National Aeronautics and
Space Administration

GRC-CONN-PLAN-0900
EFFECTIVE DATE: 05/22/2012

Space Communications and Navigation (SCaN) Testbed Project

National Aeronautics and Space Administration
John H. Glenn Research Center at Lewis Field, OH 44135

SCaN TESTBED PROJECT

SCaN TESTBED SN-NEN PLANNING GUIDE

AUTHORIZED by CM when under FORMAL Configuration Control	
Date	**Signature**
5/23/12	*/s/ Robert E. Turk*

Distribution:

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Availability:

[X] Public (No Restriction) [ ] Export Controlled [ ] Confidential/ Commercial [ ] Internal Use Only

PREFACE

National Aeronautics and Space Administration (NASA) is developing an on-orbit, adaptable, Software Defined Radio (SDR)/Space Telecommunications Radio System (STRS)-based testbed facility to conduct a suite of experiments to advance technologies, reduce risk, and enable future mission capabilities on the International Space Station (ISS). The Space Communications and Navigation (SCaN) Testbed Project will provide NASA, industry, other Government agencies, and academic partners the opportunity to develop and field communications, navigation, and networking technologies in the laboratory and space environment based on reconfigurable, software defined radio platforms and the STRS Architecture. The project was previously known as the Communications, Navigation, and Networking reConfigurable Testbed (CoNNeCT). Also included are the required support efforts for Mission Integration and Operations, consisting of a ground system and the Glenn Telescience Support Center (GRC TSC). This document has been prepared in accordance with NASA Glenn's Configuration Management Procedural Requirements GLPR 8040.1 and applies to the SCaN Testbed configuration management activities performed at NASA's Glenn Research Center (GRC). This document is consistent with the requirements of SSP 41170, Configuration Management Requirements, International Space Station, and GLPR 7120.5.30 Space Assurance Requirements (SAR).

This document contains a guide for scheduling Space Network (SN) and Near Earth Network resources in support of experiment operations.

DOCUMENT HISTORY LOG

Status (Preliminary/ Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
Baseline	–	05/22/2012	Initial Release

SIGNATURE PAGE

Prepared By:

/s/ Daniel McGiffen — *5/22/12*

Daniel McGiffin — Date
Systems/Operations Engineer
ZIN Technologies Inc.

Concurred By:

/s/ Michael Aulisio — *5/22/12*

Mike Aulisio — Date
ZIN Mission Operations Lead
ZIN Technologies Inc.

Approved By:

/s/ Diana Centeno-Gomez for — *5/22/12*

Steve Sinacore — Date
SCaN Testbed Mission Operations Lead
NASA Glenn Research Center

TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 Purpose 1
1.2 Scope 1
2.0 APPLICABLE DOCUMENTS 2
2.1 Reference Documents 2
2.2 Order of Precedence for Documents 2
3.0 DEFINITION 3
3.1 Overview and Philosophy 3
4.0 SN & NEN OPERATIONS PLANNING TIMELINE OVERVIEW 4
4.1 Experiment Requirements Introduced 4
4.1.1 URC, OIP and Flight Rule Inputs 4
4.1.2 Experiment Integration and Test 4
4.1.3 Experiment MOT Simulations Planning 5
4.1.4 Requirements Introduction to SN & NEN 5
4.1.5 OOS Development 6
4.2 Start of the SN and NEN Scheduling Process 6
4.2.1 WLP 9
4.2.2 Scheduler Submits TCR to Pointing 9
4.2.3 Pointing Submits TSR to Scheduler 10
4.2.4 Scheduler Submits Preliminary Schedule Request to SN Forecast Schedulers and NENSO Forecast Schedulers 10
4.2.5 SN Schedule Forecast Period 11
4.2.6 NENSO Schedule Forecast Period 11
4.2.7 STP to OSTPV 11
4.2.8 Scheduling Results Evaluation and Submission to Pointing 12
4.2.9 Pointing Updated TSR Submission to Scheduler 12
4.2.10 Updated TDRS Schedule to SN Real-time Scheduler 13
4.2.11 Updated TDRS SHO Status on SNAS 13
4.2.12 Update to NEN Schedule 13
4.2.13 SCAN Testbed Antenna Pointing 13
4.2.14 SCAN Testbed Antenna Pointing Operation Preparation 13
4.2.15 SCAN Testbed Experiment Execution to LoS 14
5.0 RESOURCE OVERVIEW 15
5.1 NEN Relay Overview 15
5.1.1 NEN Link Operations 17
5.1.2 NEN-LGA Field of View 18
5.1.3 NEN (WGS) Link Availability Operations 20
5.1.4 NEN Uplink Service 20
5.1.5 NEN Downlink & SAFS Service 20
5.1.6 SCAN Testbed Waveforms to NEN Service Codes 21
5.1.7 NEN Scheduling Products 22
5.1.8 NEN Scheduling Steps 22
5.1.9 NEN Scheduling POC 24
5.1.10 NEN Scheduling Considerations 25

5.2 SN Relay Overview 27
5.2.1 SN SGLTs Overview 27
5.2.2 SN TDRS Overview 28
5.2.2.1 SN TDRS Service 28
5.2.2.2 TDRS Support for SCAN Testbed 30
5.2.3 SN Antenna Locations 32
5.2.4 SN-LGA FOV 32
5.2.5 SN-MGA/HGA FOV 33
5.2.6 SN Link Availability Operations 34
5.2.7 SN Scheduling System 35
5.2.8 SN Scheduling 36
5.2.9 SN Scheduling POC 48
5.2.10 SN Scheduling Considerations 48
APPENDIX A ACRONYMS AND ABBREVIATIONS 50
A.1 Scope 50
A.2 List of Acronyms and Abbreviations 50
APPENDIX B DEFINITIONS 54
B.1 Scope 54
B.2 List of Definitions 54
APPENDIX C TBDs AND TBRs 55
C.1 Scope 55
C.2 List of TBDs 55
C.3 List of TBRs 55
APPENDIX D IIRV 56
APPENDIX E INTERNAL NOTE PROCESS 59
APPENDIX F SCAN TESTBED LINK ARCHITECTURE & PORTS 63
APPENDIX G SCAN TESTBED TDRS AND NEN COMMUNICATION SCHEDULE 65
APPENDIX H NEN POST PASS STATISTICS DESCRIPTION 66
APPENDIX I SN STATUS SUMMARIES 67
APPENDIX J SCAN TESTBED SSC 70

TABLE OF FIGURES

Figure 4-1—FDF Product Server Access 7
Figure 4-2—OSTPV 12
Figure 5-1—WGS 11.3-Meter Antenna 15
Figure 5-2—NEN-LGA Location 18
Figure 5-3—NEN-LGA FOV of WGS (5 Degree Elevation) 19
Figure 5-4—NEN-LGA Line-of-Sight Obscuration 19
Figure 5-5—1st Generation TDRS Statistics 29
Figure 5-6—2nd Generation TDRS Statistics 29
Figure 5-7—SN-LGA, SN-MGA/HGA Location 32
Figure 5-8—SN-LGA Line-of-Sight Obscuration 33
Figure 5-9—SN-HGA\MGA Line-of-Sight Obscuration 34
Figure 5-10—SNAS Login Windows 38
Figure 5-11—SNAS Login Windows 39
Figure 5-12—SNAS Login Windows 40
Figure 5-13—SSC View and Edit 41
Figure 5-14—Alert Status 41
Figure 5-15—Schedule Request Summary 42
Figure 5-16—Schedule Request Summary 42
Figure 5-17—SAR Update with TUT 44
Figure 5-18—GCMR 46
Figure 5-19—Graphical Timeline 47
Figure 5-20—Graphical Timeline 47
Figure D-1—IIRV Message Example 56
Figure E-1—All EFNs 59
Figure E-2—Internal Notes Only 60
Figure E-3—Internal Note Generate 61
Figure E-4—Recipient Selection 61
Figure E-5—Internal Note View 62
Figure E-6—Internal Note View or Revision 62
Figure F-1—EFEP/SFEP Port Description of NEN Links 63
Figure F-2—EFEP/SFEP Port Description of SN Links 64
Figure I-1—SGLT Status 67
Figure I-2—TDRS Coverage Status 68
Figure I-3—TDRS Payload Status 69

TABLE OF TABLES

Table 5-1—WGS S-band Command Characteristics Supporting SCAN Testbed (JPL Only) at Launch 16
Table 5-2—WGS WGS S-band Telemetry Characteristics Supporting SCAN Testbed (GD & JPL) at Launch 16
Table 5-3—SCAN Testbed (JPL Only) Uplink Characteristics (NEN) 17
Table 5-4—SCAN Testbed (GD & JPL) Downlink Characteristics (NEN) 17
Table 5-5—NEN-LGA to WGS Availability 20
Table 5-6—SCAN Testbed TR Codes for WGS 21
Table 5-7—NEN Specific Schedule Request File Name Definition 22
Table 5-8—NEN Specific Schedule Request File Input Definition 22
Table 5-9—NEN Scheduling POCs 24
Table 5-10—SCAN Testbed Receive Characteristics (TDRS) 30
Table 5-11—SCAN Testbed Transmit Characteristics (TDRS) 31
Table 5-12—SN-LGA/MGA/HGA to TDRS Availability 35
Table 5-13—SN Scheduling Timeline 35
Table 5-14—Service Types 36
Table 5-15—SSC 1st Character 37
Table 5-16—TDRS ID 37
Table 5-17—SAR Status Indicators 43
Table 5-18—SAR Text Format 43
Table 5-19—GCMR Options 45
Table 5-20—GCMR Options Specific to SCAN Testbed SSCs 45
Table 5-21—SN Scheduling POCs 48
Table A-1—Acronyms 50
Table B-1—Definitions 54
Table C-1—TBDs 55
Table C-2—TBRs 55
Table D-1—IIRV Message Body Format 56
Table D-2—IIRV ASCII TTY Message Body Explanation 57
Table J-1—GD Forward SSCs 70
Table J-2—GD Return SSCs 71
Table J-3—GD Track SSCs 72
Table J-4—JPL Forward SSCs 73
Table J-5—JPL Return SSCs 74
Table J-6—JPL Track SSCs 75
Table J-7—HC Forward SSCs 76
Table J-8—HC Return SSCs 77
Table J-9—Key for SSC Tables 78

1.0 INTRODUCTION

1.1 Purpose

The purpose of this document is to formalize the process of scheduling Space Network (SN) and Near Earth Network (NEN) resources in support of SCaN Testbed operations and experiments.

This document will serve as a guide for the SCaN Testbed Mission Operations Team (MOT) on how to schedule Tracking Data Relay Satellite (TDRS) communication relay support as well as communication relay support from the Wallops Ground Station (WGS). This guide will also provide constraints on SCAN Testbed communication operations levied by ISS Flight Rules, Operations Interface Procedures (OIPs), SN, and NEN restrictions.

1.2 Scope

The scope of this document covers the overall process of scheduling TDRS and WGS communication relay support. This guide provides the steps to execute to obtain an approved schedule of TDRS and WGS communication resources for SCAN Tested communication experiments and will also cover the resource elements needed from other organizations.

2.0 APPLICABLE DOCUMENTS

This section lists the NASA/Government and non-NASA/Government specifications, standards, guidelines, handbooks, or other special publications applicable to the application of this document.

2.1 Reference Documents

Reference documents are those documents that, though not a part of this document, serve to clarify the intent and contents of this document.

Document Number	Reference Document
450-NOSP-SCAN Testbed	Network Operations Support Plan for Space Communication and Navigation (SCAN) Testbed
450-NRD-SCAN Testbed	Network Requirements Document
450-OIP-WSC/DSMC	White Sands Complex (WSC)/ Data Services Management Center (DSMC) Operations Interface Procedures (OIP)
450-PSLA- SCAN Testbed	Project Service Level Agreement
450-RFICD- SCAN Testbed/SN/NEN Rev 1	Radio Frequency Interface Control Document (ICD)
450-SNUG	Space Network Users Guide
453-HDBK-GN	Ground Network Tracking and Acquisition Data Handbook
453-NENUG	Near Earth Network User's Guide
GRC-CONN-OPS-0176	Console Handbook Volume I
GRC-CONN-PLAN-0133	Mission Operations Plan

2.2 Order of Precedence for Documents

In the event of a conflict between this document and other documents specified herein, the requirements of this document shall apply. In the event of a conflict between this document and higher level documents, the higher level documents shall take precedence over this document.

All applicable documents used are to be the approved versions released as of the contract start date. All document changes issued after contract baseline establishment shall be reviewed for impact on the scope of work. Nothing in this document supersedes applicable laws and regulations unless a specific exemption has been obtained.

3.0 DEFINITION

3.1 Overview and Philosophy

The first priority of SCAN Testbed MOT is to protect the payload, ISS, and its crew. Beyond that, the priority is to achieve the science objectives. The payload is externally mounted to ISS and also not intended to be serviceable while on orbit, and therefore requires conservative operational concepts and contingency rules.

This project's science objectives (in which multiple communication connections may be used simultaneously) and the fact that SCAN Testbed will be operating on ISS, will require the coordination and schedule alignment of multiple resources, in addition coordinating with available lines-of-sight to TDRS, WGS or other communication facilities. As a result, much of the operations will be pre-planned weeks in advanced and coordinated with multiple parties including:

- Payload Activity Requirements Coordinator (PARC) at Marshall Space Flight Center (MSFC)
- Payload Planning Manager (PPM) at MSFC
- Timeline Change Officer (TCO) at MSFC
- Operations Controller (OC) at MSFC
- Payload Operations Director (POD) at MSFC
- Payload Rack Officer (PRO) at MSFC
- Goddard Space Flight Center, Flight Dynamics Facility (FDF)
- Mission Operations Directorate (MOD) / DO (Operations) / DM36 (Pointing) at Johnson Space Center (JSC)
- MOD / DM (Flight Design and Dynamics) / DM33 (Trajectory Operations Officer – TOPO) at JSC
- MOD / DI (Expedition Vehicle Division) / DI32 (Attitude Determination and Control Officer – ADCO) at JSC
- SN
- NEN

4.0 SN & NEN OPERATIONS PLANNING TIMELINE OVERVIEW

For experiment execution, the MOT Scheduler (Scheduler) will need to request TDRS and WGS support time during periods when the ISS Ku-band communications (Primary Communications Path) is in Acquisition of Signal (AoS) and during prescribed command windows or ISS S-band AoS periods. The purpose of this is to maintain command; control and monitoring capability during the Software Defined Radio (SDR) transmit and receive operations. During ISS Ku-band Loss of Signal (LoS) periods, the MOT receives no telemetry status from the SCAN Testbed and the MOT will not submit commands to the SCAN Testbed during the LoS periods. **Note:** There will be times when there are gaps in real-time telemetry monitoring and commanding of the payload. Once receive or transmit operations have been commanded to start, these functions can continue operation even through planned telemetry outages. But it is preferable from a health and safety stand point to monitor in real-time an experiment, especially one that is conducting a transmit operation. The following sections will describe what resources are needed and when they are needed in SN and NEN scheduling process.

4.1 Experiment Requirements Introduced

Prior to the actual SN-NEN schedule development, all new communication experiment requirements that are levied on the SCAN Testbed requiring additions or alterations to payload operations, will need to be processed through most if not all the following:

4.1.1 URC, OIP and Flight Rule Inputs

On the behalf of the Experimenter, if necessary the MOT will need to submit to the PARC at MSFC, an initial User Requirements Collection (URC) approximately 8 months prior to experiment execution week and a final, ~5 months prior to experiment execution week. In addition if any current Flight Rules (rules for operations on ISS) need to be augmented or additional Flight Rules need to be created then this initial URC will start the process. If a new Operations Implementation Plan (OIP) needs to be developed or existing one needs changed then the process will start here. This may include the revisiting National Telecommunications and Information Administration (NTIA) Power Flux Density (PFD) requirements and ISS and Visiting Vehicle Radio Frequency Interferences. The URC will be evaluated by the PARC, Payload Planning Manager (PPM), Timeline Change Officer (TCO) and Operations Controller (OC).

4.1.2 Experiment Integration and Test

At ~6-3 months from experiment execution week, the Principal Investigator (PI) team or Guest Experimenter will be evaluating their hardware and software on the SCAN Testbed experiment integration and test system which is controlled and maintained by the Ground Verification Facility Manager and the Experiment Integration Manager under the Sustaining Engineering group.

4.1.3 Experiment MOT Simulations Planning

At ~6-3 months from experiment execution week, the MOT will begin infusing Experimenter requirements in to an operational scheme by first developing a preliminary experiment operations timeline (for Flight simulation or dry run), this will include but not limited to preliminary procedure development and creating a simulated link operations plan. The simulated link operations plan would include the use of the SCAN Testbed Experiment Front End Processor (EFEP) or Guest Experimenter HW, the Ground Integration Unit (GIU), the use of the TDRS Simulators (TSIMs) and the SCAN Testbed Front End Processors (SFEPs at GRC & WSC). Secondly the Scheduler and MOT Antenna Pointing System (APS) Operator will begin incorporating the appropriate Experimenter operation and resource access requirements in follow ground analysis software Satellite Tool Kit (STK) and if necessary the LynxCAT Toolbox (APS operations).

4.1.4 Requirements Introduction to SN & NEN

At ~6-3 months from experiment execution week, based upon experiment new waveform parameters the Scheduler will work with the Network Integration Manager (NIM) at GSFC on any necessary updates to the RFICD (450-RFICD- SCAN Testbed/SN/NEN). The Scheduler will also develop the Service Specification Codes (SSCs) for TDRS contact operations and incorporate them into the Network Control Center Data System (NCCDS) and SNAS operations database (databases at WSC) and will also provide the experiment waveform parameters to the NEN MCE for the Configuration/Telemetry Rate (TR) code development for NEN contact operations. The experiment communication code development and integration to the SN and NEN processes will take at least 2 weeks to 1 month depending on the number of codes introduced. Below is the list of forms to complete when submitting new SSCs to the NCCDS and they can found on both Mission Planning workstations under the" C:\SCAN Testbed Planning\SN\SSC" folder. After completing the Database Change Request (DBCR) forms, they should be submitted to the NOM (robotics@ncc-comm.gsfc.nasa.gov list serve) and the NOM will check them over and pass them onto WSC to be implemented. The Scheduler will incorporate the new and/or updated SSCs on the SNAS database using the SSC view and edit function described in Section 5.2.8.

- NCCDS SSC KaSAF Form - Rev1
- NCCDS SSC KaSAR Form - Rev1
- NCCDS SSC SSAF Form - Rev1
- NCCDS SSC SSAR Form - Rev1
- NCCDS SSC SMAF Form - Rev1
- NCCDS SSC SMAR Form - Rev1
- NCCDS SSC MAF Form - Rev1
- NCCDS SSC MAR Form - Rev1
- NCCDS SSC Tracking Form - Rev1

4.1.5 OOS Development

The PPM will be the primary interface for the MOT for payload planning. Based upon the URCs the PPM will develop the payload On-orbit Operations Summary (OOS) and then provide the summary to the MOT by email for an informal review ~2.25 months prior to experiment execution week and a final delivery, at ~1 month. The MOT Mission Operations Manager (MOM) and Scheduler will work with the PPM to resolve any issues concerning SCAN Testbed operations.

4.2 Start of the SN and NEN Scheduling Process

At ~ 1 month from experiment execution week, the MOT along with the PI Team and/or Guest Experiments will execute a dry run of the experiment, using the EFEP or Guest Experimenter HW, GIU, SFEPs at GRC & WSC and ground analysis software STK and if necessary LynxCAT Toolbox (APS operations). This dry run will be the execution of the plan established several months earlier and will be a final exercise of the on-orbit procedures and simulation of the experiment concept of link operations prior to on-orbit execution. This simulation will assist in the refinement of TDRS and NEN resource support needed for the experiment in question (such as additional TDRS and NEN communication links). The data sources for the communication link simulations listed below are used by the APS Operator/Scheduler for incorporation into the STK and LynxCAT tools for modeling the predicted TDRS and NEN ground station contacts and if needed developing the antenna TRK files for SN-MGA and SN-HGA operations. The detailed descriptions of the data sources and how they are used in modeling predicted SCAN Testbed attitude, trajectory, and antenna dynamics are provided in the “SCAN Testbed Trajectory, Attitude and Antenna Modeling Plan (GRC-CONN-PLAN-0922)”.

- **TDRS ephemeris:** Trajectory data will be obtained from one organization for short term and long term planning.
    - GSFC FDF product center Bonham.fdfneto.nascom.nasa.gov FTP Server
        - An ASCII file containing a Two-Line Element (TLE) set generated every Monday-Wednesday-Friday for each required TDRS (F4-F10, K & L) is accessed by the APS Operator/Scheduler through FileZilla FTP Client software. The TDRS TLE will be saved to a text file with the same name with associated day of year (DOY) and year (YYYY) appended to the end of the file (example: C:\SCAN Testbed Planning\SN\TLE\TDE_TLE_DOY_YYYY).
- **Other Trajectory ephemerides:** If the Experimenter requires the SCAN Testbed to communicate with other space borne assets, the APS Operator\Scheduler will model these assets by obtaining the appropriate ephemeris from the asset Command and Control source if it is not available the GSFC FDF Product Server.

- **Ground station location:** Station location and mask data will be obtained from one organization for short term and long term planning.
    - GSFC FDF product center Bonham.fdfneto.nascom.nasa.gov FTP Server
        - ASCII files containing the WGS 11.3 meter antenna Geodetic static location (should not change) and antenna mask data (ASCII format) is accessed by the APS Operator/Scheduler through FileZilla FTP Client software (refer to Figure X-X below for FDF Product Server access). The station location and mask data file will be saved to a text file with the same name with associated DOY and YYYY appended to the end of the file (example: C:\SCAN_Testbed_Planning\NEN\Station\fdfstatn_DOY_YYYY).

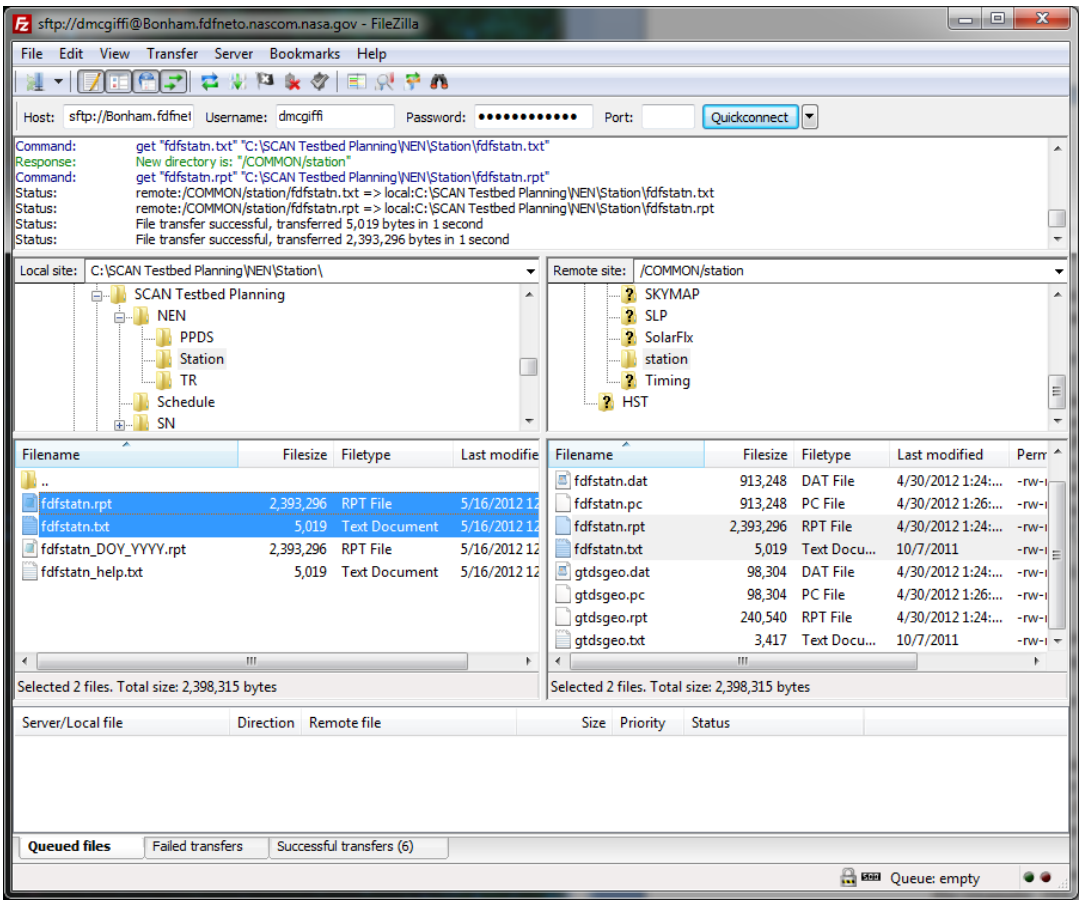


Figure 4-1—FDF Product Server Access

- **Other Ground Stations:** If the Experimenter requires the SCAN Testbed to communicate with other ground station antennas, their locations and mask data will also be incorporated on an as needed basis.

- **SCAN Testbed Ephemeris:** Trajectory data will be obtained from two organizations for short-term and long-term planning.
    - GSFC FDF product center (short-term) Bonham.fdfneto.nascom.nasa.gov FTP Server
        - Similar to the access displayed in Figure 4-1, the APS Operator/Scheduler will obtain the ASCII file containing the ISS TLE set generated every Monday-Wednesday-Friday. The APS Operator/Scheduler will use this product when determining line of sight access times and developing any necessary TRK files for support of experiment execution and affirmation of Flight Rule requirements. The ISS TLE file will be saved to a text file with the same name with associated DOY and YYYY appended to the end of the file (example: C:\SCAN_Testbed_Planning\ISS\TLE\ISS_TLE_DOY_YYYY).
    - TOPO web page (short-term and long-term) (http://mod.jsc.nasa.gov/DM/DM33/TOPO_web/main.html).
        - Long-term 6 month Mean of J2000 ISS Cartesian ASCII format ephemeris will be used by the APS Operator/Scheduler when performing long-term SN and NEN availability analysis. When the ephemeris link is selected, the ephemeris is saved to a text file with the same name with associated DOY and YYYY appended to the end of the file (example: C:\SCAN_Testbed_Planning\ISS\J2K\topo01_ISS_JAXA_J2K_Ephemeris_ascii_DOY_YYYY).
            - High density format under “Planning > Reference Trajectory > J2000 Ephemeris (High Density)” with a 5 minute time step.
        - Short term ~1.5 month Mean of J2000 ISS Cartesian ASCII format ephemeris will be used by the APS Operator/Scheduler for predicted TDRS and NEN access analysis over a month. This ephemeris also factors in predicted orbit adjust events. The high density ephemeris will be used by the APS Operator/Scheduler for predicted TDRS and NEN access analysis over a month. When the ephemeris link is selected, the ephemeris is saved to a text file with the same name with associated DOY and YYYY appended to the end of the file (example: C:\SCAN_Testbed_Planning\ISS\J2K\topo52_ISS_F13_J2K_EPH_ascii_DOY_YYYY).
            - High density format under “Planning > Short Term Plan Data > Format 13 >” with a 5 minute time step.

- **SCAN Testbed Attitude:** Attitude data will be obtained from one organization for short-term and long-term planning.
    - ADCO web page https://mod2.jsc.nasa.gov/di/di32/ADCO-Flight-Info/MCS-flt-info.html (short-term)
        - In "ISS Motion Control Systems Flight Info (Current Flight Status)" table select "Current ATL" in the "ISS Attitude Timeline (ATL)" heading. When the ATL link is selected, the ATL is saved to a Web Archive file with the same name with associated DOY and YYYY appended to the end of the file (example: C:\SCAN_Testbed_Planning\ISS\ATL\Current ISS Attitude Timeline_DOY_YYYY).
            - A ~10 day projection of the Local Vertical Local Horizontal (LVLH) referenced Attitude Timeline (ATL) that list activities occurring on ISS that impact attitude orientation, such as but not limited to Soyuz docking, some thruster disable periods, thruster tests, robotics operations, Russian antenna tests (called 'Proximity Communication Equipment Carrier Tests') that involved large maneuvers, a ISS reboost, a propellant purge, a Progress undocking, and a debris avoidance maneuver.
            - The different attitudes that ISS could operate in are described in the "SCAN Testbed Trajectory, Attitude and Antenna Modeling Plan". The APS Operator/Scheduler will use the variables under the YPR (Yaw, Pitch, Roll) heading for each event in the ATL applicable to the SCAN Testbed operations period.
    - For long-term planning the APS Operator/Scheduler will use the nominal LVLH Torque Equilibrium Attitude (TEA)

4.2.1 WLP

At ~ 18 days from experiment execution week, the Weekly Look-ahead Plan (WLP) is reviewed. It's an update to the OOS summarizing all of the activities planned on each day for a particular week of the increment projected three weeks in the future. This is where the Scheduler will obtain a preliminary summary of operational periods for the SCAN Testbed for the week of operations and also where Pointing will be able to determine probable SN and NEN link opportunities for SCAN Testbed. The PPM develops the WLP weekly and it is made available to the Payloads ~10 days from the week of event execution.

4.2.2 Scheduler Submits TCR to Pointing

At ~18 days from experiment execution week, the Scheduler submits an augmented TDRS Communications Requirements (TCR) which may include NEN communication requirement to ISS Pointing at JSC Mission Control Center – Houston (MCC-H) specifying operation time frame, the number and type of service and resource as defined in the SCAN OIP and SCAN TCR.

