

National Aeronautics and Space Administration

# Deep Space Network Updates

Presented to:
**Planetary Sciences Advisory Committee**

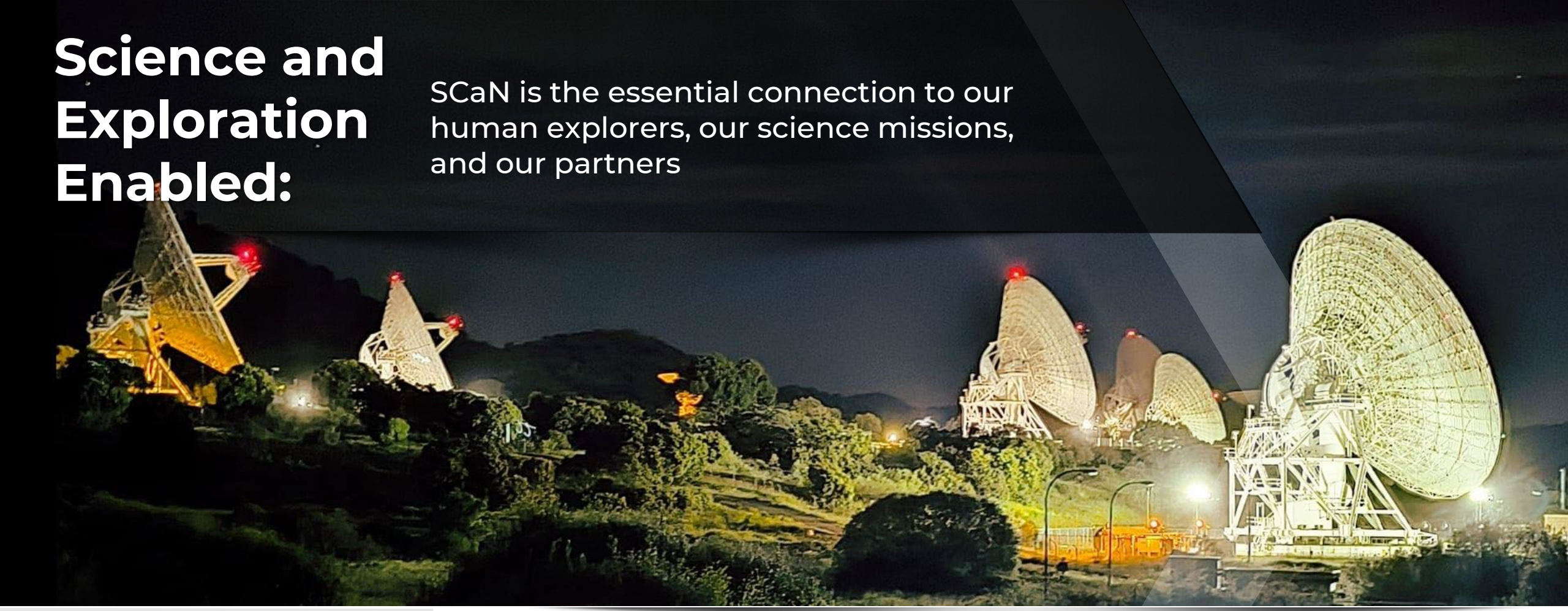
Presented by:
**Philip Baldwin**
Deputy Program Manager - Operations
Space Communications and Navigation (SCaN)
Space Operations Mission Directorate
National Aeronautics and Space Administration
July 9, 2024

SCaN Space Communications and Navigation

Science and Exploration, Enabled. Together.

# Science and Exploration Enabled:

SCaN is the essential connection to our human explorers, our science missions, and our partners



**Space Communications and Navigation (SCaN)** Serves as the enterprise responsible for all of NASA's space communications activities.

