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<u>Space Communications and Navigation</u> (SCaN) Testbed Project

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

SCAN TESTBED PROJECT

DATA MANAGEMENT PLAN

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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 describes and formalizes the methods that SCaN Testbed will use to control and store the experiment configuration data, telemetry data, and received user data that is collected during experiments.

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this document is to describe the plans for the handling science and mission data by the SCaN Testbed Project. This document will describe the types of data that are collected, stored, and distributed to the science and mission operations communities.

1.2 Scope

The plans and processes described in this document apply to all SCaN Testbed Experiments and encompass the management of the science and mission data from the perspective of the GRC mission operators, Principal Investigators (PIs), and other SCaN Testbed experimenters. This data management plan describes the environment in which SCaN Testbed experiment science and mission data is collected, processed, stored, and distributed.

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 Applicable Documents

Applicable documents are those documents that form a part of this document. These documents carry the same weight as if they were stated within the body of this document.

Document Number	Applicable Document
GRC-CONN-DBK-0128	CoNNeCT System Command and Telemetry Data Book.
GRC-CONN-ICD-0427	CoNNeCT Control Center – CoNNeCT Experiment Center ICD
GRC-CONN-PLAN-0004	CoNNeCT Project Plan

2.2 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-RFICD-CoNNeCT/SN/NEN	Radio Frequency Interface Control Document Between the Communications, Navigation, and Networking re-Configurable Testbed (CoNNeCT) and the Space Network (SN) and the Near Earth Network (NEN)
450-SNUG	Space Network User's Guide (SNUG)
EX-013-H-GRC-2430	System Security Plan for the SCAN Testbed Experimental Path
EX-013-M-GRC-2429	System Security Plan for the GRC TSC Space Station Support.
GRC-CONN-DOC-0891	SCAN Testbed Front End Processor (SFEP) Users Guide
GRC-CONN-IDD-0326	SCaN Testbed Front End Processor Requirements and Interface Definition Document
GRC-CONN-OPS-0176 Vol 1	SCAN Testbed Console Handbook Volume 1: ISS Interfaces
GRC-CONN-OPS-0371	Ground Systems Description and GIU User's Manual
GRC-CONN-PLAN-001	The Software Configuration Management Plan
GRC-CONN-PLAN-0026	Operational Concept
GRC-CONN-PLAN-0133	Mission Operations Plan
GRC-CONN-PLAN-0138	Experiment Design Reference Mission
GRC-CONN-PLAN-5006	Experimenter's Handbook
GRC-CONN-SOFT-0148	Payload Flight Avionics Software Design Document
GRC-CONN-SPEC-0808	Software Defined Radio Specification (WSC SDR)
GRC-CONN-SRD-0036	Ground Systems Requirements Document
SSP 50540, Rev F	Software Interface Definition Document Broadcast Ancillary Data

2.3 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 documents used, applicable or reference, 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 SCAN TESTBED EXPERIMENT AND OPERATIONS OVERVIEW

3.1 Mission Description

The growth of Software Defined Radios (SDRs) offers NASA the opportunity to improve the way space missions develop and operate space transceivers for communications and navigation. Reconfigurable or SDRs, with communications and navigation functions implemented in software (e.g. firmware), provide the capability to change the functionality of the radio. The SCaN Testbed Project will provide an on-orbit, adaptable, SDR/STRS-based facility to conduct a suite of experiments to advance technologies, reduce risk, and enable future mission capabilities.

The SCaN Testbed Experiments Program will conduct on-orbit experiments to validate and advance the open architecture standard for SDRs called STRS; advance communication, navigation, and network technologies to mitigate specific NASA mission risks and to enable future mission capabilities. After the initial checkout to confirm that the SCAN Testbed is operating properly, communications experiments are conducted using the capabilities of the SDRs such as communications and navigation waveforms and applications. Parameters such as availability, integrity, and performance are evaluated. Networking capability is envisioned as part of the payload design.

Initial experiments are conducted by the SCaN Testbed Principal Investigators and SCaN Testbed partners, including the Glenn Research Center (GRC), the Goddard Space Flight Center (GSFC), the Jet Propulsion Lab (JPL), and the Johnson Space Center (JSC). Later, experiments will be conducted by Guest Investigators. Experimenters may provide firmware and software for the SDRs or use existing SDR capability developed and provided by other experimenters.

3.2 SCaN Testbed System Overview

The SCaN Testbed system consists of the flight system, referred to as SCAN Testbed, and ground system. The SCAN Testbed is located on the ISS as shown in Figure 3-1.

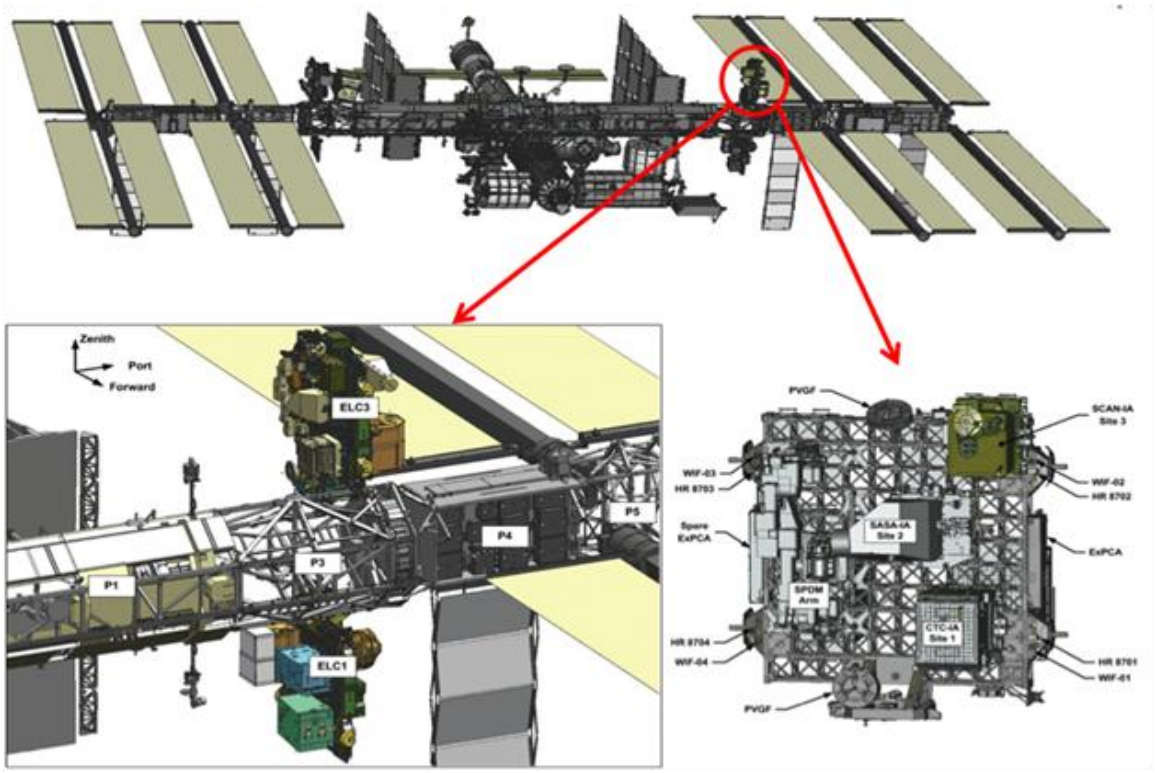


Figure 3-1—SCAN Testbed Location on the ISS

Experimenters access the SCAN Testbed through the ground system, operated by Mission Operations personnel, by exchanging data with the SCaN Testbed Control Center (STCC) which is located within the Telescience Support Center (TSC) at GRC. Experimenters operate from within the SCaN Testbed Experiment Center (STEC), which is adjacent to the STCC. Communication between SCAN Testbed and ground systems for command and telemetry occurs through established ISS paths, which is called the Primary Path. The Primary Path includes the STCC, Payload Operations Integration Center (POIC) which is part of the Huntsville Operations Support Center (HOSC) at MSFC, the NASA Space Network (SN) S-band and Ku-band services to the ISS, the ISS Multiplexer Demultiplexers (MDMs), EXPRESS Logistics Carrier (ELC) housing SCaN Testbed‘s payload, and the SCAN Testbed.

The Experimental Path, which includes the RF links used by the SDRs in SCAN Testbed, is predominantly used to transmit and receive experimental data. The SN Experimental Path includes the STCC and SN S-band and Ka-band services to the SCAN Testbed. On the Forward Link, data travels from the Experimenter equipment, to the SCAN Testbed Front End Processor (SFEP), through the TSC network, through NASA Integrated Services Network (NISN) Ground Network to White Sands (which includes either White Sands Complex (WSC) SFEP and possibly the WSC SDR) to Tracking and Data Relay Satellite System (TDRSS) and onto the SCAN Testbed. The Return Link reverses the path originating with SCAN Testbed to TDRSS to White Sands through the NISN Ground Network to the STCC SFEP and ending at the Experimenter equipment. The Near Earth Network (NEN) Experimental Path includes the STCC and NEN S-band services from Wallops to the SCAN Testbed. The Uplink starts with the GRC TSC through the NISN Ground Network to the Wallops Ground Station and onto the

SCAN Testbed. The Downlink goes from the SCAN Testbed to the Wallops Ground Station through NISN Ground Network to the GRC TSC. These data paths are shown in Figure 3-2.

