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Space Communications and Navigation (SCaN) Testbed Project

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

SCaN TESTBED PROJECT

Experimenter's Handbook

AUTHORIZED by CM when under FORMAL Configuration Control	
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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 defines the process for progressing from an approved SCaN Testbed experiment with an assigned Experiment Liaison to utilizing (a) the Experiment Development System (EDS), (b) the Ground Integration Unit with Support Systems and ultimately conducting the experiment on the SCAN Testbed payload on board the ISS.

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1.0 INTRODUCTION

1.1 Purpose

The Experimenter's Handbook provides guidance to Experimenters who are proposing or have been accepted into the SCaN Testbed Experiments Program. It documents a process for progressing from an approved SCaN Testbed experiment with an assigned Experiment Liaison to utilizing (a) the Experiment Development System (EDS), (b) the Ground Integration Unit (GIU) with Support Systems and ultimately conducting the experiment on the SCaN Testbed payload on board the ISS.

1.2 Scope

The Experimenter's Handbook encompasses the processes to be followed to progress from an approved SCaN Testbed experiment through utilizing the SCAN Testbed payload on the International Space Station (ISS). The overall Experiment Flow process is illustrated in Figure 1.1 and is further explained in Section 6.0 of this handbook.

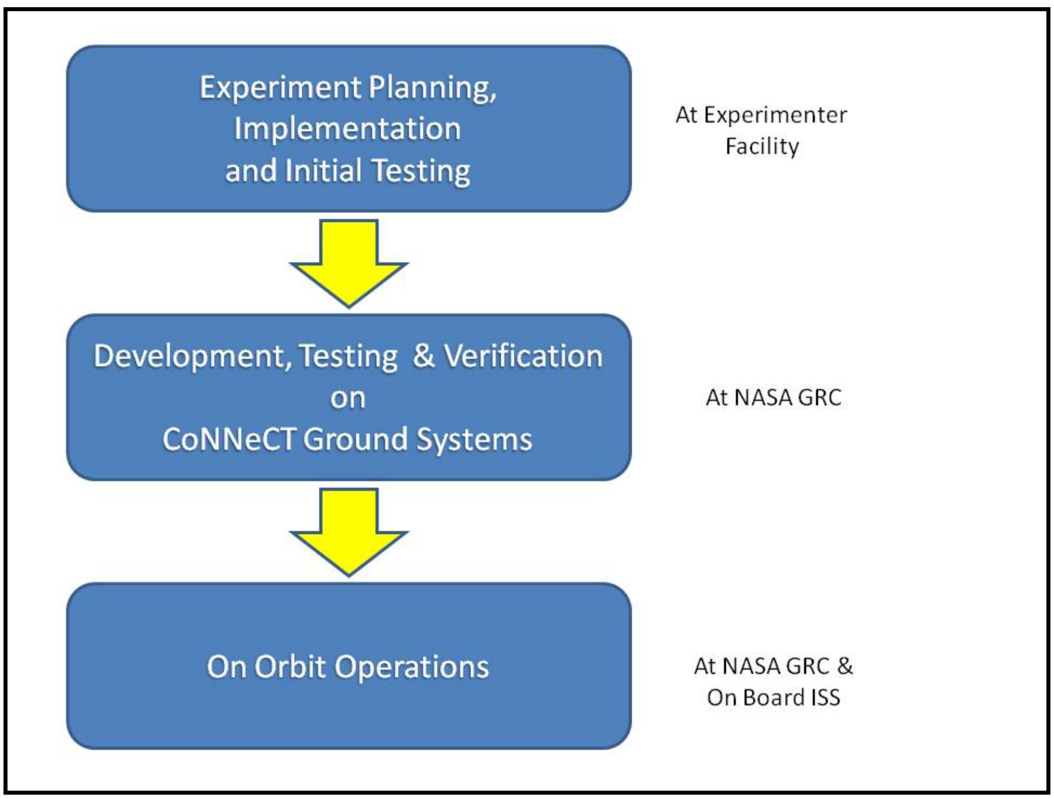
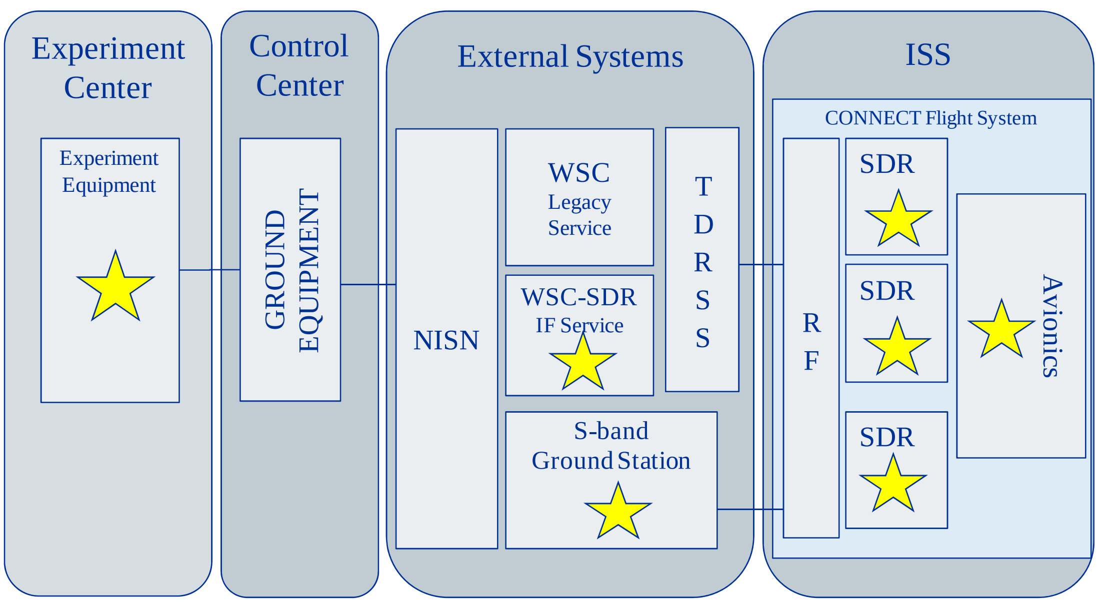


Figure 1-1—Experiment Flow

1.3 SCaN Testbed Background and Purpose

The SCaN Testbed project is a multi-center and industry development project with significant activities distributed among several organizations. Project management is led from GRC and supported by JPL and GSFC. Development of the SCaN Testbed flight system and ground system is distributed across GRC, JPL, and GSFC. The three software defined radios (SDRs) were developed by JPL, General Dynamics, and Harris Corporation. Flight system integration is conducted by GRC. JSC is the project interface for ISS integration and operations and launch vehicle integration with a Payload Integration Manager assigned to support the SCaN Testbed project. MSFC is the project interface for ISS Operations. The research, technology, and experiment leadership is also distributed across the participating Centers. The Principal Investigator and Deputy Principal Investigator reside at GRC, while JPL, GSFC, and JSC each provide a Co-Principal Investigator.

Experimenters can develop experiments by adding software/firmware and/or hardware in various places within the SCAN Testbed System illustrated in Figure 1-2. Each star represents locations where functions may be provided by experimenters within the system. Software/firmware can be installed and operated on the orbiting system on the software defined radios and/or avionics. On the ground, software/firmware can be installed and operated on the SDR at the White Sands Complex at the IF service (provided by the Operation Project). Experimenters may also provide unique experiment hardware at either a Direct To Earth (DTE) station, or at the SCaN Testbed Experiment Center (STEC). Hardware at the STEC may send and receive directly with the data stream to the flight SDRs (via WSC) through the SCaN Testbed Control Center (STCC) interface.



= Experimenter Provided Element (e.g. sw, fw, hw, component)

Figure 1-2—Experimenter Access Points

As a Laboratory aboard ISS, the SCaN Testbed payload is available to a broad range of experimenters and users from NASA, industry, academia, and other government agencies to advance SDR related technologies and applications valuable to future space missions. Technologies and applications might include advancements to the STRS Standard, wide-band, high rate waveforms for communications, techniques for improved navigation, routing and disruptive tolerant networking applications, multi-access, spectrum efficient techniques, novel science applications using the reconfigurable aspects of the SDR, and others.

1.4 SCaN Testbed Project Organization

1.4.1 Organizational Structure

The SCaN Testbed Project operates from the NASA Glenn Research Center in Cleveland, OH. The project reports to the SCaN Technology & Standards Division at NASA Headquarters in Washington D.C. As shown in Figure 1-3, the project works with several partner field centers and has principal investigators located at multiple field centers.

Experimenters will normally work with personnel resident in the Experiments, System Engineering and Integration, and Mission Operations teams, depending on the phase of activities. Approved experiments will be assigned an Experiment Liaison from within the SE&I team. The Experiment Liaison will serve as the primary point of contact for experiment teams and will facilitate information transfer between the SCaN Testbed project and the experiment teams. Additionally, the Experiment Liaison will coordinate access to SCaN Testbed resources such as the EDS and the GIU.

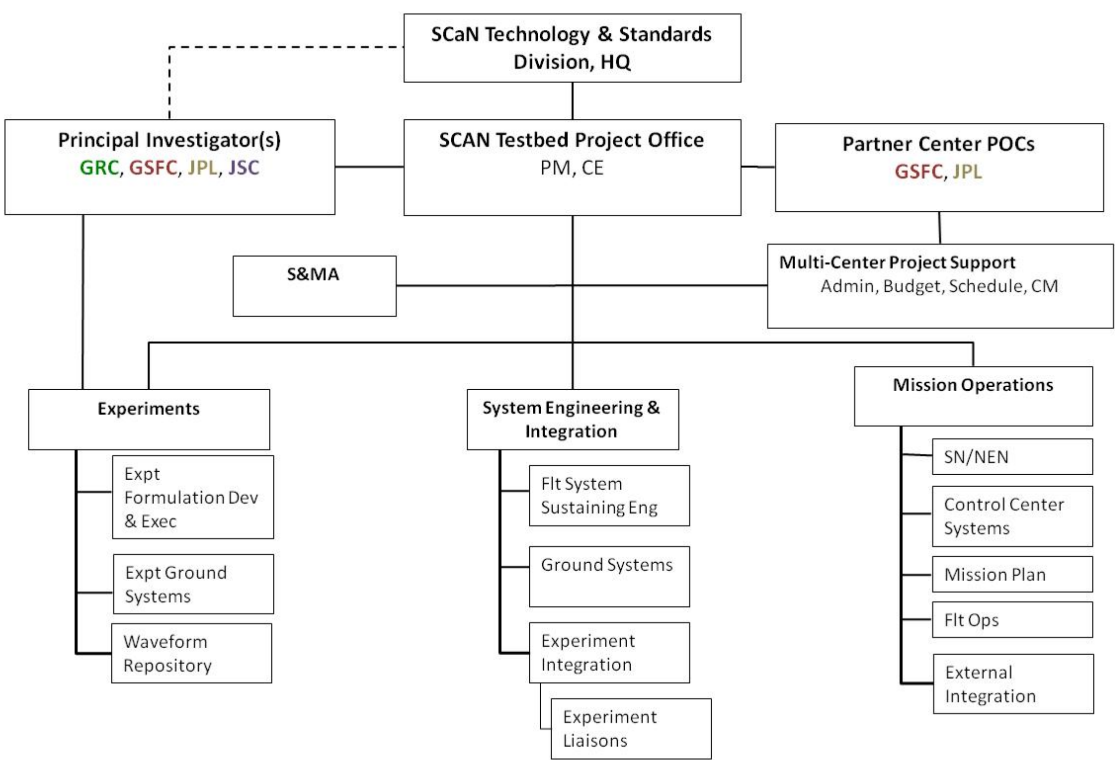


Figure 1-3—SCaN Testbed Project Organization

1.4.2 Project Contact

As mentioned in the previous section, the Experiment Liaison provides a direct means for approved Experimenters to contact the SCaN Testbed project. Prior to approval, potential experimenters may contact the SCaN Testbed Project to ask questions via the following email address:

scan-testbed-questions@lists.nasa.gov

Questions sent to this email address are routed to appropriate team members for responses.

Additionally, the SCaN Testbed project maintains general SCaN Testbed information at the following web URL:

http://spaceflightsystems.grc.nasa.gov/SOPO/SCO/SCaNTestbed/

2.0 DOCUMENTS

2.1 Applicable Documents

Applicable documents are those documents that levy requirements which must be adhered to by Experimenters, to the extent called out in this Handbook.

Document Number	Applicable Document
NASA-STD-8739.8	Software Assurance Standard
NASA-STD-8719.13	Software Safety Standard
NPR 2210.1	Release of NASA Software
NPR 7120.8	NASA Research and Technology Program and Project Management Requirements
NPR 7150.2	NASA Software Engineering Requirements

2.2 Reference Documents

The Experimenters Handbook provides a high level narrative description of the SCaN Testbed Project, the SCaN Testbed, the Ground Systems, Space and Ground Data Networks, and SCaN Testbed Mission Operations. Many sections of the Handbook provide guidance on where readers may obtain more detailed information. Note that the SCaN Testbed project was previously known as the "CoNNeCT" project and thus many of the reference documents still include this nomenclature.

Since most of the reference documents contain SBU or ITAR information, access to these reference documents will be made available through a secure website which requires a NASA-provided token. The process for obtaining a token is described in section 11.1.1 of this handbook.

Document Number	Reference Document
General Information	
450-SNUG	Space Network User's Guide
GRC-CONN-PLAN-0907	Experiment Plan Template
ISBN 0-16-016464-8	NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management (current edition).
STRS Information	
NASA/TM-2008-215445	STRS Definition and concepts
NASA/TP-2008-214813	STRS Software Architecture Concepts and Analysis
STRS-AR-00002	Space Telecommunications Radio System (STRS) Architecture Standard
Mission Operations Information	
GRC-CONN-DOC-0914	SCaN Testbed Experimenter Center Handbook (to be released Fall 2012)
GRC-CONN-IDD-0326	SCaN Testbed Front End Processor Requirements and Interface Definition Document
GRC-CONN-PLAN-0130	Data Management Plan
SCaN Testbed System Information	
GRC-CONN-DOC-5022	SCAN Testbed Flight and Ground Description

Ground System Information	
080911EGS708	GIU RF System Schematic
GRC-CONN-DOC-0890	White Sands Complex Software Defined Radio HDD
GRC-CONN-OPS-0371	GRC Development Ground Systems Description
SCaN Testbed Avionics Information	
GRC-CONN-DBK-128	Command and Telemetry Databook
GRC-CONN-DOC-0883	Avionics Hardware Interface Description/Platform (HID)
GRC-CONN-OPS-0910	Experiment Software Interface (to be released Fall 2012)
GD Software Defined Radio Information	
62-P57846P	CONNECT Baseline Waveform Specification
70-P57853	Interface Control Document (ICD) For M1 StarLight™ Platform Communications Navigation and Networking Reconfigurable Testbed
70-P57987P	Interface Control Document (ICD) for M1 Starlight Waveform Communications Navigation and Networking Reconfigurable Testbed (CONNECT)
99-P57865P	Operating Manual for the CONNECT Software Defined Radio
11424-10-002	Connect Firmware Support Manual
11424-33-002	Connect Software Design Document
JPL Software Defined Radio Information	
D-47936	Operating Environment FPGA Component Interfaces
D-47937	Operating Environment Operator's Guide
D-49217	CoNNeCT Baseband Processor Module Prototype User Guide
D-49240	CoNNeCT JPL-SDR Flight Model Hardware Description Document
D-49243	CoNNeCT JPL-SDR FM BPM Telemetry Calibration
D-49608	Electrical Interface Control Document (EICD)
D-63241	Operating Environment Integrator's Guide
D-63245	Data Interface Description
D-63258	Space Telecommunications Radio System Operating Environment Development Environment
Harris Software Defined Radio Information	
-	Hardware Interface Description (HID) for the Harris CoNNeCT Ka SDR
-	Module Wrapper Users' Guide
3191478	Ka-Band Space Programmable Modem Interface Control Document
3191940	Harris SDR Product Specification
3191941	Harris SDR Interface Control Document
8020373	Software User Manual (SUM) And Firmware Support Manual (FSM) for the CoNNeCT IR&D
TM_010	Harris SDR Power Spreadsheet TM_010
RF Subsystem Information	
TBD-1	Radio Frequency (RF) Hardware Interface Description/Platform (HID)

3.0 SYSTEM OVERVIEW

3.1 System Architechure

The SCaN Testbed Project is comprised of a Flight System and a Ground System, and makes use of space and ground data network assets as depicted in Figure 3-1. The integrated flight payload on board the ISS is referred to as the SCaN Testbed payload. The SCaN Testbed payload is resident on ExPRESS Logistics Carrier 3 (ELC3) on an exterior truss of the International Space Station (ISS). Figure 3-2 illustrates the location of the SCaN Testbed payload on the ISS.