24/7 Global Near Earth and Deep Space Communications and Navigation Services

100+ Missions currently enabled by SCaN

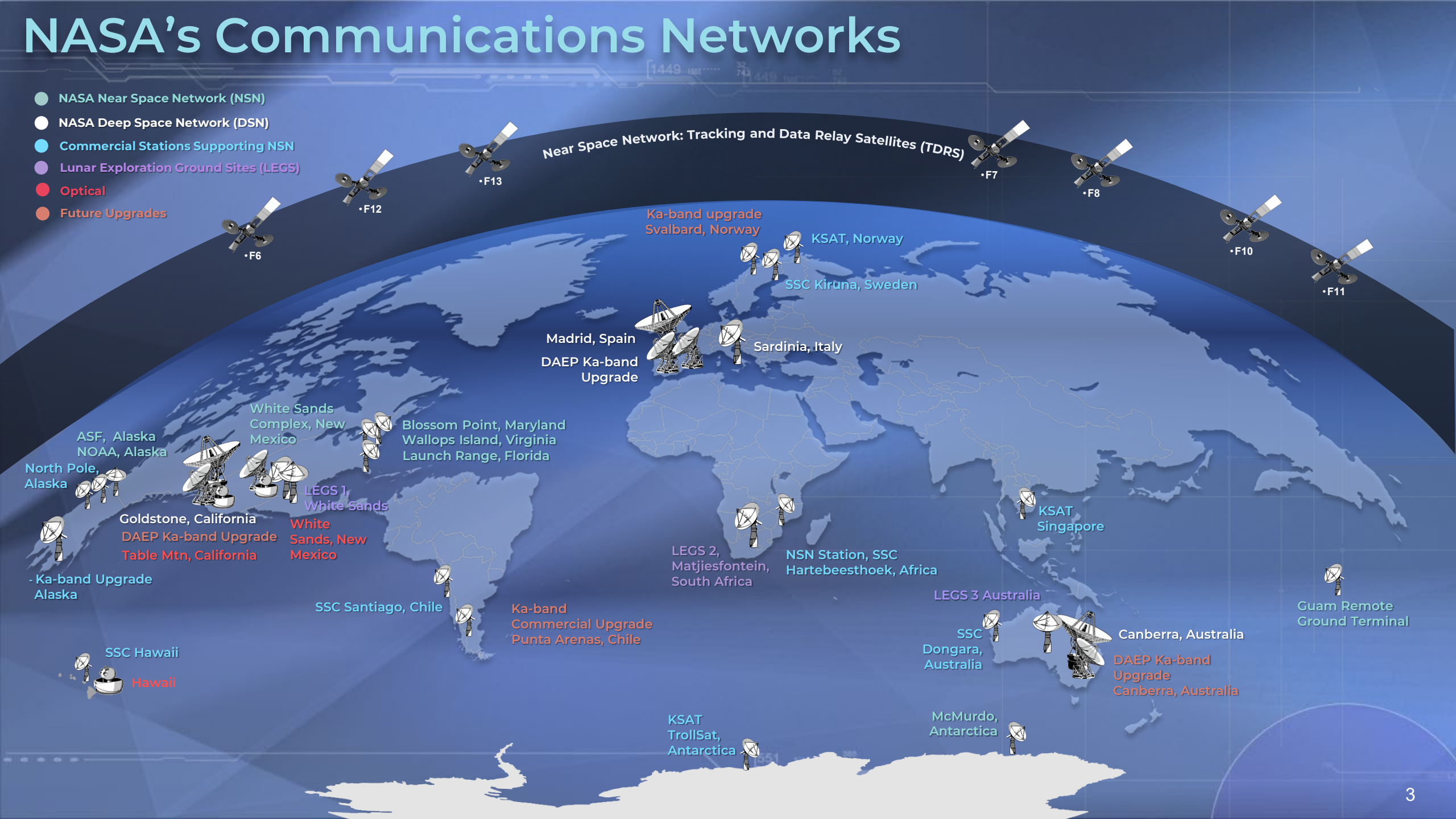
## Focal Points for NASA SCaN

Provide reliable, robust, and resilient space communications and navigation capabilities to enable safe execution of NASA missions.

Architect, develop and partner to deliver the space communications and navigation capabilities of the future.

Demonstrate world-class leadership and teamwork, with our customers, and domestic and global mission partners.

# NASA's Communications Networks



# SCaN's Deep Space Network (DSN)

## DSN's Role and Structure

DSN is the only US network dedicated to providing telecommunications services for missions in deep space

DSN also supports international spacecraft and scientific investigations (radar, radio astronomy and radio science)

DSN has three complexes, spread across the world to ensure 24/7 coverage

On behalf of SCaN, the NASA Jet Propulsion Laboratory (JPL) develops, operates, and manages DSN



