SPACE COMMUNICATIONS AND NAVIGATION PROGRAM

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Phase 2

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Service Catalog
Phase 2

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Section 1. Introduction

1.1 PURPOSE

This Service Catalog describes the services that the National Aeronautics and Space Administration's (NASA) Space Communications and Navigation (SCaN) Program has committed to providing. These Services are intended to be widely applicable, valuable, and make maximum use of the SCaN Network. User-unique, customized service from SCaN is also attainable but must be negotiated separately and will likely cost significantly more than use of these standard Services. The Service Catalog is intended to aid users of SCaN services in project planning and design. The hyperlinks included in the service descriptions provide more detailed information.

1.2 SCOPE

This Catalog provides a comprehensive list of SCaN Services and describes additional user support that the SCaN Program makes available. The SCaN Services are provided by the newly-integrated SCaN Network, comprising the Deep Space Network (DSN), the Space Network (SN), and the Near-Earth Network (NEN).

The SCaN Program is being integrated in phases. The phase described in this Catalog is Phase 2, the Integrated Network Phase.

Provision of SCaN Services and SCaN Service Management relies on the NASA Integrated Services Network (NISN) provided by NASA's Communications Services office (CSO) to transport data between ground sites.

The Services described in this version of the document are now, or will be, offered to new user missions when the SCaN network integration (Phase 2) is complete. These Services will remain available to existing user missions with a signed Service Agreement. As the SCaN Network and its Services evolve, new versions of this document will be published.

1.3 APPROVAL AND CHANGE AUTHORITY

Changes to this document shall be controlled using procedures set forth in the SCaN Information and Configuration Management Plan (SCaN-ICMP) and approved by the SCaN Program Control Board.

1.4 REFERENCE DOCUMENTS

CCSDS:

- TM Synchronization and Channel Coding
- TM Space Data Link Protocol
- Space Packet Protocol
- Encapsulation Service
- Space Link Identifiers
- Time Code Formats
- Orbit Data Messages

- Tracking Data Message
- Attitude Data Messages
- CCSDS File Delivery Protocol (CFDP)
- AOS Space Data Link Protocol
- Support Reference Model—Part 1: Space Link Extension Services
- Space Link Extension—Return All Frames Service Specification
- Return Channel Frames Service Specification
- Return Operational Control Fields Service Specification
- Forward CLTU Service Specification
- Forward Space Packet Service Specification

JPL:

- JPL Planetary Radar Group website
- SAOImage DS9: Astronomical Data Visualization Application
- VLBI Standards website
- DSN Telecommunications Link Design Handbook
- DSN Telecommunications Link Design Handbook, Module 202B
- DSN Telecommunications Link Design Handbook, Module 203C
- DSN Telecommunications Link Design Handbook, Module 209A
- DSN Telecommunications Link Design Handbook, Module 211
- DSN Telecommunications Link Design Handbook, Module 210
- DSN Telecommunications Link Design Handbook, Module 214
- Mark5 VLBI Data System website
- Deep Space Network Services Catalog

GSFC:

- FDF Orbit Determination and Contact Acquisition Aids page
- Near Earth Network (NEN) Users' Guide (453-NENUG)
- Space Network Users' Guide (450-SNUG)
- Interface Control Document Between the Network Control Center Data System and the Mission Operation Centers (451-ICD-NCCDS/MOC)

Section 2. SCaN Service System Overview

2.1 SCAN DESCRIPTION

The SCaN Program is a provider of data delivery Services, radiometric data Services, science Services, and platform modeling and media calibration Services to NASA's and other space agencies' space exploration and space science programs. "Data delivery services" are the transport of data from one point to another, involving a space-ground link. "Radiometric data services" are the measurement and provision of radiometric Doppler, range, and angle measurements tailored for application to flight system navigation. "Science services" are the measurements of radio frequency (RF) signals to provide scientific results, including radar and radio science.

The SCaN Network comprises NASA's tracking stations, which were formerly three networks: the NEN, the SN, and the DSN. Currently being integrated, these tracking, communications, and data acquisition assets will be unified by a single set of standard Services and a single Service Management interface for the Service user mission to schedule, control, and monitor Services, and to provide Service accountability information.

SCaN assets include:

- From the NEN: NASA, commercial, and partner ground stations and integration systems providing space communications and tracking services to user missions operating in orbital and suborbital locations, including Low Earth Orbit (LEO), Geosynchronous Earth Orbit (GEO), and highly elliptical orbits (HEO), and at lunar distances

- From the SN: the Tracking and Data Relay Satellite System, a constellation of geosynchronous relays (and associated ground systems) providing continuous global coverage of user missions in equatorial to highly inclined orbits from launch to LEO

- From the DSN: a set of ground stations spaced around the world providing continuous coverage of user mission platforms from GEO to the beyond the edge of our solar system

2.2 SERVICE CONCEPTS

"Service" in the context of this Catalog has a specific meaning. A Service is a self-contained set of functions with standard, well-defined interfaces: a Service is specified by its functions and interfaces. Services are delivered via Service instances, which are a specific Service performed over a specified time period. A description of each of the Services is provided in Section 3.

"Service Management" provides the interface between the Service user mission and a SCaN Network for managing the provision of services required by the service user. It allows the user mission to schedule, control, and monitor the Services and provides the user mission with Service accountability information such as a comparison of committed and delivered Services, descriptions of anomalies encountered during service provision and their resolution.

2.3 SCAN ENGINEERING SUPPORT

The SCaN Program makes its engineers available to assist user missions and increase the value of the SCaN Services. The cost of engineering support is negotiated on a case-by-case basis. Examples of available support include:

Systems Engineering Support

The SCaN Program assists user missions in mapping their needs into SCaN Services. SCaN systems engineers also assist the user mission with developing mission system and flight system designs that can incorporate SCaN Services in an effective manner. Where Service customization is deemed most cost effective, SCaN engineers can assist the user mission by developing design solutions as well as estimates of cost, schedule, and risk. SCaN systems engineers can also assist the user mission in contingency planning, including the design of contingency operations centers.

SCaN Test Support

The SCaN Network requires Service Compatibility Testing prior to Service Scheduling for any new user mission. In addition to providing and staffing facilities for these tests, the SCaN Network can make engineers available for other user mission tests such as mission end-to-end data systems tests. SCaN engineers will work with the user mission to troubleshoot problems and resolve anomalies.

Spectrum and Frequency Management Support

The SCaN Program assists user missions in selecting frequencies and signal formats that are compatible with SCaN Services, ensure compliance with applicable regulations, and protect against adversely impacting others.

SCaN Standards

The SCaN Standards Program develops internationally interoperable standards, services, and protocols that are compatible with and adopted by SCaN Services. This work is largely carried out within the environment of the Consultative Committee for Space Data Systems (CCSDS).

2.4 INTERNATIONAL INTEROPERABILITY

Most SCaN Services follow CCSDS standards, and are offered by the Interagency Operations Advisory Group (IOAG) Service Catalog. IOAG describes its Services as “core” or “extended”. The core services are to be implemented by all IOAG agencies by 2020, while the extended services are to be considered for bilateral cross support.

Section 3. SCaN Service Descriptions

This section describes each of the SCaN Services. Table 3-1 is a summary of these Services.

