SCaN-MOCS-0001

SPACE COMMUNICATIONS AND NAVIGATION PROGRAM

Space Communications and Navigation (SCaN) Mission Operations and Communications Services (MOCS)

Revision 4

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National Aeronautics and Space Administration

NASA Headquarters
Washington, D. C.

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Space Communications and Navigation (SCaN) Mission Operations and Communications Services (MOCS)

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Preface

This is the SCaN Mission Operations and Communications Services Document.

This document is controlled by the Heaquarters (HQ). SCaN Integrated Network Configuration Control (SINCCB) is delegated by SCaN to manage the configuration of the SINCCB. This document will be updated by Documentation Change Notice (DCN) or complete revision. Proposed changes to this document must be submitted to SCaN Configuration Management Office along with supportive material justifying the proposed change.

Comments or questions concerning this document and proposed changes shall be addressed to:

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SCaN-MOCS-0001	Baseline	March 21, 2016	CR 106
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Change History		
Revision	***Effective Date***	***Description of Change***
Baseline (CR 106)	March 21, 2016	Initial Release

Revision 1	March 26, 2018	• Editorial revisions for clarity, verbiage, grammar, and acronyms throughout the document • Replaced DSN Mission Services Planning & Management Office (DMSP&MO) with CIMO throughout the document • Updates throughout the document for consistency with other SCaN documentation • Changes references from Communications Service Office (CSO) to NASCOM in Sections 3.4 and 4.2 • Updated SN Rates in Section 5.3 to match published 2017 SN Rate Letter • Reconfigured Section 5.3 to create a more balanced presentation of the material between the three SCaN networks • Moved Costs for using the DSN from Section 5.4 to Appendix F • Updated contact information for the Points of Contact in Section 6 • Added references to the Customer Service Portal in Section 6.1 • Moved Acronym list to Appendix A • Updated references in Appendix B • Updated tables in Appendix D • Added Points of Contact to Appendix E • Updated cost algorithms in Appendix F
Revision 2	March 15, 2019	• General updates for 2018-19 information throughout the document • Updated SN Rates in Section 5.3 to match published 2018 SN Rate Letter • Updated Points of Contact in Section 6.2 • Updated cost algorithms in Appendix F

Revision 3	August 18, 2020	• General updates for 2019-20 information throughout the document • Added new coverage diagram to section 1.3.2 • Added new section 1.3.2.2 detailing the new Lunar Exploration Ground System (LEGS) • Added a new section 2.1.1.1 detailing SCaN's policy regarding missions' use of commercial services • Added new section 4.3 detailing the Mission Cloud Platform • Removed Section 4.6 JPL Mission Design and Navigation • Updated SN Rates in Section 5.3 to match published 2020 SN Rate Letter • Revised section 5.5, on the cost for non-SCaN services, in response to the new policy statement in section 1.2 • Updated POCs in section 6.

Revision 4	August 13, 2021	• General updates for 2021 information throughout the document • Updated document to reflect reorganization of Goddard Space Flight Center's Exploration Systems Communications (ESC), Code 450, including removing references to Space Network (SN), Near Earth Network (NEN) and Network Integration Management Office (NIMO) and adding references to Near Space Network (NSN), Advanced Communications Capabilities for Exploration and Science Systems (ACCESS), and the Commercialization, Innovation and Synergies (CIS) Office, as appropriate • Updated section 3.3 to reflect the new Memorandum of Agreement between SCaN and SMD • Added new Contingency and Emergency Services subsection and description to Section 3.5 • Updated section 4.2 to reflect new Communication Program (CP) descriptions • Updated rate tables in section 5 to reflect 2021 rates • Updated section 6 to reflect new points of contact • Updated Appendix A with new acronyms • Updated appendix B with updated references • Retitled Appendix C to the MCO Questionnaire and replaced the questionnaire itself with an updated version • Updated POC in Appendix E • Removed Appendix F and included DSN cost information in Table 5-2

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Section 1 Introduction

1.1 Purpose

This document is intended to assist in the preparation of proposals responding to Announcements of Opportunity (AO), Broad Area Announcements (BAA), and other mission focused Request for Proposals (RFP) that are issued by the National Aeronautics and Space Administration (NASA). In addition, this document may also assist missions and organizations seeking to use NASA's space communications and navigation (C&N) services.

It is NASA's policy to achieve and maintain consolidated, mission-success oriented, and cost-effective space C&N mission support; to unify the set of processes for the development, utilization, and acquisition of agency space C&N infrastructure; and to enhance this support by facilitating new capabilities for the future. NASA's space C&N infrastructure comprises the ground and space-based communications and navigation networks and infrastructure providing mission support for all planetary orbits, surfaces, and environs. To accommodate this policy, NASA leadership established the Space Communications and Navigation (SCaN) Program Office, organizationally located within the Human Exploration and Operations Mission Directorate (HEOMD), to support agency management of space C&N services, as prescribed by NASA Policy Directive (NPD) 1000.0A, *NASA Governance and Strategic Management Handbook*, and NPD 1000.3, *The NASA Organization*.

NASA provides many mission operations and communications services relating to the planning and execution of the transport of voice, video, and data for mission support. Costs accrue when using these services and estimates, and these costs need to be included in proposals responding to an RFP. Cost numbers and equations supplied in this document are for planning purposes only. The calculated estimate of services provided is required by the SMD to document the full value of the mission and its services, although not all missions will be charged by SCaN for recurring cost for aperture or per-minute fees. Please see Section 5 for details on how to estimate the cost of using the SCaN Networks. To facilitate proposal preparation, proposers are encouraged to read this document and to contact the individuals named in Section 6. Respondents preparing proposals should carefully review this entire document to ensure that the document that they are submitting addresses each applicable item.

In order to appropriately assess SCaN's ability to support candidate missions, it is in the interest of the selected investigation teams to provide information on the communication parameters when submitting a proposal. To that end, while this document provides an initial set of information, additional detail is often referenced. Appendix B contains references and links to websites where further information can be found. Appendix C, Appendix D and Appendix E provide samples of the information that should be submitted with the proposal. For more details on the requested information, proposers are encouraged to contact the points of contact listed in Section 6.

1.2 Scope

Services and support offered by NASA’s SCaN networks are available to all NASA sponsored flight projects and science investigators; the SCaN networks provide standard services to NASA missions—from Hubble Space Telescope to SmallSat missions. Other Government agencies and commercial flight projects may become eligible for services offered by the SCaN networks through negotiation with NASA Headquarters.

The scope of this document covers the SCaN networks’ services that are current at the time of publication. This document will be updated over time as new services and rates are made available to the public.

1.3 SCaN Network Services Division

The Network Services Division (NSD), a part of NASA’s SCaN Program, is responsible for managing the day-to-day operations and maintenance of the networks; directing activities related to network sustainment and development; and capturing and assessing user mission requirements. NSD is also the customer-facing division, interacting regularly with stakeholders and the user community to assess changes that are needed to continue to support users. The Network Services Division performs these activities under the direction of NPD 8074.1 *Management and Utilization of NASA's Space Communication and Navigation Infrastructure*.

1.3.1. SCaN Mission Commitment Office (MCO)

SCaN implements a well-established process to capture and assess user requirements in order to determine how to best support those requirements. The process is collaborative and relies on continuous communication and exchange of information between the customer and SCaN throughout all phases of mission development. It is the responsibility of SCaN’s Mission Commitment Office (MCO), along with the Commercialization, Innovation and Synergies (CIS) Office, the Near Space Network (NSN) mission integration group, and the Deep Space Network’s (DSN) Customer Interface Management Office (CIMO), to facilitate this process on behalf of the SCaN networks.

1.3.2. The SCaN Networks

The SCaN networks are comprised of the Near Space Network (NSN) and the Deep Space Network (DSN). These networks provide communications and navigation services over the full operational life cycle of a mission from launch to end of life and/or deorbit. SCaN oversees the Operations and Maintenance of these networks ensuring reliability and robustness to meet mission objectives. While missions may have a desire to use specific resources in accordance with NPD 8074.1, the SCaN networks ultimately decide the utilization of its network assets.

1.3.2.1. Deep Space Network (DSN)

The DSN, which has been in operation for more than 50 years, provides reliable, high-performance, and cost-effective communication and tracking services to NASA and non-NASA missions beyond geosynchronous orbit (more than 22,000 miles above the Earth’s surface). It is a worldwide network of 34-meter and 70-meter antennas that supports interplanetary spacecraft missions and radio and radar astronomy observations for the exploration of the solar system and the universe. The DSN currently consists of three deep-space communications facilities located approximately 120 degrees of longitude apart around the world: at Goldstone in California's Mojave Desert; near Madrid, Spain; and near Canberra, Australia. The site separation ensures that any spacecraft in deep space can communicate with at least one DSN facility at all times as the Earth rotates and the spacecraft continues to move along its trajectory. Additionally, NASA uses the Goldstone Solar System Radar (GSSR) capability to track and characterize near-Earth objects that pass within nine million miles of Earth. The orbits of the near-Earth objects are determined and utilized by the Science Mission Directorate's (SMD) Planetary Science Division to assess the probability of a conjunction between the object and the Earth.

1.3.2.2. Near Space Network (NSN)

NSN provides near-continuous communication services to users via commercial and government assets and providers from ground level through low earth orbit (LEO) and up to cis-lunar distances. NSN provides These space-based relay and ground-based, direct-to-Earth services are provided to the missions customers through a blend of Government Owned, Contractor Operated (GOCO) assets—managed by the Advanced Communications Capabilities for Exploration and Science Systems (ACCESS) Project—and Commercial Services Providers. Both NSN and ACCESS are managed out of Goddard Space Flight Center (GSFC). The NSN ground-based "direct-to-Earth" assets, consisting of a combination of NASA, partner, and commercial ground stations with antennas up to 18 meters in diameter, is focused on supporting launch and operational activities in the Low Earth Orbit (LEO) range as well as GEO, Lunar, and Earth-Sun Lagrange points.

NSN is working to deploy a set of new 18-meter class antennas to provide direct-to-Earth communication and navigation services for missions operating in the cisLunar and Earth - Sun Lagrangian regimes.

