National Aeronautics and Space Administration

# NASA's Implementation of Cloud Services for Human Space Flight

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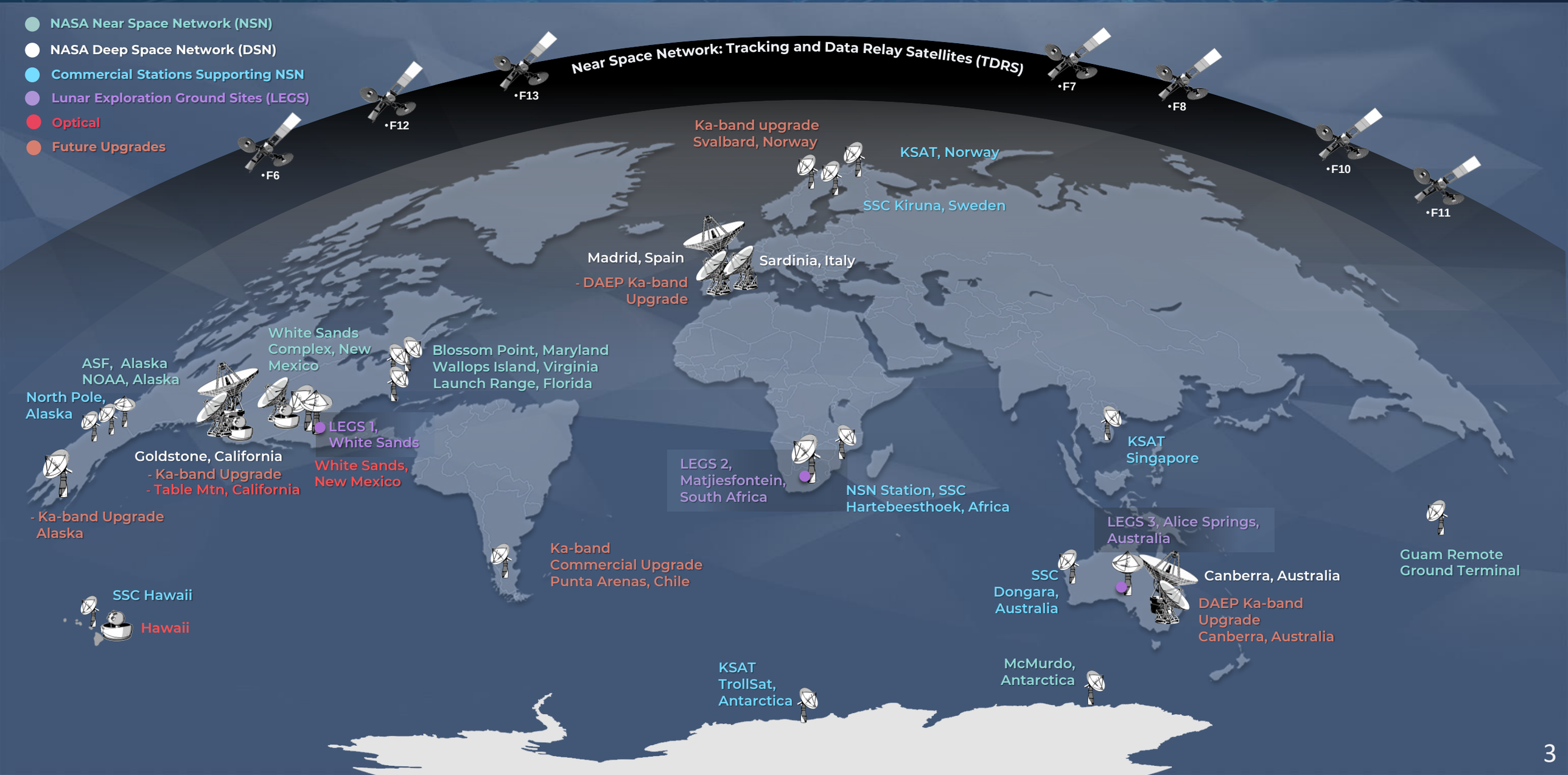
# NASA's Communications Networks

