Deep Space Network Capabilities and Costs

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Service Providers

- NASA's Procedures and Guidelines (NPG) 7120.5B (Sections 2.1.5 and 3.1.5) require all programs/projects to develop requirements for space operations services provided by NASA facilities during mission formulation. Such services include communications, tracking, mission operations, navigation, and data processing. NPG 7120.5B requires projects to use NASA services unless a more cost-effective life cycle can be found and demonstrated in the proposal.
- Programs/projects are free to propose procurement of services from sources other than NASA. Projects should conduct trade studies comparing the use of NASA-provided services with any proposed alternatives.
- If you do choose to use non-NASA assets for part of your mission, you are strongly encouraged to enlist the DSN as a facilitator to ensure compatibility and speedy transfer of responsibility and data turnover

Costing Policy

- 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 Earth-orbiting and deep space missions. The Science Mission Directorate (SMD) is implementing this policy to:
  - implement formal NASA-wide full-cost accounting,
  - better manage NASA's heavily subscribed communications resources,
  - promote tradeoffs between on-board processing and storage vs. communications requirements, and
  - • encourage hardware and operations system designs minimizing life cycle costs while accomplishing the highest-priority science objectives.

DSMS Services

Service Category	Brief Description of Service's Content
Command	RF modulation, transmission, and delivery of telecommands to spacecraft.
Telemetry	Telemetry data capture and additional value-added data routing and processing.
Mission Data Management	Data buffering, staging, short and long term storage.
Tracking and Navigation	Radio metric data capture, LEOP trajectory, ephemerides, and modeling.
Experiment Data Products	Level 1 & higher data processing providing photo and science visualization products.
Flight Engineering	Telecommunications link performance, analysis, and prediction and time correlation.
Beacon Tone	Monitors subcarrier frequencies transmitted by S/C indicating S/C's health.
Ground Communications	Data, voice, and video communications network services.
Radio Science	S/C Doppler, range, and open-loop receiver measurements at 2, 8, and 32 GHz.
Radio Astronomy / VLBI	Similar to Radio Science but measures natural phenomena. Wide & narrowband VLBI.
Radar Science	Transmits RF carrier toward user defined target; captures reflected signal.

Contacting the DSN

The primary DSMS point of contact for this AO is the Commitments Office Manager

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Space Link Extension

Project Operation Control Centers (POCCs) using DSN and SN services should use a standard *Space Link Extension* (SLE) *Services Interface* for transferring data to and from DSN sites.

This interface is designed to provide international control center–network interoperability and reduce mission risk by facilitating the rapid substitution of a different earth station, not necessarily only NASA's, in the event of a failure.

In 2005 and beyond, the SLE Services interface will require POCCs to directly access DSN stations for the following services: Command Link Transmission Unit (CLTU), Return All Frames (RAF), Return Channel Frames (RCF), and CCSDS File Delivery Protocol (CFDP).

Six international space agencies, including: ASI, CNES, DLR, ESA, JAXA, and NASA, have agreed to implement the SLE Services Interface to achieve full international interoperability. Interface architecture conforms to standards adopted by the CCSDS.

Frequencies

- **X-Band and Ka-Band Communications**
- Deep space (r ≥ 2 x 10^6 km) missions operating in a *Space Research* should be designed to communicate in either the 7/8 GHz or 7/32 GHz bands.
- Ever increasing congestion and the addition of allocations for incompatible services have restricted future; example- operations in the 2 GHz deep space band.
- Accordingly, the Science Mission Directorate is recommending that use of the 2 GHz deep space band be limited to radio science and in-situ communications.
- Deep space missions having high data rates should operate in Ka-Band (31.8 - 32.3 GHz space-to-earth) or, if using the 8400-8450 MHz band, they should comply with SFCG Recommendations regarding bandwidth-efficient modulation.

CCSDS File Delivery Protocol

- To improve station utilization efficiency as well as reduce mission risk and costs, all DSN users should employ the CCSDS File Delivery Protocol (CFDP), to transfer data to and from a spacecraft.
- CFDP operates over a CCSDS conventional packet telecommand, packet telemetry, or an Advanced Orbiting System (AOS) Path service link.
- CFDP enables the automatic transfer of a complete set of specified files and associated information from one storage location to another replacing an expensive labor-intensive manual method.
- It can transfer a file from a source point to a destination site using an Automatic Repeat Queuing (ARQ) protocol.
- In an *acknowledged mode*, the receiver notifies the transmitter of any undelivered file segments or ancillary data so that the missing elements can be retransmitted guaranteeing delivery.

Multiple Spacecraft Per Antenna

- Where a multiplicity of spacecraft lie within the beamwidth of a single DSN antenna, it may be possible to capture data from two or more spacecraft simultaneously using the Multiple Spacecraft Per Aperture (MSPA) system.
- MSPA decreases DSN loading and will save the project's money

Delta Differenced One-Way Range

- Delta Differenced One-Way Range (DDOR) can be used in conjunction with Ranging and Doppler data to:
- 1) Increase spacecraft targeting accuracy (when used with range and Doppler data).
- 2) Improve mission reliability (when used with range and Doppler data).
- 3) Reduce tracking time (if pass duration is driven by tracking data capture).

New Space Communications Capabilities Available for NASA's Discovery and New Frontier Programs

- NASA's Deep Space Network Technology Program, funded primarily by NASA's Science Mission Directorate is developing technologies needed for realizing the future evolutionary systems in the NASA Strategic Plan.
- That plan is guided by four basic principles;
  - reliably achieving negotiated mission goals,
  - increasing the science data return of future missions 1000X by 2015,
  - providing standard and cost effective mission interfaces, and
  - growing an evolving infrastructural architecture for seamless communications and navigation across the solar system.