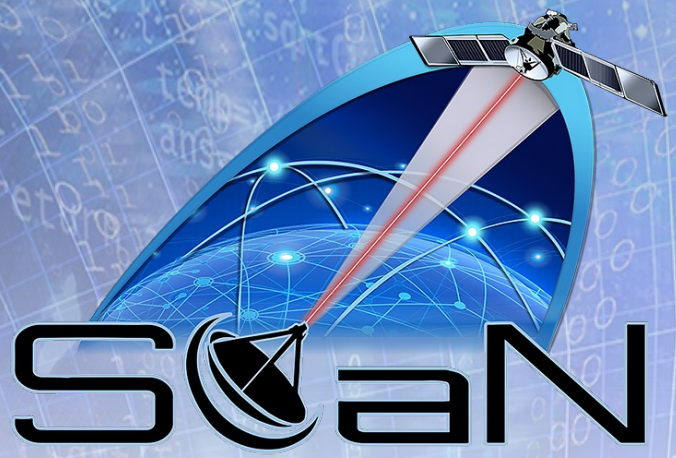
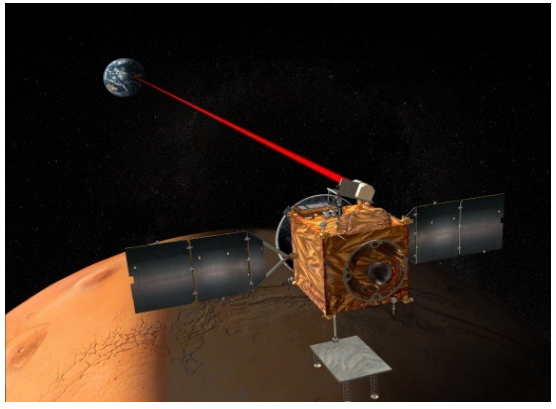
National Aeronautics and Space Administration

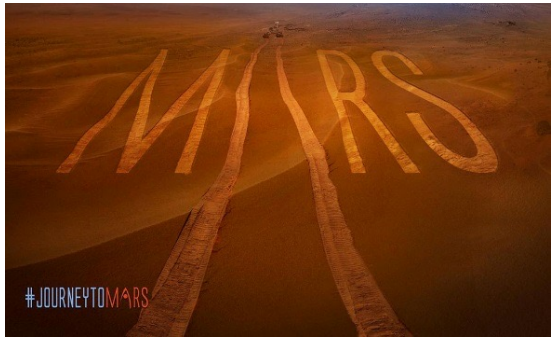


Space Communications and Navigation (SCaN) Overview
SMEX Pre-Proposal Conference

October 6, 2022

SCaN is Responsible for all NASA Space Communications





- Responsible for Agency-wide operations, management, and development of all NASA space communications capabilities and enabling technology
- Expand SCaN capabilities to enable and enhance robotic and human exploration
- Manage spectrum and represent NASA on national and international spectrum management programs
- Develop space communication standards as well as Positioning, Navigation, and Timing (PNT) policy
- Represent and negotiate on behalf of NASA on all matters related to space telecommunications in coordination with the appropriate offices and flight mission directorates

