National Aeronautics and Space Administration

NASA's Evolving Space Communication and Navigation

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Enabling Human Space Exploration and Science Missions

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

Develop, operate and manage all NASA space communications capabilities

Develop technologies to enable and enhance future mission experience

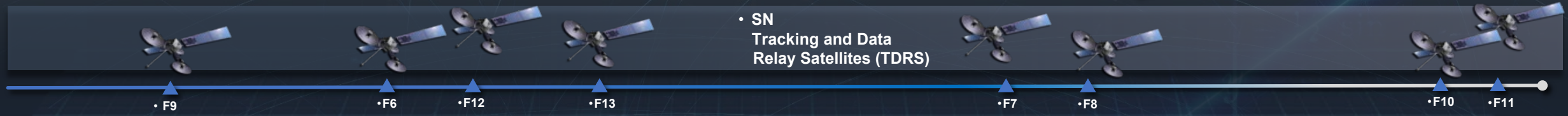
Manage NASA spectrum; represent NASA on national and international spectrum management forums

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

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

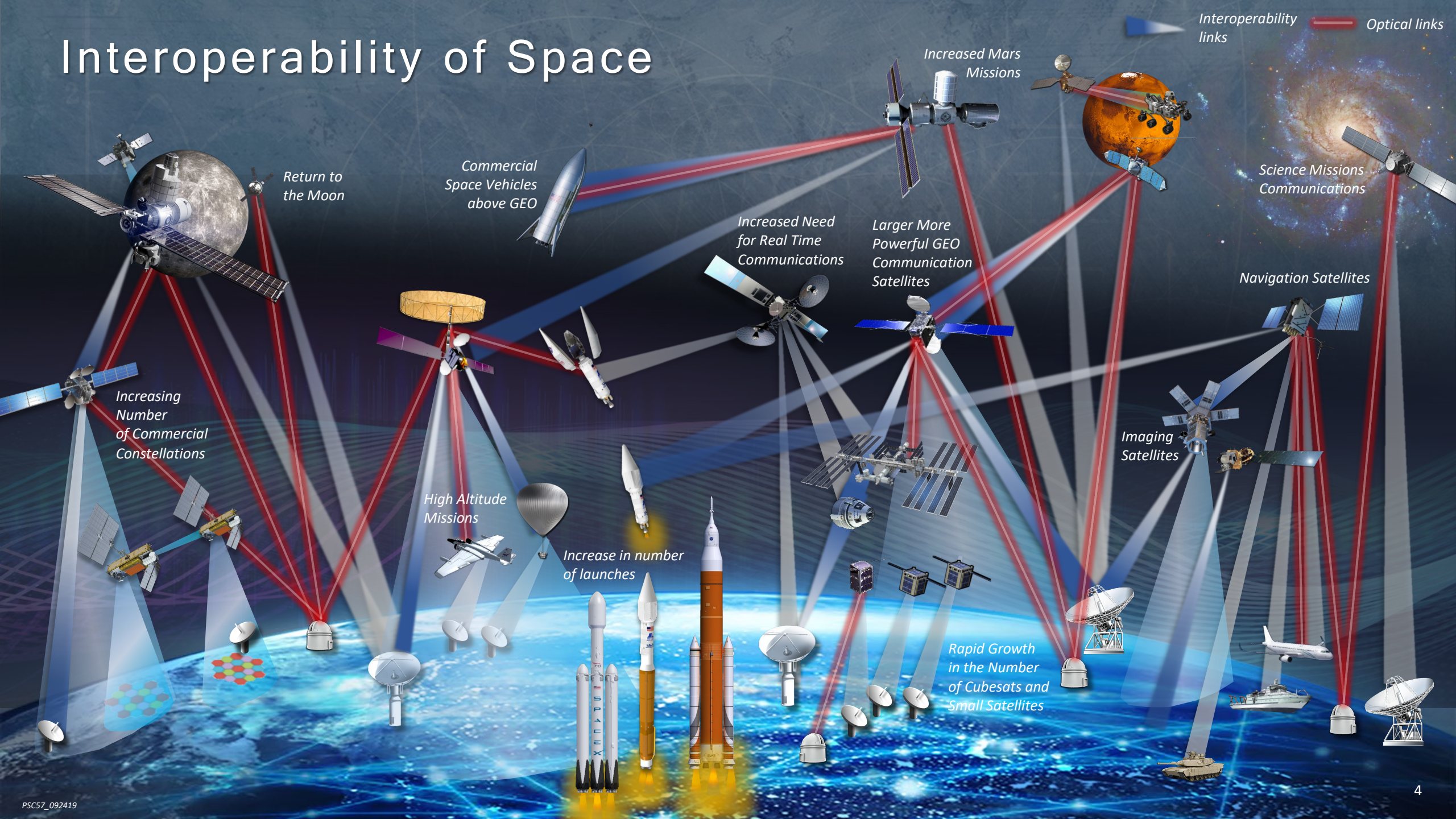
Spanning the Globe

NASA SN & NEN
Future Upgrades
NASA DSN
Commercial Supporting NEN



- NEN Station, SSC North Pole, Alaska
- NEN Stations
  - ASF, Alaska
  - NOAA, Alaska
- NEN Ka-band Upgrade Alaska Satellite Facility
- GDSCC Goldstone, California
- DAEP Ka-band Upgrade GDSCC Goldstone, California
- SN White Sands Complex, New Mexico
- NEN Station White Sands, New Mexico
- NEN Station Wallops Island, Virginia
- NEN PDL/KUS Launch Range, Florida
- NEN Station, SSC Hawaii
- NEN Ka-band Commercial Upgrade Svalbard, Norway, KSAT
- NEN Station, KSAT Norway
- NEN Station, SSC Kiruna, Sweden
- MDSCC Madrid, Spain
- New Partnership Sardinia, Italy