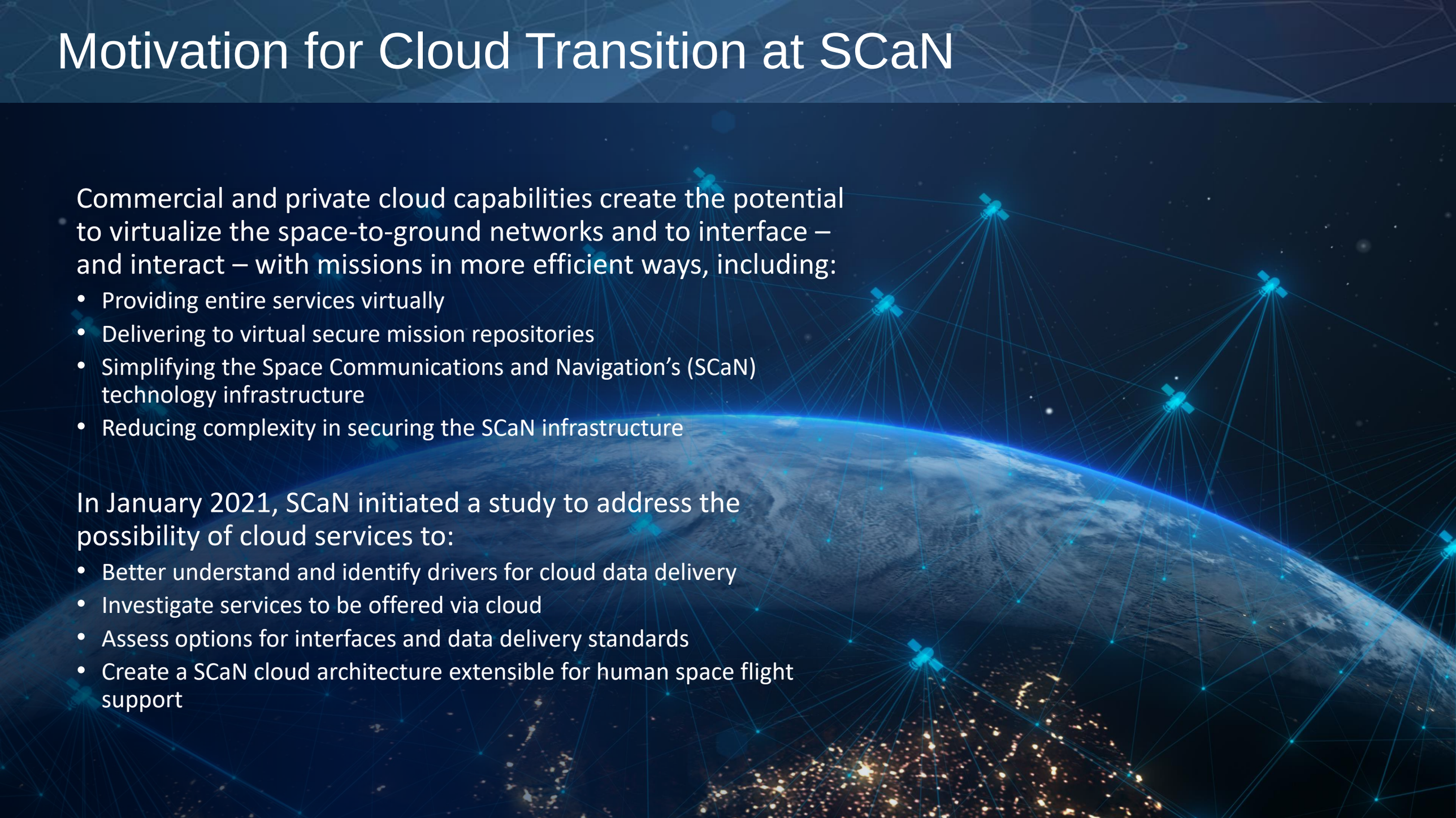


# What's Happening in the Market?

Companies across a wide variety of industries are using cloud services to leverage and maximize business performance:

- Minimizing costs and overhead for data management infrastructure
- Versatile deployment
- Secure storage management
- Utility-based sharing models
- High-level computing