Table 3-1 SCaN Network Services

Category	Group	Service
Near Earth & Deep Space	Forward	CLTU
Near Earth & Deep Space	Forward	File
Near Earth & Deep Space	Forward	Frame
South Pole	Forward	IP Datagram (HDLC)
Near Earth	Forward	IP
Near Earth & Deep Space	Return	All Frames
Near Earth & Deep Space	Return	Channel Frames
Deep Space	Return	Beacon Tone
Near Earth & Deep Space	Return	File
Deep Space	Return	Packet
Near Earth	Return	IP
South Pole	Return	IP Datagram (HDLC)
Near Earth & Deep Space	Radiometric	Validated
Near Earth	Radiometric	Raw
Deep Space	Radiometric	Delta DOR
Deep Space	Science	Radio Science
Deep Space	Science	VLBI/Radio Astro
Deep Space	Science	Radar
Deep Space	Calibration	Platform
Deep Space	Calibration	Media

Once a Service has been chosen, there are parameters to choose, such as polarization and modulation formats. For information about these and other parameters, the following Service Descriptions include links to more detailed documents in the “functional description”.

Sometimes user missions need Services besides those listed, or need to use other networks. This can often be arranged within the same commitment process described in Section 5. Besides SCaN Services, SCaN is often able to arrange Services from the European Space Agency, radar services from the Air Force, and NISN services.

Many services follow standards created by the CCSDS. The Service descriptions of each forward, return, or radiometric Service tells whether it is a core or extended Service for IOAG. Science and calibration Services are not IOAG Services.

The "constraints" section includes a description of the frequency bands at which the service is available. Each Service description tells when a service began, or will begin, according to Phase. Services that begin during Phase 2 may be available at any time during Phase 2. Services that end in Phase 2 may stop being available any time during Phase 2. For Services not offered by all three networks at the beginning of Phase 2, this section includes which of them offers the Service.

The set of frequency bands usable by user missions is defined in Table 3-2. The word "service" as used by the ITU is different from that of this document. As discussed in Section 2.3, SCaN will support user missions in determining the right frequency band, and understanding the technical and regulatory constraints on signals within that band.

Table 3-2 **Frequency Bands for SCaN Services**

Frequency Bands	Usage
139.208 MHz	Analog Service (VHF-Forward)
143.625 MHz	Analog Service (VHF-Return)
2025–2110 MHz	Earth Exploration-Satellite Service (EESS), Space Research Service (SRS), Space Operations Service (SOS) Near Earth (S-Forward), Space-to-Space and Earth-to-Space
2110–2120 MHz	SRS Deep Space (S-Forward)
2200–2290 MHz	EESS, SRS, SOS Near Earth (S-Return), Space-to-Space and Space-to-Earth
2200–2345 MHz	VLBI/Radio Astronomy Science (S-Return)
2290–2300 MHz	SRS Deep Space (S-Return)
2360–2400 MHz	Radar Science (S-Forward/Return)
7145–7190 MHz	SRS Deep Space (X-Forward)
7190–7235 MHz	SRS Near Earth (X-Forward)
8025–8400 MHz	EESS (X-Return)
8200–8600 MHz	VLBI/Radio Astronomy Science (X-Return)
8400–8450 MHz	SRS Deep Space (X-Return)
8450–8500 MHz	SRS Near Earth (X-Return)
8500–8620 MHz	Radar Science (X-Forward/Return)
12–18 GHz	VLBI/Radio Astronomy Science (Ku-Return)

Frequency Bands	Usage
13.75–13.80 GHz[a]	SRS Near Earth (Ku-Forward), Space-to-Space
14.8909–15.1159 GHz	SRS Near Earth (Ku-Return), Space-to-Space
18.0–26.5 GHz	VLBI/Radio Astronomy Science (K-Return)
22.55–23.55 GHz	SRS Near Earth (Ka-Forward), Space-to-Space
25.25–27.50 GHz	SRS Near Earth (Ka-Return), Space-to-Space
25.5–27.0 GHz	EESS and SRS Near Earth (Ka-Return), Space-to-Earth
28–34 GHz	VLBI/Radio Astronomy Science (Ka-Return)
31.8–32.3 GHz	SRS Deep Space (Ka-Return)
34.2–34.7 GHz	SRS Deep Space Radio Science (Ka-Forward)
37–50 GHz	VLBI/Radio Astronomy Science (Ka/Q)-Return
[a]NTIA has restricted use of 13.75–13.8 GHz Ku-forward to the International Space Station only. All other uses are on a case-by-case basis.	

3.1 FORWARD DATA DELIVERY SERVICES

The Forward Data Delivery Services transmit data to the user mission platform. The data are sent by the user mission ground system, e.g. Mission Operations Center (MOC) to the SCaN Network, which transmits them to the user mission platform. Data transmitted typically include commands, sequence loads, and flight software loads, but may also include any other type of data elements.

3.1.1 Forward CLTU Service

Functional Description

Forward CLTU Service takes data in the form of Communication Link Transmission Units (CLTUs) from the user mission ground system and transmits that data to a user mission platform during a pass as a series of individual data units that may be concatenated. More information is available in the Deep Space Network Services Catalog, p. 3-1 and DSN Telecommunications Link Design Handbook, Module 205C.

Typical Uses

The forward CLTU service is used when a user mission wishes to send command data to a user mission platform, but does not wish to use the file service, and does not wish guaranteed reception. The Forward Enhanced CLTU Service is used when the user mission wishes the SCaN Network to radiate AOS frames with or without forward error-correction encoding.

Service Outputs

The output is the transmission of the CLTUs to the user mission platform, with interface specifications in the CCSDS CLTU standard.

IOAG

This is an IOAG core Service.

Constraints

Forward CLTU Service is available to user missions at either near-Earth or deep space S-band or X-band, at data rates from 7.8 bps to 7 Mbps. It is also available to near-Earth missions at Ka-band, allowing data rates of 300 kbps to 25 Mbps. Exact rates obtainable depend on the antenna being used.

Other constraints are:

- CLTUs can vary in length from 16 bits to 32,752 bits.
- There is no guaranteed reception for this service.

Service begins: Currently exists at DSN & SN; Phase 2 for NEN **Service ends:** No plans to end

3.1.2 Forward File Service

Functional Description

Forward File Service accepts files from a user mission ground system, either in real-time or at any point prior to the time designated for transmission, and transmits them to the user mission platform. The Forward File Service can operate in either of two basic modes:

- Unreliable transfer: In this mode, missing Protocol Data Units (PDUs) or other uncorrected errors in transmission are not reported by the user mission platform. This mode thus does not require interactive response from the user mission platform. However, missed data will not be automatically retransmitted. This mode does not use unacknowledged CCSDS File Delivery Protocol (CFDP).
- Reliable transfer: This mode guarantees complete file transfer within the parameters established for the protocol. The forward files are stored by the SCaN Network until positive confirmation of successful file delivery to the user mission platform. Using the standard CCSDS File Delivery Protocol (CFDP), this service executes forward transmission while providing reliable "error-free" delivery of forward data to a user mission platform..

More information is available in the Deep Space Network Services Catalog, pp. 3-1 and 3-4 and DSN Telecommunications Link Design Handbook. Module 205C.