NSN's space-based assets (i.e., NASA's Tracking and Data Relay Satellites (TDRS)) are a system of government-owned/contractor-operated communications satellites in geosynchronous orbit matched with a set of space-to-ground link terminals located at NASA's White Sands Complex in New Mexico, in Guam, and in Blossom Point, MD. The constellation, enables continuous communications services to missions operating in Medium Earth Orbit (MEO) and below with support provided to Highly Elliptical Orbit (HEO) when the orbit brings the spacecraft within range. Using this capability, NASA has continuous visibility to missions from Launch through LEO operations.

1.3.2.3. Commercialization of the SCaN Networks

The provision of communications network services is undergoing a transformation; SCaN is pursuing commercialization of services for near-Earth users in the 2020s and beyond. The transition to commercial services, particularly the space-based relay and gradual phase-out of TDRS services for new users, will be an evolving and fluid process requiring coordination between SCaN and the mission community. Currently commercial partner ground assets (KSAT and SSC) and services are available through the NSN, but the portfolio of providers is expected to grow. SCaN services and capabilities will be updated periodically as additional commercial services become available.

Section 2 SCaN Network Policies and Standards

It is NASA policy that space missions receiving funding from NASA comply with all applicable international and United States regulations, standards, and agreements. Such regulations and standards include those promulgated by the:

- International Telecommunications Union (ITU);
- National Telecommunications and Information Agency (NTIA);
- Consultative Committee for Space Data Systems (CCSDS);
- Space Frequency Coordination Group (SFCG).

Information about the ITU and NTIA regulations may be obtained from NASA's Spectrum Management Office by consulting the reference documents listed in Appendix B. Additional information on recommended CCSDS standards applicable to the support that the SCaN networks provide as well as recommendations from the SFCG can also be found by consulting the reference documents listed in Appendix B.

2.1.1.1. SCaN Policy Regarding Use of Commercial Services

It is SCaN's policy to utilize commercial assets to satisfy mission requirements to the greatest extent possible. Some customer user cases may require a mixture of commercial and GOCO assets, or GOCO only (e.g., TDRS). SCaN utilizes bulk-buy agreements for the use of commercial and/or international service providers and will make every effort to negotiate the most cost-effective rates possible. Rather than purchasing commercial services on the open market, proposers and offerors are encouraged to utilize those agreements whenever possible, as there are a variety of advantages to missions for doing so, including increased cost savings for the Agency and priority scheduling for missions.

To utilize NASA's contracted commercial providers, proposers and offerors are required to contact SCaN. Please see Section 5.5 for additional information on costing non-SCaN services and Section 6 for the appropriate point of contact. These organizations will find a good blend of providers to meet the mission needs.

2.2 SCaN Policy on the Use of the Electromagnetic Spectrum

Per NPD 2570.5E *NASA Electromagnetic Spectrum Management*, it is NASA policy that all NASA satellite, airborne and other missions, whether directly developed and operated by NASA or those supported through contracts or other financial agreements that require the use of the electromagnetic spectrum, shall follow the United States and international spectrum regulatory rules and processes. All uses of the radio frequency spectrum require an authorization from the NTIA, for Federal Government systems, the ITU, for International Partners, or a license from the Federal Communications Commission (FCC) for Non-Federal Government systems (e.g., commercial, academic).

The design and operation of systems using radio-frequency communications, navigation, and sensors (i.e., any system that involves the use of the radio frequency spectrum for transmission, reception, or both) needs to consider a variety of factors, including spectrum regulations, network services, spaceflight equipment availability, and others depending upon the mission needs. Additional information concerning NASA spectrum policy and processes can be found in NPD 2570.5E and NASA Policy Requirement (NPR) 2570.1C *NASA Radio Frequency Spectrum Management Manual*. These requirements and processes apply to electromagnetic spectrum use for radio frequency (<300 GHz) communication, navigation, radio science, active sensing, and passive sensing.

All missions and projects requiring the use of the electromagnetic spectrum should contact the associated Center/Facility Spectrum Manager (SM) as early in the proposal or mission development process as possible to discuss the electromagnetic spectrum operations concept and the necessary system certification and frequency authorization (licensing) requirements. The current NASA Center SMs, NASA National Spectrum Program Manager, and other points of contact are provided on NASA's spectrum website (www.nasa.gov/directorates/heo/scan/spectrum/index.html).

2.3 Bandwidth Efficient Modulation (DSN, NSN GOCO)

Missions operating in the 2, 8, 26, and 32 GHz spectral bands should employ bandwidth efficient modulation methods in conformance with SFCG and CCSDS recommendations. Spectral Emission Masks for Category A missions ($r < 2 \times 10^6$ km, where "r" is the range from the spacecraft to Earth) are found in the SFCG's Handbook, available on the SFCG web site. Specific modulation methods meeting the SFCG mask are enumerated in CCSDS Recommendations 401 for non-deep space and Earth resources missions, respectively.

As a matter of DSN policy, it is recommended that Category B missions ($r \geq 2 \times 10^6$ km) employ bandwidth efficient modulation to comply with SFCG Recommendation 23-1, from CCSDS 413.0-G-2, whenever operating in the 8400 - 8450 MHz band. CCSDS Recommendation 401 (2.4.17B) B-1 lists acceptable modulation schemes. Not all schemes are implemented in the DSN, so there may be additional losses that need to be accounted for due to mismatches between the spacecraft transmission and the ground demodulation.

2.4 Coding Standards

Most missions employ error-detecting/error-correcting codes to substantially improve telemetry link performance. Users are reminded that their encoders should conform to the CCSDS Telemetry Channel Coding Blue Book. Supported codes include but are not limited to:

1) Uncoded
2) Convolutional Rate 1/2
3) Convolutional Rate 1/3 (DSN does not support)
4) Reed-Solomon
5) Convolutional/Reed-Solomon
6) Turbo codes with rates: 1/2, 1/3, 1/4, or 1/6
7) Low Density Parity Check (LDPC) Rate ½ (DSN supports rate 2/3 and 4/5 also)
8) LDPC Rate 7/8 (Note: This service has been partially implemented and is not yet available across the SCaN networks).

DSN has implemented LDPC for all frequency bands except Near Earth Ka-band (26 GHz) and will implement Near Earth Ka-band in the future. The NSN GOCO assets also support LDPC.

Proposers are encouraged to contact the representatives listed in Section 6.1, Requesting MCO Support, for the most recent list of supported codes.

2.5 Space Link Extension (DSN, NSN GOCO)

Missions using SCaN's space-based relay services may utilize a standard Space Link Extension (SLE) Services Interface for transferring data to and from DSN or space-based relay service sites to control centers on the ground (e.g., Project Operations Control Center [POCC], Mission Operations Center [MOC], etc.). As of December 2020, all DSN missions must utilize the SLE Services Interface, unless otherwise coordinated with SCaN MCO. SCaN's direct-to-earth SLE services are limited to certain antennas including, but not limited to, the White Sands 1 (WS1) ground system, the Wallops Ground Station (WG-1) and McMurdo Ground Station (MG-1).

Nine international space agencies have agreed to implement the SLE Services Interface to achieve full international interoperability. These agencies include Agenzia Spaziale Italiana (ASI), Centre Nationale d'Etudes Spatiales (CNES), Deutsche Zentrum fur Luft-Und Raumfahrt (DLR), European Space Agency (ESA), Indian Space Research Organization (ISRO), Japanese Aerospace Exploration Agency (JAXA), the Korea Aerospace Research Institute (KARI), the United Arab Emirates (UAE) and NASA. The interface architecture conforms to standards adopted by the CCSDS.

Section 3 Summary of SCaN Networks' Standard Services

SCaN has developed a set of Standard Services which are inherent to the current functional capabilities of the SCaN networks without modification. Use of the Standard Services enables more streamlined service evaluation, acquisition, and use. Current Standard Services include end-to-end transport of information between the point of origin (e.g., mission platform[s]) and destination (e.g., mission operations center, university, etc.).

Standard services for Data Transport facilitate the exchange of information between a mission's platform(s) and locations on the Earth. Typically, minimal processing is applied to the data—only that which is necessary to communicate with the end points (e.g., RF encoding to IP-based transport). Transported data may include voice, video, and/or data. Note that Command and Telemetry data are critical subsets of Forward and Return data transport functions. As services for this type of data deal particularly with the exchange of information to and from a mission's platform(s) for the purposes of monitoring and maintaining control of the platform, this information is typically of higher priority than other categories of data to be transported by the SCaN networks.

This section provides a very brief summary of the standard services that the SCaN networks offer their customers. For additional information on these services, please reference the documents listed in Appendix B. Each of the service categories listed in the tables below may contain several services. Some of those individual services may require that special arrangements be made with SCaN before they can be provided. Proposal respondents who are interested in services that are not a part of the standard Tracking, Telemetry & Command (TT&C) set should contact the person(s) named in Section 6 for additional information.

3.1 NSN Service Summary

Table 3-1 and Table 3-2 summarize the NSN ground-based and space-based service categories. More detailed information can be found using the following link: https://esc.gsfc.nasa.gov/NSN (See Appendix B for additional references).