- DAEP Ka-band Upgrade MDSCC Madrid, Spain
- NEN Station, KSAT Singapore
- SN Guam Remote Ground Terminal
- NEN Station, SSC Hartebeesthoek, Africa
- NEN Station, SSC Dongara Australia
- CDSCC Canberra, Australia
- DAEP Ka-band Upgrade CDSCC Canberra, Australia
- NEN Ka-band Commercial Upgrade Punta Arenas, Chile
- NEN Station, KSAT TrollSat, Antarctica
- NEN Station McMurdo, Antarctica

Interoperability of Space



Our Pathway to Interoperability

Standards

- Supporting standards bodies such as CCSDS
- Adopting commercial standards whenever possible
- Creating new standards to fill the gaps: optical, network management, bundle protocol
- Infusing standards into operations

Spectrum Access

- Working with the space community to identify the spectrum needs of a growing space market
- Working to remove regulatory barriers that impede progress

Technology

- Investing in low TRL, high impact technologies
- Wideband receivers that allow operation across all Ka-band
- Cognitive Networks to provide dynamic, flexible user access, increased security and resiliency

…create an interoperable space communications and navigation environment that can leverage civil, commercial, domestic, and international capabilities to enable the seamless transfer of information.

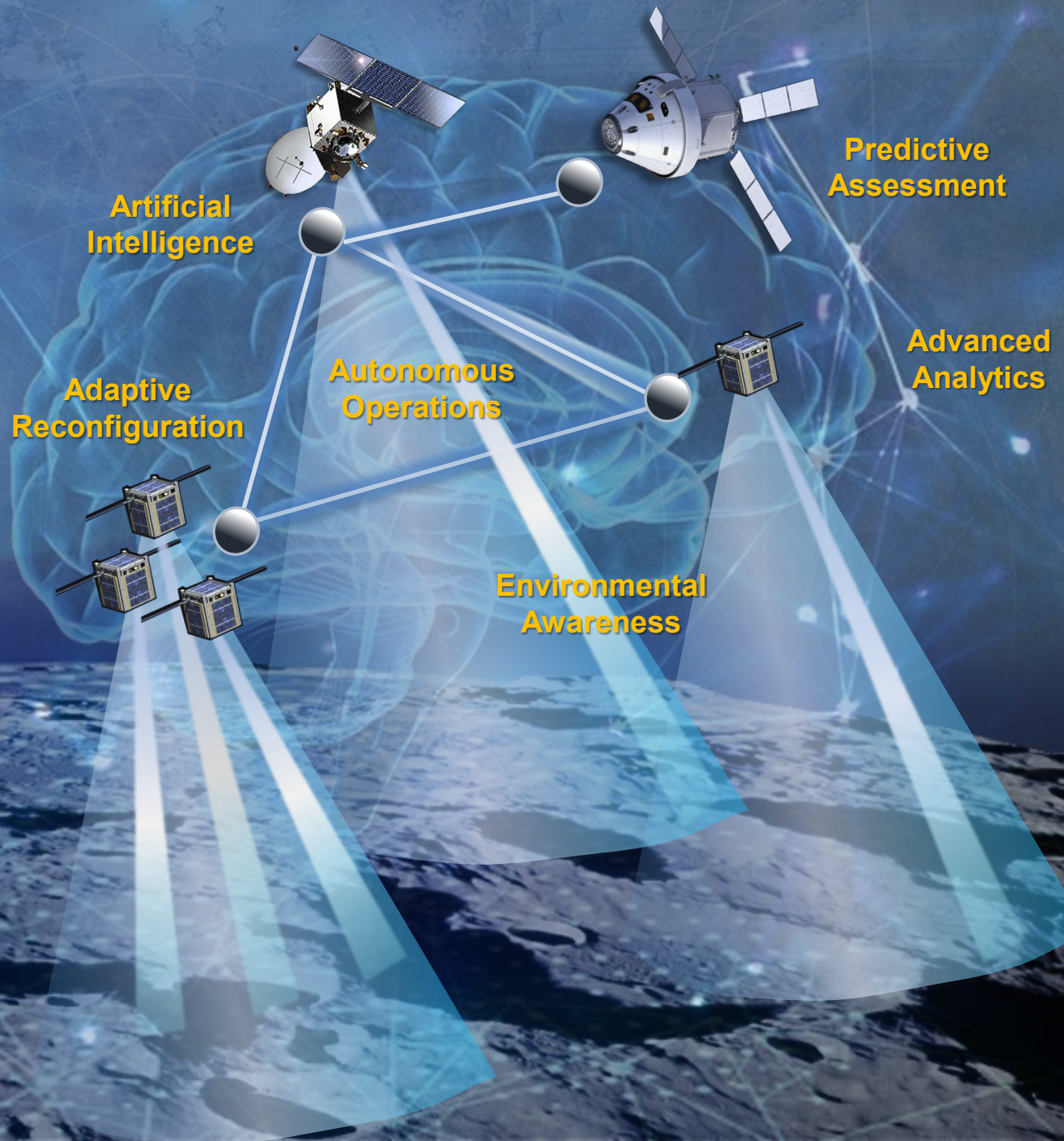
A Cognitive Network
For the Moon and Beyond