4.2.3 Pointing Submits TSR to Scheduler

At ~17 days from experiment execution week, Pointing submits an augmented comprehensive TDRS/NEN Service Request (TSR) to the Scheduler, which factors in all vehicle requirements (ISS, ATV, HTV, etc.), vehicle structural blockage, and antenna system operational constraints including NTIA Power Flux Density (PFD) ranges.

These factors or constraints are captured in the following SCAN Testbed Flight Rules:

- B19-18 ISS PAYLOAD POWER INTERRUPTION CONSTRAINTS
- B19-25 PAYLOAD KU-BAND INTERRUPTION CONSTRAINTS
- B19-28 SCAN TESTBED EVA MAINTENANCE INHIBITS
- B19-29 SCAN TESTBED POWER FLUX DENISTY CONFORMANCE LIMITS
- B19-XX SCAN TESTBED RADIATION MANAGEMENT WITH ISS
- B11-127 HTV/ATV/DRAGON/CYGNUS S-BAND COMMUNICATION CONSTRAINTS
- B12-107 MSS STAY-OUT ZONES
- B15-15 EVA KEEPOUT ZONES

4.2.4 Scheduler Submits Preliminary Schedule Request to SN Forecast Schedulers and NENSO Forecast Schedulers

At ~17-16 days from experiment execution week, the Scheduler will submit a preliminary schedule request to the SN forecast schedulers through SN Access System (SNAS). The procedure for executing this process and the products that are developed is covered in Section 5. In addition the Scheduler will submit a Specific Schedule Requests in the “comma-delimited” format to NEN (Near Earth Network Scheduling Office (NENSO)/ Wallops Orbital Tracking Information System (WOTIS) at WSC for stations (WGS) support by FTP. This Specific Schedule Request is the “i” schedule or initial schedule. SN/NENSO will use Improved Interrange Vectors (IIRVs) provided by FDF every week (Monday, Wednesday, Friday) for all ephemeris data sent to the SN and to the NEN ground stations. If the Scheduler needs to provide the IIRV for a specific event, this is executed through SNAS for the all TDRS contact events and WOTIS for all NEN ground station contact events. **Note:** If a current Guest Experimenter requires their experiment to be repeated, this is the point in the planning process to make this request to the MOT. An example and description of this IIRV product is in Appendix D.

4.2.5 SN Schedule Forecast Period

During the SN forecast period (~14-7 days from experiment execution week), the SN forecast schedulers integrates the preliminary schedule requests (TSRs) into the SNAS (SN) scheduling system for all TDRS users and generates a TDRS schedule based on the priority designations of each project and the availability of Network resources. Sometime during the SN forecast period, the Scheduler will be provided a TDRS Scheduling Order (SHO) of what SN schedulers has confirmed based on priorities. This SHO will be viewed through SNAS.

4.2.6 NENSO Schedule Forecast Period

During the NENSO forecast period (~14-7 days from experiment execution week), the NENSO forecast scheduler integrates the preliminary schedule requests (TSRs) into WOTIS for all NEN users and generates a NEN ground station schedule based on the priority designations of each project and the availability of Network resources. Before the end of the NENSO forecast period (usually a few days after the Scheduler submits the “i” file request), the NENSO/WOTIS will respond to the Scheduler with the planning schedule containing any changes to the original submitted schedule. The goal is to provide the “i” file request the Friday prior to the forecast period, so then the NENSO would transmit the request response, the “s” schedule file on Monday, which would be the start of the forecast week.

4.2.7 STP to OSTPV

The PPM develops the Short Term Plan (STP) (originating from WLP) and it contains the detailed schedule for a particular day for the increment, including system and Russian Segment (RS) activities that are coordinated with payload activities. The Scheduler and other MOT members can view STP through the Onboard Short Term Plan Viewer (OSTPV), a MCC-H resource. The only concern the MOT would have with this final revision to ISS activities, would be if there was a change to the SCAN Testbed operational period that would affect the SN/NEN scheduled events. Prior to this final revision (~ 8 days prior) the Scheduler and Pointing would have coordinated the preliminary time periods including overlapping Ku-band AoS periods with schedule SN and NEN resource support using the WLP. Figure 4-2 shows the OSTPV display and what events the MOT would be tracking during operations including the TDRS Ku-band and S-band AoS and LoS periods in relation to SDR operations. A description of this display is provided in the Console Handbook (GRC-CONN-OPS-0176).

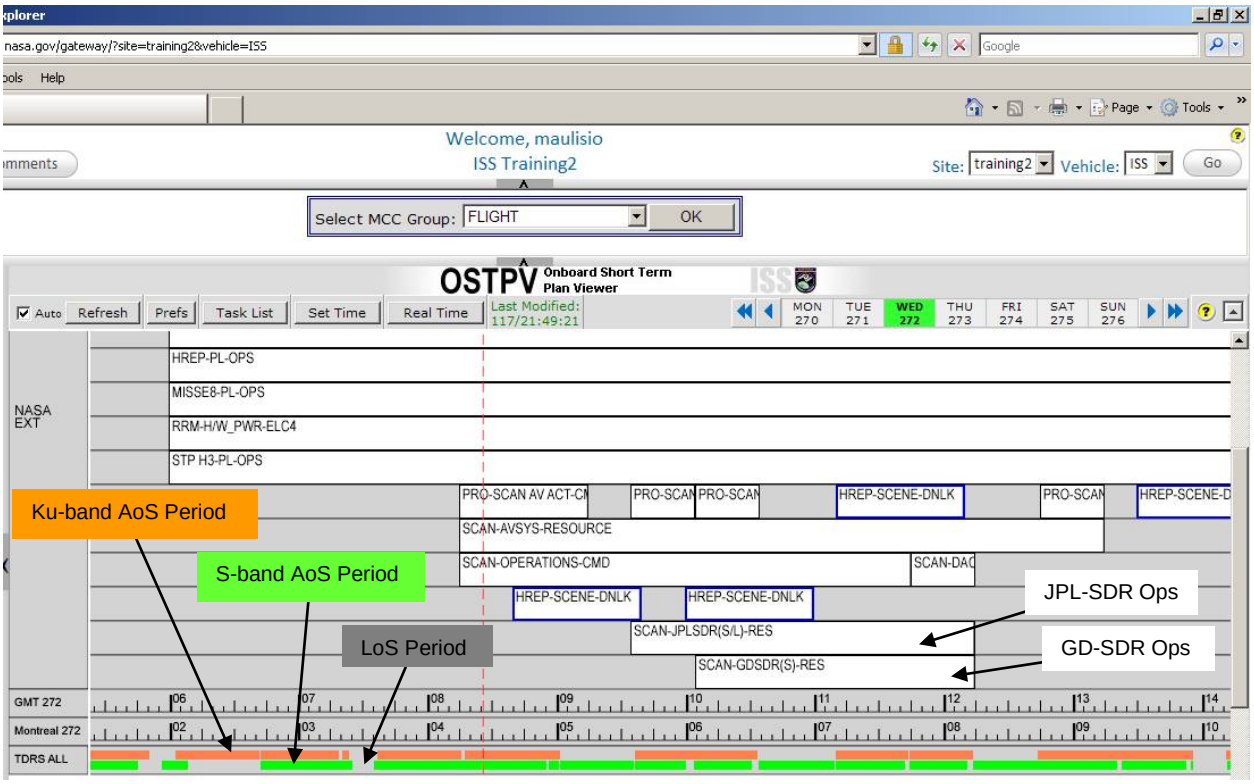


Figure 4-2—OSTPV

4.2.8 Scheduling Results Evaluation and Submission to Pointing

At ~ 7 days from experiment execution week, Scheduler compares the TDRS and NEN ground station availability times to the experiment requirements and what is presented in OSTPV. In addition the Scheduler will deliver the returned TDRS SHO and NEN "s" schedule file results to Pointing. If needed the Scheduler will contact Pointing on the voice loop "ISS PTG 1" regarding how to resolve any unmet experiment requirements. If Pointing is not available on "ISS PTG 1" or by black phone then the Scheduler will wait for a response to the Internal Flight Note (IFN) sent to Pointing with a notification through email. Refer to Appendix E for the IFN development and deliver process.

4.2.9 Pointing Updated TSR Submission to Scheduler

At ~6 days to 24 hours from experiment execution week, at the request of the Scheduler, Pointing reviews the SHO and TDRS Unused Time (TUT) contact times provided by the Scheduler in an attempt to meet SCAN Testbed experiment requirements by filling gaps in the SHO, using TUT only. In addition pointing will see if any addition NEN line of sight contacts are possible. Pointing also incorporates NTIA Power Flux Density (PFD) restrictions in their calculation per Flight Rule "B19-29 SCAN TESTBED POWER FLUX DENISTY CONFORMANCE LIMITS". Pointing delivers the updated TSR to the Scheduler.

4.2.10 Updated TDRS Schedule to SN Real-time Scheduler

At ~6 days to 24 hours from experiment execution week, the Scheduler will use the times in the TSR from Pointing and schedule new TDRS contacts using the available TUT. The Data Systems Management Center (DSMC) at WSC is responsible for coordination of all real-time requests of the SN resources from customers. Prior to transmit of this schedule requests the Scheduler will call the SN Real-time scheduler to notify them of the new events being scheduled. **Note:** The Scheduler will work with the SN schedulers through the black phones (see Section 5.2.9) to resolve any issues concerning the updated schedule requests.

4.2.11 Updated TDRS SHO Status on SNAS

During Real-time scheduling period the SN Real-time schedulers will provide an updated TDRS SHO status in SNAS for the Schedule to review. **Note:** The updated SHO is usually provided by the Real-time Schedulers within 24 hours of TDRS schedule requests.

4.2.12 Update to NEN Schedule

The Scheduler can update the NEN schedule with additions, deletions, time changes etc with a "u" file. The Data Systems Management Center (DSMC) at WSC is responsible for coordination of all real-time requests of the NEN resources from customers. In response to the "u" file (response time dependant on the change time and date), NENSO/WOTIS will again transmit an "s" file. The confirmed operations schedule from NENSO will be transmitted the Thursday before the operations week begins on Monday, this assumes the Scheduler submit the "u" file earlier in the week. Again, the file transmitted from the NENSO will be an "s" file. Changes to the confirmed schedule requests for critical and emergency activities within the operations week can be submitted by the Scheduler prior to the actual event. Changes within the 4 hours of NEN contact event will be processed on a best-effort basis, and should be made by a phone call (see Section 5.1.8) to the NENSO with a confirmation schedule from the Scheduler with the changes.

4.2.13 SCAN Testbed Antenna Pointing

The Scheduler provides the TDRS and NEN ground station AoS and LoS times to the MOT Attitude Pointing System (APS) Operator, within a week from experiment execution. The APS Operator using STK and LynxCAT then evaluates those periods, factoring in predicted orbital ephemeris, attitude orientation and antenna and ground station mask data. In addition, the APS Operator will use these data sources to generate antenna track files (TRK files) which are used by the SCAN Testbed for pointing the APS controlled SN-MGA and SN-HGA in the direction of the predicted location of TDRS. Please refer to the "SCAN Testbed Trajectory, Attitude and Antenna Modeling Plan (GRC-CONN-PLAN-0922)" for more details on this process.

4.2.14 SCAN Testbed Antenna Pointing Operation Preparation

Day 1 (Monday) of experiment execution week, the TRK files are uploaded to the SCAN Testbed for the weeks experiments. Given any changes to the ISS orbit and attitude not initially predicted, the Scheduler will work with the APS Operator to confirm that PFD values with respect to the Earth horizon are within allowable NTIA ranges as defined in Flight Rule "B19-29 SCAN TESTBED POWER FLUX DENISTY CONFORMANCE LIMITS" for all antennas with the exception of the GPS antenna. For more details concerning this process please refer to the "SCAN Testbed Trajectory, Attitude and Antenna Modeling Plan (GRC-CONN-PLAN-0922)".

4.2.15 SCAN Testbed Experiment Execution to LoS

On the day of execution and prior to SCAN Testbed activation by the PRO, the MOT will brief the POD, PRO and OC on the day's events including when a TDRS and NEN link operation event will occur. These details will be provided by the Scheduler in the combined TDRS and NEN schedule the Friday before experiment execution week. In addition the Scheduler will also provide the combined schedule to the Experimenters. The only adjustment that would need to be made to the scheduled TDRS and NEN ground station contact periods is to the start and stop times of SDR transmit operations due to orbit and attitude changes that would violate NTIA PFD ranges. There is also a chance that TDRS or NEN contact may be eliminated because alterations to the SCAN Testbed power ON periods due to a change in ISS activities. Unplanned elimination of scheduled TDRS and NEN contacts will be re-planned and executed at a later date. TDRS scheduled resource adjustments can be made through the Ground Control Message Request (GCMR) process in SNAS. During a TDRS contact event, the Scheduler and Experimenter can view performance elements of forward and return link, this is User Performance Data (UPD) and it's a product provided in SNAS. About 10 minutes after experiment execution (NEN contact period), WGS will provide post pass data statistics through email for the NEN downlink service.

5.0 RESOURCE OVERVIEW

The Resources are composed of organizations (including points of contact) and facilities on the ground and in Earth orbit that are necessary for development and execution of SCAN Testbed experiments involving the SN and NEN communication segments. And each resource has constraints associated with it that may impact communication link operation. A brief description of the resource and what it provides (services and products) for the experiment support and its constraints are listed in the following subsections.

5.1 NEN Relay Overview

The NEN consists of both the NASA owned ground stations located in Norway, Florida, Alaska, Antarctica, Virginia and the contracted commercial stations run by the Universal Space Network (USN) (Alaska, Australia, Hawaii), Santiago Satellite Station (Chile) and Kongsberg Satellite Services (Norway). The NEN also includes support from the Network Integration Center (NIC) located at the Goddard Space Flight Center (GSFC). The NENSO, WS1 S/Ka-band, and VHF systems are all located at the WSC, New Mexico. The NEN will serve as an Experimental Communications Path two-way direct ground-space link (uplink & downlink) from the STCC to the SCAN Testbed utilizing its General Dynamics (GD) (downlink only), & Jet Propulsion Laboratory (JPL) SDRs and S-Band NEN Low Gain Antenna (NEN-LGA). The Wallops Flight Facility (WFF), WGS (11.3-meter at Wallops Island, Virginia) will be the primary science data handler ground station between the STCC and the SCAN Testbed. Figure 5-1 is a photograph of the WGS antenna.

Figure 5-1—WGS 11.3-Meter Antenna

The general characteristics of the WGS ground station at WFF are as follows:

- Location: 37º 55’ 28” N Latitude, 75º 28’ 35” W Longitude
- One 11.3-meter antenna for simultaneously transmitting at S-band while receiving at S- and X-band.

Table 5-1 and Table 5-2 identify the S-band command (uplink) and telemetry (downlink) characteristics, WGS will support for the corresponding launch version waveforms implemented for the SCAN Testbed GD-SDR and JPL-SDR. Table 5-3 and Table 5-4 identify launch version of the Receive and Transmit characteristics of the SCAN Testbed (GD and JPL waveforms) for NEN link operations. Future waveforms will be introduced after SCAN Testbed checkout and commissioning that may be different than what is provided in the launch versions. Values presented in the tables mentioned above were taken from the latest revision of the “450-RFICD-SCAN Testbed/SN/NEN Rev 1”. For additional details concerning NEN link support, refer to the “450-NOSP-SCAN Testbed”. For additional details concerning the NEN ground station profiles and link capabilities, refer to the latest revision of the “453-NENUG”.

Table 5-1—WGS S-band Command Characteristics Supporting SCAN Testbed (JPL Only) at Launch

Characteristic	Value
Frequency	2041.02708 MHz
EIRP	≥ 66 dBWi
Polarization	LHCP
Output Power	200 Watts
Carrier Modulation	BPSK
Information Rate (prior to any coding)	155.346 kbps
Symbol Rate	310.692 ksps (Rate ½ Conv.)
Coding	Rate ½ Convolutional or Uncoded
Data Format	NRZ-M

Table 5-2—WGS WGS S-band Telemetry Characteristics Supporting SCAN Testbed (GD & JPL) at Launch

Characteristic	Value
Frequency	Non-coherent: 2216.5 MHz (GD & JPL) 2287.5 MHz (GD)
G/T	≥ 23.63 dB/K for clear sky and high elevation angle
System Noise Temperature	165 ˚K for clear sky and high elevation angle
Polarization	LHCP
Antenna Gain	45.8 dBi
Modulation	BPSK, SQPSK
Information Rate (prior to any coding)	769.45 & 1000 kbps
Symbol Rate (after all coding applied	1538.9 & 2000 ksps (Rate ½ Conv.)
Carrier Data Format	NRZ-M
Decoding	Viterbi or Uncoded

Table 5-3—SCAN Testbed (JPL Only) Uplink Characteristics (NEN)

Receive Signal Parameters	NEN
	S-Band
Frequency	2041.02708 MHz
User Antenna	NEN-LGA
Polarization	LHCP
Information Rate (Prior to any coding)	155.346 kbps
Symbol Rate (After all encoding applied)	310.692 ksps
Coding (Note)	Rate ½ Conv. or Uncoded
Data Format (Note)	NRZ-M
Maximum Bandwidth	~620 kHz
PN Chip Rate	N/A
Transmit Modulation	BPSK
Notes: Any coding and formatting is transparent to the NEN.	

Table 5-4—SCAN Testbed (GD & JPL) Downlink Characteristics (NEN)

Transmit Signal Parameters	NEN
	S-Band
Data Group and Mode	Non-coherent
Transmit Frequency	2216.5 MHz/2287.5 MHz (GD only)
Polarization	LHCP
Antenna	NEN-LGA
Transmit Power	7.95 Watts (GD), 7.8 Watts (JPL)
Information Rate (Prior to any coding)	769.45 & 1000 kbps
Symbol Rate (After all coding applied) for Rate ½ Convolutional	1538.9 & 2000 ksps
Coding	Rate ½ Conv. or Uncoded
Data Format	NRZ-M
Signal Bandwidth	4 MHz
Transmit Modulation	SQPSK (GD), BPSK (JPL)

5.1.1 NEN Link Operations

The Scheduler will work with the NENSO schedulers at WSC to establish the appropriate WGS antenna support through the WOTIS. The NEN schedule is processed through four periods: straw man, forecast, operations, and real-time. The MOT will make use of all 4 periods when introducing new experiments to the mission. WGS also provides Tracking services: 1- & 2-way Doppler, and antenna auto-tracking angle, these services may be explored later in the mission lifecycle or when an Experimenter requests them. The baseband data interfaces that WGS provides are TCP/IP, serial clock and data, 4800-bit blocks encapsulated in IP packets, and email. The MOT will utilize the TCP/IP and serial clock and data and email interface for its experiment support.

5.1.2 NEN-LGA Field of View

Link operations with the WGS are accomplished using the Omni directional antenna NEN-LGA (static), which is partially Nadir (towards the Earth) and Ram pointing. It's not clear in the figure but the NEN-LGA boresight is pointed 20° below the +X-axis (RAM direction) (see Figure 5-2). SCAN Testbed-to-WGS uplink and downlink service is available on a scheduled basis during intervals that NEN-Testbed line-of-sight exists and the resource is operating and available. When antenna line-of-sight exists between WGS and the SCAN Testbed NEN-LGA, is when the supporting station antenna elevation angle to the Testbed is high enough above Earth horizon and correspondingly the SCAN Testbed is above the supporting station local antenna mask to eliminate obscuration. Figure 5-3 shows the field of view (FOV) of the NEN-LGA over WGS. Figure 5-4 shows the obscuration plot of the NEN-LGA from ISS. The solid obscurations are fixed structures that are permanent; the wireframe obscurations are dynamic and may not be present all the time. The obscuration view is based upon a Torque Equilibrium Attitude (TEA) LVLH attitude, which is flown during quiescent periods. These obscurations limit contact time (line of sight) available on the order of seconds to just less than 4 minutes. NEN S-Band uplink service at WGS will be used by the JPL SDR and GD SDR (future waveform), but both the JPL and GD SDRs will use NEN S-Band downlink service.

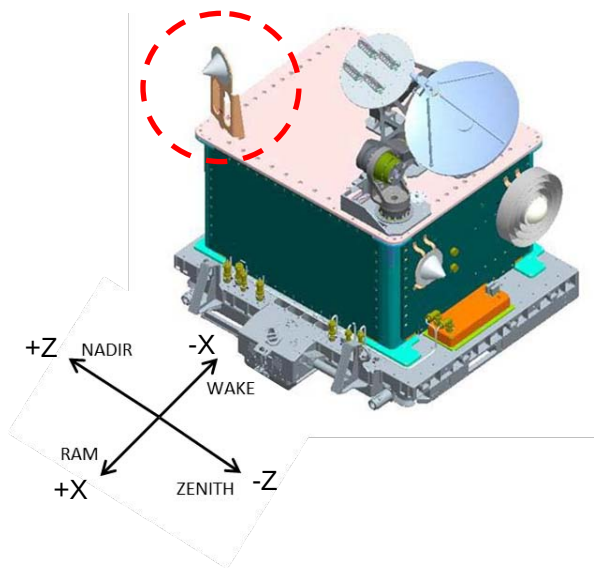


Figure 5-2—NEN-LGA Location

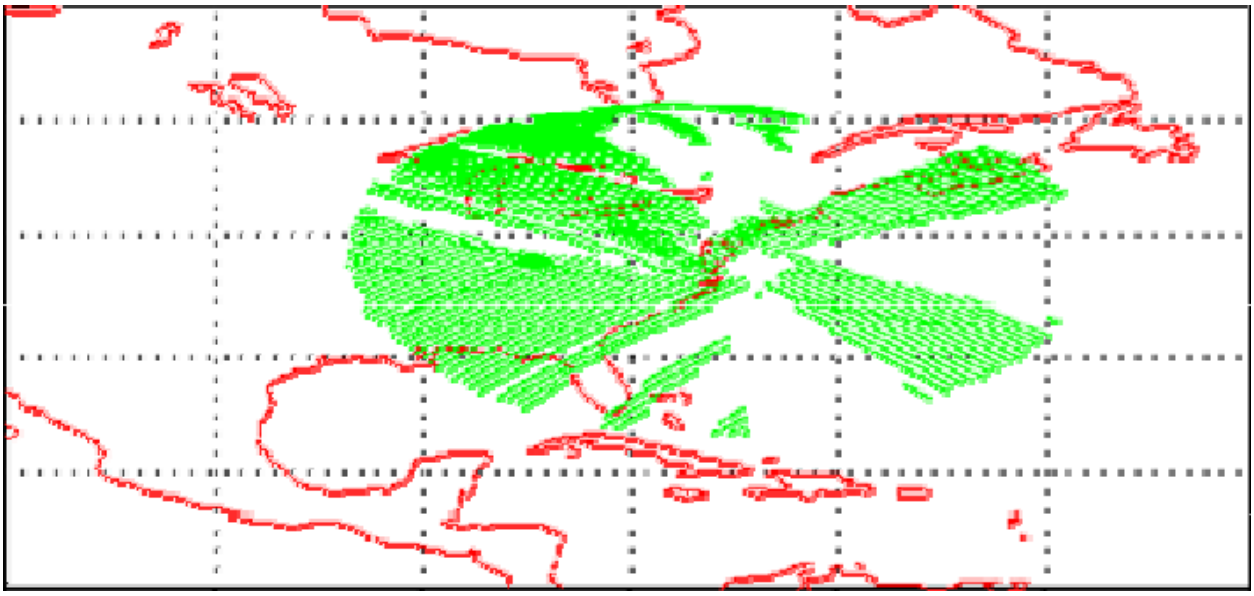


Figure 5-3—NEN-LGA FOV of WGS (5 Degree Elevation)

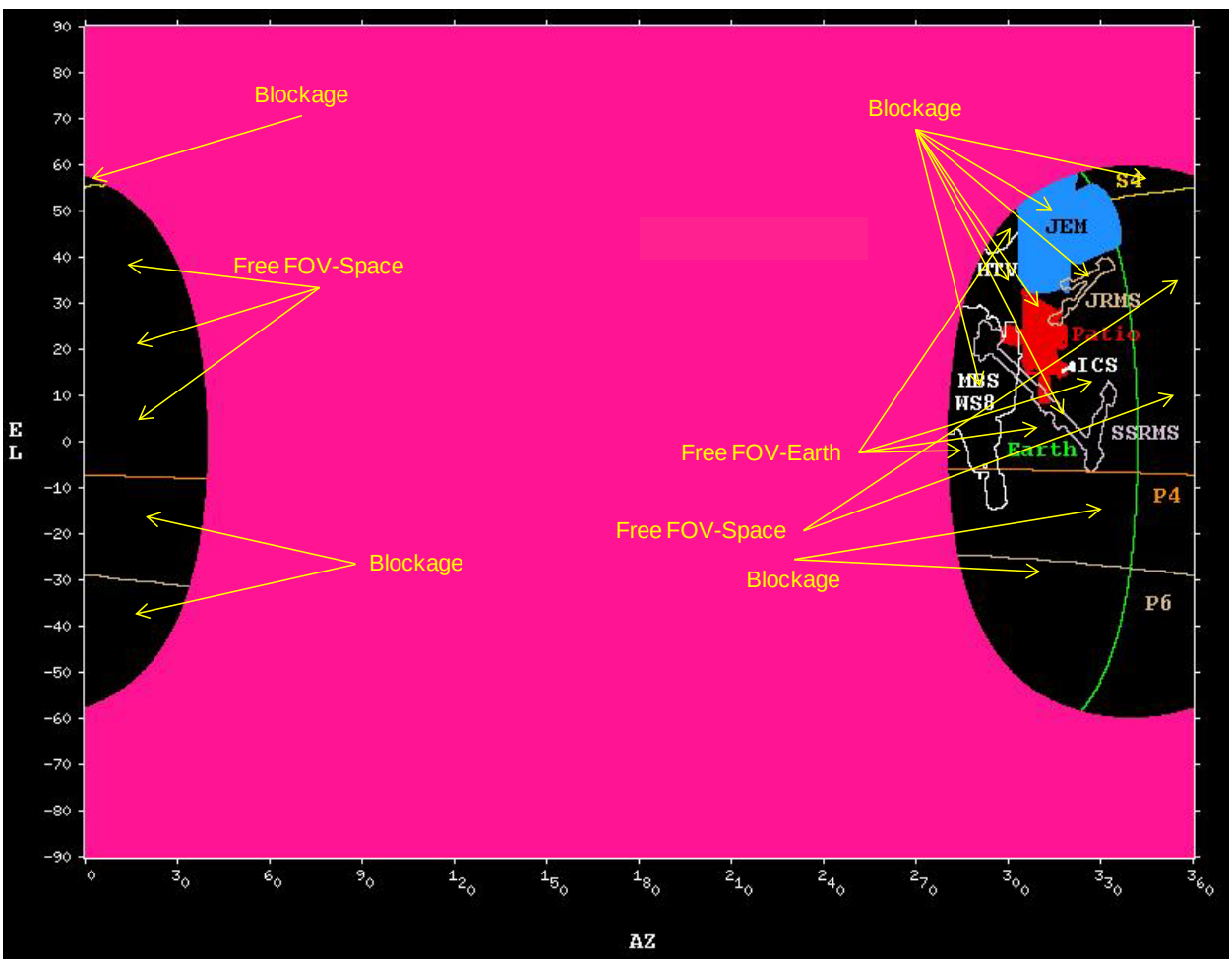


Figure 5-4—NEN-LGA Line-of-Sight Obscuration

5.1.3 NEN (WGS) Link Availability Operations

Table 5-5 below presents the NEN-LGA to WGS line of sight availability statistics for a given year of operation. The total number of contacts per month could average around ~150 with a calculated average contact time of ~2.5 minutes and a maximum of just less than 4 minutes, much lower than the required contact duration. The number of contacts between 2.5-4 minutes for a given month averages to ~11. Keep in mind as stated earlier (in section 5.1.2), there are additional WGS contacts available but are considerably less than 2.5 minutes and can be only a few seconds long. If an Experimenter chooses to take advantage of the short contact periods, the MOT will support this activity. In addition, a number of these contacts greater than 3 minutes can be days apart which would make it impossible to have consecutive maximum contact periods with the same station, unless other stations are utilized.

Table 5-5—NEN-LGA to WGS Availability

Parameter	Value
Total Contacts (annually)	1791
Average Contact Duration (minutes)	2.43
Maximum Contact Duration (minutes)	3.83

5.1.4 NEN Uplink Service

The STCC is on the Restricted IONet and waveforms uplinked to the SCAN Testbed will originate from the EFEP and pass through the GRC-SFEP. The waveform then passes through the GSFC Closed IONet then through a firewall before it reaches the Cortex Integrated Command Ranging and Telemetry baseband system (CRT) at WGS (Closed IONet) then is uplinked to the SCAN Testbed in accordance with the TR code. Note: Due to IONet security protocols, data flows on the Closed IONet are restricted to Closed to Closed or Closed to Open. No data is allowed to flow from Open to Closed. Currently based upon the launch version waveforms only the JPL-SDR can process uplink waveforms, in the future the GD-SDR may incorporate this type of waveform, but only if an Experimenter requires it.

5.1.5 NEN Downlink & SAFS Service

The NEN WGS downlink service to the STCC will not be in real-time but post contact pass. Science data will be stored in the Standard Autonomous File Server (SAFS) and then made available to the MOT 1 hour after LoS, through the TCP/IP service. SAFS provides automated management of large data files without interfering with the assets involved in the acquisition of data. SAFS is available at the following NEN ground stations: ASF, MGS, MILA, SGS, and WGS. It is also available at GSFC to provide for centralized customer data distribution, it is called the Central SAFS (CSAFS). The WGS Cortex CRT will accept the raw data from the SCAN Testbed GD or JPL SDR downlink and processes the data into files (format for later consumption) that are sent to the WGS SAFS via a standard network protocol. These files will then be sent to CSAFS for storage. The CSAFS provides the single point of contact for MOT and isolates WGS from the STCC. Then the Scheduler or SFEP Operator will retrieve the data files from CSAFS via a standard network protocol through the Mission Planning Workstation in the STCC. The port definitions with WGS are presented in Figure F1, Appendix F.