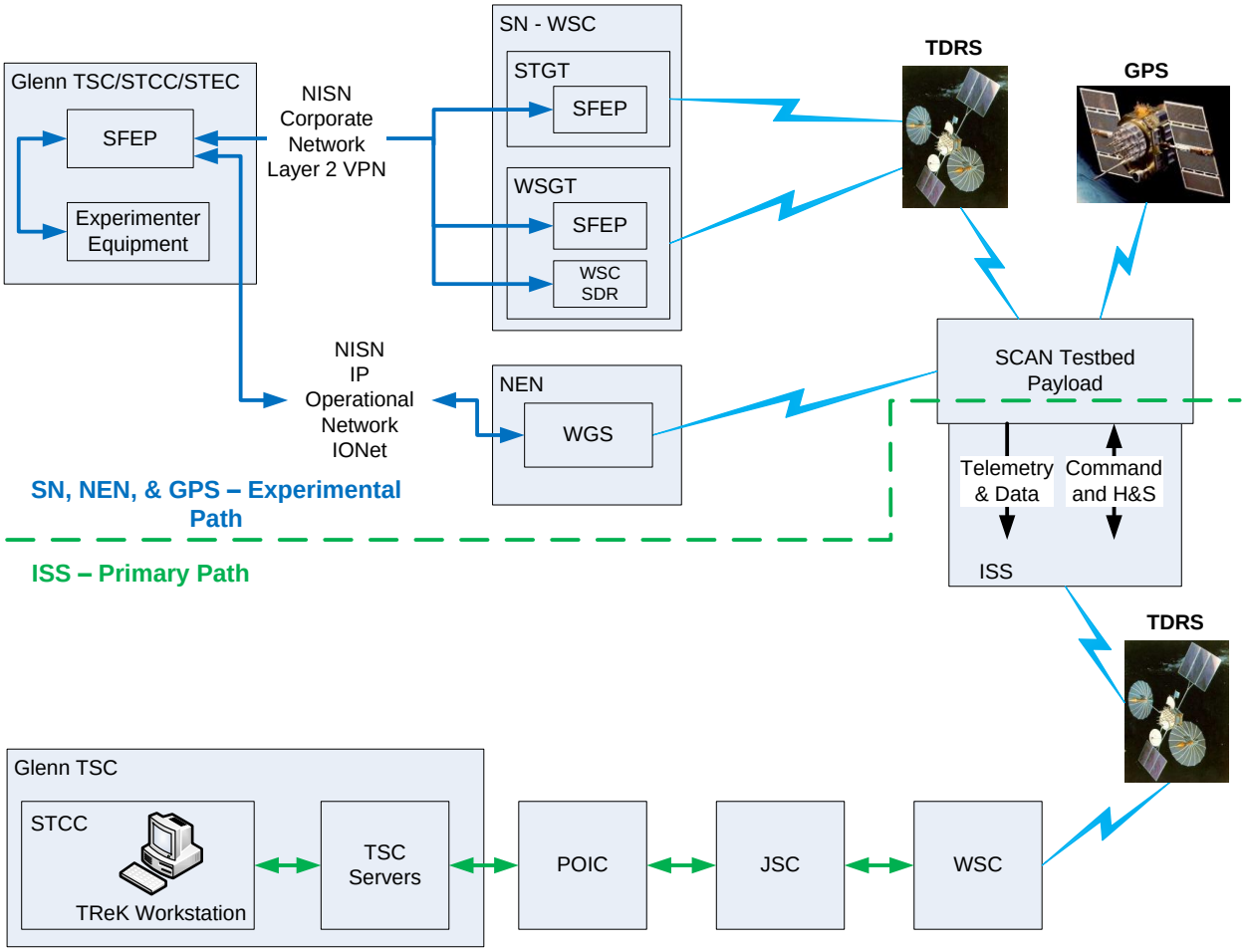


Figure 3-2—SCaN Testbed Data Paths

3.2.1 SCaN Testbed

The SCAN Testbed, which is integrated with the ExPRESS Pallet Adapter (ExPA) and installed on the ISS ExPRESS Logistics Carrier-3 (ELC3), consists of different subsystems as shown in Figure 3-3. The three SDRs were developed and provided by Jet Propulsion Lab, General Dynamics Corporation (GD) and Harris Corporation. The GD SDR is S-Band only, while JPL SDR has both S-Band and L-Band (GPS-receive only) capabilities, and Harris SDR is Ka-Band. The Avionics Subsystem controls the other subsystems and manages the connectivity to the ELC. The RF Subsystem, which includes coaxial switches, Traveling Wave Tube Amplifier (TWTA), and five antennas that provide RF signal switching, amplification, transmission and reception. The Antenna Pointing System (APS) provides movement for two antennas to point to and track TDRSS satellites.

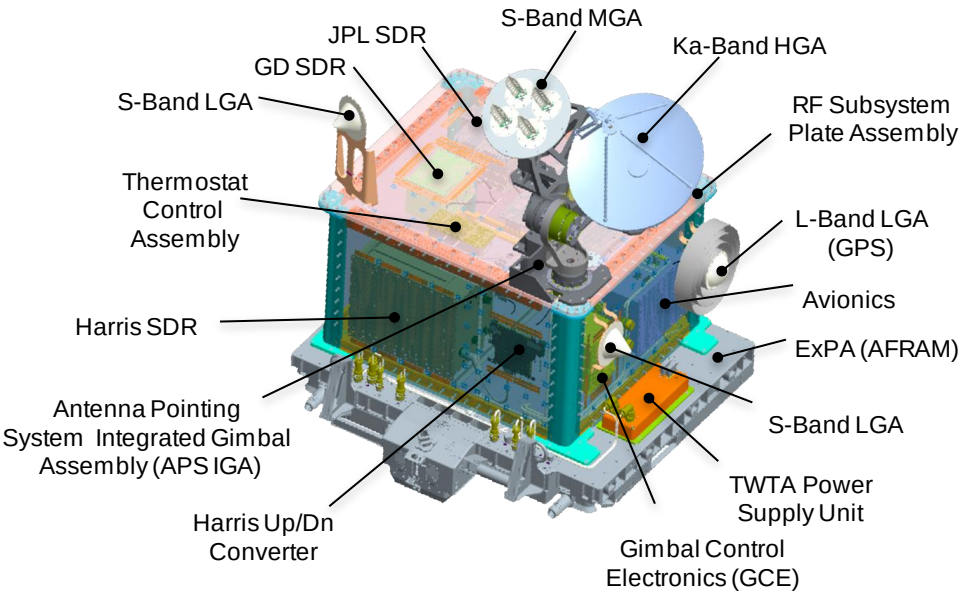


Figure 3-3—SCAN Testbed

3.2.2 SCaN Testbed Ground System

The SCaN Testbed ground system is comprised of equipment necessary to operate the SCAN Testbed, as well as develop and verify new SDR waveforms and Operating Environments (OEs), and Payload Avionics Software (PAS) upgrades.

3.2.2.1 EDS and GIUSS

The Experiment Development Systems (EDS) and Ground Integration Unit with Support Systems (GIUSS) (also referred to as the Ground Verification Facility) are used for the development and verification of new SDR waveforms and OEs, and PAS upgrades during prelaunch and flight operation phases. The GIUSS is also utilized to develop flight operating procedures, train Ground Operations personnel, and perform flight anomaly resolution. The EDS is comprised of, three Software Development Systems (SDS) with their respective TReK workstations used to develop experiments, along with breadboards of the three SDRs. The GIU, which is the main component of the GIUSS, is a ground based facsimile of the SCAN Testbed. The Support Systems include an ELC Simulator, TReK workstation for local control, TDRSS simulators (TSIMs), Test Equipment Interface (TEI) racks, and a Power Acquisition System. Details of EDS and GIUSS can be found in the *Ground Systems Description and GIU User's Manual*, GRC-CONN-OPS-0371.

3.2.2.2 GRC Telescience Support Center

The GRC TSC provides the physical space and command and communication support services for GRC led International Space Station (ISS) experiments. The TSC is located in Building 333 at GRC. Both the STCC and STEC are located within the TSC Control Room.

The TSC Server room provides space to house both Mission Operations equipment racks and an experimenter equipment rack. There are two servers located in the SCaN Testbed Mission Operation rack in the TSC Server Room, labeled CONMS and CONDB. CONMS acts as the primary server. CONDB is the backup server and mass storage device or Mission Operations Database. It is through CONMS that the data from the Primary Path is routed. CONMS then forwards (pushes) the data to the TReK workstations in the STCC and STEC for telemetry display and receives commands originating from the STCC Command TReK. CONMS also copies the data packets to CONDB for later playback, as needed. Data packets from the GIU TReK workstation, in the Building 333 high bay, are also routed through CONMS in the same manner as the flight data and subsequently copied to CONDB. Other equipment in the Mission Operations racks include the GRC SFEP with its dedicated storage server, the WSC SDR control computer, and network switches. Space is available in the Server Room for experimenters to locate one equipment rack, if needed.

3.2.2.2.1 SCaN Testbed Control Center

The STCC consists of the hardware and software required for SCaN Testbed command and telemetry processing, data display, data dissemination, and experiment and payload housekeeping. The STCC provides the interface between the SCaN Testbed and the STEC. In the STCC work area, the CoNNeCT Telemetry and Acquisition Display System (CTADS) Ground System software and NASA Telescience Resource Kit (TReK) software are used on the TReK workstations for Primary Path communication. TReK is a suite of PC-based software applications, provided by MSFC, for use by scientists and engineers to monitor and control payloads on-board the ISS. CTADS is a Graphical User Interface (GUI), developed by GRC, to interface with TReK to provide project specific telemetry displays and commanding. All Primary Path downlinked data is transmitted using a Consultative Committee for Space Data Systems (CCSDS) packet protocol. SCaN Testbed is assigned eight Application Process Identifiers (APIDs) which identifies that data contained in each telemetry packet. The APIDs are used by the HOSC to route information from ISS to the TSC.

GRC supplied computers are located within the STCC that access the GRC network and external sites. SN and NEN services are planned and scheduled by Mission Operations personnel using these computers. Satellite Tool Kit (STK) and SCaN Testbed designed software reside on one of these computers for Mission Operations personnel to create the APS program track files, with input from JSC/Mission Operations Directorate (MOD) and GSFC/Flight Dynamics Facility (FDF). Further detail on the creation of program track files can be found in section 4.4.6.1.

Located at WSC are two SFEPs, one in the White Sands Ground Terminal (WSGT) and the second in the Second TDRSS Ground Terminal (STGT), along with the WSC SDR. These components are installed at WSC but remotely configured and along with the GRC SFEP, they are operated from within the STCC.

3.2.2.2.2 SCaN Testbed Experiment Center

The STEC is the area in the TSC, adjacent to the STCC, where PIs and other experimenters will conduct their experiments. The STEC will provide the PIs and other experimenters the interface to the SCaN Testbed system, enabling these experimenters to transmit data to and receive data from each of the three SDRs. The experimenter interface to the SCaN Testbed System, through the STCC, is clock and serial data in both the forward and return directions for each radio. The STEC will allow the control and monitoring of experiments through experimenter provided hardware and software during the execution of an experiment. Investigators are able to collect science and technology data from their experiment directly, and then perform any additional post-processing analyses on their data, if desired.

The experimenters can create their own source experiment data using their own equipment and transmit it to the STCC through the experimenter interface. Depending on the SDR being utilized and the experiment goals, the experimenter equipment could apply coding, randomization (or scrambling), and framing as needed. The experiment hardware in the STEC will then transmit the data to the STCC. The experiment hardware will also receive experiment data from the STCC and the experimenter equipment will de-frame, decode, and de-randomize (or de-scramble) as appropriate, depending upon the configuration of the experiment or the SDR waveform.

A TReK workstation is provided to experimenters in the STEC, for monitoring of SCAN Testbed telemetry. Commanding capabilities are disabled on this workstation. At the time of the release of this document, the current TSC IT Security Plan does not permit experimenters to remotely conduct their experiments; they must be present in the STEC. Details of the STEC to STCC interface, as well as the STEC room layout and available equipment can be found in the *CCC to STEC ICD*, GRC-CONN-ICD-0427.

3.2.2.2.3 Ground Integration Unit Work Area

The GIU can be operated from the TReK workstation located along with the GIU in the Building 333 high bay or it can be operated remotely from the GIU work area in the TSC. There are two TReK workstations in the GIU work area, one for commanding and one for telemetry monitoring. This work area is utilized by Mission Operations personnel for the development of Mission Operations procedures, Mission Operations personnel training, flight system anomaly resolution, and for the verification runs of new or updated software to be loaded on the flight system.

3.2.3 External Systems

The Flight System and Ground System interface with the following External Systems to send and receive RF signals to and from space, and to transfer data and commands.

- HOSC/POIC – The POIC, located within MSFC's HOSC, houses the ground systems for managing the execution of on-orbit ISS payload operations including telemetry, command, voice, video, information management, data reduction, and payload planning systems.