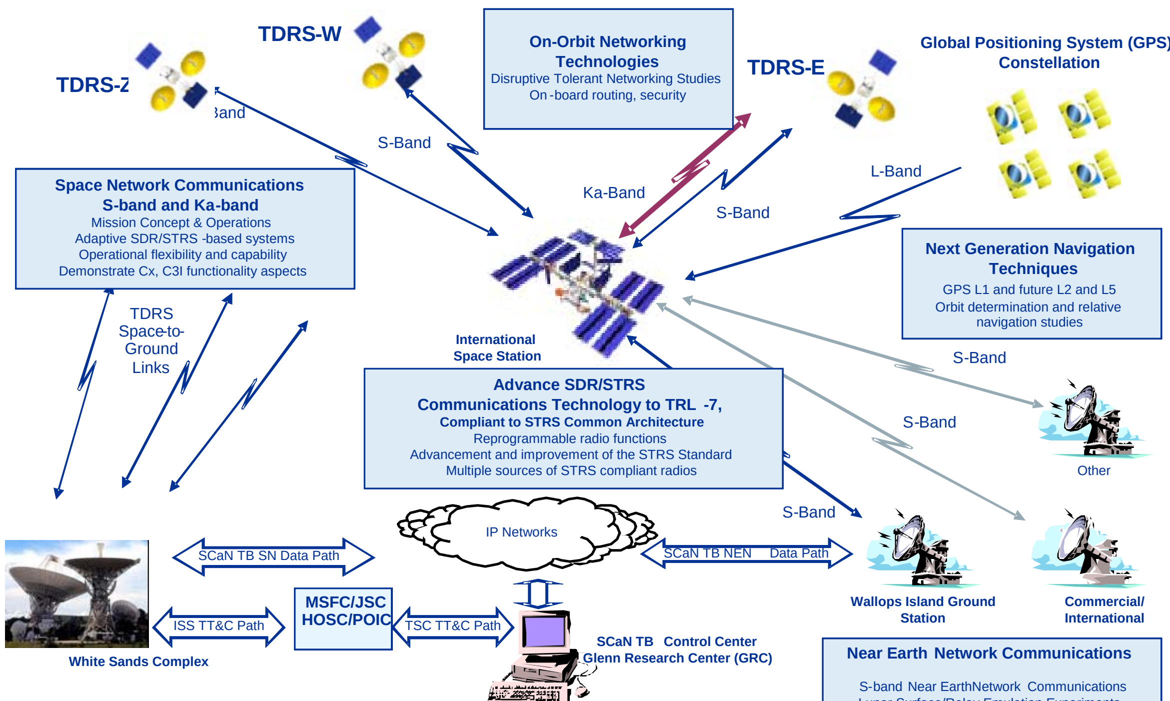


Figure 3-1—SCaN Testbed Operational System Overview

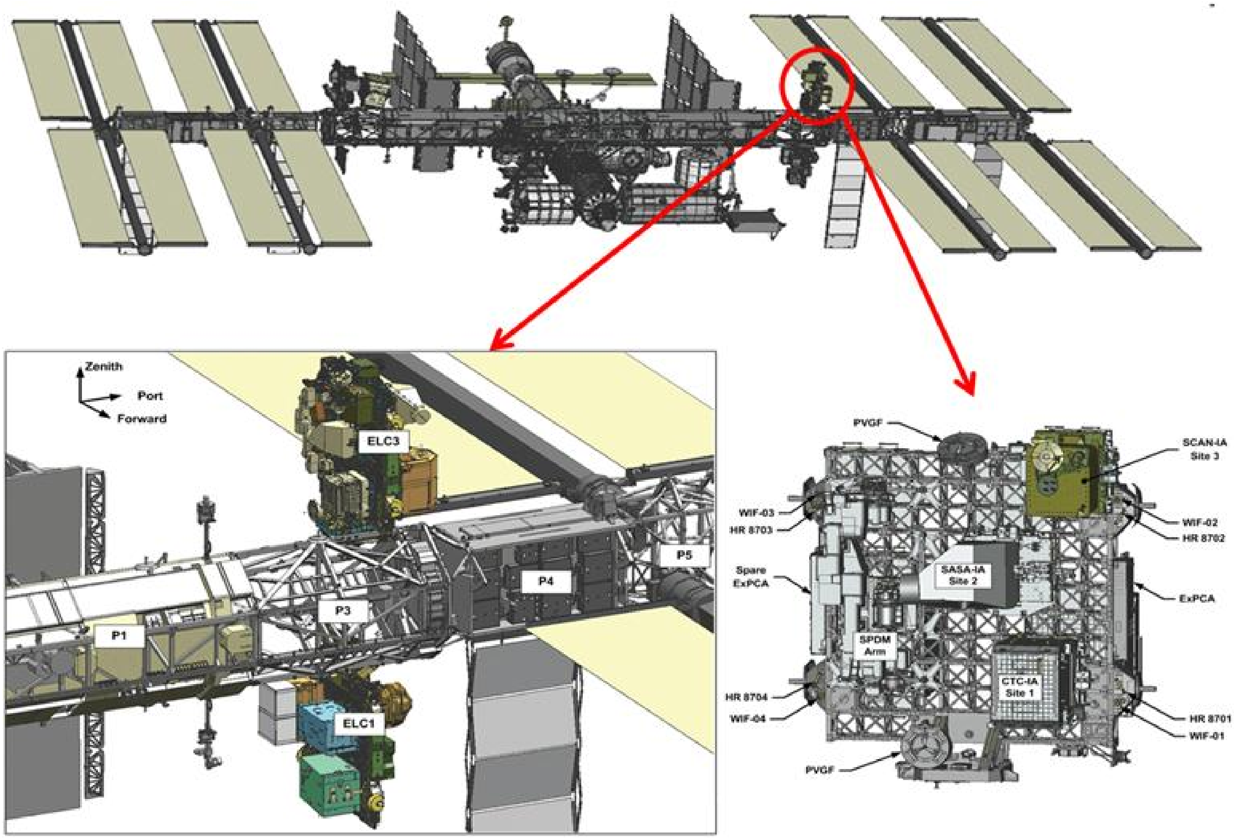


Figure 3-2—SCaN Testbed Payload Location on the ISS

The SCaN Testbed Ground System is comprised of the Engineering Development System (EDS), the Ground Integration Unit (GIU) with Support Systems, and the Telescience Support Center (TSC). The EDS serves as an early phase development platform and does not interface with the GIU, TSC or the data networks. The GIU is a high fidelity, ground based version of the SCaN Testbed payload and is used for development testing, verification testing, and flight system troubleshooting. The TSC is used for mission operations as well as testing with the GIU. The ground system is further described in section 4.0 of the handbook.

The SCaN Testbed payload and the SCaN Testbed Ground System operate in the context of two data networks that are termed "Primary Path" and "Experimental Path." The data paths are depicted in Figure 3-3.

The Primary Path is used for communication between SCAN Testbed payload and ground systems for command, telemetry and file uploads/downloads. The Primary Path includes the STCC, the 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 MDMs, and the EXPRESS Logistics Carrier3 (ELC3) carrying the SCAN Testbed payload.

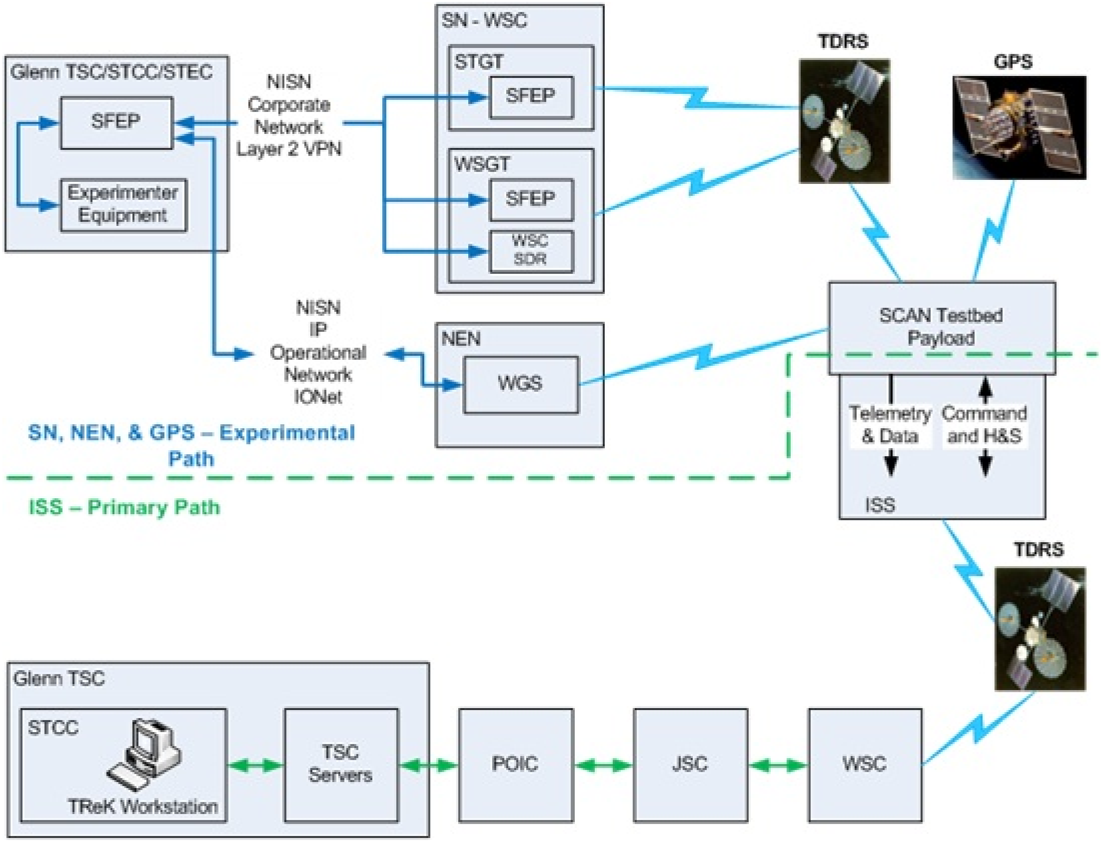


Figure 3-3—SCaN Testbed Operational Data Paths

The Experimental Path, which includes the RF links used by the SDRs in the SCAN Testbed payload, 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 payload. On the Forward Link, data travels from the Experimenter Front End Processor (EFEP), to the Mission Operation's Front End Processor (SFEP), through the TSC network, through 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 payload to TDRSS to White Sands through the NISN Ground Network to the STCC SFEP and ending at the STEC EFEP. The Near Earth Network (NEN) Experimental Path includes the STCC and NEN S-band services from Wallops to the SCAN Testbed payload. The Uplink starts with the GRC TSC through the NISN Ground Network to the Wallops Ground Station and onto the SCAN Testbed payload. The Downlink goes from the SCAN Testbed payload to the Wallops Ground Station through NISN Ground Network to the GRC TSC.

3.2 SCAN Testbed Payload Overview

The SCaN Testbed consists of reconfigurable and reprogrammable Software Defined Radio (SDR) transceivers/transponders operating at S-band, Ka-band, and L-band, along with the required RF/antenna systems necessary for communications. Designed to operate for a minimum of two years, the three SDRs will provide S-band duplex Radio Frequency (RF) links directly with the ground, (also referred to as the Near Earth Network (NEN)), S-band duplex RF links with the Tracking and Data Relay Satellite System (TDRSS), (also referred to as the Space Network (SN)), Ka-Band duplex with TDRSS, and L-Band receive-only with the Global Positioning System (GPS). The SCAN Testbed operates in low earth orbit and has multiple antennas providing connectivity to a series of NASA Space Network (SN) TDRSS satellites in geosynchronous orbits and NASA Near Earth Network (NEN) stations.

The major components of the SCaN Testbed are illustrated in Figure 3-4. A functional block diagram of the major SCaN Testbed subsystems is shown in Figure 3-5. A more complete description of the SCaN Testbed payload is provided in SCaN Testbed flight and Ground System Description, GRC-CONN-DOC-5022.

The SCaN Testbed payload RF subsystem is described in GRC-CONN-TBD-1, Radio Frequency (RF) Hardware Interface Description/Platform (HID).

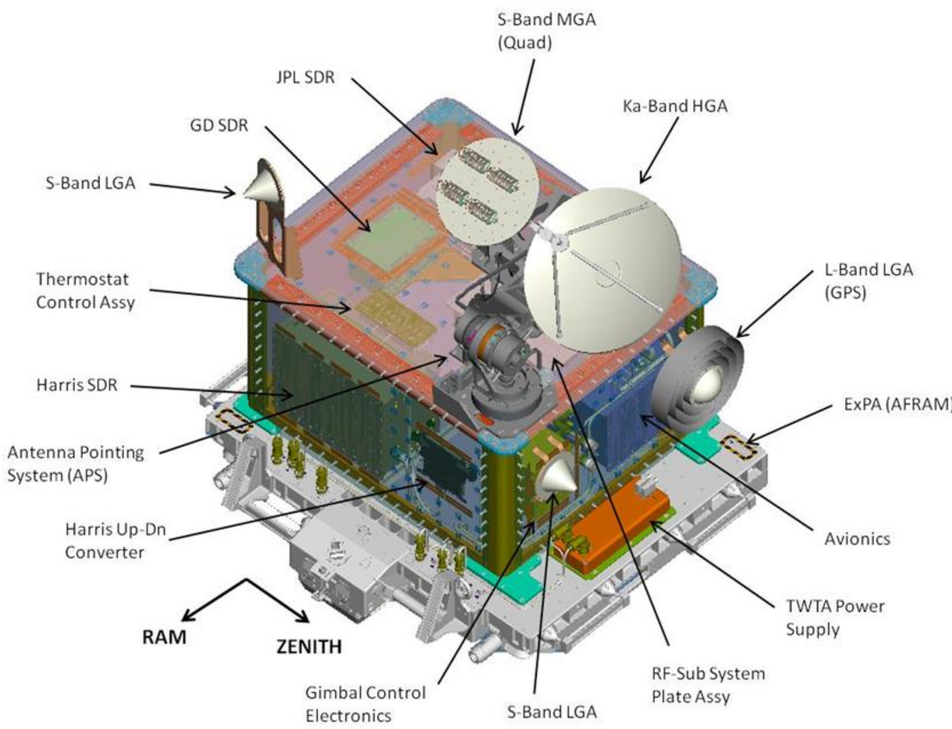


Figure 3-4—SCaN Testbed Major Components Viewed from Ram/Zenith Angle (Stowed)

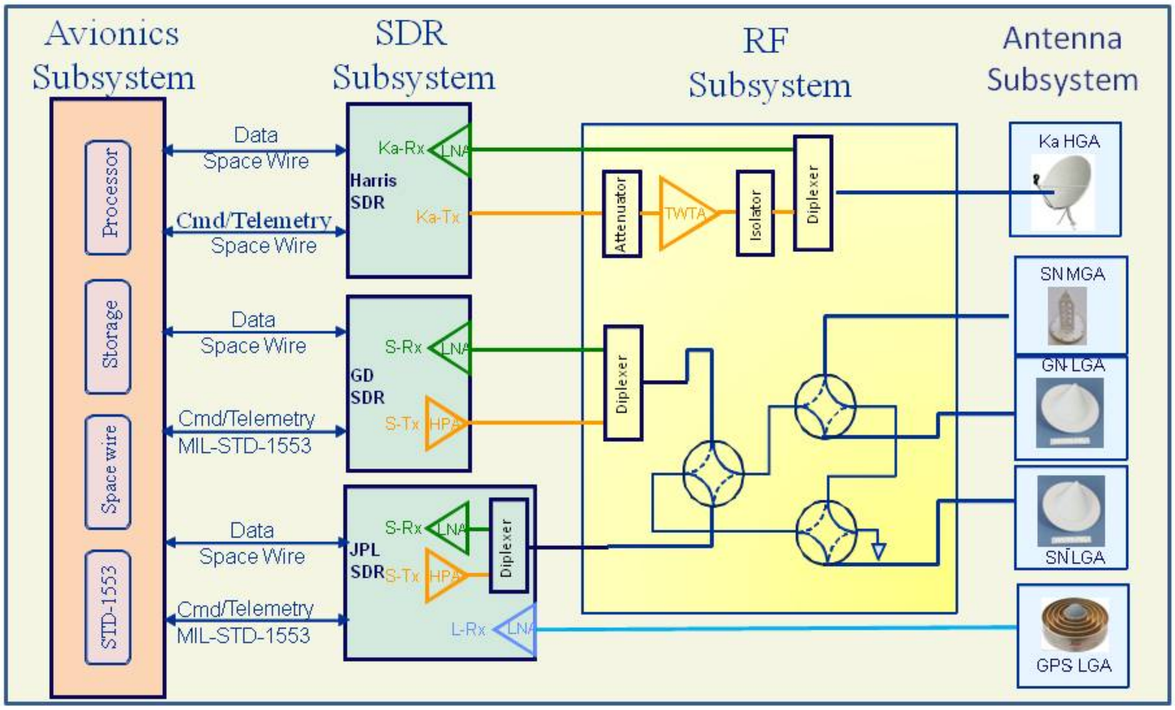


Figure 3-5—SCaN Testbed Functional Block Diagram

3.3 Reconfigurable Flight Subsystems

As noted in the introduction of the Handbook, Experimenters can develop experiments by adding software/firmware to the SCaN Testbed Avionics Subsystem, each of the SDR's and certain ground systems. The following sections highlight some of the technical characteristics of the reconfigurable flight subsystems. More detailed technical information for these subsystems is available in the respective Hardware Interface Description documents and related documents.

3.3.1 Avionics Subsystem

The Avionics Subsystem provides the electrical and command & data handling interface between ISS systems and the SCaN Testbed systems. These interfaces include power distribution and control, grounding and isolation, communication (commanding and data) interfaces with ISS, flight system health and status, and SCaN Testbed subsystem communications and control as shown in Figure 3-6. In addition, the Avionics Package contains software that can be reprogrammed on orbit to support experiment specific requirements. The Ground Support Equipment (GSE) interface was used for pre flight test only. For more detailed technical information for the Avionics Subsystem please refer to Avionics Hardware Interface Description/Platform, GRC-CONN-DOC-0883.

