National Aeronautics and Space Administration

Space Communications & Navigation: An Approach for Developing a Commercial Market based on Interoperability

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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

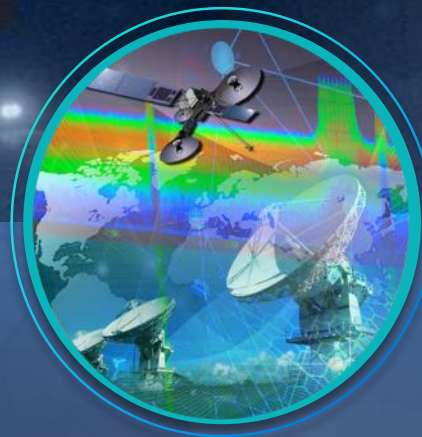**24/7** Global Near Earth and Deep Space Communications and Navigation Services

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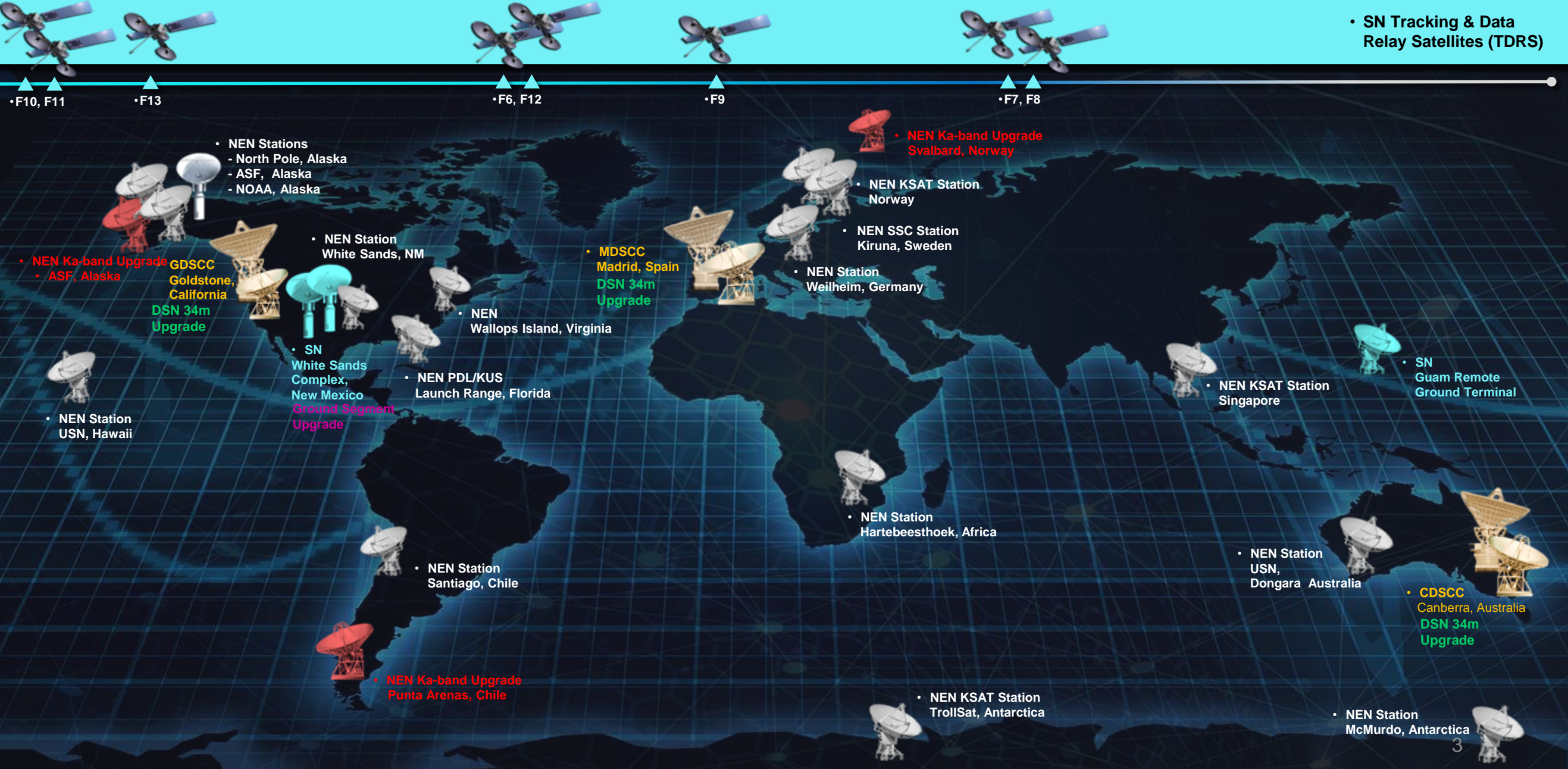
Develop space communication standards as well as positioning, navigation, and timing policies

