



National Aeronautics and Space Administration



Deep Space Network Updates

Presented to:
Planetary Sciences Advisory Committee

Presented by:

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Space Operations Mission Directorate, NASA

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SCaN

Space Communications
and Navigation
Exploration, **enabled.**

Outline

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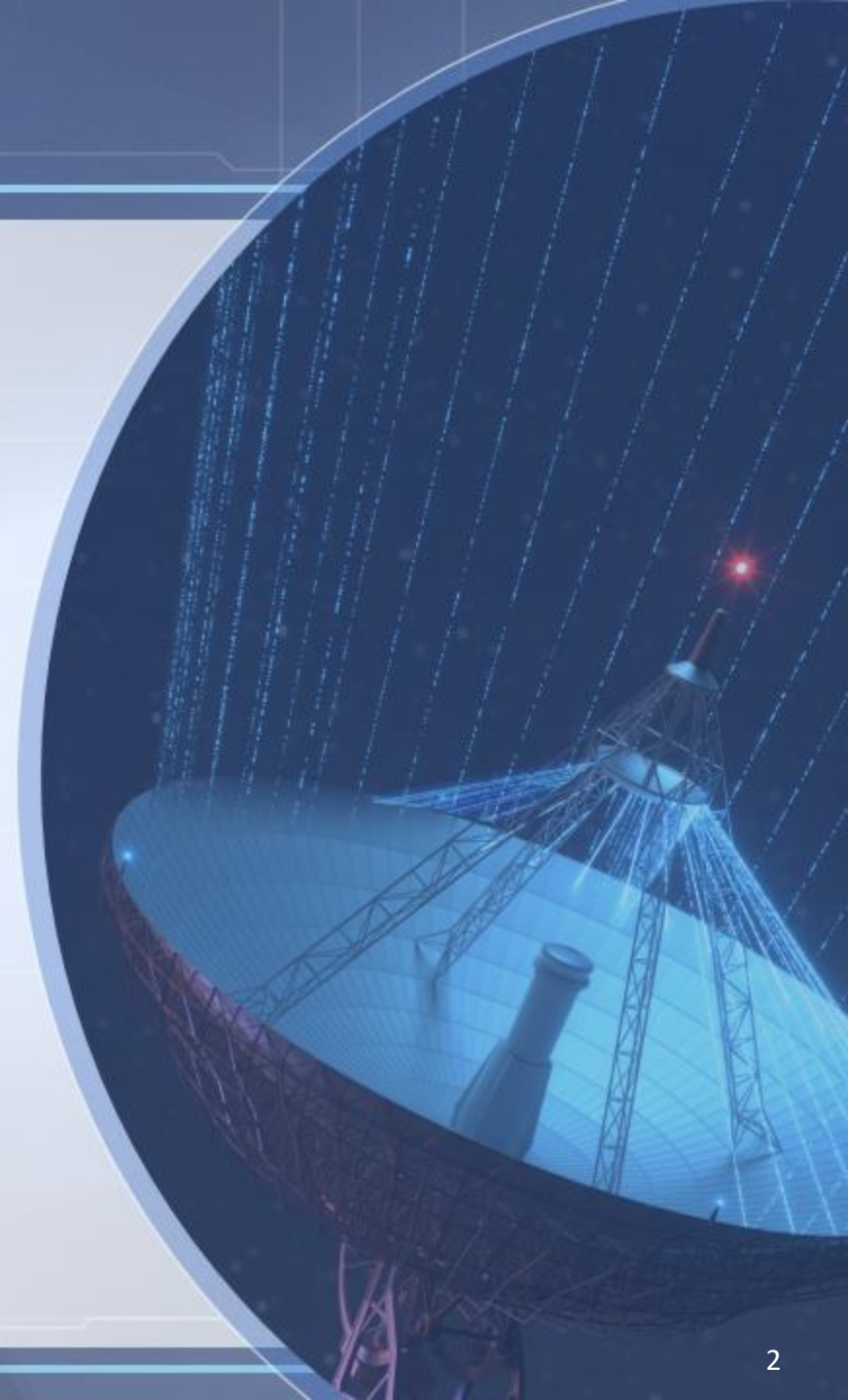
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About SCaN

2

DSN Status, Challenges, and Plans

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Enabling Human Space Exploration and Science

1

Develop, operate and manage all NASA space communications capabilities



2

Develop technologies to enable and enhance future mission experience



3

Manage NASA spectrum; represent NASA on national and international spectrum management forums



4

Develop space communication standards as well as positioning, navigation, and timing policies



5

Represent and negotiate on behalf of NASA on all matters related to space communications and navigation