Canberra





Goldstone

Madrid



# Deep Space Communications are Key to Agency Priorities

| DSN Mission Dashboard May 2024 | | | | |
|---|---|---|---|---|
| Completed Since 2019 | Current = 40 Deep Space | Cis-Lunar, Lagrange, .. | Future = 42 Deep Space | Cis-Lunar, Lagrange, ... |
| InSight *Mars* | Juno *Jupiter* | Lunar Recon. Orb. *Lunar* | 2024 or 2025 | 2024 or 2025 |
| Mars Cube One | Lucy *Asteroids* | SOHO *Helio L1 NASA-ESA* | Europa Clipper *Jupiter* | SunRISE *cluster 1* |
| DART *Asteroid* | Perseverance *Mars* | ACE *Helio L1* | ESCAPADE Blue *Mars* | SunRISE *cluster 2* |
| LICIA (ASI) *DART Cube* | Mars Odyssey Mars | Wind *Helio L1* | ESCAPADE Gold *Mars* | GOES U |
| GOES T | Mars Recon. Orbiter *Mars* | MMS 1 *Earth Ellip. Orb.* | HERA (ESA) *Asteroid* | SWFO *L1* |
| Geotail | MAVEN *Mars* | MMS 2 *Earth Ellip. Orb.* | Rocket Lab Venus | IMAP *L1* |
| Artemis 1 *Lunar* | Curiosity *Mars* | MMS 3 *Earth Ellip. Orb.* | AstroForge Odin *emergency* | Carruthers *L1* |
| NEA Scout *Cube* | New Horizons | MMS 4 *Earth Ellip. Orb.* | 2026 or later | Astrobotic Griffin *Lunar* |
| CuSP Cube | OSIRIS-REx (APEX) | Themis B *Helio L1* | Sample Return Lander | Lunar Trail Blazer |
| LunaHMAP *Cube* | Parker Solar Probe | Themis C *Helio L2* | Earth Return Orb. (ESA) | VIPER *Lunar* |
| Lunar Ice Cube | Voyager 1 *Helio* | DSCOVR *L1* | Rosalind Franklin (ESA) | Artemis-2 Orion |
| Team Miles *Cube* | Voyager 2 *Helio* | Chandra *HEO* | EnVision (ESA) *Venus* | Oracle-P Air Force *L1* |
| ArgoMoon (ASI) *Cube* | STEREO A *Helio* | JWST *L2* | DESTINY+ (JAXA) *Aster.* | Blue Orig Mark-1 SN-1 |
| Omotenashi (JAXA) *Cube* | Akatsuki (JAXA) *Venus* | TESS *Earth Ellip. Orb.* | MMX (JAXA) *Mars* | Blue Orig Mark-1 SN-2 |
| Equuleus (JAXA) *Cube* | Hayabusa-2E (JAXA) | CAPSTONE *Cube* | Emirates Asteroid (UAE) | 2026 or later |
| INTEGRAL (ESA) | BepiColombo (ESA) | TDRS 6-13 *emergency* | JUICE *Jupiter* (ESA) | Exploration Upper Stage |
| Hayabusa-2 (JAXA) | Trace Gas Orb. (ESA) | Biosentinel *Cube* | VERITAS *Venus* | Gateway *Lunar* |
| Beresheet (Israel) *Lunar* | Mars Express (ESA) | XMM (ESA) *Ellip. Orb.* | DAVINCI+ *Venus* | Human Landing Sys 1 |
| Mars Orbiter (ISRO) | Emirates Mars (UAE) | Gaia (ESA) *L2* | Dragonfly *Titan* | Human Landing Sys 2 |
| Chandrayaan 2 Land (ISRO) | Psyche *Asteroid* | KPLO (KARI) *Lunar* | | Human Landing Sys 3 |
| Chandrayaan 2 Orb (ISRO) | | | | Lunar Terrain Vehicles |
| Chandrayaan 3 Land (ISRO) | | | | Beresheet-2 (Israel) |
| Lunar Flash Light *Cube* | | | | Roman Telescope *L2* |
| SLIM & LEV (JAXA) Lunar | | | | NEO Surveyor *L1* |
| Astrobotic Peregrine | | | | Artemis-3 Orion |
| Lunar Node-1 CLPS | | | | HelioSwarm |
| Intuitive Machines 1 | | | | LUPEX (JAXA/ISRO) |