5.1.6 SCAN Testbed Waveforms to NEN Service Codes

Based upon experiment launch version waveforms that have been developed, a corresponding set of Configuration/Telemetry Rate (TR) codes have been developed and verified (compatibility testing) for use in WGS relay communication. These experiment support communication codes (applicable to only SCAN Testbed GD and JPL SDR communication operation) are listed in Table 5-6. These codes are provided in the schedule request sent to the NENSO by the Scheduler. For every new waveform introduced a new TR code will be provided.

Table 5-6—SCAN Testbed TR Codes for WGS

Mode ID	Coherence	Command (Uplink)	S-Band (Downlink)	S-Band	Purpose	Waveform ID
TR1	OFF	ON (155.346Ksps)	1.5389Msps 769.45Kbps	ON	Routine ops (JPL-SDR)	416, 415
TR2	OFF	ON (155.346Ksps)	769.45Kbps	ON	Routine ops (JPL-SDR)	414, 413
TR3	OFF	OFF	1.0 Mbps	ON	Routine ops (GD-SDR)	392
TR4	OFF	OFF	2.0Msps 1.0Mbps	ON	Routine ops (GD-SDR)	391
TR5	OFF	OFF	1.0 Mbps	ON	Routine ops (GD-SDR)	390
TR6	OFF	OFF	2.0Msps 1.0Mbps	ON	Routine ops (GD-SDR)	389
TR7	OFF	OFF	1.0 Mbps	ON	Routine ops (GD-SDR)	384
TR8	OFF	OFF	2.0Msps 1.0Mbps	ON	Routine ops (GD-SDR)	383
TR9	OFF	OFF	1.0 Mbps	ON	Routine ops (GD-SDR)	382
TR10	OFF	OFF	2.0Msps 1.0Mbps	ON	Routine ops (GD-SDR)	381

5.1.7 NEN Scheduling Products

Below is the description of the schedule products including each file naming convention. Listed below in Table 5-7 is the definition of the name of each specific schedule request file. Table 5-8 describes all the parameters in the comma-delimited schedule file. These ASCII files are processed by the NENSO using WOTIS.

Table 5-7—NEN Specific Schedule Request File Name Definition

iUbB1dD.C (Initial file), sUbB1dD.C, (scheduled file), uUbB1dD.C (updated file)		
Filename Segment	**Definition**	**Values**
I s u	Initial designator Scheduled designator Updated designator	i s u
U	3 character Mission Identifier	Assigned by WOTIS (Ex.am1, eo1)
b	Beginning period separator	**B**
B1	Year (YYYY) Day of Year (DoY) for first support in file	2011, 2012, etc. and 001 – 366
d	Duration separator	**D**
D	Duration in days (dd)	01 - 99
C	File Creation Time (hhmmss)	000000 – 235959

Table 5-8—NEN Specific Schedule Request File Input Definition

Parameter	**Value**
SSS (SCA for SCAN Testbed)	Spacecraft
FFF (WPS for WGS)	Facility
2012226020700	Beginning of support YYYYDOYHHMMSS
2012226021000	End of support YYYYDOYHHMMSS
TR10	Support Activity Code
0004	Orbit Number
S1	Band designator

5.1.8 NEN Scheduling Steps

Below are the steps that will be executed in the development, submission and reception of the NEN resource schedule for experiment support.

1. Scheduler will submit desired TCR (a MS Excel spreadsheet) from the C:\SCAN Testbed Planning\TCR\ folder on the Mission Planning workstation to ISS Pointing (example below) through Internal Note to ISS Pointing (see Appendix E).

EVENT DETAILS	GMT START (DDD/HH:MM)	GMT STOP (DDD/HH:MM)	NEN SERVICE
NEN-LGA |NEN GS: WGS-11.3 M	226/00:00	227/00:00	S-band link

2. Scheduler receives TSR (a text file) from ISS Pointing (example below) through Internal Note and the Scheduler will store the file in the C:\SCAN Testbed Planning\TSR\ folder:

```
# DAY |TDRSS|     AOS     |DURATION|    LOS     |TEL
# ORB |  ID |ddd:hh:mm:ss|hh:mm:ss|ddd:hh:mm:ss|CD
# NUM |     |             |        |            |
#-----------------------------------------------
000004 WPS   226:02:07:00 00:03:00 226:02:10:00 ---
```

3. Take the orbit number, start time, stop time from the TSR and input them into initial comma-delimited text file "i" template (example below) "iSCAb2012004d01. 090000" located in the C:\SCAN Testbed Planning\TSR\Initial NEN File\ folder. In addition include the support activity code (TR code), facility (ground station), and band designator (frequency, S1 for S-band).

   ,SCA,WPS,2012226020700,2012226021000,TR10,0004,S1

4. Submit the "iSCAb2012004d01. 090000" to the SCAN Testbed folder at WSC (wotrsfe1.wsc.nascom.nasa.gov) using FileZilla for the NENSO to retrieve.

5. NENSO provides a response "s" schedule file "sSCAb2012004d01. 102000" and the Scheduler will obtain the "sSSSb2012004d01. 102000" from the SCAN Testbed folder at WSC (wotrsfe1.wsc.nascom.nasa.gov) using FileZilla. And the Scheduler will store the file in C:\SCAN Testbed Planning\TSR\Schedule NEN File\ folder and send the schedule file "sSCAb2012004d01. 102000" to Pointing for record and for Pointing to evaluate if any changes in the start and stop times impact the Flight Rules.

   ,SCA,WPS,2012226020700,2012226021000,TR10,0004,S1

6. If an update is required, the Scheduler will submit updated TCR (a MS Excel spreadsheet in the C:\SCAN Testbed Planning\TCR\ folder) to Pointing (example below) through Internal Note to Pointing.

EVENT DETAILS	GMT START (DDD/HH:MM)	GMT STOP (DDD/HH:MM)	NEN SERVICE
NEN-LGA |NEN GS: WGS-11.3 M	227/00:00	228/00:00	S-band link

7. Scheduler receives update TSR from Pointing (example below) through Internal Note and the Scheduler will store the file in C:\SCAN Testbed Planning\TSR\ folder:

```
# DAY |TDRSS|     AOS     |DURATION|    LOS     |TEL
# ORB |  ID |ddd:hh:mm:ss|hh:mm:ss|ddd:hh:mm:ss|CD
# NUM |     |             |        |            |
#-----------------------------------------------
000021 WPS   227:03:02:00 00:03:20 227:03:05:20 ---
```

8. Scheduler if necessary will submit a "u" update file "sSCAb2012021d01. 162000" from the C:\SCAN Testbed Planning\TSR\Update NEN File\ to the SCAN Testbed folder at WSC (wotrsfe1.wsc.nascom.nasa.gov) using FileZilla for the NENSO to retrieve.

   ,SCA,WPS,2012227030200,2012227030520,TR10,0021,S1

9. NENSO provides a response "s" schedule file "sSCAb2012021d01. 140000" and the Scheduler will obtain the "sSSSb2012021d01. 140000" from the SCAN Testbed folder at WSC (wotrsfe1.wsc.nascom.nasa.gov) using FileZilla. The Scheduler will store the schedule file in the C:\SCAN Testbed Planning\TSR\Schedule NEN File\ folder and will send the schedule file "sSCAb2012021d01. 140000" to Pointing for record and for Pointing to evaluate if any changes in the start and stop times impact the Flight Rules.

   ,SCA,WPS,2012226020700,2012226021000,TR10,0004,S1

10. After finalizing the NEN schedule, the Scheduler will provide the final combined SN & NEN schedule (MS Excel spreadsheet, see Appendix G) to the MOT Controller for each day of the experiment execution week. The combined schedule will be stored in the C:\SCAN Testbed Planning\Schedule\ folder

11. After WGS LoS, the station will send post pass data statistics to the Scheduler through email and the Scheduler will make these results available to the Experimenter and store them on the Mission Planning workstation in the C:\SCAN Testbed Planning\NEN\PPDS\ folder with the file name identifying the date and orbit number. For the definition of the post past data statistics refer to Appendix H.

5.1.9 NEN Scheduling POC

The Scheduler will contact the following available POCs in Table 5-9 concerning NEN scheduling process. In addition, all NEN schedule updates (adds/deletes/changes) that are requested by the Scheduler during the Real-time week shall be accompanied by an email to the NENSO (wsg-wsc@ncc-comm.gsfc.nasa.gov), NENPAO (gnpao@ncc-comm.gsfc.nasa.gov) and the ground stations affected by the request. For now the ground station would be WGS (wotssl@listserv.gsfc.nasa.gov).

Table 5-9—NEN Scheduling POCs

Purpose	POC	Phone & Email	Availability (hours x days)
Forecast & Real-time NEN resource scheduling	NENSO	(575) 527-7130/7129/7033/7195 wsg-wsc@ncc-comm.gsfc.nasa.gov	14x5
Launch and early orbit; tests; downtimes; and maintenance and engineering activities coordination	NENPAO	(757) 824-2186 gnpao@ncc-comm.gsfc.nasa.gov	8x5

5.1.10 NEN Scheduling Considerations

1. The email that will accompany schedule requests during the Real-time week should contain the following information:

    - Customer/Project (SCAN Testbed/SCaN)
    - Station supporting the pass (WPS)
    - Acquisition of signal (AOS)/Loss of signal (LOS) times of the pass
    - Orbit number
    - Text explaining the nature of the scheduling update (e.g. add/delete/TR code change)

2. The Scheduler should review the latest Network Advisory Messages (NAMs) to identify any issues with the NEN.

3. During NENSO non-working hours, SN schedulers will be available to conduct NEN real-time scheduling changes.

4. NENSO (or SN Scheduler after working hours) will verbally coordinate with the sites and Customers affected by real-time schedule changes that will occur within 48 hours of the time the change be made.

5. Routine schedule changes shall not be requested in the real-time week as this increases the risk of an erroneous schedule. The Scheduler should provide routine schedule requests in the planning week (3 weeks prior to start of experiment execution week) or Forecast week (2 weeks prior to the start of experiment execution week).

6. The Scheduler shall submit all schedule updates NLT Close of Business (COB) on Wednesdays of the Forecast or Operations weeks (1 week prior to start of events) and should submit updates in blocks of events vice individually. Failure to meet this Wednesday deadline could result in the delay of schedule transmissions.

7. The NENSO will provide the Operations schedule to the SCAN Testbed Scheduler through a SCAN Testbed folder and sites no later than 2300Z on Thursday.

8. The Operations Schedule transmitted on Thursdays of the Operations week will serve as official notification of the confirmed schedule for the upcoming real-time week. If there is a discrepancy, it is the Scheduler's responsibility to contact NEN Scheduling prior to the Operations Schedule going real-time. The Forecast schedule will be provided to the SCAN Testbed folder and sites no later than 2300Z on Friday.

9. The Scheduler shall review each weekly schedule when received from the NENSO and, when discussing updates with the NENSO, use the most current weekly schedule and verify which week is being discussed.

10. The Scheduler/NEN Sites should contact the NENSO anytime (24x7) for scheduling issues or concerns and to report all problems that may impact SCAN Testbed support. After hours, NENSO phones are forwarded to the SN schedulers who will respond to contingency NEN situations.

11. NEN sites shall report all problems that may be associated with NISN equipment or circuits to the NISN COMM MGR in addition to the NENSO. The COMM MGR will coordinate any required troubleshooting directly with the site and/or Customer.

12. The COMM MGR shall advise both the NEN site and WSC Operations Supervisor (OS) of the status of all troubleshooting activities. WSC may request status updates as necessary.

13. NENSO will advise the Scheduler of any changes in the status of the NEN as necessary.

14. NENSO will coordinate all necessary changes to the SCAN Testbed support schedules when NEN resources become unavailable for support.

15. If unforeseen/unplanned scheduling activities arise due to short notice (e.g., engineering solutions, avoidance of data loss, security issues, testing, demand maintenance, software/hardware deliveries) requirements after the NLT COB on Wednesdays of the Operations week (1 week prior to start of events) deadline, the NENPAO will coordinate with affected sites/SCAN Testbed and notify the NENSO of schedule changes.

16. The NENSO will provide schedule revisions to the respective sites/customers. The sites/customers will be verbally notified of changes that will occur within 48 hours.

17. NEN conflict resolution is accomplished through a series of progressive steps initiated by the NENSO. This process is routinely implemented during the forecast scheduling process, however, due to emergency or contingency situations involving the SCAN Testbed or the loss of supporting Integrated Network resources, the process may be implemented during the real-time scheduling period in the Operations or Real-Time week.

18. The NENSO should negotiate with the Scheduler of the SCaN Testbed project to resolve the conflict.

19. If above step is not successful, the NENSO should coordinate with the NENPAO and use the NEN Priority List to resolve the conflict.

20. After normal working hours, the SN scheduler should coordinate with the WSC OS and refer to the NEN Priority List to resolve the conflict.

21. The WSC OS should contact the Scheduler and/or NASA Network Integration Manager (NIM) (if necessary).

22. This procedure will be implemented anytime the NENSO/WSC OS/SN Scheduler is notified that a site or antenna resource anomaly has occurred, which could impact the nominal services provided to the SCAN Testbed.

23. The NENSO will coordinate with SCAN Testbed Scheduler that could be affected by the change in status of the resource to ascertain whether the Scheduler desires their passes be moved to an alternate resource.

24. If a portion of the resource capability is still green, the option of leaving the passes as scheduled on a "best effort basis" should be discussed with the site personnel first and then the SCAN Testbed Scheduler.

5.2 SN Relay Overview

The SN is composed of a space segment and a ground segment. The SCAN Testbed experiment operations will utilize the space segment (TDRS constellation) and only some elements of the ground segment, mainly the White Sands Ground Terminal (WSGT), the Second TDRSS Ground Terminal (STGT) and the Network Control Center Data System (NCCDS). A data link, known as the Interfacility Link (IFL), exists between the WSGT and the STGT for the exchange of customer data and tracking information. SN SSA, KuSA, and KaSA forward and return IF services are available to customers on a case-by-case basis. IFL service will be used when the SCaN Testbed WSC-SDR is installed at WSGT.

5.2.1 SN SGLTs Overview

Each TDRS providing services is assigned a Space-Ground Link Terminals (SGLTs), which are located at ground terminals. The assigned SGLT performs tracking, telemetry, and command (TT&C) functions and user telecommunications and tracking functions in support of TDRS operations. However, not all SGLTs posses the same telecommunications service capabilities. The SCAN Testbed experiment operations currently will only utilize SGLTs 1-5, which reside at WSC and are directly linked to SCAN Testbed science data processing hardware WSGT-SFEP and STGT-SFEP and then linked to the GRC-SFEP through a Virtual Private Network (VPN) connection. So only those TDRSs that interface with WSC SGLTs, will be used by the SCAN Testbed for experiment link operations. But an Experimenter may request to use a TDRS that does not interface with SGLTs 1-5, for instance using a TDRS that interfaces with Guam Remote Ground Terminal (GRGT) SGLT 6. The Guam Data Interface System (GDIS) could be used to transport SCAN Testbed Return data to WSGT but limitation in bandwidth may preclude certain high data rates such as anything above 26 Mbps. **Note:** Any Experimenter that may want to utilize GRGT services will require pre-coordination with WSC well in advance of experiment execution. The Scheduler will coordinate this activity with GSFC Code 450. In addition, if there is a loss in communication service on the GDIS link, there is no provision to record data GRGT. Commands and data that pass through the SGLTs are directed through a series of User Interface Channels (UIFCs) assigned to each user. Each UIFC has a three-character identification (ID). This ID is used in scheduling a command or data interface between the WSGT-SFEP and STGT-SFEP and the High-Rate and Low-Rate switches at WSC. The first character of a UIFC ID is a letter (R for SCAN Testbed) and the last two characters are decimal numbers. Each of the SCAN Testbed SSCs has an UIFC ID and the NCCDS converts the UIFC ID to a port value on the Low-Rate and High-Rate switches. The UIFC ID and port values for the SSCs for the GD, JPL and Harris Corporation (HC) waveforms are presented in Figure F-2 in Appendix F. **Note:** Different SSC waveforms cannot share the same UIFC simultaneously, so when scheduling simultaneous GD, JPL and/or HC SSCs the Scheduler must make sure the UIFCs are not in conflict. Each TDRS and SGLT has constraints or issues with it that the Scheduler must be aware of when scheduling SN resources. These issues and constraints are made available to the

community through Network Area Messages (NAMs) and are also provided in Figure I-1 in Appendix I presents the SGLT status summary which is distributed weekly.

5.2.2 SN TDRS Overview

The TDRS constellation is composed of 1st and 2nd generation spacecraft in geosynchronous orbit and is distributed at various allocated orbit longitudes to maintain optimum coverage for all Earth orbiting vehicles. Spacecraft at geosynchronous orbit experience an East /West longitude drift depending on the longitude location. Station keeping is performed on each TDRS to maintain its longitude control box. The user community is made aware of these events through NAMs. In addition, a TDRS may be transitioned to another longitude either to be placed in storage or as an additional resource. Figure I-2 in Appendix I presents the TDRS coverage summary. The 1st generation TDRS constellation was comprised of 7 satellites but now is reduced to 4 (F3, F5, F6, F7). The 2nd generation is comprised of 3 satellites (F8-F10), each one still in operation. Figure I-3 in Appendix I provides the TDRS payload status summary. All summaries are for reference only but include updates per current NAMs and Spaceflight Tracking and Data Network (STDN) daily operations summary as of the date of summary release. The Scheduler should refer to the latest version of the STDN operations summary; the WSC long range calendar and the latest NAMs (https://cds.gsfc.nasa.gov) to verify the official status of the TDRS constellation and support facilities.

5.2.2.1 SN TDRS Service

TDRS 1st and 2nd generation provide Multiple Access (MA) services operate at fixed S-band frequencies 2106.4 MHz Forward and 2287.5 MHz Return with an antenna polarization of Left Hand Circular. The Forward service operations are time-shared among TDRS users where one user is supported per TDRS at a time. The TDRS 1st generation MA Return service is provided by an on-board 30 element phased array antenna in conjunction with beam-forming equipment located in the ground terminal. The Single Access (SA) services available through each TDRS 1st generation SA antenna are S-band and Ku-band forward and return. Figure 5-5 presents details on the 1st generation TDRS constellation capabilities. The TDRS 2nd generation S-band Multiple Access (SMA) return service is provided by an array of 32 elements in conjunction with TDRS on-board beam-forming. The arrays on both generations of TDRSs allow for spatial discrimination due to the phase differential of the customer signal received at each spaced antenna element on the TDRS. The 1st and 2nd generation MA services are one Forward and five Return per TDRS. The 2nd generation TDRS while maintaining the same user services as the 1st generation TDRS has additional capabilities such as Ka-band Single Access (KaSA) service capability to be timeshared (selectable by ground command) with the Ku-band services and have the capability for higher bandwidth Ka-band services. In addition the 2nd generation also supports simultaneous S-band and Ka-band through one SA antenna. The JPL-SDR and HC-SDR simultaneous link operations can utilize this service through the same SA antenna but the combination of the GD-SDR and HC-SDR will need to use separate SA antennas. Figure 5-6 presents the details on the 2nd generation TDRS constellation capabilities. TDRS can simultaneously support S-band and K-band either Ku-band or Ka-band (F8-F10 only) Forward and/or Return services through one SA antenna to the same ephemeris. TDRS F8-F10 cannot simultaneously support Ku-band and Ka-band services through one SA antenna.

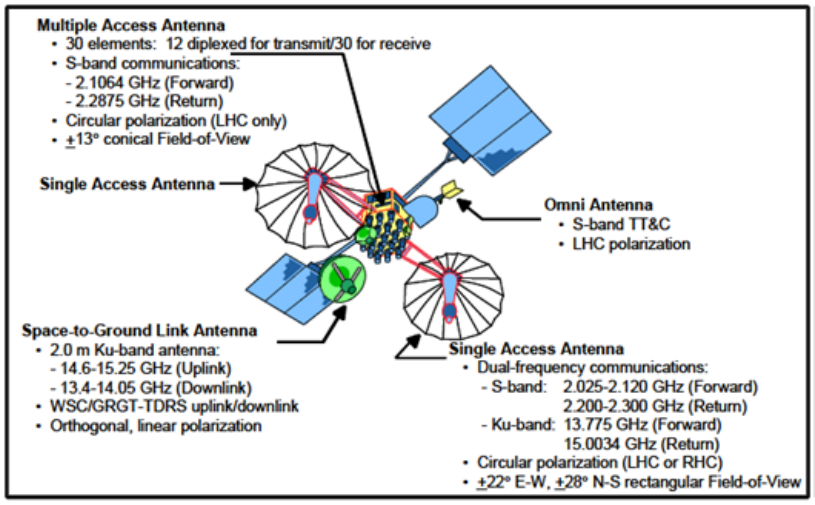


Figure 5-5—1st Generation TDRS Statistics

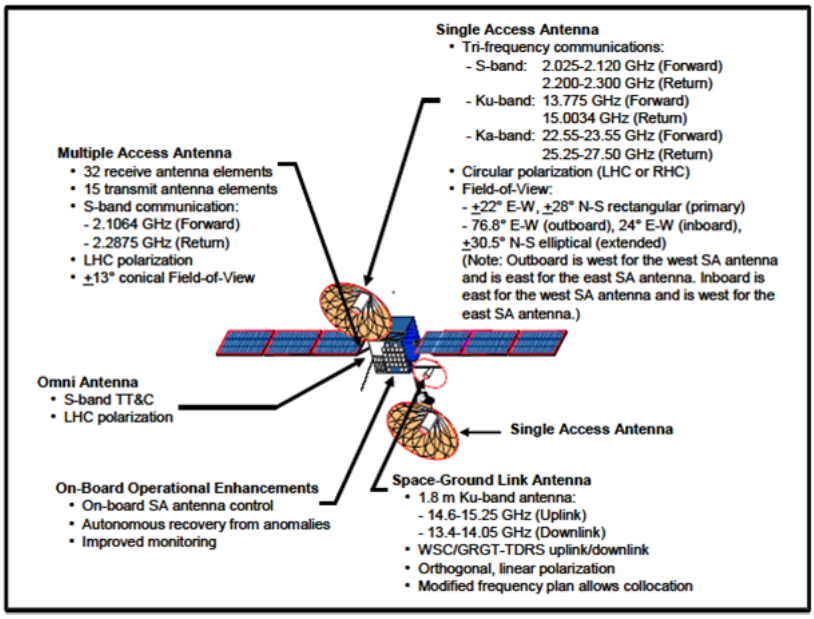


Figure 5-6—2nd Generation TDRS Statistics

5.2.2.2 TDRS Support for SCAN Testbed

For both 1st and 2nd generations the space-to-ground link antenna is responsible for forwarding and returning user commands and data. The experiments on the SCAN Testbed will utilize the Testbed SDRs HC, GD, and JPL and antenna system to access (along Experimental path) TDRS Forward /Return links. The TDRS services that will be utilized for experiments are KaSA, SSA, MA, and SMA. Table 5-10 and Table 5-11 present the Receive and Transmit characteristic of the SCAN Testbed GD, JPL and HC launch version waveforms for TDRS link operations. Values presented in the tables mentioned above were taken from the latest revision of the "450-RFICD-SCaN Testbed/SN/NEN Rev 1". Future waveforms will be introduced after SCAN Testbed checkout and commissioning that may be different than what is provided in the launch versions. For additional details concerning this link support, refer to the "450-NOSP-SCAN Testbed". For details concerning the SN space and ground segment services refer to the "450-SNUG".

Table 5-10—SCAN Testbed Receive Characteristics (TDRS)

Service	MA/SMA/SSA	KaSA
Frequency	2106.40625 MHz (MA/SMA) 2041.02708 MHz (SSA)	22679.50 MHz (Note 4)
User Antenna	SN-LGA/SN-MGA	SN-HGA
Polarization	LHCP	LHCP
Information Rate (Prior to any coding)	18 and 72 kbps (SS-UQPSK/SS-BPSK) 155.346 & 769.45 kbps (BPSK)	3 and 12.5 Mbps
Symbol Rate (After all encoding applied)	36 and 144 ksps (SS-UQPSK/SS-BPSK) 310.692 & 1538.9 ksps (BPSK)	6 and 25 Msps (Note 3)
Coding (Note 1)	Rate ½ Conv. or Uncoded	Rate ½ Conv. or Uncoded
Data Format (Note 1)	NRZ-L (GD) NRZ-M (JPL)	NRZ-L
Maximum Bandwidth	~6 MHz	50 MHz
PN Chip Rate	~3.0 MHz	N/A
Transmit Modulation	SS-UQPSK (GD) SS-BPSK/BPSK (JPL) (Note 2)	BPSK

Notes:
1. Any coding and formatting is transparent to TDRS ground terminal/NEN.
2. When the SCAN Testbed operates in SS-BPSK mode, the SN cannot reconfigure to SS-UQPSK for any of other Forward Services (i.e. MAF, SMA, or SSAF) for the same Support Identification Code. The SN will set up the SCAN Testbed GD links and SCAN Testbed JPL links under separate Support Identification Codes.
3. Currently, the SN data interface supports up to 7 Msps; however, upgrades to support up to 25 Msps are planned.
4. Per the SNUG, all KaSA forward center frequencies must be centered within 22555 MHz to 23545 MHz in 5 MHz incremental steps. The SCAN Testbed KaSA forward frequency is not centered on the 5 MHz incremental steps but within + 1.28 MHz acceptable uncertainty specified in the SNUG.
5. The SN is capable of supporting BPSK signals at data rates less than 300 kbps; however, its use will be controlled and coordinated with GSFC Code 450.

Table 5-11—SCAN Testbed Transmit Characteristics (TDRS)

Transmit Signal Parameters	**SN**	
	MA/SMA/SSA	**KaSA**
Data Group and Mode	SCAN Testbed-GD: – DG1 Mode 1 (MA/SMA/SSA) – DG1 Mode 2 (MA/SMA/SSA) – DG1 Mode 3 (SMA/SSA) – DG2 Coherent (SMA/SSA) – DG2 Non-coherent (SMA/SSA) SCAN Testbed-JPL: – DG1 Mode 2 (MA/SMA/SSA) – DG2 Non-coherent (SMA/SSA)	DG2 Non-coherent
Transmit Frequency	2287.5 MHz (MA/SMA/SSA) 2216.5 MHz (SSA)	25650 MHz (Note 2)
Polarization	LHCP	LHCP
Antenna	SN-LGA/SN-MGA	SN-HGA
Transmit Power	7.95 Watts (GD) 7.8 Watts (JPL)	39.8 Watts (HC)
Information Rate (Prior to any coding)	2 & 24 kbps (SQPN/SS-BPSK) 192 kbps (SQPN; SCAN Testbed-GD) 192.362, 769.45 & 1000 kbps (SQPSK/BPSK/SS-UQPSK)	12.5 and 100 Mbps
Symbol Rate (After all coding applied)	4 & 48 ksps (SQPN/SS-BPSK) 384 ksps (SQPN; SCAN Testbed-GD) 384.724, 1538.9 & 2000 ksps (SQPSK/BPSK/SS-UQPSK)	25 and 200 Msps
Coding	Rate ½ Conv. or Uncoded (Note 1)	Rate ½ Conv. or Uncoded
Data Format	NRZ-M	NRZ-M
Maximum Bandwidth	~ 6 MHz	200 MHz
Transmit Modulation	SCaN Testbed-GD: SQPN/SS-UQPSK/SQPSK SCaN Testbed-JPL: SS-BPSK/BPSK	SQPSK

Notes:
1. The SN is capable of providing SMAR/SSAR support for uncoded links; however, performance is not guaranteed in RFI and must be coordinated with GSFC Code 450.
2. Per the SNUG, KaSA return center frequencies operating in the 225 MHz bandwidth service that are not SNIP/SFCG compliant must be centered within 25253.4 to 27478.8 MHz in 25 MHz incremental steps with + 1.28 MHz acceptable uncertainty. The SCAN Testbed KaSA return frequency does not comply with the SNUG requirement; therefore, the SN will implement a special network modification to support the SCAN Testbed only. This modification is not intended to accommodate other noncompliant KaSA customer frequencies.

5.2.3 SN Antenna Locations

The SCAN Testbed antennas (see Figure 5-7) that will be used in link operations with TDRS are the SN High Gain Antenna (SN-HGA), SN Medium Gain Antenna (SN-MGA) and SN Low Gain Antenna (SN-LGA). SCAN Testbed-to-TDRS Forward and Return service is available on a scheduled basis during intervals that the TDRS line-of-sight exists and the resource is operating and available.

