

# Lunar IP Networking

IETF deepspace BoF

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# Note

The Moon is not technically "deep space".

Lunar one-way delays are  $>1300$  ms.

This BoF attempts to extend IP applicability to deep space, much further than the Moon, and by doing so also addresses the multi-second RTTs and disconnections present in lunar networking.

# Background

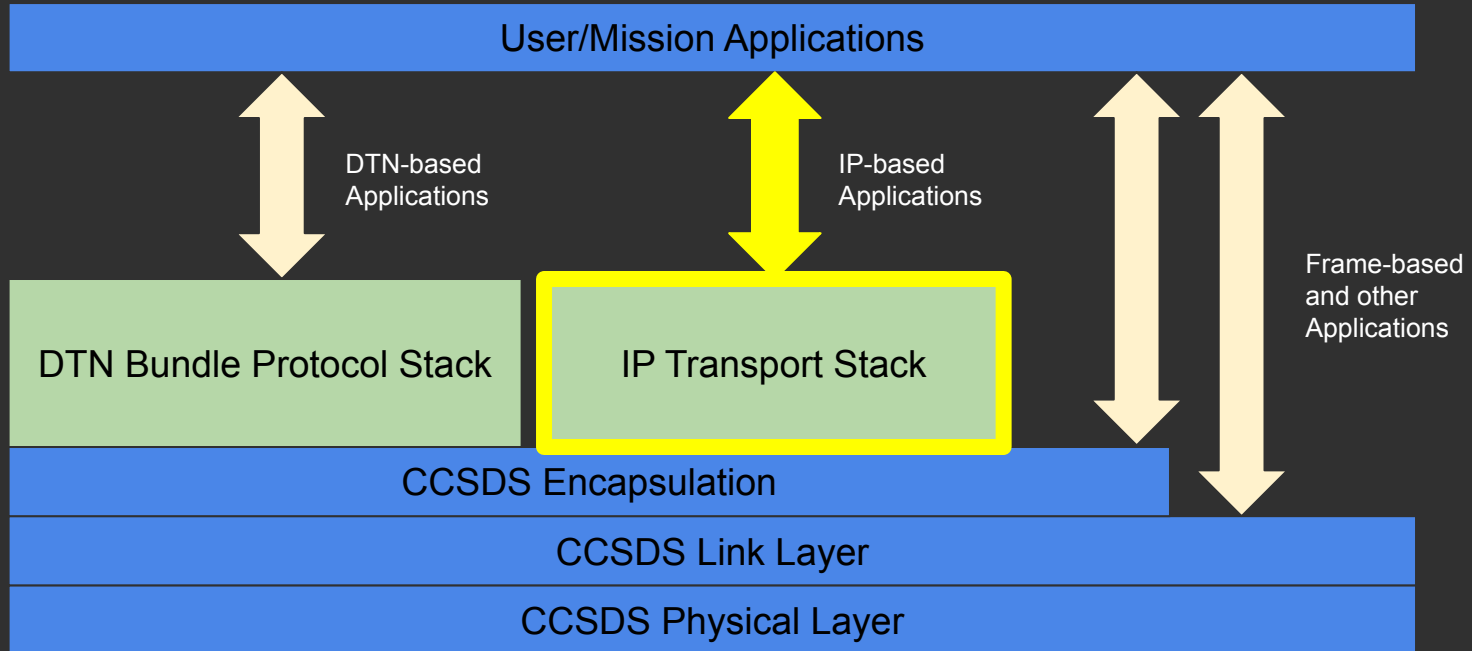
IP networks are used onboard space vehicles.

IP networks are now planned to be deployed for use:

- in lunar orbiting missions, around the moon
- on the lunar surface, in rovers, landers, space suits, and habitats
- spanning across terrestrial / Earth-based and Moon-based mission assets

DTN Bundle Protocol networks are also planned with important roles.

# Space Mission Protocol Stacks



Multiple options are available and expected for different types of users/missions. No "one size fits all" protocol solution.

# Lunar Gateway + ICSIS

Lunar Gateway moon-orbiting space station planned to start being assembled on-orbit in 2027.