- SN – The SN provides tracking and data relay services to customer missions. The SN is comprised of the space segment and ground segment. The space segment consists of the TDRS constellation and WSC is part of the ground segment. The SCAN Testbed will communicate with WSC ground stations via TDRS satellites using Ka-band and S-band. Full details of the TDRSS are contained in GSFC's document *Space Network Users Guide (SNUG)*, 450-SNUG.

- NEN – The SCAN Testbed can communicate directly with ground stations over S-band. SCaN Testbed will utilize Wallops Ground Stations (WGS) for NEN communication and the NISN IONet is used to route experiment data between WGS and the TSC.

3.2.4 SCaN Testbed Operations

SCaN Testbed operations nominally occur during a typical 5 day, 8 hour per day work week. To conduct experiments, multiple communication connections are used simultaneously, requiring coordination of multiple schedules, including that of the SN, NEN and ISS via the POIC. The Primary Path is available for commanding and receipt of telemetry in 30-40 minute blocks of time throughout the day. These are coordinated with SN's TDRS availability which varies from 5-45 minutes blocks. NEN coverage time is limited to approximately 5 minute blocks. For operational efficiency, file transfers to and from the testbed are conducted during weekly set file maintenance times, not daily.

4.0 DATA MANAGEMENT

Data management for the SCaN Testbed Project is the process of controlling the data flow, storage, distribution, retrieval, and archival of science and mission data associated with the SCaN Testbed tests and experiments. This section will discuss the data management phases and the types of data managed by the SCaN Testbed project and how they are created, received, and/or stored, and the methods used to enable the PIs, experimenters and Mission Operations personnel to obtain access to their science and mission data.

In accordance with NASA Policy, data that is defined by this document is open but subject to export controls and proprietary agreements. Data products not described in this document are at the discretion of the project or PIs.

Data management for the SCaN Testbed project has three general phases:

- Development and Prelaunch – The data products being managed from this phase are mostly the results of developmental and pre-launch test and verification. It includes calibration data collected on the SCAN Testbed and GIUSS, log files and test data collected during environmental and compatibility tests. During this phase, only data originating from GRC will fall under the process described in this document.

- Flight Operations – These data products are those created during flight operations after launch and before decommissioning. They include data from ground development and tests on the GIUSS, data from the SCAN Testbed, as well as data that is sent over the forward links, diagnostic information, and archival copies of software images loaded to the SCAN Testbed.

- Post Mission Archiving – Periodically during flight operations, and after flight operations are complete (currently estimated to be 2017), data is archived to a Final Archive where it is preserved indefinitely for future researchers and investigators to use.

4.1 Data Storage Locations

Data is created at and retrieved from many locations within the SCaN Testbed flight and ground systems. The data travels along different networks and at different points in the hardware paths, these networks intersect. Precautions must be taken to ensure that access to one network such as the Internet does not compromise the other networks such as NISN and the Mission Network. As part of these precautions, care is taken to ensure that the different storage servers are isolated from one another where necessary, either through the use of firewalls or by physical isolation. In some instances, this will require the manual transfer of data from one system to another. See the discussion for each category of data to find the details on where it is stored.

4.1.1 Mission Operations Data Storage Server

The Mission Operations data storage server, CONDB, is located in the SCaN Testbed Mission Operation rack in the TSC Server Room. The TReK recordings along with other data from the Flight System, as well as data from the GIUSS are copied directly from CONMS and the TReKs to CONDB. Files that are transferred to and from the Flight System, including experiment data files, are stored on CONDB. Data retrieved from the Internet such as performance data from SN and NEN are manually transferred from the GRC supplied computers to the TReK workstations to be copied to CONDB. This includes data from prelaunch and flight phases. Remote access to selected science and Mission Operations data, stored on CONDB, is provided through a secure web server as discussed in the data access and file management section of this document.

4.1.2 GRC SFEP Mass Storage Server

The SFEP Mass Storage Server is housed in the SFEP rack, located in the TSC Server Room. The raw experiment data returned using either the SN or NEN is stored here, after being copied post-pass from the WSC SFEP and WGS file server respectively. NEN data files from WGS are retrieved via the GRC computers and are manually copied to the SFEP. The data can be used to run the experiment through the GRC SFEP to the Experimenter equipment, in playback mode. Details on the operation of the SFEPs and the usage of the SFEP Mass Storage Server can be found in the *SCAN Testbed Front End Processor (SFEP) Users Guide*, GRC-CONN-DOC-0891

4.1.3 Science Data Storage

Experimenters are required to provide their own data storage system for their data. Data that the experimenter is responsible for storing: files from developmental testing at GRC or the experimenter's site, experiment generated forward link ground source data, ground processed data, and post-processed (resultant) experiment data. Methods of disseminating this data are the responsibility of the experimenter. Special provisions that the experimenter may require in the TSC to aid in dissemination of data should be addressed in the Experiment Plan as discussed in the *SCaN Testbed Experimenter's Handbook*, GRC-CONN-PLAN-5006.

4.1.4 File Repositories

All software updates to the PAS, SDR OEs or SDR Waveforms, that are uploaded to the Flight System must be stored under configuration control in the SCaN Testbed configuration management system to maintain control and integrity of the SCaN Testbed flight hardware, ISS systems and the network services.

All waveforms and OEs are submitted to the SCaN Testbed Waveform Repository and STRS Repository, both of which are maintained by GRC Communication's personnel. Details of the STRS Repository are available in *STRS Application Repository Design and Analysis Document*, STRS-SWL-00001 and *STRS Application Repository Implementation Document*, STRS-SWL-00002.

All PAS updates are kept in the SCaN Testbed Software Repository which is maintained by SCaN Testbed Sustaining Engineering. Details of the SCaN Testbed Software Repository can be found in *The Software Configuration Management Plan*, GRC-CONN-PLAN-0001.

Files created by Mission Operations personnel, such as APS tracking and configurations files, and data source files uploaded to Avionics are maintained by Mission Operations. These files are stored on CONDB.

4.2 Data Categories

File data includes any experiment or testing-related files created during the course of an experiment or test, or any special files which were created in order to enable the experiment/test to occur (e.g. FPGA bitstream files). File data may include waveform configuration files which define the configuration for the experiment including data rates, modulation type and coding; waveform configuration source code, bit files, and documentation; log files created by the SDRs or the flight avionics containing experiment results such as BER statistics; experiment software for the flight avionics (source code, documentation, and bit files); application source code; FPGA source code, etc.

Science and technology data specifically refers to all experiment-related data created, received, and/or stored by the experimenter hardware or the STCC during the course of a flight experiment, ground verification, or data acquired during pre-flight testing of SCaN Testbed SDRs and the SCaN Testbed system. This includes the experiment data whether in the raw form that is transmitted over the RF paths or the raw data that has been processed by an SDR, Avionics or experimenter equipment. To avoid confusion in the names assigned to the different types of data on the Experimental Path, figures 4-1 and 4-2 graphically depict the category names used for the data at different locations along the forward and return links. The data flow diagrams for the remaining data is shown in figure 4-3 for the Flight System and figure 4-4 for the GIU.

Mission Operations data is a sub-category of File data and refers to all data created or retrieved by the ground systems in support of flight system testing, which includes the STCC and the GIUSS. It also includes information retrieved from the flight system that is used to evaluate system performance. For files that are indicated as being downlinked from the Flight System during regular maintenance, this will occur nominally once per week.

All file uploads and downloads, via the Primary Path, to or from the SDRs or Avionics are performed by Mission Operations from the STCC Command TReK. Files that are generated by the flight system and provide insight into its operation, such as SDR logs and Avionics logs, are downloaded and stored by Mission Operations and accessible through the secure web server.

Depending upon the file size and test preparation activities, Mission Operations personnel will determine whether the files are transferred via SCaN Testbed uplink command or the ISS Payload Multiplexer Demultiplexer (PLMDM). Files that are larger than 100kb in size will require transfer to and from the Flight System through the PLMDM and must be provided to the POIC at MSFC, at least a week ahead of the experiment for processing.