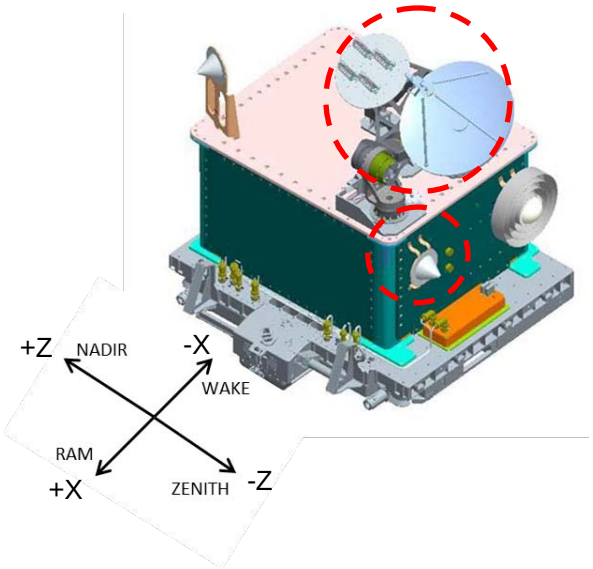


Figure 5-7—SN-LGA, SN-MGA/HGA Location

5.2.4 SN-LGA FOV

The SN-LGA is a fixed Omni directional antenna that is Zenith pointing or the opposite direction of Nadir, away from the center of the Earth. Actual TDRS access times for the SN-LGA will depend upon the position knowledge of TDRS and the position and attitude knowledge of ISS/SCAN Testbed, knowledge of static and dynamic blockage and the orientation of the static antenna boresight with respect to the TDRS location in its orbit track. The orientation of the SN-LGA will be especially dependent on ISS attitude, more so than the SN-MGA/HGA. Figure 5-8 present the FOV of the SN-LGA antenna, including the associated ISS structure blockage, which may not be present all the time during link operations.

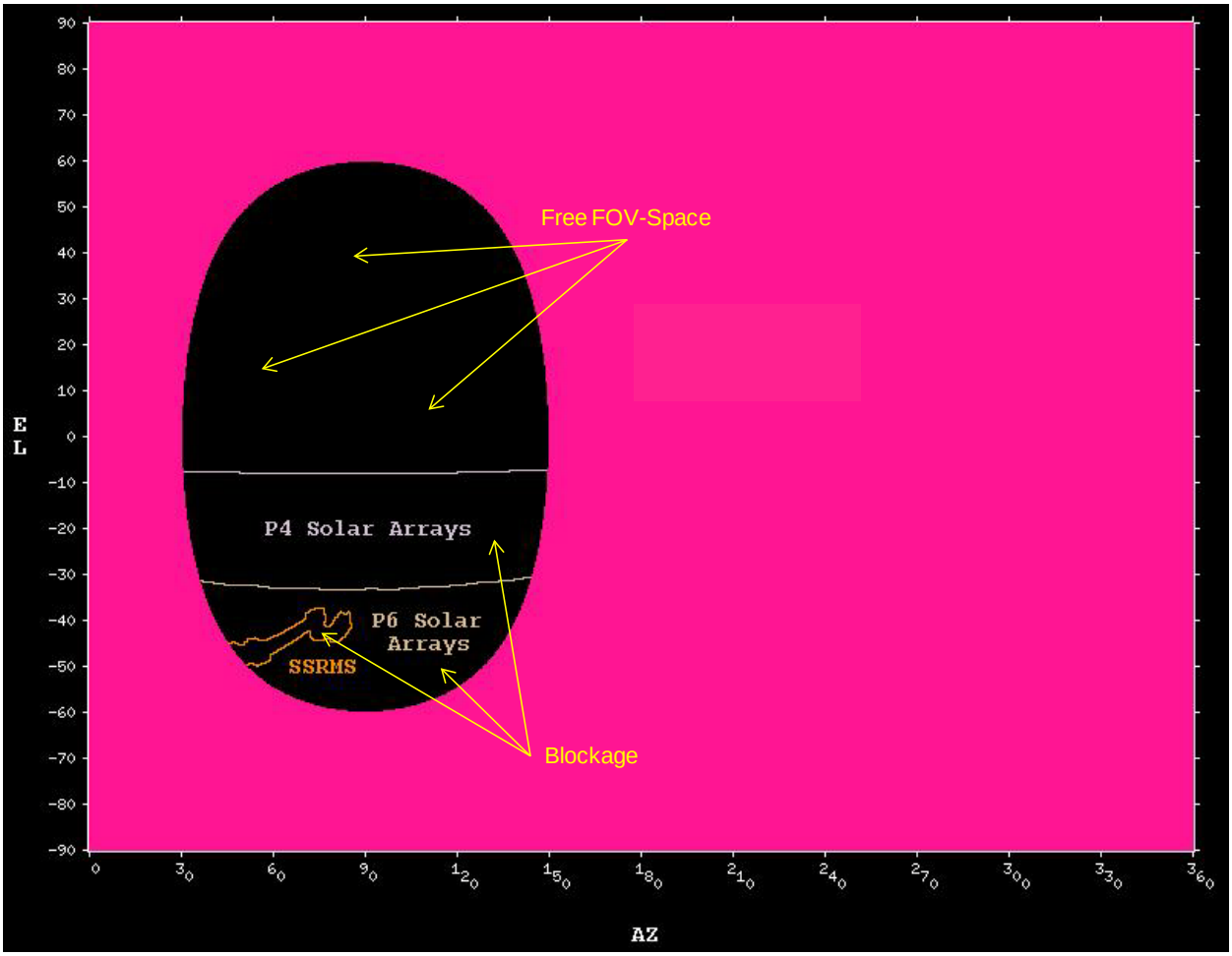


Figure 5-8—SN-LGA Line-of-Sight Obscuration

5.2.5 SN-MGA/HGA FOV

As for the steerable antenna system, the SN-MGA (see Figure 5-9) will point at the prescribed predicted Azimuth/Elevation position values contained in the APS TRK file using the two axis (base and nose) gimbal system. Given the SN-MGA large antenna beam-width, a link to TDRS can still be within the main beam with small variances in attitude. The SN-MGA FOV is constrained by hard stops on the base and nose gimbals that prevent the SN-MGA from radiating critical segments of the ISS structure. The FOV is further constrained by the mandatory restrictions imposed by the Software-based Control Stops, which prevent damage to the hard stops, as well as preventing impact to the launch lock structure. Control Stops are nominally set at Azimuth Ram = 0°, Azimuth Wake = 172°, Elevation Port = -19°, Elevation Starboard = 47.5°. So any large changes in ISS attitude on the order of 30 degrees or greater will severely decrease TDRS access times or will eliminated them. The SN-HGA is under the same access constraints as the SN-MGA but is further constrained by the decrease in beam-width. To lessen the impact of this addition constraint the a Closed-Loop signal tracking process is use that involves performing a Spiral search to acquire TDRS (assuming 3dB pointing loss corresponding to the 0.8° pointing error) and then performing a Closed-Loop dither for Auto Track of the Ka-Band link in correlation with the desired Antenna Pointing Quality Metric (APQM) threshold

being met. Small initial variance in attitude can be tolerated on the order of 8 degrees but just like the SN-MGA large attitude changes will have a large impact on TDRS access times.

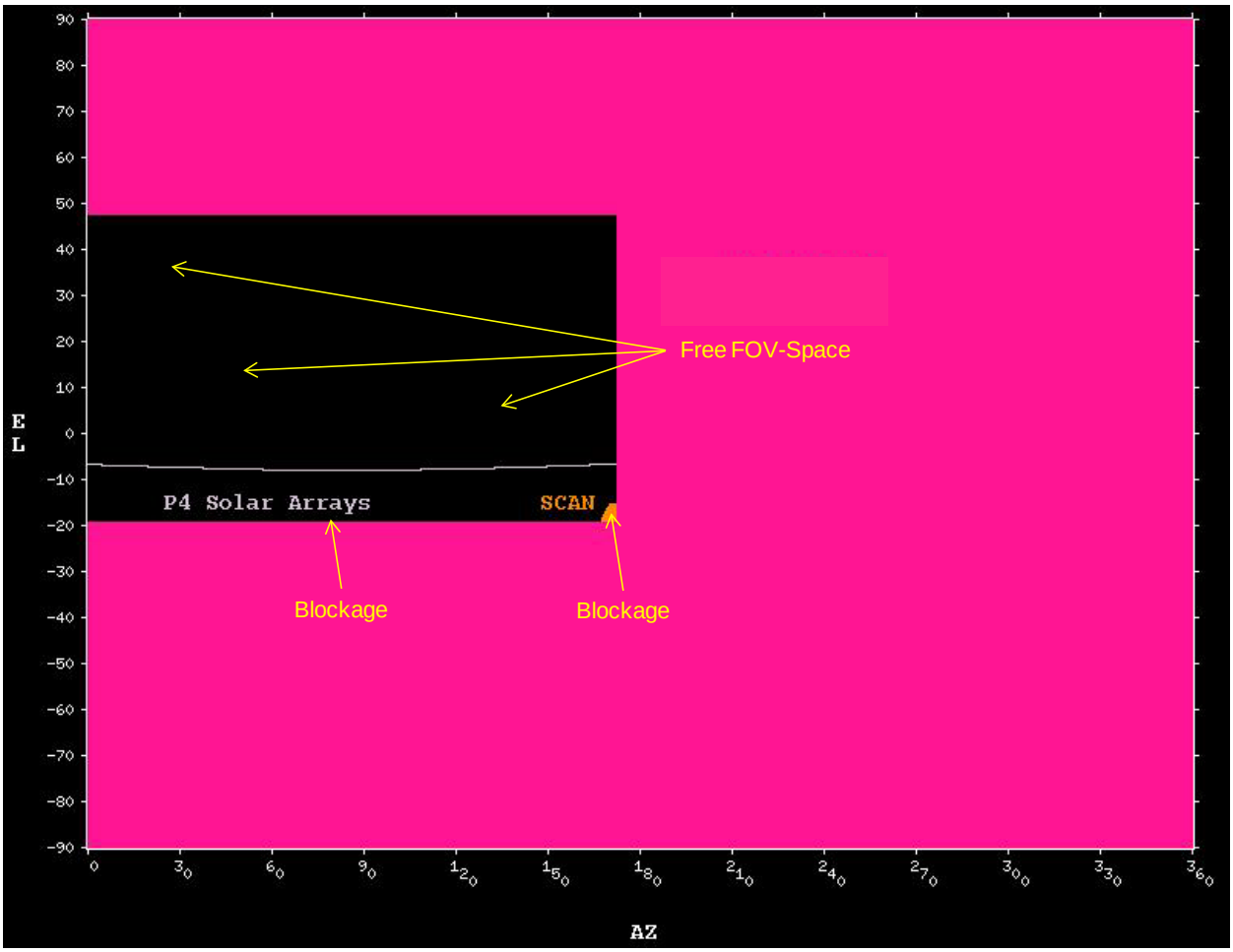


Figure 5-9—SN-HGA\MGA Line-of-Sight Obscuration

5.2.6 SN Link Availability Operations

Table 5-12 below presents the SCAN Testbed SN antennas line of sight availability statistics for a given year of operation. The total number of contacts per month for the SN-LGA could average around ~450 with a given average contact time of ~45 minutes and a maximum of about 51 minutes. For the SN-MGA and SN-HGA the average number of contacts per month could be ~350 with an average during of ~29 minutes. The obscuration view and access times are based upon the SCAN Testbed operating when ISS is in a TEA LVLH attitude. Occurring during quiescent periods, this attitude provides for the best TDRS access time. The are other attitude profiles that ISS operates in but these will have some impact on TDRS access time on each antenna depending upon which axis is changed. If ISS needs to implement a change in attitude such as a 30 or 90 or even a 180 degree rotation about the Z-axis then this would reduce the amount of TDRS access time for the SN-MGA and SN-HGA but will not affect the SN-LGA. When submitting a TCR the Scheduler will request that all TDRS contacts have duration at a minimum of 30 minutes or unless specified by the Experimenter and that experiment operation occur during quiescent periods.

Table 5-12—SN-LGA/MGA/HGA to TDRS Availability

Parameter	Value		
Antenna	SN-LGA	SN-MGA	SN-HGA
Total Contacts (annually)	5468	4260	4262
Average Contact Duration (minutes)	45.75	29.18	29.18
Maximum Contact Duration (minutes)	~51	~44	~44

5.2.7 SN Scheduling System

The Scheduler will work with the SN schedulers at WSC to establish the appropriate TDRS support through SNAS. The SN operates as a customer driven bent pipe relay system for tracking, telemetry, and command data. The SN is designed as a highly automated user driven/controlled system for supporting customer Spacecraft Tracking and Data Acquisition. SCAN Testbed operations will utilizes the following SN segment services: Space Segment (TDRS Constellation), Ground Segment (WSGT/STGT), and Monitor and Control Segment (WSC/DSMC/NCCDS). The NCCDS is the main processing component of the operations control center for the SN. The NCCDS schedules all SN elements and supporting elements, and provides interfaces for planning, acquisition, control, and status of the SN. The NCCDS is the point-of-contact between customers and the SN for scheduling and real-time performance. A customer may obtain SN support by submitting specific schedule requests to or establishing generic requirements with the NCCDS. The NCCDS translates customers' requirements into specific events. Table 5-13 presents the scheduling process for the SN from the planning to the execution stage.

Table 5-13—SN Scheduling Timeline

Planning for week-4 (Real Time)	Scheduling week-4 activities	Release week-4 to Operations	Execution Real Time week-4
day-1 … day-7	day-8 … day-14	day-15 … day-21	day-22 … day-28
M T W TH F S S	M T W TH F S S	M T W TH F S S	M T W TH F S S
Planning Period (3 weeks in future)	**SNAS Initial Schedule Add Request (SAR)**		
Planning week (week-1): WSC activities requiring TDRS service downtimes are planned and coordinated with the users for execution during the week-4 time frame. Users requiring critical TDRSS support during Week-4 should notify Forecast Scheduling during the Planning week.	Forecast Period (2 weeks in future)	**TUT Released SAR Real-time Scheduling**	
	Forecast week (week-2): WSC TDRSS downtime activities, internal maintenance /ETN/STN/EC requests, project testing, and customer SARs are scheduled in the forecast time frame. The batch schedule is developed based on the SN priority list. All requests to be scheduled for week-4 should be delivered to the WSC by 1200Z Monday of week-2. Requests received after this time frame will be on an available basis.	Confirmed Schedule (1 week in future)	**GCMR & Additional TUT SAR Real-time Scheduling**
		Operation week (week-3): After the confirmed schedule is transmitted and becomes real-time, the priority list does not apply; priority is given to the confirmed scheduled request, except for the absolute priorities listed in the SN priority list.	Real Time (Execution week)
			Execution week (week-4): In the event of a real-time emergency, operations management may enforce and/or temporarily amend the priority list as necessary. In the event of a conflict in priorities, the issue will be escalated to the Code 450.1/Networks Integration Management Office (NIMO).

5.2.8 SN Scheduling

Below are the steps that will be executed in the development, submission and reception of the SN resource schedule for experiment support. To start the Scheduler must login into SNAS and configure it in preparation for schedule development. Below is the SNAS initialization process to be executed on the Mission Planning workstations.

A. SN Service Definitions

1. SIC (Support Identification Code): Four-digit decimal value that is used to identify support in a variety of places. For example, the SIC is used in the NCCDS database to identify an SN user and allow scheduling support, inside a SUPIDEN in SN messages between the NCCDS and WSC, in IIRV acquisition data messages, and in tracking data. The SCAN Testbed has three SICs, one for each SDR; GD-SDR (8361), JPL-SDR (8372), and HC-SDR (8373). The JPL SIC has a one additional role that can be used to schedule dual JPL and HC link operations with the same SA antenna.

2. SUPIDEN (Support Identifier): Seven-character value that is used in scheduling user support. The first character is the class, which generally indicates the lead center for the customer. The next four characters are the user's SIC. The last two characters are the function, which describes the type of support. For example, SUPIDEN R8373EE has a class of R to indicate that GRC is the lead center, a SIC of 8373 to indicate HC-SDR. SCAN Testbed as three possible functions associated with each SIC; CS indicating Critical Support, MS indicating Mission Support, EE indicating Engineering Test. During on-orbit operations, the Scheduler will select MS, but CS will not be required at least for nominal operations.

3. Service Type: A service type for a SIC defines what kind of SSC's can be created. Below in Table 5-14 are the service types that will be used for SCAN Testbed experiment support:

Table 5-14—Service Types

KaSAF Ka-band Single Access Forward	SSAR S-band Single Access Return	MAF Multiple Access Forward
KaSAR Ka-band Single Access Return	SMAF S-band Multiple Access Forward	MAR Multiple Access Return
SSAF S-band Single Access Forward	SMAR S-band Multiple Access Return	Track-N Tracking Normal

4. SSC: An SSC is a set of values for a SIC and service type that is stored in the NCCDS database and is used to configure TDRSS equipment for a scheduled service. Appendix J provides all the current SSCs for each SDR. Each SSC has an ID which is a three-character value that identifies an SSC, where the first character is generally a letter and the last two characters are generally, but not always, decimal numbers. The SSCs that are currently in place for SCAN Testbed link operations are "Open Select" (meaning the codes will de-conflict if one SA antenna is scheduled). So the Scheduler cannot specify the antenna, but if one antenna is taken "Open Select" will take the other antenna. If the Experimenter requires the use on the same SA antenna, a new code will have to be developed designating that particular SA antenna or the Scheduler will schedule available TUT for the required SA antenna. Table 5-15 are the first characters that are available for experiment support.

Table 5-15—SSC 1st Character

W (KaSAF)	I, J, K, & L (SSAR)	A (MAF)
X (KaSAR)	U (SMAF)	B, C, D, E, & F (MAR)
H (SSAF)	V (SMAR)	T (Track-N)

5. TDRS ID: Below in Table 5-16 are the TDRSs available in SNAS to schedule with the associate code used in SNAS (SNAS Code/TDRS#).

Table 5-16—TDRS ID

TDE/F-9	TD171/F-5	TDZ/F-7
TDRS-6/F6	TDW/F-10	
TDS/F-3	TD271/F-8	

B. SNAS Initialization

1. Execute the runmocclient.bat (Windows batch file), the following window will appear MOC Main Control, NASA Security Banner, Login, System Status. The Scheduler will login to SNAS using SN assigned ID and user defined password and pass phrase and with "Operation Mode" selected, then the Scheduler will select the appropriate "SICs & Roles", one role at a time with those Support Identification Codes (SICs) (or mission codes) assigned to that role (see Figure 5-10). After a successful login, the "Alert Status" window appears and the "System Status Indicators" turn green indicating successful connection to the five Server components -- SAM, SvE, SNIF, SDIF, and the Data Server. Details concerning the status windows are provided in the "Help" menu in SNAS.

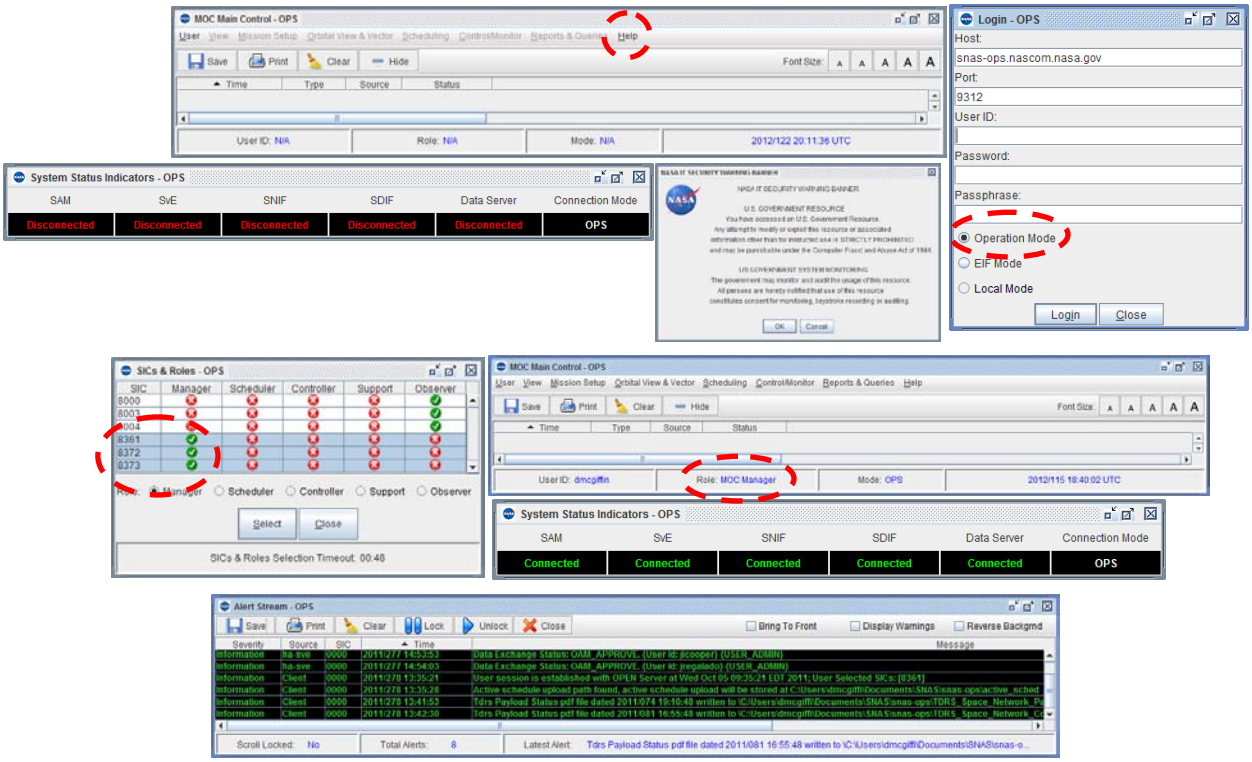


Figure 5-10—SNAS Login Windows

2. "SICs & Roles" selection: The Scheduler has two roles that can be assumed, one has managing control and the other can only observer. The "Manager" role has full privileges over the SICs assigned to that role the "Observer" role can only observe certain aspects of that SIC, mainly when that SIC is involved in a TDRS scheduled event, for this mission the other roles are not used. All members of the MOT can access SNAS as a "Manager" or as an "Observer". But both roles cannot be accessed simultaneously using the same login session. To access both the "Manager" and the "Observer" roles together, the Scheduler must login into SNAS on two separate workstations. The MOT "Manager" has full access over the three SCAN Testbed SICs; GD-SDR (8361), JPL-SDR (8372), and HC-SDR (8373). The MOT has an "Observer" role over three other space vehicle SICs; ISS (8000), ATV (8003) and HTV (8004). The Scheduler will use the "Observer" role to assess the frequency ISS, ATV and HTV are using a particular TDRS. The results of these assessments will be used in future planning (see Figure 5-11). The forecast TDRS scheduled events for the all SICs can be accessed through the following menu steps under the "MOC Main Control" window: "Scheduling/Scheduling Tools/Active Events Summary". **Note:** Not all visiting vehicle SICs are available for observation (such as Dragon).

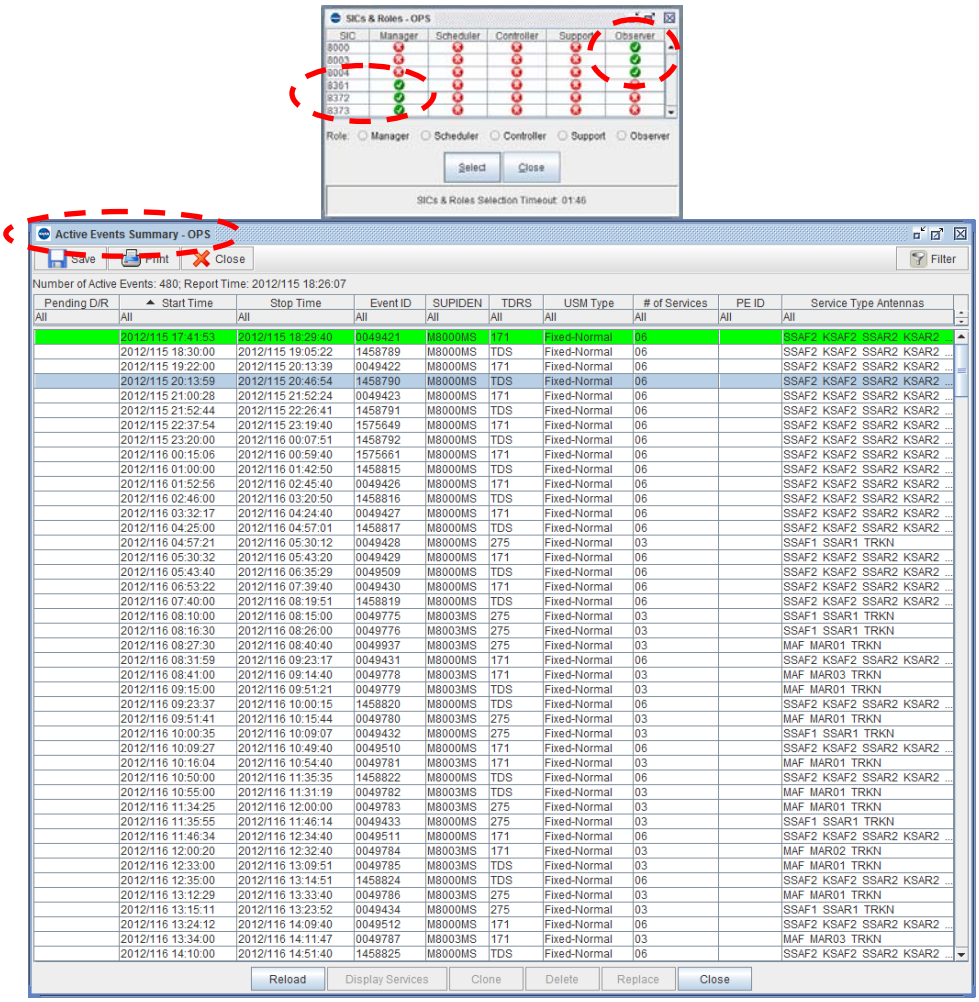


Figure 5-11—SNAS Login Windows

C. Schedule Development

1. Scheduler will submit desired TCR (a MS Excel spreadsheet) from the C:\SCAN Testbed Planning\TCR\ folder on the Mission Planning workstation to Pointing (example below) through Internal Note to Pointing.

EVENT DETAILS	GMT START (DDD/HH:MM)	GMT STOP (DDD/HH:MM)	SN SERVICE
SN-MGA|TDRS SV: F09|ATL: TEA	119/00:00	120/00:00	SSA

2. Scheduler receives TSR (a text file) from Pointing (example below) through Internal Note and the Scheduler will store the file in the C:\SCAN Testbed Planning\TSR\ folder:

```
# DAY |TDRSS|      AOS     |DURATION|     LOS      |TEL
# ORB |   ID |ddd:hh:mm:ss|hh:mm:ss|ddd:hh:mm:ss|CD
# NUM |      |             |        |             |
#-----------------------------------------------------
000004 E-TDE 119:04:07:00 00:40:00 119:04:47:00 ---
```

3. Take the start time from the TSR and then setup up a “Schedule Add Request” on the “MOC Main Control” window following the menu steps “Scheduling/NCC Requests/Schedule Add Request (SAR)”. On the “SAR” menu (see Figure 5-12) select the SUPIDEN (R8373MS) and TDRS (TDE) and then input the “Nominal Event Start Time”, then click the “Add” button for each SSC needed for the experiment for the Forward service (W01) and the Return service (Y01) and if necessary the Tracking service but this is not needed for HC-SDR operations, but is necessary for GD and JPL-SDR operations. It’s very important that SSC codes are in the Forward/Return/Track order, or the SAR will be rejected by the SN Scheduler. Then the Scheduler will input the “Nominal Duration” for each SSC. Then the Scheduler will select “Absolute Service Time Format” to view the actual start and stop time for each SSC. In addition if the Scheduler wishes to double check if an SSC is coded correctly then, click on the SSC under the “Selected Services” on the SAR menu and then click the “Parameters” button (see Figure 5-13). After the Scheduler has completed filling out the SAR, then the SAR is saved to the SNAS database by clicking “Save to DB”. This allows the Scheduler to create a SAR without sending it to the SN schedulers. The indications of this action are presented in the “Alert Status” window (see Figure 5-14). The “Alert Status” window has three types of severity indicated by color; Information (green), successful processing with additional information; Warning (yellow), successful processing by SNAS, but with warning information, such as request rejected by NCCDS; Critical (red), SNAS software, system, or Database problem which requires resolution by SNAS operator, System Administrator, or Developer. Before the SAR is submitted to the SN scheduler, the Scheduler will call the Forecast scheduler also known as the Forecast Analyst (FA), to notify that as part of the SAR, a particular TDE SA is needed, SA1 in this case. If this cannot be accomplished, then the Scheduler will wait for the release of TUT to schedule the specific TDE SA contact.