Support for IPv4 or IPv6 and IPsec is included in the standards developed for interoperability of communications systems pertaining to the Lunar Gateway.

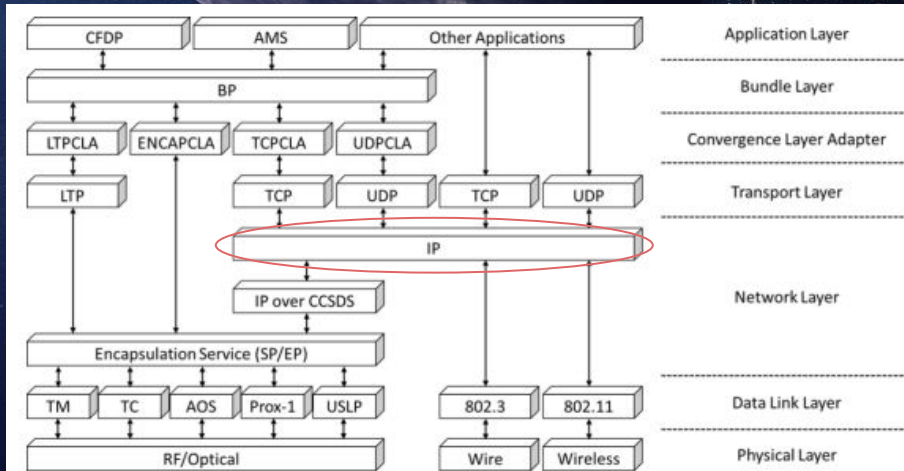


FIGURE 3.2.2.2.1.6-1 PROTOCOL STACK – OPTIONS

## International Communication System Interoperability Standards (ICSIS)

Revision A – September 2020

This document has been reviewed for Proprietary, SBU, and Export Control (ITAR/EAR) and has been determined to be non-sensitive. It has been released to the public via the NASA Scientific and Technical Information (STI) Process DAA 20205007457.

Approved by NASA Human Exploration and Operations Mission Directorate on September 29, 2020, pending Multilateral Coordination Board (MCB) concurrence and International Partner signatures.

