National Aeronautics and Space Administration

Cognitive Capability Contributions to NASA's Future Networks and Missions

Badri Younes
Deputy Associate Administrator
NASA Space Communications and Navigation

June 2021

Enabling Human Space Exploration and Science Missions

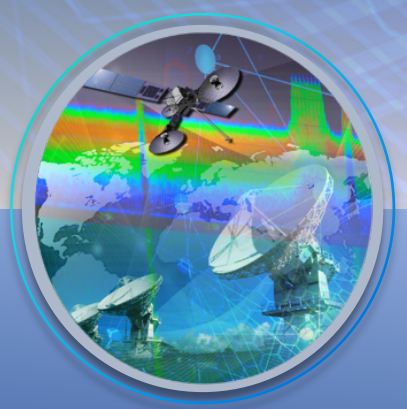
Space Communications and Navigation (SCaN)
Serves as the Program Office for all of NASA's space communications activities

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

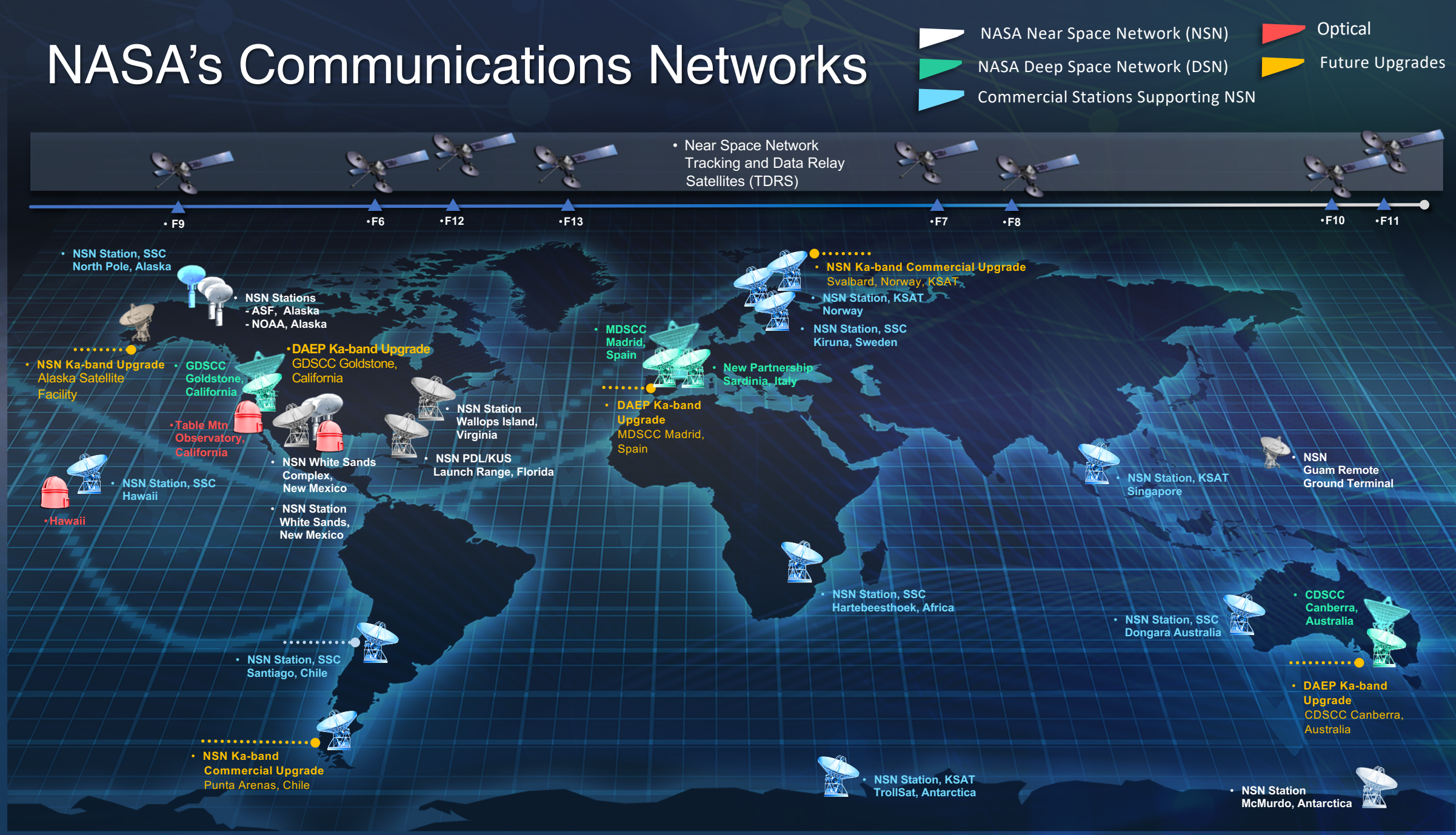


Manage NASA spectrum; represent NASA on national and international spectrum management forums

