305, Rev. B
Test Support

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Change Log

Rev	Issue Date	Paragraphs Affected	Change Summary
–	7/30/2003	All	New Module
A	5/26/2006	Many	Documents revised capabilities due to relocation of DTF-21 and MIL-71.
B	10/31/2009	Many	Replaced DSMS with DSN. Removed references to the decommissioned 26-m stations.

Note to Readers

There are two sets of document histories in the 810-005 document that are reflected in the header at the top of the page. First, the entire document is periodically released as a revision when major changes affect a majority of the modules. For example, this module is part of 810-005, Revision E. Second, the individual modules also change, starting as an initial issue that has no revision letter. When a module is changed, a change letter is appended to the module number on the second line of the header and a summary of the changes is entered in the module's change log.

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1 Introduction

1.1 Purpose

This module provides information to enable Deep Space Network (DSN) customers design tests that use the DSN test instrument and identify the appropriate site to conduct the tests. These tests are used primarily during the mission implementation process to validate spacecraft, spacecraft components, and spacecraft support.

1.2 Scope

This module deals solely with test support for flight projects currently available in the DSN. It provides characteristics of equipment that are unique to the test environment. It does not provide information about the capability of the operational equipment that is installed at each test support site. Characteristics of operational equipment may be found elsewhere in this Design Handbook.

2 General Information

The DSN exists to provide communication between a project control center and its spacecraft. Commands are relayed to the spacecraft on the forward link and the transmitted data from the spacecraft is extracted from the return link. This involves both a ground link and a space link. Trouble free communications on both links are important for mission success. The DSN provides extensive capability to demonstrate the performance of the ground link in combination with project control centers and with spacecraft hardware in a test environment. Test support is available from the three Deep Space Communications Complexes located at Goldstone, California; Madrid, Spain; and Canberra, Australia. In addition, the DSN includes three facilities that exist primarily for test support. These are the Development and Test Facility (DTF) 21 in Monrovia, California; the Compatibility Test Trailer (CTT) 22; and the Merritt Island Launch Annex (MILA) facility (MIL-71) at the Kennedy Space Center (KSC), Florida.

2.1 Functions

The DSN has three primary functions with respect to test support:

1) To support data flow testing between the DSN stations and project control centers,
2) To validate the compatibility between spacecraft or spacecraft subsystems and the DSN,
3) To provide communication between a spacecraft and its project control center during pre-launch activities.

Figure 1 provides an overview of the DSN test support that is available both at the stations and at the compatibility test sites. This support may involve elements of the Microwave, Uplink and Downlink equipment, the Telemetry Simulation Assembly (TSA), the System Performance Test (SPT) Assembly, and Service Management.

The TSA generates test data in the format specified by the customer subject to the restrictions described in this document. The data may be coupled directly into the station downlink equipment or it may be modulated on a radio frequency (RF) carrier (or on a subcarrier that is modulated on the RF carrier) by the uplink equipment, injected into the station microwave equipment, and received by the downlink equipment before being processed as if it had come from a spacecraft. The received data and any other data subscribed to by the project are forwarded to the project control center and to the SPT Assembly for analysis. The analyzed results from the SPT Assembly are made available to the project. Service Management is responsible for scheduling and the non-real-time interfaces between the DSN and the customers.

The links to and from the spacecraft are accomplished by direct cabling although Ka-band signals are normally downconverted near the spacecraft and transferred to the downlink equipment at the DSN intermediate frequency (100 – 600 MHz). The uplink equipment at the compatibility test sites may be used to relay project-originated commands that can be acted on by the spacecraft or spacecraft subsystems under test.