Typical Uses

The Forward File Service is used by any user mission wishing its forward transmissions to be organized in files, or wishing to achieve reliable forward transfer.

Service Outputs

The Service output is the transmission of files via CFDP to the user mission platform. Interface specifications can be found in the CCSDS File Delivery Protocol.

IOAG

This is an IOAG extended Service.

Constraints

Forward File Service is available to user missions at either near-Earth or deep space, using S-band or X-band, at data rates from 7.8 bps to 7 Mbps. It is also available to near_earth missions at Ka-band, allowing data rates of 300 kbps to 25 Mbps; and at near-Earth Ka-band, allowing data rates of 300 kbps to 25 Mbps. Exact rates obtainable depend on the antenna being used.

Other constraints are:

- The reliable forward delivery is accomplished through the selective retransmission scheme of CFDP; therefore, user missions subscribing to this service must implement that capability on the user mission platform compliant to the CFDP standard.
- This service requires the project to send the CFDP response directives that are received from the user mission platform via return to the SCaN Network.

Service begins: Currently exists for DSN users; Phase 2 for others **Service ends:** No plans to end

3.1.3 Forward Frame

Functional Description

The Forward Frame Service allows a user mission ground system to provide the SCaN Network with frames (encoded or not) in an asynchronous manner. The frames are then transmitted, without additional coding, to the user mission platform. In the absence of user-supplied data, the SCaN Network will insert defined idle frames.

Typical Uses

The Forward Frame Service is often used to uplink AOS frames, but is not limited to these frames.

IOAG

This is an IOAG extended Service.

Constraints

Forward Frame Service is available to user missions at either near-Earth or deep space, using S-band or X-band, at data rates from 7.8 bps to 7 Mbps. It is also available to near-Earth missions at Ka-band, allowing data rates of 300 kbps to 25 Mbps. Exact rates obtainable depend on the antenna being used.

Service begins: Phase 2 **Service ends:** No plans to end

3.1.4 Forward IP Datagram (Over HDLC)

Functional Description

Forward IP Datagram allows IP messages to be sent on the forward link.

Typical Uses

The Forward IP Datagram Service is used as part of the South Pole TDRSS Relay (SPTR) communications link, providing the primary communications path to Antarctica through the SN.

IOAG

This Service is limited to the SPTR communications link and is not an IOAG Service.

Constraints

This Service exists only using the Earth-based Relay Element and only for communications with the South Pole.

Service begins: Currently exists **Service ends:** No plans to end

3.1.5 Forward IP (Over CCSDS)

Functional Description

Forward IP Service sends IP packets from a user ground system to a user platform, possibly using several hops.

Typical Uses

The Forward IP typically delivers commands, sequence loads, and flight software loads. The user mission ground system delivers IP datagrams to the SCaN Network over an IP based ground link. For hops over the space link, the IP datagrams will be wrapped into CCSDS Encapsulation packets.

Service Outputs

The Service output is IP datagrams wrapped in CCSDS Encapsulation packets.

IOAG

This is an IOAG extended Service.

Constraints

This Service is available to user missions whose platforms are near Earth, if end-to-end connectivity can be established, if the connectivity will be continuously available during transmission, and if the round-trip

delay is less than ten seconds. Data rates of 7.8 bps to 7 Mbps are available at S-band or X-band; rates of 300 kbps to 25 Mbps are available at Ka-band.

Service begins: Phase 2 **Service ends:** No plans to end

3.1.6 Forward Bitstream Service

Functional Description

Forward Bitstream Service accepts a serial stream of bits (bitstream) from a user mission ground system and transmits the bitstream to the user mission platform. The internal structure and boundaries of fields within the bitstream are unknown to the SCaN Network. The bitstream can be received by the SCAN Network either in real-time or at any point prior to the time designated for transmission. More information is available at Space Network Users' Guide p. 3-1, and Near Earth Network (NEN) Users' Guide, 453-NENUG, Sections 3 to 10. The Service preserves sequence ordering.

This is a legacy Service of the SN and NEN, retired except for user missions whose Service Level Agreements (SLAs) already include it.

Typical Uses

The forward bitstream typically includes commands, sequence loads, and flight software loads. The user mission ground system delivers unframed data to the SCaN Network in User Datagram Protocol/Internet Protocol (UDP/IP) encapsulated form.

Service Outputs

The Service output is a stream of bits modulated on the carrier/subcarrier that the user mission platform will receive and interpret as a bitstream.

IOAG

This is an IOAG legacy Service.

Constraints

This Service is available to user missions using the SN and NEN. When used with the SN, it uses S-band, allowing data rates of 300 kbps to 7 Mbps, and Ka-band, allowing data rates of 300 kbps to 25 Mbps. Capabilities using the NEN depend on the individual station, and can be found in Near Earth Network (NEN) Users' Guide, 453-NENUG, Sections 3 to 10.

Service begins: Currently exists **Service ends:** Phase 2

3.2 RETURN DATA DELIVERY SERVICES

Return Data Delivery Services retrieve data that a user mission platform has transmitted, and send them to the user mission ground system. This data can be platform health, engineering data, science data, or whatever else the user mission's designers have chosen.

Return data are time-tagged when received by the SCaN Network so that user missions may correlate the user mission platform clock time with the standard terrestrial time reference.

3.2.1 Beacon Tone Service

Functional Description

The Beacon Tone Service acquires and detects a beacon and forwards it to the user mission ground system. Beacon tones generated and transmitted by the user mission platform are used by the user mission ground system to monitor the high-level state of the platform. The SCaN Network is capable of acquiring and detecting the 4-tone Beacon Monitoring signals at signal-to-noise ratios as low as 5 dB-Hz, with detection time up to 1000 seconds. More information is available in the Deep Space Network Services Catalog p. 3-17 and DSN Telecommunications Link Design Handbook, Module 206A.

Typical Uses

The Beacon Tone Service allows the user mission ground system to monitor the high-level state of the user mission platform. Some deep-space user missions have a long cruise and/or require frequent visibility during periods when the downlink signals drops below threshold for normal return (for example, below a signal-power-to-noise ratio of approximately 18 dB-Hz). In these scenarios, the Beacon Tone Service offers a useful mechanism for the user mission ground system to gain some minimum knowledge about the health and safety of its user mission platform.

Service Outputs

The detected tone will be forwarded to the user mission ground system. The interpretation of the detected tone is the responsibility of the user mission ground system.

IOAG

This is not an IOAG Service

Constraints

This Service is available to user missions in deep space using X- and Ka-bands.

Other constraints are:

- This service does not include the capability to detect a large number of tones in the challenging low signal level and high dynamics condition that is typically needed for user mission's Entry, Descent, and Landing (EDL) support.

Service begins: Exists now **Service ends:** No plans to end

3.2.2 Return All Frames Service

Functional Description

The Return All Frames Service captures frames transmitted by the user mission platform and delivers them to the user mission ground system. When a user mission platform transmits frames with a structure compliant with the CCSDS Packet Telemetry or CCSDS Advanced Orbiting Systems (AOS) recommendation, the Return All Frame Service acquires the telemetry data, extracts the frames, and delivers them to the user mission's ground system. Filler frames as well as data frames are returned. More information is available in the Deep Space Network Services Catalog Section 3.2 and DSN Telecommunications Link Design Handbook, Module 206A.