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 and navigation

NASA's Communications Networks



SCaN's Vision, Goal & Strategy

VISION: Interoperable and resilient space and ground communications and navigation infrastructure

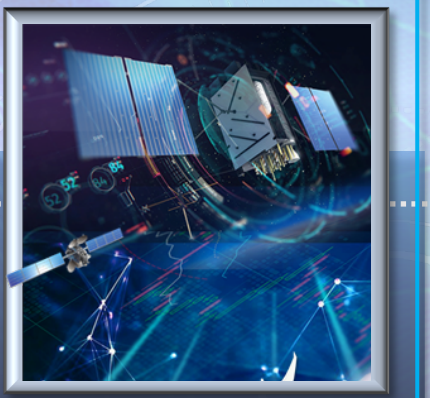
GOAL: Enable high speed, robust, secure, and cost-effective space communications and navigation services to future science and exploration missions

Foster an Affordable and Growing U.S. Space Industry

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

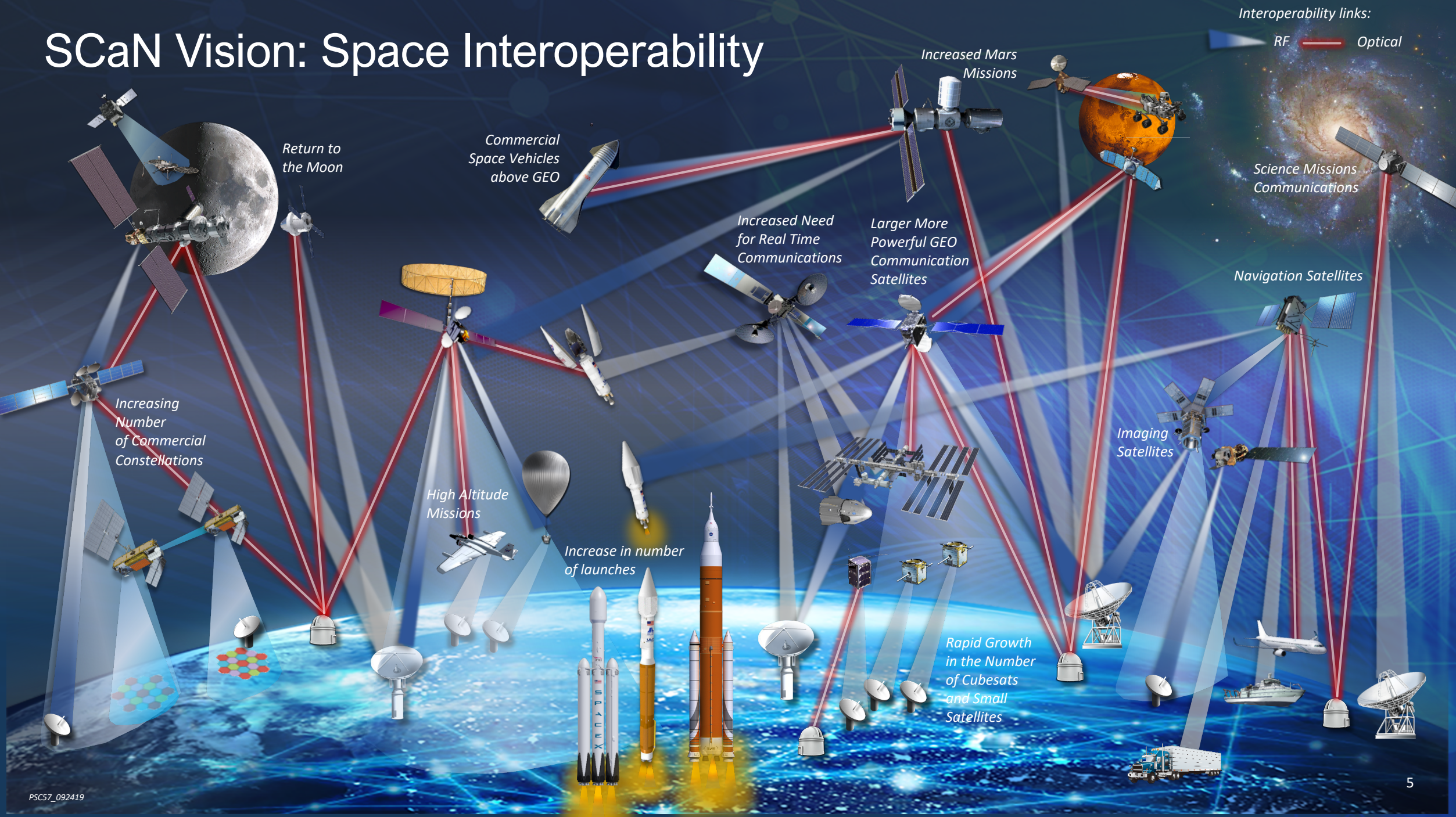
Infuse Transformational Technologies to Enhance Services Near the Earth and Beyond