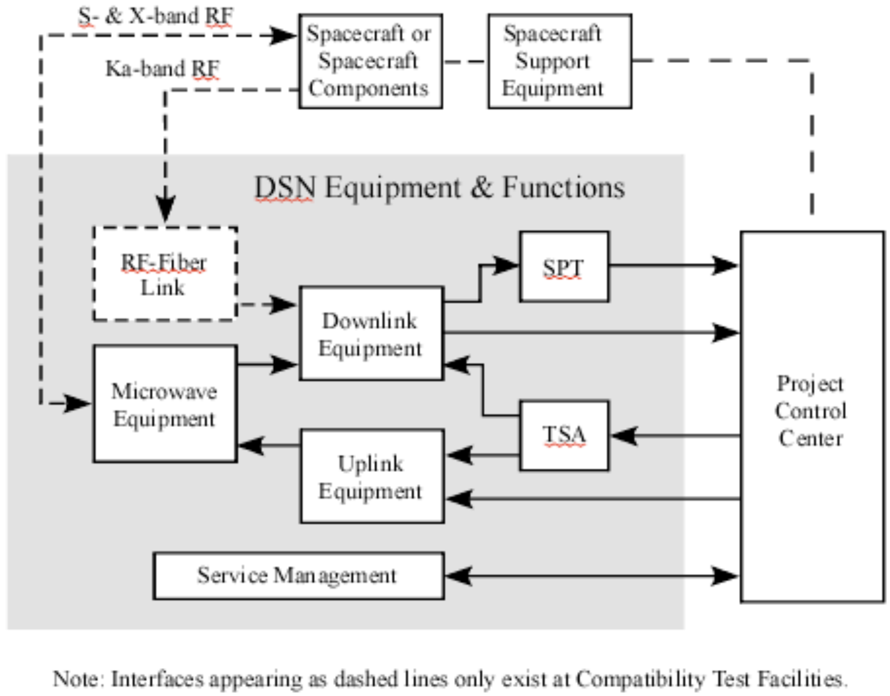


Figure 1. DSN Test Support Overview.

2.2 Station Test Support Equipment

Each DSN location includes a TSA, an SPT Assembly, and appropriate equipment to generate simulated spacecraft signals.

2.2.1 Telemetry Simulation Assembly

The TSA enables telemetry testing to be performed without the need for a spacecraft. It includes either two or four independent channels that can be controlled locally or remotely. Each channel can replay pre-recorded data from disk or generate telemetry data in real time without using disk storage. Pre-recorded data can be uncoded or can be symbols in any coding scheme acceptable to the equipment under test. Pre-recorded data is the only way turbo coded data can be simulated at this time.

Pre-recorded or real-time data can be converted to any pulse code modulation (PCM) format, have any convolutional coding acceptable to the DSN applied, have Reed-Solomon (RS) coding added, modulate the data onto a subcarrier, add Gaussian (noise amplitude decreases with increasing frequency in output bandwidth) or white noise (noise amplitude is uniform across output bandwidth), and simulate Doppler frequency shifts of the subcarrier frequency and data rate. The capabilities and limitations of the TSA are summarized in Table 1.

Table 1. TSA Capabilities and Limitations.

Capability	Limitations
RECORDED DATA	
Spacecraft ID (used for locating recorded data)	1–255
Data Types	No Restrictions – Examples are Uncoded, RS coded, Convolutional Coded, Turbo Coded, etc.
Starting Byte Offset for Playback	1–1,000,000,000
REAL-TIME DATA	
Data Types	Uncoded, RS coded, Convolutional Coded, concatenated RS and Convolutional Coded
Data Pattern	All 1s, all 0s, alternating 1s & 0s, PN sequences, 1–128 1s followed by 1–128 0s
DATA FRAME OPERATIONS (each channel)	
Frame Length	8–128000 bits (any multiple of 8)
Frame Sync Word	
Length	8–32
Pattern	Hexadecimal, limited by length
Frame Counter	Starts at 0. Repeats upon overflow.
Starting Bit	1–128000 or disabled
Field Length (bits)	3–32
Time Tag	
Length (bits)	50 (9 day-of-year, 17 second-of-day, 24 millisecond-of-day)
Starting Bit	1–127951
Fixed Fields (Content does not change from frame to frame)	Fields may not overlap any other fixed or variable field.
Number of Fields	0–32
Starting Bit (each field)	1–128000
Field Length (bits, each field)	3–32
Contents (each field)	Hexadecimal or unsigned integer value
Variable Fields (Content changes from frame to frame as described below)	Fields may not overlap any other fixed or variable field.
Number of Fields	0–32
Starting Bit (each field)	1–128000
Contents (each field)	Data file, ramp function, sinusoidal function, triangular function, Taylor series expansion

Table 1. TSA Capabilities and Limitations (Continued).

Capability	Limitations
Fixed Frame Errors	
Number of Errors	0–32
Starting Bit (each error)	1–128000
Error Mask (each error)	6 hexadecimal digits
DATA RATE	
Uncoded Data (b/s)	3.0000 – 25,000,000.0000
Coded Data (s/s)	3.0000 ÷ Code Rate to 25,000,000.0000
Doppler Simulation (data & subcarrier)	Carrier Doppler Predict File Must Exist
DATA ENCODING	
PCM Formats	NRZ-L, NRZ-M, NRZ-S, Bi-ϕ-L, Bi-ϕ-M, Bi-ϕ-S
Convolutional Coding	
Rate (*r*)	1/2, 1/3, 1/4, 1/5, 1/6
Constraint Length (*k*)	3–15
Connection Vectors	2–6 vectors expressed as 4 hexadecimal digits
k = 7, *r* = 1/2 Symbol Order	CCSDS or DSN
Alternate Symbol Inversion	Optional
Reed-Solomon Encoding	
Code Supported	RS (255,223)
Interleave Factor	1–8
Virtual Fill	Provided for short frames (< 223 x Interleave)
Sync Word	Attached or Embedded
OUTPUT (each channel)	
Subcarrier (bi-phase modulated)	
Frequency (Hz)	100.000 – 1,000,000.000
Waveform	Sine or Square
Noise	Gaussian (frequency dependent) or white (frequency independent)
Signal/Noise Ratio (dB)	–60.0 to +40.0