ARTEMIS

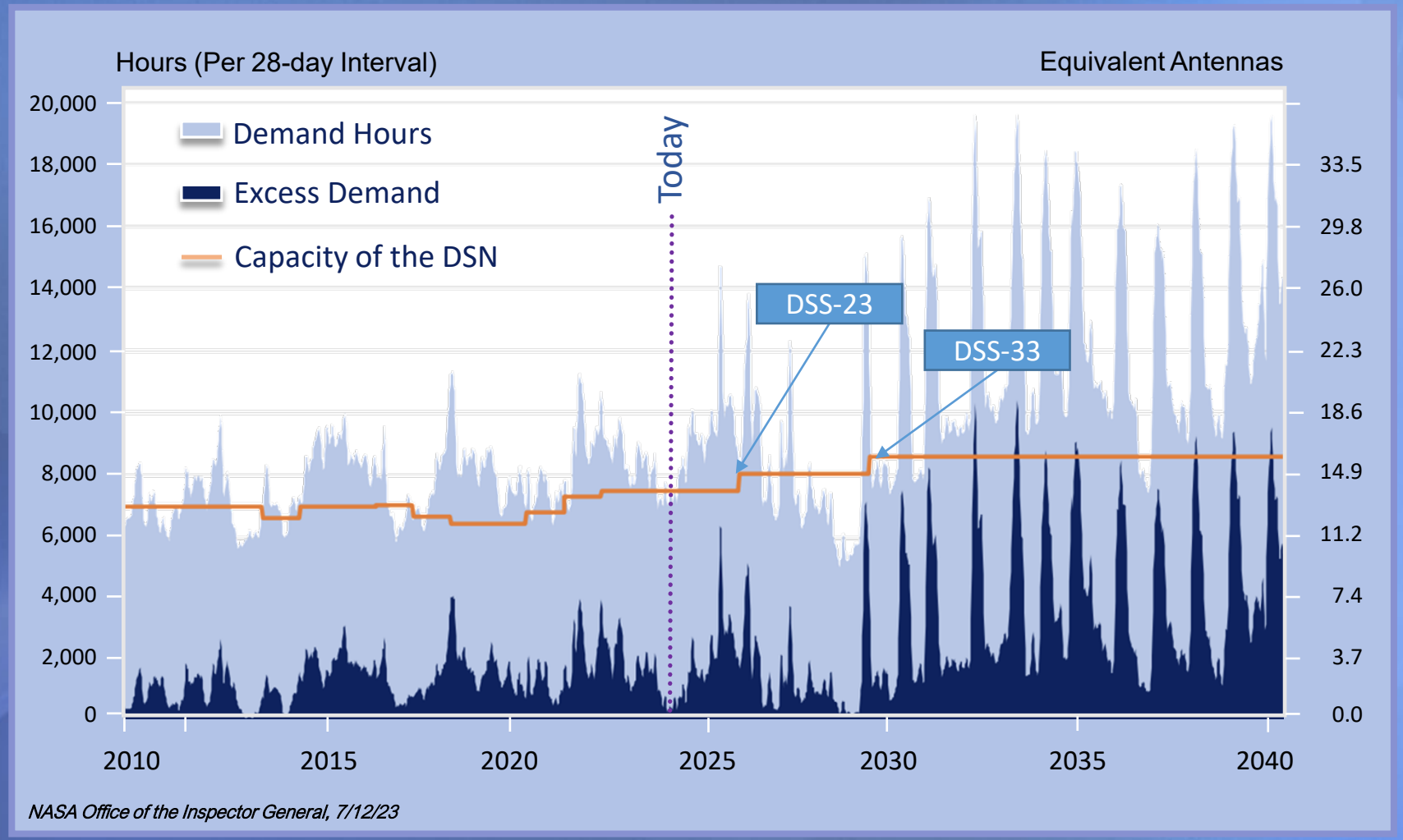
PSYCHE • JOURNEY TO A METAL WORLD • PSYCHE • JOURNEY TO A METAL WORLD •



# The DSN Challenge: Rapidly Growing User Needs

**Cadence and complexity of cis-lunar and SMD missions are creating a new level of network demand not seen in decades**

- New technologies to achieve Decadal Survey priorities are ever more data hungry
- JWST alone uses 10% of DSN capacity; sending back 25x the data of Hubble
- Infrastructure support has not kept up

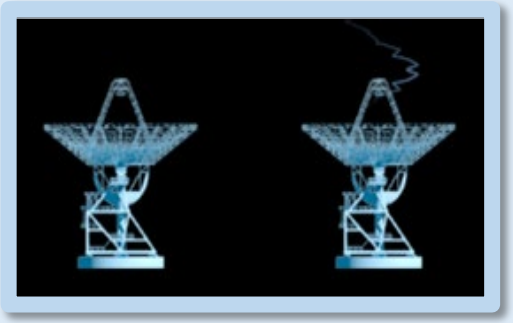


# Supporting DSN Users: Addressing the Needs



**Building Capacity with DAEP**
The DSN Aperture Enhancement Project (DAEP) will result in the following at each site:

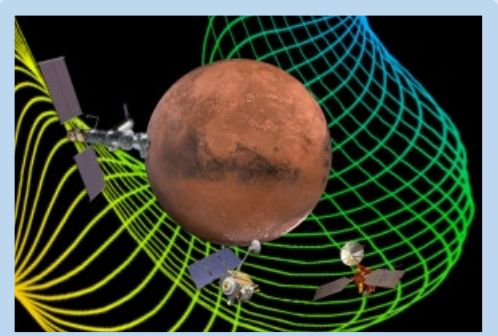
- Four BWG
- One 70 m backup
- One 80kw transmitter



**Enhancing Capabilities with DLEU**
The DSN Lunar Exploration Upgrades (DLEU) will result in upgrading two DSN antennas at each complex, enabling simultaneous operations, enhanced uplinks, and increase data rates



**Adding Support with LEGS**
Lunar Exploration Ground Sites (LEGS) will "lighten" the load on DSN by shifting selected lunar missions to a network of new 18-meter class antennas