Ensure Efficient Use of Spectrum through Regulatory Oversight and Streamlined Processes



Provide Technical Leadership in Pursuing and Implementing PNT Policies and Technology

SCaN Vision: Space Interoperability



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 Technology 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.

Technology: Cognitive Communication Capabilities Areas

Cognitive Links

The technologies, algorithms and protocols applicable to the physical and data link layers

- **Optimize performance and reliability**
- **Gain spectrum efficiency**

- Interference mitigation
- Link optimization
- Flexible waveforms
- Adaptive coding and modulation
- Cognitive antenna beamforming/arraying/steering
- Software defined radios
- Cognitive Radios

Cognitive Networks

Network-layer technologies and protocols that can contribute to a decentralized, service-based, interoperable architecture

- **Increase useful data throughput and resiliency**
- **Reduced network operating cost**

- Blockchain technology
- Cognitive gateways
- Network optimization
- Virtualization
- Intelligent / cognitive routing

Cognitive Systems

System-wide cognition using an array of cognitive nodes spanning protocol layers

- **System-of-systems capability enabling new mission and network operational paradigms**

- System-wide intelligence
- User-Initiated / automated scheduling
- Flight segment operations management
- Software-defined networking
- Self-organizing network concept

Cognitive Links/Wideband COMSATCOM Ka-band User Terminal

Technology Development

> Wide bandwidth Ka-band systems that span 17.2 GHz to 30 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