Real-time data includes the capability for frame generation with fixed or pseudo-noise (PN) data patterns, optional frame counter, time-tag, programmable data fields, and systematic frame error generation. Real-time data generation starts by filling a suitable data structure from which a continuous data stream can be produced with the selected data pattern. Next, the data pattern is overlaid with the Attached Synchronization Marker (ASM), for frame-synchronized data, and other fixed and variable fields at appropriate intervals if required. If Reed-Solomon (RS) coding is required, sufficient space is allowed between the end of one frame and the start of the next ASM to permit the RS parity symbols to be inserted as the frame is coded. RS frame sizes specified as having a data length of less than 223 bytes multiplied by the interleave factor will result in an appropriate amount of virtual fill being inserted at the beginning of each frame. The completed data may be convolutionally coded prior to being converted to PCM. Figure 2 illustrates this process for a 1784 bit data frame using a PN11 fill pattern, a standard 32-bit ASM, no additional data fields, and RS encoding.

Each TSA channel functions independently and each DSN location can support as many test activities as the number of channels in the TSA. Initial configuration of each channel is from a pre-programmed configuration file that can be modified using operator directives (ODs). The revised configuration can then be saved under a new file name for later use.

2.2.2 System Performance Test Assembly

The SPT assembly operates as a stand-alone system test tool. It is used to collect and analyze test data from the test equipment and present the results to the project. The SPT functions include:

1) Telemetry bit error rate (BER) tests,

2) Telemetry time delay tests,

3) Data stream continuity tests,

4) Data stream extraction tools,

5) Data analysis tools.

2.2.2.1 Telemetry Bit Error Rate Tests

Telemetry BER tests evaluate the performance of the Telemetry Service by comparing the telemetry data output when supplied with a known (TSA generated or, in the case of turbo codes, previously recorded) input to the system. A desired E_b/N_0 (energy-per-bit to noise spectral density ratio) or E_s/N_0 (energy-per-symbol to noise spectral density ratio) is established using the received noise as a reference for RF testing or the additive noise capability of the TSA for data testing. The bit or symbol error rate determined by the SPT is used to calculate the theoretical input E_b/N_0 or E_s/N_0 for a lossless system employing the specified code. The difference between the actual input and the theoretical input is the system loss. The following codes can be used for BER tests.

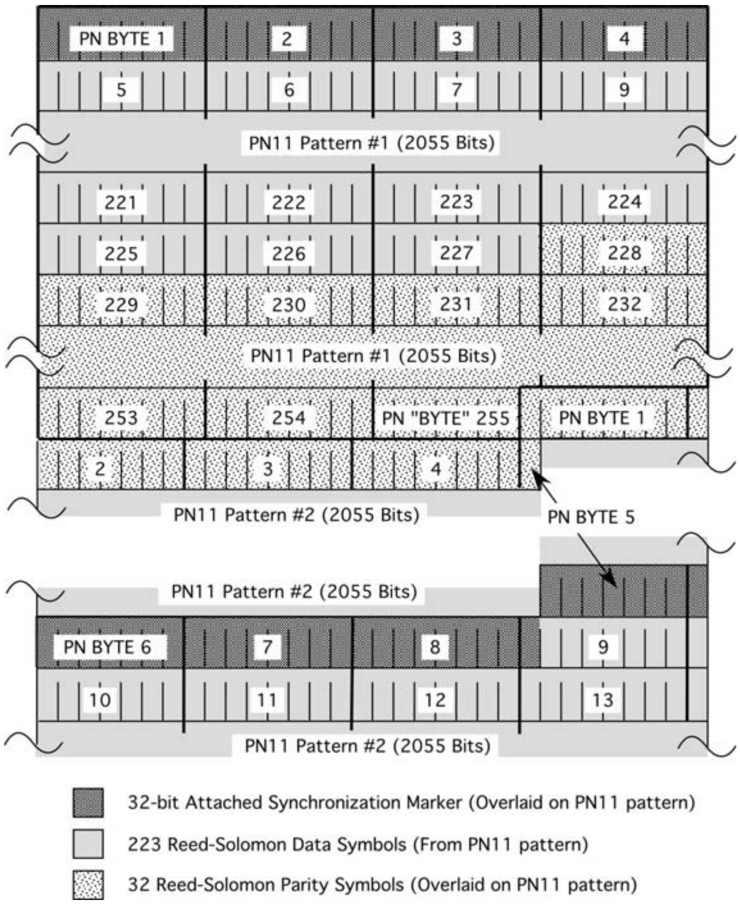


Figure 2. TSA Real-time Data Generation Process.