Typical Uses

The Return All Frames Service is typically used to return science data and customer platform status information from a user mission platform to the user mission ground system.

Service Outputs

The outputs are the frames, both data frames and filler frames, that were transmitted by the user mission platform. Interface specifications can be found in the CCSDS Space Link Extension -- Return All Frames Service Specification

IOAG

This is an IOAG core Service.

Constraints

This Service is available to missions in both the near-Earth and deep space domains.

Near-Earth, data rates from 10 bps to 6 Mbps are available at S-band and X-band. Data rates up to 300 Mbps are available for near-Earth Ka-band. Data rates of 10 bps to 6 Mbps are available for deep space S, X, and Ka-band. At least 40 bps is recommended for timely acquisition. Not all data rates are available on all antennas.

Other constraints are:

- Return All Frames Service requires a fixed length frame, with each frame preceded by a CCSDS compliant synchronization marker. Each frame must either contain an error-detecting checksum or use a block code that will reject undecodable frames (e.g., LDPC).

Service begins: Exists now for DSN and SN, Phase 2 for NEN **Service ends:** No plans to end

3.2.3 Return Channel Frames Service

Functional Description

The Return Channel Frames Service captures frames transmitted by the user mission platform and delivers them to the user mission ground system. The Service acquires the telemetry data, extracts the data frames, i.e. virtual channel data units (VCDUs), within each virtual channel, and delivers them to the user mission's ground system. More information is available in the Deep Space Network Services Catalog Section 3.2 and DSN Telecommunications Link Design Handbook, Module 206A.

Typical Uses

The Return Channel Frames Service is typically used to return science data and customer platform status information from a user mission platform to the user mission ground system.

Service Outputs

The service outputs are data frames, i.e., VCDUs, within each virtual channel. Interface specifications can be found in the CCSDS Space Link Extension -- Return Channel Frames Service Specification.

IOAG

This is an IOAG core Service.

Constraints

This Service is available to missions in both the near-Earth and deep space domains.

Near-Earth, data rates from 10 bps to 6 Mbps are available at S-band and X-band. Data rates up to 300 Mbps are available for near-Earth Ka-band. Data rates of 10 bps to 6 Mbps are available for deep space S, X, and Ka-band. At least 40 bps is recommended for timely acquisition. Not all data rates are available on all antennas.

Other constraints are:

- Return Channel Frames Service requires a fixed length frame, with each frame preceded by a CCSDS compliant synchronization marker. Each frame must either contain an error-detecting checksum or use a block code that will reject undecodable frames, e.g., LDPC.

Service begins: Exists now for DSN & SN, Phase 2 for NEN **Service ends:** No plans to end

3.2.4 Return Packet Service

Functional Description

The Packet service receives frames from the user mission platform, and then extracts packets from frames, i.e., VCDUs, and delivers them to the user mission ground system. More information is available at Deep Space Network Services Catalog Section 3.2 and DSN Telecommunications Link Design Handbook, Module 206A.

Typical Uses

The packet service is typically used by user missions wishing their data to be organized in packets.

Service Outputs

The following output options are available for Packet service:

- Extracted packets are ordered by Earth received time (ERT)
- Extracted packets are ordered by a combination of user mission-specified parameters, e.g., application identifier, packet generation time, packet sequence number, etc. Note: This order is a non-real time query.

IOAG

This is not an IOAG Service.

Constraints

This Service is available to missions in both the near-Earth and deep space domains.

Near-Earth, data rates from 10 bps to 6 Mbps are available at S-band and X-band. Data rates up to 300 Mbps are available for near-Earth Ka-band. Data rates of 10 bps to 6 Mbps are available for deep space S, X, and Ka-band. At least 40 bps is recommended for timely acquisition. Not all data rates are available on all antennas.

Service begins: Exists now for DSN, Phase 2 for SN and NEN **Service ends:** No plans to end

3.2.5 Return File Service

Functional Description

The Return File service receives files transmitted according to the CCSDS File Delivery Protocol (CFDP) and forwards them to the user mission ground system. The service extracts PDUs from packets and re-assembles the PDUs into files. The resulting files are then made available to the user mission ground system.

The Return File service can operate in either of two basic modes:

- Unreliable transfer: In this mode, missing PDUs or other uncorrected errors in transmission are not reported to the user mission platform. This mode thus requires neither use of an uplink nor interactive response from the user mission platform. However, missed data will not be automatically retransmitted. The file will be delivered with transactions containing metadata and the transaction completeness data.

- Reliable transfer: This mode guarantees complete file transfer within the parameters established for the protocol. The SCaN Network will automatically notify the user mission ground system if file segments or ancillary data are not successfully received, i.e., PDUs are missing or malformed; the notification is done using the SLE Return PDU (RPDU) interface. The SCaN Network can also respond automatically to the user mission platform with acknowledgement or non-acknowledgement PDUs. The platform can then retransmit the missed items, and the SCaN Network will combine them with the portions that were previously received. Reliable transfer requires use of an uplink and that the user mission platform cooperate in accord with the CFDP specification. CFDP is a content-independent protocol, which requires no knowledge about the content or structure of a transferred file.

More information is available at Deep Space Network Services Catalog Section 3.2 and DSN Telecommunications Link Design Handbook, Module 206A.

Typical Uses

The Return File Service is used by any user mission wishing its return transmissions to be organized in files, or wishing to achieve reliable return file transfer.

Service Outputs

The files, along with the meta-data contained within the transaction and the metadata summarizing the file contents and the time of receipt of the initial and final PDUs, are made available to the user mission ground system. This service also supports transfer of directory listings, file transmission status, and other messages as specified in the CCSDS File Delivery Protocol (CFDP). Communication between the user mission ground system and the DSN does not follow the CCSDS Space Link Extension standard.

IOAG

This is an IOAG extended Service.

Constraints

This Service is available to missions in both the near-Earth and deep space domains.

Near-Earth, data rates from 10 bps to 6 Mbps are available at S-band and X-band. Data rates up to 300 Mbps are available for near-Earth Ka-band. Data rates of 10 bps to 6 Mbps are available for deep space S, X, and Ka-band. At least 40 bps is recommended for timely acquisition. Not all data rates are available on all antennas.

Other constraints are:

- The time needed to deliver a complete file via the CFDP is a function of the file size, data rate, and round-trip-light-time effect. This is particularly significant in the case of the reliable transfer.

Service begins: Exists now for DSN, Phase 2 for others **Service ends:** No plans to end

3.2.6 Return IP Datagram (Over HDLC)

Functional Description

Return IP Datagram allows IP messages to be sent on the return link.

Typical Uses

The Return IP Datagram Service is used as part of the South Pole TDRSS Relay (SPTR) communications link, providing the primary communications path to Antarctica through the SN.

IOAG

This Service is used only on the SPTR communications link, and is not an IOAG Service.

Constraints

This Service exists only for SN communications with the South Pole.

Service begins: Currently exists **Service ends:** No plans to end

3.2.7 Return IP (Over CCSDS)

Functional Description

Return IP Service sends IP datagrams from a user platform to a user ground system, possibly using several hops.

Typical Uses

The Return IP Service typically delivers the same types of information as other Return Services. For hops over the space link, the IP datagrams will be wrapped into CCSDS Encapsulation packets.