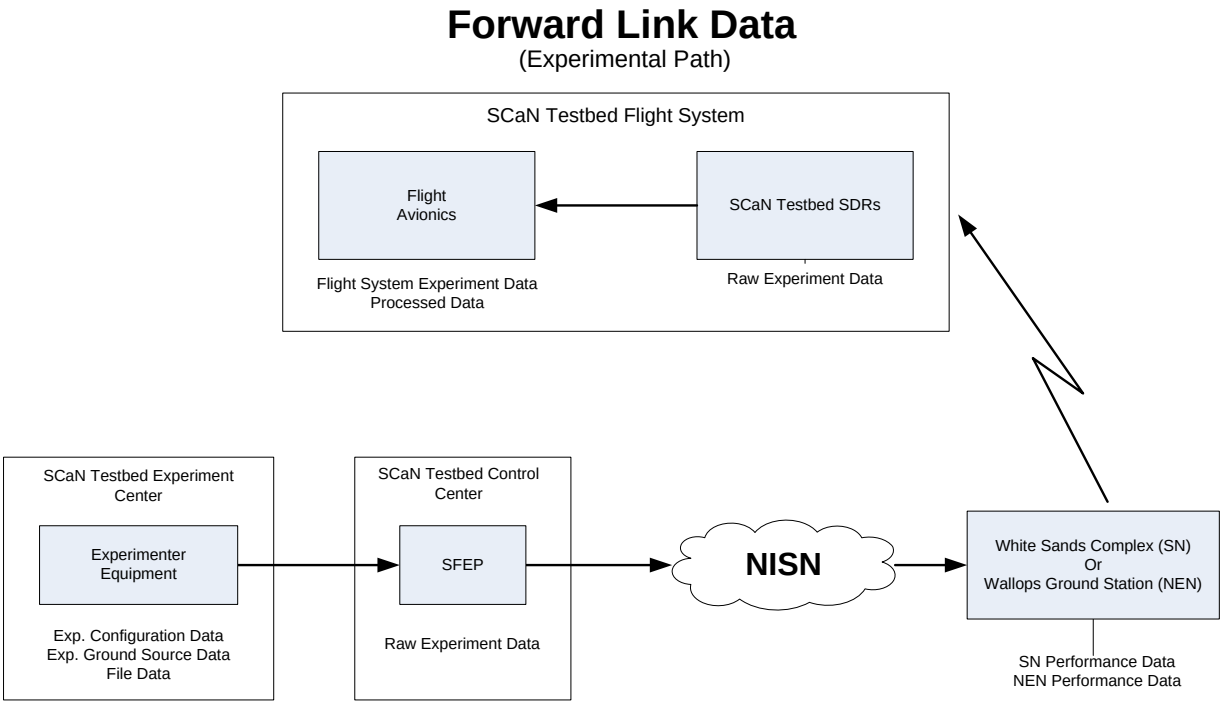


Figure 4-1—Forward Link Data Naming

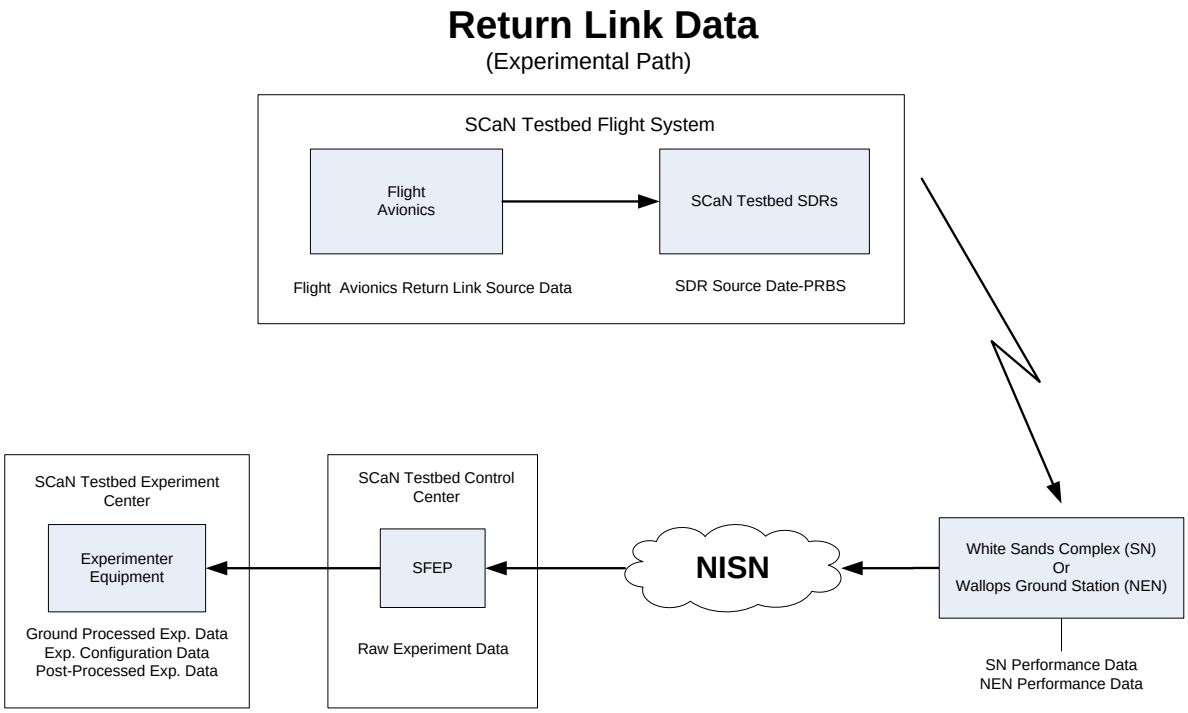


Figure 4-2—Return Link Data Naming

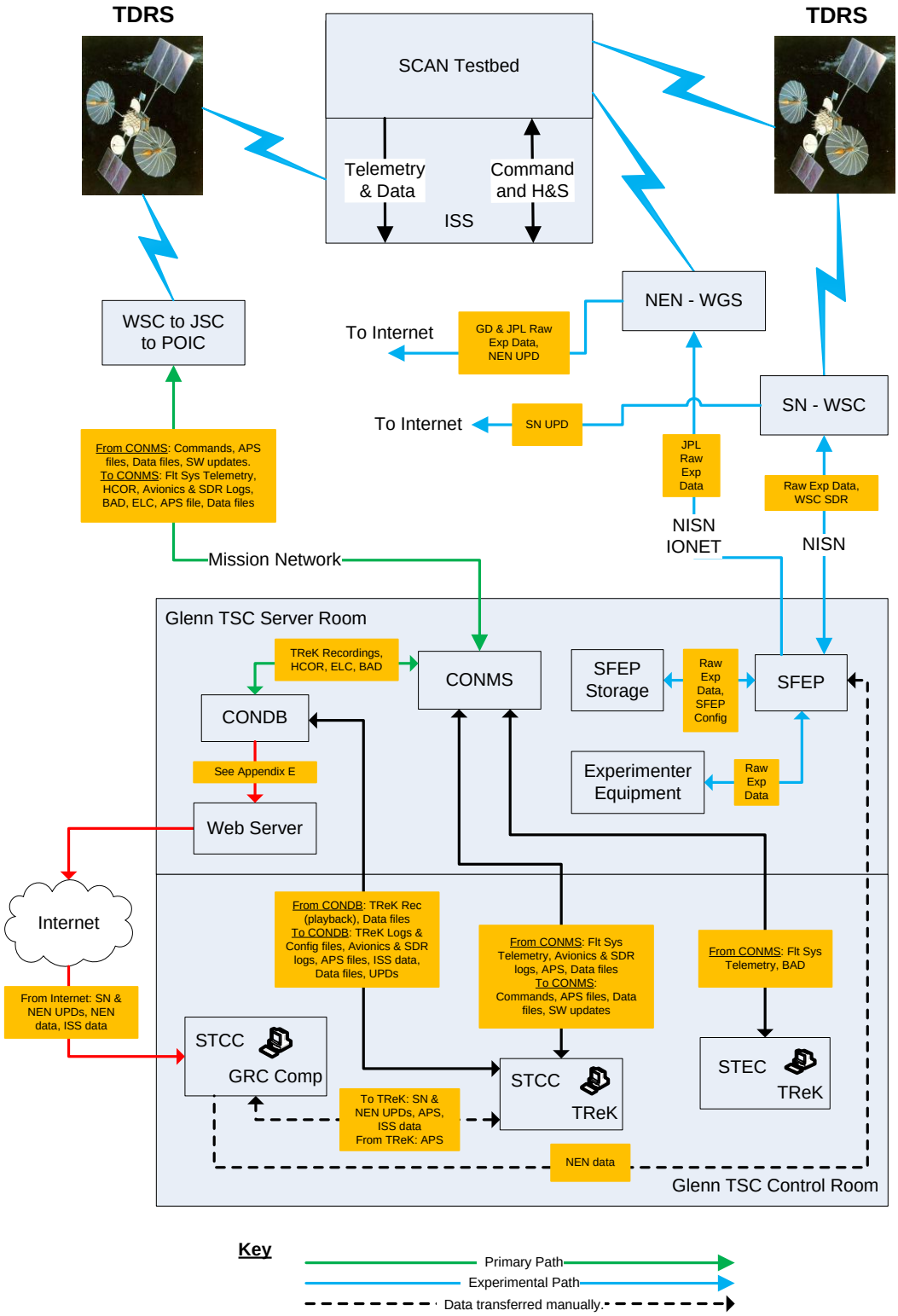


Figure 4-3—Flight System Data Flow Diagram

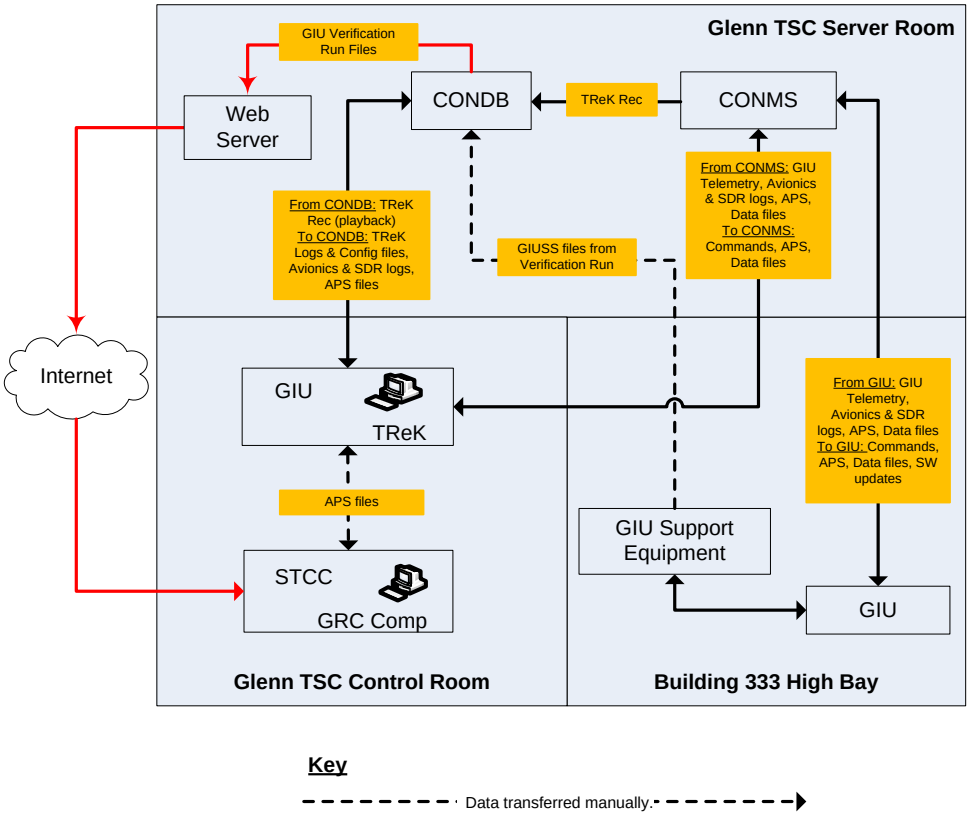


Figure 4-4—GIU Data Flow Diagram

4.2.1 Experiment Configuration Data

Configuration data is unique information about the test or experiment that is performed. Configuration data includes names and organizations of people involved; test setup (i.e. data rates, SDRs involved, waveform configuration, framing, coding, randomization, etc); identification of proprietary data; date and time; and names any files that are unique to the experiment including FPGA bit files, waveform programming files, avionics files, etc... A configuration data form is filled out for each event using the data that is found in Appendix F. These forms are stored on CONDB.

4.2.2 Experiment Data

The term experiment data in this document refers to the data transmitted and/or received over the experiment link.

4.2.2.1 Source Data

Source data is defined as any source of experiment data within the SCaN Testbed system. Forward link source data is created in the STEC by experimenter equipment. Return link data (typically transmitted by one or more of the SDRs) may be generated within the radio, by the avionics, or received from another radio (in a relay experiment). The avionics provides a way to send files to a radio and generate pseudo random data sequences. Experimenter provided PAS might also generate return link data. A waveform or application instantiated in the radio may contain a data generator or file transfer mechanism as well. Finally, in a networking experiment, return link data will have originated as forward link data transmitted from a ground station or other experimental asset.

4.2.2.1.1 Experimenter Generated Forward Link Ground Source Data

SCaN Testbed experimenters will create their own data within their special experimenter equipment and transmit it through the SCaN Testbed system. Experimenters are responsible for storing their own source data files for information (i.e. data file names, pattern, etc.) about the source data.

In the launch configuration, the SCaN Testbed system utilizes two different Pseudo-Random Binary Sequence (PRBS) data sequences, a 2^{23}-1 sequence compatible with the Harris SDR, and a $2^{11} – 1$ sequence compatible with the General Dynamics (GD) and JPL SDRs. Experimenters may wish to use these sequences in their equipment to support bit error rate testing or to simulate user data.

4.2.2.1.2 SDR Return Link Source Data

The launch waveforms of the SCaN Testbed SDRs can generate PRBS data for transmission to the ground on the return link, in test mode only. In their launch configurations, each SDR can apply coding, randomization (or scrambling), and framing to the PRBS data depending on the experiment configuration and the SDR being utilized. Contact the Experiment Liaison for the details of each SDR launch waveform.