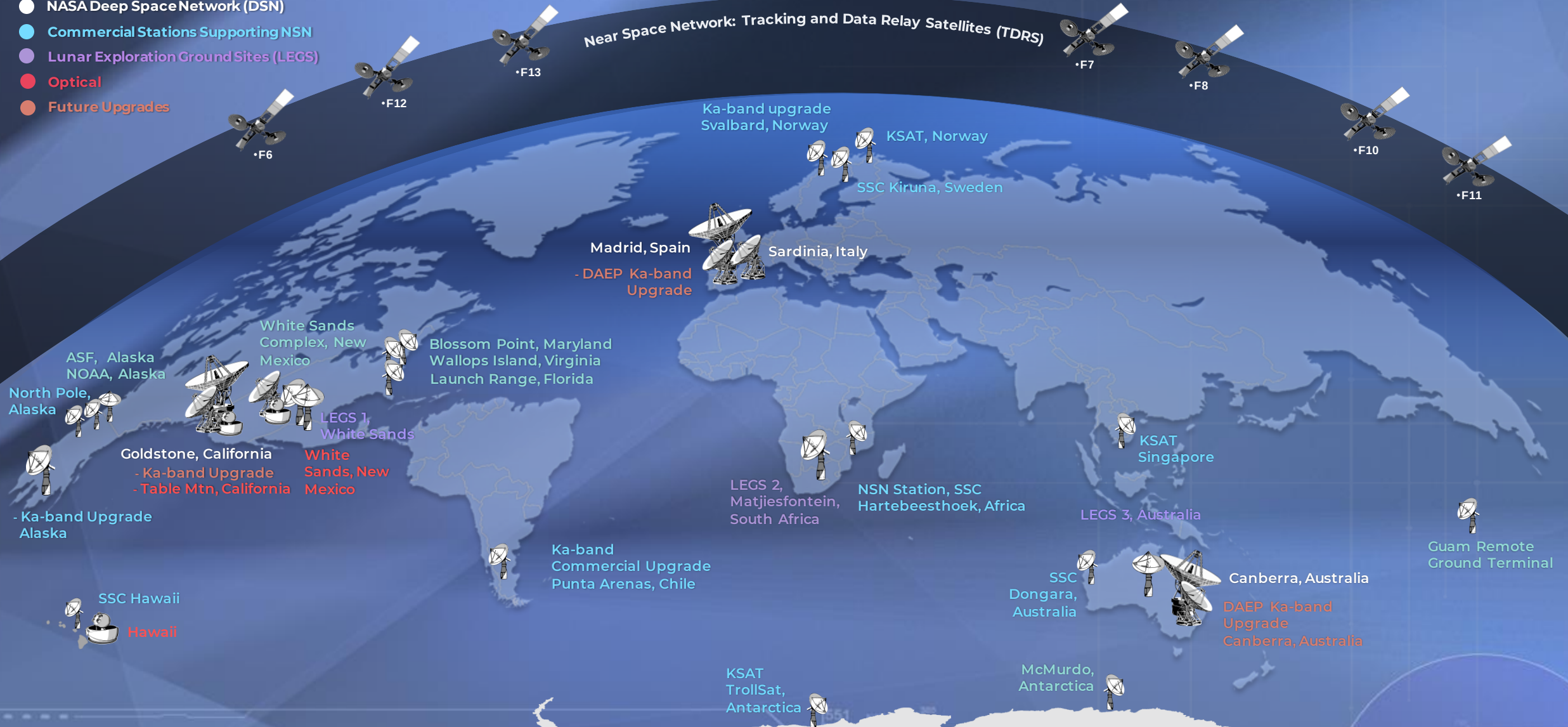
Space Communications and Navigation (SCaN) serves as the Program Office for all of NASA's space communications activities

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

100+ Missions currently supported by SCaN

NASA's Communications Networks

- NASA Near Space Network (NSN)
- NASA Deep Space Network (DSN)
- Commercial Stations Supporting NSN
- Lunar Exploration Ground Sites (LEGS)
- Optical
- Future Upgrades



Deep Space Network (DSN)

DSN's Role and Structure

DSN is the only US network dedicated to providing telecommunications services for missions beyond LEO