# Motivation for Cloud Transition at SCaN



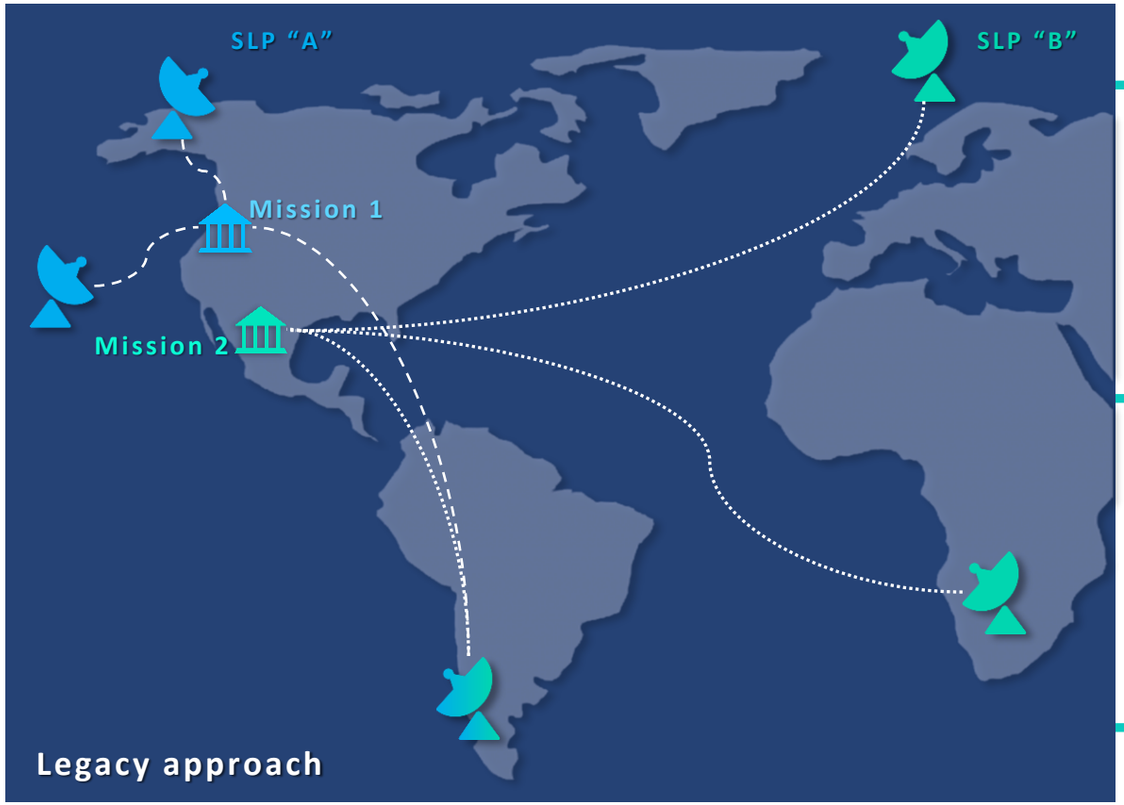
Commercial and private cloud capabilities create the potential to virtualize the space-to-ground networks and to interface – and interact – with missions in more efficient ways, including:

- Providing entire services virtually
- Delivering to virtual secure mission repositories
- Simplifying the Space Communications and Navigation's (SCaN) technology infrastructure
- Reducing complexity in securing the SCaN infrastructure

In January 2021, SCaN initiated a study to address the possibility of cloud services to:

- Better understand and identify drivers for cloud data delivery
- Investigate services to be offered via cloud
- Assess options for interfaces and data delivery standards
- Create a SCaN cloud architecture extensible for human space flight support

# Why Cloud? Legacy vs. Future





- Interfaces required to be established with each service provider
- Need to account for physical and computing resources
- Direct impacts by mapped providers' outages
- Risks associated with distributed sustainment of mission unique assets
- Complexity of managing security

- Establishes single interface between a mission and the cloud
- Does not require establishing new interfaces
- Does not require accounting for physical and computing resources
- No impacts by mapped providers' outages
- Reduces/eliminates risks associated with distributed sustainment of mission unique assets