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

SCaN: Spanning the Globe – Serving the Solar System

- SN Tracking & Data Relay Satellites (TDRS)

•F10, F11   •F13   •F6, F12   •F9   •F7, F8

- NEN Ka-band Upgrade Svalbard, Norway

- NEN Stations
  - North Pole, Alaska
  - ASF, Alaska
  - NOAA, Alaska

- NEN KSAT Station Norway

- NEN Station White Sands, NM

- NEN SSC Station Kiruna, Sweden

- NEN Ka-band Upgrade
- ASF, Alaska

GDSCC Goldstone, California
DSN 34m Upgrade

- MDSCC Madrid, Spain
DSN 34m Upgrade

- NEN Station Weilheim, Germany

- NEN Wallops Island, Virginia

- SN White Sands Complex, New Mexico
Ground Segment Upgrade

- NEN PDL/KUS Launch Range, Florida

- SN Guam Remote Ground Terminal

- NEN KSAT Station Singapore

- NEN Station USN, Hawaii

- NEN Station Hartebeesthoek, Africa

- NEN Station USN, Dongara Australia

- NEN Station Santiago, Chile

- CDSCC Canberra, Australia
DSN 34m Upgrade

- NEN Ka-band Upgrade Punta Arenas, Chile

- NEN KSAT Station TrollSat, Antarctica

- NEN Station McMurdo, Antarctica

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Our **Vision**

NASA's Vision, Goal & Strategy

VISION: Partner with industry and other government agencies to develop and maintain an interoperable and resilient space and ground communications and navigation infrastructure

GOAL: Create partnerships with industry and other government agencies to develop standards, infuse transformational technologies, and provide high speed, robust, secure, and cost-effective space communications and navigation services to future science and exploration missions

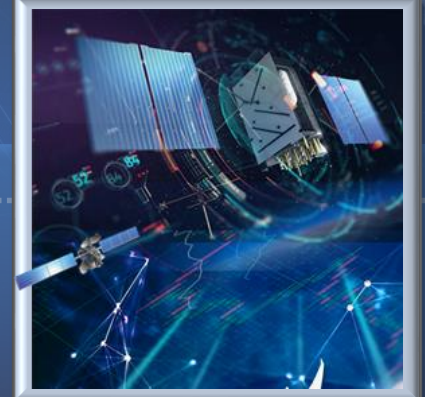**Partner to Foster an Affordable and Growing US Space Industry**

Leverage Commercial Capabilities to Increase Efficiency and Robustness of NASA Space Networks

**Infuse Transformational Technologies to Enhance Services Near the Moon and Beyond**

Ensure Efficient Use of Spectrum through Regulatory Oversight and Streamlined Processes

Provide Technical Leadership in Pursuing and Implementing PNT Policies and Technology

Our Vision: Interoperable Space Communication & Navigation Architecture

Router   ATM Switch

RF   Optical Links
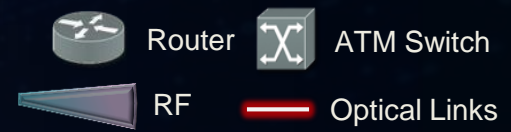
L2 & Lunar

Other Government Agencies (OGAs)