1) None (Uncoded)

2) Convolutional (k=7, r=1/2)

3) Convolutional (k=15, r=1/4),

4) Convolutional (k=15, r=1/6),

5) Concatenated Reed-Solomon and any of above convolutional codes,

6) CCSDS turbo codes for block sizes of 8920 bits and smaller (using recorded data prepared in accordance with the frame generation process described above).

The SPT operates with the data patterns specified below. To do real time data validation, the SPT needs a frame description; fill pattern used, and location and content of fields. It is important to note that the SPT expects the type of frame generation process employed by the TSA, where the fields overlay the fill pattern. Frames generated with a different process cannot be checked in real time.

1) Alternating 1s and 0s,

2) Alternating 00 and FF bytes,

3) PN11 through PN16 data with operator modifiable connection vector,

4) Frame sync word or other user specified pattern only,

5) User data file that includes frame sync and frame sequence number;

2.2.2.2 Telemetry Time Delay Tests

The telemetry time delay test compares the time-tag applied to each data frame header by the telemetry system with the time-tag inserted into the simulated telemetry data by the TSA. The test provides the mean, standard deviation, and number of blocks exceeding a user specified tolerance between these two times. This test is not available for turbo coded or other previously coded playback data.

2.2.2.3 Data Stream Continuity Tests

The SPT can monitor any data stream routed through the Reliable Network Server (RNS). The SPT evaluates data stream continuity by detecting missing or duplicate block serial numbers and by detecting time gaps within the headers of the data blocks.

The SPT has the capability to record the data being processed during BER tests for off-line analysis of data stream continuity.

2.2.2.4 Data Stream Extraction Tools

The SPT can extract user-specified data items from any data stream routed through the RNS. The extraction mechanism permits the user to specify the structure of the data block including position, length, and conversion units of each item to be extracted. The extracted data is stored in a delimited, user-specified format and is accessible for real-time and post-test analysis.

2.2.2.5 Data Analysis Tools

The SPT includes a complete set of graphical and mathematical tools for analysis of data extracted from any data stream visible from its network port. These tools include the capability to:

1) Provide the capability to graph real-time or stored data by specifying the inputs for the X- and Y-axes. This capability includes the ability to modify the axis scales and provide text notations to the graph and its components.

2) Calculate the mean, variance, standard deviation, and standard error of a sample when provided with the initial and end point of the data.

3) Determine the 90% and 95% confidence intervals for the mean when the sample size is greater than 30

4) Perform a linear squares fit to the data and determine the correlation coefficient

5) Perform a null hypothesis test.

2.2.3 RF Signal Generation

The principal RF signal source is the DSN exciter equipped with appropriate attenuators to generate an uplink signal with command and ranging modulation as expected by the spacecraft. For tests not involving a spacecraft, the exciter can be modulated by simulated telemetry from the TSA, ranging modulation, or both. The RF output of the exciter is translated to the downlink frequency and can be attenuated to whatever level is appropriate to simulate the expected signal-to-noise ratio for the spacecraft signal during its various mission phases. The ability of the exciter to follow a pre-determined frequency profile can be used to simulate Doppler effects.

A secondary frequency source for spacecraft simulation (the Receiver Test Signal Generator) exists at all sites except CTT-22 and MIL-71. It is capable of producing an adjustable output with modulation from one of the TSA channels and can be used independently of the exciter to simulate a second S-band or X-band telemetry downlink or possibly an interfering spacecraft.

2.3 DSN Compatibility Test Facilities

There are three DSN facilities that are provided primarily to support compatibility testing. Each of these facilities has its own unique capabilities and contains both operational and specialized test equipment. The equipment available in each of the facilities is summarized in Table 2.

2.3.1 DTF-21

DTF-21 is located near JPL in Monrovia, CA. It is equipped with simulated front ends for the DSN 70-m and 34-m stations, uplink and downlink equipment, and at least one set of all data processing equipment found in the Signal Processing Centers (SPCs). Simulators for the antennas, transmitters, and microwave control equipment are provided to mimic their responses. Communications are provided by standard JPL/NASA Integrated Service Network (NISN) ground communications interfaces and a Cesium Beam Frequency Standard provides station timing. DTF-21 may be configured to simulate any station at a DSCC. This capability provides a convenient environment for Project/DSN interface testing. DTF-21 includes an RF shielded room in order to isolate devices under test.