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

The NASA Jet Propulsion Laboratory (JPL) develops, operates, and manages DSN



Canberra



Goldstone



Madrid



Deep Space Communications are Key to Agency Priorities

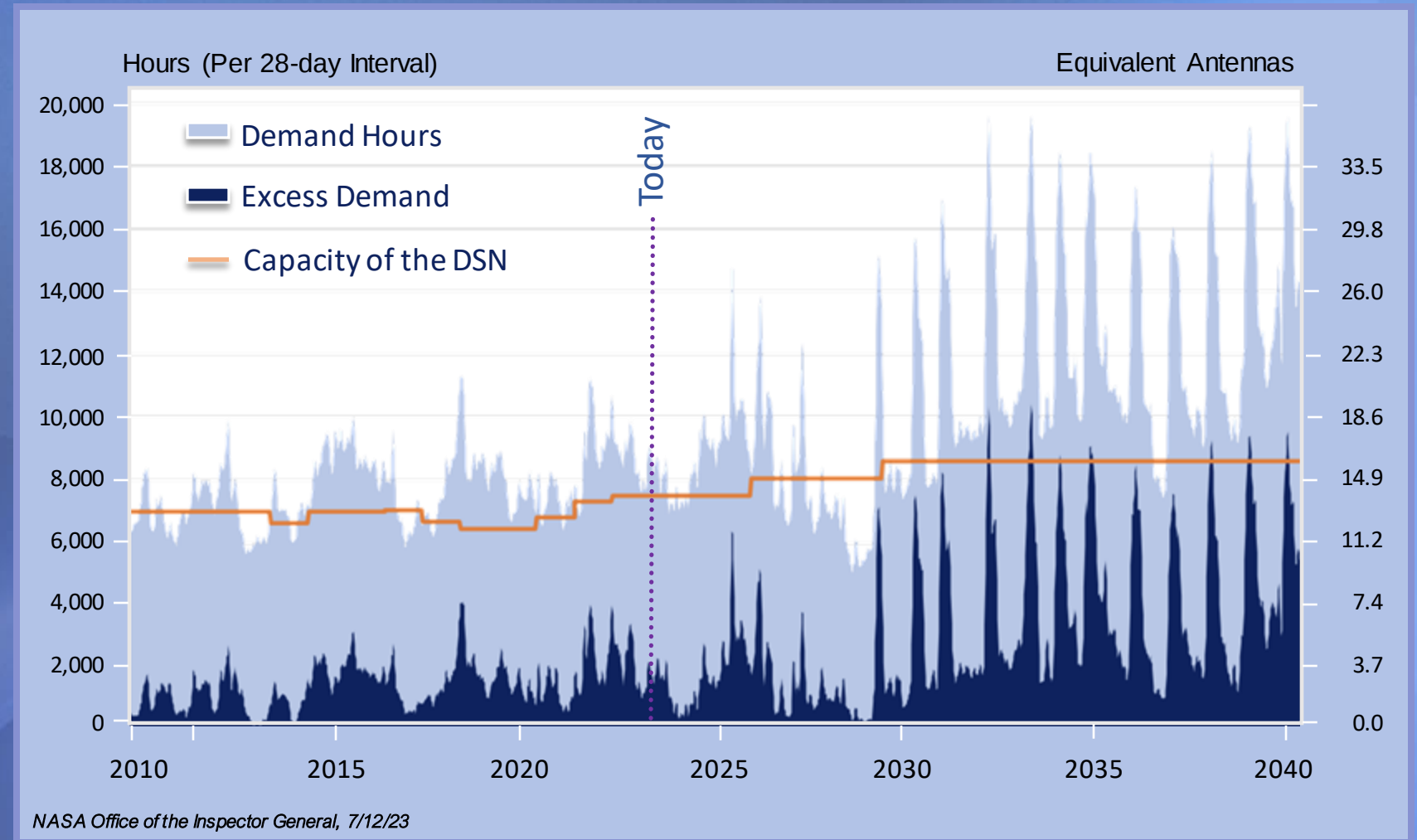
+ DSN Mission Dashboard October 2023 (Updated Monthly -- Contact S. Asmar)					
	Completed	Current 20+22 = 42		Future 15+26 = 41	
#	Since 2019	Deep Space	Cis-Lunar, Lagrange, ...	Deep Space	Cis-Lunar, Lagrange, ...
1	InSight Mars	Juno Jupiter	Lunar Recon. Orb. Lunar	VERITAS Venus	SunRISE
2	Mars Cube One InSight Cube	Lucy Asteroids	SOHO Helio L1 NASA-ESA	DAVINCI+ Venus	GOES U
3	DART Asteroid	Perseverance Mars	ACE Helio L1	Dragonfly Titan	SWFO L1
4	LICIA (ASI) DART Cube	Mars Odyssey Mars	Wind Helio L1	Europa Clipper Jupiter 2024	IMAP L1
5	GOES T	Mars Recon. Orb. Mars	MMS 1 Earth Ellip. Orb.	ESCAPADE Blue Mars	Carruthers L1
6	Geotail	MAVEN Mars	MMS 2 Earth Ellip. Orb.	ESCAPADE Gold Mars	Astrobotic Peregrine Lunar
7	Artemis 1 Lunar	Curiosity Mars	MMS 3 Earth Ellip. Orb.	Sample Return Land. Mars	Astrobotic Griffin Lunar
8	NEA Scout Cube	New Horizons	MMS 4 Earth Ellip. Orb.	Earth Return Orb. (ESA) Mar	Lunar Node-1 CLPS Lunar
9	CuSP Cube	OSIRIS-REx (APEX)	Themis B Helio L1	Rosalind Franklin (ESA) Mars	Lunar Trail Blazer Mar 2024
10	LunaHMAP Cube	Parker Solar Probe Helio	Themis C Helio L2	EnVision (ESA) Venus	VIPER Lunar
11	Lunar Ice Cube	Voyager 1 Helio	DSCOVR L1	HERA (ESA) Asteroid	Artemis-2 Orion
12	Team Miles Cube	Voyager 2 Helio	Chandra HEO	DESTINY+ (JAXA) Asteroid	Artemis-3 Orion
13	ArgoMoon (ASI) Cube	STEREO A Helio	JWST L2	MMX (JAXA) Mars (L 2024)	Exploration Upper Stage
14	Omotenashi (JAXA) Cube	Akatsuki (JAXA) Venus	TESS Earth Ellip. Orb.	Emiratres Asteroid (UAE)	Gateway Lunar
15	Equuleus (JAXA) Cube	Hayabusa-2 Ext (JAXA) Astero	CAPSTONE Cube	Rocket Lab Venus	Human Landing Sys 1
16	INTEGRAL (ESA)	BepiColombo (ESA)	TDRS 6-13 emergency		Human Landing Sys 2
17	Hayabusa-2 Prime (JAXA)	Trace Gas Orb. (ESA) Mars	Biosentinel Cube		Human Landing Sys 3
18	Beresheet (Israel) Lunar	Mars Express (ESA)	Lunar Flash Light Cube		Blue Origin Mark-1 SN-1
19	Mars Orb. Mission (ISRO)	Emirates Mars (UAE)	XMM (ESA) Earth Ellip. Orb.		Blue Origin Mark-1 SN-2
20	Chandrayaan 2 Land. (ISRO)	Psyche Asteroid	Gaia (ESA) L2		Lunar Terrain Vehicles
21	Chandrayaan 2 Orb. (ISRO)		KPLO (KARI) Lunar		Beresheet-2 (Israel) Lunar
22	Chandrayaan 3 Land. (ISRO)		SLIM & LEV (JAXA) Lunar		Roman Telescope L2 2027
23					NEO Surveyor L1 2027
24					Oracle-P Air Force L1 2025
25					Astrobotic third lander
26					LUPEX (JAXA/USRO)