This document has been approved for public release per DAA # 20205007457

<https://internationaldeepspacestandards.com/>



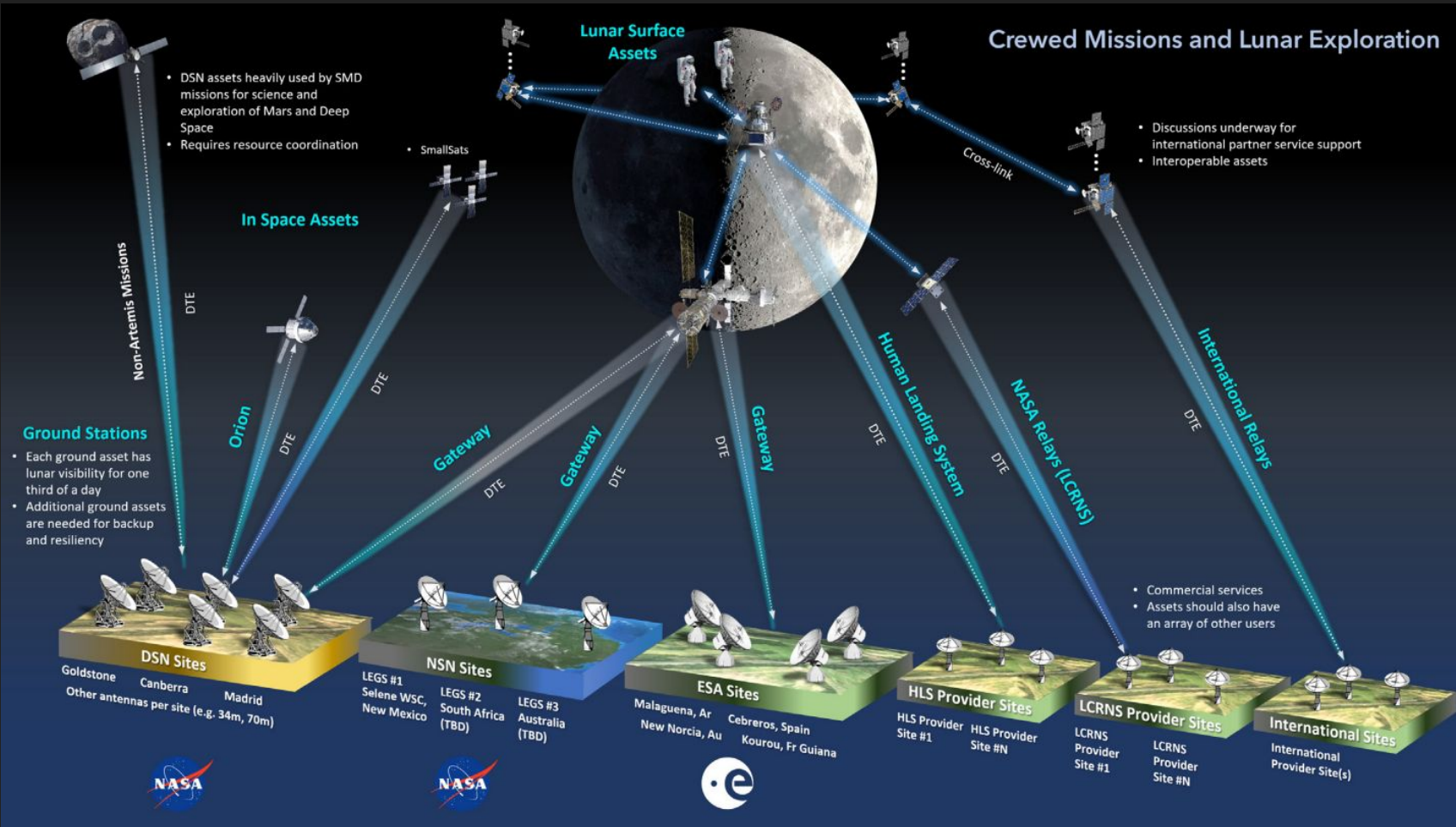
# Lunar Communications Relay and Navigation Systems (LCRNS)

"Establishing a network of communication relay satellites in lunar orbit will enable continuous and reliable communication between Earth and lunar missions, even in locations where the Earth is not directly visible from the Moon."

"The Lunar Communications Relay and Navigation Services project will provide consistent availability, visibility, and higher data rates for surface users. With multiple relays incrementally launched, the project can offer phased and incremental coverage of the South Pole region."