# Modular Architecture Approach (1)

SCaN cloud architecture will be extensible and leverage modularity

- Software modules are loosely coupled

SCaN will be able to increase the resilience of systems

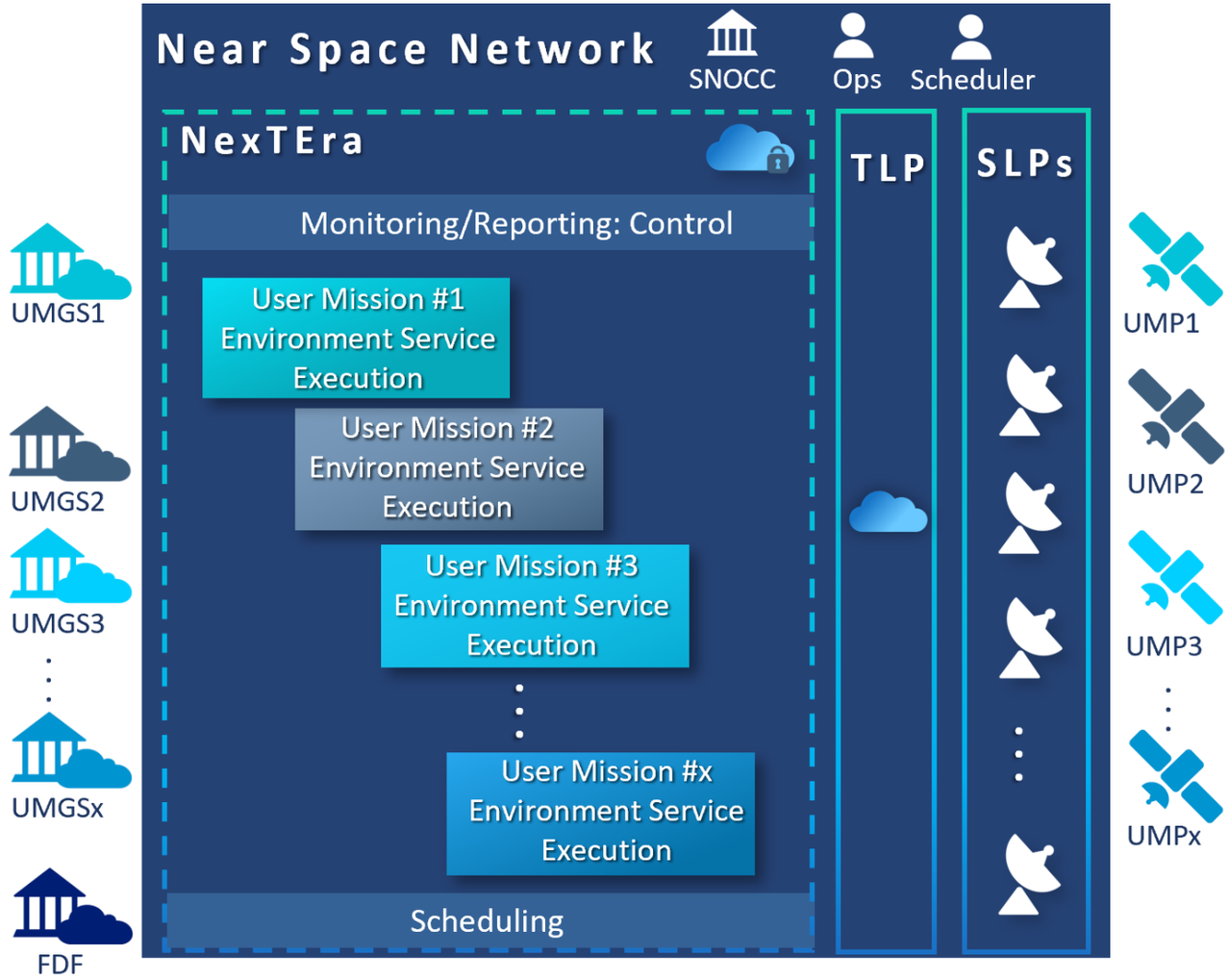
- Modules connected, but not dependent
- Streamlined sustainment; robust to failure

SCaN implemented this approach with the Data Acquisition Processing and Handling Network Environment (DAPHNE)

- Uses Amazon Web Services (AWS) capabilities
- Supports two upcoming missions: NASA-ISRO Synthetic Aperture Radar (NISAR) and Plankton, Aerosol, Cloud, ocean Ecosystem (PACE)

The Near Space Network (NSN) has worked to advance SCaN's cloud architecture with NexTEra

- Extends the functionality and capability of DAPHNE




NexTEra – Nexus, Terra, Astra; meaning to state "Connecting Earth to Stars"

# Modular Architecture Approach (2)

Each User Mission Environment (UME) is a preconfigured "virtual private cloud"

- Unique data processing and security considerations
- Independent software modules

Front end of the UME is a translation layer

- Accommodates data or frame formats
- Translates the information with a preferred format

The Mission Operations Centers (MOC) and Service Link Providers' (SLP) connect to the Scheduling module