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

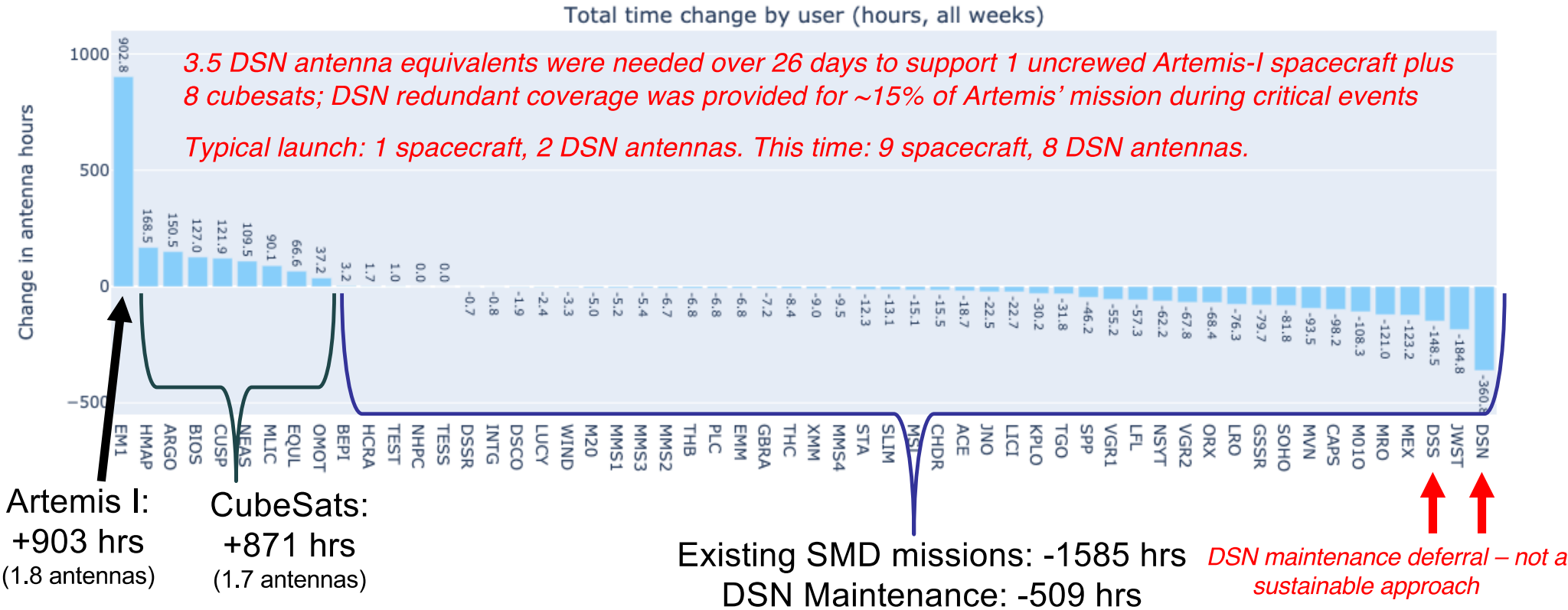
- ❑ New technologies to achieve Decadal Survey priorities are ever more data hungry
- ❑ JWST alone uses 10% of DSN capacity; sending back 25x the data of Hubble
- ❑ Infrastructure support has not kept up



DSN Challenge: Demand Spikes During Artemis

Artemis-I + Deep Space CubeSat Support: DSN Impacts

Impact (antenna hours by mission) of EM1 Nov16 launch schedule on 2022 weeks ['2022-46', '2022-47', '2022-48', '2022-49']



How SCaN Plans to Support DSN Users



New Deep Space Network (DSN) Capacity & Upgrades

1

- Building six 34m antennas across all three DSN complexes
- Upgrading two DSN antennas at each complex to enable simultaneous operations, enhance uplinks, and increase data rates



Lunar Exploration Ground Segment (LEGS)

2

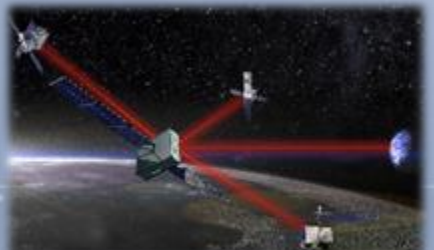
- Network of new 18-meter class antennas to support lunar missions
- Starting with three government owned, commercial operated sites around the Earth, offering continuous coverage
- Commercial LEGS will add additional capacity as demand grows



Commercial and International Partners

3

- Further drawing upon commercial service procurement to develop lunar relays to reduce user PNT burden and remove DTE line-of-sight constraints (enabling South Pole and Far-Side operations)
- Seeking additional commercial and international contributions for both Earth based and Lunar C&N assets