Table 3-1: Ground-Based Direct-to-Earth Service Summary

Service Category	Service	Service Type	Brief Description
Data Transport	Forward	Data Stream	Forward: Transmission of voice, video, and/or data, and delivery of telecommands to spacecraft. Return: Telemetry voice, video, and/or data capture, decoding, and additional value-added data routing.
	Return	Data Stream	
Navigation and Radiometric	Radiometric	Raw Doppler	Measurements and products based on one-way Doppler, two-way Doppler, and range tones; processing to determine orbital elements for mission platform navigation.
	Radiometric	Raw Ranging	
	Radiometric	Tracking Angle Data	

Table 3-2: Space-Based Relay Service Summary

Service Category	Service	Service Type	Brief Description
Data Transport	Forward	Data Stream	Forward: Transmission of voice, video, and/or data and delivery of telecommands to spacecraft. Return: Telemetry voice, video, and/or data capture, decoding, and additional value-added data routing.
	Forward	Forward Communications Link Transmission Unit (FCLTU)	
	Return	Data Stream	
	Return	All Frames	
	Return	Channel Frames	
Navigation and Radiometric	Radiometric	Raw Doppler	Measurements and products based on one-way Doppler, two-way Doppler, and Pseudo Noise (PN) ranging; processing to determine orbital elements for mission platform navigation.
	Radiometric	Raw Ranging	
	Radiometric	Tracking Angle Data	

3.2 DSN Service Summary

Table 3-3 summarizes the service categories supported by the DSN. More detailed information can be found in the DSN Service Catalog (see Appendix B for additional references). See Table 3-3 for a list of standard DSN services included in the *Aperture Fee.*

Table 3-3: DSN Service Summary

Service Category	Service	Service Type	Brief Description
Data Transport	Forward	FCLTU	Forward: Transmission of voice, video, and/or data, and delivery of telecommands to spacecraft. Return: Telemetry voice, video, and/or data capture, decoding, and additional value-added data routing.
	Forward	File	
	Return	All Frames	
	Return	Channel Frames	
	Return	File	
	Return	Packet	
Navigation and Radiometric	Radiometric	Validated Doppler	Measurements and products based on one-way Doppler, two-way Doppler, and range signal; processing to determine orbital elements for mission platform navigation. Radio interferometric techniques used to determine the plane-of-sky position and velocity of a user mission platform (Delta-DOR).
	Radiometric	Validated Ranging	
	Radiometric	Delta-DOR	
Science	Science	Radio Science	Radio Science: Open-loop receiver measurements. VLBI: Similar to Radio Science but measures natural phenomena. Wide and narrowband VLBI. Radar: Transmits Radio Frequency (RF) carrier toward user-defined target; captures reflected signal.
	Science	Very Long Baseline Interferometry (VLBI)/Radio Astronomy	
	Science	Radar Science	

3.3 MCO Service Summary

Table 3-4 through Table 3-6 summarizes the services supported by MCO. Additional information can be found at https://www.nasa.gov/directorates/heo/scan/services/overview/index.html.

Table 3-4: MCO Service Summary - Mission Planning and Integration

Activity	Description
Mission Engineering Support (MP&I Labor)	Personnel assuring the continued understanding of the mission's requirements, concerns, system performances, etc., by providing and integrating Network services. Mission Managers (MM) at GSFC and Mission Interface Managers (MIM) at JPL act as the service provider gateway and interface with customers from early planning through design, development, testing, flight operations, and closeout.

Activity	Description
Loading, Coverage, and RF Analyses	Loading analyses assess (internal) the Network service capabilities and capacity with respect to mission requirements. Missions requiring unique communications equipment and modifications at SCaN facilities for unique data-handling requirements. Coverage analysis determine the extent to which Network assets cover the area for the requested communications and/or navigation services. The analysis is performed to verify that SCaN is able to meet customer requirements with respect to the SCaN and/or commercial assets identified for mission service. Coverage analysis begins during the early customer requirements phases and continues until firm-coverage requirements and flight segment design are finalized.
RFICD Development	The RF Interface Control Document (RFICD) (called the Operations Interface Control Document [OICD] for DSN) is a required document developed early in the design phase. It describes, defines, and identifies the specific radio frequency communications interface details and the performance parameters of the communications link between the customer's spacecraft and the SCaN Network asset. As part of its development, analysis activities determine that the RF link can be closed using the Networks assets.
Service Level Agreements	Documents the commitment for a specific mission to receive standard and custom data support services from SCaN Networks, including any request for supplemental services from non-NASA stations. Service Level Agreements (SLAs) commit SCaN's Networks to specific services for the duration identified in the agreement.
Other MP&I Documentation (CONOPs, Requirements)	Generation of mission operations-related documentation to meet mission requirements (e.g., DSN’s Operation Interface Control Document (OICD).
Verification Testing	Various tests performed to verify the Networks ability to meet mission requirements. Network verification testing is accomplished without the mission's participation. It is an internal network check of operational configuration and capability where coordination of the applicable engineers and assets are exercised. It may include test data injection at the front end and cursory local systems checks.
Compatibility Testing	Verify and validate the compatibility between the satellite/spacecraft transponder and the networks, using test equipment at GSFC facilities and JPL facilities that emulate the utilization of a network asset. Compatibility tests occur prelaunch in order to minimize post-launch anomalies and expensive troubleshooting. Completion of the required testing results in certification of the transponder/transmitter being tested and validates RF computations.

Activity	Description
End-to-End Validation	Utilizing Network assets end-to-end tests (e.g., Project Interface Tests [PIT]) verify that all applicable Network interfaces and electronic communications, including mission operations [control] center(s), communications circuits/paths, and the network service provider are in place and functioning to fully support mission operations.
Readiness Reviews	Mission Commitment Organizations (MCOs) support major reviews for a mission event (e.g., launch, planetary Entry, Departure, and Landing [EDL], planetary maneuver) that include the assessment of the readiness of the SCaN Networks and integrated service providers (e.g., Flight Dynamics Facility [FDF], Ranges, and Department of Defense DoD]). They may include reviews of the Networks' requirements and readiness for a specific mission and/or milestone event.

Table 3-5: MCO Service Summary – Network Services (Operations and Maintenance)

Activity	Description
LEOP and IOC Support	Services provisioned during launch and early orbit operations and initial operating phases of the mission, which may require more intensive network support and coordination, troubleshooting, etc. to ensure mission success.
Critical Event Support	Services provisioned during critical events such as trajectory maneuvers, orbit insertions, etc., which may require more intensive network support and coordination, troubleshooting, etc. to ensure mission success.
Anomaly Resolution	Anomaly resolution will be undertaken, as necessary, to identify the root cause of an anomalous event. Note: The first block of time, as identified in the DSA/PSLA/SLA, is funded by SCaN. Additional charges are assigned in accordance with the cause of the anomaly.
Service Management	Missions will have access to scheduling and performance data to conduct mission operations. The access to service management capabilities consist of schedule, performance, and monitoring of the mission.
Post-Mission Reporting	Provides a report to the customer with a timeline of the Networks' activities that occurred during the service period as well as any anomaly follow-up information. The team conducts a lessons-learned review to assess the planning and operations activities executed during mission support, summarize those findings, and identify opportunities for improvement in the process.

Flight Dynamics / Navigation Support (DSN Not applicable)	The Goddard Space Flight Center FDF provides services related to antenna pointing and navigation requirements including expertise that provides support through the entire mission life cycle. Flight dynamics and navigation support includes several areas such as expendable launch vehicle tracking and trajectory, mission design, mission analysis, orbit maneuvers, orbit determination, tracking station, and network and data performance evaluation. Note: The Jet Propulsion Laboratory Advanced Multi-Mission Operations System (AMMOS) provides similar services, beyond geostationary orbit, that are reimbursed to the Science Mission Directorate.
OCIO / NISN Tail Circuits	Unique circuits between the mission control center(s) (MOCs) and the standard NASA-provided/existing communications networks point-of-presence. Activities that are part of this category include planning and coordinating with NASA Communications Network (NASCOM) or commercial entity to provide data transport services for mission.
Hosting Unique Project Equipment / Modifications	Non-recurring and recurring costs associated with projects requiring unique communications equipment and modifications at SCaN facilities for unique data-handling requirements, including hosting customer equipment, custom modification of Network equipment, and mandated site selections.
Mission Operations Proficiency Testing	Data flow testing with all MOCs and SCaN assets on a routine basis to maintain operations proficiency. Includes coordinating and conducting testing among all Flight Operations teams and shifts with a goal of maintaining familiarity and team proficiency, maintaining the interface connectivity, exercising failover, and confirming MOC software performance levels.
Primary Mission Operations	Nominal service provision spanning data, telemetry, tracking and other network services, throughout the planned operational life of the mission.
Extended Mission Operations	Missions are routinely extended beyond their planned design life. SCaN continues to provide nominal services to missions that continue to operate beyond that point. Service agreements are renewed and extended accordingly.

Table 3-6: MCO Service Summary - Network Sustainment

Activity	Description
Network-Driven Sustainment / Engineering	Any change or update required to the network that is a result of a routine network sustainment tasks, rather than a specific mission need or requirement.
Mission-Driven Sustainment / Engineering	Any change or update required to the network that is a result of a specific mission need or requirement, rather than being routine network sustainment tasks. For example, the mission updates their MOC and requests that the Networks revalidate connectivity with the updated interfaces.

3.4 Critical Event Communications

When requesting mission critical event support, proposers may want to consider an expanded set of communications and navigation services and assets compared to routine operations. The MCO is prepared to discuss common approaches to ensure support during critical events. Critical Events are defined as "spacecraft events that could result in the loss of mission if anomalies occur." These events include:

- Launch and early orbit operations
- Spacecraft separation
- Powered flight
- Critical Maneuvers (e.g., Deep Space Maneuvers [DSMs], docking/undocking)
- Orbit insertion
- Entry/Descent/Landing
- Flybys
- Re-entry

Either of the networks (NSN or DSN) can provide critical event support—including launch, early orbit, and separation—if the trajectory permits. However, in cases where there are coverage gaps, SCaN may need to use one or more communication assets from an external organization to provide adequate coverage.

3.5 Emergency or Contingency Communication Support

In the event of a spacecraft anomaly—whether it be a partial loss of data or a full spacecraft emergency—the SCaN Networks can provide rapid connectivity to mission during critical times. Either of the networks (NSN or DSN) can provide emergency event support if the mission trajectory permits. However, in cases where there are coverage gaps, SCaN may need to use communication assets from an external organization to provide adequate coverage. Given the unique and fluid nature of these situations, proposers are encouraged to discuss network capabilities with the POCs listed in Section 6, so that in event that immediate support is required, the mission fully understands SCaN's capabilities and priorities.

Section 4 Support from Non-SCaN Network Service Providers

If needed, the SCaN networks will assist user missions with procuring services from other non-SCaN network entities and partners, including but not limited to other SCaN divisions, other NASA organizations, other Government agencies, and international and commercial partners. This section discusses the most common external organizations for whom the SCaN networks assist missions with procuring services. The SCaN networks will facilitate the coordination between the mission and these organizations during the mission integration phases to ensure that mission needs, such as those related to terrestrial communications and data processing in the cloud, are met.