Viasat NGSO

SpaceX

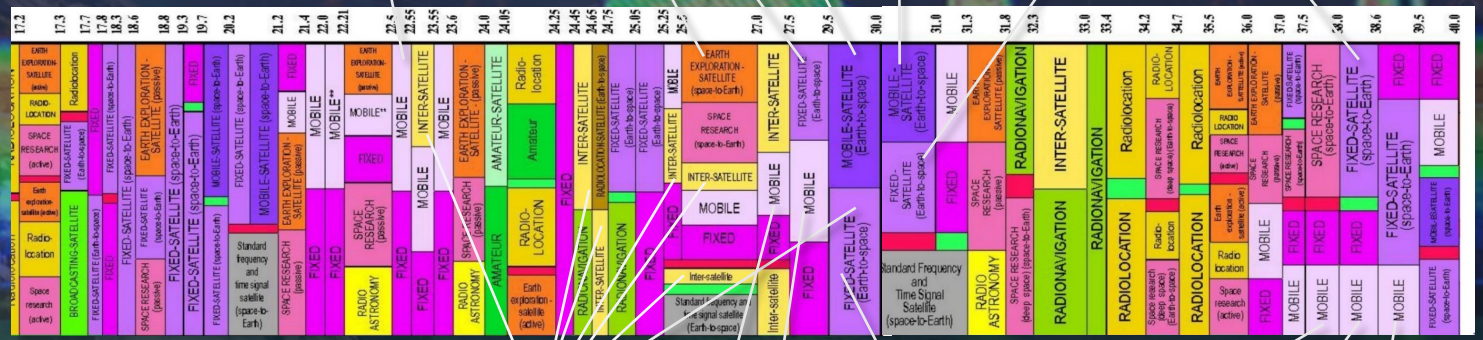
Inmarsat

Audacy

Near Earth SGL

Intelsat

Deep Space SGL



Intersatellite Links

Telesat

Viasat 3

OneWeb

O3b

SpaceX

Viasat NGSO

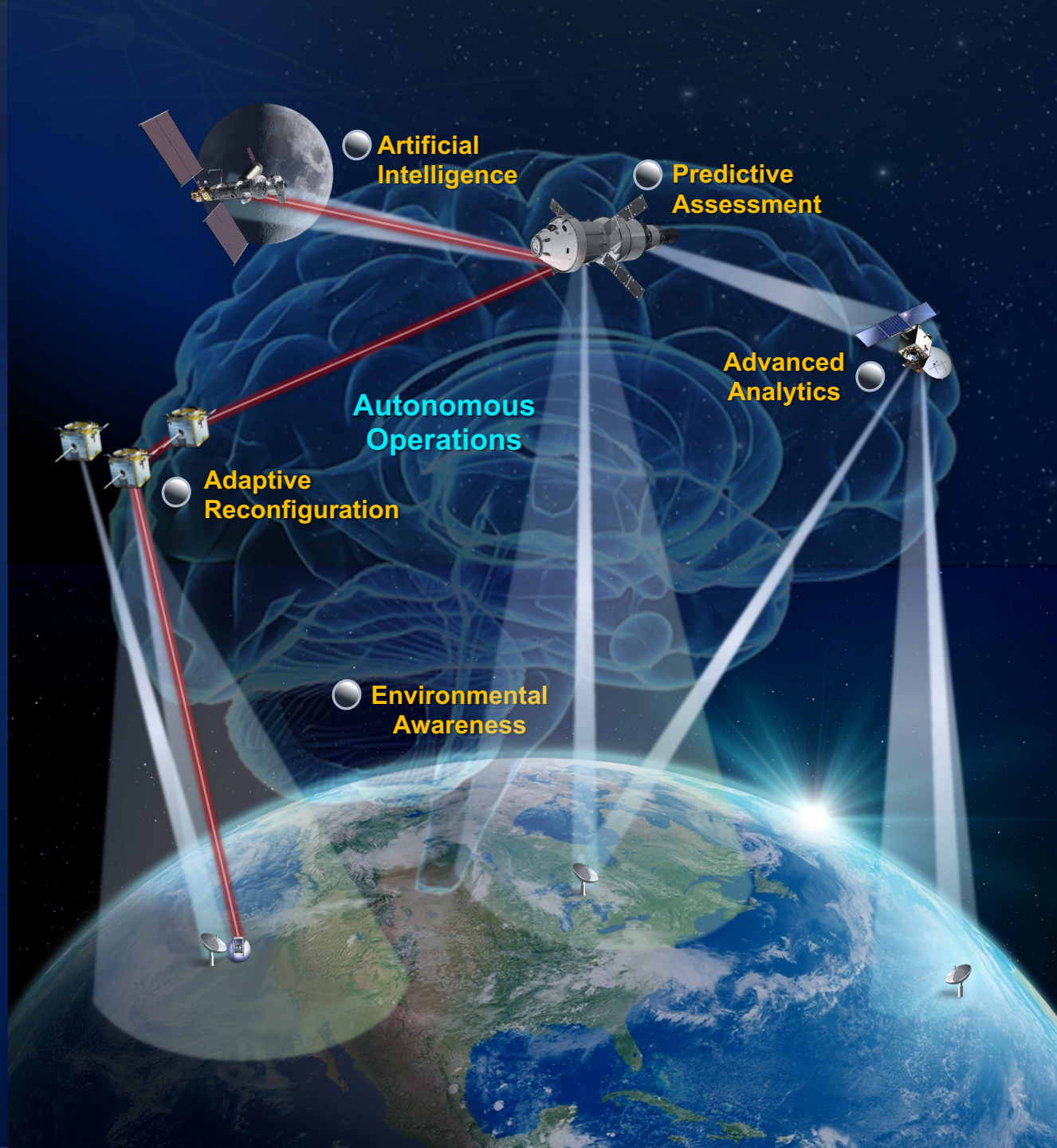
Tunable from 17.2 GHz to 30.0 GHz

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

Cognitive Network/Systems

Cognitive network/systems objective: system-wide cognition using an array of cognitive nodes spanning multiple protocol layers

- Automatic configuration of network equipment (ground stations, relays, etc.) communication parameters
- Monitoring of network parameters and communications environment used to ensure efficient operations
- Machine learning in support of autonomous network monitoring – supports fault detection, classification, and recovery



Interoperability Vision

Our vision of interoperability in space communication extends from Earth to deep space.

Cognitive technology is a key enabler for achieving this goal.

Let’s work together on this vision.