Any reconfigurations/updates to the Avionics Subsystem default software version will be developed and implemented in accordance with Class C procedural requirements as stated in NPR 7150.2, NASA Software Engineering Requirements. The SCaN Testbed Project envisions that Experimenters and the SCaN Testbed Software team will need to closely work together on any new software that needs to reside on Avionics Subsystem.

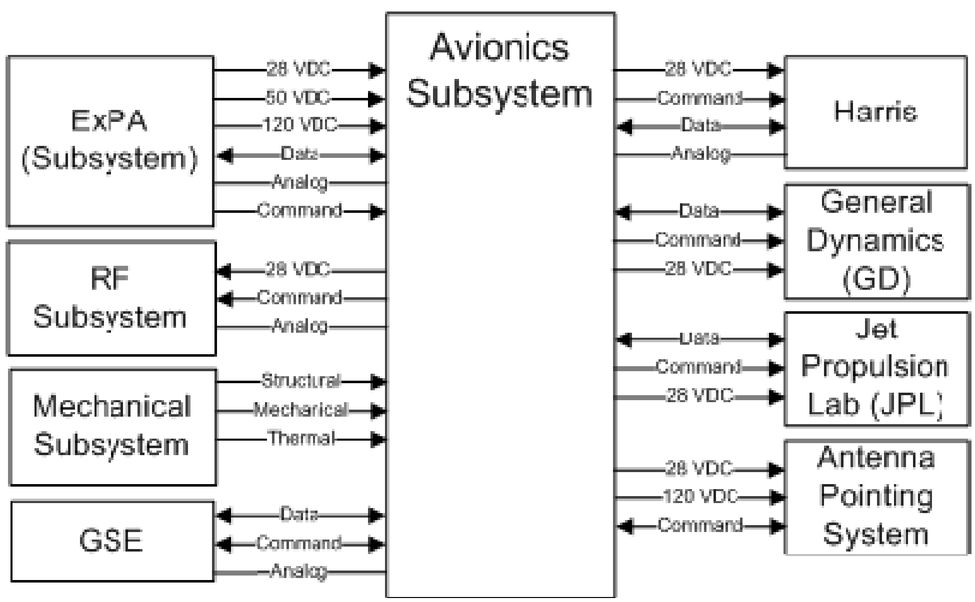


Figure 3-6—Avionics Subsystem Interface Block Diagram

Experimenters considering development of software to run on the Avionics Subsystem can refer to Experiment Software Interface, GRC-CONN-OPS-910 for development information. Additionally, the Command and Telemetry Databook, GRC-CONN-DBK-0128, may be useful in assessing interfaces to the Avionics Subsystem software. Experimenters are advised that significant interaction with the SCaN Testbed project team will likely be required for all software intended to run directly on the Avionics Subsystem. Depending on the experiment envisioned, availability of CPU resources may be limiting factor.

3.3.2 Software Defined Radios

Each of the three Software Defined Radios has an Operating Environment (OE), which includes an operating system and provides infrastructure services to applications and waveforms in accordance with the Space Telecommunications Radio System Standard (STRS). In addition to the OE, each SDR runs waveform applications which implement the unique capabilities of the radio to receive and transmit radio frequency (RF) signals. The OE is the STRS architecture standard middleware that abstracts the SDR hardware from the waveform application software (i.e. general purpose processor code and Field Programmable Gate Array (FPGA) configuration data). Each SDR has an OE which acts as an operating system to process commands, interact with hardware, and configure the SDR. All three OEs comply with the STRS Standard. Each SDR must run waveforms which implement the capability of the radio including functions such as coding, modulation, demodulation, decoding, as well as unique capabilities specific to an experiment.

OE updates, if needed, will generally be developed by the Project in partnership with the SDR platform developer. Waveform applications will be developed and provided by experimenters for operation on the individual SDRs.

3.3.2.1 General Dynamics SDR

The GD radio will utilize S-band for forward and return links to TDRSS or direct links to a ground station, this radio is a reprogrammable S-band transceiver designed for space use. The delivered SDR is compliant with the STRS architecture. The S-band SDR operates at two unique frequency pairs for operation with the multiple access service of TDRSS or the single access service of TDRSS. Either frequency can be used for the direct to ground link. Each operating frequency provides a 6 MHz wide RF link for use by the experimenter waveform application. The GD SDR contains Actel RTAX and Xilinx QPRO Virtex II Field Programmable Gate Arrays (FPGA), a ColdFire micro processor, and utilizes Verilog and Very high speed integrated circuits Hardware Description Language (VHDL) Hardware Description Languages. Summary technical information for the GD SDR is provided in the list below, more detailed technical information for the GD SDR can be found in the reference documents listed in section 2.2 of this handbook.

Hardware Platform

- S-band Transmit/Receive
- Transmit Frequency: 2.2-2.3 GHz, 8W Output Power
- Receive Frequency: 2.025-2.12 GHz
- One Virtex II FPGA QPRO
- ColdFire Processor (~60 MIPS),
- Chalcogenide RAM (CRAM)

STRS Operating Environment

- Uses VxWorks operating system
- GD developed STRS infrastructure

Initial Demonstration Waveforms

- S-band TDRSS compatible with Single Access and Multiple Access Services

3.3.2.2 Jet Propulsion Laboratory SDR

The JPL radio utilizes S-band for forward and return links to TDRSS or direct links to a ground station. The JPL SDR also receives GPS frequencies of L1, L2, and L5. This radio is a reprogrammable S-band transceiver designed for space use. The delivered SDR is compliant with the STRS architecture. The S-band SDR operates at two unique frequency pairs for operation with the multiple access service of TDRSS or the single access service of TDRSS. Either frequency can be used for the direct to ground link. Each operating frequency provides a 6 MHz wide RF link for use by the experimenter waveform application. The JPL SDR contains Actel RTAX 2000 and Xilinx FPGAs, an Actel 697 with SPARC processor, RF converter section, and a nominally 10W power amplifier. Summary technical information for the JPL SDR is provided in the list below, more detailed technical information for the JPL SDR can be found in the reference documents listed in section 2.2 of this handbook.

Hardware Platform

- S-band Transmit/Receive
- L-band receive (GPS)
- Transmit: 2.2-2.3 GHz, 7.5W Output Power, 16 MHz Bandwidth
- Receive: 2.025-2.12 GHz, 11 MHz Bandwidth
- Two Virtex II FPGA
- SPARC Processor (~100 MIPS)

STRS Operating Environment

- Uses open source RTEMS operating system
- JPL developed STRS infrastructure

Initial Demonstration Waveforms

- GPS and S-band raw sample capture
- S-band raw sample playback
- S-band TDRSS compatible with Single Access and Multiple Access Services

3.3.2.3 Harris SDR

The Harris radio will utilize the TDRSS Ka-band service. This radio is a reprogrammable Ka-band transceiver designed for space use and the delivered SDR is compliant with the STRS architecture. The Ka-band SDR operates at a unique Ka-band frequency pair for operation with the single access Ka-band service of TDRSS. The Ka-band SDR provides a 225 MHz wide RF link for use by the experimenter waveform application. The Harris SDR contains Xilinx Vertex-4 FPGAs, an AITech 950 single board computer utilizing the VxWorks Operating System, a TI SM320C6701 DSP, and an S-band to Ka-band RF converter. Detailed technical information for the Harris SDR can be found in the reference documents listed in section 2.2 of this handbook.

Hardware Platform

- Ka-band Transmit/Receive
- Transmit Frequency: 25.65-26.16 GHz, 225 MHz Bandwidth
- Receive Frequency: 22.515-23.115 GHz, 50 MHz Bandwidth
- Four Virtex IV FPGA
- AiTech Processor (~700 MIPS),
- DSP (1 GFLOP),
- Scrubbing ASIC

STRS Operating Environment

- Uses VxWorks operating system
- Harris developed STRS infrastructure

Initial demonstration waveforms

- Ka-band TDRSS compatible with Single Access Service

4.0 GROUND SYSTEMS

The term "ground systems" is used to describe the SCaN Testbed project equipment and systems resident at the NASA Glenn Research Center, and, in some contexts, portions of the data network.

4.1 Development and Verification Systems

Experimenters will have access to two SCaN Testbed project ground based systems for development and verification. The Experiment Development System (EDS) is intended to provide initial opportunity for software testing and basic functional validation. The EDS equipment is lower fidelity than the Ground Integration Unit (GIU) but provides a basic emulation of the hardware and software features of the SCaN Testbed flight system. Configuration control of the EDS is not as formal as that implemented for the GIU and thus affords more of the laboratory development work environment.

The GIU is a high fidelity version of the SCaN Testbed flight system and is therefore used for more controlled final development testing and verification testing. Because of the high fidelity of the GIU, it is also used by the SCaN Testbed Mission Operations team for mission training as well flight operations anomaly resolution. Configuration control of the GIU is more formal and thus the use is also more formally controlled.

It should be noted that either due to the EDS capability or due to the maturity of the experiment, in some cases the Experimenter may initiate ground test exercises on the GIU and corresponding support systems (i.e, bypassing using the EDS capabilities). Therefore, GIU use may occur prior to verification activities described in sections 6.5 thru 6.7.

4.1.1 Experiment Development System

The EDS is comprised of a Software Development System (SDS) and SDR (Harris, JPL, and GD) breadboards (BBs). The SDS emulates the Mission Operations command interface to the SCaN Testbed by the use of the TReK Workstation and an ELC Suitcase Simulator. The TReK Workstation emulates the command and control workstation within the SCaN Testbed Command Center. The ELC Suitcase Simulator emulates the ISS command and data interfaces with the SCaN Testbed. The general SDS configuration is depicted in block diagram format in Figure 4-1. For more specific details regarding EDS, please refer to GRC Development Ground Systems Description, CONN-PLAN-OPS-0371.

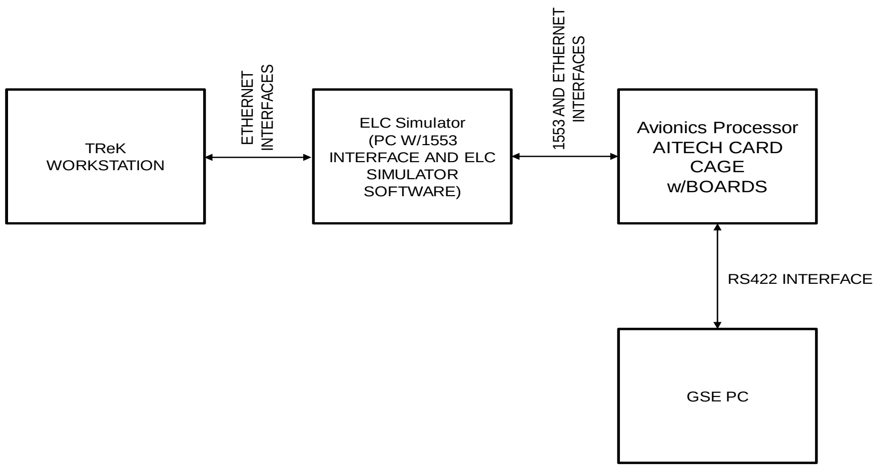


Figure 4-1—SDS Block Diagram

Each of the SDR breadboards, one each for the JPL, GD or Harris SDR's, can be interfaced to an SDS. A general SDS-BB configuration is depicted in block diagram format in Figure 4-2 using the GD SDR BB as an example. In this configuration, the combination SDS-BB can be used to emulate the end to end command and telemetry data interfaces and operations. Additionally, this configuration can be used to perform initial waveform code testing in a flight-like command and telemetry configuration. In general, the SDR BB's do not fully emulate the RF sections of the SDRs or of the complete SCAN Testbed payload. For the majority of approved experimenters, the EDS will serve as the initial GRC-based development platform. For more specific details regarding the capabilities of each SDR BB, please refer to GRC Development Ground Systems Description, CONN-PLAN-OPS-0371.

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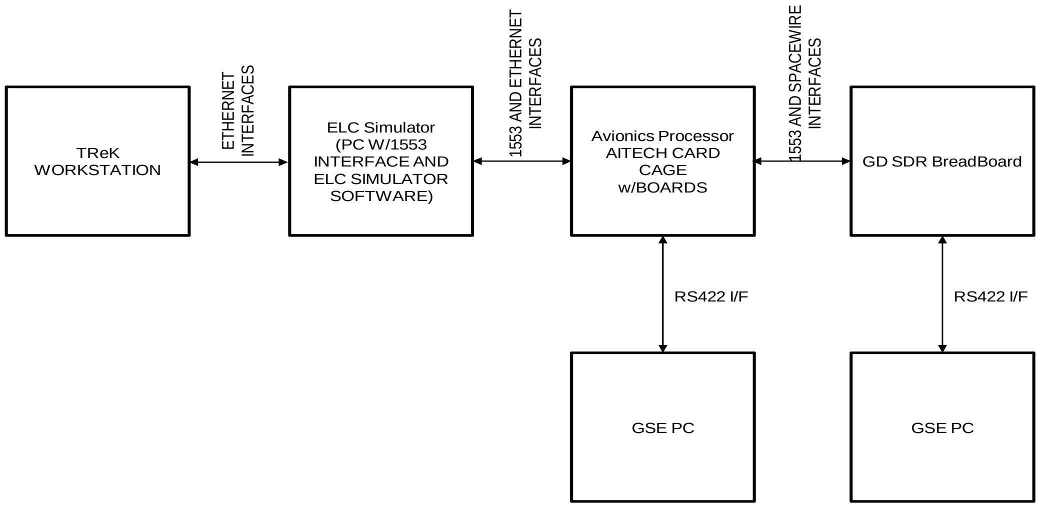

Figure 4-2—SDS-BB Block Diagram (GD Example)

Experimenter-specific test configurations of the SDS, including Experimenter provided test equipment or support systems associated with the GIU, can be accommodated. Such test configuration requirements should be documented in the Experiment Plan and coordinated through the Experiment Liaisons.

The EDS is a shared resource amongst the SCaN Testbed software team, experimenters and SCaN Testbed Sustaining Engineering. Access to it is provided on a scheduled basis. Requests for access to the EDS or any constituent component should be documented in the Experiment Plan and coordinated through the Experiment Liaisons.

Remote access to the EDS may be provided to Experimenters subject to adherence to NASA IT security limitations and requirements. Requests for remote access to the EDS or any constituent component should be documented in the Experiment Plan and coordinated through the Experiment Liaisons.

4.1.2 Ground Integration Unit with Support Systems

The GIU with Support Systems consists of the GIU, Antenna Pointing System (APS) Rack, Test Equipment Interface (TEI) Racks #1 and #2, Power Acquisition System (PAS), two S-Band TDRSS Simulators (TSIM), Ka-Band TSIM and Data Acquisition System and Experiment Front End Processor (EFEP), ELC Suitcase Simulator (SCS), Telescience Resource Kit (TReK) Workstation, WSC-SDR and GPS antenna. The GIU is illustrated in block diagram format in Figure 4-3. For more specific details regarding the GIU, please refer to GRC Development Ground Systems Description, CONN-PLAN-OPS-0371.

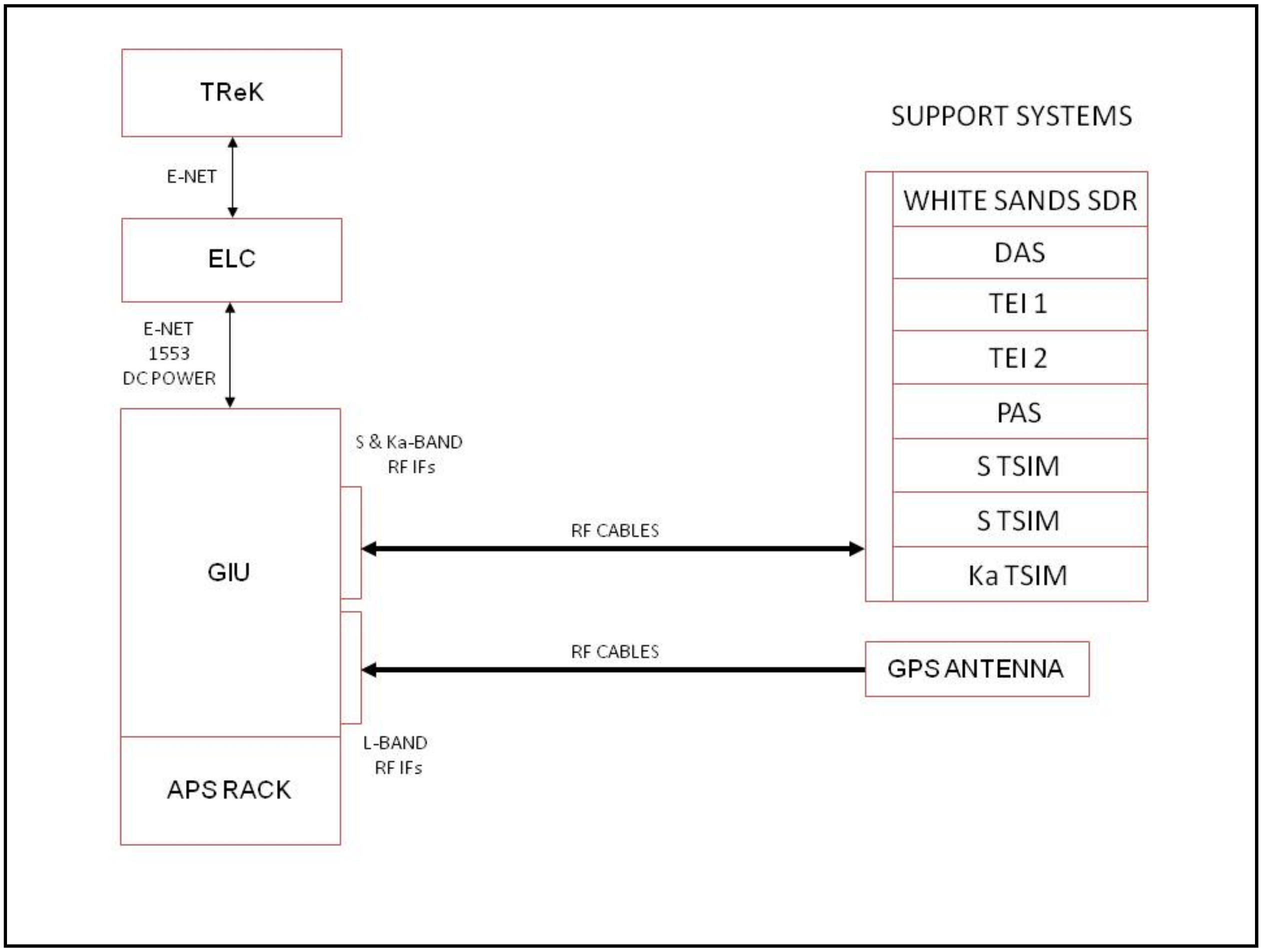

Figure 4-3—GIU and Support Systems

The GIU itself includes SDR Engineering Models (EM) and an Avionics System (AS) spare Flight Model (FM). The GIU also includes two Travelling Wave Tube Amplifiers (TWTA) EM, Gimbal Control Electronics (GCE) EM, an Interconnect Harness EM, Temperature Sensors EM, an Antenna Pointing System (APS) EM, Gimbals EM, an RF System EM/FM/SE custom version, and additional Support Equipment (SE). For more specific details regarding the GIU, please refer to GIU Design Description, CONN-PLAN-OPS-0905.