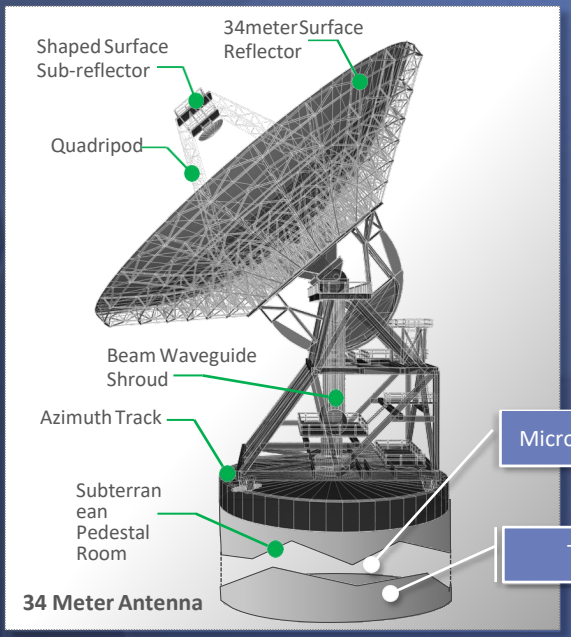
**Increasing Efficiency with MSPA and Ka-band**
Multiple Spacecraft per Aperture (MSPA) will unlock increasingly efficient asset utilization, while use of Ka-band will allow higher throughput links and reduce use-clock demand for new missions

**The use of MSPA and Ka-band on future missions will reduce DSN load and enhance performance for individual missions as well as the network**

# Supporting DSN Users: Reliability, Robustness and Resiliency

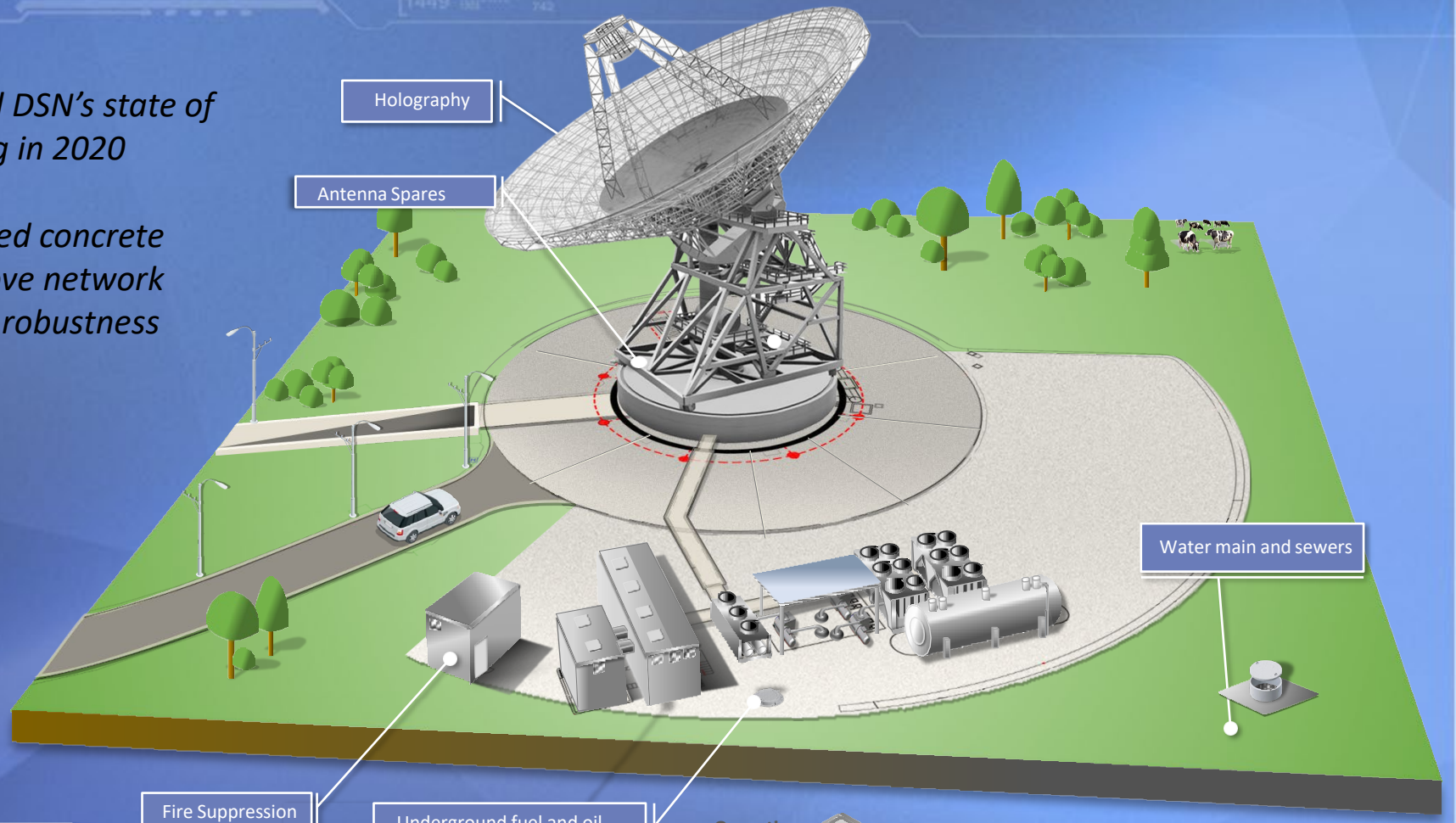
*R2G examined DSN's state of health starting in 2020*