4.2.2.1.3 Flight System Avionics Return-Link Source Data

The flight avionics subsystem is capable of generating framed and unframed pseudo-random data using the polynomials that generate the standard sequences of lengths 2^{23}-1 and $2^{11} – 1$ bits. The flight system avionics can transmit data files to the SDRs over a SpaceWire link. These experimenter generated data files are uploaded, via the STCC Command TReK, to the flight system using the ISS PLMDM. Due to their potentially large size, these data files are uploaded during a scheduled maintenance time, a minimum of 7 days in advance of the experiment pass. Since these files are uploaded by Mission Operations, they are stored on CONDB.

4.2.2.2 Received Data

Received data is defined as any experiment data that has been received after being transmitted through the SCaN Testbed experimental link. Forward-link received data is located on the flight system avionics and return-link received data is located in the ground experiment equipment.

4.2.2.2.1 Raw Experiment Data

Raw experiment data (data that has not been decoded, deframed, derandomized, etc.) is the unprocessed return-link experiment data received by the STCC over the experiment link after the NISN network overhead has been removed. Essentially this data is the same as the demodulated and decoded return-link experiment data at White Sands.

For data returned over the SN, the raw experiment data is stored temporarily in the WSC SFEP while being transmitted real-time to the experiment hardware for processing. After the pass, the copy of the raw data is transferred from the WSC SFEP directly to the STCC SFEP storage server. The data is then deleted from the WSC SFEP due to its limited storage capacity. Data processed using launch waveforms and downlinked over the NEN, is not received real-time but captured by WGS and then retrieved by Mission Operations from the WGS server, within that shift. Future waveforms, utilizing different data rates, may allow for real time downlinking through NEN.

The stored raw experiment data, transmitted over either network, can be used to rerun experiments through the SFEP in a playback configuration. The data is stored on the SFEP storage server for a minimum of 6 months. The raw experiment data will not be stored on CONDB. Raw experiment data is not accessible in the forward-link direction at the either the SDRs or the Flight Avionics.

4.2.2.2.2 Ground Processed Experiment Data

Processed experiment data is the result of changing or affecting the raw experiment data through various functions by the experimenter hardware. Processing might include bit processing, such as de-randomizing, descrambling, removing header frames, etc. Experimenters will receive their return-link data through a synchronous clock and serial data interface to the STCC SFEP (as defined in the *CCC to STEC ICD*, GRC-CONN-ICD-0427*)* for each SDR. The experimenters are responsible for ground processing of the experiment data, as well as retrieval and storage of this processed data.

4.2.2.2.3 Flight System Experiment Forward Link Data

Some experiments will want to capture data at the flight payload. The SDRs and/or the flight avionics receive the data and could perform some limited BER measurements and/or post-processing of the data, as determined by the experimenter. Files captured by Avionics are sent from the SDR over SpaceWire. SpaceWire files are limited to 2GB in size so forward link experiments using higher data rates may need to restrict their experiment run time. Due to their large size, the data files captured by Avionics are downloaded to the STCC Command TReK, using the PLMDM, during a scheduled weekly maintenance time and not directly after each pass. Files approaching the SpaceWire limit of 2 GB will take 100+ hours to download through the PLMDM at the rate shown in table 4-1. Mission Operations will store these files on CONDB and they are accessible via the secure web server.

SDR and Avionics real-time processed experiment data, including bit error rates, etc. may be included in telemetry data for both the SDR and the avionics which are transmitted to the STCC through the Primary Path.

4.2.2.2.4 Post-Processed (Resultant) Experiment Data

Post-processed experiment data, sometimes called resultant data, is information obtained from experiment data through non-real-time post-processing following the completion of the experiment. Examples of post-processed data are BER curves, networking statistics, error locations, burst error patterns, frame statistics, lost/added bits, etc. Resultant data does not include the actual received experiment data or telemetry data, but it does include the results of analyses performed on the received experiment data or the results after extracting specific information from the telemetry data. Collection and storage of resultant data is solely the responsibility of the experimenter.

4.2.3 Flight System Software Updates

Occasionally the PAS is updated to add features and resolve payload issues. Also, experimenters may require modifications to the PAS, new or updated OEs, and new or updated waveforms. Files to be uploaded to the flight system are thoroughly tested on the GIUSS. PAS updates are submitted into the SCaN Testbed Software Repository. OEs and waveforms are submitted to the SCaN Testbed Waveform Repository and STRS Repository. File transfer of software updates are coordinated with the POIC during maintenance time and performed from the STCC Command TReK. Experimenters should reference *The Software Configuration Management Plan*, GRC-CONN-PLAN-0001for access to the SCaN Testbed Software Repository.

4.2.4 Flight System Telemetry Data

Telemetry information generated by the SDRs, flight avionics, and the antenna/gimbal are gathered by the PAS and sent to the STCC through the Primary Path. This data is displayed on TReK workstations both in the STEC and STCC. A partial set of the telemetry items can be displayed on the TReK workstation, in predesigned displays for each subsystem. Another option for viewing telemetry is the “Ad Hoc” displays with which the experimenters can customize the telemetry they view, for each subsystem. Log files can be created from the Ad Hoc screens and are saved to the TReK workstation. Mission Operations personnel will not be normally logging telemetry using the Ad Hoc displays in the STCC. Experimenters can log telemetry of interest using Ad Hoc displays on the STEC TReK workstation. These log files are transferred to CONDB where they are accessible through the secure web server. A limited number of telemetry items are viewable “near” real-time via the secure web server.

The available telemetry data is defined in *CoNNeCT System Command and Telemetry Data Book*, GRC-CONN-DBK-0128.

4.2.5 External System Data

Data is collected from the external systems associated with the SCAN Testbed on-orbit operations. External systems that interface to the SCAN TESTBED flight system or ground system includes TDRSS, WSC, ISS, and WGS.

4.2.5.1 Space Network Performance Data

As part of the SN Experimental path performance assessment, Mission Operations will request User Performance Data (UPD), by way of the Space Network Access System (SNAS). The UPDs provide information about the SN's forward and return link configurations, the state of the service event, and the SN-perceived performance of the return link. Post pass result files are not critical for SCaN Testbed Flight System health and status but are necessary for experiment success determination. The files are copied from the GRC computers in the STCC work area and transferred to CONDB where they are accessible through the secure web server. Examples of SN UPDs can be found in Appendix C.

4.2.5.2 Near Earth Network Performance Data

The NEN post pass data statistics are provided for Experimental path operations. The WGS will provide post pass data statistics approximately 10 minutes (via email to the Mission Operations Team) after Loss Of Signal (LOS). The files are copied from the GRC computers in the STCC work area and transferred to CONDB where they are accessible through the secure web server. The template for the NEN UPD can be found in Appendix D.

4.2.5.3 Broadcast Ancillary Data (BAD)

BAD provides the means to distribute cyclic data from various components of the ISS. This data is repeated every 10 seconds. A user selected set of BAD telemetry is viewed real-time at the STCC and STEC TReK workstations using configurable displays provided by the Enhanced HOSC System (EHS) PC (EPC). Mission Operations will require state vector, attitude and attitude rate data from BAD prior to on-orbit operations to generate the APS track file. The Mission Operations data is brought into the STCC TReK using a GSE packet. This is automatically stored on CONDB and is accessible through the secure web server.

Experimenters may configure EPC displays to display BAD telemetry from the STEC TReK workstation. The list of data available is found in the *Software Interface Definition Document Broadcast Ancillary Data*, SSP 50540 Rev F. The experimenter can retrieve their BAD telemetry (post pass) from the EPC using the STEC TReK workstation and copy it to removable media for storage on their mass storage devices. Instructions to access the EPC and display and retrieve the BAD telemetry on the STEC TReK workstation can be obtained from the Experiment Liaison.

4.2.5.4 ISS Data

ISS and GSFC FDF data is utilized to generate APS track files used for pointing of the medium-gain and high-gain antennas. ISS Attitude Timelines (ATLs) are provided by the Attitude Determination and Control Office (ADCO) and trajectory ephemerides from the Trajectory Operations Office (TOPO). Both offices are part of the MOD at JSC. ISS (Soyuz & ISS only) and TDRS initial Two Line Elements (TLEs) or J2K position and velocity vectors with corresponding GMT timestamp are received from the FDF.

The initial vectors (TLE or J2K) are used to initialize the orbit prediction analysis for a specified time frame (around the epoch time). In the case of a J2K vector, the epoch time is required for the initialization. The TLE has, embedded in it, the epoch time. The ATL will define the yaw-pitch-roll sequenced angles which are used to transform the return link vector from the Local Vertical/Local Horizontal (LVLH) coordinates to the specific flight attitude at hand. This is required to compute the final Azimuth-Elevation look angles used by the APS.

These files are stored on CONDB and are accessible through the secure web server.

4.2.5.5 WSC SDR Data

The WSC SDR is designed to provide a generic signal processing capability to SCaN Testbed experiments to facilitate waveform implementation beyond TDRSS legacy waveforms. This SDR is integrated into the WSC but controlled and monitored from the STCC, using the WSC SDR control computer that will reside in the SFEP rack in the TSC server room. Details on the WSC SDR can be found in *Software Defined Radio Specification (WSC SDR)*, GRC-CONN-SPEC-0808. Data to be retrieved from the WSC SDR is <TBD 04-01>.

4.2.6 Networking Data

Data networking experiments may be performed to investigate Delay/Disruptive Tolerant Networking (DTN) protocols and on-board routing. Network data is science and technology data associated with these networking experiments. This networking data may include network statistics, waveform configurations, frame information, packet statistics, etc.

4.2.7 Mission Operations Data

Mission Operations data refers to all data created or retrieved by the ground systems in support of flight system testing, which includes the STCC and the GIUSS. It also includes information retrieved from the flight system that is used to evaluate system performance. For files that are indicated as being downlinked from the Flight System during regular maintenance, this will occur nominally once per week. The discussion for each type of data will indicate whether the data is collected for on-orbit and/or prelaunch operations.

4.2.7.1 TReK Recordings

The Mission Operations server CONMS is set up to copy the data packets received from the flight system and the GIUSS directly to CONDB, as TReK Recordings, during the flight operation phase. The Recordings can be played back through the TReK workstation to rerun an experiment. Instructions for how to play back TReK Recordings are found in the *SCAN Testbed Console Handbook Volume I: ISS Interfaces*, GRC-CONN-OPS-0176. The TReK recordings from both the flight system and GIUSS, for all development and prelaunch phase activities are also stored on CONDB. The TReK Recordings are available through the secure web server for experimenters that have their own CTADS equivalent. GRC Ground Software personnel are only responsible for maintaining CTADS on the TReK Workstations located at GRC.

4.2.7.2 ELC Telemetry

The ELC telemetry includes the 6 RTDs mounted to the SCaN Testbed baseplate and the ELC3 power and current measurements. The RTDs will verify proper operation of the contingency heaters when the SCAN Testbed is not powered. The ELC telemetry is constantly monitored by the Payload Rack Officer (PRO) at the POIC. Mission Operations will view the display created by the PRO to monitor the ELC telemetry. ELC data is brought into the STCC TReK using the same GSE packet that is used for the BAD telemetry. This data is monitored only for on-orbit operations of the flight system. This data is stored on CONDB and accessible through the web server.