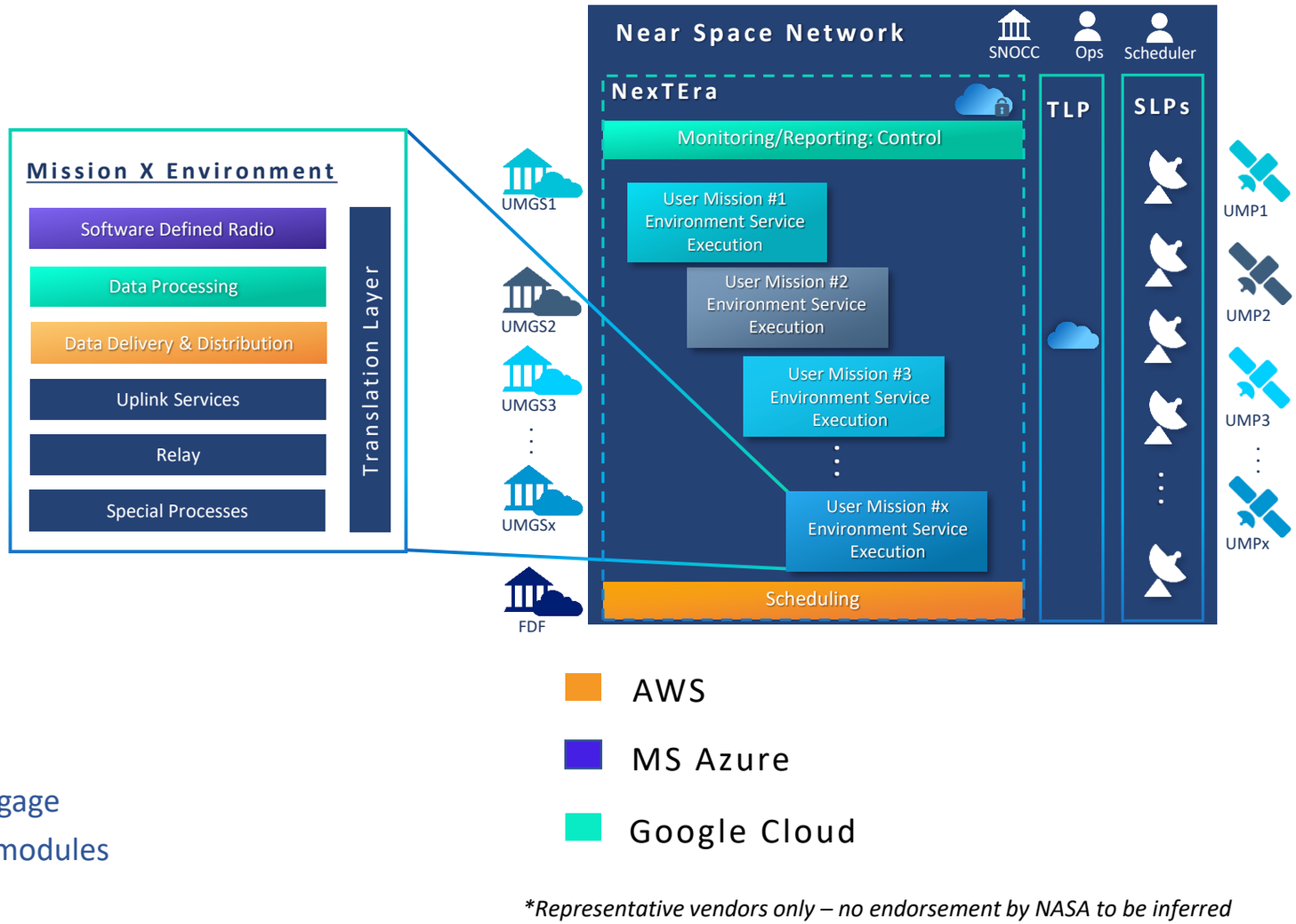
- Receives schedule requests
- Generates a deconflicted schedule
- Sends schedule requests to providers

The Monitoring/Control/Reporting module interfaces with the SLPs, the Scheduling module, and all the UMEs

- Monitors the status of each UME

The modular cloud architecture can be deployed using commercial capabilities

- Does not have to be built by NASA – variety of providers can engage
- Missions have opportunity to select different vendor-provided modules




**Representative vendors only – no endorsement by NASA to be inferred*

# Artemis and the Return to the Moon

NASA anticipates multiple vehicles in orbit and at diverse locations on the surface of the moon as the Artemis Program evolves toward a sustainable human presence