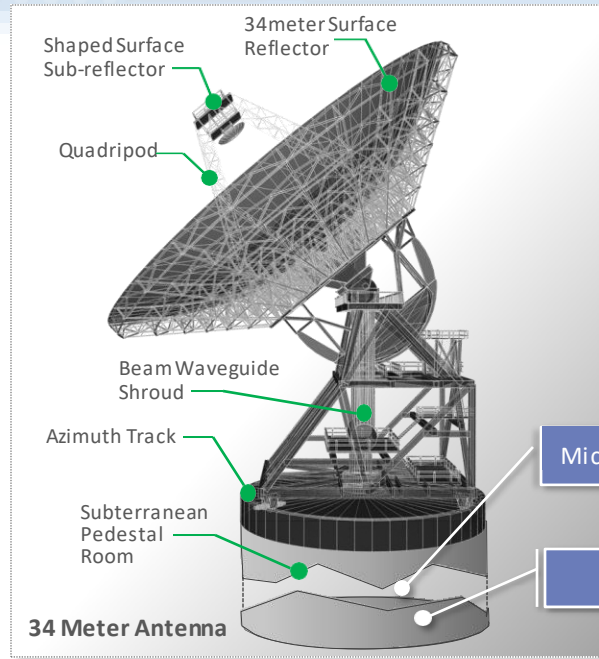


Optical and other New Technologies

4

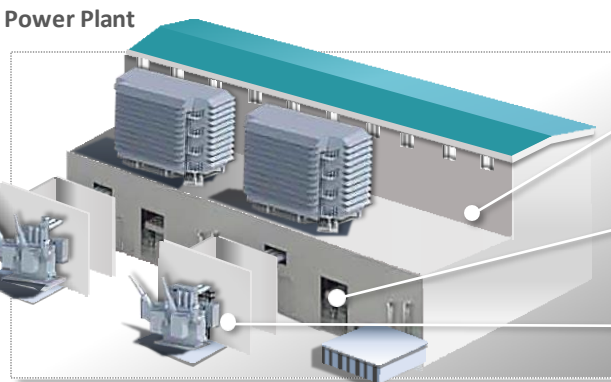
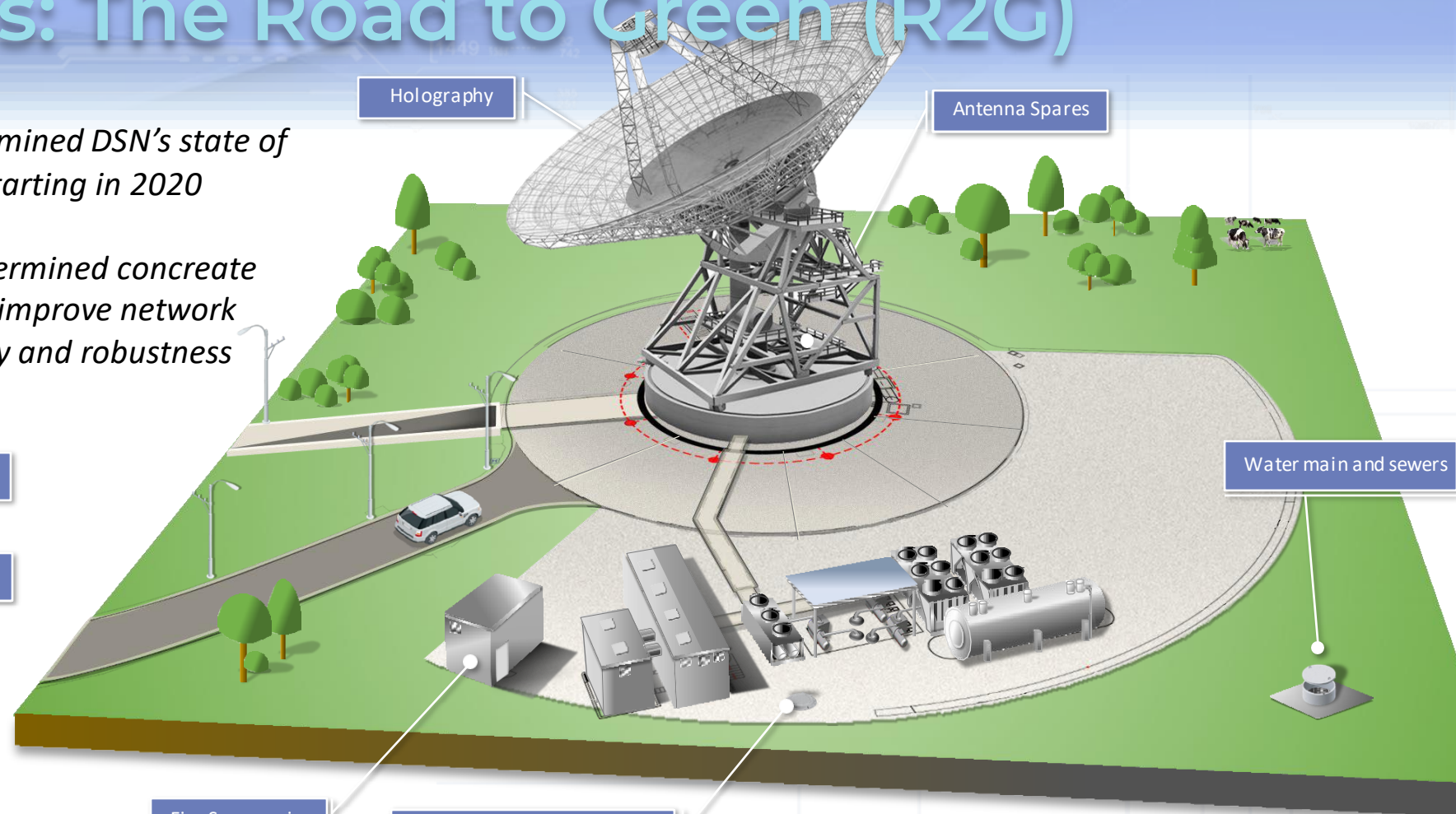
- Optical will reduce burden on DSN alongside other technologies
- Priority 1: Direct-to-Earth assets that meet or exceed LEGS performance
- Priority 2: Lunar relay comm and PNT services
- Priority 3: Lunar surface comm and PNT capabilities

DSN Upgrades: The Road to Green (R2G)



R2G examined DSN's state of health starting in 2020

R2G determined concrete steps to improve network reliability and robustness



- Generators
- Uninterruptible Power Supply
- Transformers and Switchgear

Fire Suppression

Underground fuel and oil tank (move to above ground)

Funds prioritized to address:

- Health and safety
- IT security
- Facility infrastructure
- Vulnerable antenna components