NASA

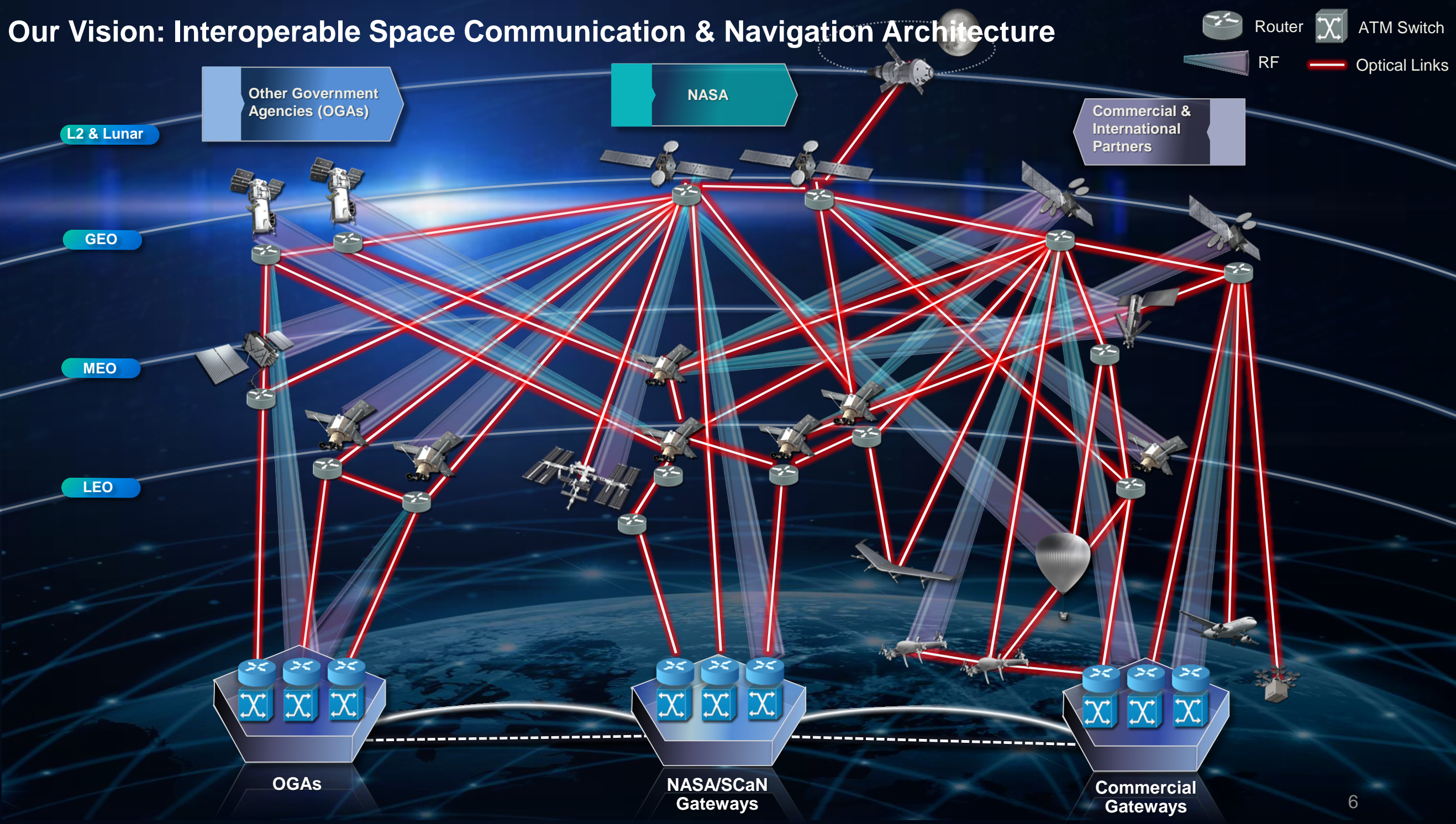Commercial & International Partners

GEO

MEO

LEO

OGAs

NASA/SCaN Gateways

Commercial Gateways

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Open Architecture Features

- **Each organization controls the extent of inter-operation with partner networks**
  - No interoperability – each organization provides its own stand-alone network
  - Selected interoperability for specific conditions/events, e.g., Continuity of Operations, national civil reserve
  - Full interoperability during normal operations, e.g., Internet, cellular telephony
- **The only thing imposed on other agencies adopting this architecture is the use of standard services & interfaces**
  - Does not require common or coordinated acquisitions
- **Enhance network resilience & performance through disaggregation and modularity**
- **Architect for scalability & potential to be adopted universally**
- **Enables space market growth that supports many vendors**