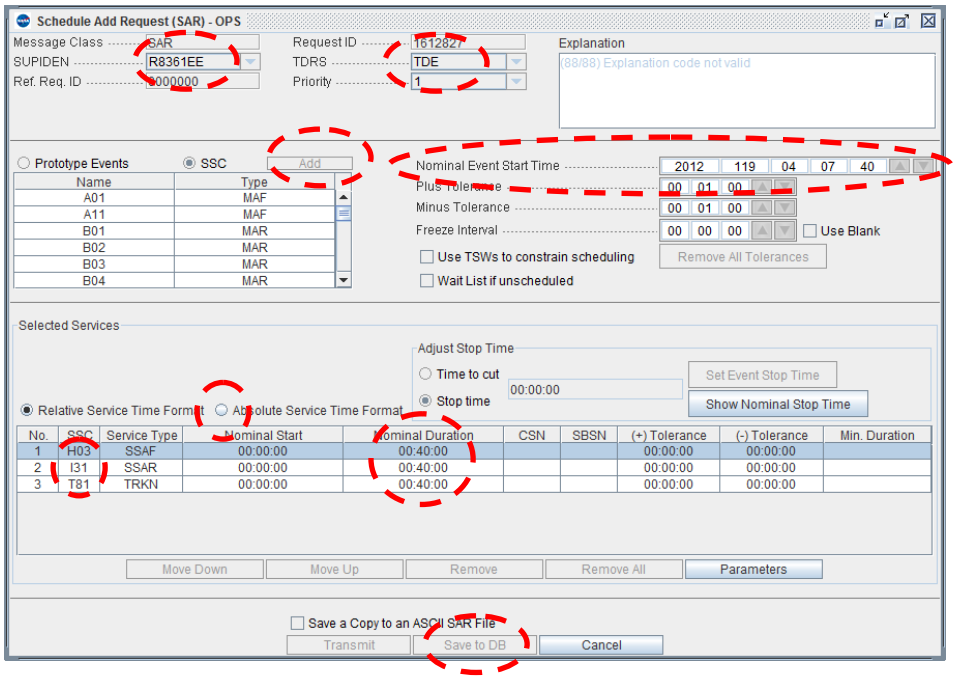


Figure 5-12—SNAS Login Windows

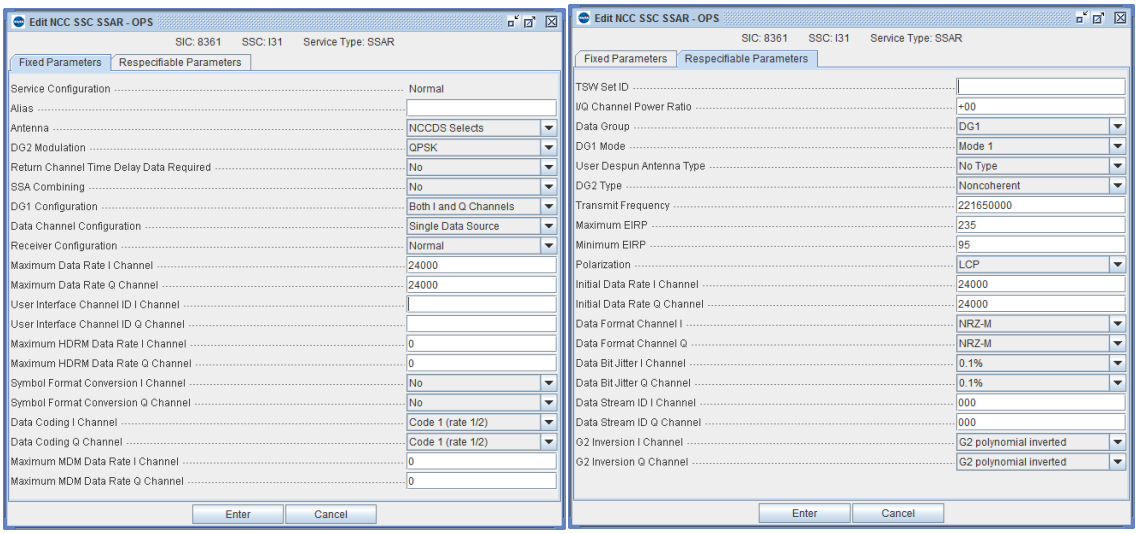


Figure 5-13—SSC View and Edit

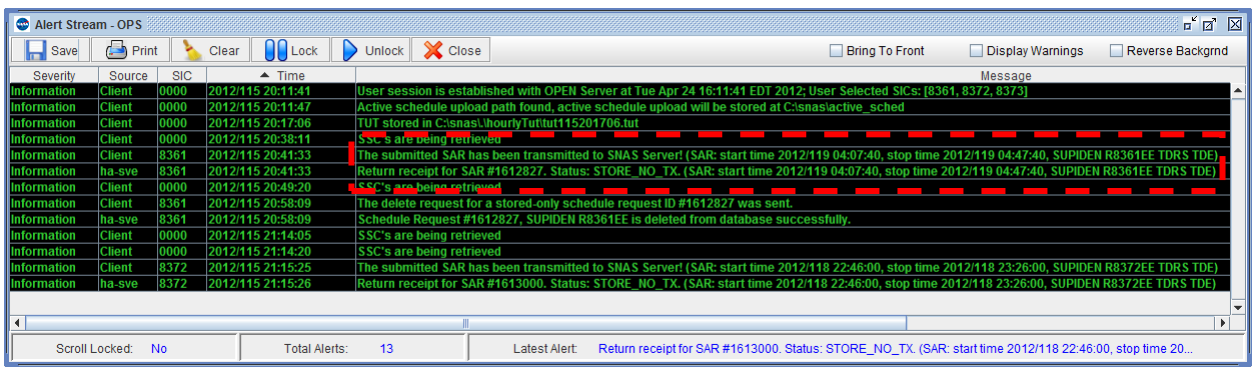


Figure 5-14—Alert Status

4. To view a SAR that has been saved the Scheduler will follow the menu steps "Scheduling/Scheduling Tools/Schedule Request Summary" (see Figure 5-15), where the Scheduler can review the SAR or submit it by clicking on the "Transmit" button on the "Schedule Request Summary" after highlighting the request or on the SAR menu. To address a dual SDR link event sharing one TDRS, the Scheduler can create a combined SAR, combining the codes for both SDRs. An example of this combined SAR is presented in Figure 5-16. **Note:** When combining codes, the Schedule must have the Forward links codes for both SDRs first followed by the Return codes and then the Track code. In addition when combining codes for a dual SDR event (JPL & HC), the SAR SUPIDEN must be JPL (not HC).

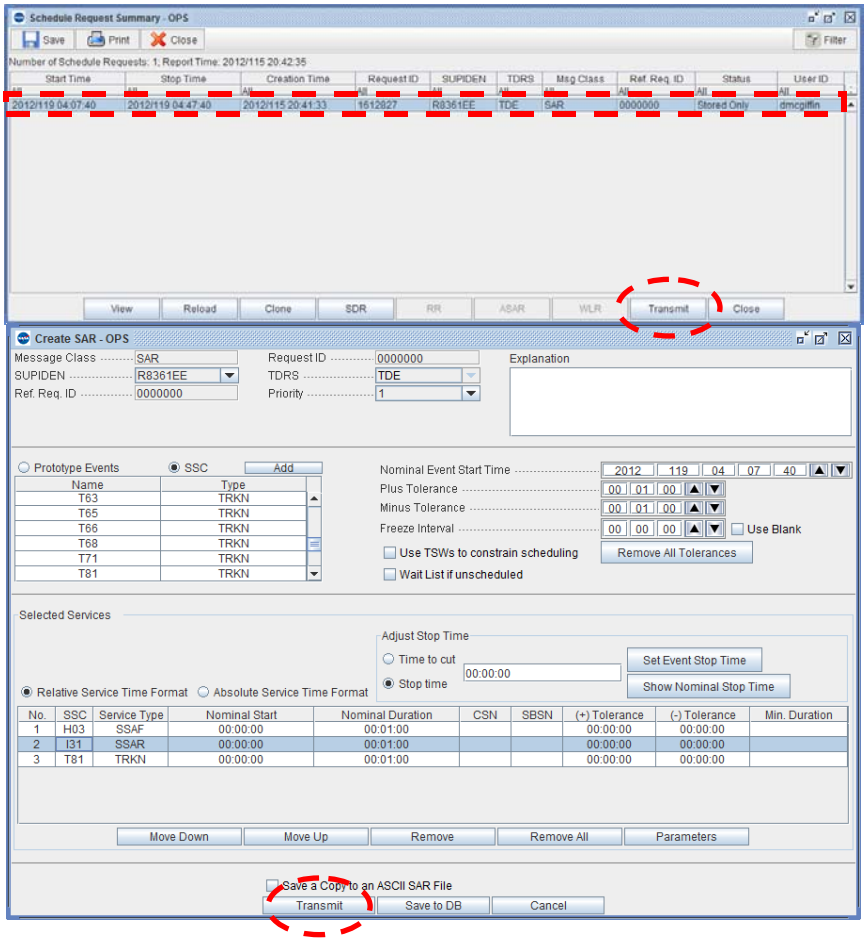


Figure 5-15—Schedule Request Summary

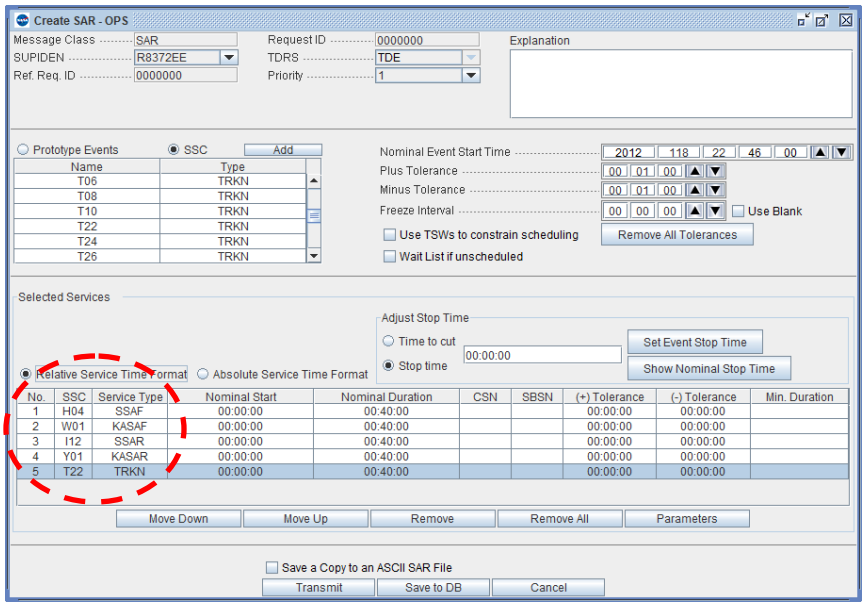


Figure 5-16—Schedule Request Summary

5. Once the SAR has been submitted to the SN schedulers' indication of the submission will be presented in the "Alert Status" window. There 14 applicable indicators for the status of a SAR submission by the Scheduler (see Table 5-17).

Table 5-17—SAR Status Indicators

Completed - A request is marked as Completed if it was Granted by NCCDS and the current time has moved past the request's stop time.	**Queued** - SNAS Server assigns a Queued status to a request originally marked as Saved when the connection to NCCDS has been restored/activated and SNAS Server has retrieved the request and is queuing it for transmission.
Declined - A status applicable only to an NCCDS request.	**Rejected** - A request is marked as Rejected if rejected by NCCDS.
Deleted - An NCCDS request has a status of Deleted if the SRM received for the request.	**Saved** - SNAS Server assigns a Saved status to a request if the Server detects connection problems with NCCDS and SNAS Server stores the request in the database without transmitting it to NCCDS.
Expired - A request is marked as Expired if it had a status of Saved, Queued, Transmitted, or Stored Only and the current time has moved past the request's stop time.	**Stored Only** - When the user interactively builds and submits a SAR for stored to database only, SNAS stores the request in the database and assigns a Stored Only status to it.
Granted - A request has the status of Granted if it has been accepted by NCCDS.	**Transmitted** - A request is of the Transmitted status if, after transmission to NCCDS, no responses have been received.
Invalid - SNAS Server assigns an Invalid status to a request if it detects errors in the request. The request is not sent to NCCDS.	**Waitlisted** - An NCCDS request has the Waitlisted status if NCCDS has placed the request on a waitlist.
NCC Queued - A status applicable only to an NCCDS request.	**Timeline Saved** - A request saved in conjunction with an open graphical timeline panel. The request is deleted when the graphical timeline panel is closed.

6. After the SAR is "Granted" the Scheduler will save each SAR in the following location, C:\SCAN Testbed Planning\SAR\ folder with the name "SAR_YYYY_DOY_Event_#", where "#" indicates the TDRS contact number. An example of a SAR in text format is provided in Table 5-18. And the Scheduler will send the SAR to Pointing through Internal Note for record and for Pointing to evaluate if any changes in the start and stop times impact the Flight Rules, the Scheduler and APS Operator will have the final responsibility of assuring no Flight Rules are violated.

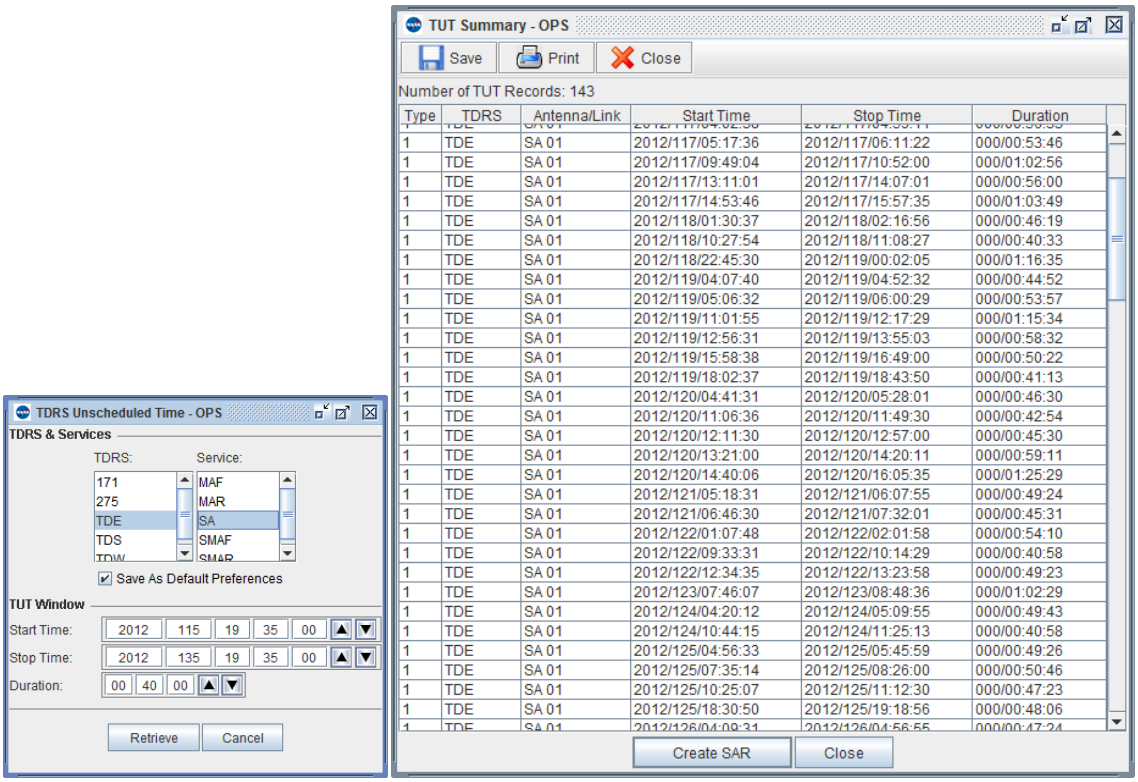
Table 5-18—SAR Text Format

Start Time,Stop Time,Creation Time,Request ID,SUPIDEN,TDRS,Msg Class,Ref. Req. ID,Status,User ID
2012/119 04:07:00,2012/119 04:47:00,2012/115 20:41:33,1612827,R8361MS,ANY,SAR,0000000, Queued,dmcgiffin

7. At the request of the Scheduler, Pointing will look to fill any gaps from SARs that did not get "Granted" by looking a TUT periods provided by the Scheduler in the Internal Note.

8. Scheduler receives update request from Pointing (example below) through Internal Note and the Scheduler will store the file in C:\SCAN Testbed Planning\TSR\ folder:

9. Scheduler if necessary will submit a new SAR based upon the TUT period agreed upon with Pointing. The Scheduler will view the available TUT by following the menu steps “Scheduling/TDRS Unscheduled Time (TUT)” (see Figure 5-17). The Scheduler would highlight the appropriate TUT period in the “TUT Summary” window and click on the “Create SAR” button. A SAR window would appear and then the Scheduler will input the appropriate information to support the experiment.



Type	TDRS	Antenna/Link	Start Time	Stop Time	Duration
1	TDE	SA 01	2012/117/05:17:36	2012/117/06:11:22	000/00:53:46
1	TDE	SA 01	2012/117/09:49:04	2012/117/10:52:00	000/01:02:56
1	TDE	SA 01	2012/117/13:11:01	2012/117/14:07:01	000/00:56:00
1	TDE	SA 01	2012/117/14:53:46	2012/117/15:57:35	000/01:03:49
1	TDE	SA 01	2012/118/01:30:37	2012/118/02:16:56	000/00:46:19
1	TDE	SA 01	2012/118/10:27:54	2012/118/11:08:27	000/00:40:33
1	TDE	SA 01	2012/118/22:45:30	2012/119/00:02:05	000/01:16:35
1	TDE	SA 01	2012/119/04:07:40	2012/119/04:52:32	000/00:44:52
1	TDE	SA 01	2012/119/05:06:32	2012/119/06:00:29	000/00:53:57
1	TDE	SA 01	2012/119/11:01:55	2012/119/12:17:29	000/01:15:34
1	TDE	SA 01	2012/119/12:56:31	2012/119/13:55:03	000/00:58:32
1	TDE	SA 01	2012/119/15:58:38	2012/119/16:49:00	000/00:50:22
1	TDE	SA 01	2012/119/18:02:37	2012/119/18:43:50	000/00:41:13
1	TDE	SA 01	2012/120/04:41:31	2012/120/05:28:01	000/00:46:30
1	TDE	SA 01	2012/120/11:06:36	2012/120/11:49:30	000/00:42:54
1	TDE	SA 01	2012/120/12:11:30	2012/120/12:57:00	000/00:45:30
1	TDE	SA 01	2012/120/13:21:00	2012/120/14:20:11	000/00:59:11
1	TDE	SA 01	2012/120/14:40:06	2012/120/16:05:35	000/01:25:29
1	TDE	SA 01	2012/121/05:18:31	2012/121/06:07:55	000/00:49:24
1	TDE	SA 01	2012/121/06:46:30	2012/121/07:32:01	000/00:45:31
1	TDE	SA 01	2012/122/01:07:48	2012/122/02:01:58	000/00:54:10
1	TDE	SA 01	2012/122/09:33:31	2012/122/10:14:29	000/00:40:58
1	TDE	SA 01	2012/122/12:34:35	2012/122/13:23:58	000/00:49:23
1	TDE	SA 01	2012/123/07:46:07	2012/123/08:48:36	000/01:02:29
1	TDE	SA 01	2012/124/04:20:12	2012/124/05:09:55	000/00:49:43
1	TDE	SA 01	2012/124/10:44:15	2012/124/11:25:13	000/00:40:58
1	TDE	SA 01	2012/125/04:56:33	2012/125/05:45:59	000/00:49:26
1	TDE	SA 01	2012/125/07:35:14	2012/125/08:26:00	000/00:50:46
1	TDE	SA 01	2012/125/10:25:07	2012/125/11:12:30	000/00:47:23
1	TDE	SA 01	2012/125/18:30:50	2012/125/19:18:56	000/00:48:06

Figure 5-17—SAR Update with TUT

10. After all SARs are finalized with the SN schedule, the Scheduler will provide the final combined SN & NEN schedule (MS Excel spreadsheet) to the MOT Controller for each day of the experiment execution week. The combined schedule will be stored in the C:\SCAN Testbed Planning\Schedule\ folder.

11. The next step is the execution, Ground Control Message Request (GCMR), and monitoring the TDRS link event. To view an upcoming TDRS link event, the Scheduler will follow the menu steps "Scheduling/Scheduling Tools/Active Events Summary". Then select the appropriate "SUPIDEN" and click the "Submit" button. Then the "Active Events Summary Panel" will appear. When an event is in progress, i.e. the current time is between the event Start and Stop times; the background color of that event turns green, signaling that the event is ongoing. Upon the completion of an ongoing event, the listing in the "Active Events Summary" disappears. Prior to event start the Scheduler will highlight the appropriate event and click the "Display Services" button, where then the Scheduler can click on the "Create GCMR" button (see Figure 5-18) and the "Ground Control Message Reconfiguration" window will then appear (see Figure 5-18). The Scheduler will then make the appropriate modification and submit it by clicking the "Submit" button. The following reconfigurable options are available in a GCMR, and may be requested by the PI or Guest Experimenters in Table 5-19. More specific to the SCAN Testbed SSCs, Table 5-20 presents the GCMR options more specific to the SCAN Testbed Forward and Return SSCs.

Table 5-19—GCMR Options

Data Rate (cannot exceed Maximum value identified in the SSC)	Forward Link Sweep Request
Receive Frequency	Forward Link EIRP Reconfiguration – Normal Power (Need prior approval from CSC or WSC OS)
Polarization (Need prior approval from Communications Services Controller (CSC) or WSC OS)	Forward Link EIRP Reconfiguration – High Power (Need prior approval from CSC or WSC OS)
Command Channel PN Modulation	Expanded User Frequency Uncertainty Request
Doppler Compensation Required	Doppler Compensation Inhibit Request
User Reacquisition Request	

Table 5-20—GCMR Options Specific to SCAN Testbed SSCs

GD, JPL and HC Forward SSC GCMR Options
Data Rate (cannot exceed Maximum value identified in the SSC)
Frequency
PN Mod
Polarization (Need prior approval from Communications Services Controller (CSC) or WSC OS)
Normal/High Power (Need prior approval from CSC or WSC OS)
GD, JPL and HC Return SSC GCMR Options
Data Rate (cannot exceed Maximum value identified in the SSC)
Frequency
DG2 Modulation (BPSK or QPSK and only if the Q channel is scheduled to go from BPSK to QPSK)
Min and Max EIRP
Polarization (Need prior approval from CSC or WSC OS)
I/Q Power Ratio
Data Group Mode (Coherent or Non-Coherent)
Data Format (NRZ-M, NRZ-L, NRZ-S, etc…)
G2 Inversion (data inversion both I and Q)

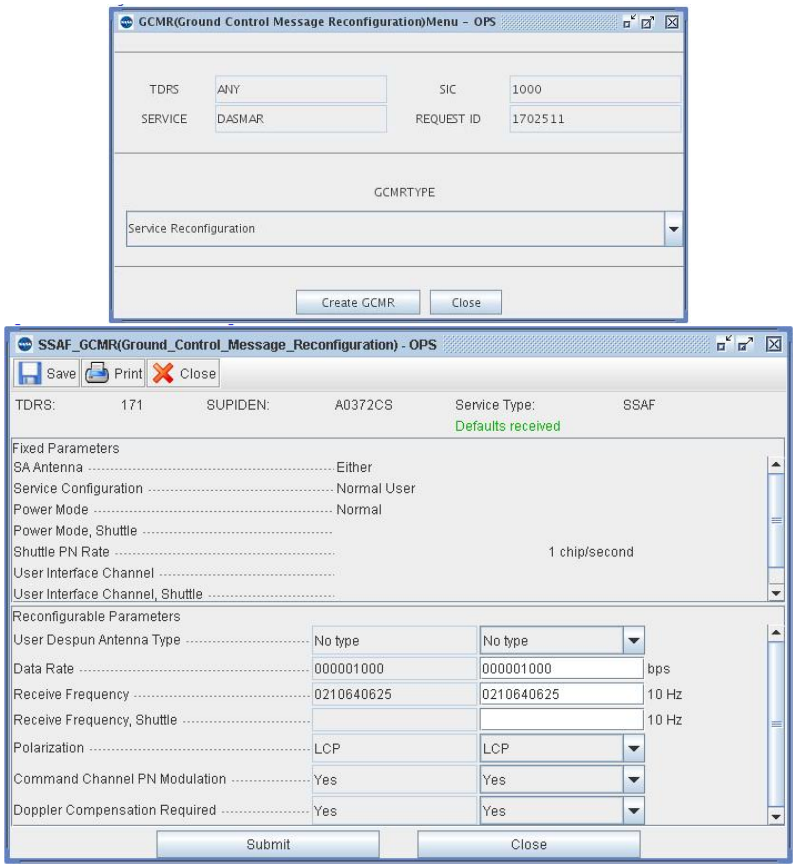


Figure 5-18—GCMR

12. During event execution the Scheduler will view the event through the “Graphical Timeline” which is accessed by following the menu steps “Scheduling/Scheduling Tools/Graphical Timeline” and the following window in Figure 5-19 will appear. The legend for the timeline is also presented. The Scheduler will also observe the User Performance Data (UPD) indicators for the Forward and Return links. UPDs are provided every five (5) seconds during an active TDRS event. Figure 5-20 presents a sample UPD for a GD Forward and Return link operation. Note: UPD log files are created during the event. This option is set in the “client” setup file in the SNAS directory. The heading on the file is “UPDLogging” where UPD messages received from NCCDS are logged. The value for “UPDLogging” should be set to “true”.

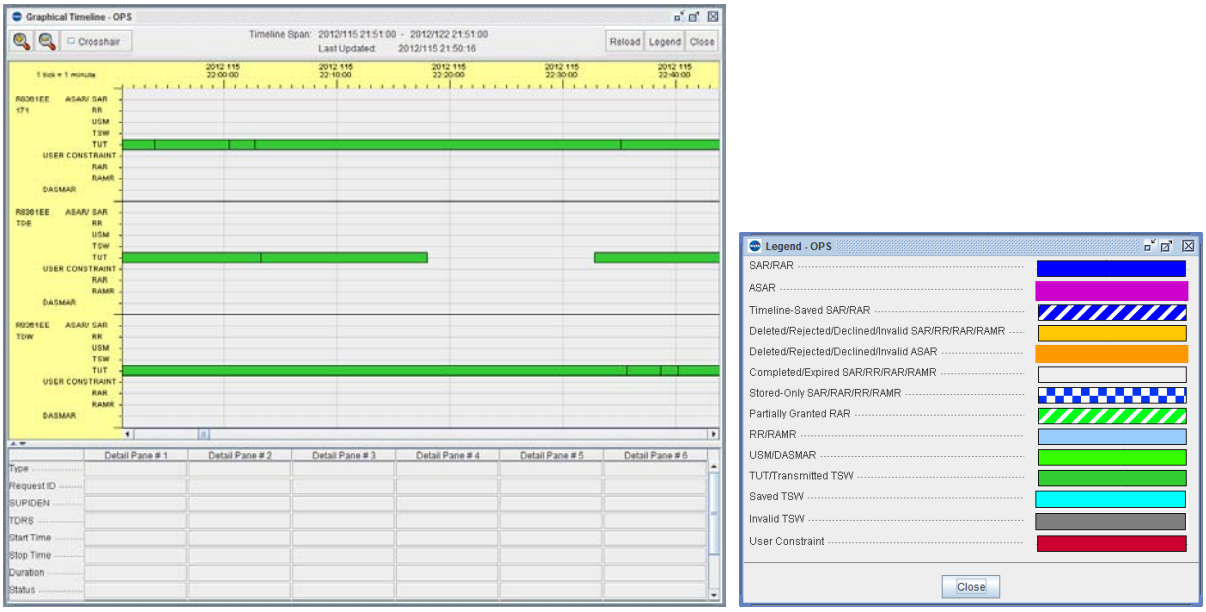


Figure 5-19—Graphical Timeline

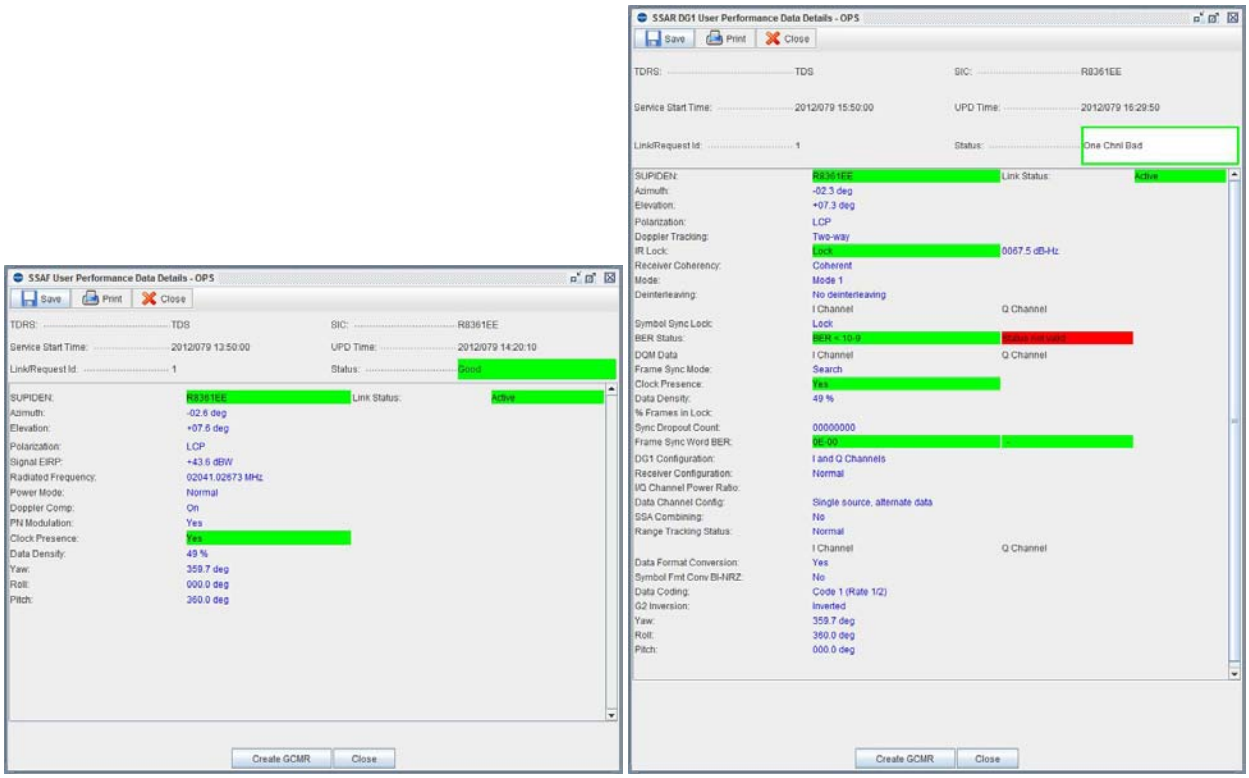


Figure 5-20—Graphical Timeline

13. After TDRS event LoS, the Scheduler will provide the UPD log files to the Experimenter and will store them on the Mission Planning workstation in the C:\SCAN Testbed Planning\SN\UPD\ folder with the file name identifying the date and TDRS event number.