The GIU is expected to be utilized by experimenters for the following experiment development activities after initial development on the EDS:

- Develop Avionics Software
- Develop Ground Software
- Develop an Operating Environment (OE) for a given radio
- Develop Waveforms for the radios
- Develop the On-Orbit Operating Procedures for Experiments

The GIU will support final experiment formal verification and validation consisting of the following:

- Avionics Software
- Ground Software
- Operating Environment (OE) for the radios
- Waveforms for the radios
- On-Orbit Test Sequences for Experiments

Experimenter-specific test configurations of the GIU, including Experimenter provided test equipment, can be accommodated. Such test configuration requirements should be documented in the Experiment Plan and coordinated through the Experiment Liaisons.

The GIU is a shared resource amongst the SCaN Testbed software team, Experimenters, the Mission Operations team, and SCaN Testbed Sustaining Engineering. Access to it is provided on a scheduled basis. Requests for access to the GIU or any constituent component should be documented in the Experiment Plan and coordinated through the Experiment Liaisons.

4.2 GRC Telescience Control 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 SCAN Testbed Control Center (STCC) and SCaN Testbed Experiment Center (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.

4.2.1 SCaN Testbed Control Center

The STCC is used to send and receive commands and data, and manipulate (stores, routes, and processes) data for the SCAN Testbed and Ground System. The Flight System and Ground System interface with external systems to send and receive RF signals to and from space. The RF signals carry commands and data between the two SCaN Testbed elements. The Ground System provides terrestrial control of the Flight System through the SCaN Testbed Control Center, a top-level schematic of these interfaces is shown in Figure 3.4. A more detailed description of SCaN Testbed ground systems and mission operations networks can be found in SCaN Testbed Flight and Ground System Description, GRC-CONN-DOC-5022.

4.2.2 SCaN Testbed Experiment Center

The STEC is the real time mission data analysis and interface for the Experimenter team. It is physically adjacent to the STCC and located within the TSC. It is separate from the STCC because it is an experimental data center while the STCC is the overall operations center. The physical location is necessary because of the proximity of experiment supplied equipment to the STCC and the desire to analyze and make adjustments real-time during experimental data link connections with a TDRS or a ground station. Future experimenters may be required to provide additional support equipment depending on what is needed and what is available. The interface is governed by the STCC-STEC ICD, GRC-CONN-ICD-0427.

4.3 Reconfigurable Ground System Elements

4.3.1 Experiment Processor

Experimenters may provide their own Experiment Processor to interface with the SFEP at the STCC, as depicted in Figure 3-3. These systems could create source experiment data or utilize a generated source pseudo-random or file data for the experiment. Depending on the SDR being utilized and the experiment goals, the front end processor equipment applies coding, randomization, and framing as needed. The Experiment Processor could also transmit the data to the STCC. The FEP experiment hardware also receives experiment data from the STCC and de-frames, decodes, and de-randomizes as appropriate, depending upon the configuration of the experiment. The interface to the STCC SFEP is discussed in SCaN Testbed Front End Processor Requirements and Interface Definition Document, GRC-CONN-IDD-0326.

4.3.2 White Sands Center SDR

The White Sands Complex (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. Experimenters requiring this capability are responsible for developing the waveform software that would reside-on/utilize this SDR. For additional technical information regarding this ground system element, please refer to White Sands Complex Software Defined Radio HDD, GRC-CONN-DOC-0890.

4.4 Data Collection and Archival

During development and testing on the EDS, Experimenters are responsible for collecting and archiving all test data. SCaN Testbed personnel will assist Experimenters with retrieval of test data resident on the SCaN Testbed equipment (Avionics log files, SDR log files, TReK command and telemetry logs, test equipment logs, etc.). Experimenters will be responsible for bringing data mass storage devices to accept the test data. Experimenters are also responsible for data retrieval/storage from any Experimenter-unique GSE they may provide.

During development and testing on the GIU, Experimenters are responsible for collecting and archiving all test data. SCaN Testbed personnel will assist Experimenters with retrieval of test data resident on the SCaN Testbed equipment (TSIM data files, GIU Support System Racks data files, Avionics log files, SDR log files, TReK command and telemetry logs, test equipment logs, etc.). Experimenters will be responsible for bringing data mass storage devices to accept the test data. Experimenters are also responsible for data retrieval/storage from any Experimenter-unique GSE they may provide.

During Verification testing on GIU, the SCaN Testbed Project is responsible for collecting and archiving all test data except for that associated with Experimenter-unique GSE. SCaN Testbed Project stored test data will be retrievable from the Mission Operations data storage server. Experimenter access to this data is provided through a secure web server. Further details for this data storage and access can be found in the Data Management Plan, GRC-CONN-PLAN-0130. Experimenters are responsible for data retrieval/storage from any Experimenter-unique GSE they may provide.

During experiment mission operations on the SCaN Testbed, the SCaN Testbed Project will collect and archive experiment test data as described in the Data Management Plan, GRC-CONN-PLAN-0130. Stored test data will be retrievable from the Mission Operations data storage server. Experimenter access to this data is provided through a secure web server as described inGRC-CONN-PLAN-0130. Experimenters are responsible for data retrieval/storage from any Experimenter-unique GSE they may provide.

5.0 CONCEPT OF EXPERIMENT OPERATIONS

5.1 Overall Concept and Approach

From an Experimenter point of view, operation of the SCaN Testbed is focused on two groups of personnel: the Experimenter team and the SCaN Testbed Mission Operations team.

The Experiment team has responsibility for defining experiment requirements, including required flight system configurations, ground and space data network configurations, and for real time and post flight analysis of experiment data. Additionally, the experimenter will conduct their experiment from the STEC and provide real time guidance and support to the Mission Operations team during flight operations.

The Mission Operation team has overall responsibility for planning and scheduling mission support services, both on the ground and in space. Additionally, the Mission Operation team has responsibility for the operation and maintenance of the SCaN Testbed payload as a test platform. And the Mission Operation team has the primary responsibility for direct command and control of the SCaN Testbed, including upload of Experiment-unique software, and execution of experiment commands and data capture.

Mission operations will be conducted from the SCaN Testbed Control Center (STCC) located at the NASA GRC Telescience Support Center (TSC) in Cleveland, OH. The Mission Operations team will staff the positions within the STCC.

The SCaN Testbed Experiment Center (STEC) is the real time mission data analysis and interface for the Experimenter team involved with the SCaN Testbed mission. It is physically adjacent to the STCC and located within the TSC as well. It is separate from the STCC because it is primarily an experimental data center while the STCC is the overall operations center.

Two TReK work stations will be made available to the Experimenter team in the STEC. Due to the limited size of the TSC, only Experiment Team personnel directly involved with operation of the experiment are permitted to be stationed at the STEC (for flight operations). Note that this limitation is not applicable to testing on the EDS/GIU.

A more detailed description of SCaN Testbed flight operations can be found in CoNNeCT (SCaN Testbed)Project Mission Operations Plan, GRC-CONN-PLAN-0133.

5.2 Mission Operations

The Mission Operations team is comprised of several personnel who provide the following functions during mission operations:

- Mission Operations Manager - Leads the Mission Operations team. Maintains staffingand organization of overall effort. Reports to the SCaN Testbed Project Manager.
- Commander - Real-time Operations role that issues any commands or scripts.
- Controller - Real-time Operations role that maintains the timeline, monitors telemetry, writes OCR and PARs as necessary, and supports the Commander as needed. The Controller also acts as the real-time liaison to the STEC during an experiment.
- Scheduler - Responsible coordinating and defining the planned operations of the payload, tracking resources, and scheduling activities for the ISS, Space Network (SN), and Near Earth Network (NEN).
- SFEP Operator - Responsible for configuring the SFEP for SN and NEN contacts. The SFEP Operator verifies that data is flowing to / from the payload in the uplink / downlink direction as applicable via the experiment path.
- APS Operator - Responsible for developing inputs and generating the antenna tracking files, preparing APS pre-simulation, preparing XML configuration files and post-processing APS performance.

5.3 Experimenter Team

The Experimenter team structure is defined by the Experimenter. However, it is envisioned that the Experimenter team resident at the STEC will have sufficient knowledge of the experiment to be able to support real time decision making in terms of the operation of the experiment, and the interpretation and analysis of the data.

5.4 Experiment Timeline

The mission operational timeline of a specific experiment will be highly dependent on the experiment requirements. However, all experiments which make use of ISS and SN, NEN and NISN Data networks for experiment operations will need to work within the availability constraints imposed by these resources. For example, the initial enabling constraint is schedule availability of power and primary path command and telemetry data from the ISS to operate the SCaN Testbed. Add to this TDRS view times that are compatible with the orbital mechanics of the ISS, as well as SCaN Testbed view factors.

The result is a series of constraints that must be satisfied in order to provide an Experiment operation opportunity. Figure 5-1 depicts a notional scheduling of a week's worth experiment operation based on various availability constraints. The small rectangular blocks in the figure represent various resource availabilities (TDRS, ISS power, ISS data, etc). A given experiment will require differing resources which must be available to support the experiment. The availability of the resources will drive how often and when the experiment can be operated.

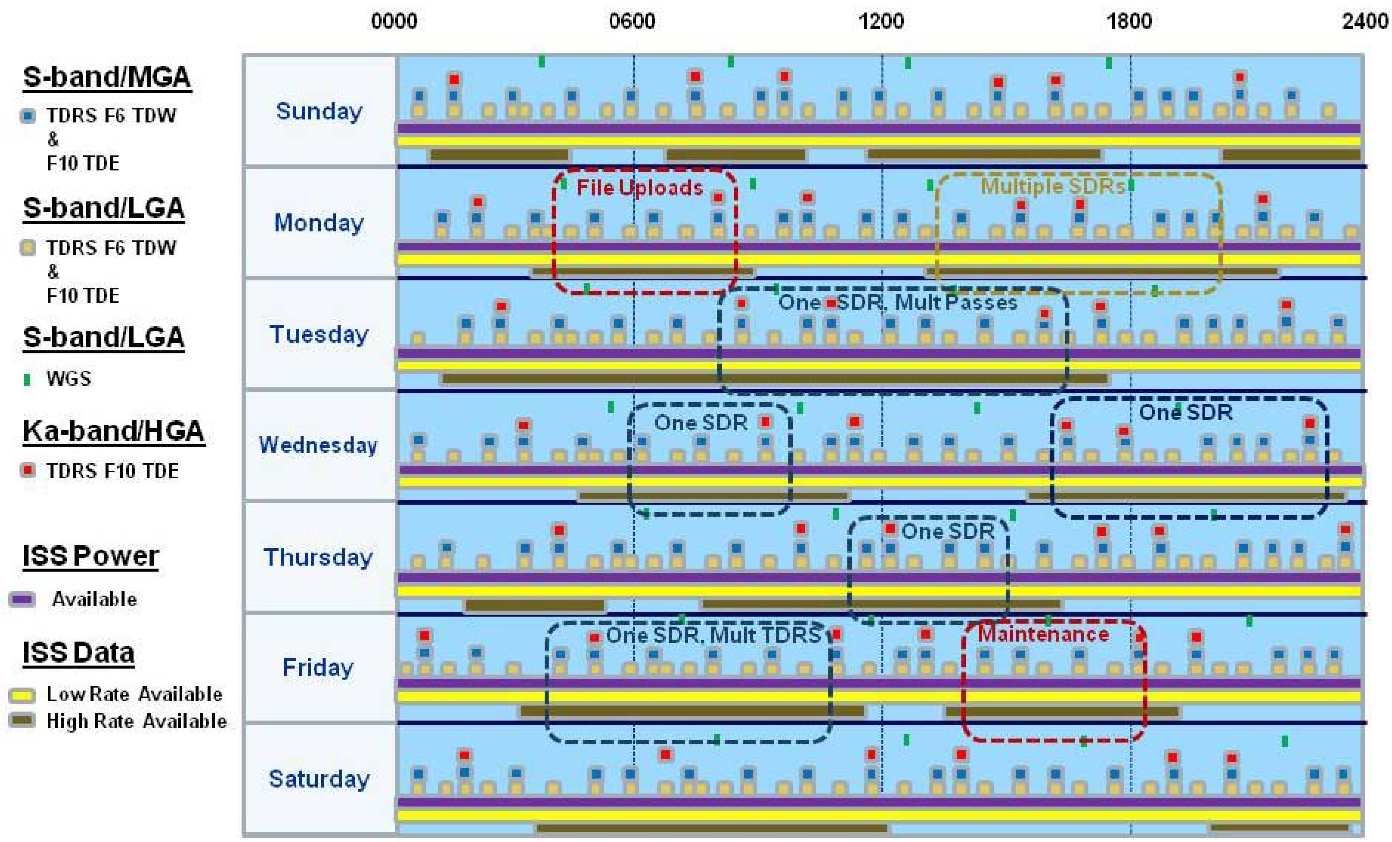

Figure 5-1—Notional SCaN Testbed Experiment Operation

In general, SN and NEN availability will determine when experiments are run. S-band opportunities are more numerous than Ka-Band opportunities. NEN opportunities will be based on Wallops ground site availability or Experimenter provided station.

Experimenters should consider that a single experiment may require between several orbits to several days to be completed:

- A single SN contact will be on the order of 20 to 30 minutes
- A single NEN contact will be on the order of 5 minutes
- A short GPS contact will be on the order of 30 minutes
- A long GPS contact will be on the order of 48 hours

Replanning during experiment operations may be possible. The challenge is one of having all the external resource constraints being available for the given activity. The Mission Operations team will work with Experimenters on a real time basis to determine what can be done in a given circustance. If Experimenters anticipate potential re-plan scenarios, these should discussed with the Experiment Liaison and the Mission Operations team during mission planning.

5.5 Experiment Path Planning

Experiment path operations are planned in advance through a sequential process that requires approximately 5 weeks before experiment operation. As depicted in Figure 5-2, service opportunities are identified and then negotiated, leading to service commitments and ultimately operations.

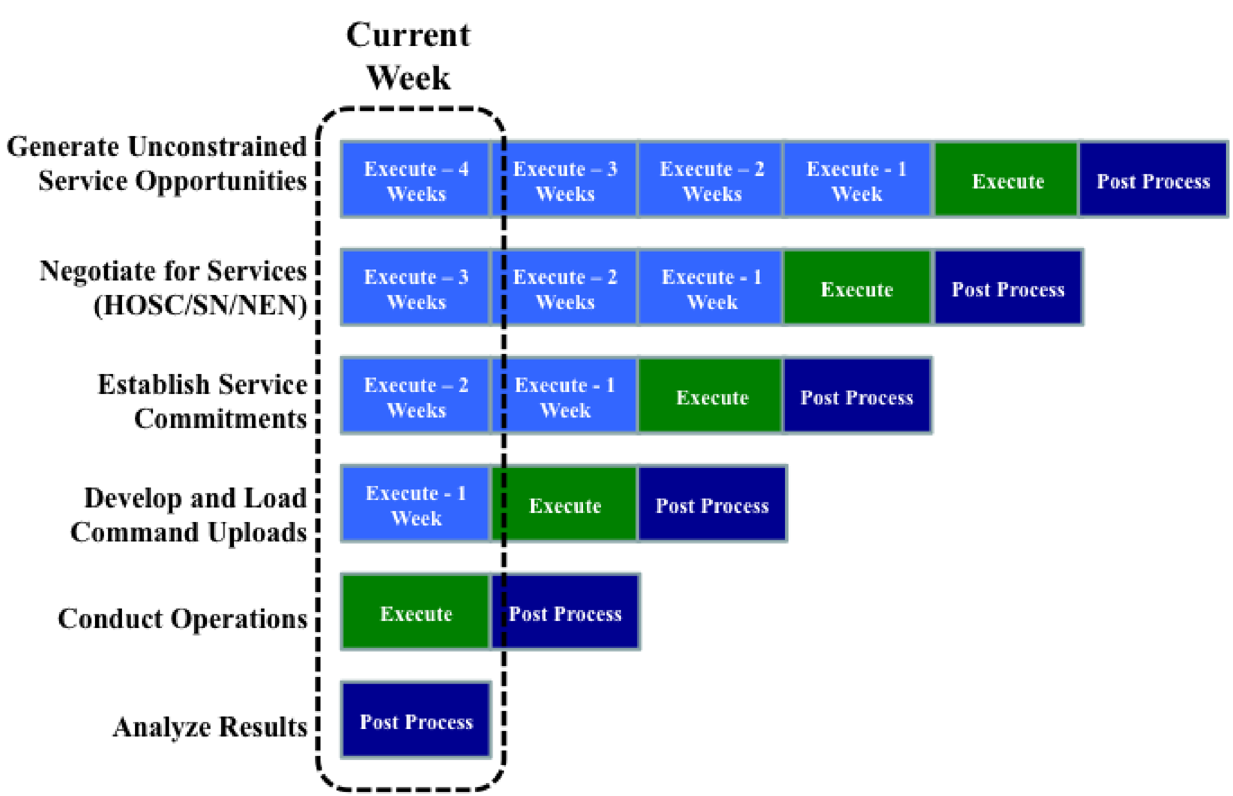

Figure 5-2—Experiment Path Planning

5.6 Flight Data Management

During the course of experiment test run, a variety of data will be generated on various systems. These data can range from Experimenter's data that has been transmitted across space and ground data networks, SDR flight logs, SCaN Testbed flight logs and telemetry, ground command and control logs, and recordings of all telemetry data received at the STCC TReK workstations.