Planetary Networks:
Earth, Moon and Mars – Common Architecture
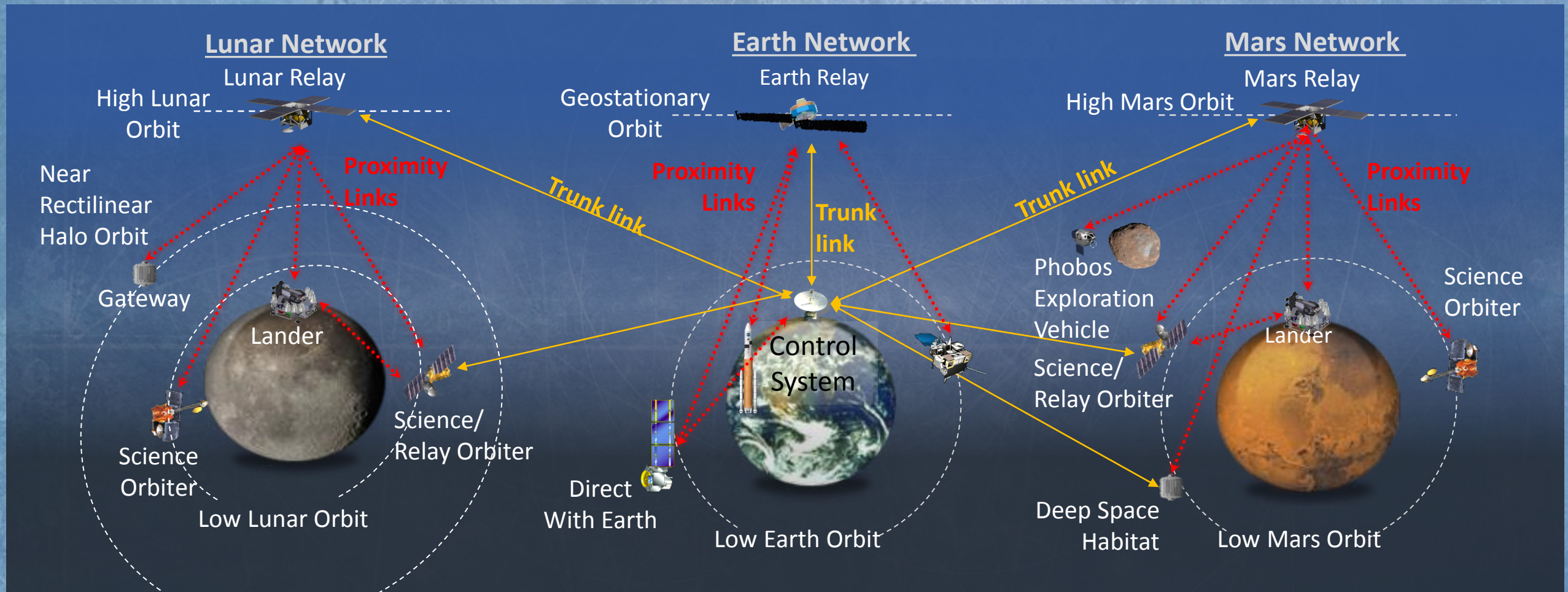
- **User-network *Proximity Links*** (space-space & space-ground/surface) provide standardized services & design for users of planetary networks
- **Network-network *Trunk Links*** are internal network space-ground connections for long distance "back haul"

Realizing the **Vision**

NASA Policy Shifting to Favor Commercial Solutions

- **SpaceIL requested reimbursable service from NASA's Deep Space Network for its lunar lander, *Beresheet***

- **NASA conducted a survey of the current market for the communication & tracking services being sought by SpaceIL**

- **Survey conclusion was that there is currently no commercial entity that can provide DSN capabilities that meet SpaceIL's requirements, however, the market is evolving quickly**

- **NASA agreed to provide DSN service to *Beresheet* but modified its policy for future external missions:**

  - NASA will provide deep space comm and nav support as an exception, with the standard being support from commercial sources