4.2.7.3 TReK Logs and Configuration Files

The Command TReK will create the following log files whenever avionics is powered: CTADS_Connect_Config.log, CmdLog.csv, ErrorStrings.txt, SquawkMessages.txt, and CTADSAppLog.txt. They are useful for troubleshooting. These files from both the flight system and GIUSS, for all operational phases, are copied to CONDB and accessible through the secure web server.

4.2.7.4 Avionics Log Files

Avionics log files are created whenever avionics is operational. The logs contain software messages that are useful for troubleshooting/debugging system issues. These files are downlinked from avionics memory during weekly maintenance, using the Command TReK for both the flight system and GIUSS, and copied directly to CONDB. These files are saved for all phases of operation, and are accessible through the secure web server.

4.2.7.5 SDR Log Files

SDR log files are created by each of the radios when powered. The log files contain SDR telemetry, error messages, warnings, etc. These log files are moved to avionics at the end of each shift when deemed necessary by the experimenter. Those files that have been saved are then downlinked from avionics memory during weekly maintenance, using the Command TReK for both the flight system and GIUSS, and copied directly to CONDB. These files are saved for all phases of operation, and are accessible through the secure web server.

4.2.7.6 Antenna Pointing System Files

4.2.7.6.1 APS Uploads

The APS utilizes two files, created by Mission Operation's personnel, for tracking. They are the ASCII (TXT) angle command files created using the SCaN Testbed orbit analysis tool. This tool will initially be Satellite Tool Kit (STK) but will evolve to an embedded SGP4 propagator of equal fidelity. The ASCII (TXT) angle command files output from the orbit analysis tool are then converted, using the LynxCAT SK Toolbox, into the binary TRK files. Thus Configuration Management requires that both the basis file (TXT) and converted file (TRK) be saved for reference. In addition, the LynxCAT SK Toolbox software is used to generate the XML configuration file. These files are created on one of the GRC supplied computers in the STCC workarea, for both flight system and GIUSS operations.

The files are copied to the STCC or GIUSS Command TReK and uplinked to the flight system or GIUSS avionics utilizing the File Uplink functions under File Operations. For flight operations, the TRK files and XML configuration files can be uplinked nominally 5 days ahead of the pass in which they are used; however, in some cases, they may be refreshed before the time of the pass if tracking conditions require this. Mission Operations is responsible for maintaining control of the TRK and XML files. The files are copied to CONDB and accessible through the secure web server.

4.2.7.6.2 APS Downloads

The LYX file is created by Avionics and is a recorded history of the APS at each integration step when the TRK file is being executed. The files are typically 8 to 17MB in size; the size is directly proportional to the user defined output rate. The files can be downlinked using the File Downlink functions under File Operations. For both the flight system and GIUSS, during prelaunch and flight operations phases, they are copied to CONDB and accessible through the secure web server.

4.2.7.7 SFEP Configuration Files

Each SFEP is reconfigured for each pass depending on which SDRs are operating, their data rates and whether the SN or NEN is being used. Since there are many variables to set for each configuration it is wise to save the configurations. These configuration files are saved directly to the SFEP. The details on how to configure the SFEPs and the configuration file management can be found in the *SCAN Testbed Front End Processor (SFEP) Users Guide*, GRC-CONN-DOC-0891. A notation is made on the configuration data sheet for each experiment to indicate the SFEP configuration utilized.

4.2.7.8 HCOR Data Recordings

ISS Payloads experience loss of telemetry due to ISS Ku-Band LOS throughout each operating shift. During this time, primary path data is stored on the ISS High Rate Communications Outage Recorder (HCOR). After one or more LOS periods, the POIC "dumps" the telemetry stored on HCOR, to the STCC. An application on the SCaN Testbed server receives the dumped telemetry and blends it with the telemetry received real-time and they are then stored, in proper sequence, in the TReK Recordings on CONDB. The recordings can be played back through CTADS, to allow viewing of the data received from the HCOR dump. GSE packets which include the BAD and ELC data are not included in the HCOR data recordings.

4.2.8 EDS Data

Retrieval and storage of data created on any EDS component, during developmental, prelaunch or flight operation phases, is the responsibility of the experimenter.

4.2.9 GIUSS Equipment Data

Data from the GIUSS TSIMs, TEI equipment, Power Acquisition System, GIU front end processor and Avionics GSE computer is copied from each of these systems daily to a storage server located within GRC Building 333 high bay. Files include raw experiment data, TSIM configuration files, Data Acquisition System files, Power Acquisition System files and Avionics GSE Terminal Logs. Mission Operations personnel copy support equipment data for the Mission Operation conducted verification, tests, to store on CONDB. These files are accessible through the secure web server. Experimenters are responsible for retrieval and storage of the support equipment data from their developmental testing. For details on how to access data from the GIU support equipment, consult with the Experiment Liaison.

4.3 Data Access and File Management

Data access is required by SCaN Testbed personnel and experimenters for system monitoring, troubleshooting, analysis, performance comparison, file retrieval, etc… The SCaN Testbed File Management Table in Appendix E outlines where SCaN Testbed files are stored and their accessibility. The table indicates which files are available remotely from CONDB, through the secure web server. Limited sets of data are viewable “near real-time”.

4.3.1 Web Server Access to CONDB

The SCaN Testbed Web Server will provide secure, read-only connections to experimenters and SCaN Testbed project personnel for access to files on the Mission Operations server CONDB. Directories on CONDB are shared to a Linux web server in the TSC. This server supports Secure Shell File Transfer Protocol (SFTP) which is accessible via manual and automated downloads.

Files are stored on CONDB in either “public” or “private” folders. All users granted access to the web server are permitted to view data in the public folders. For the private folders, data access is limited to only the folders that each user is permitted to view as detailed in each experimenter’s Experiment Plan. The files are available through the web server once copied to CONDB and are stored on CONDB for a minimum of 6 months. Prior to removal from CONDB, the files are archived. Instructions on how to access data through the secure web server can be obtained from the Experiment Liaison.

4.3.2 Near Real-Time Data

Telemetry from Avionics and the subsystems is available to experimenters and SCaN Testbed personnel for near real-time viewing using server secure web site. The ground system in the TSC server room deposits the telemetry into a database and then the web server uses scripts and web tools to retrieve and display the telemetry. These readings are available approximately 5 seconds after the TSC acquires them and are updated every 10 seconds.

For easier viewing, the limited list of telemetry from the CoNNeCT Command, Engineering & Science Database is available. Should an experimenter find it necessary to view telemetry near real-time beyond what is listed, they need to make provisions through their Experiment Plan.

4.3.3 SFEP Data

The only data files stored on the SFEP system are the Raw Experiment Data and the SFEP Configuration Files. Mission Operations personnel are the only ones that utilize the SFEP Configuration Files. The Raw Experiment Data is stored on the SFEP mass storage server for a minimum of 6 months and is available for playback to the experimenter equipment.

4.3.4 Science Data

Each experimenter is responsible for storage and dissemination of Science data which includes Configuration Data, Experimenter Generated Forward link Source Data, Flight Avionics Return Link Source Data, Ground Processed Experiment Data, and Post Processed (Resultant) Experiment Data.

4.3.5 Data Archiving

CONDB is backed up approximately once per month to DLT4 archival tapes that are stored at an off-site location. Archival tapes are store for a minimum of 10 years starting at the time of on-orbit checkout of SCAN Testbed.

4.3.6 File Maintenance

Regular file clean up is necessary to prevent failures due to unavailability of sufficient file storage space. This applies to Harris and Avionics memory for both the Flight System and GIUSS and also SFEP storage.

4.3.6.1 Avionics File Maintenance

Periodic file maintenance is required for Avionics flash memory in /ffx0, /ffx1, /cffs2, and /cffs3. Checks are made during regularly scheduled weekly file maintenance times. Each memory location is 16GB in size and when a memory location is above 50 % full, a file cleanup procedure is performed. To alleviate memory storage capacity issues, Avionics log files, SDR log files and APS LYX files are downloaded on a weekly schedule.

4.3.6.2 Harris File Maintenance

During the Harris nominal startup procedure, a check is made on whether either of the two Harris flash file locations (Log A, Log B) are full. This can be seen with the “Error Log State” telemetry item on the Harris Nominal Operations Display in CTADs. At that time, if either log is full, a script is run to remove the files from the log and place them in a location on Avionics where they can then be downloaded to the STCC.

4.3.6.3 GD File Maintenance

GD stores its log files in volatile memory so they are deleted when the radio is powered off. The OE, WF and configuration files are written to the EEPROM but no temporary files are written there with the launch waveforms so, maintenance is not necessary. Once new waveforms are loaded on GD, this may require reassessment.

4.3.6.4 JPL File Maintenance

JPL also stores its log files in volatile memory so, as with GD, they are deleted when it is powered off. There are 64 memory stripes used to store the OE, waveforms and FPGA images. At launch time there is no need to monitor this, however as future experimenters upload custom waveforms, memory management will become important.

4.3.7 File Transfers

Primary Path file transfers between the ground and Flight System Avionics can be accomplished by two different methods. The first being through the PLMDM and the second is with the use of File Uplink/Downlink commands. The method used is determined by the file size and 100 kB is the breaking point. For files 100 kB and smaller, these files are uplinked through the File Manager during scheduled weekly file maintenance times with the exception of APS files that may need to be generated closer to experiment time.

Files that are larger than 100 kB are transferred up/down through the PLMDM which requires planning and a lead time of at least a week to schedule the transfer with the POIC. Files larger than 8 MB must be divided into blocks that are 8 MB or smaller and then these smaller blocks are concatenated in Avionics or on the ground, due to PLMDM file length limitations. The file transfer rate to/from the PLMDM is approximately 5kB/sec. So larger files such as Flight System Return Link Source Data files or Flight System Experiment Data files on Avionics could be GBs in size and will take days to download through the PLMDM.

Each SDR then has its own specific commands that are used to pass files between Avionics and the SDR. Table 4-1 shows the various transfer paths and the data rates they can accommodate and any limitations. This does not take into account possible ISS/ELC limitations that may reduce the stated transfer rate.

Table 4-1—File Transfer Rates

	Data Rate	Comment
To Avionics		
- Retrieve File from PLMDM	~5 kB/sec	PLMDM file length limit: 8 MB
- File Uplink	~100 bytes/sec	Ops file length limit: 100 kB
From Avionics		
- Send File to PLMDM	~5 kB/sec	PLMDM file length limit: 8 MB
- File Downlink (Ethernet)	~260 kB/sec	Ops limit of 200 packets/sec.
- File Downlink (LRT Squawk)	~100 bytes/sec	None
Avionics to GD SDR	~10 kB/sec in STRS mode, 7 kB/sec in OE w/o WF running, 2 kB/sec in OE w/ WF running	RamDisk = 4 MB, STRS OE = 1.5 MB, STRS OE Config = 10.2 kB, Xilinx Image = 1.5 MB, App1 Load Module = 486 kB, App1 Config = 41 kB, App2 Load Module = 486 kB, App2 Config = 41 kB, User Defined File = 57 kB.
GD SDR to Avionics	~10 kB/sec in STRS mode, 7 kB/sec in OE w/o WF running, 2 kB/sec in OE w/ WF running	None
Avionics to JPL SDR, BCSW Mode	~3.3 kB/sec	RamDisk files: Undefined, disk grows as needed up to max memory utilization (128 MB) Flash files: 8 MB/stripe, 64 stripes total, one file/stripe
Avionics to JPL SDR, OE Mode	~1.7 kB/sec	RamDisk files: Undefined, disk grows as needed up to max memory utilization (128 MB) Flash files: 8 MB/stripe, 64 stripes total, one file/stripe
JPL SDR to Avionics, BCSW Mode	~3.8 kB/sec	None
JPL SDR to Avionics, OE Mode	~2.9 kB/sec	None
Avionics to/from Harris SDR	~2 MB/sec	None, but Harris only has 32 MB of diskspace.