<https://esc.gsfc.nasa.gov/projects/LCRNS?tab=overview>

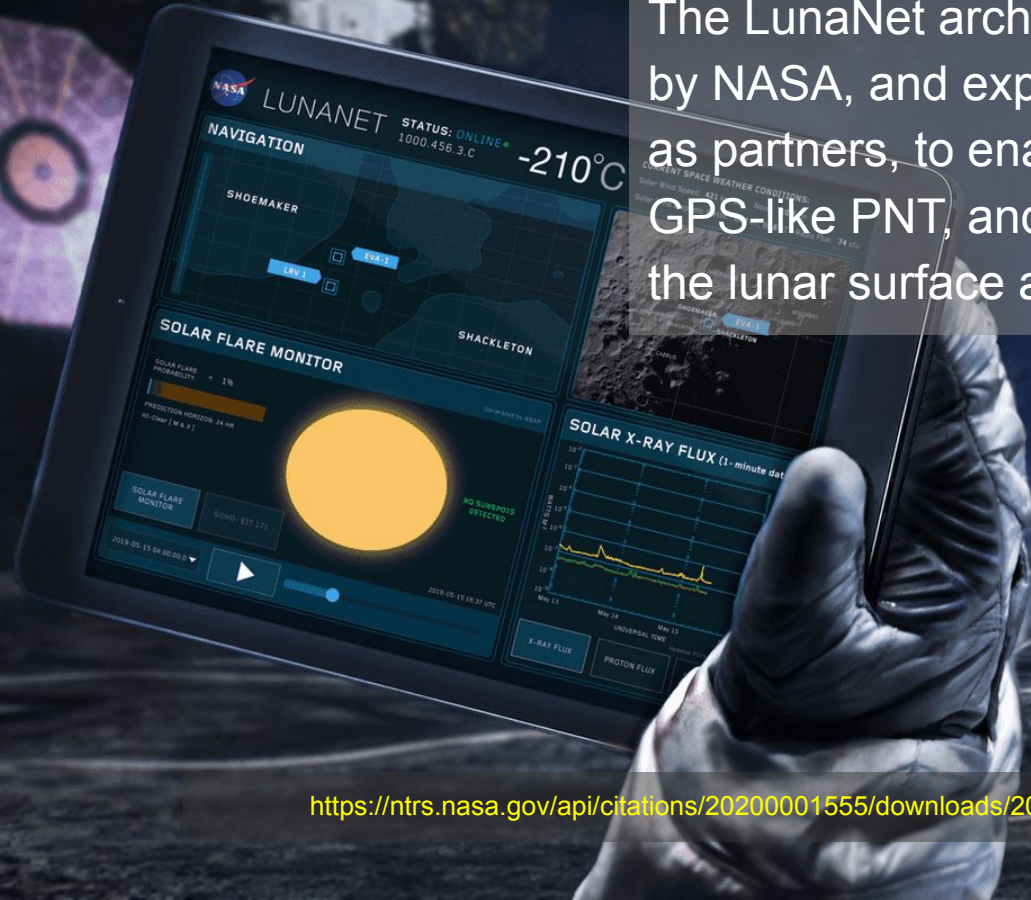
# Crewed Missions and Lunar Exploration





# LunaNet

The LunaNet architecture concept was created by NASA, and expanded with ESA and JAXA as partners, to enable Internet-like data, GPS-like PNT, and other services to users on the lunar surface and in orbit.



<https://ntrs.nasa.gov/api/citations/20200001555/downloads/20200001555.pdf>

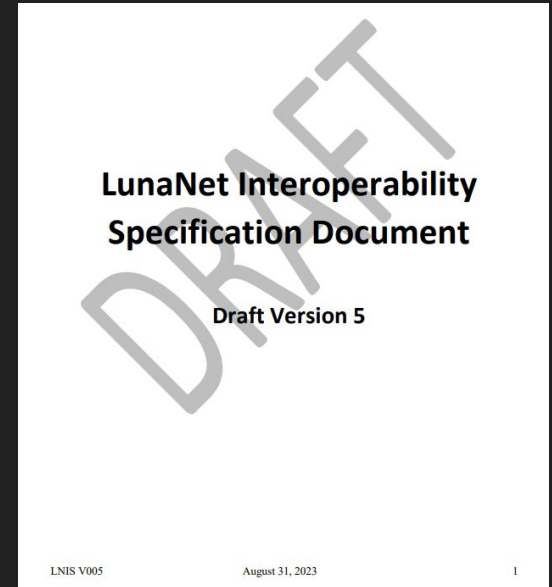


# LunaNet Interoperability Specification (LNIS)

"The purpose of the LunaNet Interoperability Specification (LNIS) is to define a framework of mutually agreed-upon standards to be applied by users and service providers in a cooperative network supporting missions on and around the Moon."

Includes data communications services for:

- (1) Real-time frames
- (2) **Real-time IP packets**
- (3) DTN bundles



<https://www.nasa.gov/directorates/somd/space-communications-navigation-program/lunanet-interoperability-specification/>

# LunaNet Service Providers (LNSPs)

The architecture enables multiple LNSPs that lunar mission users might be able to choose between, or supplement coverage across.

Routing could initially be PCE-like, with time-varying static routes, due to small network size.

Some LNSPs are expected to be commercially-owned, commercially-operated.

# Role for IETF - My View

Supplement the work done by other groups (CCSDS, LNIS partners, etc.), by working on profiles, BCPs, and possible standards enhancements, helping to extend the reach and performance of IP and IP-based transport stacks for applications on networks with interplanetary delays, and disconnections.