  - NASA will only provide DSN services in cases where it is clear the DSN is the only capability available for a viable mission
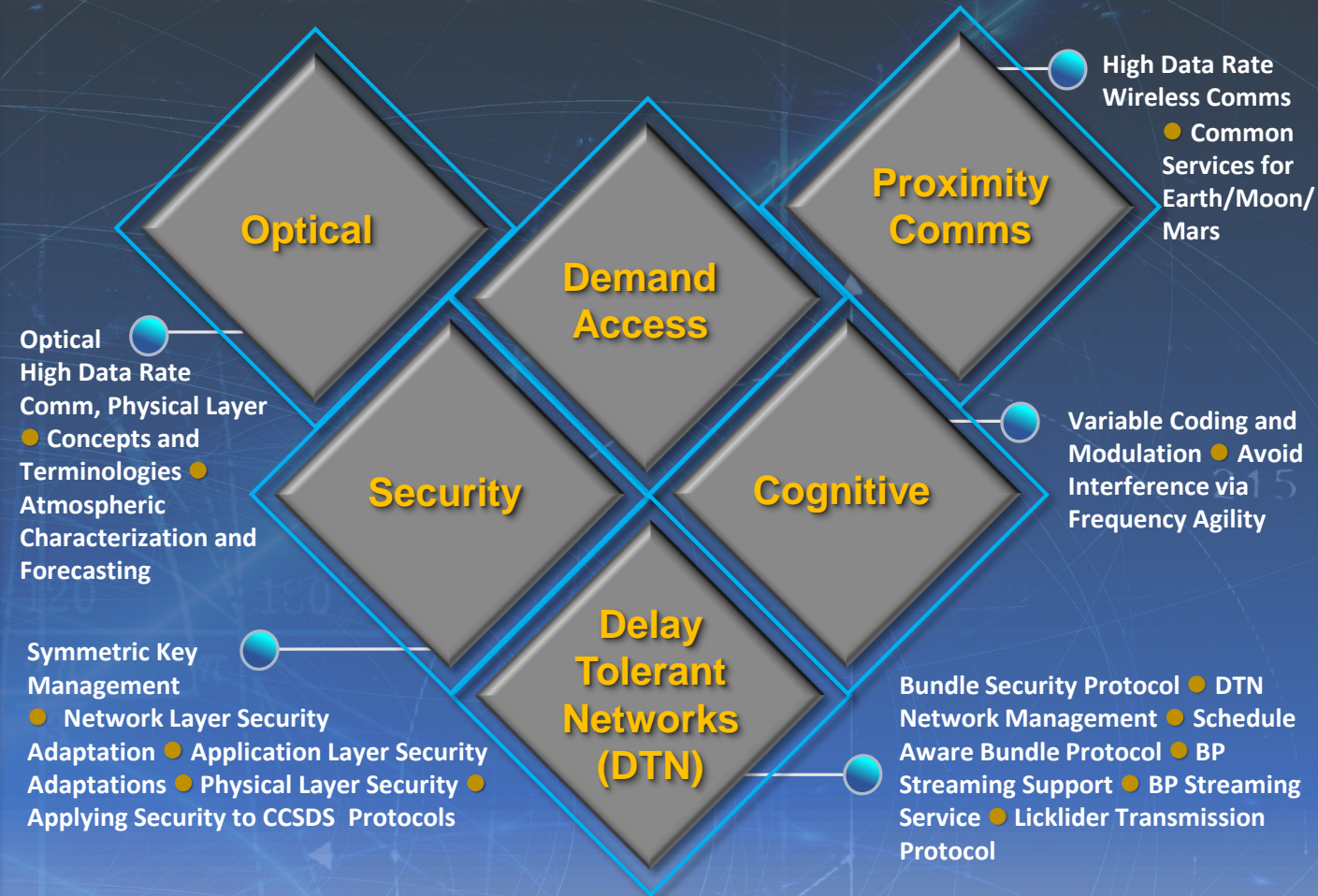
Develop and Implement Standards to Enable Interoperability

Development and Adherence to Standards

> Required in an interoperable architecture

> Critical to complex operational environments such as sustainable human lunar campaign

Interoperable Architecture Tenets

> Protocols built for terrestrial communications adapted to space user needs

> Standard protocols foster equipment product lines and higher volume to lower cost

> Industry-wide common services shift basis of competition to quality and cost

Optical

Demand Access

Proximity Comms

Security

Cognitive

Delay Tolerant Networks (DTN)

High Data Rate Wireless Comms ● **Common Services for Earth/Moon/Mars**

Optical High Data Rate Comm, Physical Layer ● Concepts and Terminologies ● Atmospheric Characterization and Forecasting

Variable Coding and Modulation ● **Avoid Interference via Frequency Agility**

Symmetric Key Management ● Network Layer Security Adaptation ● Application Layer Security Adaptations ● Physical Layer Security ● Applying Security to CCSDS Protocols

Bundle Security Protocol ● **DTN Network Management** ● **Schedule Aware Bundle Protocol** ● **BP Streaming Support** ● **BP Streaming Service** ● **Licklider Transmission Protocol**

Standards Roadmap

Existing Standards

Standards Refinement

New Standards Development

Infusion

Refinement

Driving Missions
Gateway, Artemis, NISAR

Adopting Missions, Communication Networks

Public Private Partnership for Communications and Navigation Space Services (NextSTEP-2 Broad Agency Announcement)

NASA is exploring options to offer:

- Shared payload/network development to introduce innovative optical & RF capabilities, providing operational services to NASA through shared investment & common standards.