5.2.9 SN Scheduling POC

The Scheduler will contact the following available POCs in Table 5-21 concerning SN scheduling process.

Table 5-21—SN Scheduling POCs

Purpose	POC	Phone & Email	Availability (hours x days)
Forecast SN resource scheduling	FA	(575) 527-7051/7121 forecastanalyst@mail.wsc.nasa.gov	9x5
Real-time SN resource scheduling	Schedulers	(575) 527-7152/7040 (575) 527-7233 (fax) wsnso@mail.wsc.nasa.gov	24x7
IIRV submission	Site Specialist	(575) 527-7157 wscos@mail.wsc.nasa.gov	24x7

5.2.10 SN Scheduling Considerations

The following ground rules are agreements between the user, network elements, and the SN Schedulers.

1. The Scheduler should review the latest NAMs to identify any issues with the SN.
2. The Scheduler shall contact the SN scheduler prior to performing any scheduling activity (i.e., delete/replace/add) via established voice loops/telephone/E-mail contacts that are currently in use.
3. All SHO activity between 2000z - 2100z should be avoided to allow vector transmissions.
4. The Scheduler may add/replace/delete requests to the NCCDS up to 10 minutes prior to the event start time.
5. For Full Support Scheduler's, use of the replace request (RR) is highly recommended.
6. Scheduler is required to wait at least 10 minutes before sending a replace request after an initial SHO add or any subsequent replace request.
7. When it is necessary to delete or replace a recently added event, the Scheduler should verify with the SN scheduler that the original SHO has been accepted. After this verification, the Scheduler can then submit the SHO delete/replace request.
8. A SHO delete request should never be sent within 10 minutes prior to the event start time. Wait until event start time, and then send a delete request.
9. During bulk SHO transmissions, a maximum of 50 SARs at one time is allowable during the real-time period. This restriction does not apply during the forecast period.
10. The Scheduler shall provide the SN schedulers with after-hours POC and contact information.
11. The Scheduler will be notified of a planned NCCDS outage via a NAM at least 5 working days prior to the outage.
12. The SN scheduler should negotiate with the Scheduler to resolve the conflict.

13. If above step is not successful, the SN scheduler will coordinate with the WSC OS and refer to the SN Priority List to resolve the conflict.
14. The WSC OS should contact the NASA NIM responsible for SCAN Testbed requesting the service time if necessary. The NIM will negotiate the conflict with the NIM responsible for the other missions involved and will advise WSC of the resolution.
15. The FA will coordinate planned handovers with the user during the forecast scheduling period.
16. Network notification for the reassignment of a TDRS supporting user services will be provided via NAM.
17. The WSC OS and CSC shall advise the Scheduler of impact to services due to unscheduled re-assignment of a TDRS.
18. The SN scheduler will work with the user to off-load critical events to other TDRS.
19. If necessary, the SN scheduler will coordinate with the Scheduler in the retransmission of any SHOs that were rejected during the reassignment.

APPENDIX A ACRONYMS AND ABBREVIATIONS

A.1 Scope

This appendix lists the acronyms and abbreviations used in this document.

A.2 List of Acronyms and Abbreviations

Table A-1—Acronyms

ACBSP	Assembly and Contingency Base Band Signal Processor
AoS	Acquisition of Signal
APS	Antenna Pointing System
APQM	Antenna Pointing Quality Metric
BER	Bit Error Rate
BPSK	Binary Phase-Shift Keying
BRTS	Bilateration Ranging Transponder System
C&DH	Command and Data Handling
CCB	Configuration Control Board
STCC	SCaN Testbed Control Center
CE	Chief Engineer
STEC	SCaN Testbed Experiment Center
CO	Coherent
CoNNeCT	Communications, Navigation, and Networking reConfigurable Testbed
COTS	Commercial Off The Shelf
CTS	Compatibility Test Set
CTV	SN Compatibility Test Van
DG	Data Group
DL	Downlink
EFEP	Experiment Front End Processor
EH&S	ExPA Health and Status
EIRP	Effective Isotropic Radiated Power
ELC	ExPRESS Logistics Carrier
ENMC	Enterprise Network Management Center
ExPA	ExPRESS Pallet Adapter
ExPA	ExPRESS Pallet Adapter
ExPRESS	EXpedite the PRocessing of Experiments to Space Station
F	Forward (SN Forward link service)
GD	General Dynamics
GIU	Ground Integration Unit
GPS	Global Positioning System
GPSA	GPS Antenna
GRC	Glenn Research Center
GRGT	Guam Remote Ground Terminal
GSE	Ground Support Equipment
GVF	Ground Verification Facility
H&S	Health and Safety
HC	Harris Corporation

HDR	High Data Rate
HGA	High Gain Antenna
HOSC	Huntsville Operations Support Center
HRDL	High Rate Data Link
HRT	High Rate Telemetry
ICD	Interface Control Document
IR	Incident Reports
ISS	International Space Station
JPL	Jet Propulsion Laboratory
KaSA	Ka-Band Single Access (SN/TDRS F8-F10 service)
kbps	kilobits per second
ksps	Kilo symbols per second
LDR	Low Data Rate
LGA	Low Gain Antenna
LoS	Loss of Signal
LRDL	Low Rate Data Link
LRT	Low Rate Telemetry
MA	Multiple Access (SN/TDRS F4-F7 service)
Mb	Megabyte
MCC	Mission Control Center
MDR	Medium Data Rate
MGA	Medium Gain Antenna
MHz	Megahertz
MILA	Merritt Island Launch Annex
MOM	Mission Operations Manager
MOT	Mission Operations Team
MRDL	Medium Rate Data Link
MSFC	Marshall Space Flight Center
N/A	Not Applicable
NASA	National Aeronautics and Space Administration
NC	Non-Coherent
NCCDS	Network Control Center Data System
NEN	Near Earth Network
NENSO	NEN Scheduling Office
NIC	Network Integration Center
NISN	NASA Integrated Services Network
NRZ	Non-Return-to-Zero
NRZ-L	Non-Return-to-Zero Level
NRZ-M	Non-Return-to-Zero Mark
NRZ-S	Non-Return-to-Zero Space
OCR	Operational Change Request
OE	Operating Environment
Ops	Operations
PCM	Pulse Code Modulated
PI	Principle Investigator
P/L	Payload
PM	Program Manager
PN	Pseudo Noise
POC	Points of Contact

POIC	Payload Operations Integration Center
PRN	pseudo-random noise
PRO	Payload Rack Officer
PSU	Power Supply Unit
QA	Quality Assurance
R	Return (SN Return link service)
RF	Radio Frequency
RID	Review Item Discrepancies
RMP	Risk Management Plan
SAA	South Atlantic Anomaly
SARG	Space Assurance and Requirements Guideline
S&MA	Safety and Mission Assurance
SCAN	Space Communications and Navigation
SDR	Software Defined Radio
SEU	Single Event Upset
SFEP	SCAN Testbed Front End Processor
SHO	Schedule Order
SMA	Multiple Access (SN/TDRS F8-F10 service)
SME	Subject Matter Expert
SN	Space Network
SNAS	Space Network Access System
SNIP	Space Network Interoperability Program
SOP	Standard Operating Procedure
SQPN	Staggered Quadrature Phase-Shift Keying with PN codes
SRD	Systems Requirements Document
SSA	S-Band Single Access (SN/TDRS Service)
SS-BPSK	Spread Spectrum – Binary Phase Shift Keying
SSP	Space Station Program
SSPA	Solid State Power Amplifier
STGT	Second TDRSS Ground Terminal
STRS	Space Telecommunications Radio System
SV	Space Vehicle
TBD	To Be Determined
TBR	To Be Resolved
TCA	Thermostat Control Assembly
TDRS	Tracking Data Relay Satellite
TDRSS	Tracking Data Relay Satellite System
TLM	Telemetry
TSC	Telescience Support Center
TSIM	TDRS Simulator
TWTA	Traveling Wave Tube Amplifier
UL	Uplink
UPD	User Performance Data
UQPSK	Unbalanced Quadrature Phase-Shift Keying
V	Volts
VHDR	Very High Data Rate
VLDR	Very Low Data Rate
W	Watt
WF	Waveform

WFF	Wallops Flight Facility
WGS	Wallops Ground Station
WO	Work Order
WOTIS	Wallops Orbital Tracking Information System
WSC	White Sands Complex
WSGT	White Sands Ground Terminal

APPENDIX B DEFINITIONS

B.1 Scope

This appendix lists the definitions used in this document.

B.2 List of Definitions

Table B-1—Definitions

APPENDIX C TBDs AND TBRs

C.1 Scope

This appendix provides a list of all items in this document that need to be determined (TBD) and or that need to be resolved (TBR).

C.2 List of TBDs

Table C-1—TBDs

TBD Number	Description	Document Paragraph
F-01	IP to Wallops will be defined in June after the System Security Plan is completed.	Appendix F
F-02	Port number on the SFEP for the GD EFEP link to Wallops IP will be defined after the System Security Plan is completed.	Appendix F
F-03	IP to Wallops will be defined in June after the System Security Plan is completed.	Appendix F
F-04	Port number on the SFEP for the JPL EFEP link to Wallops IP will be defined after the System Security Plan is completed.	Appendix F

C.3 List of TBRs

Table C-2—TBRs

TBR Number	Description	Document Paragraph

APPENDIX D IIRV

121183610100115804001513205 3

000003091651 000002884168-000005276415093

-000005517838 000004840895-000000586521104

01092032479370100 0000000048

Figure D-1—IIRV Message Example

Table D-1—IIRV Message Body Format

Line	Characters
1	_ _ _ _ _ < < ≡ ≡ (optional message text)
2	G I I R V a r r r r < < ≡ ≡ s s s s i i i i
3	v s 1 c c c c c b b n n n d o y h h m m s s s s s c c c < < ≡ ≡
4	s x x x x x x x x x x x x y y y y y y y y y y y y z z z z z z z z z z z z c c c < < ≡ ≡
5	s ẋ ẋ ẋ ẋ ẋ ẋ ẋ ẋ ẋ ẋ ẋ ẋ ẏ ẏ ẏ ẏ ẏ ẏ ẏ ẏ ẏ ẏ ẏ ẏ ż ż ż ż ż ż ż ż ż ż ż ż c c c < < ≡ ≡
6	m m m m m m m m a a a a a k k k k s r r r r r r r c c c < < ≡ ≡
7	I T E R M _ o o o o < < ≡ ≡
KEY: < Carriage Return, ≡ Line Feed, Δ ASCII Space	

Table D-2—IIRV ASCII TTY Message Body Explanation

Line	Characters	Explanation
1	_ _ _ _	Optional message text.
2	GIIRV	Start of message (fixed).
	a	Alphabetic character indicating originator of message: ASCII space = GSFC Z = WLP, E = ETR L = JPL, W = WTR J = JSC, P = PMR A = CSTC, K = KMR C = CNES
	rrrr	Destination routing indicator. Specifies the site for which the message was generated. If for more than one station, this field should contain "MANY."
3	v	Vector type: 1 = Free flight (routine on-orbit), 2 = Forced (special orbit update), 3 = Spare, 4 = Maneuver ignition, 5 = Maneuver cutoff, 6 = Reentry, 7 = Powered flight 8 = Stationary, 9 = Spare
	s	Source of data: 1 = Nominal/planning, 2 = Real-time, 3 = Off-line, 4 = Off-line/mean. NOTE Nominal/planning sets cannot be sent to WSGT from the NCC.
	1	Fixed one (1)
	c	Coordinate system: 1 = Geocentric True-of-Date Rotating, 2 = Geocentric mean of 1950.0 (B1950.0), 3 = Heliocentric B1950.0, 4 = Reserved for JPL use (non-GSFC), 5 = Reserved for JPL use (non-GSFC), 6 = Geocentric mean of 2000.0 (J2000.0), 7 = Heliocentric J2000.0.
	sic (4 characters)	SIC Spacecraft Identification Code
	bb	Body number/VID (01-99)
	nnn	Counter incremented for each vector in a set of vector data on a per-station per transmission basis.
	doy	Day of year (001 = January 1).
	hhmmsssss	Vector epoch in UTC with resolution to nearest millisecond. (The implied decimal point is three places from the right).
	ccc	Checksum of the decimal equivalent of the preceding characters on Line 3: 0 through 9 = face value. Minus (-) = 1. ASCII Space = 0.
4	s	Sign character: ASCII Space = positive, Minus sign = negative
	x x x x x x x x x x x x	X component of position (meters)
	y y y y y y y y y y y y	Y component of position (meters)
	z z z z z z z z z z z z	Z component of position (meters)
	ccc	Checksum of the decimal equivalent of the preceding characters on Line 4: 0 through 9 = face value, Minus (-) = 1, ASCII Space = 0
5	s	Sign character (same as above)
	ẋ ẋ ẋ ẋ ẋ ẋ ẋ ẋ ẋ ẋ ẋ ẋ	X-component of velocity
	ẏ ẏ ẏ ẏ ẏ ẏ ẏ ẏ ẏ ẏ ẏ ẏ	Y-component of velocity
	ż ż ż ż ż ż ż ż ż ż ż ż	Z-component of velocity
		NOTE All velocity components are in meters/second with resolution to the nearest millimeter/second. The implied decimal point is three places from the right.
	ccc	Checksum of the decimal equivalent of the preceding characters on Line 5: 0 through 9 = face value, Minus (-) = 1, ASCII Space = 0

6	mmmmmmmm	Mass of spacecraft in kilograms with resolution to 1/10 of a kilogram. The implied decimal point is one place from the right. Contains all zeros when not used.
	aaaaa	Average spacecraft cross-sectional area in square meters with resolution to the nearest hundredth of a square meter. The implied decimal point is two places from the right. Contains all zeros when not used.
	kkkk	Dimensionless drag coefficient. The implied decimal point is two places from the right. Contains all zeros when not used.
	s	Sign character for coefficient of solar reflectivity: ASCII Space = positive, Minus Sign = negative
	rrrrrrr	Dimensionless Solar Reflectivity coefficient. The implied decimal point is six places from the right. Contains all zeros when not used.
	ccc	Checksum of the decimal equivalent of the preceding characters on Line 6: 0 through 9 = face value, Minus (-) = 1, ASCII Space = 0
7	ITERM	End of message (fixed)
	Oooo	Originator routing indicator

APPENDIX E INTERNAL NOTE PROCESS

Follow the following steps to generate an Internal Note for sending a TCR to Pointing and receiving a TSR from Pointing.

For the following steps refer to Figure E-1.

- Access MCC-H Gateway, https://ops1.jsc.nasa.gov/gateway/ (requires NDC ID and Password)
- Select “TOOLS” Tab
- Under “TOOLS” tab click on “EFN”
- On the “EFN” menu select the pull down for “Type” and select “Internal Note”

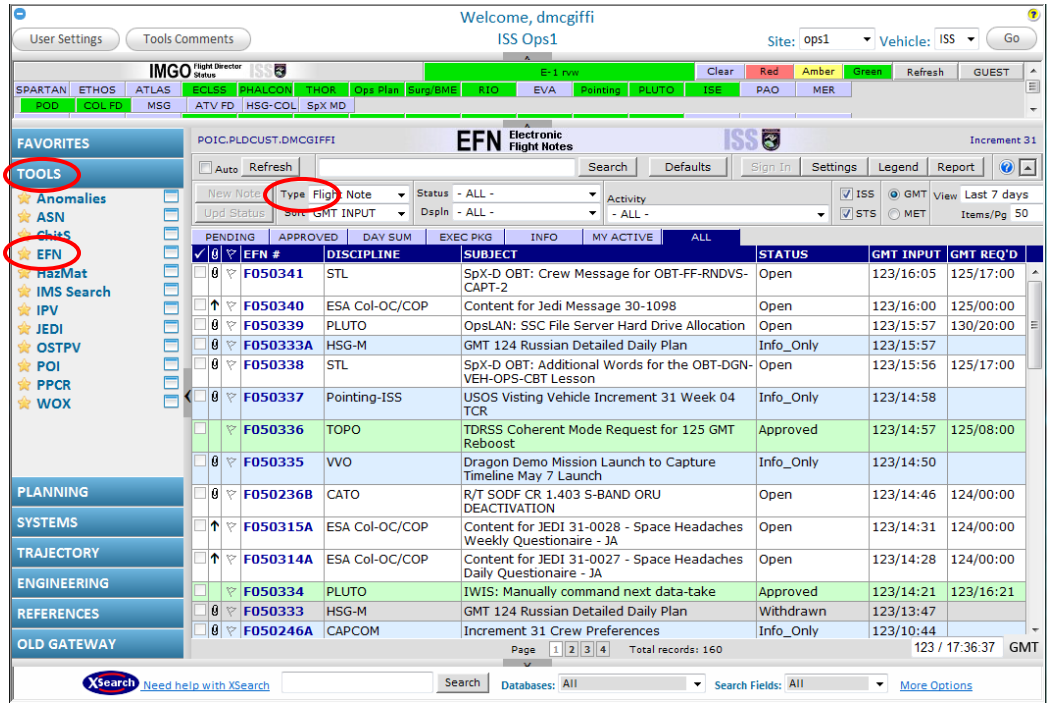


Figure E-1—All EFNs

For the following steps refer to Figure E-2.

- On the “EFN” menu click “New Note”

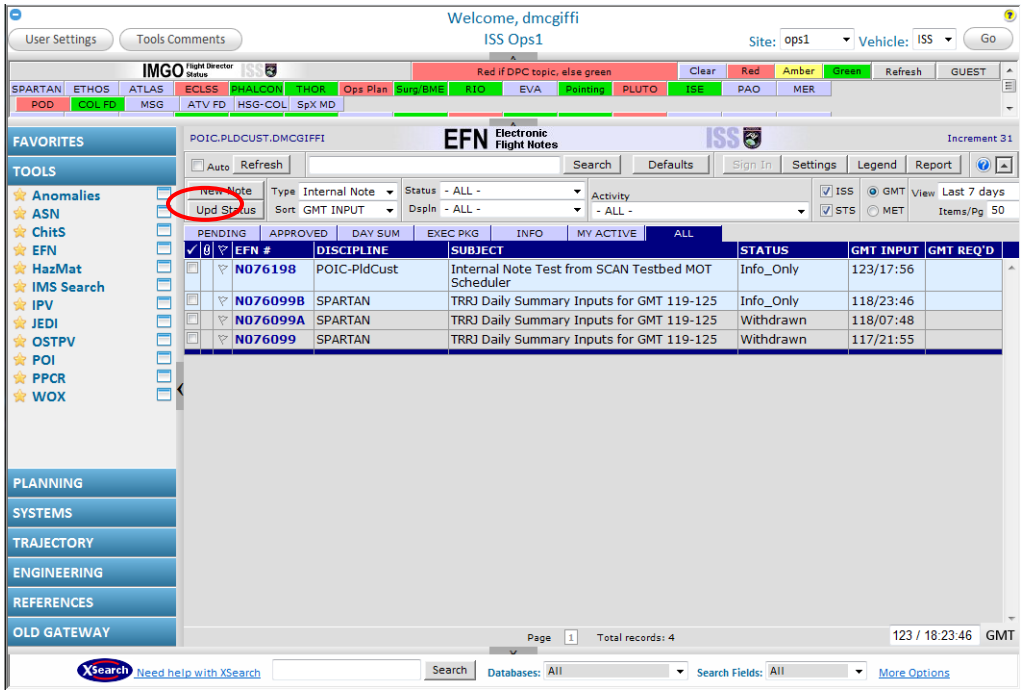


Figure E-2—Internal Notes Only

For the following steps refer to Figure E-3 and Figure E-4.

- New window will appear, Electronic Flight Notes, select Save As: “Internal Note”
- Under GMT Action pull down, select “N/A-Info Only”
- Click on the “To…” button, select “Pointing-ISS” under MOD recipient list

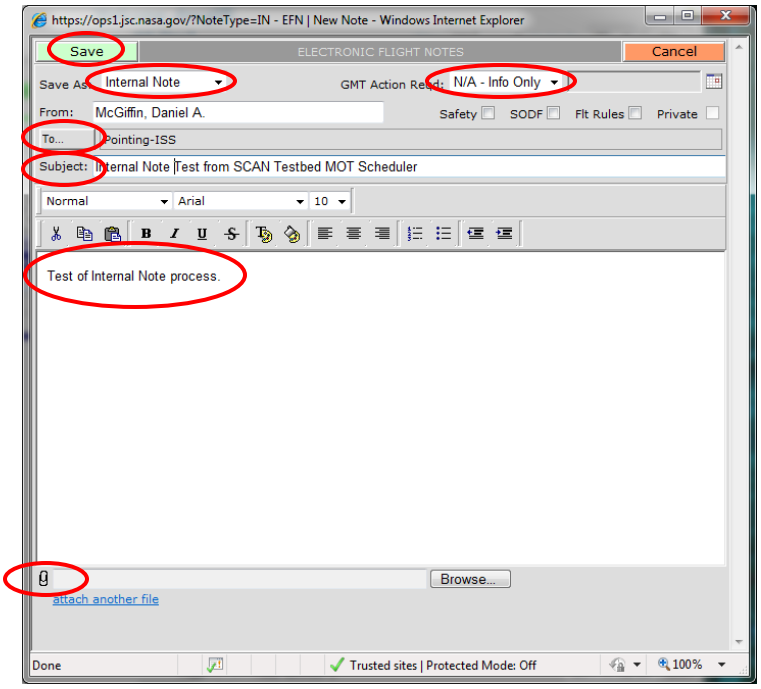


Figure E-3—Internal Note Generate

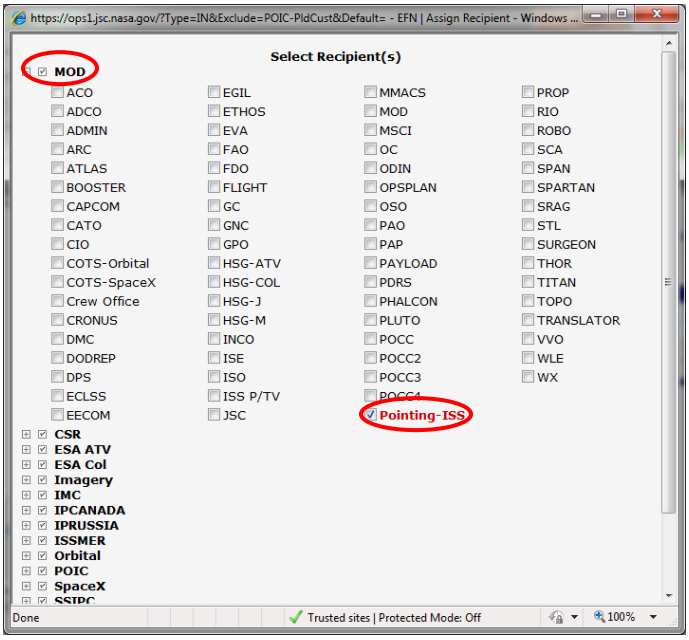


Figure E-4—Recipient Selection

- Type in the “Subject” the reason for the note, “SCAN Testbed TCR, Initial” and then attach the TCR file
- When complete, click the green “Save” button.

For the following steps refer to Figure E-5 and Figure E-6.

- To view an Internal Note (TSR sent from Pointing or TCR sent from the Scheduler) and/or revise the Internal Note click on the "EFN#" of the note in question.