Benefits

- Reduced network operating costs
- Provide dynamic, flexible user access
- Increase performance and reliability
- Increase security and resiliency

Challenges

- Maturation and infusion of next generation technologies
- User burden; i.e., terminal Size, weight and power (SWAP) constraints
- Spectrum regulatory structure
- Unknowns, unknowns, unknowns



Wideband COMSATCOM Ka-band User Terminal

Overcome regulatory challenges

Technology Development

> Wide bandwidth Ka-band systems that span 17.2 GHz to 40 GHz

> Software-Defined Radios (SDR) capable of storing and running both NASA and commercial waveforms

Frequency flexibility hardware that allows users to roam free in space

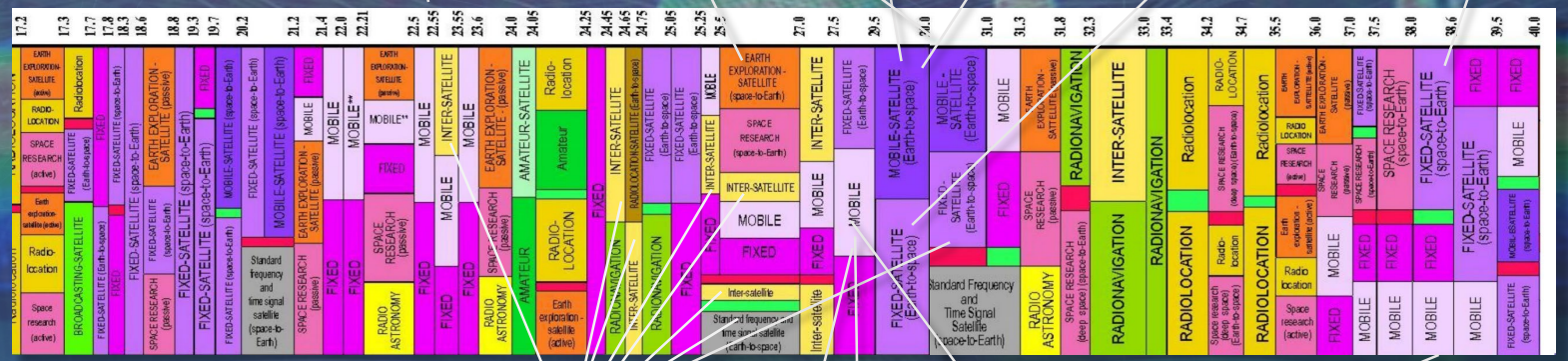
Mission Flexibility

> Missions would be able to connect to government and commercial networks that best fit their needs

* Representative set of commercial systems

Commercial

Government



Audacy

Viasat NGSO

Near Earth SGL

SpaceX

Inmarsat

Intelsat

Deep Space SGL

Intersatellite Links

Telesat

O3b

Viasat 3

OneWeb

SpaceX

Viasat NGSO

Tunable from 17.2 GHz to 40.0 GHz

Develop Flexible Modem with Commercial Partnership	ISS demonstrations	Operational Deployment	Next Generation Development