Table 2. Equipment at Compatibility Test Facilities

Equipment	DTF-21	CTT-22	MIL-71
34-M/70-M EQUIPMENT			
Antenna Pointing Assy	1	–	–
Uplink Assembly Command Modulation Generators (2), Exciter and ranging control)	2	1	1
Block V Exciter (with uplink ranging)	1	1	1
Downlink Channel Processors	3	2	2
Receiver Test Signal Generator	1	–	–
Microwave Switch Control	1	–	–
SPC EQUIPMENT			
Full Spectrum Receiver	1	–	–
Frequency and Timing Assembly	1	1	1
NETWORK MONITOR AND CONTROL EQUIPMENT (NMC)			
Operator Consoles	3	1	1
GROUND COMMUNICATIONS FACILITY (GCF) EQUIPMENT			
GCF Monitor Processor	2	1	1
Router	2	2	2
Reliable Network Server (RNS)	2	1	1
Operational Voice	Yes	No	Yes
Telephone	Yes	Yes	Yes
COMPATIBILITY TEST EQUIPMENT			
S-band Microwave	Yes	Yes	Yes
X-band Microwave	Yes	Yes	Yes
Ka-band Reception	No	1 as required	1 as required
TSA	4-channel	2-channel	2-channel
SPT Assembly	1	1	1
Y-factor detector	1	1	1

2.3.2 CTT-22

CTT-22 is a 14.6-m (48-foot) towable trailer designed and implemented specifically to perform compatibility and telemetry data flow testing at spacecraft manufacturing facilities and to provide launch support of spacecraft from locations other than Cape Canaveral. It provides capabilities representative of those found at a DSCC. It can be relocated to any convenient location around the world. However, special arrangements would be required for locations outside the continental United States.

The trailer requires an 18.6 m by 6.6 m (61 ft by 21.6 ft) area for parking and access that is connected via roadways for delivery. Recommended setup time is 24 hours to allow for parking, connection, and equipment stabilization. Interfaces between the CTT and spacecraft are normally made with low-loss coaxial cable. A router is included to enable communication with networks or leased communication circuits. A photograph of the trailer is provided as Figure 3. Significant characteristics and the recommended parking site dimensions can be found in Appendix A.

Figure 3. Compatibility Test Trailer, CTT-22.

2.3.3 MIL-71

MIL-71 is located in the Mission Operations Support Building (MOSB) at the Kennedy Space Center in Florida, USA. The facility is normally maintained in a caretaker status between launches and is implemented as needed, usually to simulate a 34-m Beam Waveguide (BWG) station, for pre-launch project and DSN compatibility. MIL-71 RF interfaces are via fiber optic links to various launch support facilities and to project control centers via NISN ground communications circuits. Use of the facility must be planned and scheduled early enough to allow for temporary relocation of personnel and re-verification of equipment.

2.3.4 Specialized Test Support Equipment

The equipment requirements for the compatibility test facilities differ from DSN tracking sites – the most obvious difference is the lack of a large antenna. Characteristics of the compatibility test equipment that are significantly different from equipment at the tracking sites are summarized in Table 3.

3 Test Activities

The following paragraphs provide a brief discussion of the test activities for which the DSN provides support.

3.1 Data Flow Testing

Data flow tests are usually conducted at the Deep Space Communications Complexes. They include Ground Data System (GDS) tests, Mission Operations System (MOS) tests, and Operations Readiness Tests (ORTs).

3.1.1 GDS Tests

GDS tests are conducted under the direction of the project Mission Manager, who will delegate the responsibility to either the GDS Integration Engineer or the End-to-End Information System (EEIS) Test Engineer who is responsible for scheduling and running the tests and for documenting the results. The emphasis of these tests is on the end-to-end integrity of the GDS, that is, the DSN, the Ground Communications Facility (GCF), the Advanced Multi-mission Operations System (AMMOS), end user devices, and all the associated interfaces. GDS testing normally starts with a minimum number of components and gradually builds up in complexity to involve all elements of the GDS.

3.1.2 MOS Tests

MOS tests address the state of training and readiness of the project mission operations personnel to carry out their assigned responsibilities on a realistic mission time line using the GDS facilities. Similarly to GDS tests, the Mission Manager is responsible for the MOS test program. The MOS Test and Training Engineer has responsibility for the design, scheduling, and execution of the MOS tests. At the successful completion of MOS testing, the flight team is certified as “flight ready.”

Table 3. Characteristics of Compatibility Test Equipment.

Parameter	Value*	Remarks
SHIELDED ENCLOSURE		DTF 21, only
Dimensions		
Width [m (ft)]	3.7 (12)	
Depth [m (ft)]	3.7 (12)	
Height [m (ft)]	3.0 (10)	
Entry Door		
Width [m (ft)]	1.2 (4)	
Height [m (ft)]	2.1 (7)	
Isolation (dB)	140	
Available Power		Within enclosure
Voltage (VAC)	120	Single Phase, nominal
Current (A)	30	
RF INTERFACES		
S-band Direct Input		
System Temperature (K)	500 ±50	
S-band Fiber Optic Input		
Noise (dB)	49	
Nominal input signal level (dBm)	13	
X-band Direct Interface		
System Temperature (K)	500 ±50	
X-band Fiber Optic Input		
Noise (dB)	59	
Nominal input signal level (dBm)	13	
Ka-band Interface		Downconverted to fiber optic IF
System Temperature (K)	725 ±50	Includes follow-on contribution
Output signal levels (dBm)	+3	Maximum, S- and X-band
Output (Exciter) Power Stability (dB)	< 0.5	Over 12-h period
Attenuator step size (dB)	0.1	Independent for input and output

* All values are manufacturer’s specifications.