If the mission desires to use communication and navigation assets outside of the SCaN network, the mission needs to consult NPD 8074.1 and work with MCO, NSN or CIMO to obtain the capabilities needed to ensure the most cost-effective method for the agency.

4.1 Spectrum Management

Although the Spectrum Management Office falls under the responsibility of the SCaN Program Office, it is not part of the SCaN networks or MCO. It is NASA policy that any satellite mission supported by the Agency, whether directly developed and operated by NASA or those supported through contracts or other financial agreements that require the use of the electromagnetic spectrum for transmission, reception, or both, shall follow the United States spectrum regulatory rules and processes as well as all applicable international spectrum regulations. NASA missions are encouraged to engage with the SCaN Networks for Spectrum Management needs.

The Center/Facility Spectrum Manager or NASA National Spectrum Program Manager will provide assistance during all phases of a mission or project from conceptual, preproposal efforts through formulation and implementation. The Spectrum Manager will support the project at each review in the project life cycle and assist with design and spectrum considerations such as frequency selection, conformance to regulatory constraints, and compliance with any other electromagnetic spectrum constraints. A key element of this support is assisting with or preparing inputs for spectrum certification as early in the acquisition and procurement cycles as possible.

If support from the Spectrum office is required, proposal respondents may either contact their local center Spectrum Manager or the National Spectrum Program Manager directly or request assistance in coordinating Spectrum support from the SCaN networks by consulting one of the Points of Contact listed in Section 6.

4.2 Communications Program (CP)/NASA Communication Network (NASCOM)

The Communications Program (CP) is responsible for the enterprise-wide delivery of Wide Area Network voice, video, and data services in support of the agency, including the following:

- Agency WAN Services

- Agency LAN Services
- Russian Communication Services
- Network Security Services
- Agency Network Architecture
- Agency Video Services
- Center Unique Communications Services
- Communications and Network Innovation
- Communications Service Integration

CP staffing is primarily drawn from the three Host Centers – ARC, GSFC, and MSFC:

- Ames Research Center (ARC) provides cross-cutting integration and leadership in the areas of IT security, research networking, emerging network technology and innovation, enterprise architecture, and project management governance
- Goddard Space Flight Center (GSFC) provides leadership for the overall management of the mission communications services
- Marshall Space Flight Center (MSFC) provides leadership for the overall program management, administrative and financial management, and management of the corporate communications services

The corporate communications services include NASA-wide voice and video teleconferencing, corporate network routed data services, as well as Layer 2 Virtual Private Network service. The fundamental function of these services is to provide enterprise-level communications services across the Agency.

The mission communications services include mission routed data services (including IONet), dedicated mission data services, and mission voice services. The fundamental purpose of these services is to support spacecraft operations. These include terrestrial transport of spacecraft command, telemetry, and tracking data as well as delivery of science data products. The mission network must also address risks to the health and safety of human life as well as serious damage or loss of spacecraft. The mission voice services provide order wire and other voice service in support of spacecraft operations.

4.3 Mission Cloud Platform (MCP)

The GSFC Cloud Computing Program Office established the MCP to provide consolidated cloud computing services for mission customers, giving them a streamlined process for implementing and using those resources. The MCP captures detailed requirements from each customer in the Cloud Architecture Requirements Document (CARD) and uses this information to form the basis of the cloud architecture.

In support of the networks, MCP provides missions with the following cloud computing capabilities:

- Virtual private cloud (VPC)
- Server-less computing
- Compute
- Storage
- Database

- Application development
- Science data processing
- Artificial intelligence/machine learning
- External collaboration and/or file sharing

Additional information regarding MCP networks and mission services and their timetables will be defined in the Service Level Agreement (SLA). More details regarding requested services and products can be obtained from the MCP Project Manager.

4.4 Flight Dynamics Facility (FDF)

The GSFC FDF, which is not part of SCaN but works closely with the NSN, provides expertise in navigation analysis and system design, operations planning, trajectory design, orbit determination, network operations support, and critical real-time mission operations. This expertise spans the technical areas of orbit determination and trajectory design for low-Earth, geosynchronous, highly elliptical, lunar, libration-point, heliocentric orbits, other celestial-body centered orbits ELV and human spaceflight operations, and support of over 25 on-orbit spacecraft.

FDF evaluates tracking data from commercial providers, NSN/SR, DSN, and both NASA and DoD C-band radar sites and certifies tracking capability for new stations needed for mission support. FDF also participates in end-to-end verification and validation to ensure that FDF products, such as pointing data for the NSN/SR assets, are received in the proper format. Mission integration is a part of FDF's support of the SCaN networks and its flight project customers. FDF can interface with any of the SCaN networks to support a mission's flight dynamics needs. Products generated by FDF include ephemerides; acquisition data, which is used to establish two-way communication with space vehicles; maneuver planning and execution for spacecraft; on-console support for testing and real-time operations; and evaluation of Expendable Launch Vehicle (ELV) performance during ascent utilizing guidance data. FDF also generates other navigation sources, such as local oscillator frequency analysis for Tracking Data Relay Satellite (TDRS) transponders, orbit event predictions, and calibration of sensors used for tracking spacecraft.

The capabilities of the Goddard FDF include the following:

1) Orbit determination in multiple regimes
2) Launch vehicle support, including but not limited to Atlas V, Delta II, Delta IV, and Sea Launch
3) Launch and early-orbit support utilizing a diversity of networks
4) Tracking performance evaluation of a multitude of ground-based and space-borne assets
5) Certification of new tracking equipment
6) Mission integration that combines engineering knowledge of the SCaN networks and the analytical and operational aspects of our flight project customers
7) Backup navigation support to the Human Spaceflight Program
8) International Space Station orbit determination and support to all Visiting Vehicles.

4.5 Advanced Multi-Mission Operations System (AMMOS)

AMMOS is the responsibility of the Multi-Mission Ground System and Services (MGSS) Program located at the JPL. While not inherently part of SCaN, AMMOS works closely with the SCaN Network to achieve mission needs. AMMOS consists of a core set of products that can be readily customized to accommodate the specific needs of individual missions. AMMOS provides the elements of a Mission Operations System (MOS) that are common to multiple missions, eliminating the need for duplication of development and maintenance of the MOS. Using AMMOS may lower mission cost and risk by providing a mature base for a MOS.

AMMOS is comprised of multi-mission hardware, software, processes, procedures, and facilities used to implement and operate the MOS. Components of the AMMOS include:

- Planning and Sequencing
- Telemetry Processing
- Data Archive
- Navigation, Mission Design, and Solar System Dynamics
- Operations Configuration Management
- Mission Support Facilities
- Ground Data System (GDS) Integration, Test, Deployment and Support
- Operations Engineering
- Data Relay Coordination for Landed Assets who do not have the direct-to-earth bandwidth needed to execute the mission'
- Multimission Resource Scheduling Service (MRSS) used to schedule DSN apertures.

AMMOS supports the entire life cycle of a flight project or experimental investigation.

Section 5 Network Support Cost Estimation

As a matter of policy, NASA includes estimated costs for mission operations and communications services as well as an assessment of key parameters for mission operations in the evaluation and selection processes of all near-space and deep-space missions. The purpose of this policy is to:

- Enable evaluation of the reasonableness and cost effectiveness of the proposed communications and navigation approach
- Implement formal NASA-wide, full-cost accounting
- Better manage NASA's heavily subscribed communications resources
- Promote trade-offs between space and ground, including parameters such as data volume, data latency, data rate, contact time, aperture size, and cost of associated systems
- Encourage hardware and operations system designs minimizing life-cycle costs while accomplishing the highest-priority science objectives.

Generally, mission proposals must include nonrecurring (e.g., Mission Planning & Integration [MP&I]) and recurring estimates as well as those for services during routine operations and critical event support.

Cost numbers and equations supplied in this section are for planning purposes only. The calculated estimate of services provided is required by the SMD to document the full value of the mission and its services. NASA missions that use standard services will not be charged by SCaN for recurring cost for aperture or per-minute fees.

This section explains how to estimate costs for the DSN and NSN. To ensure accuracy and to validate cost estimates, proposal respondents should contact the appropriate representatives listed in Section 6.

5.1 Mission Engineering Support Costs

Nonrecurring engineering (NRE) costs (e.g., TT&C services, ground communications, MIM support) are those associated with unique equipment that a mission customer provides at NASA facilities, including installation and sustainment engineering. NRE costs also include any unique equipment that a mission requires as well as its installation and the sustaining engineering of that equipment as well as modifications that the networks must make to their systems in order to recognize a new mission. Proposal respondents are advised to contact the point of contacts listed in Section 6 to determine a cost estimate for their missions.

5.2 Mission Planning and Integration (MP&I)

MP&I is the set of activities performed and coordinated by the SCaN MCO, NSN, and CIMO to facilitate the successful provision of NASA's space communications services to evaluate and address mission needs. MP&I includes those tasks that must be executed prior to the operational use of the SCaN networks as well as actual cost estimates for the use of SCaN networks in accordance with needed functionality. Typically, MP&I activities occur prior to the launch of a space vehicle, although they may occur any time within the life of a mission if changes are needed. Additionally, for longer-duration missions (e.g., interplanetary), a set of MP&I activities is typically incorporated during the initial planning activities. These MP&I activities may include the development of the RFICD, Compatibility Testing, Anomaly Resolution, and Post Mission Reporting. MP&I activities ensure common understanding of the mission services requirements, understanding of the capabilities of the SCaN networks, and mutual compatibility between the mission (i.e., platform[s], mission operations center[s]) and the SCaN networks). Funding of these efforts is dictated by NASA policies. Because both NASA missions and SCaN are funded through NASA, NASA missions fund SCaN only for the MP&I activities related to the dependencies on their processes/functionality (e.g., planning and development for non-standard services); they are not charged for the SCaN networks internal management functions related to standard services (e.g., network capacity planning). Conversely, non-NASA missions are responsible for funding all network integration and data-services activities in support of their missions, including reimbursement of SCaN costs in support of their MP&I activities. It is not possible to provide a simple cost structure such as the one used for the specific stations and/or services. Proposal respondents are advised to contact the point of contacts listed in Section 6 to obtain a cost estimate for their missions.