- Foster the growth of commercial satellite communications market from LEO to Moon and beyond.

NASA is exploring the ability to obtain:

- Commercial capabilities for future NASA missions aligned with future architecture.

- Basis of future acquisition activities to help share the cost and risk of developing and providing these services and capabilities.
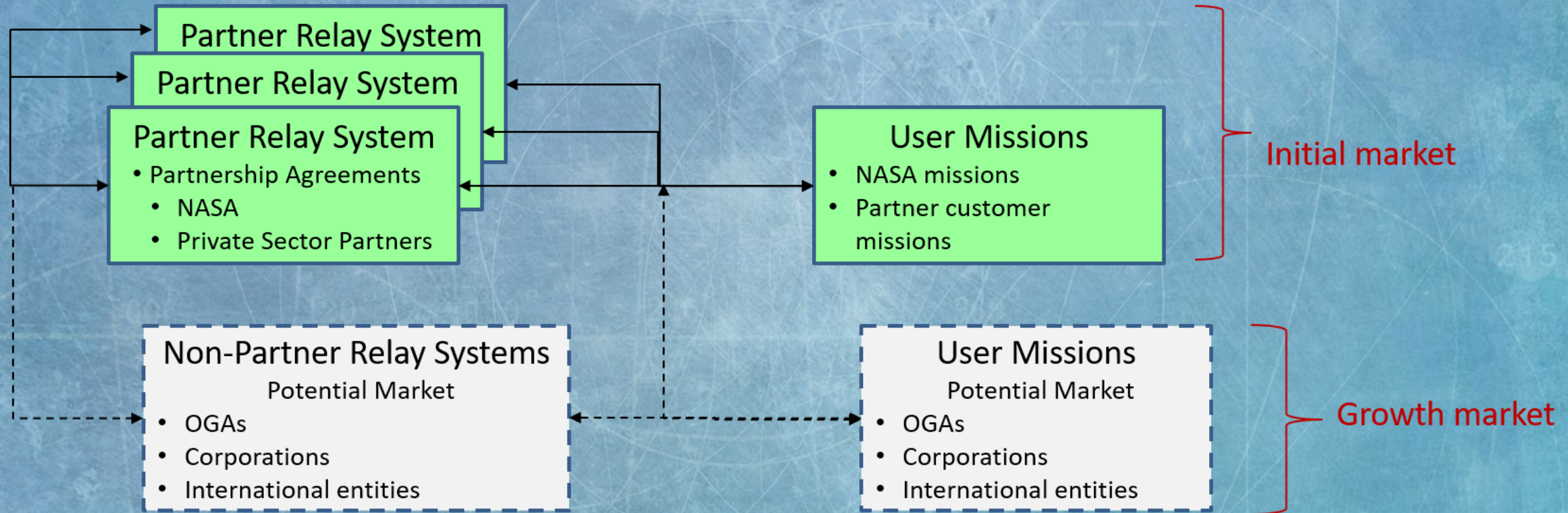
Considerations for Commercially Provided Services

- NASA's vision entails the interoperability of the industry-provided services with those provided by NASA, International partners and Other Government Agencies (OGAs).

- Relies on agreement of standards for optical & RF network & user interfaces for service management (scheduling, accounting), operations (access & authentication), & data distribution.

- Compatibility among service providers to compete on cost & reduce risk of changing services or loss of providers.

Key Interfaces: User Services & Internetwork

Internetwork Interface

User Services Interface

Partner Relay System

Partner Relay System

Partner Relay System
- Partnership Agreements
  - NASA
  - Private Sector Partners

User Missions
- NASA missions
- Partner customer missions

Initial market

Non-Partner Relay Systems
Potential Market
- OGAs
- Corporations
- International entities

User Missions
Potential Market
- OGAs
- Corporations
- International entities

Growth market

Awardees

- ATLAS Space Operations, Inc.
- Boeing Co.
- Eutelsat America Corp.
- General Dynamics Mission Systems, Inc.
- Intelsat General
- Northrop Grumman Corporation
- Space Systems/Loral, LLC
- Space Exploration Technologies Corporation

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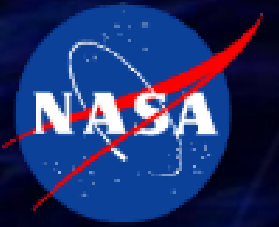
Decade of **LIGHT**

www.nasa.gov/SCaN