*R2G determined concrete steps to improve network reliability and robustness*

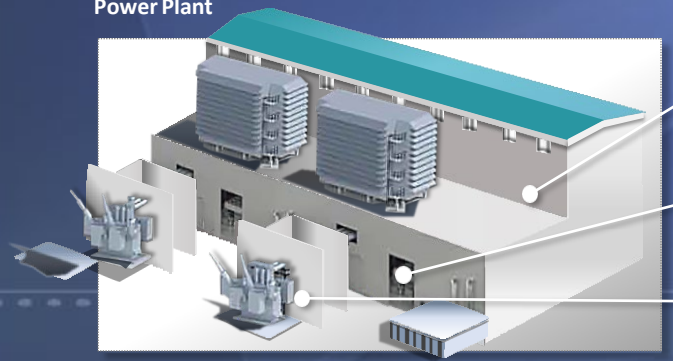



Microwave Controller

Transmitter




Power Plant



Generators

Uninterruptible Power Supply

Transformers and Switchgear

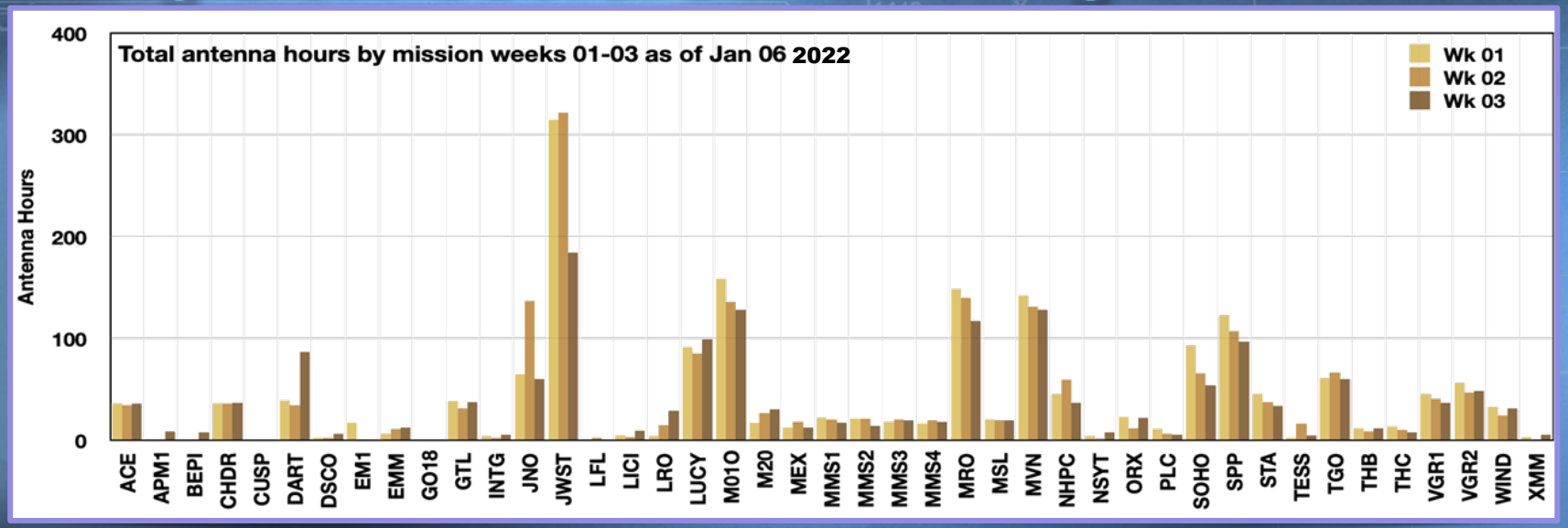
Operations Center Co...