5.3 Cost Estimates for Using the SCaN Networks

Each of the SCaN Networks has a charging paradigm optimized in accordance with the structure of the network. For the purpose of initial costing, service costs can be estimated by multiplying the length of the needed pass (see Table 5-1) by the cost of that pass (see Table 5-2).

In some cases, the length of the pass is just the time that the mission requires service. In others, the length of a pass is determined by taking the length of time that the mission requires service and then adding a period of time at the beginning, called "set up time," to move the antenna into position and establish the link, and a period of time at the end of the pass, called "tear down time," to dissolve the link and remove the antenna and link from operations. See Table 5-1 for details on how to calculate the pass length.

Table 5-1: Pass Length Calculation

Asset Type	Pass Type	Pass Length
NSN Direct-to Earth Assets	Nominal	Minutes of required service plus 10 minutes of set up time and 10 minutes of tear down time.
NSN Space-Based Relay Assets	Nominal	Minutes of required service.
	Extended Elliptical	Minutes of required service plus a minimum of 4 minutes of set up time and 4 minutes of tear down time.
DSN	Nominal	Integer multiples of 1-hour plus 45 minutes of set up time and 15 minutes of tear-down time.

The NSN charges missions for direct-to-earth services on a per-pass basis while the cost for using the space-based relay services is dependent on the services provided. The DSN uses a complex set of algorithms to determine aperture fees.

Table 5-2 lists the advertised rates for using the NSN's direct-to-earth and space-based relay assets as well as rates for using the DSN. These rates are for missions with ops concepts for relatively brief and infrequent communications. Missions whose requirements are different should contact the points of contact listed in Section 6 to determine the cost for using the networks.

Table 5-2: Rates for Estimation for Using the SCaN Networks

Asset Type	Services	Cost
NSN Direct-to Earth Assets	S-band, X- band, and/or Ka-band forward/command, return/telemetry, and tracking services	$550.00 per pass, where one pass is ≤ 30 minutes of uplink/downlink time
NSN Space-Based Relay Assets	Single Access (SA) Service (forward/command, return/telemetry, tracking, or any combination of these)	• $94.00 per minute • Commercial Space Launch Act (CSLA) Customers: $29.00 per minute
	Multiple Access Forward Service	• $15.00 per minute • CSLA Customers: $5.00 per minute
	Multiple Access Return Service	• $9.00 per minute • CSLA Customers: $3.00 per minute
DSN	Single Spacecraft Tracking	• Single 34-meter Station: $1,792 per hour • Two 34-meter Array: $3,583 per hour • Three 34-meter Array: $5,375 per hour • Four 34-meter Array: $7,167 per hour • 70-meter Stations: $5,375 per hour

The rates listed in Table 5-2 are reviewed and may be changed each Fiscal Year. Proposers are encouraged to get the most recent rates directly by contacting NSN and/or CIMO (see Section 6 for POCs) or from the network websites:

- NSN: https://esc.gsfc.nasa.gov/projects/NSN
- DSN: https://dse.jpl.nasa.gov/ext/

5.4 Critical or Emergency Event Support Costing

Costs for critical or emergency event support, which can be obtained from one of NASA's networks (DSN, NSN), is computed in the same way as for routine telemetry support. If it is not possible to utilize one of the NASA networks because no station element is in view or they are otherwise unavailable, then estimates will have to be provided by the appropriate network representatives identified above.

Because mission requirements vary over such a broad range, it is not possible to provide a simple means to calculate the cost of telemetry support in the early mission phase. Please see Section 6 for the point of contact who can assist in establishing alternative solutions and/or in costing the required support.

5.5 Non-SCaN Support Costing

Cost for support from non-SCaN networks resources and entities is dependent on the mission needs and the supporting entity to be used. As stated in Section 2.1.1.1, SCaN negotiates bulk-buy agreements for the use of commercial service providers and makes every effort to negotiate the most cost-effective rates possible. These agreements are negotiated on a periodic basis and, as such, the actual costs for using such providers cannot be included in this document.

SCaN negotiates the costs for using non-NASA, non-SCaN, non-commercial (i.e., international, academic) assets on a case-by-case basis and therefore cannot include that information in this document. However, if requested, SCaN will integrate the requested support into the overall network plan.

If support is required from outside the SCaN networks, proposal respondents should contact SCaN MCO (per NPD 8074.1) for assistance in assessing the need, capabilities, and cost of those services. Please see Section 6 for the appropriate point of contact.

Section 6 Requesting Support from the SCaN Networks

Early planning and coordination between SCaN and its customers are critical to ensuring quality service with minimal complications. Proposers are encouraged to contact SCaN as early in their development process as possible to begin pre-mission planning and analysis activities and to ensure that the network(s) have both the capability and capacity to satisfy the mission requirements.

During the concept study phase (Phase-A or Step-2), as the mission's concept is more clearly defined, proposers should contact the SCaN MCO to obtain a Letter of Acknowledgement (LOA) documenting the fundamentals of the coordination, namely that the exchange of mission needs, and preliminary guidance and direction on network support has been completed. The agreement will identify all mission operations requirements, including those provided by non-SCaN sources, becoming a source of end-to-end operations information and documenting any cost analyses leading to the selection of non-SCaN services. If use of NASA SCaN's network services beyond the capabilities and capacities described in the NASA's Mission Operations and Communications Services document is proposed, the proposal shall include a Letter of Commitment (LOC) from the SCaN Program Office. Please reference the RFP documentation for a description of Phase A, Step 1, and Step 2 requirements.

The mission commitment process is tailored for each mission and its needs. From the time Mission Commitment personnel are first contacted, the mission commitment process can take anywhere from 2 to 7 weeks, depending on the mission needs and the complexity of the requirements, to develop pre-planning estimate and provide a letter of commitment.

6.1 Requesting SCaN Network Services

Missions desiring use of SCaN services should make contact with the SCaN Mission Commitment Office as early in the concept and design phase process as possible. In order to begin the mission commitment process, missions should send their questions, concerns, or services requests to the following e-mail address:

exploration-enabled@lists.hq.nasa.gov

Missions may also contact the SCaN Mission Commitment Manager for questions:

John Hudiburg
Mission Integration & Commitment Manager
Space Communications and Navigation (SCaN)
NASA Headquarters
Washington, D.C. 20546
Office: HQ 7Z76
Phone: (202) 358-1202
Email: john.j.hudiburg@nasa.gov

For additional information on MCO, its points of contact and the services that it and SCaN provides, proposal respondents may visit the SCaN Customer Service Portal (https://www.nasa.gov/directorates/heo/scan/services/services/index.html). Please note that this is a public website. Access to the restricted section of this portal, which contains the mission-specific information, will only be granted to the selected proposers after award.

6.2 Additional Points of Contact

At the time when initial science operations concepts are being defined, proposers may contact NSN or DSN at the address in this section for information about mission operations services and costs. A representative will assist proposers by providing information concerning services and costs.

The point of contact for NSN is CIS, which can be reached at:

gsfc-missiononboarding@mail.nasa.gov

The point of contact for DSN services is CIMO:

Brian J. Giovannoni
Manager
Jet Propulsion Laboratory
Interplanetary Network Directorate
Customer Management Interface Office
Mobile phone: 626-755-8829
Email: brian.j.giovannoni@jpl.nasa.gov

Appendix A. Acronym List

ACCESS	Advanced Communications Capabilities for Exploration and Science Systems
AF	Aperture Fee
AF'	Aperture Fee discounted for Multiple Spacecraft per Aperture applications
AMMOS	Advanced Multi-Mission Operations System
AO	Announcement of Opportunity
ARC	Ames Research Center
ASI	Agenzia Spaziale Italiana (Italy)
AW	Aperture Weighting (For costing DSN stations)
b/s	Bits per second
BER	Bit Error Rate
BWG	Beam Wave Guide (Refers to specific DSN 34M antennas)
C&N	Communication and Navigation
CARD	Cloud Architecture Requirements Document
Category A	Missions whose distance from Earth is < 2 x 10 6 km
Category B	Missions whose distance from Earth is ≥ 2 x 10 6 km
CCSDS	Consultative Committee for Space Data Systems
CDR	Critical Design Review
CIMO	Customer Interface Management Office
CIS	Commercialization, Innovation and Synergies
CNES	Centre National d'Etudes Spatiales (France)
CP	Communication Program
CSO	Communications Service Office
CSR	Concept Study Report
dB	Decibels
DCN	Documentation Change Notice
DDOR	Delta Differenced One-way Range

DLR	Deutsche Zentrum fur Luft- Und Raumfahrt (Germany)
DoD	Department of Defense
DOR	Differential One-way Range
DSA	Deep Space Network Service Agreement
DSM	Deep Space Maneuver
DSN	Deep Space Network
DTE	Direct to Earth
EDL	Entry, Departure, and Landing
ELV	Expendable Launch Vehicle
ESA	European Space Agency
FC	Frequency of Contacts (For costing DSN stations)
FCC	Federal Communications Commission
FCLTU	Forward Communications Link Transmission Unit
FDF	Flight Dynamics Facility
FY	Fiscal Year
GDS	Ground Data System
GEO	Geosynchronous Earth Orbit
GHz	Gigahertz (1 x 10 9 cycles per second)
GOCO	Government Owned, Contractor Operated
GSFC	Goddard Space Flight Center
HEO	Highly Elliptical Orbit
HEOMD	Human Exploration and Operations Mission Directorate
Hz	Hertz (cycles per second)
IAD	Implementing Arrangement Document
ISRO	Indian Space Research Organization
ITA	Internal Task Agreement
ITU	International Telecommunications Union
JAXA	Japanese Aerospace Exploration Agency
JPL	Jet Propulsion Laboratory