SCaN delivers IP datagrams to the user mission ground system over an IP-based ground link.

Service Outputs

The Service output is IP datagrams.

IOAG

This is an IOAG extended Service.

Constraints

This Service is available to user missions whose platforms are near Earth. This Service only works if an end-to-end connectivity can be established, if the connectivity will be continuously available during transmission, and if the round-trip delay is less than ten seconds.

Service begins: Phase 2 **Service ends:** No plans to end

3.2.8 Return Bitstream Service

Functional Description

The Return Bitstream Service receives a serial stream of bits (bitstream) from a user mission platform and provides it to the user mission ground system. The internal structure and boundaries of fields within the bitstream are unknown to the SCaN Network. The Service preserves the order of the user mission's transmission sequence. More information is available at Space Network Users' Guide Section 3 and Near Earth Network (NEN) Users' Guide, 453-NENUG, Sections 3 to 10.

This is a legacy Service of the SN and NEN, retired except for user missions whose SLAs already include it.

Typical Uses

The Return Bitstream Service is used to deliver unframed baseband data transmitted from user mission platform to the user mission ground system.

Service Outputs

The Return Bitstream Service delivers unframed data to user mission ground systems in UDP/IP encapsulated form.

IOAG

This is an IOAG legacy Service.

Constraints

This Service is available to user missions using the SN or NEN. When used with the SN, it uses S-band, allowing data rates of 300 kbps to 6 Mbps, and Ka-band, allowing data rates up to 300 Mbps. Capabilities using the NEN depend on the individual station, and can be found in Near Earth Network (NEN) Users' Guide, 453-NENUG, Sections 3 to 10.

Other constraints are:

- The Service does not provide data quality information.

Service begins: Exists now **Service ends:** Phase 2

3.3 RADIOMETRIC SERVICES

3.3.1 Raw Radiometric Services

Raw Radiometric Services make measurements that aid in the navigation of the user platform. The measurements are delivered in near-real time and are not validated, that is, they are "raw".

3.3.1.1 Raw Doppler Service

Functional Description

The Raw Doppler Service measures the frequency difference between the received return carrier and the transmitted forward carrier (coherent Doppler) or the difference between the received return carrier and

an estimate of the transmitted return carrier at the user mission platform. Detailed technical information can be found in the Space Network Users' Guide, Section 9, or the Near Earth Network (NEN) Users' Guide, 453-NENUG, Sections 3 to 10.

Typical Uses

The Raw Doppler Service is used for trajectory determination and prediction.

Service Outputs

The Raw Doppler Service provides measurements of frequency difference delivered in Universal Tracking Data Format. The format for this product is defined in The Ground Network Tracking and Acquisition Data Handbook.

IOAG

This is an IOAG extended Service.

Constraints

The Service is available to user missions using the SN or the NEN. Because of its limited use for user missions far from earth, this Service will not be made available at the DSN.

Other constraints are:

- In order for the user mission to derive coherent Doppler from this Service, the user mission platform must fly a transponder, and schedule a two-way tracking pass.

Service begins: Exists now **Service ends:** No plans to end

3.3.1.2 Raw Ranging Service

Functional Description

The Raw Ranging Service allows measurement of the distance between the user mission platform and the tracking station. In order to do this, the tracking station modulates the forward carrier with specialized signals and then measures the time it takes for the return of these signals from the user mission platform, thereby measuring the two-way range, or distance, between the user mission platform and the tracking station. Depending on the SCaN Network and tracking stations being used, the specialized signals may be a series of tones or a pseudo noise (PN) code. The user mission platform receives and modulates signals onto the return carrier, and the SCaN Network then uses the received return carrier, modulated with the signals, to determine the round trip distance between the SCaN asset and the user mission platform. Detailed technical information can be found in the Space Network Users' Guide, Section 9, or the Near Earth Network (NEN) Users' Guide, 453-NENUG, Sections 3 to 10.

Typical uses

The Raw Ranging Service is used for trajectory determination and prediction.

Service Outputs

The Raw Ranging Service provides measurements of two-way range delivered in Universal Tracking Data Format. The format for this product is defined in The Ground Network Tracking and Acquisition Data Handbook.

IOAG

This is an IOAG extended Service.

Constraints

The Service is available to user missions using the SN or the NEN. Only PN ranging is available using the SN. Some NEN stations use tone ranging, while others use PN ranging. Because of its limited use for user missions far from earth, this Service will not be made available at the DSN.

Other constraints are:

- The user mission platform must be capable of recovering the specialized signal from the forward link and re-modulating and retransmitting it on the return carrier

Service begins: Exists now **Service ends:** No plans to end

3.3.1.3 Tracking Angle Data Service

Functional Description

The Tracking Angle Data Service measures the pointing angles to the user mission platform in the antenna reference frame. For the data to be meaningful, the antenna pointing must be performed using closed-loop control that drives the pointing to a location that maximizes the received power from the user mission platform. Detailed technical information can be found in the Near Earth Network (NEN) Users' Guide, 453-NENUG, Sections 3 to 10.

Typical Uses

Angle data is used to determine the user mission platform trajectory and is typically most important during launch and initial acquisition of the user mission platform, when the orbit is poorly known.

Service Outputs

The Tracking Angle Data Service provides measurement in UTDF, defined in The Ground Network Tracking and Acquisition Data Handbook, in Section 4.2.

Constraints

This Service is available for near-Earth support, including launch and early orbit phase (LEOP) support for deep space user missions. It uses the NEN.

The user mission must ensure that the user mission platform or launch vehicle is transmitting a radio frequency (RF) signal at S-, X-, or Ka- band depending on the antenna.

Service begins: Exists now **Service ends:** No plans to end

3.3.2 Validated Radiometric Services

Validated Radiometric Services make measurements that aid in the navigation of the user mission platform. All measurements from a tracking pass are delivered in a single file. If all equipment used to make the measurements have reported nominal status and performance, the file containing the measurements is marked "valid".

3.3.2.1 Validated Doppler Service

Functional Description

The Validated Doppler Service measures and time tags the phase of the transmitted forward carrier and the received return carrier at the asset providing the Service. It also provides ancillary data, e.g., station location and media calibration. Interpretation of these measurements allows the user mission to determine the Doppler frequency of the return carrier. If the user mission platform is in transmit only mode, i.e., no forward carrier, or not transmitting a return carrier that is phase coherent with the received forward carrier, i.e., non-coherent transmission, only received return carrier phase is meaningful.

Detailed technical data can be found in the DSN Telecommunications Link Design Handbook, Module 202B.

Typical Uses

The Validated Doppler Service is used for orbit determination and prediction by user missions. It is also used by scientists for modeling gravity fields of large bodies such as planets and their moons.

Service Outputs

Two outputs are available:

- Time tagged measurements of transmitted carrier phase and received carrier phase as a real time flow or as part of an electronic file in DSN Tracking System Archival Data Format, DSN External Interface TRK-2-34
- Time tagged measurements of transmitted carrier frequency and received carrier frequency as part of an electronic file in DSN Tracking Data Message (TDM), DSN External Interface 0212-Tracking-TDM

Both data format definitions are available at the DSN Interface Server. An account and password are required to access the interface specification on this site.

IOAG

This is an IOAG core Service.

Constraints

In order to derive coherent Doppler from this Service, the user mission platform must fly a transponder.