Optical Communications Technology Demonstrations

From Near Earth

LCRD Terminal
1.244 Gbps
Optical Relay

Optical User Terminal
ILLUMA-T on ISS and O2O on Orion: 1.244 Gbps Relay User and 80 Mbps from the Moon

To Deep Space

DSOC Gen-1 User Terminal
DSOC on Discovery Psyche Asteroid Mission
125 Mbps from 40M km

RF/Optical Hybrid Antenna
Integrate 8-m optical apertures into a DSN 34m Beam Waveguide antenna

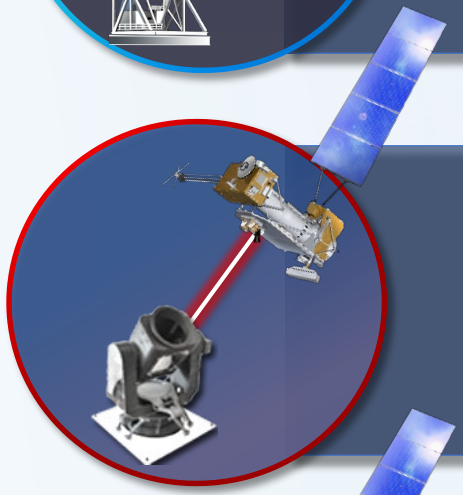
Laser Comm Relay Terminal (LCRD) (2020) → Optical User Terminal ILLUMA-T (2022) → O2O (2022) → DSOC Optical User Terminal (2022) → Advanced DSOC Optical User Terminal (2024)

Push the Envelope on Communication Capabilities

Conventional Radio Communication
Systems use large geometries because wavelengths are large

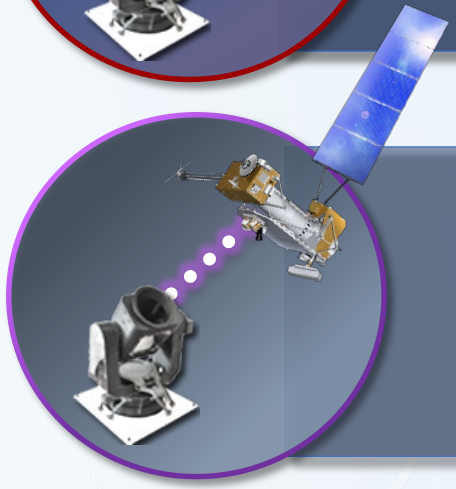
- Communication antennas are typically 10's of meters to a few centimeters
- Data capacities are very limited due to the large geometries and limited spectrum

Optical Communication
Systems use very small geometries and optical (laser) wavelengths



- Optical systems use lasers and telescopes to communicate
- Data capacities are virtually unlimited

Quantum Communication
Systems use single photons of light to transmit quantum information

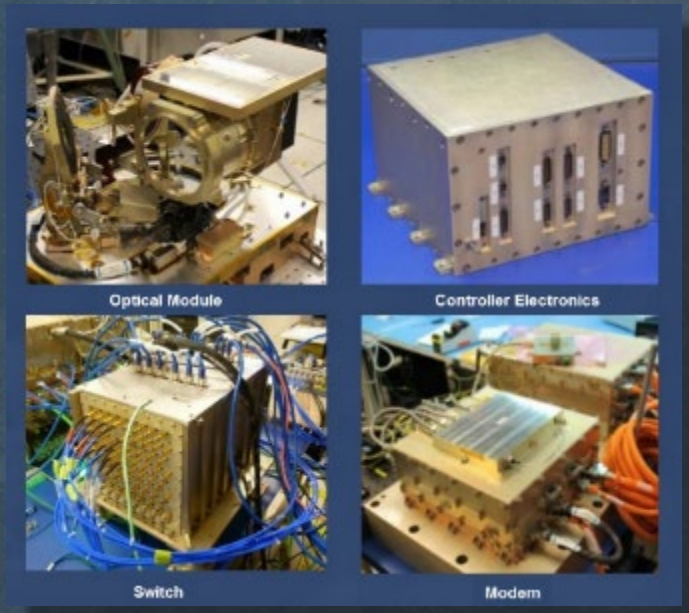


- Quantum systems use single photons to communicate **OVER OPTICAL NETWORKS**
- **Quantum Networks will have capabilities never before available, such as unlimited security**

Roadmap to Quantum Networks

Demonstrations on the ISS

SPACE PAYLOAD



> Ultra-low power operating point required for modem
> Software modification

GROUND TERMINAL

> Integration of fiber-coupled high-rate photon-counting receiver
> Development of high dynamic range wavelength separation optics

Multi-Node Testing Using ISS (2024)

Secure Quantum Networks across U.S. (2028)

US Global Quantum Network (2032)

Quantum Leap Forward