K	Kilo (1 x 10 3) or Kelvin
KA-Band	Frequency band: • Deep Space (Category B) 31.8 - 32.3 GHz downlink • Near-Earth (Category A) 25.5 - 27.0 GHZ downlink
KARI	Korea Aerospace Research Institute
Km	Kilometers
LAN	Local Area Network
LDPC	Low Density Parity Check
LEO	Low Earth Orbit
LEOP	Launch and Early Orbit Phase
MCO	Mission Commitment Office
MCP	Mission Cloud Platform
MEO	Middle Earth Orbit
MG-1	McMurdo Ground 1
MGSS	Multiple Ground System and Services
MHz	Megahertz
MIM	Mission Interface Manager
MM	Mission Manager
MOC	Mission Operations Center
MOCS	Mission Operations and Communications Services
MOS	Mission Operations System
MP&I	Mission Planning and Integration
MRSS	Multimission Resource Scheduling Service
MSFC	Marshall Space Flight Center
MSPA	Multiple Spacecraft per Aperture
Msps	Megasymbols Per Second
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communications Network
NEN	Near Earth Network
NIMO	Networks Integration Management Office at GSFC

NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
NRE	Nonrecurring Engineering
NSN	Near Space Network
NTIA	National Telecommunications and Information Agency
OCIO	Office of the Chief Information Officer
OICD	Operations Interface Control Document
PDR	Preliminary Design Review
PIT	Project Interface Test
PN	Pseudo Noise
POC	Point of Contact
POCC	Project Operations Control Center
PSLA	Project Service Level Agreement
Rad	Radians
RB	Base Rate (For costing DSN stations)
RF	Radio Frequency
RFICD	RF Interface Control Document
RFP	Request for Proposal
S/C	Spacecraft
SA	Single Access
SCaN	Space Communications and Navigation
SCMM	Space Communications Mission Model
SFCG	Space Frequency Coordination Group
SLA	Service Level Agreement
SLE	Space Link Extension
SM	Spectrum Manager
SMD	Science Mission Directorate (formerly NASA Headquarters Office of Space Science Code S)
SN	Space Network (TDRS)

SR	Space Relay
TA	Task Agreement
TDRS	Tracking Data Relay Satellite
TT&C	Tracking, Telemetry, and Command
UAE	United Arab Emirates
VLBI	Very Long Baseline Interferometry
VPC	Virtual Private Cloud
WAN	Wide Area Network
WG-1	Wallops Ground 1
WS1	White Sands 1
X-Band	Frequency band (Space Research Segment): • Deep Space (Category B) 7145-7190 MHz uplink, 8400-8450 MHz downlink • Near-Earth (Category A) 7190-7235 MHz uplink, 8450-8500 MHz downlink

Appendix B. Reference Documents and Websites

Prospective users of NASA facilities can obtain additional information from the following documents. Please note that some of these documents may only be available behind the NASA firewall. If proposal respondents are in need of a document and cannot access it, they are advised to contact the appropriate point of contact in Section 6.

1) *Radio Regulations*, International Telecommunications Union, Geneva, Switzerland, Latest Edition.

2) *Manual of Regulations and Procedures for Federal Radio Frequency Management*, National Telecommunication & Information Administration, U.S. Department of Commerce, Washington D.C., Latest Edition. ***Information is available at:*** http://www.ntia.doc.gov/osmhome/redbook/redbook.html

3) Consultative Committee for Space Data Systems (CCSDS). Blue Books published by the CCSDS Secretariat, NASA Headquarters, Washington D.C. 20546. ***Copies of CCSDS Recommendations and Reports are available at:*** http://public.ccsds.org/publications/default.aspx

4) *Space Frequency Coordination Group On-Line Handbook*, ***Recommendations and other technical documents are available at:*** https://www.sfcgonline.org/resources

5) *Management and Utilization of NASA's Space Communication and Navigation Infrastructure,* NPD 8074.1. ***Copies of the document are available at:*** http://nodis3.gsfc.nasa.gov/displayDir.cfm?t=NPD&c=8074&s=1

6) SCaN Customer Service Portal. ***Web site located at:*** https://www.nasa.gov/directorates/heo/scan/csp

7) NSN Homepage. ***Web site located at:*** https://esc.gsfc.nasa.gov/projects/NSN

8) ACCESS Homepage. ***Web site located at:*** https://esc.gsfc.nasa.gov/projects/ACCESS

9) Deep Space Network Homepage. ***Web site located at:*** https://www.jpl.nasa.gov/deepspace/

10) DSN Commitments homepage. ***Web site located at:*** https://www.jpl.nasa.gov/deepspace/about/commitments-office/

11) DSN Aperture Fee Calculator located at: https://www.jpl.nasa.gov/deepspace/about/commitments-office/proposal-preparation/ under the heading “DSN Aperture Fee Online Tool”

12) NASA Communication Network (NASCOM)/Communications Service Office (CSO) homepage. ***Web site located at:*** https://cso.nasa.gov/learn

13) Flight Dynamics Facility (FDF) homepage. ***Web site located at:*** http://fdf.gsfc.nasa.gov/services

14) AMMOS Homepage. ***Web site located at:*** https://ammos.nasa.gov

15) Spectrum Management Office homepage. ***Web site located at:*** http://www.nasa.gov/directorates/heo/scan/spectrum/index.html

16) NPD 2570.5E, NASA Electromagnetic Spectrum Management, 11 July 2011. ***Copies of the document are available at:*** http://nodis3.gsfc.nasa.gov/lib_docs.cfm?range=2

17) NPR 2570.1C, NASA Radio Frequency Spectrum Management Manual, 22 Sep 2014. ***Copies of the document are available at:*** http://nodis3.gsfc.nasa.gov/lib_docs.cfm?range=2

Appendix C. Sample Mission Commitment Questionnaire

PART A – MISSION INFORMATION

Project full name: Acronym or short title:

Person Submitting Questionnaire: Date:

Title: e-mail address: Telephone:

Project purpose (25 words or less):

Sponsoring organization type: NASA Center Sponsoring org. name:

Current project phase: ☐ Formulation (Phase A-B) ☐ Implementation (Phase C-D) ☐ Operations (Phase E) ☐ Extended operations (Phase E extension)

Expected prime mission duration: Potential extended operations:

Are you planning on utilizing NASA navigation services? ☐ Yes, JPL-NAV ☐ Yes, FDF ☐ No ☐ Not sure

Where is the mission operations control center?

Where will the science data be delivered (facility and location)?

What are your plans for Terrestrial Communications for Telemetry, Tracking, and Commanding with NSN?
☐ NASCOM ☐ Cloud Interface ☐ Other ☐ Not sure

Will you require mission voice services? ☐ Yes ☐ No ☐ Not sure

Do you require NSN services during launch and early orbit when the S/C may still be connected to the launch vehicle? ☐ Yes ☐ No ☐ Not sure

Do you require NSN or DSN services during powered flight? ☐ Yes ☐ No ☐ Not sure

Do you require NSN or DSN services immediately following separation when the spacecraft is not at its nominal attitude or not under its final attitude control (i.e., tumbling/rotating)? ☐ Yes ☐ No ☐ Not sure

Are there other assets providing services? ☐ Yes ☐ No ☐ Not sure

If yes, which assets?

Points of Contact	**Name**	**Phone**	**Email**
Project Manager			
Project networks services			
Financial point-of-contact			
Radio frequency engineer			

Types of SCaN Network services requested, if known (check all that apply):

Service	SR	DTE	DSN
Telemetry	☐	☐	☐
Tracking*	☐	☐	☐
Science Data	☐	☐	☐
Command	☐	☐	☐
Radio Science	☐	☐	☐

Activities for which services are requested, if known (check all that apply):

Activity	SR	DTE	DSN
Testing	☐	☐	☐
Launch only	☐	☐	☐
Launch and Phase E Support	☐	☐	☐
Please define mission phases			
Backup Contingency	☐	☐	☐
Pre-Launch Non-Recurring Engineering	☐	☐	☐

*Do you need 1-way or 2-way Doppler during launch & early orbit and/or during on-orbit ops? ☐ Yes ☐ No ☐ Not sure * If 2-way Doppler is needed, is Ranging data needed? ☐ Yes ☐ No ☐ Not sure *Are there specific critical events that require mandatory coverage? ☐ Yes ☐ No ☐ Not sure Critical events: List critical support requirements	Post Launch special events ☐ ☐ ☐ Please list mission phases Nominal operations ☐ ☐ ☐ Special Support Reqts ☐ ☐ ☐ End-of-life (EOL)/Mission (DSN) ☐ ☐ ☐

Launch-Related Information

Launch site location:

Launch vehicle:

Launch date:

Name of Primary Payload:

Launch window:

Launch trajectory:

Launch period: to

Recycle time for launch scrubs:

Orbit Information

Apogee and perigee, or semi-major axis and eccentricity for earth orbiting missions:

Inclination for earth orbiting missions:

Argument of right ascension:

Nodal crossing type (ascending or descending) for earth orbiting missions:

Local time of nodal crossing for earth orbiting missions:

Will there be any transfer orbits?

Repeat cycle, if appropriate:

For non earth orbiting missions, describe destination (example L1, L2, Lunar Orbit, Mars orbit, Mercury flyby):

PART B – ADDITIONAL INFORMATION

What organization is obtaining spectrum and frequency authorizations?

If applicable, provide NTIA/FCC Spectrum Certification number and Radio Frequency Authorization (RFA) number.

_____

What organization will do acquisition data (ephemeris) generation?

Are there applicable CCSDS standards? ☐ Yes ☐ No Which version?

COP-1? ☐ Yes ☐ No Will VCIDs will be utilized?

COP-2? ☐ Yes ☐ No

Has NASA determined if this mission is a reimbursable? ☐ Yes ☐ No

If yes, provide NASA Point of Contact:

Any additional information or special requests you would like to add?