Service begins: Exists now for DSN users; Phase2 for SN and NEN **Service ends:** No plans to end

3.3.2.2 Validated Ranging Service

Functional Description

The Validated Ranging Service allows measurement of the distance between the user mission platform and the tracking station. In order to do this, it modulates the forward carrier with specialized signals and then measures the time it takes for the return of these signals from the user mission platform, thereby measuring the two-way range between it and the tracking station. Two modes are available. The first mode, sequential ranging, uses a series of sinusoidal tones at various frequencies to modulate the carrier. In the second mode, PN codes are used to modulate the carrier.

Detailed technical data on sequential ranging can be found in the DSN Telecommunications Link Design Handbook, Module 203C

Detailed technical data on PN and regenerative ranging can be found in the DSN Telecommunication Link Design Handbook, Module 214

Typical Uses

The Validated Ranging Service is used for orbit determination and prediction by user missions. It is also used by scientists for modeling gravity fields of large bodies such as planets and their moons.

Service Outputs

Validated data include traditional and Pseudo-Noise ranging results. These results are assembled by the SCaN Network into files which are provided to the user mission ground system.

Format definitions are available at the DSN Interface Server. An account and password are required to access the interface specification on this site.

IOAG

This is an IOAG core Service.

Constraints

The user mission platform must be capable of receiving, demodulating, re-modulating and re-transmitting the ranging signal. In the case of PN ranging, the ranging signal may be recovered and "regenerated" before modulation onto the return carrier in order to improve ranging signal-to-noise ratio.

Service begins: Exists now for DSN; Phase 2 for SN and NEN **Service ends:** No plans to end

3.3.3 Delta DOR Service

Functional Description

The Delta DOR (Differential One-way Ranging) Service measures the time delay between user mission platform signals arriving at two different SCaN tracking stations and, contemporaneously, measures the time delay of RF emissions from a quasar arriving at the same two tracking stations. From these measurements, the angular position of the user mission platform along the baseline between the two tracking stations, relative to the quasar can be inferred. The Service also provides an Extra-Galactic Radio Source (EGRS) Catalog listing the plane-of-sky position in inertial space of quasars used in the Delta DOR Service.

Detailed technical data can be found in the DSN Telecommunications Link Design Handbook, Module 210.

Typical Uses

The Delta DOR Service provides measurements that can be used to determine the plane-of-sky position and velocity of a user mission platform. These measurements complement Doppler and range measurements that are line-of-sight measurements and are used in orbit determination and prediction.

Service Outputs

The Delta DOR Service provides time-tagged measurements of the delay and delay rate of user mission platform and quasar signals as a real time flow or as part of an electronic file in DSN Tracking System Archival Data Format, DSN External Interface TRK-2-34. Delta DOR is also available in the 0212 interface. It also provides an EGRS Catalog as an American Standard Code for Information Interchange (ASCII) file. The formats for these products are available at the DSN Interface Server. An account and password are required to access the interface specification on this site.

IOAG

This is an IOAG extended Service.

Constraints

The Service is available to deep space user missions, at X- or Ka-band.

Other constraints are:

- The user mission platform must be capable of transmitting "DOR tones". See DSN Telecommunications Link Design Handbook, Module 210, page 15.

Service begins: Exists now **Service ends:** No plans to end

3.4 SCIENCE SERVICES

3.4.1 Very Long Baseline Interferometry (VLBI) Science Service

Functional Description

The VLBI Service provides antenna pointing, RF signal capture and amplification, down-conversion, appropriate filtering, digitization and recording of RF signals from extraterrestrial sources. To effect a VLBI interferometry network, the Service is scheduled simultaneously with other instances of this Service and/or with observatories outside the SCaN Network. Detailed technical data can be found in the DSN Telecommunications Link Design Handbook, Module 211.

Typical Uses

Typical uses of the VLBI Service are the determination of Earth orientation parameters, astrometric measurements, radio imaging, and geodynamics.

Service Outputs

The VLBI Service delivers data to users, or their designated correlator, on International VLBI Service (IVS) Mark 5 magnetic disks, in IVS Mark 5C data format.

Constraints
Constraints are:

- Available frequency ranges and polarizations can be found in the DSN Telecommunications Link Design Handbook, Module 211.
- Configuration and control information for this Service must be in the form of IVS VLBI EXperiment (VEX) control files. The format can be found at the VLBI Standards Website
- Users are responsible for scheduling and compatibility of configuration and operations among all other observatories/services in their VLBI network.
- Users may correlate the data themselves or have the correlation done by SCaN (if both data streams come from SCaN antennas).

Service begins: Exists now **Service ends:** No plans to end

3.4.2 Radar Science Services

Functional Description

The Radar Service provides high power transmission of specialized radar signals, then captures, amplifies, frequency downconverts, digitizes and records the reflected signal from extraterrestrial targets. The Service provides transmission and data acquisition at X-band but can provide data acquisition at S-band for bi-static radar observations with the planetary radar at Arecibo. Detailed technical information can be found at the JPL Planetary Radar Group webpage.

Typical Uses

The Radar Service is used to study astronomical targets such as planets and their satellites, the Moon, near-Earth asteroids and comets, and for reconnaissance of potential landing sites for robotic or human space flight missions. The Radar Service can also provide data for tracking of orbital debris that could pose a hazard to mission platforms.

Service Outputs

Radar data is provided to users on magnetic hard drives in a standard format. The format can be obtained by contacting the JPL Planetary Radar Group.

Constraints

Radar signal reception at multiple sites is needed for radar imaging observations.

Service begins: Exists now **Service ends:** No plans to end

3.4.3 Radio Science Service

Functional Description

The Radio Science Forward Carrier Service transmits a phase and amplitude stable RF carrier toward a user mission platform. The use of the much stronger forward carrier can increase the signal-to-noise ratio (SNR) for Radio Science observations by orders of magnitude.

The Radio Science Return Signal Recording Service captures, down-converts, digitizes and records signals from a user mission platform. Down-conversion is performed “open-loop” using predictions of the return link frequency and amplitude, using no closed loop tuning or automatic gain control so that the recorded data can be used to reconstruct the actual received signal from the user mission platform.

Further information can be found at DSN Telecommunications Link Design Handbook, Modules 103B, 104F, 101D, and 209A.

Typical Uses

Typical uses are radio occultation measurements of planetary atmospheres and rings, occultation measurements of moons, occultation measurements of the solar corona, precision Doppler measurements, and detection of beacon signals.

Service Outputs

The Radio Science Forward Carrier Service provides a carrier that is phase and amplitude stable, suitable for use in Radio Science observations.

The Radio Science Return Signal Recording Service delivers an electronic file of the digital recordings of the down-converted RF signal in Radio Science Receiver Standard Formatted Data Units, DSN External Interface Specification 0159-Science. The format is available at DSN Interface Server. An account and password are required to access the interface specification on this site.

Constraints

The Forward Carrier Service is available to user missions using the DSN at X-band, 7145–7190 MHz.

The Return Signal Recording Service is available to missions using the Deep Space Network, at either near-Earth or deep space S-band, X-band, or Ka-band.

Other Constraints are:

- To use the Forward Carrier Service, the user mission platform must carry a radio science data acquisition system onboard the user mission platform, capable of receiving, processing, and recording data.