Table 3. Characteristics of Compatibility Test Equipment (Continued).

Parameter	Value	Remarks
FREQUENCY STABILITY		DTF 21, only. CTT 22 and MIL 71 do not have thermal controls and stability is unknown
1 s	5.0×10^{-12}	
10 s	3.5×10^{-12}	
100 s	8.5×10^{-13}	
1000 s	2.7×10^{-13}	
10000 s	8.5×10^{-14} *	
86400 s (1 day)	3.0×10^{-14} *	
TIME ACCURACY		
Reference Time (μs)	1.0	With respect to Global Positioning Satellite (GPS) Time
Time Distribution (ns)	100	With respect to reference time

* Excluding environmental effects

3.1.3 GDS Tests

GDS tests are conducted under the direction of the project Mission Manager, who will delegate the responsibility to either the GDS Integration Engineer or the End-to-End Information System (EEIS) Test Engineer who is responsible for scheduling and running the tests and for documenting the results. The emphasis of these tests is on the end-to-end integrity of the GDS, that is, the DSN, the Ground Communications Facility (GCF), the Advanced Multi-mission Operations System (AMMOS), end user devices, and all the associated interfaces. GDS testing normally starts with a minimum number of components and gradually builds up in complexity to involve all elements of the GDS.

3.1.4 MOS Tests

MOS tests address the state of training and readiness of the project mission operations personnel to carry out their assigned responsibilities on a realistic mission time line using the GDS facilities. Similarly to GDS tests, the Mission Manager is responsible for the MOS test program. The MOS Test and Training Engineer has responsibility for the design, scheduling, and execution of the MOS tests. At the successful completion of MOS testing, the flight team is certified as “flight ready.”

3.1.5 ORTs

ORTs are conducted to demonstrate the readiness of the MOS to support flight operations. The successful completion of these tests demonstrates that all elements of the MOS (hardware, software, people, procedures, and facilities) work together to accomplish routine and mission critical activities. The DSN considers ORTs to be real-time mission activities and provides full support with all committed resources.

3.2 Demonstration Tracks

From time to time, the DSN requests the support of flight projects to verify that a newly implemented capability provides the required support in an actual tracking environment. These activities are referred to as *Demonstration Tracks* and are scheduled with projects that can tolerate data loss should something not work as planned. They are very similar to GDS tests except that they are planned and conducted by DSN personnel who are also responsible for analyzing the results. Demonstration Tracks are always conducted prior to committing a DSN capability for operational support.

3.3 Compatibility Tests

The DSN recommends compatibility testing with all spacecraft for which support is committed. If the project waives compatibility testing, the DSN cannot assume responsibility for spacecraft/DSN interface compatibility. In such cases, DSN support would be provided on a “best-efforts” basis.

Compatibility testing validates the compatibility between the spacecraft radio frequency subsystem and its telecommunications capabilities as they interface with DSN RF and data systems. This testing is conducted at DTF-21, at MIL-71, or at a spacecraft manufacturing facility using CTT-22. Compatibility testing is normally conducted in three phases depending on project requirements: spacecraft subsystem design, spacecraft system design, and system compatibility verification. Figure 4 illustrates the major steps in the compatibility test process.

3.3.1 Subsystem Design Compatibility Tests

The objective of these tests is to demonstrate design compatibility between the spacecraft radio subsystems and the DSN telecommunications subsystems. The tests are performed as early as practical in the spacecraft development program (typically 1-3 years before spacecraft integration). DTF-21 is equipped with an RF shielded enclosure and supporting facilities to accommodate project equipment needed for testing.

The spacecraft telecommunications subsystems are likely be in the form of engineering-level (breadboard or prototype) hardware at this point in the design process. If a new DSN capability is being verified, the test facility (DTF-21 or CTT-22) will be configured with valid (but not necessarily DSN operationally ready) subsystem equipment and software. The types of tests performed during this phase include:

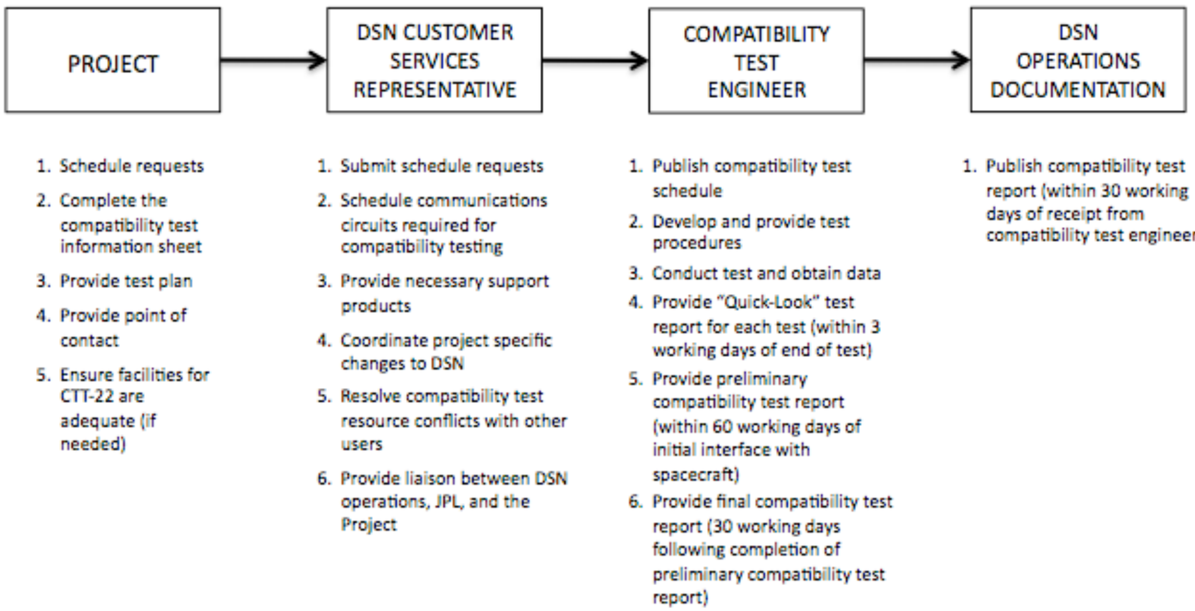


Figure 4. Compatibility Test Process

1) Radio frequency tests including maximum acquisition sweep rates, RF spectrum, transponder rest frequency determination, threshold signal levels, and ranging delay calibration.

2) Telemetry tests including bit error rate, modulation index measurement, and acquisition time.

3) Command tests including performance with ranging modulation and performance with Doppler.

3.3.2 System Design Compatibility Tests

The objective of these tests is to demonstrate the compatibility between the DSN and spacecraft telecommunications system designs and that these designs are in accordance with negotiated flight project/DSN agreements. The tests involve a fully assembled spacecraft and are usually supported by CTT-22. When appropriate, the tests may utilize AMMOS or the Deep Space Operations Center (DSOC). The types of tests performed during this phase are:

3.3.3 System Design Compatibility Tests

The objective of these tests is to demonstrate the compatibility between the DSN and spacecraft telecommunications system designs and that these designs are in accordance with negotiated flight project/DSN agreements. The tests involve a fully assembled spacecraft and are usually supported by DTF-21 for JPL spacecraft or by CTT-22 for non-JPL spacecraft. When appropriate, the tests may utilize AMMOS or the Deep Space Operations Center (DSOC). The types of tests performed during this phase are:

1) RF tests including two-way phase jitter measurements,

2) Repeats of selected subsystem design tests,

3) Data flow compatibility tests with the Project Operations Control Center (POCC).