PART C1 – NSN SERVICES INFORMATION

Frequency

Frequency band to be used: ☐ Ku ☐ Ka ☐ S ☐ X ☐ Other

Will simultaneous receipt (return link) of two bands be required? ☐ Yes ☐ No

What modulation will be used with each band on return link (deg or rad/sin or square)?
What modulation will be used with each band on forward link (deg or rad/sin or square)?
For SR service : ☐ SA ☐ MA ☐ SMA ☐ DAS

Data Delivery (see part D1 for DSN)

Command (R/T forward link) data rates in sps:

Telemetry (R/T return link) data rates in sps:

Science data volume per contact (Mbytes)

Latency (science data delivery) requirements:

PART C1 – NSN SERVICES INFORMATION CONTINUED

Spacecraft Services Information

	Near Space Network/SR			Near Space Network/DTE		
	Min	**Avg**	**Max**	**Min**	**Avg**	**Max**
Desired number of contacts per day:						
Average length of each contact:						
Are there required min./max. separation times between contacts for telemetry and command?						

Other constraints:

Other special considerations:

PART C2 – NSN RADIO FREQUENCY (RF) INFORMATION FOR LINK ANALYSES

Uplink/Forward Link Information (for each link)

Service Description:

Frequency:

Polarization:

Data Modulation Information:

Description: (Note: If there are multiple channels, please provide the details for each channel; for example, if the signal includes both a channel on the baseband carrier and includes a channel on the subcarrier which modulates the carrier, please describe each channel individually. If the signal is a single data source and separated into channels, please describe (or provide a block diagram) how this signal is separated, including single data rate and separate channel rates and any requirements to recombine the channels into a single data stream.)

Modulation Type:

Modulation Index (if not PSK):

Sub-carrier Modulation Frequency (if applicable):

Data rate prior to any coding (should include CCSDS overhead):

Data format:

Symbol rate prior to any convolutional coding:

Symbol rate after all coding:

Symbol format:

PN spreading rate constraints (if applicable):

Required BER:

Receiver implementation loss:

Required acquisition performance:

Other links, modes, playbacks?

DTE-Ranging Modulation Information (if applicable):

Description:

Highest tone/code frequency:

Highest tone/code modulation index:

Lower tone/code modulation index (if applicable):

Receive Vehicle RF Information:

Description:

Receive antenna gain Information (include gain characteristics, polarization, and beam-width and axial ratio associated with gain):

Passive loss from antenna to receiver:

Noise figure of receiver and/or system noise temperature at receiver:

Downlink/Return Link Information (for each link):

Service description:

Frequency (include description on coherent and non-coherent operations as applicable):

Data Modulation Information:

Description: (Note: If there are multiple channels, please provide the details for each channel; for example, if the signal includes both a channel on the baseband carrier and includes a channel on the subcarrier which modulates the carrier, please describe each channel individually. If the signal is a single data source and separated into channels, please describe (or provide a block diagram) how this signal is separated, including single data rate and separate channel rates and any requirements to recombine the channels into a single data stream.)

Modulation type:

Modulation index (if not PSK):

Subcarrier modulation frequency (if applicable):	Data rate prior to any coding (should include CCSDS overhead):
Data format:	Symbol rate prior to any convolutional coding:
Type of coding:	
Symbol rate after all coding:	Symbol format:
PN spreading rate (if applicable):	
Required BER:	

DTE Ranging modulation information (if applicable):

Description:

Turnaround Modulation Index for a single uplink tone:

Accuracy Requirements:

Transmit vehicle RF information:

Description:

Transmitter power:

Passive loss from transmitter to antenna input:

Transmit antenna gain Information (include gain characteristics and beamwidth and axial ratio associated with gain & polarization):

Tracking Information (excludes ranging, which was discussed earlier):

Description:

Doppler Requirements: ☐ 1-way ☐ 2-way ☐ Differenced One-Way

Doppler Accuracy Required:

Point-of-Contact for RF Link Analyses Questions (name, phone, email):

PART C3 – NEXTERA DTE DATA DISTRIBUTION INFORMATION (TBD)

Data Volume per Pass	
AOS Frame Size	CRC? ☐ Yes ☐ No
VC Separation? ☐ Yes ☐ No	If Yes, VC List:
Latency Requirement:	Data File naming convention:
Delivery Protocol (SFTP, CFDP, SCP):	
SFTP End Point Retrieval? ☐ Yes ☐ No	If No, Self Service retrieval? ☐ Yes ☐ No

PART C4 – NEXTERA SR DATA DISTRIBUTION INFORMATION (TBD)

SR Gateway Encapsulation Format:

Space Link Extension ☐ **LEO-T** ☐ **IPDU** ☐

Encapsulation Format General Information:

Frame Sync Enabled? ☐ Yes ☐ No

Frame Sync Pattern xxxxxxxx **Frame Length** ####

Location ☐ First ☐ Last **Size in Bits (default is 32)** ##

Slip Size ## **Search Frames** #

Lock Frames # **Check Frames #**

Automatic Polarity Control Enabled? ☐ Yes ☐ No

NOTE: A detailed questionnaire for selected encapsulation format will be sent to project.

PART D1 – DSN SERVICES INFORMATION OVERVIEW

Frequency

Frequency band to be used: (Near Earth or Deep Space) ☐ Ka ☐ S ☐ X

Will simultaneous receipt of two bands on return link be required? ☐ Yes ☐ No

Data Delivery

Command (R/T forward link) data rates in bps:

Telemetry (R/T return link) data rates in bps:

Science data volume per contact (Mbytes) in bps:

Latency (science data delivery) requirements:

Delay Tolerant Networking (DTN) requirements:

CFDP service requirements and type:

Spacecraft Services Information

Required number of passes per mission phase, e.g. - LEOP, Cruise, orbit insertion, etc., use the DSN RF Aperture Fee tool located at https://dse.jpl.nasa.gov/ext/			
Any 70 meter requirements, if yes give description:	Yes	No	
Any high power uplink requirements above 20kw, if yes give frequency band:	Yes	No	
Are there any special tracking pass requirements: e.g. – DDOR passes per week in what mission phase, MSPA, Relay, Array, Beacon. If yes put it in the DSN RF Aperture Fee tool.	Yes	No	
Is DSN Direct from Earth (DFE) service required (telemetry, command) for a rover or lander? If yes, what is the minimum horizon elevation (when pointed to earth) for the lander or rover?:	Yes	No	
Will the mission operate at a low Sun Earth Probe (SEP) angle (other than inferior or superior conjunction? If yes what is the minimum SEP angle?:	Yes	No	

Other constraints:

Other special considerations:

PART D2 – DSN RADIO FREQUENCY (RF) INFORMATION

Uplink/Forward Link Information (for each link)

Service Description: Command

Frequency:

Polarization:

Minimum EIRP required:

SLE FCLTU: PLOP 1 PLOP-2

Modulation Type: Modulation Index: Sine Square

Sub-carrier Modulation Frequency (if applicable): 8Khz 16Khz

Bit rate in bps:

Modulation format: NRZ-L,M,S Bi-Phase L

Manchester M,S

CLTU Frame Length:

Ranging Modulation Information (if applicable):

Type: Highest Clock:

Sequential

PN – regenerative

PN – non-regenerative Lower Clock:

Spacecraft Receive G/T Information:

Description:

Receive antenna gain Information (include gain characteristics, polarization, and beam-width and axial ratio associated with gain):

Passive loss from antenna to receiver:

Noise figure of receiver and/or system noise temperature at receiver:

Downlink/Return Link Information:

Service description:

Frequency (include description on coherent and non-coherent operations as applicable):

Data Modulation Information:

Description: The DSN supports multiple polarizations and modulations schemas. Describe each frequency downlink channel if more than more for an off-nominal configuration, e.g. – LCP and RCP combined for S or X-band, LCP only for Ka-band.

Modulation type: Modulation index:

Subcarrier modulation frequency (if applicable):

Telemetry bit rates including headers (all) in bps:

Data format:

Type of coding, e.g. – Turbo, LDPC, Reed-Solomon, Convolutional:

Spacecraft RF information:

Description:

Transmitter power:

Minimum G/T required at the ground antenna:

Tracking Information (excludes ranging, which was discussed earlier):

Description:

Doppler Requirements: ☐ 1-way ☐ 2-way

Point-of-Contact for RF Link Analyses Questions (name, phone, email):

PART D3 – DSN COMMUNICATIONS WAN/LAN INFORMATION

Data Volume per Pass MBs/GBs

Latency Requirement for Science and Engineering data, Specify each VC separately:
VC0 =
VC1 =
Etc.
Timely = within 10 second
Complete = Streaming service that commences during the tracking
Offline = normally postpass with latency commensurate with data volume and data circuit capacity

Appendix D. Sample DSN Communications System Parameter Tables

The requirements in this appendix do not apply to Step 1 proposals. They apply only to the Concept Study Reports (CSR) that will be prepared by investigations selected at the outcome of Step 1 to conduct Phase A concept studies.

At a minimum, proposals should contain the set of telecommunications parameters shown in Table D-1. While proposers may or may not wish to use a tabular format, the required parameter values should be supplied in a clear, concise, and readily apparent form.

Table D-1: Telecommunications Parameters and Definitions

Parameter	Units	Description
Maximum Spacecraft (S/C) Distance	Kilometers (Km)	Maximum S/C-earth station distance during primary mission.
1st Encounter Distance	Km	Maximum S/C-earth station distance during first encounter.
2nd Encounter Distance	Km	Maximum S/C-earth station distance during second encounter.
Nth Encounter Distance	Km	Maximum S/C-earth station distance during Nth encounter.
Uplink Transmitter Power	Watts	Earth Station Transmitter Output.
Uplink Frequency Band	GHz	Proposed earth-to-space frequency band expressed in Gigahertz (GHz) (2, 7, 34 GHz).
Uplink Command Mod. Index	Radians (Rad)	Earth Station Uplink Command Modulation Index (Peak Radians).
Uplink Ranging Mod. Index	Rad	Earth Station Uplink Ranging Modulation Index (Peak Radians).
Uplink Transmit Antenna Gain	Decibels (dBi)	Gain (or name) of earth stations transmitting antenna (*e.g.,* 34M Beam Wave Guide (BWG).
S/C HGA Receive Gain/Loss	dBi/dB	Gain of spacecraft's high-gain receive antenna/Circuit loss to LNA.
S/C MGA Receive Gain/Loss	dBi/dB	Gain of spacecraft medium-gain receive antenna/Circuit loss to LNA.
S/C LGA Receive Gain/Loss	dBi/dB	Gain of spacecraft low-gain receive antenna/Circuit loss to LNA.