SCaN is committed to supporting Artemis:

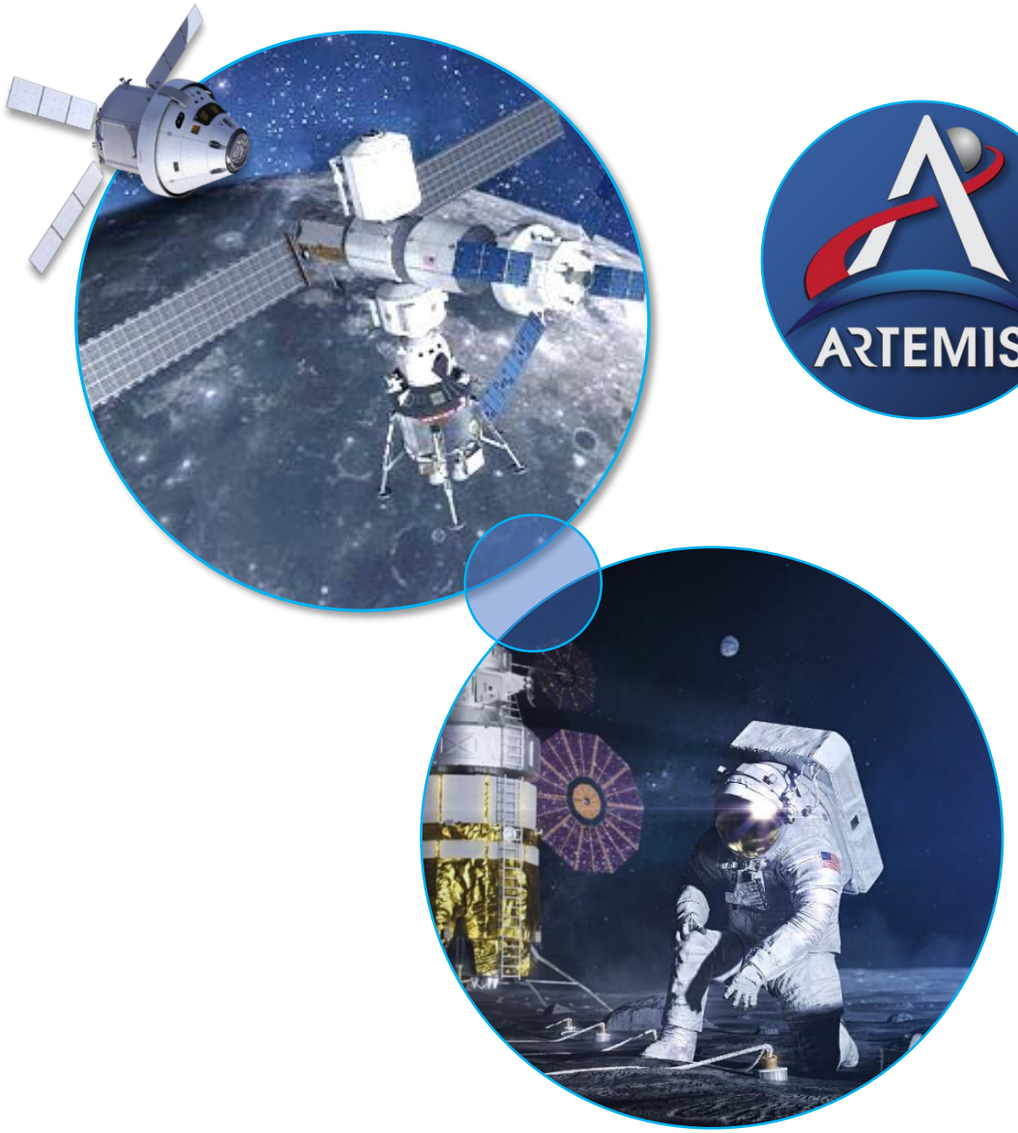
- Communications and navigation architecture includes new lunar-capable ground stations and lunar relay capabilities in addition to the resources of the Deep Space Network (DSN)

NexTEra system is a first step in the implementation of the SCaN cloud architecture