Experimenters will have access to this data during flight operations as well as post mission. Real time or near real time data requirements should be explicitly defined and documented in the Experiment Plan.

A more detailed description of flight data management can be found in CoNNeCT (SCaN Testbed) Project Data Management Plan, GRC-CONN-PLAN-0130.

5.7 Waveform Repository Access

The STRS Repository is a collection of firmware and software modules, definitions, and documents for mission reuse. STRS documentation aids third party developers with the structure under which they can develop new hardware and software modules. Users will want to contribute their waveform applications to the STRS Repository for free use of the SCAN Testbed. Additional information pertaining to the waveform repository is provided in section 8.0 of this handbook.

5.8 On-Orbit Flight Procedures

Experiment-unique on-orbit flight procedures will be developed by the Mission Operations team using inputs from the Experimenter. As discussed in section 6.5, these flight procedures will be developed by the Mission operations team based on test sequences used by Experimenters during functional testing on the GIU.

5.9 Spectral (NTIA and SNUG) Approval

The SCaN Testbed has obtained an Experimental authorization with the National Telecommunications Information Agency (NTIA) to transmit per the provisions stated in Appendix A. In addition, to operate with the Space Network, the Space Network spectral limitations stated in Appendix D of the Space Network User's Guide (SNUG), 450-SNUG, apply. The Deep Space Network imposes additional spectral limitations to limit interference to their systems. These are also defined in Appendix D of SNUG. Appendix D is helpful even for non-SN users. It provides very detailed guidance for calculating the spectral mask and power flux density limits to align with the NTIA authorization. NTIA and SNUG spectral approval applies to transmit waveforms only.

New transmit waveform concepts and designs will be evaluated early to determine whether they are within the current certification parameters. The experimenter is expected to provide the models and analysis to the project to make this determination. If they are not, the extent of the modifications necessary against the existing certification will be evaluated and the effort to adjust the existing certification will be determined.

Although the SCaN Testbed is capable of radiating at other frequencies than those assigned by the NTIA, to obtain regulatory spectrum approval for radiating at these frequencies would require going back to the NTIA/SPS (Spectrum Planning Subcommittee) and amending the current SCAN Testbed spectrum certificate to include the new frequencies and providing the necessary analysis/material to get their approval. Also, within NASA, Johnson Space Center must complete another RF Compatibility (RFC) analysis to assess compatibility with other ISS systems and obtain ISS program approval to operate on these additional frequencies. Coordination with the Space Network Office at Goddard Space Flight Center (GSFC) would also be required if operation with the SN is intended in the new frequencies. There is also an international ITU/SFCG process that needs to be worked through another NTIA subcommittee called the SSS (Space Systems Subcommittee). The time required to obtain the approval to transmit at additional frequencies may be significant.

If the proposed transmit waveform design is determined to be within the current certification parameters, or modifications to the existing certification is allowed, the SCaN Testbed project, with the experimenter's assistance, will verify that the NTIA and SN (if applicable) restrictions are met in the final waveform prior to on-orbit operation. This includes measurement of the transmit power, assuring that the signal falls below the defined spectral mask, and a Power Flux Density (PFD) analysis to assure that the PFD levels are not exceeded.

A significant effort was required to assure compatibility with the Space and Near Earth Network for the waveforms developed and launched with the SCaN Testbed. Instead of repeating the compatibility test process for all new or modified waveforms, an agreement with the Space Network has been obtained to limit the formal compatibility test process. This agreement requires that the project (with SN oversight as needed) perform the appropriate analysis and test to demonstrate the capability and performance of the new waveform and document the results. Formal compatibility testing by the Space Network Compatibility team will only occur if it is determined that there is significant concern that the new waveform will not be compatible with the SN. If any of the SN requirements are not met, the SCaN Testbed project will coordinate with SN and/or ISS to attempt to obtain waivers and understand the likely performance impacts.

6.0 EXPERIMENT PROCESS FLOW

The overall Experiment process spans from the initial selection of the Experiment through on-orbit mission operations. As Experimenters work through the process, they will work with various SCaN Testbed project organizational elements. The Experiment Liaison will work with the Experimenters during the entire process. Through the completion of the Experiment Plan, Experimenters will work closely with the SCaN Testbed Principal Investigator team. Upon completion of the Experiment Plan and through initial phases of mission planning, Experimenters will primarily work with their Experiment Liaison and the SE&I team. Beginning with mission planning, Experimenters will also work closely with the Mission Operations team through completion of on orbit operations. The general flow of the Experiment process is depicted in Figure 6-1.

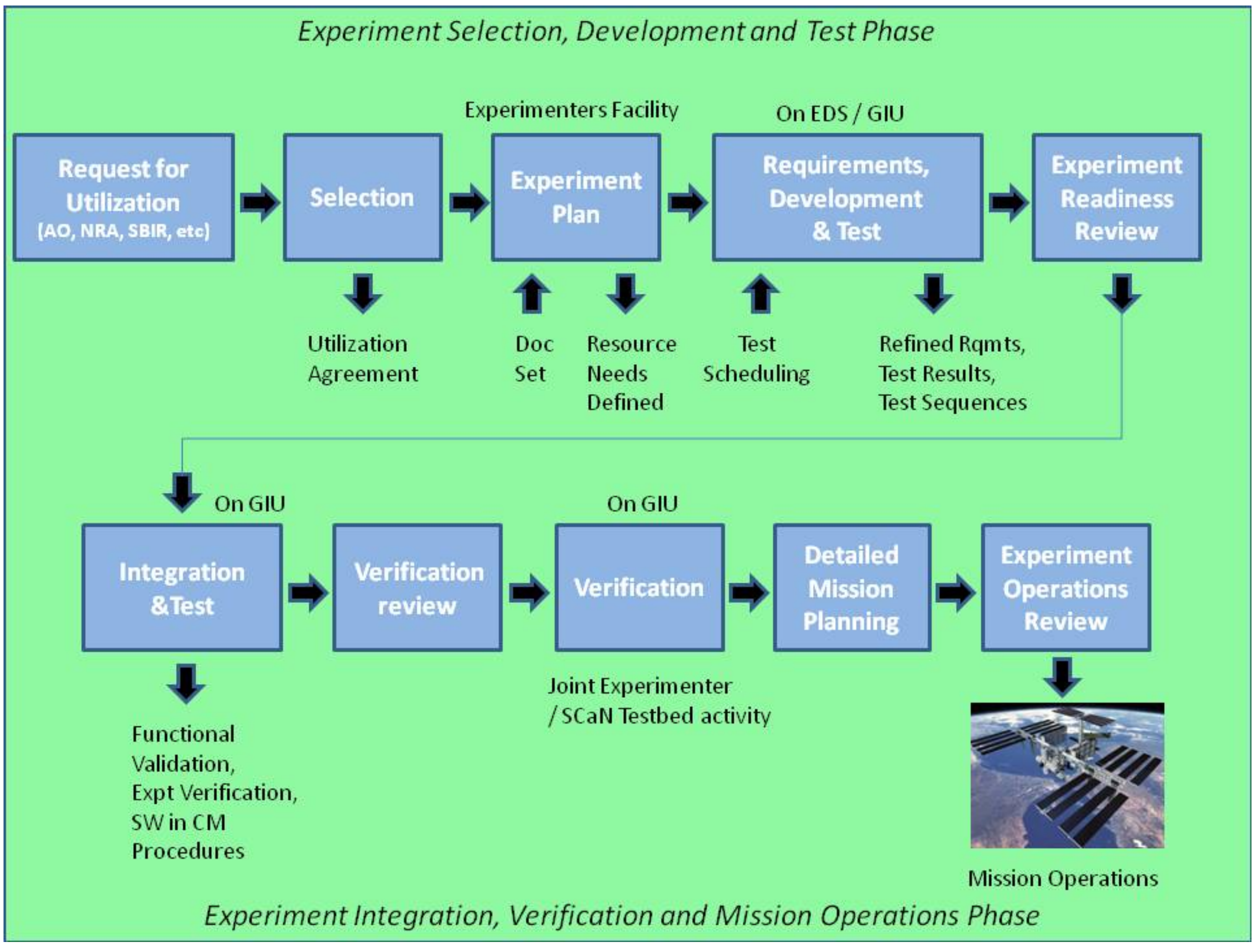

Figure 6-1—Overall Experiment Process Flow

6.1 Requests for Utilization & Selection

For information regarding submission of experiment proposals, please refer to the SCaN Testbed website:

http://spaceflightsystems.grc.nasa.gov/SOPO/SCO/SCaNTestbed/

The outcome of the selection process will be a Utilization Agreement which can take the form of a Space Act Agreement, a grant or a subcontract.

6.2 Experiment Plan

An Experiment Plan will be written by the Experimenter using an Experiment Plan Template. Experiment Plan submittals that contain proprietary information should be marked appropriately.

The Experiment Plan serves a key role in conveying a variety of information from the Experimenter to the SCaN Testbed project. Additionally, the Experiment Plan serves as a means for specifying resources/support to be provided from the SCaN Testbed Project to the Experimenter. Elements of the plan will be used by the SCaN Testbed Project to (a) identify Experimenter developing testing needs on the EDS and GIUSS, (b) experiment-unique support requirements, (c) derive initial requirements for SCaN Test project updates to ground and flight software, (d) establish initial schedules, and (e) begin mission planning.

The Experiment Plan can be developed by providing series of data inputs to a document template, GRC-CONN-PLAN-0907. In some cases, the information requested for the Experiment Plan may reside in existing documents already prepared by the Experimenter organization. Experimenters are encouraged to reference/provide those documents in order to reduce preparation of redundant documentation. The template includes explanatory notes and instructions intended to describe the specific types of information being requested. A summary of the content requested, in the form of the template table of contents, is provided below:

1.0 EXPERIMENT PLAN TEMPLATE INTRODUCTION
- 1.1 Experiment Plan Template Purpose
- 1.2 Experiment Plan Template Scope

2.0 INTRODUCTION
- 2.1 Purpose
- 2.2 Scope

3.0 DOCUMENTS
- 3.1 Applicable Documents
- 3.2 Reference Documents

4.0 EXPERIMENT DEFINITION
- 4.1 Objective
- 4.2 Experiment Concept, Definition and Design summary

5.0 EXPERIMENT ON-ORBIT EXECUTION DESCRIPTION
- 5.1 Experiment Data Flow
- 5.2 Experiment Operational Scenario
- 5.3 Data Rate and Frequency Plan
- 5.4 Commands, Telemetry, and File Description

6.0 MANAGEMENT PLAN
- 6.1 Experiment Point-of-Contact
- 6.2 Experiment Sponsor
- 6.3 Agreement mechanism (Space Act Agreement, Cooperative Agreement, SBIR Contract, etc.)
- 6.4 Roles and Responsibilities
- 6.5 Reporting Plan (interface with Project)
- 6.6 Resources

7.0 EXPERIMENT NEEDS
- 7.1 Requirement Approach Overview
- 7.2 Experiment Activity Requirements
- 7.3 SCaN Testbed Project Requirements

8.0 KEY EVENTS SUMMARY
- 8.1 Project Phases (design, development, ground test, on-orbit test)
- 8.2 Major activities
- 8.3 Key milestones (including reviews)
- 8.4 Deliverables
- 8.5 Dependencies
- 8.6 Ground resource test schedule plan
- 8.7 On-orbit experiment schedule plan

9.0 EXPERIMENT APPROACH BY PHASE
- 9.1 Development and Test Approach
- 9.2 Verification and Validation Approach
- 9.3 On-Orbit Operations Approach
- 9.4 Results Dissemination Phase

Questions regarding the requested content for the Experiment Plan may be directed to the SCaN Testbed PI team and/or the Experiment Liaison, if one has already been named for your experiment.

6.3 Requirements, Development and Test

It's anticipated that the Experimenter and SCaN Testbed Project teams will work together closely and interactively during the development and test period on the EDS and GIU. Information provided in the Experiment Plan will evolve as initial experiment development and testing is performed in the EDS and/or GIU. Data products will be updated to reflect refined Experimenter engineering requirements.

6.3.1 Development and Testing on EDS

After initial development and testing are completed at the Experimenter's facilities, most Experimenters will require access to the EDS to perform additional development and testing on systems which more closely emulate the flight system.

Testing activities will be dependent on the specific nature of the Experiment, but are expected to include:

- Development of waveforms for the SDR's
- Development of Avionics Software
- Development of Ground Software
- Initial development of experiment test sequences/steps

Additionally, Experimenters may have unique test requirements that employ Experimenter-provided test equipment.

As noted in previous sections, the Experiment Plan is used to identify testing requirements, SCaN Testbed project resources requested, schedules and similar types of information. Access to the EDS and other test equipment should be coordinated through the Experiment Liaison.

6.3.2 Development and Testing on GIU

After initial development and testing are completed in EDS, Experimenters will have an opportunity to perform development, functional and performance testing in the GIU. Testing needs will be dependent on the specific nature of the Experiment, but can include high fidelity waveform tests, emulation of ground and space data networks, and final functional testing of changed Avionics and/or ground system software.

As with the EDS testing, Experimenters may have unique test requirements that employ Experimenter-provided test equipment. Experimenter test equipment will need to be reviewed to ensure that it adheres to a basic set of ground support equipment (GSE) guidelines. These guidelines exist to ensure that new equipment interfaced to the GIU will not cause harm. The process for obtaining approval to use Experimenter-provided GSE is provided in Appendix B.

The Experiment Plan is used to identify/update testing requirements, SCaN Testbed project resources requested, schedules and similar types of information. Access to the GIU and other test equipment should be coordinated through the Experiment Liaison.

As an aid to familiarizing the Mission Operations team with the experiment, Mission Operation team members will support the Experimenter in conducting portions of the functional testing on the GIU. In general, the intent is to pair a Mission Controller to work with the Experimenter throughout functional, verification and flight operations.

Prior to conducting testing on the GIU, a Test Preparation Assessment (TPA) will be conducted by the SCaN Testbed Project. This can be performed via teleconference or meeting. The TPA will review:

- Intended use of SDR, Avionics & ground software,
- Confirm safety of testing technical approach,
- EDS test results,
- GSE data package with approvals,
- Test sequence/steps,
- Test schedules.

An important outcome of functional testing on the GIU is confirmation of experiment requirements that were initially documented in the Experiment Plan. In particular, confirmation and further delineation of requirements that trace to (a) changes in SCaN Testbed Avionics software, (b) SCaN Testbed Ground System Software, and (c) scheduling of ISS, SN and NEN support should be completed by the end of these tests. Updated requirements should be documented in an update to the Experiment Plan.

6.4 Experiment Readiness Review

After initial testing and development is completed on the GIU, but prior to conducting pre-flight integration and testing on the GIU, Experimenters will be asked to support a Experiment Readiness Review. The objective of the review is:

- Technology Objective: Determine if sufficient technical maturity of the Experiment has been achieved to support a decision to proceed to integration with project.
- Engineering Objective: Determine that the Experiment is ready to be integrated with Project Engineering. Segments, components, and subsystems are available and ready to be integrated into the SCaN Testbed Project (full ground system, formal process support). Integration facilities, support personnel, and integration plans and procedures are ready for integration. The review will be chaired by the SCaN TestbedDeputy Principal Investigator. Review team members will include representatives from SCaN Testbed SE&I and Mission Operations, and Software Quality Assurance.

The following entrance criteria will be used to confirm that an Experimenter has attained sufficient maturity to hold the review:

- Baseline Agreement (SAA, MOU, etc)
- Baseline Experiment Plan
  - Delivery mechanism
- Evidence that technology has reached sufficient maturity
  - Successful Requirements & Design Review
  - Simulation/coding results that demonstrate system is expected to perform as required
- Project Engineering Requirements
- Baseline Software Management Plan
- Experimenter Software in Software CM Repository
- Verification Plan
- Version Description Document
- Evidence of Compliance for the C/E Requirements Matrix

Upon successful completion of the Experiment Readiness Review, the Experimenter's software will be allowed to be loaded onto the GIU for further development and integration activities.

6.5 Pre-Flight Integration and Test

During the early portions of pre-flight integration and test activities, the SCaN Testbed SE&I team will work with the Experimenter to begin integrating SCaN Testbed project developed software with the Experimenter's software. An example of this could be a new Experimenter-developed waveform that requires changes to the ground software (commands and telemetry) that need to be integrated and tested.