Parameter	Units	Description
Telecommand Data Rates	bits per second (b/s)	Maximum and Minimum desired telecommand data rate (Max/Min).
Telecommand Bit-Error-Rate	-	Required telecommand Bit-Error-Rate (BER).
S/C Receiver Noise Temperature	Kilo (K)	Total spacecraft receiver system noise temperature.
S/C Receiver Bandwidth	Hertz (Hz)	S/C Receiver's phase-locked-loop threshold bandwidth (2 Blo).
Turnaround Ranging	Yes/No	Statement whether turnaround ranging is required.
Required Ranging Accuracy	Meters	Specify project's required range measurement accuracy.
S/C Transmitting Power	Watts	S/C Power amplifier output.
Downlink Modulation Format	Name	Format name (*e.g.,* PCM/PM/Bi-phase, PCM/PSK/PM, BPSK, QPSK, etc.).
Downlink Frequency Band	GHz	Proposed space-to-earth frequency band expressed in GHz (2, 8, 26, 32 GHz).
S/C HGA Transmit Gain/Loss	dBi/dB	Gain of spacecraft's high-gain transmit antenna/Circuit loss from PA.
S/C MGA Transmit Gain/Loss	dBi/dB	Gain of spacecraft's medium-gain transmit antenna/Circuit loss from PA.
S/C LGA Transmit Gain/Loss	dBi/dB	Gain of spacecraft's low-gain transmit antenna/Circuit loss from PA.
Downlink Receive Antenna Gain	dBi	Gain (or name) of earth station receiving antenna (*e.g.,* 34M BWG).
Telemetry Data Rates	Bits per second (b/s)	Maximum and minimum desired uncoded telemetry data rates (Max/Min).
Downlink Telemetry Mod Index	Rad	S/C Downlink Telemetry Modulation Index (Peak Radians).
Telemetry Coding & Code Rate	Name & Rate	Telemetry code (*e.g.,* convolutional, Reed-Solomon, concatenated, Turbo, etc.).
Telemetry Frame Length	Bits	Total telemetry frame length.
Frame Deletion Rate	Rate	Acceptable Transfer Frame deletion rate from bit errors.
Telemetry Bit-Error-Rate	-	Telemetry Bit Error Rate (BER) required for desired frame deletion rate.

Parameter	Units	Description
Subcarrier frequency and format	Hz/Sine or Square	Subcarrier frequency used/Sine or Square wave format.
Ground Station Implementation Losses	dB	Total losses, including phase jitter, demodulation loss, and waveform distortion.
Downlink Ranging Mod Index	Rad	S/C Downlink Ranging Modulation Index (Peak Radians)
Hot Body Noise	(K)	The predicted increase from the reference temperature (Tr), resulting from the receiving antenna being directed toward a body having a temperature greater than that of the cold sky reference.

Table D-2 is a sample telecommunications link parameter form containing the necessary parameters. Proposers are requested to include this completed form in their proposals.

Table D-2: Sample Table for Inclusion in Proposal

Parameter	Value	Parameter	Value
Maximum S/C Distance (km)		Turnaround Ranging (Yes/No)	
1st Encounter Distance (km)		Required Ranging Accuracy (m)	
2nd Encounter Distance (km)		S/C Transmitting Power (Watts)	
Nth Encounter Distance (km)		Downlink Modulation Format (Name[s])	
Uplink Transmitter Power (Watts)		Downlink Frequency (GHz)	
Uplink Command Mod Index (Peak Radians)		S/C Downlink Telemetry Mod Index (Peak Radians)	
Uplink Ranging Mod Index (Peak Radians)		S/C Downlink Ranging Mod Index (Peak Radians)	
Uplink Frequency (GHz)		S/C HGA Transmit Gain (dBi)/Loss (dB)	
Uplink Transmit Antenna Gain (dB)		S/C MGA Transmit Gain (dBi)/Loss (dB)	
S/C HGA Receive Gain (dBi)/Loss (dB)		S/C LGA Transmit Gain (dBi)/Loss (dB)	

Parameter	Value	Parameter	Value
S/C MGA Receive Gain (dBi)/Loss (dB)		Downlink Receive Antenna Gain (dBi)	
S/C LGA Receive Gain (dBi)/Loss (dB)		Downlink Subcarrier frequency and format	
Telecommand Data Rates (b/s)		Telemetry Data Rates (b/s)	
Telecommand Bit-Error-Rate		Telemetry Coding (Name)	
S/C Receiver Noise Temperature (K)		Telemetry Frame Length	
S/C Receiver Bandwidth (Hz)		Frame Deletion Rate	
Hot Body Noise (K)		Telemetry Bit-Error-Rate	
		Ground Station Implementation Losses (dB)	

Information requested in Table D-2 above should be provided for each link whether Direct-to Earth, Relay, or other (spacecraft separation, Launch and Early Orbit Phase [LEOP], cruise, Entry, Departure, and Landing [EDL], orbit ops).

Link design control tables should be provided for the following conditions as a minimum:

- Spacecraft separation
- Emergency mode at maximum distance from Earth
- Maximum science data rate at maximum distance from Earth.

If a proposal does not contain sufficient information for an evaluator to independently verify that each communication's link operates properly, a negative finding is likely to be made.

Station Requirements by Mission Phase

Proposers should clearly state their Networks support requirements, preferably in a tabular format. For all mission phases (*e.g.,* launch and early orbit operations, cruises, maneuvers, flybys, orbit insertion, orbit operations, data return, etc.) proposals should show the mission's phase, the year in which the services are desired, stations required, pass length, number of passes per day/week, and the duration that these services are required. A sample table containing a few entries for a fictitious planetary mission appears below in Table D-3. Proposers are requested to include a completed form showing all major mission phases and the services required in their proposals.

Table D-3: Sample Station Requirements by Mission Phase Table

DSN Support Summary												
Mission(s)				2022	2023	2024	2025	2026	2027	2028	2029	
Cost Method	Fiscal		Total Setup Time	157.4	163.9	196.3	320.1	528.6	364.6	554	69.7	
Fiscal Year	2018		Total Teardown Time	39.4	41	49.1	80	132.1	91.1	138.5	17.4	
User Type	Gov		Total Configuration Time	196.8	196.8	196.8	196.8	196.8	196.8	196.8	196.8	
Additional Fees	$0		Total Tracking Time	1081.4	692.4	970.3	2370	4188.6	2892.6	4296	533.7	
Total DSN Time (hours)	19968.1		Total DSN Time	1278.2	897.2	1215.6	2770.2	4849.3	3348.3	4988.5	620.8	
Total DSN Passes	2353		Total Cost	$2,556,006.00	$1,322,620.00	$1,878,662.00	$5,063,609.00	$9,724,249.00	$6,721,997.00	$10,058,689.00	$1,207,547.00	
Total Cost	$38,533,379											
Brakedown by Support Activity												
Mission	Support Activity Name	Antenna	Service Year	Usage	Number of Weeks	Total Number of Passes	Average Number of Passes Per Week	Total Setup Time (hours)	Total Teardown Time (hours)	Total Track Time (hours)	Total DSN Time (hours)	Total Cost for Period
	X TTC 34m BWG1 BWG2 BWG3 BWG4 2022	34m	2022		25	143	6	143.4	35.9	1032.4	1211.7	$2,478,446
	X TTC 34m BWG1 BWG2 BWG3 BWG4 2025	34m	2025		3	25	8	25.4	6.4	203.4	235.2	$470,465
	K+X TTC 34m BWG1 2022	34m	2022		7	14	2	14	3.5	49	66.5	$77,560
	K+X TTC 34m BWG1 2023	34m	2023		52	163	3	163.9	41	692.4	897.2	$1,322,620
	K+X TTC 34m BWG1 2024	34m	2024		52	196	4	196.3	49.1	970.3	1215.6	$1,878,662
	K+X TTC 34m BWG1 2025	34m	2025		50	295	6	294.7	73.7	2166.6	2535	$4,593,144
	K+X TTC 34m BWG1 2026	34m	2026		53	518	10	518.6	129.6	4148.6	4796.8	$9,612,919
	K+X TTC 34m BWG1 2027	34m	2027		36	359	10	358.6	89.6	2868.6	3316.8	$6,655,199
	K+X TTC 34m BWG1 2028	34m	2028		52	520	10	520	130	4160	4810	$9,680,167
	K+X TTC 34m BWG1 2029	34m	2029		7	64	9	63.7	15.9	509.7	589.3	$1,140,749
	X TTC 70m 2026	70m	2026		10	10	1	10	2.5	40	52.5	$111,330
	X TTC 70m 2027	70m	2027		6	6	1	6	1.5	24	31.5	$66,798
	X TTC 70m 2028	70m	2028		34	34	1	34	8.5	136	178.5	$378,522
	X TTC 70m 2029	70m	2029		6	6	1	6	1.5	24	31.5	$66,798

MSPA User(s) Information (DSN)

Missions planning to employ Multiple Spacecraft per Aperture (MSPA) can reduce their costs by using shorter track lengths and operating in a non-coherent, one-way mode, provided that they do not require an uplink. However, proposers planning to avail themselves of such savings should include a Letter(s) of Agreement from each of the other projects with whom they will be sharing the MSPA capability, stating how the uplink services (*e.g.,* commanding, coherent radio metric data capture, etc.) will be shared.

Absent such Letter(s) of Agreement, reviewers will employ their judgment as to whether the proposed MSPA utilization is within “reasonable” levels.

Appendix E. Form for Estimating DSN Mission Support Costs

Proposers calculating DSN aperture fees should use the on-line tool located at the URL https://dse.jpl.nasa.gov/ext/.

Training on the use of the tool can be provided by contacting:

Brian J. Giovannoni
Manager
Jet Propulsion Laboratory
Interplanetary Network Directorate
Customer Management Interface Office
Mobile phone: 626-755-8829
Email: brian.j.giovannoni@jpl.nasa.gov

Document Number

Space Communications and Navigation (SCaN)
Mission Operations and Communications Services (MOCS)