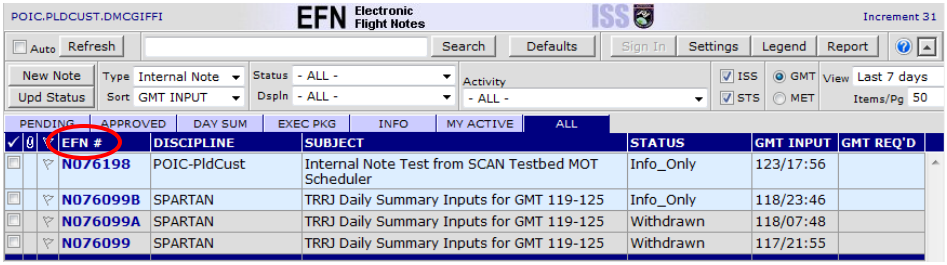


Figure E-5—Internal Note View

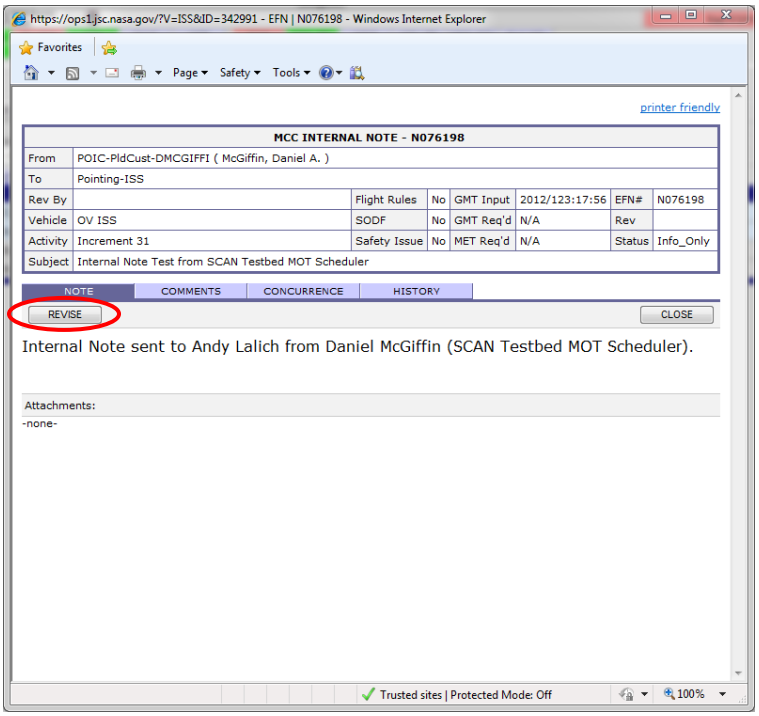


Figure E-6—Internal Note View or Revision

APPENDIX F SCAN TESTBED LINK ARCHITECTURE & PORTS

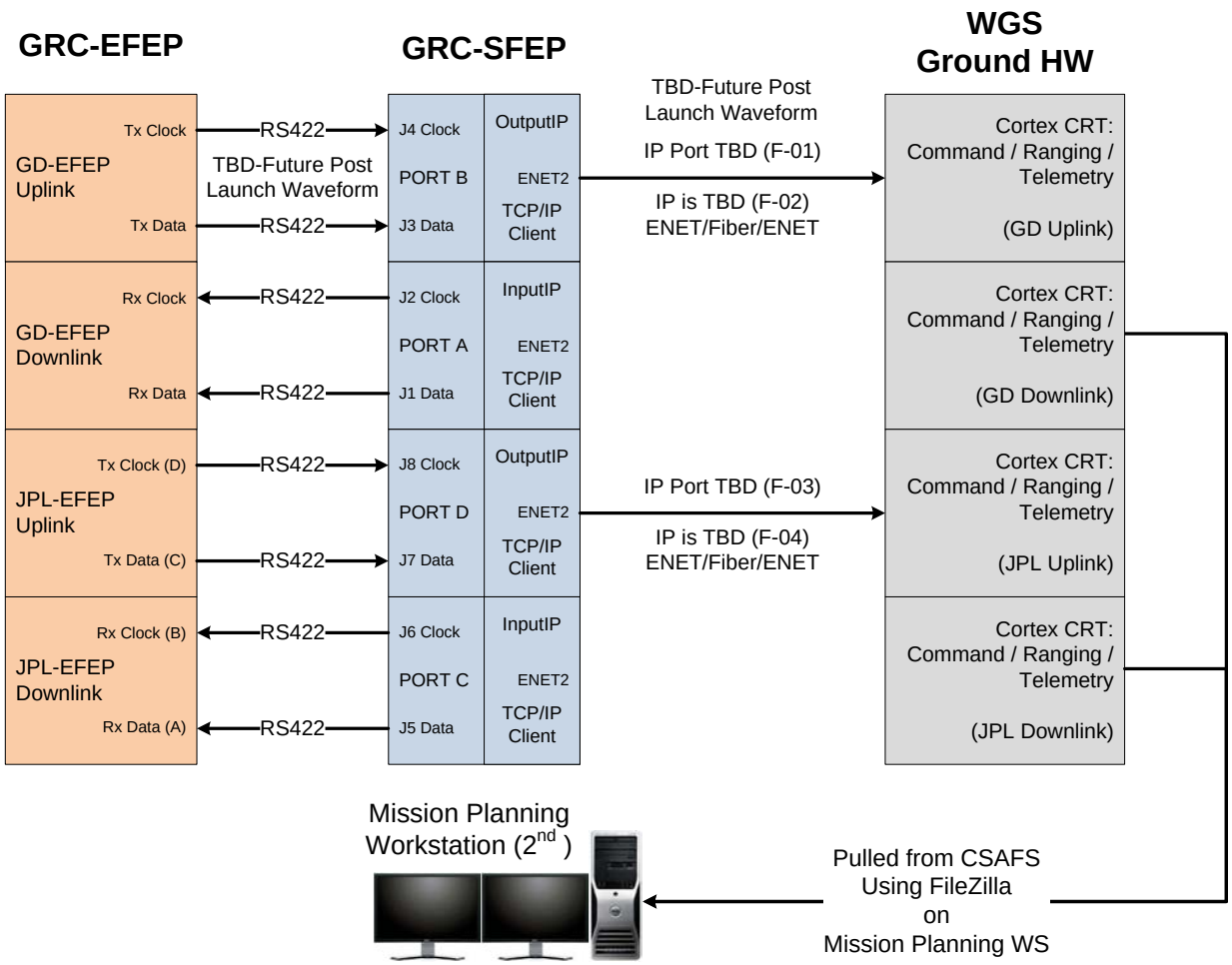


Figure F-1—EFEP/SFEP Port Description of NEN Links

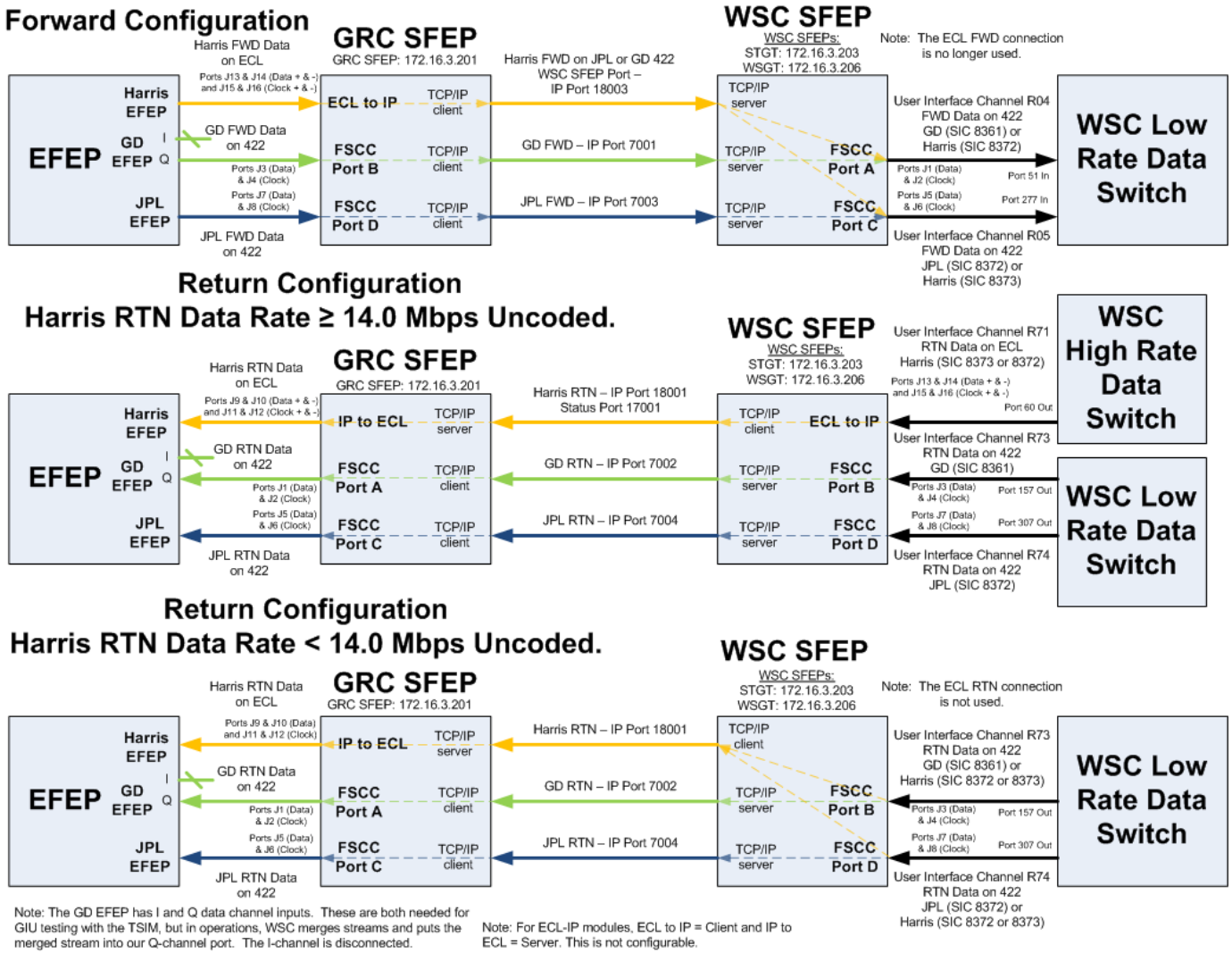


Figure F-2—EFEP/SFEP Port Description of SN Links

APPENDIX G SCAN TESTBED TDRS AND NEN COMMUNICATION SCHEDULE

SCAN Testbed TDRS and NEN Communications Schedule

For GMT Days XXX - XXX (March 19, 2012 - March 23, 2012)

WeekXX (Increment XXX)

Day	Band	SN-NEN	Antenna	SCAN Testbed Antenna	Start Time (GMT)	End Time (GMT)	Status		Start Time (EST)	End Time (EST)		SIC	TR or SSC (Forward, Return, Track)	WF ID (Forward, Return)
3/19 - 079	GD S-band	TDS	SA1	SN-LGA	13:50	14:30	Granted		9:50	10:30		8361 - GD	H03, I31, T81	181, 169
3/19 - 079	GD S-band	TDS	SA1	SN-LGA	15:50	16:30	Granted		11:50	12:30		8361 - GD	H03, I33, T83	203, 189
3/19 - 079	GD S-band	TDS	SA2	SN-MGA	17:30	18:10	Granted		1:30	2:10		8361 - GD	H03, I31, T81	181, 169
3/19 - 079	GD S-band	TDS	SA2	SN-MGA	19:06	19:46	Granted		3:06	3:46		8361 - GD	H03, I33, T83	203, 189

Day	Band	SN-NEN	Antenna	SCAN Testbed Antenna	Start Time (GMT)	End Time (GMT)	Status		Start Time (EST)	End Time (EST)		SIC	TR or SSC (Forward, Return, Track)	WF ID (Forward, Return)
3/20 - 080	JPL S-band	TDS	SA1	SN-LGA	14:30	15:10	Granted		10:30	11:10		8372 - JPL	H04, I12, T22	C
3/20 - 080	JPL S-band	TDS	SA1	SN-LGA	15:50	16:30	Granted		11:50	12:30		8372 - JPL	H06, I18, T28	F
3/20 - 080	JPL S-band	WPS	N/A	NEN-LGA	18:07	18:10	Granted		2:07	2:10		8372 - JPL	TR1	O
3/20 - 080	JPL S-band	TDS	SA1	SN-MGA	20:17	20:57	Granted		4:17	4:57		8372 - JPL	H04, I12, T22	C

Day	Band	SN-NEN	Antenna	SCAN Testbed Antenna	Start Time (GMT)	End Time (GMT)	Status		Start Time (EST)	End Time (EST)		SIC	TR or SSC (Forward, Return, Track)	Waveform ID (Forward, Return)
3/21 - 081	Harris Ka-band	TDE	SA2	SN-HGA	15:00	15:40	Granted		11:00	11:40		8373 - Harris	W01, Y01	335, 155
3/21 - 081	Harris Ka-band	TDE	SA2	SN-HGA	16:45	17:25	Granted		12:45	1:25		8373 - Harris	W01, Y03	335, 143
3/21 - 081	Harris Ka-band	TDE	SA2	SN-HGA	18:10	18:50	Granted		2:10	2:50		8373 - Harris	W01, Y09	296, 277
3/21 - 081	Harris Ka-band	TDE	SA1	SN-HGA	19:00	19:40	Granted		3:00	3:40		8373 - Harris	W01, Y03	296, 285

Day	Band	SN-NEN	Antenna	SCAN Testbed Antenna	Start Time (GMT)	End Time (GMT)	Status		Start Time (EST)	End Time (EST)		SIC	TR or SSC (Forward, Return, Track)	WF ID (Forward, Return)
3/22 - 082	Harris Ka-band	TDE	SA2	SN-HGA	12:44	13:19	Granted		8:44	9:19		8373 - Harris	W01, Y01	335, 155
	GD S-band	TDS	MA	SN-LGA	12:44	13:19	Granted		8:44	9:19		8361 - GD	A01, B01, T01	185, 177
3/22 - 082	Harris Ka-band	TDE	SA1	SN-HGA	17:38	18:18	Granted		1:38	2:18		8373 - Harris	W01, Y03	296, 285
	GD S-band	TDS	MA	SN-LGA	17:38	18:18	Granted		1:38	2:18		8361 - GD	A01, B03, T03	207, 197

Day	Band	SN-NEN	Antenna	SCAN Testbed Antenna	Start Time (GMT)	End Time (GMT)	Status		Start Time (EST)	End Time (EST)		SIC	TR or SSC (Forward, Return, Track)	WF ID (Forward, Return)
3/23 - 083	Harris Ka-band	TDE	SA2	SN-HGA	14:43	15:23	Granted		10:43	11:23		8372 - JPL	W01, Y01	335, 155
	JPL S-band	TDE	SA2	SN-LGA	14:43	15:23	Granted		10:43	11:23		8372 - JPL	H04, I12, T22	C
3/23 - 083	Harris Ka-band	TDE	SA1	SN-HGA	18:28	19:08	Granted		2:28	3:08		8372 - JPL	W01, Y03,	296, 285
	JPL S-band	TDE	SA1	SN-LGA	18:28	19:08	Granted		2:28	3:08		8372 - JPL	H06, I18, T28	F

APPENDIX H NEN POST PASS STATISTICS DESCRIPTION

1 - 10	11 - 25	26 - 35	36 - 45	46 - 62			63 - 79			80 - 96			97 - 113			114 - 118	119 - 121	122 - 126
Wotrs Line Item	Tape #	Tape Start Add	Tape End Add	Tape Event Start			Tape Event End			Bit Sync Lock			Bit Sync Unlock			% Lock	Event Designator	Recorder ID
				Year	Date	Time	Year	Date	Time	Year	Date	Time	Year	Date	Time			
Alpha	Alpha	Numeric	Numeric	yyyy	mmdd	hh:mm:ss	yyyy	mmdd	hh:mm:ss	yyyy	mmdd	hh:mm:ss	yyyy	mmdd	hh:mm:ss	%	Mnemonic	Alpha

General Format:
SSSRRxxxxxxxxxx, where
SSS = GS Designator
RR = Recorder Type
xxxxxxxxxx = 10 Character Tape Volume Label.

General Time Format
YYYYMMDD HH:MM:SS

1/sec Bit Sync & Demod Lock Count divided by # secs to be recorded (in Master Schedule) X 100. Number is %.

0=None NON
1=Support SUP
2=Playback PBK
3=Test TES
4=Time Window P/B TWP
5=Down DWN
6=Special Support SPS
7=Special Playback SPP
8=Bit Error Test BEX
9=Internal Rec Test TST

Recorder Type:
AA=Ampex
SS=Sony
MM=Metrum

Event Designators 0-5 are scheduled (WOTRS) activities sent to the ground station. Numbers 6-9 are scheduled at the ground station. Results of all activities are returned to WISDB

GS Designator:
WPS=Wallops 11-Meter
MGS=McMurdo 10-Meter
AGS=Alaska Ground Station
ASF=Alaska Science Foundation
SGS=Svalbard Ground Station

127	128	129 - 133	134 - 143	144 - 153	154 - 163	164 - 173	174 - 183	184
Tracked	Recorded	Recorder Quality	TP #1	TP #2	TP #3	TP #4	TP #5	TP Op
Y/N	Y/N	%	Numeric	Numeric	Numeric	Numeric	Numeric	Alpha

If the sum of AZ & EL movement is < 10 degrees, Tracked = N (No); else Tracked = Y (Yes).

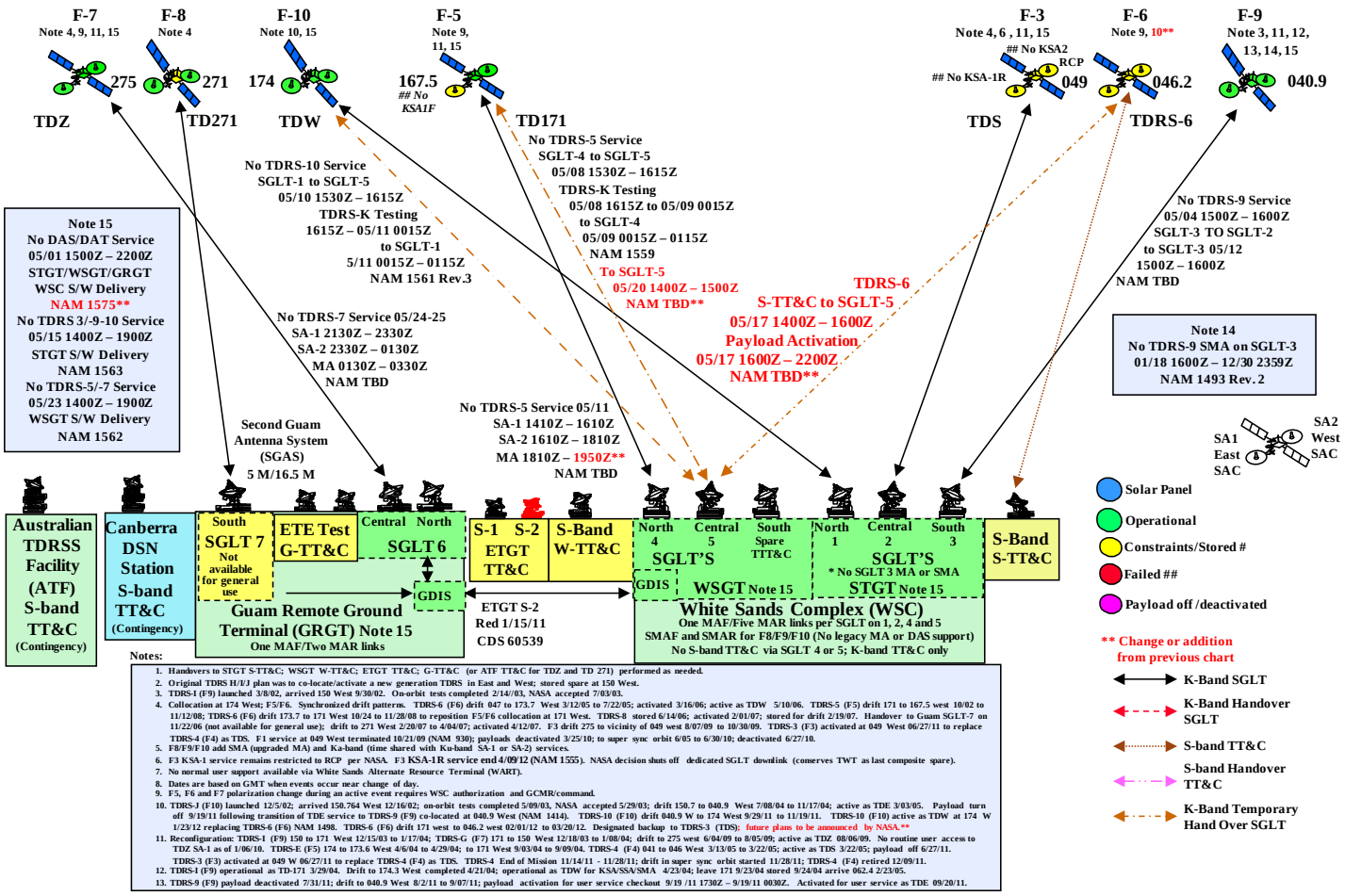
If Event Designator = SUP or SPS and End Address – Start Address < 200, Record = N (No); else Record = Y (Yes).

Telemetry Processor	TP#1	TP#2	TP#3	TP#4	TP#5	TP Op
AVTEC PTP Command	# Frames xmitted	# Headers received	# Headers accepted	# Data units sent	# Command Echos	PTP Stream ID
AVTEC PTP Telemetry	# Bytes output to file of socket	Total # of frames received	# CRC errors (CCSDS)	# correctable Reed-Solomon frames (CCSDS)	# un-correctable Reed-Solomon frames (CCSDS)	PTP stream ID
TSI Data Stripper (Adeos S/C)	Total # of frames processed	# of corrected frames	# of uncorrected frames	Back_to_ search count	Bit error rate	Downlink band (X1/X2/X3)

General Notes:
No Line Item will exist for Event Designator = BEX, TST, SPS.
Bit Sync fields are not applicable for Event Designator = BEX, TST, TWP, PBK

All Times:
H:M:S = UTC time to the nearest second => Example 14:21:33
Y = 4 digit year => Example 1997
M D = 2 digit month followed by 2 digit day => Example 0205 is Feb 5

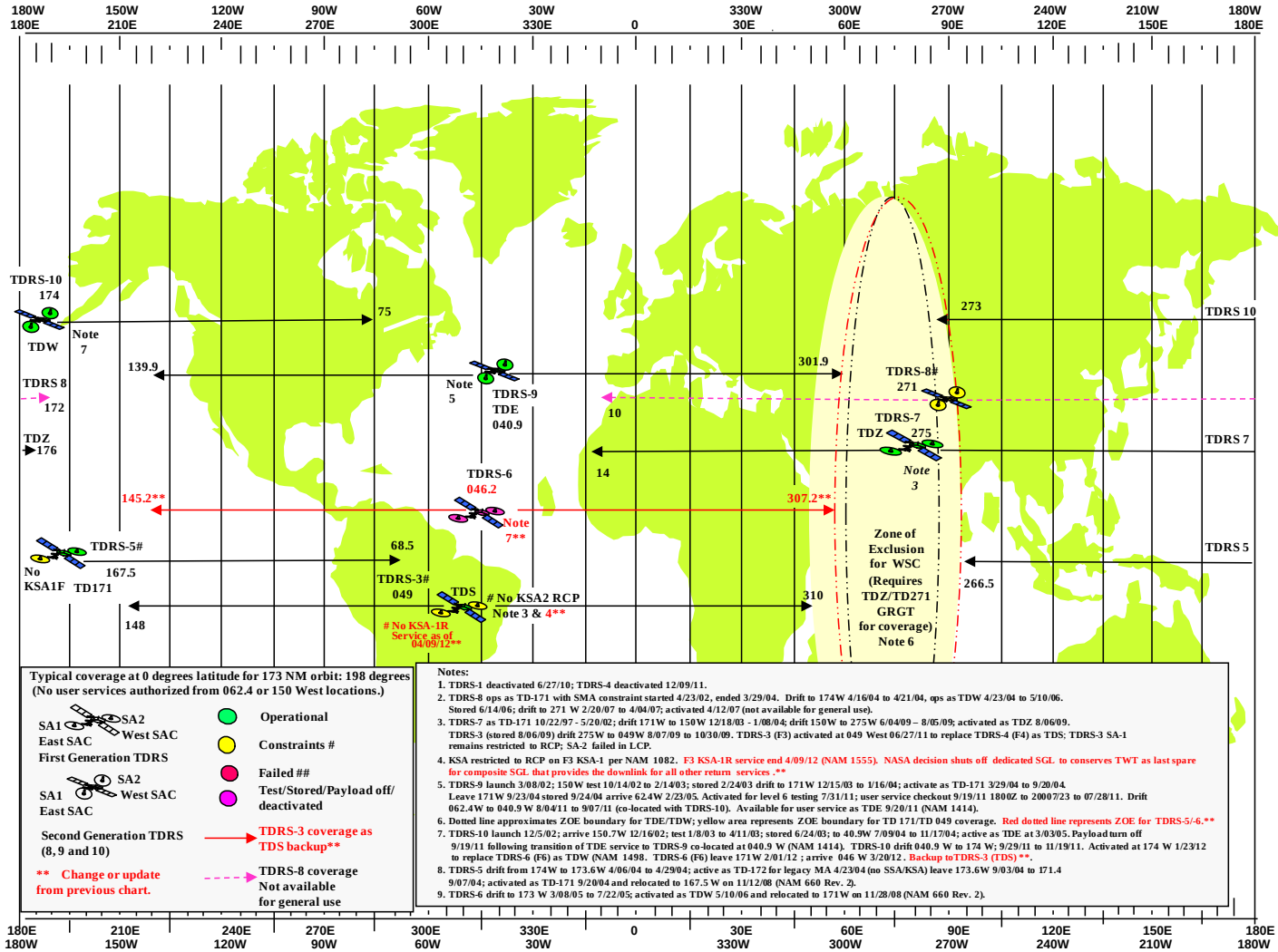
APPENDIX I SN STATUS SUMMARIES



Notes:

1. Handovers to STGT S-TT&C; WSGT W-TT&C; ETGT TT&C; G-TT&C (or ATF TT&C for TDZ and TD 271) performed as needed.
2. Original TDRS H/I/J plan was to co-locate/activate a new generation TDRS in East and West; stored spare at 150 West.
3. TDRS-I (F9) launched 3/8/02, arrived 150 West 9/30/02. On-orbit tests completed 2/14/03, NASA accepted 7/03/03.
4. Collocation at 174 West; F5/F6. Synchronized drift patterns. TDRS-6 (F6) drift 047 to 173.7 West 3/12/05 to 7/22/05; activated 3/16/06; active as TDW 5/10/06. TDRS-5 (F5) drift 171 to 167.5 west 10/02 to 11/12/08; TDRS-6 (F6) drift 173.7 to 171 West 10/24 to 11/28/08 to reposition F5/F6 collocation at 171 West. TDRS-8 stored 6/14/06; activated 2/01/07; stored for drift 2/19/07. Handover to Guam SGLT-7 on 11/22/06 (not available for general use); drift to 271 West 2/20/07 to 4/04/07; activated 4/12/07. F3 drift 275 to vicinity of 049 west 8/07/09 to 10/30/09. TDRS-3 (F3) activated at 049 West 06/27/11 to replace TDRS-4 (F4) as TDS. F1 service at 049 West terminated 10/21/09 (NAM 930); payloads deactivated 3/25/10; to super sync orbit 6/05 to 6/30/10; deactivated 6/27/10.
5. F8/F9/F10 add SMA (upgraded MA) and Ka-band (time shared with Ku-band SA-1 or SA-2) services.
6. F3 KSA-1 service remains restricted to RCP per NASA. F3 KSA-1R service end 4/09/12 (NAM 1555). NASA decision shuts off dedicated SGLT downlink (conserves TWT as last composite spare).
7. No normal user support available via White Sands Alternate Resource Terminal (WART).
8. Dates are based on GMT when events occur near change of day.
9. F5, F6 and F7 polarization change during an active event requires WSC authorization and GCMR/command.
10. TDRS-J (F10) launched 12/5/02; arrived 150.764 West 12/16/02; on-orbit tests completed 5/09/03, NASA accepted 5/29/03; drift 150.7 to 040.9 West 7/08/04 to 11/17/04; active as TDE 3/03/05. Payload turn off 9/19/11 following transition of TDE service to TDRS-9 (F9) co-located at 040.9 West (NAM 1414). TDRS-10 (F10) drift 040.9 W to 174 West 9/29/11 to 11/19/11. TDRS-10 (F10) active as TDW at 174 W 1/23/12 replacing TDRS-6 (F6) NAM 1498. TDRS-6 (F6) drift 171 west to 046.2 west 02/01/12 to 03/20/12. Designated backup to TDRS-3 (TDS); future plans to be announced by NASA.**
11. Reconfiguration: TDRS-I (F9) 150 to 171 West 12/15/03 to 1/17/04; TDRS-G (F7) 171 to 150 West 12/18/03 to 1/08/04; drift to 275 west 6/04/09 to 8/05/09; active as TDZ 08/06/09. No routine user access to TDZ SA-1 as of 1/06/10. TDRS-E (F5) 174 to 173.6 West 4/6/04 to 4/29/04; to 171 West 9/03/04 to 9/09/04. TDRS-4 (F4) 041 to 046 West 3/13/05 to 3/22/05; active as TDS 3/22/05; payload off 6/27/11. TDRS-3 (F3) activated at 049 W 06/27/11 to replace TDRS-4 (F4) as TDS. TDRS-4 End of Mission 11/14/11 - 11/28/11; drift in super sync orbit started 11/28/11; TDRS-4 (F4) retired 12/09/11.
12. TDRS-I (F9) operational as TD-171 3/29/04. Drift to 174.3 West completed 4/21/04; operational as TDW for KSA/SSA/SMA 4/23/04; leave 171 9/23/04 stored 9/24/04 arrive 062.4 2/23/05.
13. TDRS-9 (F9) payload deactivated 7/31/11; drift to 040.9 West 8/2/11 to 9/07/11; payload activation for user service checkout 9/19 /11 1730Z – 9/19/11 0030Z. Activated for user service as TDE 09/20/11.

Figure I-1—SGLT Status



Typical coverage at 0 degrees latitude for 173 NM orbit: 198 degrees (No user services authorized from 062.4 or 150 West locations.)

SA1 East SAC / SA2 West SAC — First Generation TDRS

SA1 East SAC / SA2 West SAC — Second Generation TDRS (8, 9 and 10)

** Change or update from previous chart.

Operational

Constraints #

Failed ##

Test/Stored/Payload off/ deactivated

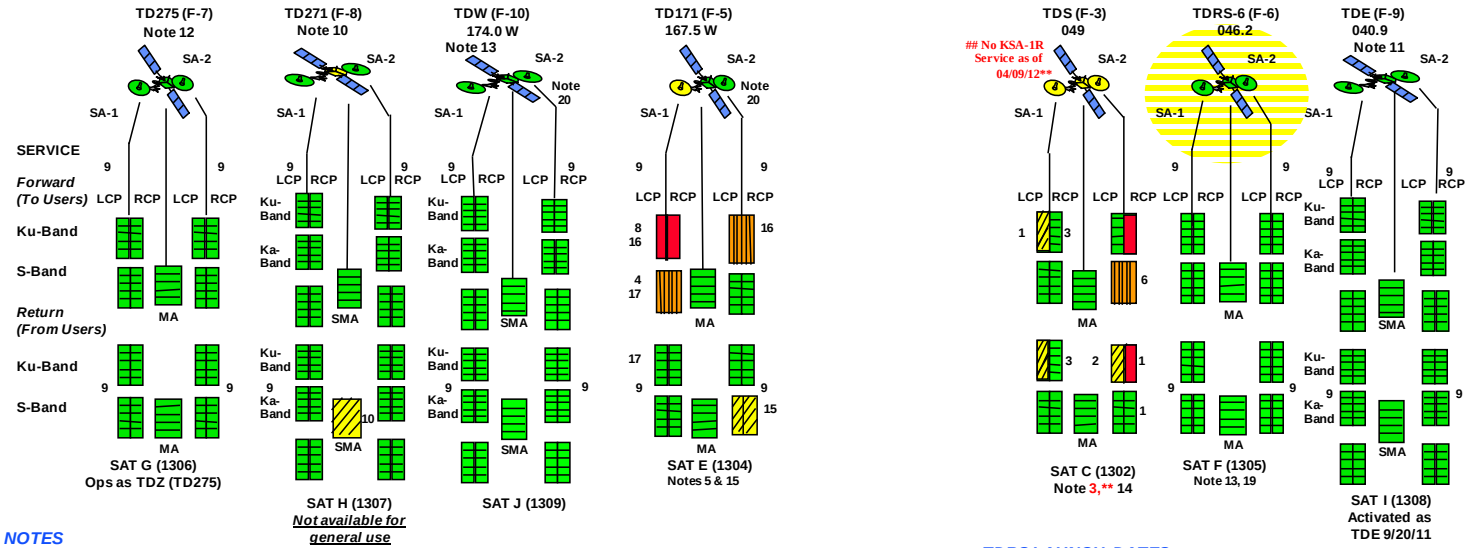
TDRS-3 coverage as TDS backup**

TDRS-8 coverage Not available for general use

Notes:

1. TDRS-1 deactivated 6/27/10; TDRS-4 deactivated 12/09/11.
2. TDRS-8 ops as TD-171 with SMA constraint started 4/23/02, ended 3/29/04. Drift to 174W 4/16/04 to 4/21/04, ops as TDW 4/23/04 to 5/10/06. Stored 6/14/06; drift to 271 W 2/20/07 to 4/04/07; activated 4/12/07 (not available for general use).
3. TDRS-7 as TD-171 10/22/97 - 5/20/02; drift 171W to 150W 12/18/03 - 1/08/04; drift 150W to 275W 6/04/09 – 8/05/09; activated as TDZ 8/06/09. TDRS-3 (stored 8/06/09) drift 275W to 049W 8/07/09 to 10/30/09. TDRS-3 (F3) activated at 049 West 06/27/11 to replace TDRS-4 (F4) as TDS; TDRS-3 SA-1 remains restricted to RCP; SA-2 failed in LCP.
4. KSA restricted to RCP on F3 KSA-1 per NAM 1082. F3 KSA-1R service end 4/09/12 (NAM 1555). NASA decision shuts off dedicated SGL to conserves TWT as last spare for composite SGL that provides the downlink for all other return services .**
5. TDRS-9 launch 3/08/02; 150W test 10/14/02 to 2/14/03; stored 2/24/03 drift to 171W 12/15/03 to 1/16/04; activate as TD-171 3/29/04 to 9/20/04. Leave 171W 9/23/04 stored 9/24/04 arrive 62.4W 2/23/05. Activated for level 6 testing 7/31/11; user service checkout 9/19/11 1800Z to 20007/23 to 07/28/11. Drift 062.4W to 040.9 W 8/04/11 to 9/07/11 (co-located with TDRS-10). Available for user service as TDE 9/20/11 (NAM 1414).
6. Dotted line approximates ZOE boundary for TDE/TDW; yellow area represents ZOE boundary for TD 171/TD 049 coverage. Red dotted line represents ZOE for TDRS-5/-6.**
7. TDRS-10 launch 12/5/02; arrive 150.7W 12/16/02; test 1/8/03 to 4/11/03; stored 6/24/03; to 40.9W 7/09/04 to 11/17/04; active as TDE at 3/03/05. Payload turn off 9/19/11 following transition of TDE service to TDRS-9 co-located at 040.9 W (NAM 1414). TDRS-10 drift 040.9 W to 174 W; 9/29/11 to 11/19/11. Activated at 174 W 1/23/12 to replace TDRS-6 (F6) as TDW (NAM 1498. TDRS-6 (F6) leave 171W 2/01/12 ; arrive 046 W 3/20/12. Backup toTDRS-3 (TDS) **.
8. TDRS-5 drift from 174W to 173.6W 4/06/04 to 4/29/04; active as TD-172 for legacy MA 4/23/04 (no SSA/KSA) leave 173.6W 9/03/04 to 171.4 9/07/04; activated as TD-171 9/20/04 and relocated to 167.5 W on 11/12/08 (NAM 660 Rev. 2).
9. TDRS-6 drift to 173 W 3/08/05 to 7/22/05; activated as TDW 5/10/06 and relocated to 171W on 11/28/08 (NAM 660 Rev. 2).