4.3.8 IT Security

The SCaN Testbed experiment data paths are covered by 2 security plans. The data travelling along the Primary Path are covered by the *System Security Plan for the GRC TSC Space Station Support*, EX-013-M-GRC-2429. For data transmitted along the Experimental Path see the *System Security Plan for the CoNNeCT Project*, EX-013-H-GRC-2430.

5.0 RIGHTS AND RESPONSIBILITIES

5.1 Data Rights and Release Policy

All experimenters are required to share their raw and processed data and their results with the SCaN Testbed Experiment Board, through the control of the SCaN Testbed Project PI. In general, all experimenters are highly encouraged to share their data and results with the SCaN Testbed experimenter community in an effort to fully characterize and understand the SCaN Testbed SDR performance, particularly if NASA is funding the experiment.

5.2 Responsibilites

5.2.1 SCaN Testbed Project Responsibilities

The SCaN Testbed Mission Operations is responsible for storing, controlling, and archiving the types of science and mission data as indicated in the SCaN Testbed File Management Table in Appendix E.

5.2.2 Experimenter Responsibilities

Each experimenter is responsible for storing, controlling, and archiving their science data that is not listed above in section 5.2.1. These data types may include source data, SDR source file data, flight avionics source data, processed experiment data, post-processed experiment data, file data (e.g. experiment equipment FPGA firmware files, processing software files, etc.), networking data, resultant data, and experiment configuration data.

5.3 Waveform Repository

The SCaN Testbed will maintain a repository of all SCaN Testbed waveforms used during the course of the experiment phase of the project. All waveforms must be tested and verified on the GUISS before they can be loaded onto the flight system. Experimenters are required to submit their final (verification run) waveform files to the SCaN Testbed Waveform Repository. This repository will maintain all verified waveforms for the life of the project.

All verification run waveforms must be submitted by the experimenter to the STRS Repository, as well as to the SCaN Testbed Waveform Repository. Experimenters are able to utilize any SCaN Testbed waveform submitted to the STRS Repository for their own experiments. Details of the STRS Repository are available in *STRS Application Repository Design and Analysis Document*, STRS-SWL-00001 and *STRS Application Repository Implementation Document*, STRS-SWL-00002.

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

ADCO	Attitude Determination and Control Office
APID	Application Process Identifier
APS	Antenna Pointing System
ATL	Attitude Timeline
BER	Bit Error Rate
CCSDS	Consultative Committee for Space Data Systems
CoNNeCT	Communications, Navigation, and Networking reConfigurable Testbed
COTS	Commercial Off The Shelf
CTADS	CoNNeCT Telemetry and Acquisition Display System
DAS	Data Acquisition System
DTN	Delay/Disruptive Tolerant Network
ECPC	Experiment Control and Processing Computer
EHS	Enhanced HOSC System
ELC	ExPRESS Logistics Carrier
ExPA	ExPRESS Pallet Adapter
FDF	Flight Dynamics Facility (at GSFC)
FEP	Front End Processor
FPGA	Field Programmable Gate Array
FTP	File Transfer Protocol
GD	General Dynamics
GPS	Global Positioning System
GSFC	Goddard Space Flight Center
GIUSS	Ground Integration Unit and Supporting Systems
GRC	Glenn Research Center
GUI	Graphical User Interface
GVF	Ground Verification Facility
HCOR	High rate Communication Outage Recorder
HOSC	Huntsville Operations Support Center
ISS	International Space Station
ITOS	Integrated Test and Operations System
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
LOS	Loss Of Signal
LVLH	Local Vertical/Local Horizontal
LynxCAT	Closed loop feedback command and control system employed to direct the motion on SCaN Testbed APS
LYX	LynxCAT State matrix file format
MDM	Multiplexer Demultiplexer
MOD	Mission Operations Directorate (at JSC)
MSFC	Marshall Space Flight Center

NASA	National Aeronautics and Space Administration
NEN	Near Earth Network
NISN	NASA Integrated Services Network
OE	Operating Environment
PAS	Payload Avionics Software
PI	Principal Investigator
PLMDM	Payload Multiplexer Demultiplexer
POIC	Payload Operations Integration Center
PRBS	Pseudo-Random Binary Sequence
PRO	Payload Rack Officer
SARG	Space Assurance and Requirements Guideline
SBU	Sensitive But Unclassified
SCAN	Space Communications and Navigation
SDR	Software Defined Radio
SDS	Software Development System
SFEP	SCAN Testbed Front End Processor
SFTP	Secure Shell (SSH) File Transfer Protocol
SNAS	Space Network Access System
STCC	SCaN Testbed Control Center
STEC	SCaN Testbed Experiment Center
STGT	Second TDRSS Ground Terminal
STRS	Space Telecommunications Radio System
TBD	To Be Determined
TBR	To Be Resolved
TCP/IP	Transmission Control Protocol/Internet Protocol
TDRSS	Tracking Data Relay Satellite System
TLE	Two Line Element
TOPO	Trajectory Operations Office
TReK	Telescience Resource Kit Software
TRK	Track file specifying open loop command motion
TSC	Telescience Support Center
UPD	User Performance Data
VCN	Verification Completion Notice
WGS	Wallops Ground Station
WSC	White Sands Complex
WSGT	White Sands Ground Terminal

APPENDIX B TBDs AND TBRs

B.1 Scope

This appendix lists all items in this document that need to be determined (TBD) and that need to be resolved (TBR).

B.2 List of TBDs

Table B-1—TBDs

TBD Number	Description	Section	Resolution Plan
TBD 04-01	Data management details for WSC SDR data.	4.2.5.5	To be resolved during WSC SDR commissioning.