Operations Center Concept

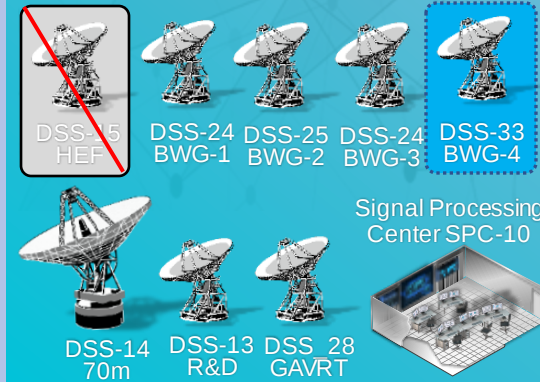


General Cyber Security

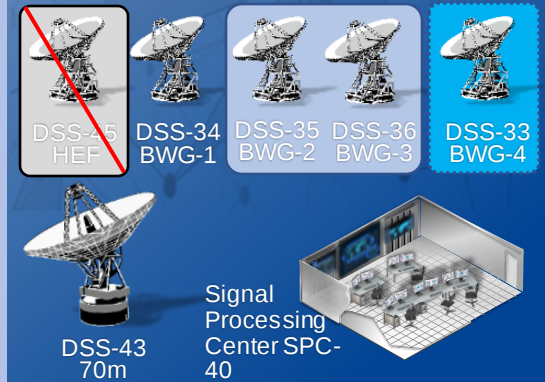
DSN Upgrades: DSN Aperture Enhancement Project (DAEP)

- DAEP is building six 34m Beam Wave Guide (BWG) antennas across all three DSN complexes to provide additional capacity
- FY2024 DAEP STATUS SNAPSHOT:
 - Four 34m BWG deliveries completed (Two in Canberra and two in Madrid)
 - One 34m BWG in process in Goldstone; Delivery to service April 2026
 - One 34m BWG in the future at Canberra; Delivery to service expected October 2029
- Further expansion after FY30 will be based on a *DSN Futures Study*, Agency requirements, and available support
 - May include higher power transmitters, HEF antenna refurbishments, and site diversity measures
 - Post-FY30 development work is funding dependent

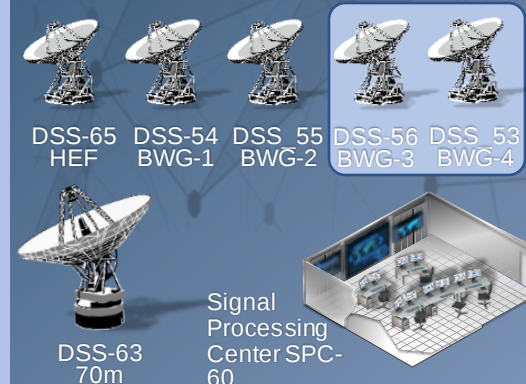
GDSCC – Goldstone, California



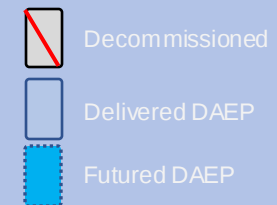
CDSCC – Canberra, Australia



MDSCC – Madrid, Spain



Legend



DSN Upgrades: DSN Lunar Exploration Upgrades (DLEU)

Upgrading six DSN antennas (two at each of the three complexes)

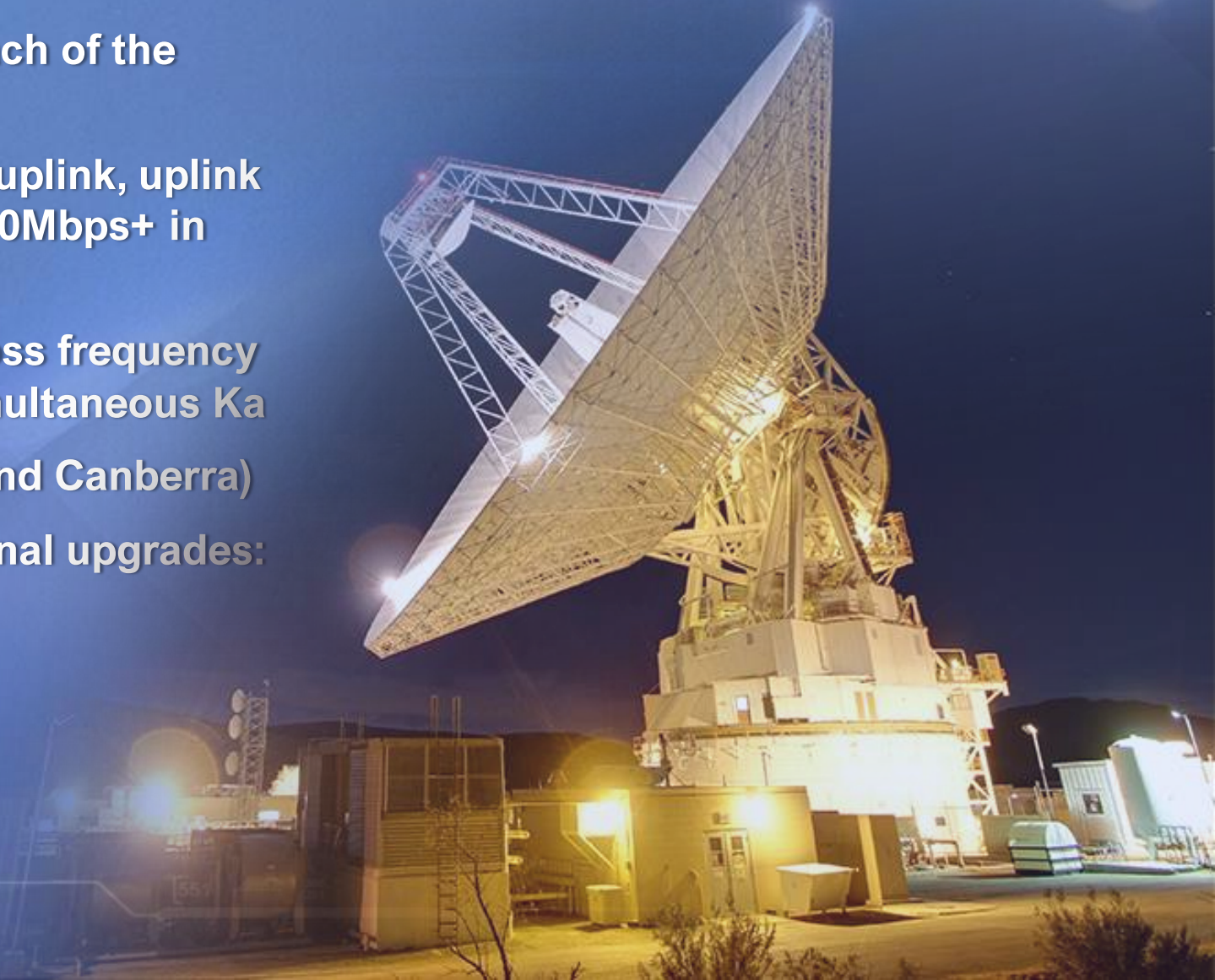
Adds capability for near-earth K-band uplink, uplink encoding, and increased data rates (100Mbps+ in Ka)