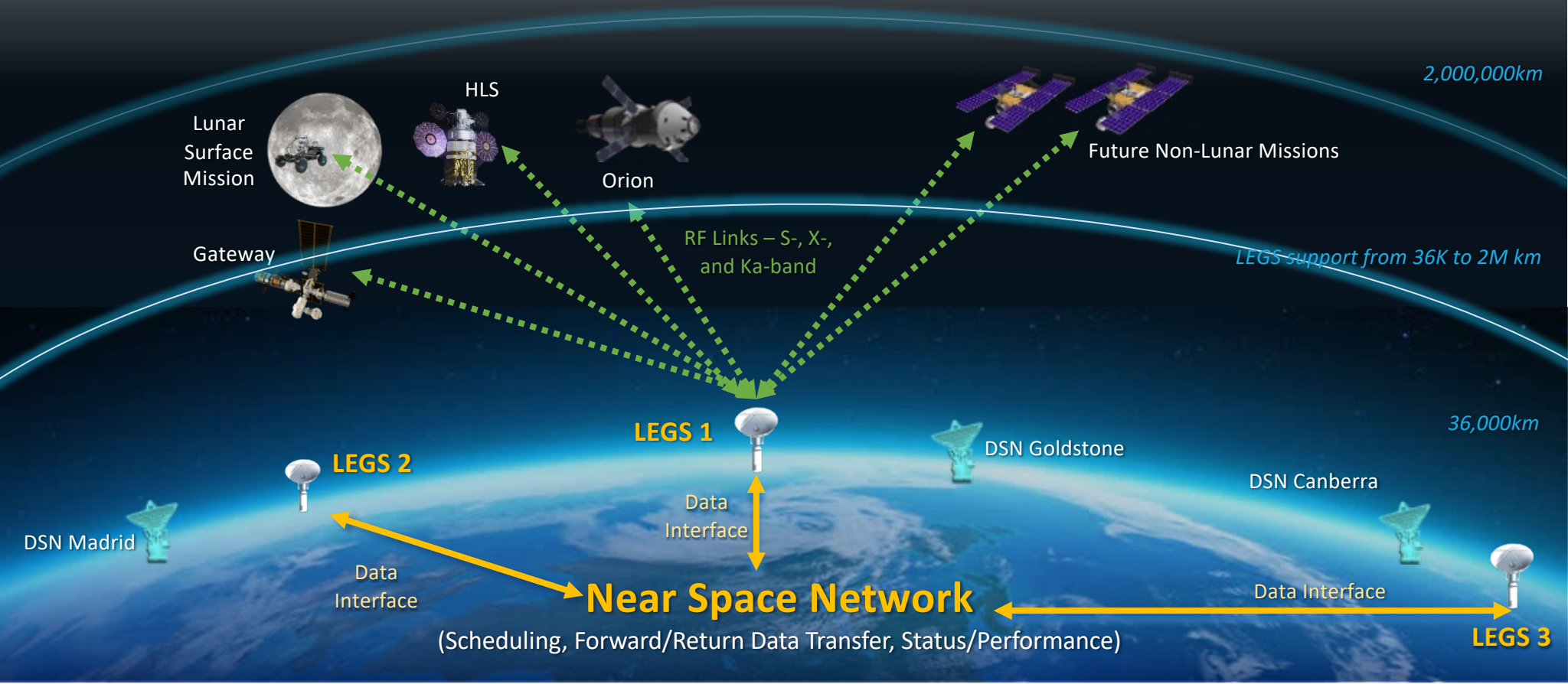
NASA Networks Span the Globe

Key Points about the SCaN Networks and Trends

- The Near Space Network (NSN) is inclusive of services provided through government assets such as the Tracking and Data Relay Satellites, as well as commercial partner ground stations (e.g., select KSAT and SSC sites).
- The Deep Space Network (DSN) provides services to missions beyond 2 million km. Proposers are strongly encouraged to use the NSN for missions within 2 million km.
- SCaN is actively working to increase offerings through commercial service providers and as services are onboarded, they will be reflected in the SCaN MOCS document.
- SCaN is also pursuing Lunar Exploration Ground Segment Sites (LEGS) and services:
  - The LEGS mission is to provide direct-to earth communication and navigation services for missions operating from 36,000 kilometers (km) in the GEO to cis-Lunar and other orbits out to 2 Million km
  - To fully support distant orbits there will be three LEGS sites equally spaced around the Earth.
- In cooperation with SMD, SCaN is working to provide guidance in future AOs that is consistent with ideals for network stewardship, in particular, encouraging applicable missions to design to LEGS standards rather than DSN, to help alleviate loading on the DSN – reserving service time for planetary and deep space missions to the degree feasible.

LEGS Concept

- Lunar Exploration Ground Sites (LEGS) will provide Direct to Earth (DTE) RF comms to users ranging from Earth GEO orbit cis-Lunar space and to Sun-Earth-Lagrange orbits
- Minimum of three sites located around the Earth to provide continuous coverage
- Ability to add further assets as demand grows and to add redundancy / resiliency



LEGS Capabilities

- LEGS Planned Implementation Approach
- Sites 1 – 3
  - X-band Uplink & Downlink capability
  - Ka-band Uplink & Downlink capability
- Sites 4 – 6
  - S-band Uplink & Downlink capability
  - X-band Uplink & Downlink capability
  - Ka-band Uplink & Downlink capability

*Antenna image above is WS1 at WSC

LEGS Locations (Site, Lat., Long.)