B.3 List of TBRs

Table B-2—TBRs

TBR Number	Description	Document Paragraph
	NONE	

APPENDIX C EXAMPLE OF SN UPDs

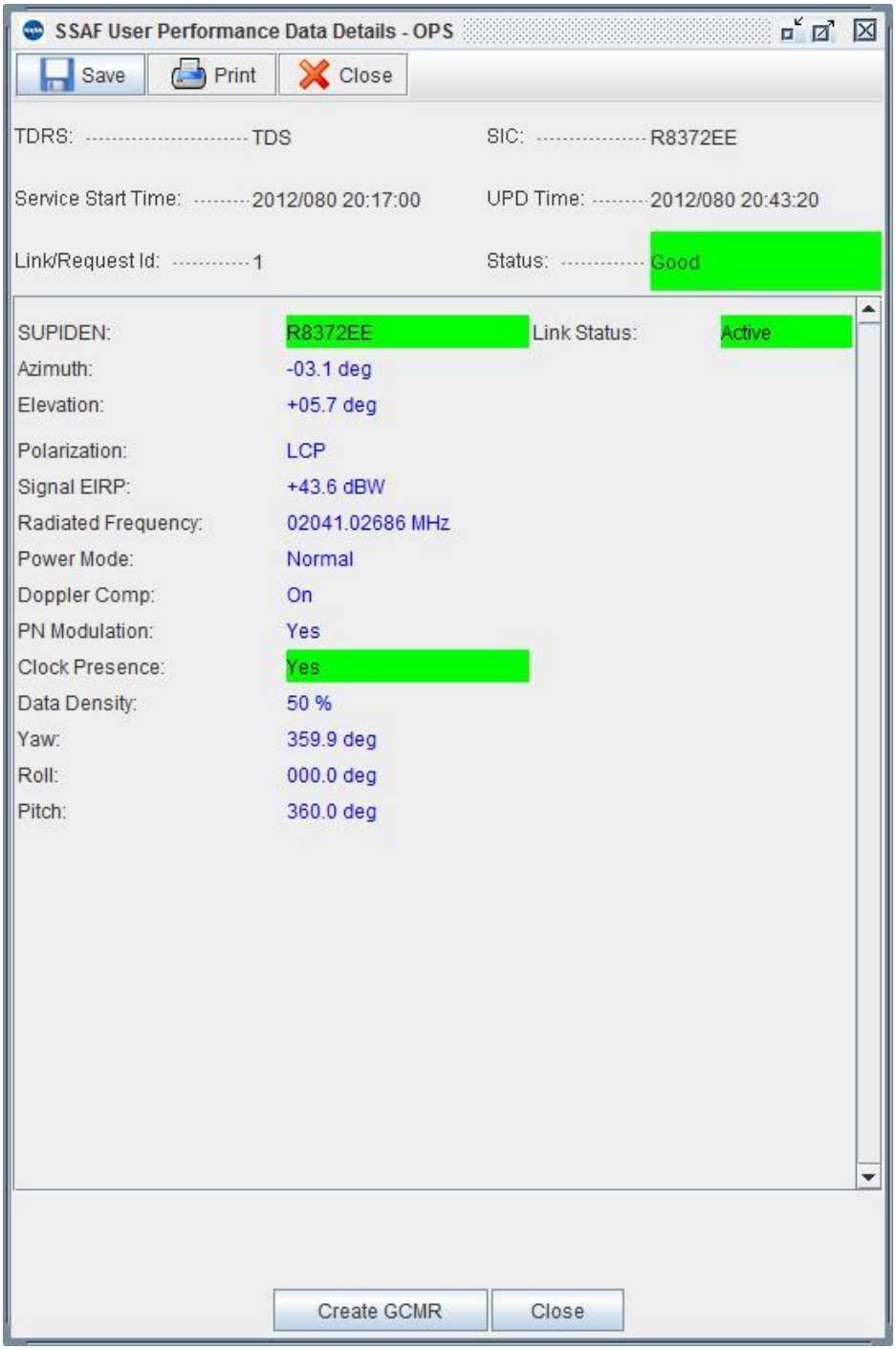


Figure C-1—SN UPD, S-band, Single Access, Forward Link

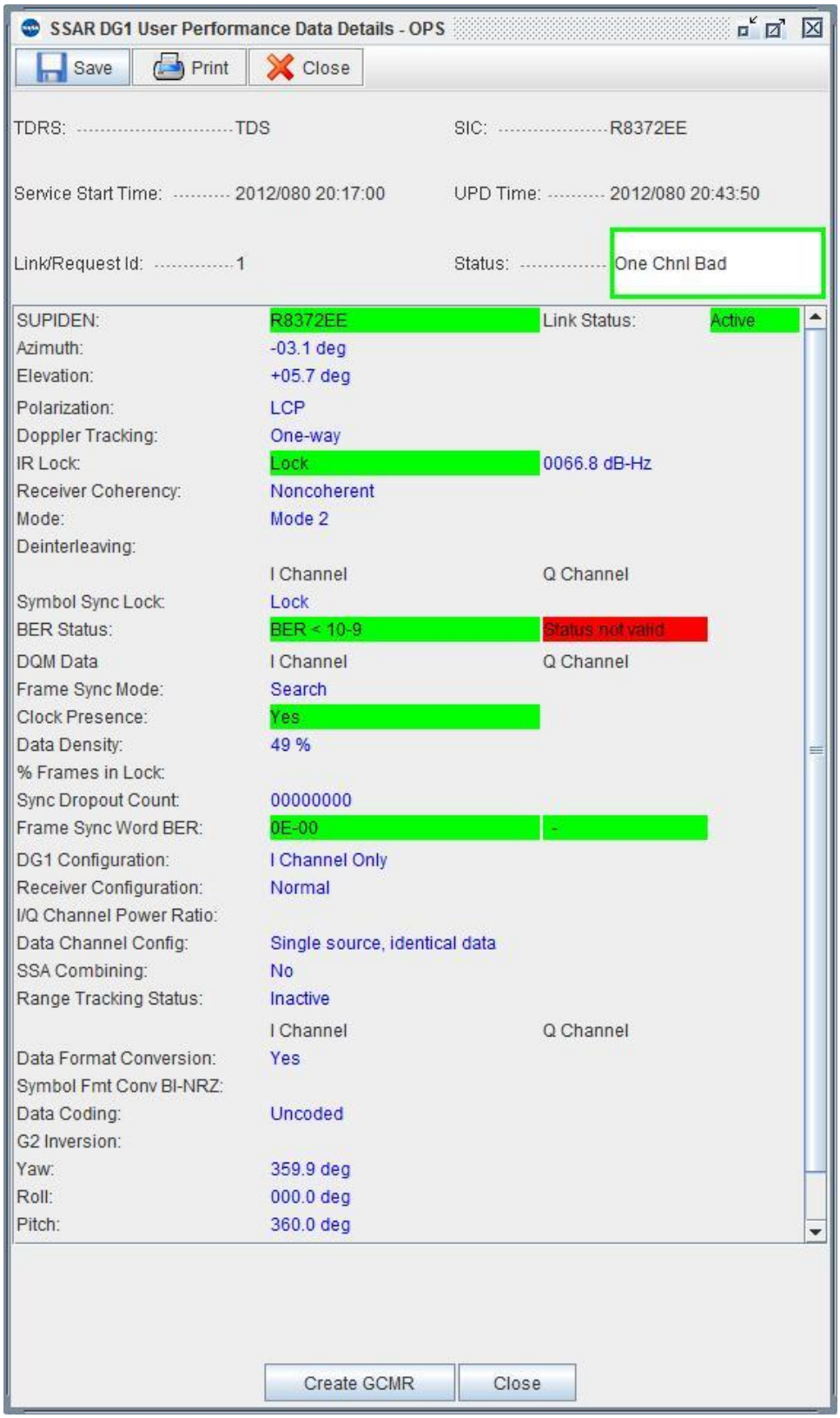
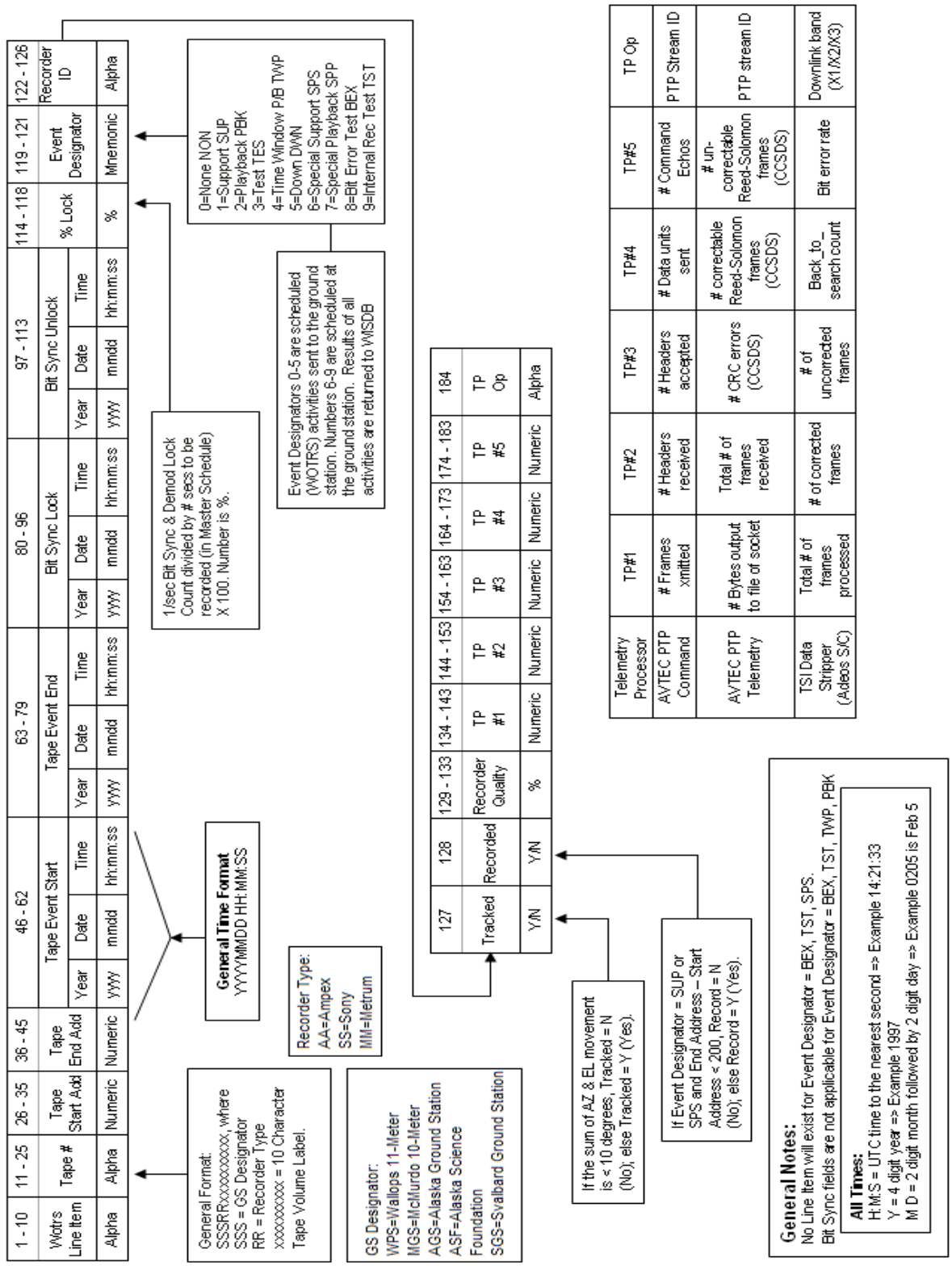


Figure C-2—SN UPD, S-band, Single Access, Return Link

APPENDIX D NEN UPD TEMPLATE



APPENDIX E SCAN TESTBED FILE MANAGEMENT TABLE

Data Description	Section	Source	Storage/Access	Mission Ops Web Server	Deliver to CONDB
Configuration Data	4.2.1	Project/ Experimenter/ Mission Ops	CONDB	Yes	As Created
Experimenter Generated Forward Link Source Data	4.2.2.1.1	Experimenter File/PRBS	Experimenter	No	N/A
SDR Return Link Source Data	4.2.2.1.2	SDR PRBS	N/A	N/A	N/A
Flight Avionics Return Link Source Data	4.2.2.1.3	Experimenter File/PRBS	CONDB	Yes	Prior to Upload
Received Raw Experiment Data	4.2.2.2.1	Flight System	SFEP Storage Server	TBD	TBD
Ground Processed Experiment Data	4.2.2.2.2	Experimenter	Experimenter	No	N/A
Flight System Experiment Forward Link Received Data	4.2.2.2.3	Flight System	CONDB	Yes	7-10 days after pass
Resultant Experiment Data	4.2.2.2.4	Experimenter	Experimenter	No	N/A
Flight System Software Updates	4.2.3	Software/ Experimenter	SCaN Testbed SW Repository	No	N/A
Flight System OE/WF Updates	4.2.3	Software/ Experimenter	SCaN Testbed Waveform Repository	No	N/A
Flight System Telemetry Data (Ad Hocs)	4.2.4	Flight System	CONDB	Yes	After Pass
SN Performance Data (UPDs)	4.2.5.1	SNAS	CONDB	Yes	Daily
NEN Performance Data (UPDs)	4.2.5.2	NEN	CONDB	Yes	Daily
BAD	4.2.5.3	ISS/HOSC	CONDB	Yes	Daily
ISS Data	4.2.5.4	MOD & GSFC FDF	CONDB	Yes	Weekly
WSC SDR Data	4.2.5.5	WSC SDR	CONDB	TBD	TBD

Networking Data	4.2.6	Avionics	TBD	TBD	TBD
TReK Recordings	4.2.7.1	CONMS	CONDB	Yes	Daily
ELC Telemetry	4.2.7.2	ISS/HOSC	CONDB	Yes	Daily
TReK Logs and Config Files	4.2.7.3	STCC & GIU TReKs	CONDB	Yes	Daily
Avionics Log Files	4.2.7.4	Flight System & GIUSS	CONDB	Yes	Weekly
SDR Log Files	4.2.7.5	Flight System & GIUSS	CONDB	Yes	Weekly
APS Uploads	4.2.7.6.1	STK	CONDB	Yes	Weekly
APS Downloads	4.2.7.6.2	Flight System & GIUSS	CONDB	Yes	Weekly
SFEP Configuration Files	4.2.7.7	SFEPs	SFEP Storage Server	No	N/A
HCOR Data Recordings	4.2.7.8	ISS/HOSC	CONDB	Yes – Blended w/ TReK Recording	Daily
EDS Data	4.2.8	EDS Equipment	Experimenter	Experimenter	N/A
GIUSS Equip Data (Mission Ops Runs)	4.2.9	GIUSS	CONDB	Yes	Daily
GIUSS Equip Data (Experimenter Runs)	4.2.9	GIUSS	Experimenter	No	N/A

APPENDIX F CONFIGURATION DATA SHEET

Configuration data sheets are created during the Mission Operations planning process and are attached to each Mission Operations script. The script along with the corresponding procedures are used by Mission Operations personnel to conduct each day's experiments. These configuration data sheets are stored along with the scripts on CONDB. The data sheets will contain the following information:

- Ordinal date
- GMT of Events
- Experimenter(s) names and affiliations
- Avionics SW Version
- SDR details (GD, JPL, Harris, WSC)
  - OE and WF Versions
  - Forward and return data rates
  - Waveform configuration (framing, coding, randomization, NRZ)
- SN or NEN details
  - TDRS utilized (East or Spare) and corresponding SGLT and WSC SFEP
  - SN User Performance Data file name
  - NEN User Performance Data file name
- Data Source
- Files Uploads
  - APS Track file name
  - APS Configuration file name
  - Avionics Return-Link Source Data file name
- File Downloads
  - SDR log file names
  - Avionics log file names
  - APS XML file names
  - Received Flight System Experiment data file names
- SFEP files
  - SFEP Configuration file names
  - Raw Experiment file names
- EFEP Configuration file names