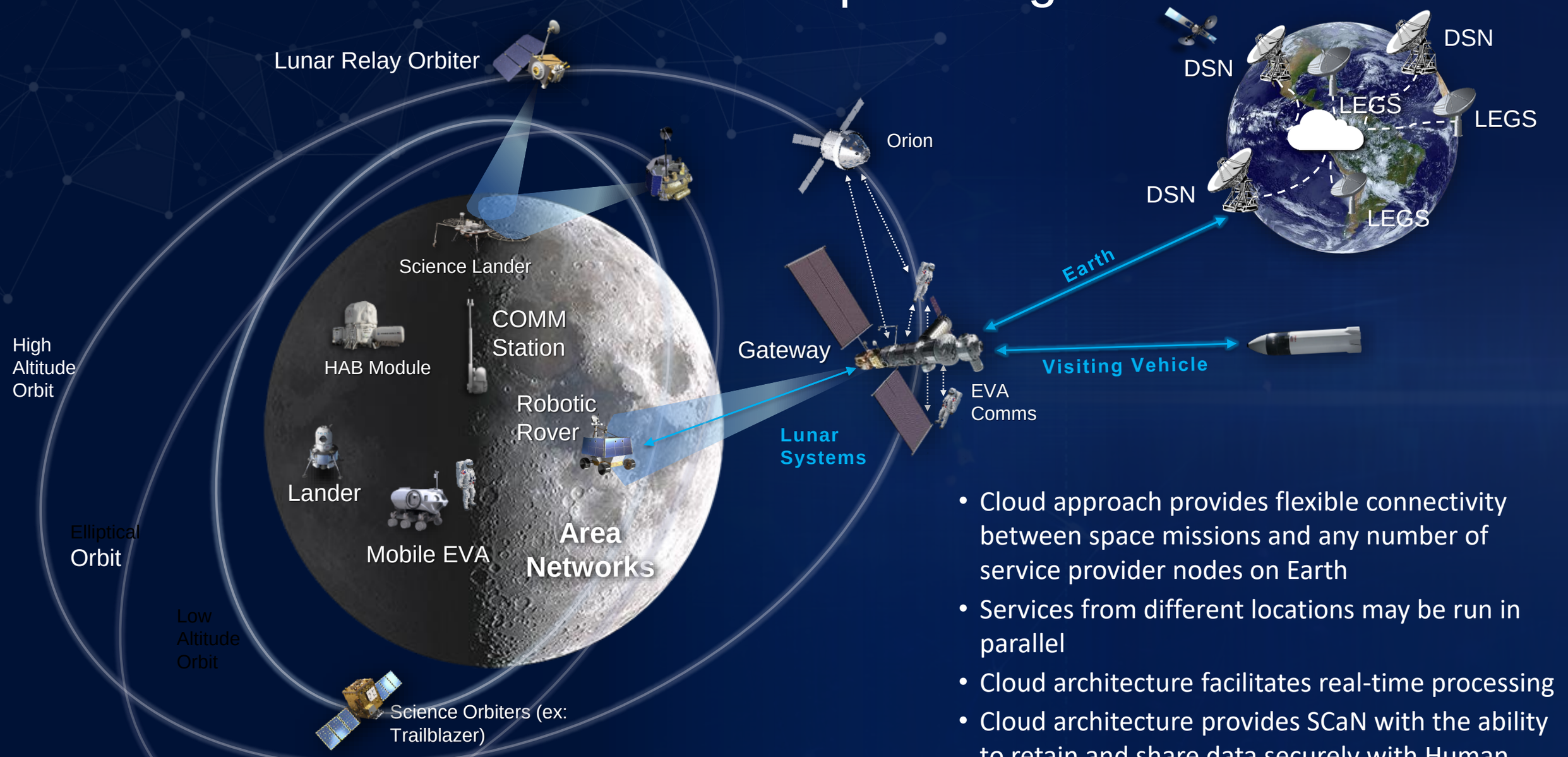
- Will provide connectivity from the diverse locations for vehicles in orbit and on the moon
- Transition to a commercial services model will allow for more cost savings and efficiency

Human Space Flight has a unique and rigorous set of requirements

- There is a need to provide a greater reliability and availability than robotic missions