Service begins: Exists now **Service ends:** No plans to end

3.5 CALIBRATION SERVICES

3.5.1 Platform Modeling Service

Functional Description

The Platform Modeling Service provides Earth orientation parameters (EOP) data referenced to the terrestrial and celestial frames.

Typical Users

This Service is used by deep space missions with a need for more precise data than our radiometric data, or by anyone needing very fine calibration of the inertial position of a DSN station.

In order to process DSN radiometric data, the subscriber must know the inertial position of the station at the time of the measurement. Although the locations of DSN antennas are known to within centimeters and the baselines between them to millimeters, the variations in polar motion and the rotation rate of the Earth can move the inertial position by much larger amounts than this. The terrestrial frame tie data provide a temporal model for the orientation of the Earth's pole and the spin rate based upon Very Long Baseline Interferometry (VLBI) observations and tracking of Global Positioning System (GPS) satellites. These data provide the subscriber with an instantaneous knowledge of the inertial position of a crust fixed location on the Earth's equator to 30 cm. A posterior knowledge on the order of 5 cm (1-sigma) is available after 14 days. For Earth orientation parameters (EOP), the accuracy of the polar motion parameters (PMX and PMY) is within 5 cm (1-sigma) and the spin parameter (UT1) is within 30 cm (1-sigma) in real-time.

Service Outputs

A quasi-inertial celestial reference frame in International Earth Rotation and Reference Systems (IERS) format referenced to epoch J2000 is provided with an accuracy to better than 1 nrad (1-sigma) with a measured stability of better than 0.1 nrad/year (1-sigma).

Typically, platform calibration data, i.e., EOP data and reference frame tie data, are delivered twice a week. More details are available in the DSN Service Catalog.

Constraints

This Service is available to user missions using the DSN.

Service begins: Exists now **Service ends:** No plans to end

3.5.2 Media Calibration Service

Functional Description

The Media Calibration Service provides adjustments to signal delays due to the Earth's troposphere and ionosphere. In order to achieve the data accuracies discussed in the previous sections on data services, it is necessary to calculate adjustments for the delays due to these.

Typical Uses

This Service is used by deep-space missions with a need for more precise radiometric data than that produced by SCaN radiometric Services, or by anyone needing a fine calibration of the ionosphere or troposphere.

Service Outputs

Calibrations are generated once per day for all users, with a latency of 2 hours post real time for troposphere calibrations and 6 hours post real time for ionosphere calibrations. Quick-look calibrations are delivered to all users within one hour of creation. The operator typically delivers calibrations that have been validated visually to users twice per week, or more often during critical periods as negotiated. More details are available in the DSN Service Catalog.

Constraints

This Service is available to user missions using the DSN.

Service begins: Exists now **Service ends:** No plans to end

Section 4. Service Management

4.1 SERVICE MANAGEMENT OVERVIEW

The SCaN Network provides Service Management capabilities to allow the user mission to plan, schedule, control, and monitor Service execution by the SCaN Network.

The components of Service Management are:

Service Planning

The SCaN Network accepts support plans from user missions during their mission-planning phase. The user mission support needs are evaluated and the SCaN Network makes sure that the necessary assets will be available or negotiates with the user missions, or facilitates their negotiation, to resolve conflicts between available assets and user mission needs.

Service Scheduling

Each Service instance is scheduled by the SCaN Network. User missions submit Service requests specifying the desired Service instances. The Service request contains all the information needed to schedule the SCaN assets, including the specific Service instances and needed ancillary data, for example information on the predicted flight system dynamic state and data-rate predicts. The SCaN Network responds to Service requests with schedules stating the committed service instances and ancillary data needed by the user mission. If the Service request cannot be fulfilled, the SCaN Network and the user mission will negotiate. Changes to a Service schedule that require the scheduling of new assets require a new service request.

Service Monitor and Control

During the execution of a Service instance the SCaN Network will generate monitor data about the performance of SCaN Services. The SCaN Network may need monitor data from the user mission concerning flight system telecommunications performance to distinguish link problems caused by flight system anomalies and those caused by anomalies within the SCaN Service system.

During the service instance execution, the user mission may control some configuration control parameters. These parameters and their limits are defined and provided to the user mission prior to the Service instance.

Service Accountability

At the end of the Service instance, a summary report will be generated that compares the committed Service to the Service delivered.

Emergency Support

SCaN Service scheduling will accept emergency support requests in case of user mission platform emergency. The SCaN Network will reschedule assets even if this requires not meeting commitments to other user missions. This is not a normal operational mode, nor is it a schedulable service. Declaration of a flight system emergency may allow a user mission to bypass the normal Service scheduling process. In the case of a SCaN asset anomaly or contingency, the SCaN Network may have to shift a Service instance to another SCaN asset or pre-empt Service commitment(s) to user mission(s). In this case, the SCaN Network will do its best to minimize the Service disruption to user mission(s).

4.2 SERVICE MANAGEMENT INTERFACES

The following are descriptions of the interface products exchanged between user missions and the SCaN Network.

Service Level Agreement

The result of Service Planning is an SLA. The SLA is an agreement by the SCaN Network to provide Services and an agreement by the user mission to comply with the constraints imposed by SCaN.

The SLA between the user mission and the SCaN Network accomplishes objectives important to both. First, it provides the user mission and its sponsor with evidence that the SCaN Network will provide the needed Services. Second, it allows the SCaN Program to perform long-range asset scheduling and planning.

Service Request

The user mission schedules Services using a Service Request. The SCaN Network uses Service Requests from its user mission community to develop a master schedule of SCaN assets.

Schedule

After the SCaN Network has developed a master schedule for its assets, it provides each user mission with a schedule containing the exact Service instances that the SCaN Network is committed to providing.

User Service Control Directives

In some cases, between the time when a user mission receives a schedule and the end of a Service instance, the user mission may direct the SCaN Network to change Service parameters. A list of Service parameters is defined and provided to the user mission prior to the Service instance.

Service Monitor Data

For each Service, the SCaN Network provides standard monitor parameters for the user mission.

Service Accountability Report

At the end of a Service instance, the SCaN Network provides the user mission with a Service Accountability Report comparing the Services and performance committed to the Services and performance actually delivered. In the case of a SCaN committed Service not being delivered, the SCaN Network provides a description of the root cause and its resolution.

Section 5. Obtaining SCaN Services

5.1 SCAN SERVICE USER ELIGIBILITY

SCaN Services and support are available to all NASA sponsored flight projects and science investigators. Non-NASA flight projects can become eligible through negotiation with NASA Headquarters. (Contact the SCaN Director of Network Services, (202) 358-2020)

5.2 SCAN SERVICE COMMITMENT PROCESS

User missions of SCaN Services should make contact as early in the development process as possible. User missions should first engage through the online SCaN Service Planning System. As part of the commitment process the user mission will provide descriptions of its communications capabilities and configurations, and the commitment office will translate these into detailed descriptions of the communications modes that the SCaN Network is committed to supporting. The commitment process also includes supporting the users with link analyses, loading analyses, spectrum, and definition of interface specifications.

The SCaN Network will work with the user mission to create an SLA. For competitively selected missions, the SCaN Network provides a letter of commitment early in the process, before selection.