General Cyber Security

OS Upgrades

# Supporting DSN Users: Scheduling and Prioritization

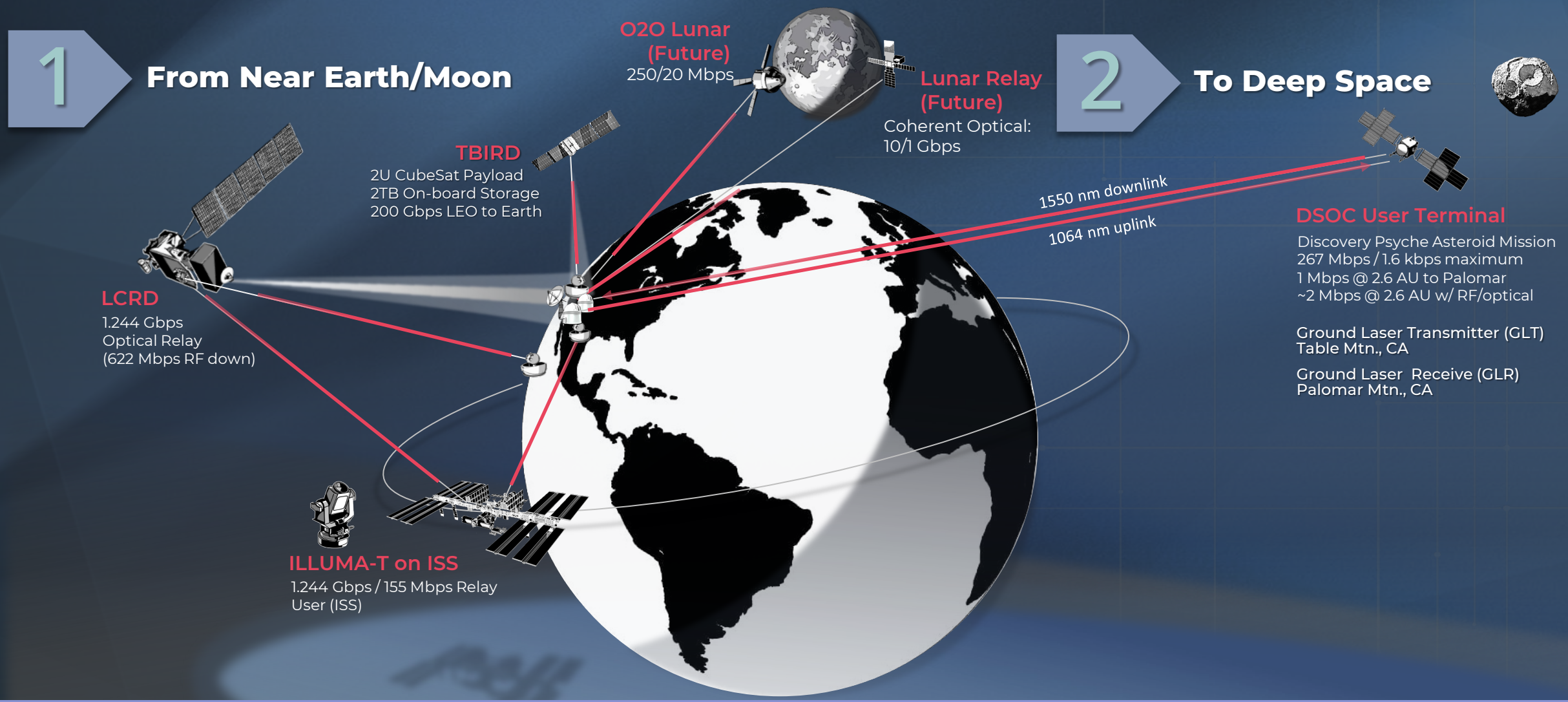



**Applying lessons learned from JWST and Artemis 1 scheduling and prioritization techniques will also be key to SCaN's future approaches in support of planetary missions.**

- A Multi-directorate working group has been formed to consider a new framework for DSN prioritization and scheduling
- Process improvements will include speeding up software, automation, collection of user preferences, and further definition of actions during spacecraft emergencies
- Evaluating the distributed nature of the scheduling teams to ensure efficiency and alignment
- **Ultimately, there will be changes in how we provide missions with network support**

**We invite you to collaborate with us to generate a robust scheduling process, as well clear articulation of mission needs/preferences, to enable more dynamic schedules support in the era of human spaceflight**