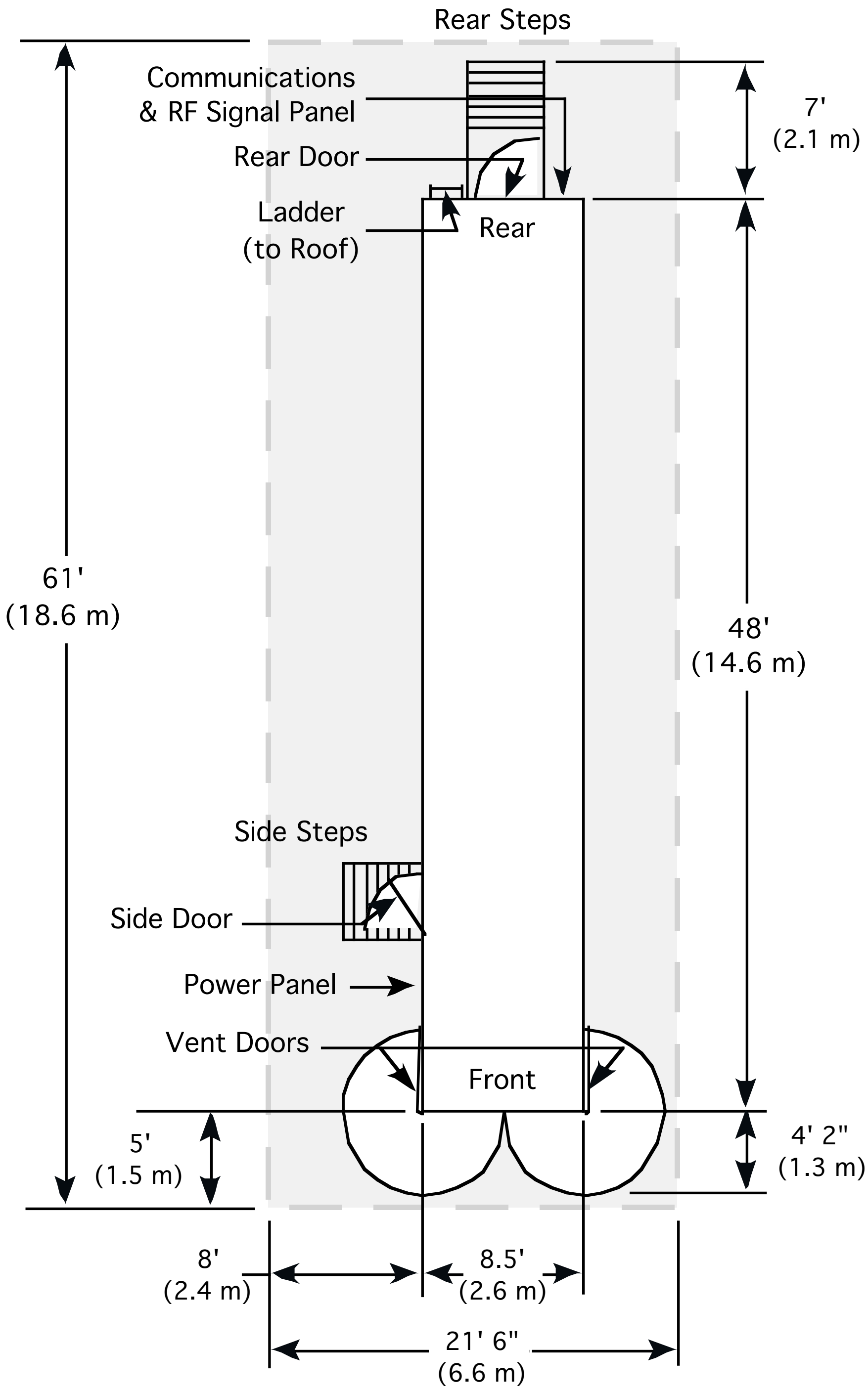
3.3.4 System Compatibility Verification Tests

The objective of these tests is to ensure that the design compatibility (established during system-level tests) is maintained after equipment implementation and transportation of the spacecraft to the launch site. System verification tests are usually a subset of the tests run in the previous phases and are normally supported by MIL-71. The tests may be performed as part of the DSN Operational Verification Test (OVT) or as a project end-to-end test. Both the spacecraft and the DSN facilities must be in a mission-ready status for these tests to ensure that the final decision of compatibility status is valid. Formal waivers are required to permit substitution of non-operational DSN equipment or software for the tests.

Appendix A
Compatibility Test Trailer Significant Characteristics

Table A-1. CTT-22 Significant Characteristics.

Parameter	Value	Remarks
DIMENSIONS AND WEIGHT		Highway Configuration
Length [m (ft)]	14.6 (48)	Rear stairs removed and stowed
Width [m (ft)]	2.6 (8.5)	Side stairs removed and stowed
Height [m (ft)]	4.1 (13.5)	
Weight [kg (lbs)]	22,700 (50,000)	Maximum
Rear Access Door		
Width [cm (in)]	107 (42)	
Height [cm (in)]	227 (89.5)	
Side Access Door		
Width [cm (in)]	91 (36)	
Height [cm (in)]	208 (82)	
ENVIRONMENTAL REQUIREMENTS		
Slope of parking pad (deg)	5	Maximum
Exterior Temperature [C (F)]	–18 to 41 (0 to 105)	Interior is climate controlled
POWER REQUIREMENTS (60 Hz)		Two 30.5 m (100 ft) cables and 3 m (10 ft) pigtails provided for each circuit
Voltage (VAC)	120/208	60 Hz, 3-Phase, 4-wire plus ground
Equipment Buss		
Service Rating (A)	100	Per phase
Connector	AR61047-S22	Crouse-Hinds Reversed Contacts
Utility Buss		
Service Rating (A)	125	Per phase
Connector	AR2041-S22	Crouse-Hinds Reversed Contacts
RF INTERFACES		Two 30.5 m (100 ft) Type N (male) to Type N (male) low-loss cables provided
RF Connectors	4 Type N, Female 6 Type TNC, Female	Connector impedance is 50 ohms.
DATA INTERFACES		One 30.5 m (100 ft) cable provided for each interface
Serial Data	RS-449 and RS-530	Several circuits, data rates from 9.6 to 3.0 Mb/s, DB25S or DB37P connectors. Data rates above 1.4 Mb/s are supported via MLPP routing protocol and multiple circuits.
Local Area Network (data)	10/100 MB/s	RJ-45 Connector
Local Area Network (monitor)	10/100 MB/s	RJ-45 Connector (Used at JPL, only)
Telephone	2/4 wire	Several circuits, RJ11 and RJ45 female connectors
Intercom	4 wire/channel	Analog intercom voice instrument provided



A-1. Recommended CTT Parking Site Dimensions.