Provides simultaneous operations across frequency bands – S+Ka-band, X+Ka-band, or simultaneous Ka

Two upgrades completed (Goldstone and Canberra)

Estimated completion dates for additional upgrades:

- ❑ Goldstone: December 2023
- ❑ Canberra: July 2024
- ❑ Spain (DSS-56): April 2025
- ❑ Spain (DSS-54): March 2028



Lunar Exploration Ground Segment (LEGS)

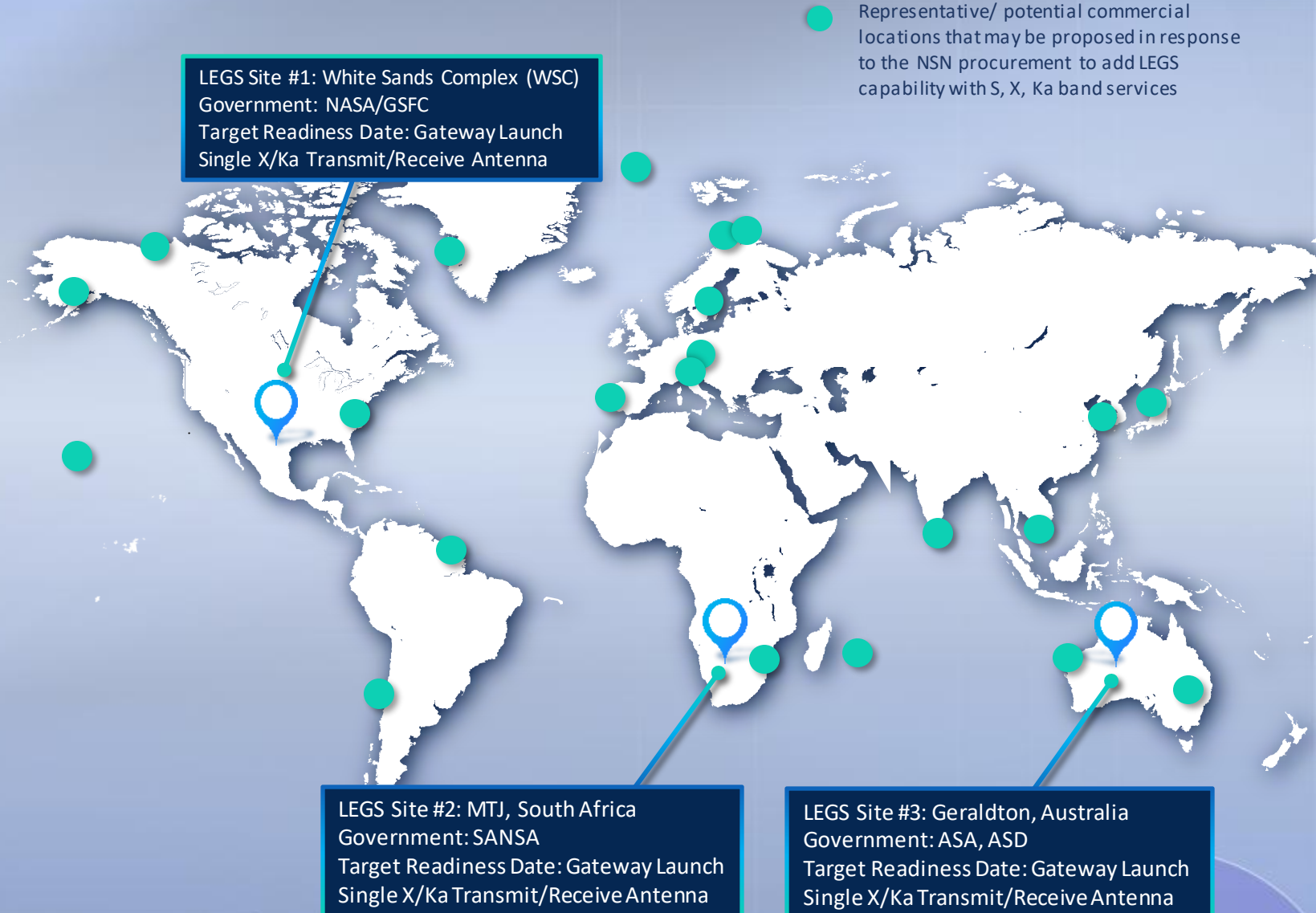
LEGS is a new network of DTE antennas that reduce contention for DSN by absorbing new Artemis demands