Figure I-2—TDRS Coverage Status



NOTES

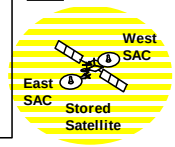
1. TDRS-3 SAC-2 switching anomaly due to blown fuse, 01/16/90. KSA polarization switch failed in LCP. S-Band polarization switching via redundant Polarity Coils: LCP = TCMD, 1476 RCP = TCMD, 0777.
2. TDRS-3 C/No degraded up to approximately 3.5 dB. KSA-2 return configured via redundant Paramp down converter pair as a result of the SAC-2 switching anomaly on 01/16/90. Refer to SOAR 100-3 and 104-3.
3. TDRS-3 KSA Fwd/Rtn restricted to RCP per NASA; SA-2 failed in LCP. TDRS-3 KSA-1R (dedicated SGL) service end 4/09/12 (NAM 1555). NASA decision conserves TWT as a last composite SGL spare; no other spare available).**
4. TDRS-5 SSA 1E failed on DOY 149 (5/29/94) at 0055Z.
5. TDRS-5 Composite Downlink TWTA5/UC degraded on DOY163 (6/11/96); switched to TWTA6/UC.
6. TDRS-3 SSA 1W failed on DOY 156 (6/4/96) at 0445Z.
7. TDRS-1 payloads deactivated 3/25/10. End of mission orbit raising/fuel depletion start 6/5/10; completed and satellite deactivated 6/27/10.
8. TDRS-5 KSA 1E replaced by KSA 2E on DOY 131 (5/10/00) at 0830Z. Increased Helix current and degraded EIRP following a CPE/CTE anomaly and subsequent under voltage on 9/27/99.
9. TDRS 5 through 10 polarization change during an active event requires coordination with WSC for authorization and WSC will transmit GCMR/command.
10. TDRS-8 SMA performance shortfall per NAM 1082. TDRS-8 post eclipse battery recharge (03/08/12) 1ABAR3ST measurand fault to FAIL, known bad cell 12 in battery.
11. TDRS-9 activated as TD-171 on 03/29/04. Arrived 150 W 9/30/02 on orbit tests complete 2/14/03; stored 2/24/03; accepted by NASA 7/03/03. To be activated 7/18/11; level 6 testing 7/18/11 to 7/22/11; performance testing 7/19/11. Drift 062.4W to co-locate with TDRS-10 (F10) at 040.9 W 8/2/11 to 9/07/11.Activation and user service checkout 9/19/11; activated for user service as TDE 09/20/11.
12. TDRS-7 stored 5/20/02 with no user support; drift from 171 to 150 W 12/18/03 to 01/08/04; drift from 150 W to 278.5 W 6/04/09 to 8/05/09; activated as TDZ (TD275 08/07/09; drift to 275 W 08/07/09 to 08/19/09 per NAM 871. No SA-1 routine user access as of 1/06/10.
13. TDRS-10 arrived 150.7 W 12/16/02; co-located with TDRS-7. at 150 W. On-orbit tests completed 5/9/03; accepted by NASA 5/29/03 and configured for storage6/24/03; drift from 150 to 40.9 W 7/08/04 to 11/17/04. Active as TDE 3/03/05. Payload turn off 9/19/11 following transition of TDE service to TDRS-9 (F9) co-located at 040.9 W (NAM 1414). TDRS-10 (F10) drift 040.9 W to 174 W; 9/29/11 to 11/19/11. Activated for user service as TDW 01/23/12 (NAM 1498) replacing TDRS-6 (F6).
14. TDRS-3 SA-1 Pitch Gimbal intermittent movement monitoring by WSC. TDRS-3 composite KSA switched from TWTA 6 to 1 on 01/07/04 due to rising helix current. Drift from 275 to 049 W 08/07/09 to 10/30/09. Handover from SGLT-2 to S-TT&C 3/07/11; TDRS-3 (F3) activated at 046 W 06/27/11 to replace TDRS-4 (F4) as TDS. TDRS-3 KSA1R intermittent dropout monitoring since 7/22/11 (NAM 1384 Rev. 3; extended to 12/31/12 by NAM 1495 issued 01/03/12.) TDRS-3 Composite Downlink Anomaly impacting KSAR-2 services isolated to Master Frequency Generator (MFG) per SER 1097 version 2 closed 2/02/12; spacecraft can support customer services.
15. TDRS-5 KSA-1 return dropout monitoring per NAM 763. TDRS-5 SSA-2 return dropouts NAM 730; closed to NAM 11 Rev. 2; opened 10/26/06 to NAM 212; replaced by NAM 391, then replaced by 1246, and then 1495 Rev. 1 that was closed 02/02/12.
16. TDRS-5 KSA1F failed TWT (no spare) NAM 1082. KSA-2F degraded; replaced by spare 8/02/07 (NAM 362 Rev. 5).
17. TDRS-5 KSA1R TWTA 5 HELIX current spiked on 7/23/04 to a maximum of 3.3 milliamp, indicating impending failure. Replaced with TWTA 3 on 8/24/04. (Reference CDS 36445.)
18. TDRS-4 to Ops as TDS 3/22/05; KSA1 Forward prime TWTA degraded; operating on backup as of 7/26/05, no redundancy; failed 2/14/08. KSA-2 below specification WSC monitoring performance. TDRS-4 end of mission activities 11/14/11 – 11/28/11; retired 12/09/11.
19. TDRS-6 to Ops as TDW 5/10/06; KSA-1 SGL degraded; switched to spare TWTA 12/05/06 (two additional spares remain). TDRS-6 leave 171W 02/01/12 arrive 046W 03/20/12 designated backup to TDRS-3 (TDS).
20. TDRS-5 repositioning 171 to 167.5 W; 10/02-11/12/08; TDRS-6 174 to 171 W 10/24 to 11/28/08 per NAM 660 Rev 2.
21. Ground rules for SGLT 7 operations (normally assigned to TDRS-8; not available for general use) 3/03/10 by NAM 1029; replaced 7/12/11 by NAM 1372.

TDRS LAUNCH DATES

TDRS-1	(A)	DOY 094	4 Apr 83	1830Z	STS-6	Challenger
TDRS-2	(B)	DOY 028	28 Jan 86	1638Z	STS-51L	Challenger
TDRS-3	(C)	DOY 273	29 Sep 88	1537Z	STS-26	Discovery
TDRS-4	(D)	DOY 072	13 Mar 89	1357Z	STS-29	Discovery
TDRS-5	(E)	DOY 214	2 Aug 91	1502Z	STS-43	Atlantis
TDRS-6	(F)	DOY 013	13 Jan 93	1359Z	STS-54	Endeavour
TDRS-7	(G)	DOY 194	13 Jul 95	1341Z	STS-70	Discovery
TDRS-8	(H)	DOY 158	6 Jun 00	1256Z	Atlas IIA	
TDRS-9	(I)	DOY 304	8 Mar 02	2259Z	Atlas IIA	
TDRS-10	(J)	DOY 339	5 Dec 02	0242Z	Atlas IIA	
TDRS-11	(K)	DOY XXX	1 Dec 12	XXXXZ	Atlas V Future launch	

LEGEND

- FULL CAPABILITY
- SCHEDULING CONSTRAINTS
- OPERATIONAL CONSTRAINTS
- FAILED
- PAYLOAD OFF OR TEST STATUS NO USERS
- OPERATING ON REDUNDANCY PRIMARY FAILED



** Update or change from previous chart

Figure I-3—TDRS Payload Status

APPENDIX J SCAN TESTBED SSC

Table J-1—GD Forward SSCs

SIC	SSC	Serv	Ant	UIFC	Max DR (b)	Initial DR (b)	FREQ (Hz)	PN Mod	Polar	Doppler Comp	Despun	Power
8361	A01	MAF	Open	R04	144000	18000	210640625	Y	L	Y	N	Norm
8361	A11	MAF	Open		72000	18000	210640625	Y	L	Y	N	Norm
8361	U01	SMAF	Open	R04	144000	18000	210640625	Y	L	Y	N	Norm
8361	U02	SMAF	Open		72000	18000	210640625	Y	L	Y	N	Norm
8361	H03	SSAF	Open	R04	144000	18000	204102708	Y	L	Y	N	Norm
8361	H04	SSAF	Open	R04	144000	18000	204102708	Y	L	Y	N	High
8361	H11	SSAF	Open	R04	144000	72000	210640625	Y	L	Y	N	Norm
8361	H13	SSAF	Open	R04	144000	18000	204102708	Y	L	Y	N	Norm
8361	H14	SSAF	Open		72000	18000	204102708	Y	L	Y	N	High

Table J-2—GD Return SSCs

SIC	SSC	Service	Data	Polar	CO	Data G	C	Mod	DG1	Em	EM	FREQ (Hz)	Channel	UIF	Symbol	Coding	Initial I (b)	Max I (b)	Initial Q (b)	Max Q (b)	DSI	DF	JIT	I
8361	B01	MAR	SI	L	CO					95	235	228750000	I	R73	N	1	24000	24000	24000	24000	372	NM	0.10%	I
8361	B02	MAR	SI	L	NC					95	235	228750000	I	R73	N	1	24000	24000	24000	24000	372	NM	0.10%	I
8361	I03	SSAR	SI	L		1	B	Q	CO	95	235	228750000	I	R73	N	1	96000	96000	96000	96000	0	NM	0.10%	I
8361	I04	SSAR	SI	L		1	B	Q	NC	95	235	228750000	I	R73	N	1	96000	96000	96000	96000	0	NM	0.10%	I
8361	I05	SSAR	SI	L		1	B	Q	CO	95	235	228750000	I	R73	N		96000	96000	96000	96000	0	NM	0.10%	I
8361	I06	SSAR	SI	L		1	B	Q	NC	95	235	228750000	I	R73	N		96000	96000	96000	96000	0	NM	0.10%	I
8361	I07	SSAR	SI	L		1	B	Q	CNI	95	235	228750000	I	R73	N	1	500000	1000000	500000	1000000	0	NM	0.10%	I
8361	I08	SSAR	SI	L		1	B	Q	CNI	95	235	228750000	I	R73	N		500000	1000000	500000	1000000	0	NM	0.10%	I
8361	I09	SSAR	SI	L		2	B	Q	CO	95	235	228750000	I	R73	N	1	500000	1000000	500000	1000000	0	NM	0.10%	I
8361	I10	SSAR	SI	L		2	B	Q	CO	95	235	228750000	I	R73	N		500000	1000000	500000	1000000	0	NM	0.10%	I
8361	I11	SSAR	SI	L		1	B	Q	C	95	235	221650000	I	R73	N		24000	24000	24000	24000	0	NM	0.10%	I
8361	I12	SSAR	SI	L		1	B	Q	NC	95	235	221650000	I	R73	N		24000	24000	24000	24000	0	NM	0.10%	I
8361	I13	SSAR	SA	L		1	B	Q	C	95	235	221650000	I	R73	N		192000	192000	24000	24000	0	NM	0.10%	I
8361	I14	SSAR	SA	L		1	B	Q	NC	95	235	221650000	I	R73	N		192000	192000	96000	192000	0	NM	0.10%	I
8361	I15	SSAR	D	L		1	B	Q	CNI	95	235	221650000	I	R73	N		1000	1000	1000000	1000000	0	NM	0.10%	I
8361	I16	SSAR	SA	L		2	B	Q	NC	95	235	221650000	I	R73	N		500000	1000000	500000	1000000	0	NM	0.10%	I
8361	I31	SSAR	SI	L		1	B	Q	C	95	235	221650000	I	R73	N	1	24000	24000	24000	24000	0	NM	0.10%	I
8361	I32	SSAR	SI	L		1	B	Q	NC	95	235	221650000	I	R73	N	1	24000	24000	24000	24000	0	NM	0.10%	I
8361	I33	SSAR	SA	L		1	B	Q	C	95	235	221650000	I	R73	N	1	192000	192000	96000	192000	0	NM	0.10%	I
8361	I34	SSAR	SA	L		1	B	Q	NC	95	235	221650000	I	R73	N	1	96000	96000	24000	24000	0	NM	0.10%	I
8361	I35	SSAR	D	L		1	B	Q	NC	95	235	221650000	I	R73	N	1	1000	1000	1000000	1000000	0	NM	0.10%	I
8361	I36	SSAR	SA	L		2	B	Q	NC	95	235	221650000	I	R73	N	1	500000	1000000	500000	1000000	0	NM	0.10%	I
8361	V01	SMAR	SI	L		1	B	Q	NC	95	235	228750000	I	R73	N		24000	192000	24000	192000	0	NM	0.10%	I
8361	V02	SMAR	SI	L		1	B	Q	NC	95	235	228750000	I	R73	N		24000	192000	24000	192000	0	NM	0.10%	I
8361	V03	SMAR	D	L		1	B	Q	NC	95	235	228750000	Q	R73	N		1000	1000	1000000	1000000	0	NM	0%	I
8361	V05	SMAR	SA	L		1	B	Q	NC	95	235	228750000	I	R73	N		96000	96000	96000	96000	0	NM	0.10%	I
8361	V06	SMAR	SA	L		1	B	Q	NC	95	235	228750000	I	R73	N		96000	96000	96000	96000	0	NM	0.10%	I
8361	V08	SMAR	SA	L		2	B	Q	NC	95	235	228750000	I	R73	N		500000	500000	500000	500000	0	NM	0.10%	I
8361	V11	SMAR	SI	L		1	B	Q	NC	95	235	228750000	I	R73	N	1	24000	24000	24000	192000	0	NM	0.10%	I
8361	V12	SMAR	SI	L		1	B	Q	NC	95	235	228750000	I	R73	N	1	24000	24000	24000	192000	0	NM	0.10%	I
8361	V13	SMAR	D	L		1	B	Q	NC	95	235	228750000	Q	R73	N	1	1000	1000	1000000	1000000	0	NM	0%	I
8361	V15	SMAR	SA	L		1	B	Q	NC	95	235	228750000	I	R73	N	1	96000	96000	96000	96000	0	NM	0.10%	I
8361	V16	SMAR	SA	L		1	B	Q	NC	95	235	228750000	I	R73	N	1	96000	96000	96000	96000	0	NM	0.10%	I
8361	V18	SMAR	SA	L		2	B	Q	NC	95	235	228750000	I	R73	N	1	1000000	1000000	1000000	1000000	0	NM	0.10%	I
8361	V21	SMAR	SI	L		1	B	Q	NC	95	235	228750000	I		N		24000	24000	24000	192000	0	NM	0.10%	I
8361	V22	SMAR	SI	L		1	B	Q	NC	95	235	228750000	I		N		192000	192000	192000	192000	0	NM	0.10%	I
8361	V23	SMAR	D	L		1	B	Q	NC	95	235	228750000	Q		N		1000	1000	1000000	1000000	0	NM	0.10%	I
8361	V25	SMAR	SA	L		1	B	Q	NC	95	235	228750000	I		N		96000	96000	96000	96000	0	NM	0.10%	I
8361	V26	SMAR	SA	L		1	B	Q	NC	95	235	228750000	I		N		96000	96000	96000	96000	0	NM	0.10%	I
8361	V31	SMAR	SI	L		1	B	Q	NC	95	235	228750000	I		N	1	24000	24000	24000	192000	0	NM	0.10%	I
8361	V32	SMAR	SI	L		1	B	Q	NC	95	235	228750000	I		N	1	192000	192000	192000	192000	0	NM	0.10%	I
8361	V33	SMAR	D	L		1	B	Q	NC	95	235	228750000	Q		N	1	1000	1000	1000000	1000000	0	NM	0.10%	I
8361	V35	SMAR	SA	L		1	B	Q	NC	95	235	228750000	Q		N	1	96000	96000	96000	96000	0	NM	0.10%	I
8361	V36	SMAR	SA	L		1	B	Q	NC	95	235	228750000	Q		N	1	96000	96000	96000	96000	0	NM	0.10%	I
8361	V38	SMAR	SA	L		2	B	Q	NC	95	235	228750000	Q		N	1	1000000	1000000	1000000	1000000	0	NM (I) NS (Q)	0.10%	I

Table J-3—GD Track SSCs

SSC ID (T##)	SSC Type	Tracking Configuration (Normal or Cross)	Range Tracking	Doppler Tracking (0=NotRequired, 1=1way, 2=2way)	Return Service Type	@Forward-Link Reference SSC ID	@Return-Link Reference SSC ID	@Sample Rate (1/1, 1/5, 1/10, 1/60, 1/300, sec)
T01	TRK	Normal	Yes	2	MA	A01	B01	1/10
T02	TRK	Normal		1	MA		B02	1/10
T03	TRK	Normal	Yes	2	MA	A01	B03	1/10
T04	TRK	Normal		1	MA		B04	1/10
T07	TRK	Normal	Yes	2	MA	A01	B07	1/10
T08	TRK	Normal		1	MA		B08	1/10
T11	TRK	Normal	Yes	2	SMA	U01	V01	1/10
T12	TRK	Normal		1	SMA		V02	1/10
T13	TRK	Normal	Yes	2	SMA	U01	V03	1/10
T15	TRK	Normal	Yes	2	SMA	U01	V05	1/10
T16	TRK	Normal		1	SMA		V06	1/10
T18	TRK	Normal		1	SMA		V08	1/10
T23	TRK	Normal	Yes	2	SSA	H11	I03	1/10
T24	TRK	Normal		1	SSA		I04	1/10
T25	TRK	Normal	Yes	2	SSA	H11	I05	1/10
T26	TRK	Normal		1	SSA		I06	1/10
T27	TRK	Normal	Yes	2	SSA	H11	I07	1/10
T28	TRK	Normal	Yes	2	SSA	H11	I08	1/10
T29	TRK	Normal	Yes	2	SSA	H11	I09	1/10
T30	TRK	Normal	Yes	2	SSA	H11	I10	1/10
T31	TRK	Normal	Yes	2	SSA	H03	I11	1/10
T32	TRK	Normal		1	SSA		I12	1/10
T33	TRK	Normal	Yes	2	SSA	H03	I13	1/10
T34	TRK	Normal		1	SSA		I14	1/10
T35	TRK	Normal	Yes	2	SSA	H03	I15	1/10
T36	TRK	Normal		1	SSA		I16	1/10
T51	TRK	Normal	Yes	2	SSA	H04	I11	1/10
T53	TRK	Normal	Yes	2	SSA	H04	I13	1/10
T55	TRK	Normal	Yes	2	SSA	H04	I15	1/10
T61	TRK	Normal	Yes	2	SMA	U01	V11	1/10
T62	TRK	Normal		1	SMA		V12	1/10
T63	TRK	Normal	Yes	2	SMA	U01	V13	1/10
T65	TRK	Normal	Yes	2	SMA	U01	V15	1/10
T66	TRK	Normal		1	SMA		V16	1/10
T68	TRK	Normal		1	SMA		V18	1/10
T71	TRK	Normal	Yes	2	SSA	H04	I35	1/10
T81	TRK	Normal	Yes	2	SSA	H03	I31	1/10
T82	TRK	Normal		1	SSA		I32	1/10
T83	TRK	Normal	Yes	2	SSA	H03	I33	1/10
T84	TRK	Normal		1	SSA		I34	1/10
T85	TRK	Normal	Yes	2	SSA	H03	I35	1/10
T86	TRK	Normal		1	SSA		I36	1/10
T97	TRK	Normal	Yes	2	SSA	H04	I31	1/10
T99	TRK	Normal	Yes	2	SSA	H04	I33	1/10

Table J-4—JPL Forward SSCs

SIC	SSC	Serv	Ant	UIFC	Max DR (b)	Initial DR (b)	FREQ (Hz)	PN Mod	Polar	Doppler Comp	Despun	Power
8372	A01	MAF	Open	R05	144000	18000	210640625	Y	L	Y	N	Norm
8372	U01	SMAF	Open	R05	144000	18000	210640625	Y	L	Y	N	Norm
8372	H04	SSAF	Open	R05	144000	18000	204102708	Y	L	Y	N	Norm
8372	H05	SSAF	Open	R05	144000	18000	204102708	Y	L	Y	N	High
8372	H06	SSAF	Open	R05	1538900	155346	204102708	N	L	Y	N	Norm
8372	H07	SSAF	Open	R05	1538900	155346	204102708	N	L	Y	N	High
8372	H08	SSAF	Open	R05	1538900	769450	204102708	N	L	Y	N	Norm
8372	H09	SSAF	Open	R05	1538900	769450	204102708	N	L	Y	N	High
8372	H11	SSAF	Open	R05	144000	72000	210640625	Y	L	Y	N	Norm
8372	W01	KaSF	Open	R04	6000000	6000000	2267950000	N	L	Y	N	Norm
8372	W02	KaSF	Open		12500000	12500000	2267950000	N	L	Y	N	Norm
8372	W11	KaSF	Open	R04	6000000	6000000	2267950000	N	L	N	N	Norm

Table J-5—JPL Return SSCs

SIC	SSC	Service	Data	Polar	CO	Data G	C	Mod	M	Em	EM	FREQ (Hz)	Channel	UIF	Symbol	Coding	Initial I (b)	Max I (b)	Initial Q (b)	Max Q (b)	DSI	DF	JIT	I
8372	B02	MAR	SI	L	NC					21	142	228750000	I	R74	N		24000	24000	0	0	0	NL	0%	N
8372	I08	SSAR	SI	L		1	B	Q	NC	21	142	228750000	I	R74	N		24000	24000	0	0	367	NM	0.10%	I
8372	I10	SSAR	SI	L		1	B	Q	NC	21	142	228750000	I	R74	N	1	24000	24000	0	0	367	NM	0.10%	I
8372	I12	SSAR	SI	L		1	I	B	NC	21	142	221650000	I	R74	N		24000	24000	0	0	0	NM	0%	N
8372	I14	SSAR	SI	L		2	I	B	NC	21	142	221650000	I	R74	N		192362	769450	0	0	0	NM	0%	N
8372	I16	SSAR	SI	L		1	I	B	NC	21	142	221650000	I	R74	N	1	24000	24000	0	0	0	NM	0%	N
8372	I18	SSAR	SI	L		2	I	B	NC	21	142	221650000	I	R74	N	1	192362	769450	0	0	0	NM	0%	N
8372	I20	SSAR	SI	L		2	I	B	NC	21	142	221650000	I	R74	N		769450	769450	0	0	0	NM	0%	N
8372	I22	SSAR	SI	L		2	I	B	NC	21	142	221650000	I	R74	N	1	769450	769450	0	0	0	NM	0%	N
8372	V02	SMAR	SI	L		1	I	B	NC	21	142	228750000	I	R74	N		24000	24000	0	0	0	NM	0%	N
8372	V04	SMAR	SI	L		2	I	B	C	21	142	228750000	I	R74	N		192362	769450	0	0	0	NM	0%	N
8372	V06	SMAR	SI	L		1	I	B	NC	21	142	228750000	I	R74	N	1	24000	24000	0	0	0	NM	0%	N
8372	V08	SMAR	SI	L		2	I	B	C	21	142	228750000	I	R74	N	1	192362	769450	0	0	0	NM	0%	N
8372	Y01	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R71	N	1	50000000	100000000	50000000	100000000	367	NM	0.10%	I
8372	Y02	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R71	N		50000000	100000000	50000000	100000000	0	NM	0.10%	I
8372	Y03	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R71, R73	N	1	6250000	12500000	6250000	12500000	367	NM	0.10%	I
8372	Y04	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R71, R73	N		6250000	12500000	6250000	12500000	0	NM	0.10%	I
8372	Y05	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R73	N	1	150000	300000	150000	300000	367	NM	0.10%	I
8372	Y06	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R73	N		150000	300000	150000	300000	0	NM	0.10%	I
8372	Y07	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R74	N	1	150000	300000	150000	300000	367	NM	0.10%	I
8372	Y08	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R74	N		150000	300000	150000	300000	0	NM	0.10%	I
8372	Y09	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R71	N	1	12500000	25000000	12500000	25000000	367	NM	0.10%	I
8372	Y10	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R71	N		12500000	25000000	12500000	25000000	0	NM	0.10%	I
8372	Y11	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R71	N	1	25000000	50000000	25000000	50000000	0	NM	0.10%	I
8372	Y12	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R71	N		25000000	50000000	25000000	50000000	0	NM	0.10%	I

Table J-6—JPL Track SSCs

SSC ID (T##)	SSC Type	Tracking Configuration (Normal or Cross)	Range Tracking	Doppler Tracking (0=NotRequired, 1=1way, 2=2way)	Return Service Type	@Forward-Link Reference SSC ID	@Return-Link Reference SSC ID	@Sample Rate (1/1, 1/5, 1/10, 1/60, 1/300, sec)
T02	TRK	Normal		1	MA		B02	1/10
T06	TRK	Normal		1	SMA		V04	1/10
T04	TRK	Normal		1	SMA		V02	1/10
T08	TRK	Normal		1	SMA		V06	1/10
T10	TRK	Normal		1	SMA		V08	1/10
T22	TRK	Normal		1	SSA		I12	1/10
T24	TRK	Normal		1	SSA		I14	1/10
T26	TRK	Normal		1	SSA		I16	1/10
T28	TRK	Normal		1	SSA		I18	1/10
T38	TRK	Normal		1	SSA		I08	1/10
T40	TRK	Normal		1	SSA		I10	1/10

Table J-7—HC Forward SSCs

SIC	SSC	Serv	Ant	UIFC	Max DR (b)	Initial DR (b)	FREQ (Hz)	PN Mod	Polar	Doppler Comp	Despun	Power
8373	W01	KaSF	Open	R05	6990000	6000000	2267950000	N	L	Y	N	Norm
8373	W02	KaSF	Open		12500000	12500000	2267950000	N	L	Y	N	Norm
8373	W11	KaSF	Open	R05	6000000	6000000	2267950000	N	L	N	N	Norm

Table J-8—HC Return SSCs

SIC	SSC	Service	Data	Polar	CO	Data G	C	Mod	DG1	Em	EM	FREQ (Hz)	Channel	UIF	Symbol	Coding	Initial I (b)	Max I (b)	Initial Q (b)	Max Q (b)	DSI	DF	JIT	I
8373	Y01	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R71	N	1	50000000	100000000	50000000	100000000	367	NM	0.10%	I
8373	Y02	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R71	N		50000000	100000000	50000000	100000000	0	NM	0.10%	I
8373	Y03	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R71, R74	N	1	6250000	12500000	6250000	12500000	367	NM	0.10%	I
8373	Y04	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R71, R74	N		6250000	12500000	6250000	12500000	0	NM	0.10%	I
8373	Y05	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R73	N	1	150000	300000	150000	300000	367	NM	0.10%	I
8373	Y06	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R73	N		150000	300000	150000	300000	0	NM	0.10%	I
8373	Y07	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R74	N	1	150000	300000	150000	300000	367	NM	0.10%	I
8373	Y08	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R74	N		150000	300000	150000	300000	0	NM	0.10%	I
8373	Y09	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R71	N	1	12500000	25000000	12500000	25000000	367	NM	0.10%	I
8373	Y10	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R71	N		12500000	25000000	12500000	25000000	0	NM	0.10%	I
8373	Y11	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R71	N	1	25000000	50000000	25000000	50000000	0	NM	0.10%	I
8373	Y12	KaSAR	SI	L		2	I	Q	NC	422	562	2565000000	I	R71	N		25000000	50000000	25000000	50000000	0	NM	0.10%	I

Table J-9—Key for SSC Tables

Data	Data source configuration (SI= Single Identical, D= Dual)
Polar	Polarization (R= right, L= left)
CO	MA Coherent Mode (NC= Non-Coherent, CO = Coherent)
Data G	Data group
C	Data group 1 channel configuration (I = I-channel, Q= Q-channel, I/Q = both)
Mod	DG2 modulation (B= BPSK, Q= QPSK)
DG1	DG1 Mode (NC=non-coherent, C=coherent, CNI=coherent no interleave)
Em	Minimum EIRP
EM	Maximum EIRP
freq	Transmit frequency
UIFC	User interface channel
Symbol	Symbol Format Conversion (N=no, Y= yes)
Coding	Data Coding (1, 2, or 3)
DSID	Data stream ID (Decimal)
DF	Data format (NM = NRZ-M)
JIT	Data bit jitter
I	G2 Inversion (I = inverted)