After the early integration and test activities are completed, it's envisioned that Experimenters will need to conduct system level performance tests to characterize performance and verify their requirements.

During the integrated testing, Experimenter developed test scripts will be used by the Mission Operations team to begin development of flight procedures.

After the Experimenter integrated testing is completed, final software files (project and Experimenter) will be submitted into the SCaN Testbed project software CM repository. These final files will form the baseline set to pulled from the CM repository for the Verification test phase.

6.6 Pre-Verification Review

The purpose of the Pre-Verification Review is to validate that Experimenter team, the SE&I team, the Mission Operations team, and other SCaN Testbed team members are fully prepared to perform verification testing.

The objective of the review is to:

- Confirm that all software is resident in the CM repository.
- Confirm that the test procedures are base-lined and ready for use,
- Confirm that specific test objectives can be met with planned test activities,
- Confirm that required test configuration, including GSE set up, is ready for use,
- Define roles and responsibilities for test team,
- Confirm that all test personnel are available to support the test (for both Experiment and SCaN Testbed teams),
- Confirm schedule availability of all required test assets,
- Review results of the preliminary (Experimenter) Verification testing,
- Review JIRAs from previous EDS/GIU tests and confirm adequate resolution,
- Confirm that test will operate within the constraints of the NASA GRC Building 333 room 100W safety permit.

The following products should be available at the time of the review:

- CM-released test procedures
- GSE data package with approvals
- Overall test schedule

6.7 Verification Testing

The primary objective of the verification testing is to confirm that CM-controlled versions of flight and ground software, and final mission operations procedures are ready for flight operations. This will be accomplished by conducting an experiment functional test using the CM-released products. Additionally, implementation of safety-related controls and/or inhibits will be verified.

The verification testing will be conducted on the GIU, using the SCaN TestbedControl Center to conduct test operations.

The verification test will be conducted by members of the Mission Operation team, using the flight mission operation procedures. Experimenters will support the test in a fashion analogous to ISS mission operations. The Mission Operation team will use the verification test to further familiarization of experiment operation, in preparation for flight operations.

Certain aspects of GIU and GSE operation will dictate the use of non-flight procedures. For example, GSE and similar items that emulate portions of the flight operational environment will require non-flight procedures.

6.8 Mission Planning

The mission planning function will be implemented during the overall course of the experiment integration process, though it will have very high focus after the verification test. Initial mission planning data will be obtained from Experiment Plan and subsequent reviews of this data. Additionally, the functional testing on the GIU will provide opportunity to confirm early assessments of the experiment time line.

The Mission Operations team will use the updated Experiment Plan and to schedule SCaN Testbed, ISS, SN, NEN and NISN resources. It is expected that the mission planning process will be somewhat iterative in nature.

Key events in the mission planning timeline for the Experimenter include:

- Joint Review of Experiment Plan
    - Define initial experiment operational requirements.
- Mission Operations Participation in Functional Testing on GIU
    - Confirm/update experiment operational requirements.
- Mission Operations Execution of Verification Testing on GIU
    - Finalize flight procedures.

The ISS and the SN, NEN and NISN data networks all have defined planning protocols and schedules. The Mission Operations team will compile and translate the Experimenter's operational requirements into discrete data inputs for each of these organizations.

6.9 Experiment Operations Review

The purpose of the Experiment operations Review is to validate that the Experimenter team, the Mission Operations team, and other SCaN Testbed team members are fully prepared to conduct flight experiment operational activities.

The objective of the review is to:

- Confirm that Verification Testing was successfully completed.
- Confirm that all required software (ground and flight) is resident in the SCaN Testbed Software CM repository.
- Confirm that all test procedures are base-lined and resident in the SCaN Testbed CM repository.
- Confirm that required ground systems configuration is available for use.
- Confirm roles and responsibilities for the flight operations team.
- Confirm that all test personnel are available to support the operations (for both Experiment and SCaN Testbed teams).
- Confirm that all required training has been completed.
- Confirm schedule availability of all required operational assets.
- Review test issues from previous GIU tests and confirm adequate resolution.
- Confirm operational status of SCaN Testbed and disposition any open anomalies that may impact experiment performance.

The following products should be available at the time of the review:

- Summary of Verification Test Results
- CM-released ground software
- CM-released flight software
- CM-released flight procedures
- Flight Operations Team Training records
- Overall Operational Schedule

6.10 Operations Execution

The SCaN Testbed project nominally plans for mission operations to occur during a normal eastern time zone work week. However, experiment requirements and ISS utilization opportunities will sometimes demand that operations be performed outside of normal business hours.

Experiment operations for the SCaN Testbed will be conducted from the STCC at the NASA GRC TSC in Cleveland, OH. Experiment teams will operate from the STEC also located at the NASA GRC TSC in Cleveland, OH. The STEC is located adjacent to the STCC within the TSC.

The SCaN Testbed Mission Operations team is responsible for overall control and monitoring of the SCaN Testbed payload as well as experiments. Experimenters will provide direct support and guidance to the Mission Operations team. Through the STEC, Experimenters will have access to real time mission data.

7.0 EXPERIMENT REQUIREMENTS

Experimenters who develop experiments for the Software Defined Radios (SDR) are required to be compliant with NASA Procedural Requirements (NPR) 7150.2A, NASA Software Engineering Requirements, requirements applicable to Class E software with some additional requirements (termed Class E+). The requirements applicable to SCaN Testbed experiments are explained below and are listed in a table in Appendix C and defined for SCaN Testbed SDR use as Class E+ requirements.

Software that is developed to run on the SCaN Testbed Avionics Subsystem operates as Class C per NPR 7150.2A and may be rated as Safety Critical. If an Experimenter requires this software to be modified for their experiment, the Experimenter will need to work with SCaN Testbed Project personnel to identify the changes that are needed. SCaN Testbed Project personnel will work with Experimenters to ensure and verify that all Class C and Safety Critical requirements are met.

7.1 Software Management Plan

Experiment developers are expected to develop and implement a Software Management Plan (SMP), in accordance with the standard guidelines of their organization. Experimenters may provide a separate SMP, or provide this information via the Experiment Plan Template. Experiment developers are required to update the SMP during the development phase to keep the information current. The SMP will include:

- a schedule that will be coordinated with the SCaN Testbed Project.
- a cost estimate that covers the entire life cycle of the experiment and is based on the experiment's complexity and size.
- a description of the hardware and software environment for developing the experiment
- a list of hardware or software tools that will be used
- a list of required training.

Experiment developers are required to select a software development life cycle that will be implemented and document it in the SMP.

The schedule will include the following items:

- A Requirements Review to show understanding of SCaN Testbed and the SDR
- A Test Readiness Review to show that the experiment is of sufficient maturity to be tested in the SDR
- Dates for Verification and Validation (V&V)
- Dates for integration with the SCaN Testbed Ground Integration Unit (GIU)
- Dates for V&V on the SCaN Testbed GIU

Experiment developers are required to report schedule status to the SCaN Testbed Project periodically.

Experiment developers are required to develop a software configuration management plan. Minimally, this plan will list the configuration items and show that the software will be under configuration control. The configuration management plan may be included in the SMP.

NASA Software Assurance will conduct an analysis of the experiment software to determine whether or not it is safety critical. In the event that the experiment is determined to be safety critical, the Experiment developer is required to meet NASA-STD-8719.13, Software Safety Standard. Also, a safety-critical designation requires that the software be developed as Class C software, not Class E+.

7.2 Software Test Plan

Experiment developers are required to develop a Software Test Plan (STP). The STP will document the planned software V&V activities (verification shows that the requirements are properly implemented; validation shows that the proper product was built). The planning includes identifying the method (test, analysis, demonstration, or inspection) that will be used to verify each requirement, determining the environment needed to perform the verification (e.g., the SCaN Testbed GIU), and the criteria by which a verification will be determined to be successful. Any validation activities will be similarly planned.

V&V activity results along with an evaluation of the results are required to be documented and provided to the SCaN Testbed Project. Any anomalies detected during V&V are to be recorded. The resolutions to any anomalies are to be worked and tracked until the anomaly is satisfactorily closed out. Some anomalies may not have a correction that is implementable for some reason such as lack of schedule time but may have a workaround. Any problems of this nature along with the workaround are to be reported to the SCaN Testbed Project. In addition, the results of unit testing are to be provided to the SCaN Testbed Project.

7.3 Software Requirements Specification

Experiment developers are required to document the software requirements in a format agreed to with the SCaN Testbed Project. Any changes to the requirements are to be summarized and provided to the SCaN Testbed Project at TBD intervals. The experiment developer is required to document functional requirements, states and modes, external interface requirements, performance and timing requirements, and computer resource requirements in the software requirements document.

In addition to requirements changes, a summary of changes to any products are to be provided to the SCaN Testbed Project. Experiment developers are to notify the SCaN Testbed Project of any changes that threaten the schedule.

7.4 Version Description Document

Experiment developers are required to provide a version description document. This document will identify the version number of the released software, provide data integrity checks for the executable software, and a list of workarounds for open problem reports.

7.5 Software Users Manual

Experiment developers are required to provide a software users manual and any software licenses. A user's manual can be in any format (electronic or paper) and contains the following information:

- A description of the files included and what they do
- Installation instructions
- A list of any new commands and parameter options
- A list of any new telemetry items and their significance
- How to operate the software, a description of its capabilities and options
- Contact information for software problems

7.6 Software Delivery

Prior to the start of Verification testing, Experiment developers are required to deliver their software to the SCaN Testbed project Software CM Repository. Experiments should contanct their Experiment Liaison for specific instructions for the submission process.. Note that this repository is different than the STRA Application Repository; software placed in the project's CM system is used to create the flight payload software builds.

8.0 STRS WAVEFORM APPLICATION REPOSITORY

The STRS Architecture Standard encourages the development of waveform firmware and software that are modular, portable, reconfigurable, and reusable. To enable reuse, the STRS project maintains an STRS application repository containing the STRS compliant applications and associated artifacts to allow waveform applications to be recreated, reused, or ported to STRS compliant platforms across multiple projects, Unlimited or Government Purpose License agreements are being encouraged in all NASA waveform application procurements to enable the reuse aspects. SCaN Testbed experimenters developing waveforms are required to submit the waveforms and corresponding artifacts to the repository as a condition for free use of SCAN Testbed.

SCaN Testbed experimenters will have access to the items in the STRS repository, subject to the constraints in the specific license agreements. Because the SCaN Testbed is the first flight instantiation of STRS, the primary items in the STRS repository that are available are the waveforms developed for the SCaN Testbed.

To reduce the effort to reuse items from the repository and provide the information required to select the appropriate application, a number of artifacts, along with the software and firmware needed to recreate the application, are required to be submitted to the STRS Repository. These artifacts include:

1. The items defined in the STRS Architecture Standard, STRS-AR-00002. Requirement STRS-12 provides a high-level list of the items that must be submitted to the repository to comply with STRS.

   (STRS-12) Application development artifacts shall be submitted to the NASA STRS Repository. The use will be subject to the appropriate license agreements. The application development artifacts shall include the following:

   a. High level system or component software model
   b. Documentation of application firmware external interfaces (e.g., signal names, descriptions, polarity, format, data type, and timing constraints)
   c. Documentation of STRS application behavior
   d. Application function sources (e.g. C, C++, header files, VHDL, Verilog)
   e. Application libraries, if applicable (e.g. EDIF, DLL)
   f. Documentation of application development environment and tool suite
      i. Include application name, purpose, developer, version, and configuration specifics
      ii. Include the hardware on which the application is executed, its OS, OS developer, OS version, and OS configuration specifics
   g. Test plan and results documentation
   h. Identification of Flight Software Development Standards used
   i. Version of STRS Architecture Standard used

2. Additional specific items defined by the SCaN Testbed project to meet the Class E+ classification requirements, as defined in [*section xxx of this document?*]

3. Because the items in the STRS Waveform Repository are to be released by NASA Procedural Requirement (NPR) 2210.1, Release of NASA Software, applies.. The SCaN Testbed Experimenter must work with the STRS project to comply with the items in NPR 2210.1. The information reported must include:
   a. Any programmatic restrictions on release of the software
   b. The software classification (A-H) as defined in NPR 7150.2, NASA Software Engineering Requirements
   c. Whether the software complies with the software engineering and assurance requirements of NPR 7150.2, NASA Software Engineering Requirements, and NASA-STD-8739.8, Software Assurance Standard, for the applicable software classification;
   d. Whether the software is safety-critical software as defined in NASA-STD-8739.8, Appendix A, The Software Assurance Classification Assessment, and if so, whether it complies with the software safety requirements of NASA-STD-8719.13, Software Safety Standard;
   e. The software's Technology Readiness Level (TRL) as defined in NPR 7120.8, NASA Research and Technology Program and Project Management Requirements (and reproduced in Appendix E of NPR 2210.1);
   f. Any software documentation, as defined in paragraph NPR 2210.1 section A.1.14, that is proposed (or available) for release with the software (e.g. owner's manuals, user's manuals, installation instructions, operationg instructions);
   g. Whether any known export restrictions apply to the software;
   h. Whether the software includes any Open Source or other third party software;
   i. Whether Open Source Release of the software is proposed; and
   j. Whether the software includes any embedded computer databases.
   k. Whether the software is Section 508 compliant.

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.

Further regarding the STRS Architecture Standard, STRS-AR-0002, STRS Software Architecture Concepts and Analysis, NASA/TP—2008-214813, and STRS Definition and concepts, NASA/TM-2008-215445.

9.0 ROLES AND RESPONSIBILITIES

This section provides a general overview of the anticipated responsibilities of both NASA and the experimenter. A Space Act Agreement (SAA) or Memorandum of Mutual Understanding (MMU) will be the official vehicle for defining the specific roles and responsibilities of each party.

9.1 NASA

The SCAN Program will provide approved experimenters the following:

9.1.1 Liaison

An Experiment Liaison will be provided by the SCaN Testbed project and is the primary interface between the Project and the Experimenter. The liaison will assist the experimenter in gaining access to ground assets, aid Experimenters in gaining information from project documents, and assist where needed during operations.

The liaison will be responsible for advising and guiding the experimenter through the development process. Specifically, the liaison will:

1. Serve as advocate for the Experimenter within the project,
2. Provide SCaN Testbed expertise and general information to experimenter,
3. Ensure Subject Matter Experts (SME's) are provided by the Project to aid experimenters in implementing their applications on either the SDR or avionics, as needed. The SME will:
    a. Be a recognized expert with a particular SDR used by the Experimenter
    b. Assist the Experimenter with application waveform implementation and/or verification testing with target SDR or avionics breadboard and engineering units
4. Review the Experimenters' Experiment Plan and assist the Experimenter from development through implementation of their experiment,
5. Assist the Experimenter in preparing for the required reviews to progress through the development process,
6. Review all experiment simulation and test data and make recommendations to the PI on advancing the Experimenter to breadboard or GIU testing,
7. Coordinate with technical experts, software, and operations support for the Experimenter,
8. Coordinate with project scheduler for access to ground assets (EDS, GIU) and SCAN Testbed,
9. Negotiate, on behalf of the Experimenter, with the Mission Operations Lead for resources and available experiment time for conducting experiment operation,

10. Guide Experimenter through the use of the hardware and software systems in the STEC (e.g., TReK workstation, CTADs, similar).

9.1.2 System Engineering & Integration

SCaN Testbed SE&I team members will work with Experimenters during testing on the EDS and GIU systems. This support may range from assistance in powering on systems to accessing test data that is stored on various systems.

9.1.3 Subject Matter Experts

Subject Matter Experts (SMEs) will be assigned when questions regarding the functionality of the various SDRs, the Avionics subsystem, the TDRSS simulators (TSIMs), and the ground systems arise during the planning and execution of the experiment.

9.1.4 Configuration Management

Configuration Management (CM) personnel provide data management tools and services for all engineering design, data, and documentation generated. This also includes the experimenter developed and delivered software and documentation. Maintains data and information according to NASA Glenn Research Center product data management processes and practices; provide necessary indexing, referencing, storage, and retrieval functions.

Specifically, CM will:

1. Configuration-manage all project developed software prior to uploading to the SCAN Testbed on the ISS for experiment operations

2. Experiment developed software used on the GIU for verification and/or SCAN Testbed and/or exchanged in the STRS

3. Configuration-manage the required documentation developed in this process, including flight procedures.

9.1.5 Mission Operations

The Mission Operations team will be responsible for the overall coordination and implementation of all activities required to operate the SCAN Testbed on the International Space Station.

Specifically, the Mission Ops Lead will:

1. Develop experiment operational and timeline requirements

2. Perform Mission Operations and upload experiment and system software for conducting experiment operations

3. Perform mission operation training and planning

4. Negotiate with the liaison for resources and available experiment time for conducting experiment operation

5. Process schedule requests for the International Space Station (ISS), Near Earth Network (NEN), Space Network (SN), and NASA Integrated Services Network (NISN)

6. Coordinate with the PI, LSE and Liaison to assure the development of plans and procedures to be used during flight experiment operations

7. Coordinate with the LSE in anomaly resolution

9.2 Experimenter

The Experimenter will interface with the Experiment Liaison and will have the overall responsibility for the investigation and the experiment team. The responsibilities of the Experimenters include:

1. Provide for the resources to conduct the experiment, including financial and personnel,
2. Develop their Experiment Plan and related documentation,
3. Develop their unique science/technology requirements,
4. Develop algorithms/firmware/software to implement their experment,
5. Port and test software/firmware on the breadboards or GIU, with assistance from the liaison or SME,
6. Perform science/technology verifications on the GIU,
7. Perform experiment operations on the SCAN Testbed on the ISS,
8. Publish findings.