White Sands, USA: 32.544863, -106.612504
Matjiesfontein, South Africa: -33.231224, 20.58163 (TBD)
Pacific Region TBD

Additional Information

FUNCTION	PERFORMANCE
Antenna Diameter (D)	D > 18m
Services	TT&C, CCSDS Forward and Return data, Radiometric tracking and antenna auto tracking angles
Transmit and Receive Polarizations	Tx: RHC or LHC Rcv: RHC & LHC
Antenna Travel Range	>360 deg Azimuth Continuous (TBR) 0-90 deg Elevation
Antenna axis Tracking rate	0.5 deg/s velocity (TBR)
Radiometric Tracking	Per CCSDS 414.1-B-2, Pseudo-Noise (PN) Ranging Systems
Radiometric Accuracy	Equivalent to DSN adjusted to C/No
Autotrack Accuracy	+/- 0.2 dB of beam peak (TBR)
Multiple Spacecraft Per Antenna (MSPA)	Up to 4 simultaneous return services per aperture (Max 3 Ka)
Timing Reference	short term stability better than 10^-14 (TBR)

Lunar Exploration Ground Sites (LEGS)

The LEGS mission is to provide direct-to earth communication and navigation services for missions operating from 36,000 kilometers (km) in the GEO to cis Lunar and other orbits out to 2 Million km. To fully support distant orbits there will be three LEGS sites equally spaced around the Earth. The Ground sites utilize CCSDS Modulation and coding schemes for forward and return data. Specialized/unique Mod-Cods are optional. User Local Equipment on site is optional. Ground system performance characteristics are provided below:

Antenna System Radio Frequency Operating Regimes

Radio Frequency (RF) Band	Operating Frequency	
	Lower limit	Upper limit
S-Band (Forward)	2025 MHz	2120MHz
S-Band (Return)	2200 MHz	2300 MHz
X-Band (Forward)	7145 MHz	7235 MHz
X-Band (Return)	8400 MHz	8500 MHz
Ka-Band (Forward)	22.55 GHz	23.15 GHz
Ka-Band (Return)	25.50 GHz	27.0 GHz

RF Performance Criterion	Radio Frequency Performance (Forward)		
	S-Band	X-Band	Ka-Band
EIRP (minimum) [3]	81 dBW	86 dBW	89 dBW
Approx 3 dB Beamwidth [3]	0.5°	0.1°	0.04°
Forward Distortions [2]	1 dB max	1 dB max	1 dB max
Carrier Modulation	Direct PCM/PM PCM/PM/PSK, OQPSK, BPSK [1]	Direct PCM/PM PCM/PM/PSK, OQPSK, BPSK [1]	BPSK, OQPSK Filtered OQPSK [1]
Max Data Rate	10 Msps	10 Msps	40 Msps

RF Performance Criterion	Radio Frequency Performance (Return)		
	S-Band	X-Band	Ka-Band
G/T (minimum) [3]	28 dB/K	39 dB/K	47.5 dB/K
Approx 3 dB Beamwidth [3]	0.5°	0.1°	0.04°
Implementation loss [2]	2 dB max	2 dB max	2 dB max
Demodulation	Direct PCM/PM, PCM/PM/PSK, OQPSK, BPSK [1]	Direct PCM/PM, PCM/PM/PSK, OQPSK, BPSK [1]	OQPSK, Filtered OQPSK [1]
Max Data Rate	20 Msps	150 Msps	500 Msps

[1] Additional modulation schemes or data service types are optional
[2] GSFC CLASS link calculations use a 3dB implementation loss of which, the receive system is allocated 2dB and the transmit system distortions are allocated 1dB
[3] TBR pending finalization of antenna system requirements

Costing and Spectrum

- In the SMEX AO, NSN and DSN costs are represented as reductions to the AO Cost Cap to better capture the full costs to NASA SMD for each mission
- For assistance in cost estimating, proposers may:
  - Contact the SCaN Mission Commitment Office at Exploration-enabled@lists.hq.nasa.gov
  - Reference the SCaN Mission Operations and Communications Services (MOCS) document and/or (for DSN) the Interplanetary Network Directorate's Commitment Office website at https://deepspace.jpl.nasa.gov/about/commitments-office for costing information
- Reaching out to SCaN and/or Center Spectrum Managers as early as possible is also advised
  - All NASA missions that require the use of the electromagnetic spectrum shall follow the U.S. spectrum regulatory rules/processes as referenced in NASA spectrum policy
  - All missions/projects using RF spectrum must be certified/authorized by the appropriate regulatory authority

SCaN Points of Contact

- Missions are strongly advised to contact with the SCaN Mission Commitment Office as early in the concept and design phase process as possible. This office can help whether or not you are planning to use SCaN resources.
  - Missions engaging with SCaN in early planning is in alignment with NPD 8074.1
- In order to begin the mission commitment process, missions should send their questions, concerns or services requests to the following points of contact:
  - Exploration-enabled@lists.hq.nasa.gov
  - (202) 358-1202

NASA

www.nasa.gov

Space Communications and Navigation

www.nasa.gov/scan

www.facebook.com/NASASCaN

Twitter: @NASASCaN

Keeping the Universe Connected