LEGS 1 to 3:

- ❑ Cover three geographically diverse sites, offering continuous lunar coverage
- ❑ 18-meter class performance in X and Ka
- ❑ Government-owned / contractor operated

LEGS 4+:

- ❑ Locations TBD
- ❑ 18-meter class performance in X, Ka and S
- ❑ Being pursued under full commercial services procurement



DSN Futures Study

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DSN Futures Study objectives:

- ❑ Look at near-term issues (network scheduling efficiency, network and element brittleness, and fragility), and projected capability needs through 2050
- ❑ Understand what probable technology will be available, when it could be infused into the DSN, and the required costs

Incorporating SMD (Decadals) and ESDMD (Lunar and Mars architectures) as long-term planning inputs

Study Team members include NASA stakeholders from ESDMD, SMD, and SOMD that are asked to review study progress on a quarterly basis

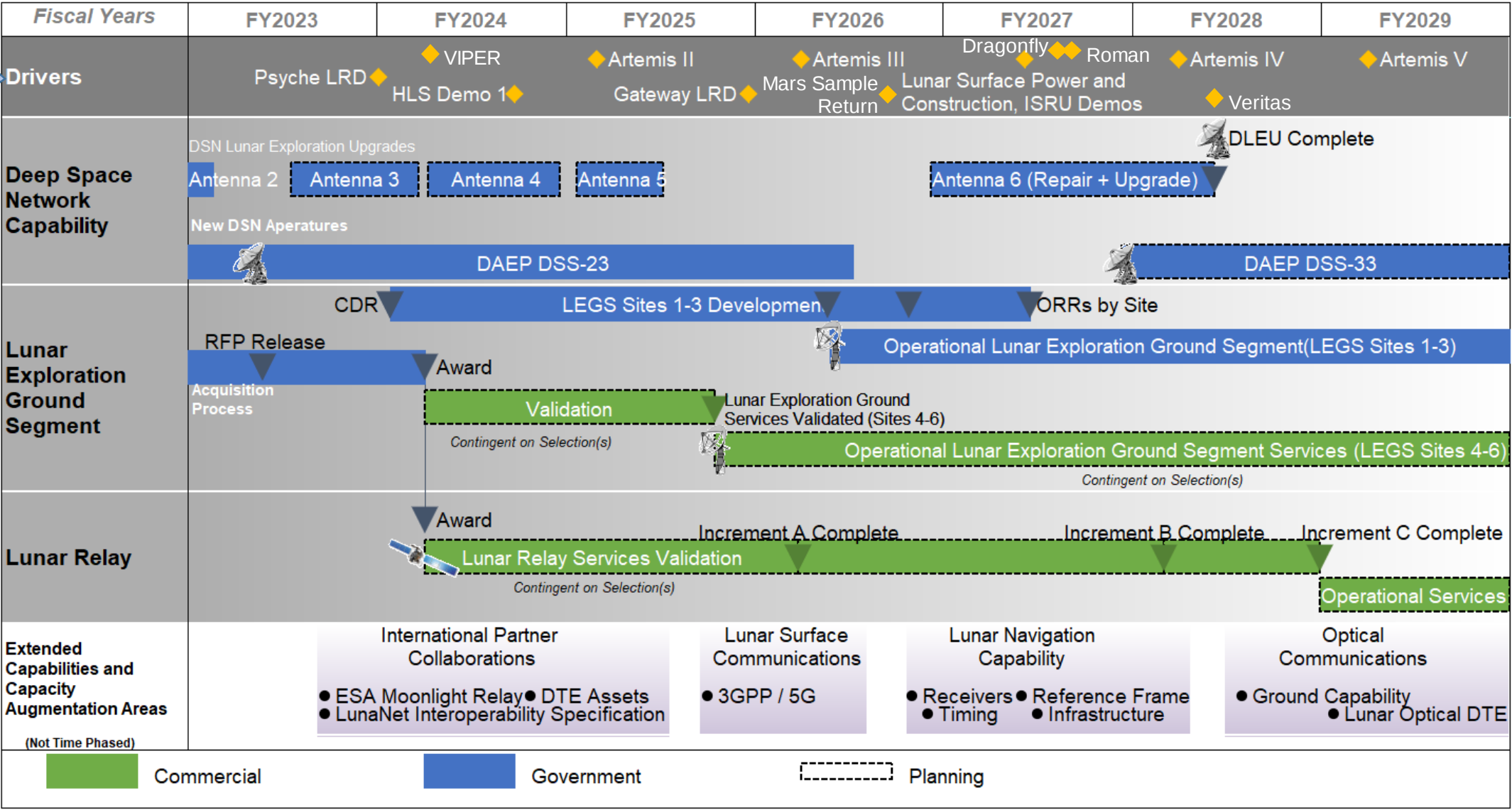
Plan is to bring the final report to this board for review



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Orchestration of Supply

Examples only... critical event list is significant



O&M and sustainment must be orchestrated around mission demands and capability variance is 1:1 with funding variance

Synopsis: The Future of SCaN

New Challenges and New Opportunities

- ❑ Growing DSN demand is putting flagship SMD and SOMD missions at risk
- ❑ Investment in reliability, robustness, and capacity will be necessary to secure DSN's future
- ❑ LEGS government and commercial investments can also offload some Artemis and CLPS requirements from DSN, alongside international partnerships



SCaN

Space Communications and Navigation

Exploration, enabled.

National Aeronautics and
Space Administration



Mr. Jeffrey Volosin

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Space Communications and Navigation (SCaN) Office

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