10.0 STANDARD SERVICES

Per the agreement with Experimenter, the NASA SCaN Testbed Project and/or NASA SCAN will provide the following services at no cost to approved SCaN Testbed Experimenters:

1. Experiment Integration Support Personnel, including Experiment Liaison
2. Access to Subject Matter Experts,
3. Access to EDS for development and test,
4. Access to GIU and SS for development, test and verification,
5. Mission Planning Support Personnel,
6. Mission Operation Support Personnel,
7. Periodic status updates on experiment integration and mission planning,
8. TSC Access and Basic STEC Services,
9. Coordination of SN, NEN and NISN Data Network Services,
10. Use of SN, NEN and NISN Data networks for experiment operations,
11. Scheduling of SCaN Testbed experiment time,
12. Access to data from the ground support equipment, data acquisition systems, spacecraft telemetry and network operations that are collected and available.

11.0 LOGISTICS

11.1 IT Security

11.1.1 RSA Tokens

Experimenters requiring access to the SCaN Testbed eRoom repository of reference documents will require an RSA token. The token provides a changing access code, that when used with a static username and passcode, enables access to the eRoom. Requests for obtaining a token may be submitted to the following email address:

scan-testbed-questions@lists.nasa.gov

Please note that tokens can only be provided to U.S. citizens.

11.1.2 Remote Network Access to SCaN Testbed Resources

Remote network access to the Experiment Development System (EDS) can be achieved on the internal GRC network. External remote access for off-site experimenter access to the EDS may be provided on a case-by-case basis and in compliance with NASA IT policies. Remote access to the GIU and the support systems will not be provided.

11.2 Physical Access to NASA Glenn Research Center

Depending on the experiment, the Experiment Liaison will determine what level of badging is necessary for those without a NASA badge.

11.2.1 Visitor

Experimenters that need access to GRC for not more than 15 days in a 365 day period may be processed as a Visitor. Visitors are required to show a state-issued picture identification at the time of badging. Lawful Permanent Residents (LPRs) are required to present their permanent resident card.

11.2.2 Temporary

Experimenters that need access to GRC for more than 15 days but less than 180 days within a 365 day period will need a temporary badge. Experimenters that need a temporary badge will work with their technical liaison in completing NASA C-9975. This will need to be completed BEFORE their first expected day at the NASA GRC campus. As an option, Experimenters can come in as a visitor prior to receiving a temporary badge.

APPENDIX A NTIA AUTHORIZATION

FOR INFORMATION Doc. 37746/1

FORM NTIA-44 (3/91) U.S. DEPARTMENT OF COMMERCE NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION CERTIFICATION OF SPECTRUM SUPPORT	Classification: UNCLASSIFIED	Control Number: SPS-17358/1

Recipient Agency	System	Stage of Review
NASA	**Communications, Navigation and Networking Reconfigurable Testbed (CoNNeCT)**	2 – Experimental

Section 1: OPERATING CHARACTERISTICS FOR WHICH SUPPORT IS CERTIFIED

Frequency (MHz)	Emission	Mean Power (W)	Station Class (Stage 4)	Transmit Location	Receive Location
2041.027 2106.406	800KG1D	200.0	TH	White Sands, NM Wallops Island, VA	CoNNeCT (Space)
2216.5	5M00G1D	8.9	EH	CoNNeCT (Space)	White Sands, NM Wallops Island, VA
2287.5		7.55			
2216.5	315KG1D 528KG1D 6M00G1D	8.9			Tracking and Data Relay Satellites (41° W, 174° W, 85° E)
2287.5	740KG1D 4M00G1D 6M00G1D				
25650	25M0G1D 50M0G1D 100MG1D 225MG1D	40.0	ES		
25795	25M0G1D 50M0G1D				

Section 2: SOURCE DOCUMENTS

Docket Number	Description of Document	Dated
SPS-17112/2	NASA Replacement Request for Stage 2 System Review	January 26, 2010
SPS-17263/1	NTIA Preliminary Assessment	January 11, 2010

Section 3: SPS RECOMMENDATIONS

The Spectrum Planning Subcommittee has reviewed this system under the provisions of Chapter 10 of the NTIA Manual, noting that this system may not progress to Stage 4 (operational) status, and recommends that:

1. NTIA certify Stage 2 spectrum support for the Communications, Navigation and Networking Reconfigurable Testbed (CoNNeCT), as specified in Section 1.
2. NASA be aware that for earth station transmitters at White Sands, NM and Wallops Island, VA on the 2041.027 MHz and 2106.406 MHz frequencies, coordination is required with non-federal terrestrial receiving stations at fixed sites, in accordance with Footnote US346 to the National Table of Frequency Allocations.
3. NTIA waive compliance with the power flux-density (PFD) limits specified in Section 8.2.36 of the NTIA Manual for the space-to-Earth and space-to-space transmissions of this system using the frequencies 2216.5 MHz and 2287.5 MHz that exceed the specified PFD limits by as much as 16 dB but can comply with alternate PFD criteria, as stipulated in guidance provided to the SPS by the IRAC (Ref. SPS-12038/1). An antenna off-pointing algorithm requires that earth horizon offset angles up to 25.9° be maintained, depending upon the emissions, to ensure compliance with the alternate criteria.
4. NASA be aware that the space-to-space TDRS return link transmissions of this system using the frequencies 25650 MHz and 25795 MHz can potentially exceed the PFD limits specified in Section 8.2.36 of the NTIA Manual, and an antenna off-pointing algorithm requires that earth horizon offset angles up to 2.2° must be maintained, depending upon the emissions.
5. NASA submit ITU Appendix 4 data to the Space Systems Subcommittee (SSS) for international registration.
6. NASA ensure that personnel are protected from radiation levels that exceed generally accepted exposure criteria.

Name/Title of Recommending Official	Signature	Date
Stephen J. Butcher SPS Chairman	Stephen J. Butcher	APR 07 2010

Section 4: NTIA CERTIFICATION

The Office of Spectrum Management certifies Stage 2 spectrum support for this system.

This office concurs with the SPS recommendations in Section 3.

Name/Title of Certifying Official	Signature	Date
Edward M. Davison Deputy Associate Administrator	Earl M. D[illegible]	APR 07 2010

Downgrading Instructions	Classification	Distribution
	UNCLASSIFIED	IRAC, SPS, FAS

APPENDIX B GROUND SUPPORT EQUIPMENT APPROVAL

B.1 Approval of Ground Support Equipment Interfacing to the GIU

All test/development ground support equipment (GSE) that is intended to be interfaced to the GIU will be evaluated for its potential to cause damage to the GIU. In some cases, GSE will be directly interfaced to the GIU, while in other cases the equipment may be interfaced to an intermediate element such as one of the TEI racks. A key concept in the evaluation the equipment's potential for damaging GIU is ability for a failure occurring in the test/development equipment to propagate and damage the GIU. For example, a fault in a waveform signal generator that interfaces directly to an antenna port on the GIU itself has clear potential for propagating a signal of excessive power into the SDR. Likewise, it is possible for waveform signal generator that interfaces to a TEI rack and then to the GIU to propagate a signal of excessive power into the SDR. In both cases, the equipment generating the signal must have controls in place to limit the output power and thus mitigate the risk of damage to the GIU and the support systems.

The Experimenter is responsible for collecting, analyzing and/or producing all of the required information needed for the SCaN Testbed Project to approve GSE for use with the GIU. The requirements for Commercial-Off-The-Shelf (COTS) equipment differ slightly from custom developed equipment. In the case of equipment which is comprised of both COTS and custom items, a hybrid evaluation approach will be required.

A summary of data/activities that are needed for GSE is provided in Table B-1.

Table B-1—GSE Approval Requirements Summary

	Laptops / Desktop computers	Cables and Harnesses	COTS Equipment	Custom Equipment	Test Software
GIDEP Search	X		X		
Virus Scan at Point of Use	X				
Installed Software Review	X			X	
Wiring Diagrams		X		X	
Continuity Checks		X			
Calibration Data			X	X	
Interface Compatibility Analysis	X		X	X	
UL Listing	X	X	X	X	
FMEA Results				X	
Acceptance Test Results				X	
Post Ship Physical Inspection	X	X	X	X	
Post Ship functional Test results	X		X	X	
Test Results					X
Evidence of CM Version Control					X

The following paragraphs identity the means for assessing common types of GSE. If an Experimenter needs to use a piece of GSE that does not fit the general descriptions provided, please contact your Experiment Liaison to identify the appropriate assessment approach.

B.2 GSE Evaluation Techniques

B.2.1 GIDEP Searches

For most COTS items, a search of the Government-Industry Data Exchange Program databases will be performed to confirm that the COTS item in question does not have known issues and quality problems that would make it unsuitable for use as GSE with the GIU.

Organizations that have access to the GIDEP system are required to perform and document the results of the GIDEP search for all COTS equipment. For those organizations that do not have access to the GIDEP system, the SCaN Testbed Project will arrange to have the GIDEP search performed based on a submitted GSE equipment list.

GIDEP searches are most commonly performed on COTS equipment such as hand held meters, oscilloscopes, power supplies, bench top equipment, specialized RF components, and personal computers.

B.2.2 Performance Inspections/Analyses

For equipment that will interface to the RF circuits of the GIU, inspection and analysis of the technical data sheets or equivalent will need to be performed to confirm that when the equipment is operated in modes that will produce the highest power output signals, that these signal levels are below the relevant signal strength limitations for the interface point in question. Tables are provided at the end of this section to define signal limitations at the common GIU interface ports. The tables are organized by SDR.

In the event an inspection reveals that it is possible to operate the equipment such that the signal strength limit can be exceeded, some form of fixed attenuation will be required.

B.2.3 FMEA

For custom GSE equipment, a standard method for evaluating the potential for the GSE to cause damage to the GIU is the completion of a Failure Modes and Effects Analysis (FMEA). The purpose of the FMEA is to posit potential failure modes within the GSE and determine the severity of the impact of the failure, as well as its potential to propagate into a damaging event in the GIU. The failure modes should encompass hardware failures as well as operator errors that could lead to an event which causes damage to the GIU. The SCaN Testbed Project can provide examples of FMEA's to aid Experimenters in performing their own analyses.

B.2.4 Testing

Testing is performed to demonstrate/confirm specific attributes of equipment. It may take the form of functional acceptance testing for more complex GSE or range to simple continuity tests for a cable. Additionally, testing may be used to demonstrate that a particular interface port has signal levels that are within the allowable limits for a given GIU interface point. Post shipment testing is performed to confirm that GSE was not damaged during the shipping process and to confirm its readiness to be used with the GIU.

B.2.5 Physical Inspections

After shipment to NASA GRC, physical inspections of GSE will be performed by the SCaN Testbed Project to confirm that no damage was caused during shipping. Additionally, post shipment inspections will seek to confirm that the overall condition of the equipment is adequate for its intended use. For obvious reasons, this step of the certification process will need to occur at NASA GRC.

B.3 Requirements for Specific Classes of GSE

B.3.1 Laptop & Desktop Personal Computers

For laptops and desktop personal computers that will interface to GIU, particularly the serial debug/test ports of the SDRs, the following are required for approval for use:

1. Perform a GIDEP Search and confirm that no issues are noted in database.
2. Perform a virus scan with an up to date virus definition file prior to interfacing with GIU
3. Perform an inspection of the software to be used.
4. Post shipment inspection by SCaN Testbed Project personnel for visible damage and overall condition.

B.3.2 Cables and Harnesses

For each test cable or harness that will be interfaced to the GIU, Experimenters will be required to provide the following:

1. A pin to pin wiring diagram with pin functions defined.
2. Results of a pin to pin continuity test to confirm continuity to wiring diagram.
3. Results of a pin to every other pin continuity test to confirm that no short circuits exist. High potential insulation resistance testing is not required.
4. For RF co-ax cables, testing should include full 2 port S-parameters.

After arrival at NASA GRC, the following is required:

1. A post shipment inspection by SCaN Testbed Project personnel for visible damage and overall condition prior to use with the GIU.

These requirements apply both to Experimenter custom built and COTS cables and harnesses.

B.3.3 COTS Test Equipment

For each piece of COTS test equipment that will be interfaced to the GIU, Experimenters will be required to provide the following:

1. Evidence that the equipment is within its calibration period.
2. If calibration data is not available, results of vendor perform acceptance testing.
3. Results of inspection/analysis to show interface port signal compatibility with GIU interface port limits.
4. Evidence of UL Listing if available.

After arrival at NASA GRC, the following is required:

1. Post shipment inspection by SCaN Testbed Project personnel for visible damage and overall condition.
2. Evidence of a successful post shipment functional acceptance test (i.e., unit boots, unit completes self calibration, etc) prior to use with the GIU.

B.3.4 Custom or COTS/Custom Test Equipment

For each piece of custom or combination of COTS/custom test equipment that will be interfaced to the GIU, Experimenters will be required to provide the following:

1. Results of FMEA to demonstrate that no failure modes can propagate and lead to damage of the GIU.
2. Evidence that the COTS equipment is within its calibration period.
3. If COTS calibration data is not available, results of vendor perform acceptance testing.
4. Results of performance and acceptance testing of the custom equipment.
5. Results of inspection/analysis to show interface port signal compatibility with GIU interface port limits.
6. Evidence of UL Listing if available.
7. Written, signed off, Operating Procedure.

After arrival at NASA GRC, the following is required:

1. Post shipment inspection by SCaN Testbed Project personnel for visible damage and overall condition.
2. Evidence of a successful post shipment functional acceptance test (i.e., unit boots, unit completes self calibration, etc) prior to use with the GIU.

B.3.5 Test Software

Software of differing sources will be used on the various GSE types. Listed below are three categories of software that may be used on Ground Support Equipment (GSE) and Software Assurance activity related to each category. Pre-loaded software provided as part of a COTS item is not included and is not required to meet any of these requirements (for example, built in software on a COTS multi-meter). Listed under each category are examples (lower case letters, a, b, etc) and the associated software assurance activities (lower case roman numerals, i, ii, iii, etc). Software of differing categories may be used on the same GSE.

1. Purchased Software (COTS) that‘s loaded one time on a GSE laptop or PC.
    a. Example; OS like Microsoft XP, Windows 7, MS Word, Anti-Virus etc
        i. Come from a licensed source CD or factory loaded (License on back of PC).
        ii. Any open source tool requires special consideration.

2. Experimenter developed software that is used on GSE laptop or PC connected to flight hardware.
    a. Example; Tools written to help loading waveform software.
    b. Example; Tools written to collect data for later analysis not used in verification.
        i. Meet Class E requirements
        ii. Indicate testing that was done to verify correct operation
        iii. Version controlled in a CM system
        iv. Have written operation procedure

3. Experimenter developed software tools to simulate components (GSE) that connect to flight hardware
    a. Example; ELC Simulator Software (GSFC)
    b. Example; KaTSIM Software
        i. Identify who and how software was obtained.
        ii. Identify history of software. Document any known problems.
        iii. Version controlled in CM system
        iv. Have written operation procedure

B.4 Environmental Requirements

The GIU is located in a class 100,000 clean room facility at NASA GRC. All GSE that is intended to interface directly with the GIU will need to meet the following general clean room requirements:

1. Equipment external surfaces must be capable of being brought to Visibly Clean Sensitive per JSC SNC 0005. Lint free wipes and isopropyl alcohol will be available to clean incoming equipment.

2. Equipment should not release particulate matter into clean room environment.

3. Equipment should be compatible with an operating environment of 65 to 75 F and relative humidity ranging from 30% to 70%.

B.5 SDR and Test Point Interface Signal Limitations

The maximum allowable signal strengths that may be applied to various GIU RF subsystem interface points are defined in drawing 080911EGS708. Experimenters wishing to interface GSE to these locations will be required to show that the GSE is not capable of producing signals greater than the specified limits.

B.6 Approval Process

Prior to conducting testing on the GIU at NASA GRC, Experimenters will need to provide a list of the GSE intended to be used along with the data products defined in Table B.1.

Additionally, for COTS equipment, please provide Manufacturer, Model, and Serial Number. For custom equipment, please provide a design description document, functional block diagram, supply power interface description, power requirements, and operational information.

The data should be provided to the Experiment Liaison 3 weeks prior to arrival at NASA GRC in order to facilitate an appropriate review of the information. Upon [1] successful review/acceptance of the data package, [2] post ship physical inspection at NASA GRC, and [3] post shipment functional testing, the GSE equipment will be approved for use with the GIU.

APPENDIX C NPR 7150.2A CLASS E+ REQUIREMENTS

The following table is a tailored, extended version of Appendix E from NASA Software Engineering Requirements, NPR 7150.2A. It addresses the unique requirements of the SCaN Testbed wherein modification of the software is a key element of the experiment.

The left most column refers to the NPR 7150.2A requirement, the center column is the explicit wording of the requirement and the right most column is the tailored, minimum requirement for the SCaN Testbed Experimenter software for non-Avionics software.