# Supporting DSN Users: Exploring Optical

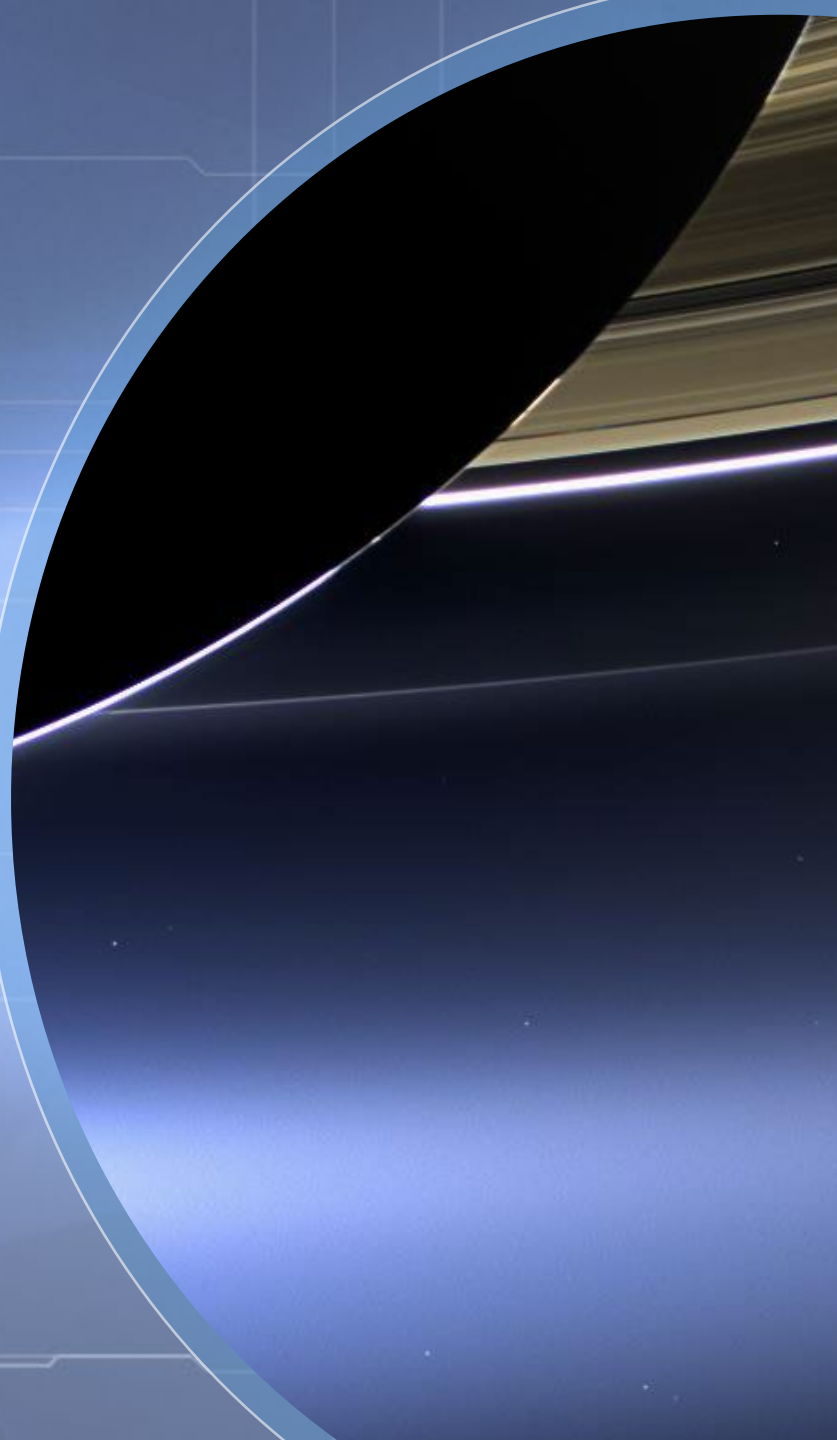



**NASA has successfully completed extensive optical demonstrations.**
**Operationalization needs to be driven by mission community.**

# Summary

## If we're successful, so are you

- Growing DSN demand is causing challenges to meeting science and exploration mission needs
- SCaN is working to enhance the capabilities, capacities, and efficiency of the DSN
- Major sustainment investments in the DSN are also helping improve reliability, robustness, and resiliency
- We need **your** help:
  - Scheduling and prioritization will be a collaborative effort with the science community
  - Future missions are encouraged to use Ka band and explore other mission efficiencies maximizing throughput (e.g., higher-order modulation and coding via ground system receiver and flight system transceiver upgrades)



# SCaN

## Space Communications and Navigation

Science & Exploration, enabled.



National Aeronautics and Space Administration

Follow us at: https://www.nasa.gov/scan

Facebook: NASASCaN

Twitter: @NASASCaN

# Acronyms

| | |
|---|---|
| ASF | Alaska Satellite Facility |
| BWG | Beam Waveguide |
| C&N | Communications & Navigation |
| CDR | Critical Design Review |
| CLPS | Commercial Lunar Payload Services |
| DAEP | DSN Aperture Enhancement Project |
| DLEU | DSN Lunar Exploration Upgrades |
| DSN | Deep Space Network |
| DSS | Deep Space Station |
| DTE | Direct-to-Earth |
| ESDMD | Exploration Systems Development Mission Directorate |
| GAVRT | Goldstone Apple Valley Radio Telescope |
| HEF | High Efficiency |
| JPL | Jet Propulsion Laboratory |
| JWST | James Webb Space Telescope |
| KSAT | Kongsberg Satellite Services |

| | |
|---|---|
| LEGS | Lunar Exploration Ground Sites |
| LEO | Low-Earth Orbit |
| NOAA | National Oceanic and Atmospheric Administration |
| NSN | Near Space Network |
| ORR | Operational Readiness Review |
| PDR | Preliminary Design Review |
| PNT | Position Navigation and Timing |
| R2G | Road to Green |
| RFP | Request for Proposal |
| SCaN | Space Communications and Navigation |
| SMD | Science Mission Directorate |
| SOMD | Space Operations Mission Directorate |
| SPC | Signal Processing Center |
| SSC | Swedish Space Corporation |
| TDRS | Tracking Data and Relay Satellite |