Sustained Human and Robotic Presence on the Moon and Mars

Integrated Power and Communications Architecture

Document ID: SDC-COMMS-2040-LUNAR-MARS-Rev A
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Date: October 12, 2025

Executive Summary

This document outlines the integrated long-term vision for permanent human and robotic operations on the Moon and Mars. It merges the SDC & COMMS terabit-class laser communication framework with Autonomous Hydrogen Module (AHM) power systems to provide sustained life-support, energy, and communications infrastructure for interplanetary operations.

1. System Overview

The architecture consists of: - SDC GEO clusters forming a terabit optical mesh between Earth, Luna, and Mars. - Multi-terminal WDM laser arrays providing up to 4 Tbps interplanetary throughput. - AHM power clusters delivering 10–40 kWe per module with shared hydrogen headers. - ISRU systems converting water ice to H2/O2/CH4 for propulsion, power, and life-support.

2. Lunar–Mars Duality Doctrine

Lunar operations act as a testbed for Mars deployment. Each lunar AHM cluster is overbuilt to replicate Martian environmental conditions, providing data for PHYSCORE and RELIAB teams to derate and validate hardware for Mars missions.

3. Supercharged Communications Framework

The SDC & COMMS optical backbone employs adaptive routing per LNIS §5.2.4 and DTN custody per ICSIS §7.3. Each GEO node supports 8–16 optical terminals with WDM carriers, enabling multi-Tbps throughput across GEO–NRHO–AreoGEO links. Surface relays maintain line-of-sight optical connectivity for base communication and telemetry.

4. Autonomous Hydrogen Module (AHM) Clusters

Each AHM is a modular power plant combining nuclear baseload, fuel cells, and electrolyzers. Waste heat is captured for habitat warming and greenhouse operations. Clusters of five or more provide N–2 redundancy for critical systems. Hydrogen and oxygen are stored for both power and propellant production.

5. Phased Deployment Plan

Phase	Period	Location	Focus
0	2026–2028	Earth Orbit / LEO	SDC GEO cluster and LEO bridge integration
1	2028–2032	Lunar South Pole	Lunar AHM cluster and terabit GEO–NRHO link
2	2032–2036	Mars Transit 1	Mars AHM cluster and AreoGEO relay pair
3	2036+	Luna + Mars	Scaled operations and crewed habitats

6. Long-Term Vision

By 2040, Earth–Luna–Mars will be connected through a continuous data and energy grid. AHM clusters will enable self-sufficient colonies with in-situ resource utilization, while terabit laser comms provide instantaneous data relay across planets, enabling scientific, industrial, and human expansion beyond Earth.