-DAAC event message traffic during data transmission activity.

11.3.1.3 Test Case B110310.030 - Analysis Reports

The Analysis Reports test case verifies the ability of FOS to generate, process and output various analysis reports based on data residing in the DMS archive. These reports are generated via the Analysis Request Builder and support both real-time and off-line spacecraft trending analysis and anomaly resolution. Reports consist of either graphical displays or listing type products. The Test and Demonstration test methods are used to verify tested requirements.

The test begins with the initialization of the FOS operational string configuration and Analysis Request Builder Tool at configured EOC and IST user stations. Once initialization is complete, steps are provided for the FOT and IOT engineers to generate dataset requests. These requests, whether graphical or listing, consist of user selected spacecraft telemetry parameters containing various sampling rates, data filters, and applicable data bases. Graphical displays selected contain other user selected scaling, X-Y coordinates, line styles, and symbols. After creating the datasets, the FOT/IOT engineers input specified start/stop times and submit individual analysis requests. Individual requests are designed to verify the processing for each report type with different sampling rates and data filters. Examples of list reports include Statistical, Tabular, Downlink Ordered and Min/Max/Mean. Graphical display examples include Parameter vs. Time and Parameter vs. Parameter.

Following completion of the original report requests, the FOT/IOT engineers generate other analysis products via the Product Selector window in order to verify the queuing, display, archiving and printout of individual analysis reports. At various times throughout the test, Analysis Request Builder status display panels are viewed in order to verify report processing stages (i.e. processing, pending, or completed). Report and graph output accuracy is verified by comparing raw data residing in the DMS archive with applicable report and graph print results.

11.3.2 FOS Performance Sequence

The FOS Performance Sequence tests various performance capabilities of the EOC, ASTER ICC, and ISTs. The user interface performance is verified with respect to operator response and display updates when performing nominal real-time and off-line functions. Data receipt and processing is verified to meet required data rates. Command and load performance is verified for generation, validation, and execution. The capacity for system growth without any major redesign is also verified.

11.3.2.1 Test Case B110320.010 - User Interface Performance

The User Interface Performance test case verifies FOS requirements for operator response and display update rates for the user interface. The Test and Demonstration test methods are used to verify tested requirements.

For this test case, FOS operational strings are initialized to perform nominal real-time data receipt and off-line analysis operations. Telemetry data processing and analysis activities are initiated to load the system. Once the configuration is established, various user directives and ECL PROCs are initiated at specified EOC and IST user stations. For each directive initiated, response time is verified by viewing response messages at the initiating user station's response area and event windows.

The test continues by bringing up various displays at the EOC and IST user stations while telemetry data receipt and analysis activities continue. The displays include tables and schematic displays for real-time and historical telemetry values. Display update rates are selected and the system's ability to update the display of rapidly changing information is verified.

11.3.2.2 Test Case B110320.020 - Data Receipt, Processing and Uplink Performance

The Data Receipt, Processing and Uplink Performance test case verifies FOS performance requirements during simultaneous command uplink and telemetry processing activity. The Test, Demonstration and Inspection test methods are used to verify tested requirements.

A FOS logical string is initialized to perform real-time and off-line activities which provide a nominal load to the FOS system. An exhaustive set of command uplink and telemetry processing scenarios are performed, with performance characteristics monitored and reported for each uplink/downlink activity. Performance characteristics being monitored include CPU utilization of command and telemetry processes, FUI display rates and command metering information. Each scenario is based on an increasing data uplink rate/decommutation/replay rate.

For example, the first scenario may include uplinking commands at 125 bps, with real-time telemetry decommutated at 1 kbps, and historical data replayed at 1 kbps. The last scenario may include uplinking commands at 10 kbps, decommutating real-time telemetry at 16 kbps, processing a SSR dump at 1.544 Mbps, and providing historical replay at 150 kbps.

11.3.2.3 Test Case B110320.030 - Command Performance

The Command Performance test case verifies FOS performance requirements for processing spacecraft and instrument loads and commands. The Test, Demonstration and Analysis test methods are used to verify tested requirements.

A FOS logical string is initialized to perform command and load processing activities at EOC and IST workstations and command transmission activities. Steps are provided for the FOT scheduler to access a previously generated DAS covering a 24-hour period and enter start/stop times to allow a new ground script to be generated from the DAS. ATC scheduling tools are activated to initiate ATC generation and subsequent generation of the ground script. The existence of loads with uplink references in the DAS are verified. The time required to complete the ATC generation and verification activities are recorded. Generated commands are transmitted from the EOC and the time required to send the commands is recorded.

At IST user stations, preplanned commands and command groups are retrieved and transferred to the EOC. The time to retrieve, begin transfer, and complete transfer of the commands and command groups to the EOC is recorded.

11.3.2.4 Test Case B110320.040 - Growth Capacity

The Growth Capacity test case verifies FOS requirements for system growth of hardware, software, and functionality including requirements to support additional spacecraft and instruments. The Test, Demonstration and Analysis test methods are used to verify tested requirements.

For this test case, the FOS system architecture specifications are compared with total system capacities such as memory, I/O channel bandwidth, processor speed, communications bandwidth, interface capabilities, and spare hardware and software. These features are analyzed for the presence of additional capacity, which can be accessed without system modification. Computer hardware performance specifications are analyzed to confirm that the delivered FOS hardware components are able to support twice the estimated fully loaded operational capacities on a continuous basis. The utilization of computer processing, storage, and communications capacities is verified to be less than fifty percent at the Release B turnover. Test inputs include a FOS system maximum-load benchmark executed on a fully operational FOS configuration while utilizing available performance monitoring tools to record performance statistics. Benchmark test execution utilizes the available interfaces, tools, and simulators to provide the system load. Simulated real-time and spacecraft recorder data are downlinked, analysis activities are performed, and planning activities are executed simultaneously to load the FOS system. At the conclusion of benchmark test execution, performance output reports are analyzed to verify the executed performance capabilities.