NPR 7150.2A Requirement Number	Requirement Wording	Minimum Requirements for non-Avionics flight software
SWE-001	This NPR shall be applied to software development, maintenance, retirement, operations, management, acquisition, and assurance activities started after its initial date of issuance [SWE-001].	
SWE-013	The project shall develop software plan(s). [SWE-013]	Experimenters need to develop a SMP and STP. The SMP may be included in the Experiment Plan.
SWE-014	The project shall implement, maintain, and execute the software plan(s). [SWE-014]	Experimenters need to implement and maintain a SW development schedule.
SWE-015	The project shall establish, document, and maintain at least one software cost estimate and associated cost parameter(s) that satisfies the following conditions: [SWE-015] a. Covers the entire software life cycle. b. Is based on selected project attributes (e.g., assessment of the size, functionality, complexity, criticality, and risk of the software processes and products). c. Is based on the cost implications of the technology to be used and the required maturation of that technology.	Experimenters need to provide one cost estimate, covering the entire life cycle, based on size, complexity. The cost estimate may be included in the Experiment Plan.
SWE-016	The project shall document and maintain a software schedule that satisfies the following conditions: [SWE-016] a. Coordinates with the overall project schedule. b. Documents the interactions of milestones and deliverables between software, hardware, operations, and the rest of the system. c. Reflects the critical path for the software development activities.	Experimenters need to provide a software development schedule. The schedule may be included in the Experiment Plan.

NPR 7150.2A Requirement Number	Requirement Wording	Minimum Requirements for non-Avionics flight software
SWE-018	The project shall regularly hold reviews of software activities, status, and results with the project stakeholders and track issues to resolution. [SWE-018]	Experimenters need to support a requirements review to confirm understanding of SCaN Testbed and the SDR along with a test readiness review
SWE-019	The project shall select and document a software development life cycle or model that includes phase transition criteria for each life cycle phase (e.g., formal review milestones, informal reviews, software requirements review (SRR), preliminary design review (PDR), critical design review (CDR), test readiness reviews, customer acceptance or approval reviews). [SWE-019]	Minimum set: internal V&V, integration with our GIU, V&V on GIU
SWE-020	The project shall classify each of system and subsystem containing software in accordance with the software classification definitions for Class A, B, C, D, E, F, G and H in Appendix E. [SWE-020]	Choose E for waveforms and similar, Choose C if the SCaN Testbed's Avionics software will need to be modified.
SWE-021	If a system or subsystem evolves to a higher software classification as defined in Appendix E, then the project shall update its plan to fulfill the added requirements per the Requirements Mapping Matrix in Appendix D. [SWE-021]	Experimenters to meet requirement as written
SWE-022	The project shall implement software assurance per NASA-STD-8739.8, NASA Software Assurance Standard. [SWE-022]	Experimenters shall implement software assurance per organization guidelines.
SWE-023	When a project is determined to have safety critical software, the project shall ensure that the safety requirements of NASA-STD-8719.13, Software Safety Standard, are implemented by the project. [SWE-023]	If the software is safety-critical , it is Class C.
SWE-028	The project shall plan software verification activities, methods, environments, and criteria for the project. [SWE-028]	Experimenters shall address these items in the STP
SWE-029	The project shall plan the software validation activities, methods, environments, and criteria for the project. [SWE-029]	Experimenters shall address these items in the STP
SWE-030	The project shall record, address, and track to closure the results of software verification activities. [SWE-030]	Experimenters to meet requirement as written
SWE-031	The project shall record, address, and track to closure the results of software validation activities. [SWE-031]	Experimenters to meet requirement as written

NPR 7150.2A Requirement Number	Requirement Wording	Minimum Requirements for non-Avionics flight software
SWE-049	The project shall document the software requirements. [SWE-049]	Experimenters to document requirements in electronic format readable by NASA.
SWE-053	The project shall collect and manage changes to the software requirements. [SWE-053]	Experimenters to provide summary of changes to NASA.
SWE-062	The project shall ensure that the software code is unit tested per the plans for software testing. [SWE-062]	Experimenters to provide results of unit testing to NASA.
SWE-063	The project shall provide a Software Version Description document for each software release. [SWE-063]	Experimenters to document version number of the executable software, data integrity checks for the executable code, open problem reports with workarounds
SWE-065	The project shall establish and maintain: [SWE-065] a. Software Test Plan(s). b. Software Test Procedures. c. Software Test Reports.	Experimenters to provide test plan and test reports
SWE-066	The project shall perform software testing as defined in the Software Test Plan. [SWE-066]	Experimenters to provide test results.
SWE-068	The project shall evaluate test results and document the evaluation. [SWE-068]	Experimenters to provide test results.
SWE-069	The project shall document defects identified during testing and track to closure. [SWE-069]	Experimenters to provide list of problem reports with workarounds
SWE-077	The project shall complete and deliver the software product to the customer with appropriate documentation to support the operations and maintenance phase of the software's life cycle. [SWE-077]	Experimenters to provide a user guide or operations manual, licenses for any licensed sotware, version description
SWE-079	The project shall develop a Software Configuration Management Plan that describes the functions, responsibilities, and authority for the implementation of software configuration management for the project. [SWE-079]	Experimenters to develop a SW CM Plan that ensures code is under CM control; may be just a section of the SW Management Plan (or Experiment Plan)
SWE-080	The project shall track and evaluate changes to software products. [SWE-080]	Experimenters to provide summary of changes to NASA and notify NASA of any changes that threaten the schedule.

NPR 7150.2A Requirement Number	Requirement Wording	Minimum Requirements for non-Avionics flight software
SWE-081	The project shall identify the software configuration items (e.g., software documents, code, data, tools, models, scripts) and their versions to be controlled for the project. [SWE-081]	Experimenters to identify the software configuration items
SWE-085	The project shall establish and implement procedures for the storage, handling, delivery, release, and maintenance of deliverable software products. [SWE-085]	Experimenters to develop a release process for delivering software products to NASA or NASA may develop one in which case this requirement goes away
SWE-102	The Software Development or Management Plan shall contain: [SWE-102] a. Project organizational structure showing authority and responsibility of each organizational unit, including external organizations (e.g., Safety and Mission Assurance, Independent Verification and Validation (IV&V), Technical Authority, NASA Engineering and Safety Center, NASA Safety Center). b. The safety criticality and classification of each of the systems and subsystems containing software. c. Tailoring compliance matrix for approval by the designated Engineering Technical Authority, if the project has any waivers or deviations to this NPR. d. Engineering environment (for development, operation, or maintenance, as applicable), including test environment, library, equipment, facilities, standards, procedures, and tools. e. Work breakdown structure of the life-cycle processes and activities, including the software products, software services, non-deliverable items to be performed, budgets, staffing, acquisition approach, physical resources, software size, and schedules associated with the tasks. f. Management of the quality characteristics of the software products or services. g. Management of safety, security, privacy, and other critical requirements of the software products or services. h. Subcontractor management, including subcontractor selection and involvement between the subcontractor and the acquirer, if any. i. Verification and validation. j. Acquirer involvement. k. User involvement. l. Risk management. m. Security policy. n. Approval required by such means as regulations, required certifications, proprietary, usage, ownership, warranty, and licensing rights.	Experimenters to include schedule, life cycle, cost estimate (non-University only), software and hardware environment, software and hardware tools, V&V plan (may be separate document), training plans, CM plan in Experiment Plan.

NPR 7150.2A Requirement Number	Requirement Wording	Minimum Requirements for non-Avionics flight software
	o. Process for scheduling, tracking, and reporting. p. Training of personnel, including project unique software training needs. q. Software life-cycle model, including description of software integration and hardware/software integration processes, software delivery, and maintenance. r. Configuration management. s. Software documentation tree. t. Software peer review/inspection process of software work products. u. Process for early identification of testing requirements that drive software design decisions (e.g., special system level timing requirements/checkpoint restart). v. Software metrics. w. Content of software documentation to be developed on the project. x. Management, development, and testing approach for handling any commercial-off-the-shelf (COTS), government-off-the-shelf (GOTS), modified-off-the-shelf (MOTS), reused, or open source software component(s) that are included within a NASA system or subsystem.	

NPR 7150.2A Requirement Number	Requirement Wording	Minimum Requirements for non-Avionics flight software
SWE-116	The Software Version Description shall identify and provide: [SWE-116] a. Full identification of the system and software (i.e., numbers, titles, abbreviations, version numbers, and release numbers). b. Executable software (i.e., batch files, command files, data files, or other software needed to install the software on its target computer). c. Software life-cycle data that defines the software product. d. Archive and release data. e. Instructions for building the executable software including, for example, the instructions and data for compiling and linking and the procedures used for software recovery, software regeneration, testing, or modification. f. Data integrity checks for the executable object code, and source code. g. Software product files (any files needed to install, build, operate, and maintain the software). h. Open change requests and or problem reports, including any workarounds. i. Change requests and/or problem reports implemented in the current software version since the last Software Version Description was published.	Experimenters to document version number of the executable software, data integrity checks for the executable code, open problem reports with workarounds
SWE-120	For those cases in which a Center or project desires a general exclusion from requirement(s) in this NPR or desires to generically apply specific alternate requirements that do not meet or exceed the requirements of this NPR, the requester shall submit a waiver for those exclusions or alternate requirements for approval by the NASA Headquarters' Chief Engineer with appropriate justification. [SWE-120]	Experimenters to meet requirement as written
SWE-121	Where approved, the requesting Center or project shall document the approved alternate requirement in the procedure controlling the development, acquisition, and/or deployment of the affected software. [SWE-121]	Experimenters to meet requirement as written

NPR 7150.2A Requirement Number	Requirement Wording	Minimum Requirements for non-Avionics flight software
SWE-125	Each project with software components shall maintain a compliance matrix against requirements in this NPR, including those delegated to other parties or accomplished by contract vehicles. [SWE-125]	Experimenters to meet requirement as written
SWE-132	The project's software assurance organization shall perform an independent classification assessment. [SWE-132]	Experimenters to meet requirement as written
SWE-133	The project, in conjunction with the Safety and Mission Assurance organization, shall determine the software safety criticality in accordance with NASA-STD-8739.8. [SWE-133]	Experimenters to meet requirement as written
SWE-139	Centers and projects shall fully comply with the "shall" statements in this NPR that are marked with an "X" in Appendix D consistent with their software classification. [SWE-139]	Experimenters to meet requirement as written
SWE-140	When the requirement and software class are marked with a "P (Center)," Centers and projects shall meet the requirement with an approved non-null subset of the "shall" statement (or approved alternate) for that specific requirement. [SWE 140]	Experimenters to meet requirement as written

APPENDIX D ACRONYMS AND ABBREVIATIONS

D.1 Scope

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

D.2 List of Acronyms and Abbreviations

Table D-1—Acronyms

Acronym	Definition
AO	Announcement of Opportunity
APS	Antenna Pointing System
ASIC	Application Specific Integrated Circuit
ATP	Authority to Proceed
AU	Avionics Unit
BB	Breadboard
BER	Bit Error Rate
BERT	Bit Error Rate Test
BNC	Bayonet Neill-Concelman Connector
BPF	Band Pass Filter
CI	Configuration Item
CM	Configuration Management
CMP	Configuration Management Plan
Comm	Communication
CONN	CoNNeCT
CoNNeCT	Communications, Navigation, and Networking reConfigurable Testbed
CR	Change Request
D/A	Digital to Analog
D/C	Downconvert
DAS	Data Acquisition System
DC	Direct Current
Dev	Develop
DLE	Designated Lead Engineer
DSP	Digital Signal Processor
DSSS	Direct-Sequence Spread Spectrum
DTN	Delay Tolerant Networking
ECI	Experiment Co-Investigator
EDP	Experiment Development Package
EDS	Experiment Development System
EFEP	Experiment Front End Processor
ELC	ExPRESS Logistics Carrier
EM	Engineering Model
E-NET	Ethernet
EORR	Experiment Operational Readiness Review
EPI	Experiment Principal Investigator
eQip	Electronic Questionnaires for Investigations Processing
ERR	Experiment Readiness Review
EVR	Extravehicular Robotics
EVR	Experiment Verification Review
Expt	Experiment
FPGA	Field-Programmable Gate Array
F/W, FW	Firmware

Acronym	**Definition**
GB	Gigabyte
GCE	Gimbal Control Electronics
GD	General Dynamics
GFS	Ground Flight System
GHz	Gigahertz
GIU	Ground Integration Unit
GIU	Ground Integration Unit with Support Systems
GLPR	NASA Glenn's Configuration Management Procedural Requirement
Gov	Government
GPP	General Purpose Processor
GRC	Glenn Research Center
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
GUI	Graphical User Interface
HC	Harris Corporation
HID	Hardware Interface Description
HTV	H-II Transfer Vehicle
I&T	Integration and Test
I/O	Input and Output
ICD	Interface Control Document
IF	Intermediate Frequency
IONET	Internet Protocol Operational Network
ISS	International Space Station
IT	Information Technology
JAXA	Japan Aerospace Exploration Agency
JPL	Jet Propulsion Laboratory
JTAG	Joint Test Action Group
Ka-band	22.5 to 27.5 GHz
L-band	1 to 2 GHz
L2	1227.60 MHz
L5	1176.45 MHz
LNA	Low Noise Amplifier
LO	Local Oscillator
LPR	Lawful Permanent Resident
LSE	Lead Systems Engineer
MDM	Multiplexer and Demultiplexer
MHz	Megahertz
MIL-STD	Military Standard
MMU	Memorandum of Mutual Understanding
MOL	Mission Operations Lead
NASA	National Aeronautics and Space Administration
NEN	Near Earth Network
NISN	NASA Integrated Services Network
NPD	NASA Policy Directives
NPR	NASA Procedural Requirement
NTIA	National Telecommunications and Information Administration
OE	Operating Environment
Ops	Operations
O-Scope	Oscilloscope
PAS	Power Acquisition System
PC	Personal Computer
PCI	Peripheral Component Interconnect
PFD	Power flux Density
PI	Principal Investigator
POP	Program Operating Plan

Acronym	Definition
PM	Project Manager
PS	Project Scientist
PSU	Power Supply Unit
QNA	QinetiQ North America
RF	Radio Frequency
RSA	Rivest, Shamir, and Adleman
RTD	Resistive Thermal Device
SAA	Space Act Agreement
SARG	Space Assurance and Requirements Guideline
S-band	1.55 to 5.2 GHz
SBIR	Small Business Innovation Research
SBU	Sensitive But Unclassified
SCaN	Space Communications and Navigation
SCS	Suitcase Simulator
SDR	Software Defined Radio
SDS	Software Development System
SEU	Single Event Upset
SFEP	SCAN Testbed Front End Processor
SMA	Sub-Miniature Version A Connector
SME	Subject Matter Expert
SMP	Software Management Plan
SN	Space Network
SNUG	Space Network Users Guide
SOMD	Space Operations Mission Directorate
SRD	System Requirements Document
SSL	Space to Space Link
SSP	Space Station Program
STP	Software Test Plan
STEC	SCaN Testbed Experiment Center
STCC	SCaN Testbed Control Center
STRS	Space Telecommunications Radio System
S/W, SW	Software
TASS	TDRSS Augmented Service for Satellites
TBD	To Be Determined
TBR	To Be Resolved
TDRSS	Tracking and Data Relay Satellite System
TEI	Test Equipment Interface
TIM	Technical Interchange Meeting
TReK	Telescience Resources Kit
TRL	Technology Readiness Level
TRR	Test Readiness Review
TSC	Telescience Support Center
TSIM	TDRSS Simulator
TWTA	Traveling Wave Tube Amplifier
UA	Utilization Agreement
U/C	Upconvert
US	United States
USB	Universal Serial Bus
V&V	Verification and Validation
VAC	Volts Alternating Current
VDC	Volts Direct Current
VSA	Vector Signal Analyzer
VSG	Vector Signal Generator
WF	Waveform
WSC	White Sands Complex

APPENDIX E DEFINITIONS

E.1 Scope

This appendix lists the definitions used in this document.

E.2 List of Definitions

Table E-1—Definitions

Baseline: An agreed-to set of requirements, designs, or documents that will have changes controlled through a formal approval and monitoring process.

Configuration Management: A systematic process for establishing and maintaining control and evaluation of all changes to baseline documentation, products (Configuration Items), and subsequent changes to that documentation which defines the original scope of effort. The systematic control, identification, status accounting, and verification of all Configuration Items throughout their life cycle.

Interface Control Document (ICD): A specification of the mechanical, thermal, electrical, power, command, data, and other interfaces that system elements must meet.

Level 1 Requirement: A Project's fundamental and basic set of requirements levied by the Program or Headquarters on the project.

Operations Concept: A concept that defines how the mission will be verified, launched, commissioned, operated, and disposed of. Defines how the design is used to meet the requirements.

Project: (1) A specific investment having defined goals, objectives, requirements, life-cycle cost, a beginning, and an end. A project yields new or revised products or services that directly address NASA's strategic needs. They may be performed wholly in-house; by Government, industry, academia partnerships; or through contracts with private industry. (2) A unit of work performed in programs, projects, and activities.

Requirement: The agreed upon need, desire, want, capability, capacity, or demand for personnel, equipment, facilities, or other resources or services by specified quantities for specific periods of time or at a specified time expressed as a "shall" statement. Acceptable form for a requirement statement is individually clear, correct, feasible to obtain, unambiguous in meaning, and can be validated at the level of the system structure at which stated.

Software: As defined in NPD 2820.1, NASA Software Policy.

Specification: A document that prescribes, in a complete, precise, verifiable manner, the requirements, design, behavior, or characteristics of a system or system component.

System: (a) The combination of elements that function together to produce the capability to meet a need. The elements include all hardware, software, equipment, facilities, personnel, processes, and procedures needed for this purpose. (Refer to NPR 7120.5.) (b) The end product (which performs operational functions) and enabling products (which provide life-cycle support services to the operational end products) that make up a system.

APPENDIX F TBDS AND TBRS

F.1 Scope

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

F.2 List of TBDs

Table F-1—TBDs

Number	Description	Section
TBD-01	The Radio Frequency (RF) Hardware Interface Description/Platform (HID) document is under development..	2.2

F.3 List of TBRs

Table F-2—TBRs

Number	Description	Section
-	-	-