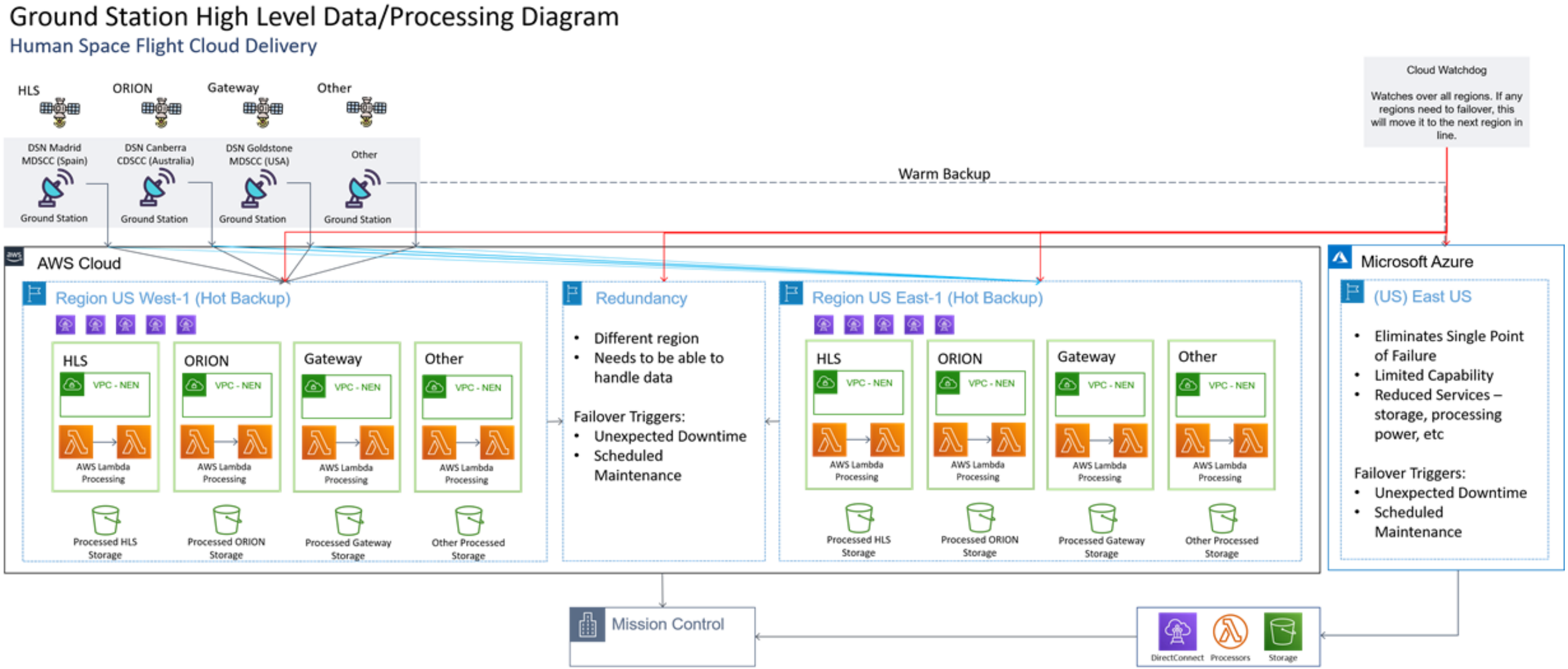


# SCaN Cloud Services for Human Space Flight




- Cloud approach provides flexible connectivity between space missions and any number of service provider nodes on Earth
- Services from different locations may be run in parallel
- Cloud architecture facilitates real-time processing
- Cloud architecture provides SCaN with the ability to retain and share data securely with Human Space Flight stakeholders

# Notional Cloud Architecture for Human Space Flight



# Cloud Services Security

SCaN is responsible for the security of space communications

- **Must provide high network security and resiliency**

Cloud services must be compliant with applicable security standards

- **Includes international partners who would like to provide cloud services**

An advantage of the cloud architecture is the ability to select providers who are compliant with appropriate security standards such as the Federal Risk and Authorization Management Program (FedRAMP)

NASA anticipates a more diverse set of providers will be available to provide compliant security certifications

# Summary / Concluding Thoughts

SCaN completed significant work to define and initiate implementation of a cloud-based architecture for the Near Space Network (NSN).

SCaN is working with both the NSN and Deep Space Network (DSN) to mature the broader cloud architecture approach to support:

- Unique, more rigorous service reliability and availability needs of Human Space Flight
- Connectivity between lunar assets and the array of NASA, partner, and commercial network resources

Commercial industry capability and innovation will be sought out and leveraged as the cloud architecture matures

- Mission users will benefit from a diversity of competitive suppliers

# SCaN

## Space Communications and Navigation

National Aeronautics and Space Administration

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