Negotiation of the SLA creates a commitment to the user mission, and allows the SCaN Network to analyze requested support with future loading of the SCaN Service system, and plans for development of the SCaN Network. The document will also define the information that must be supplied to the SCaN Network for SCaN Service provision and compatibility with SCaN Services. Extended missions or other major changes in the user mission's plan may require a re-negotiation of the document.

5.3 SERVICE COMPATIBILITY TESTING

User missions using SCaN Services pass a SCaN Service Compatibility Test, verifying the interfaces between actual flight equipment and requested SCaN Services.

Appendix A. Abbreviations and Acronyms

Acronym	Definition
AOS	Advanced Orbiting Systems
ASCII	American Standard Code for Information Interchange
bps	Bits per second
CCSDS	Consultative Committee for Space Data Systems
CFDP	CCSDS File Delivery Protocol
CLTU	Command Link Transmission Unit
CSO	Communications Services Office
dB	Decibel
Delta DOR	Delta Differential One-way Ranging
DSA	DSN Service Agreement
DSN	Deep Space Network
EDL	Entry, descent and landing
EES	Earth Exploration Satellite Service
EGRS	Extra-Galactic Radio Source
ERT	Earth Received Time
FDF	Flight Dynamics Facility
GEO	Geosynchronous Earth Orbit
GSFC	Goddard Space Flight Center
HEO	Highly Elliptical Orbit
Hz	Hertz
ICD	Interface Control Document
ICMP	Information and Configuration Management Plan
IP	Internet Protocol
ITU	International Telecommunications Union
IVS	International VLBI Service
JPL	Jet Propulsion Laboratory
kbps	Kilobits per Second

Acronym	Definition
LEO	Low Earth Orbit
LEOP	Launch and Early Orbit Phase
Mbps	Megabits per Second
MOC	Mission Operations Center
MOS	Mission Operations System
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communications
NCCDS	Network Control Center Data System
NEN	Near Earth Network
NENUG	Near Earth Network Users Guide
NIMO	Network Integration Management Office
NISN	NASA Integrated Service Network
NTIA	Nation Telecommunications and Information Administration
PDU	Protocol Data Units
PN	Pseudo noise
PSLA	Project Service Level Agreement
Pt/No	Total signal power divided by the noise spectral density
RPDU	Return Protocol Data Unit
RF	Radio Frequency
SCaN	Space Communications and Navigation Program
SFDU	Standard Formatted Data Unit
SN	Space Network
SNR	Signal to Noise Ratio
SNUG	Space Network Users Guide
SOS	Space Operations Service
SRS	Space Research Service
TDRSS	Tracking and Data Relay Satellite System
UDP	User Datagram Protocol
UTC	Universal Time, Coordinated
UTDF	Universal Tracking Data Format

Acronym	Definition
VCDU	Virtual Channel Data Unit
VEX File	VLBI Experiment file
VLBI	Very Long Baseline Interferometry

Appendix B. Glossary

Advanced Orbiting System (AOS) Space Link Data Protocol is a CCSDS standard for transfer of data over space links between tracking stations and spacecraft.

Beacon tones are single frequency signals sent from a user mission platform to provide status information about its health and that of its instruments. For instance, a particular frequency may be used to inform the ground that the user mission platform is "healthy", with all systems nominal. Another "tone" may be used to inform the ground that there is a problem onboard that requires attention from operators.

Communications Services transfer data from one point to another, such as from the radio link from a user mission platform to a user mission ground system, often a mission operations center (MOC).

Communications Link Transmission Unit (CLTU) is a CCSDS term for command information transmitted from a user mission ground system to a user mission platform, or spacecraft.

Communications Services Office is the NASA office which provides NISN.

Consultative Committee for Space Data Systems (CCSDS) is an organization of Space Agencies and produces recommendations and standards for the development of communications and data systems standards for spaceflight.

Deep Space is defined by the International Telecommunications Union (ITU) as space at distance more than 2,000,000 km above the surface of the earth.

The Deep Space Network (DSN), part of the SCaN Network, is a set of ground stations spaced around the world providing coverage of user mission platforms from GEO to beyond the edge of our solar system.

Delta Differential One-Way Ranging (Delta DOR) is a radio interferometric technique used to determine the plane-of-sky position and velocity of a user mission platform. It is complimentary to radial, line-of-sight Doppler (velocity) and range measurements.

The Flight Dynamics Facility is a NASA facility that provides services to spaceflight missions, including platform navigation and attitude prediction and control,

Mission Operations Center (MOC) is generic term for the facilities and people that perform mission operations for a spaceflight mission. See also, MOS

Mission Operations System (MOS) is another name for the MOC.

NASA Integrated Service Network is a global system of communications transmission, switching, and terminal facilities that provides NASA with wide area network communications services.

Near Earth is defined by the ITU as space at distance less than 2,000,000 km above the surface of the earth.

The Near Earth Network (NEN), part of the SCaN Network, consists of NASA, commercial, and partner ground stations and integration systems providing space communications and tracking services to user missions operating in orbital and suborbital locations, including LEO, Geosynchronous Earth Orbit (GEO), and highly elliptical orbits, and at lunar distances.

The **Networks Integration Management Office** (NIMO) at Goddard Space Flight Center (GSFC) serves as a liaison for customers needing access to the NEN and SN.

Radio Astronomy is the observation and analysis of the radio emissions from natural radio sources, such as planets and quasars.

Radiometric data are measurements of the radio signal from or to a user mission platform. In the context of this document, this term is applied to measurements of the signal needed to estimate the Doppler or measurements of range between the user mission platform and the ground or space asset providing the Service.

Radio Science is the use of the radio links between a user mission platform and ground tracking station for direct science observations.

Service is a self-contained set of functions with well-defined, standard interfaces.

Service Catalog describes the list of standard Services provided by a Service provider.

Service Execution is the set of functions performed by the SCaN Network or its assets for the execution of the various types of services.

Service Instance is a specific Service performed over a specific time interval.

Service Management is the interface between the Service provider and the Service user and allows the user mission to schedule, monitor, and control Service execution and to receive accountability reports information from the Service provider.

Space Communications and Navigation (SCaN) Program is a NASA Program providing communications, radiometric, navigation and science Services to NASA spaceflight missions and scientists. As part of NASA's agreements with international partners, SCaN also provides these Services to spaceflight missions and scientists from other space agencies and organizations.

Space Link Extension is a CCSDS developed standard method for transferring spacecraft forward and return data between tracking stations and mission operations control centers.

The Space Network (SN), part of the SCaN Network, consists of a Ground Segment and the Tracking and Data Relay Satellite System, a constellation of geosynchronous relays (and associated ground systems) providing continuous global coverage of user missions in equatorial to highly inclined orbits from launch to Low Earth Orbit (LEO).

Tracking Services are the provision of radiometric data for user mission platform navigation.

User mission platform is the spacecraft, launch vehicle, balloon, aircraft or ground station that interfaces with the SCaN Network.

User mission ground system is the system, often a Mission Operations System or a Principal Investigator, with whom the SCaN Network interfaces during Service Execution.

Very Long Baseline Interferometry (VLBI) is a technique used in radio astronomy that allows observations of an object that are made simultaneously by many telescopes to be combined, such that the angular resolution is equivalent to a telescope the size of the baseline