

NASA Lunar Exploration – Gateway’s Power and Propulsion Element Communications Links

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Background

As a key part of NASA's Artemis program to return to the Moon sustainably, the lunar gateway will provide a platform for staging lunar missions, for gaining experience in operations beyond earth orbit, and for creating sustainable infrastructure. Of specific interest, the lunar gateway will provide communications support to landers, orbiters, and surface systems, including in the south polar region where direct line of sight to Earth is limited or non-existent.

The Power and Propulsion Element (PPE), shown in Figure 1, will carry solar arrays to provide power to the Gateway, Electric Propulsion Thrusters to raise the Gateway into, and maintain in, its operational orbit in cislunar space, and Communication Links between the Earth and Gateway, the Moon and Gateway, and relays from the Moon to the Earth.

PPE Comm Links include X-band Command, Ranging, and Telemetry (CR&T) with Earth, which also carries low to medium rate data; Ka-band Direct to Earth (DTE) for high data rate transmissions; and Ka-band lunar links for high data rate connections to lunar surface systems, lunar orbiters, and landers in flight. This paper describes the PPE communication links from a technical perspective. Other Gateway links supported by other modules are outside the planned scope of this paper.



Figure 1. Power and Propulsion Element

Comm Link Requirements

PPE will provide communications for Gateway during the operational Near Rectilinear Halo Orbit (NRHO). In addition, links are required to support the Early Orbit test phase, communication checks during Electric Orbit Raising (EOR), and safe mode recovery links. PPE also includes S-band antennas to support proximity and docking operations.

Each link is described in terms of its function and purpose; uses and required data rates; antenna sizes and end points (e.g. lunar systems or NASA Space Communication and Navigation (SCaN) ground stations); coverage area, including analysis of blockage by the Gateway itself; required EIRP and G/T; polarization; and modulation type and coding rates.

We describe the adaptation of a standard geosynchronous satellite bus for service as the PPE. In addition, unique features of the implementation are presented (e.g. software defined modems, booms and gimbals, dual-use boom/antenna for Ka-band), and fault tolerance is considered.

Implementation and Link Descriptions

Detailed descriptions are provided for each of the following links, shown in Figure 2, and operational modes:

- Ka-band lunar link
- Ka-band Direct to Earth link
- X-band Direct to Earth link
- X-band Omni antenna CR&T
- X-band Omni antenna Safe Mode

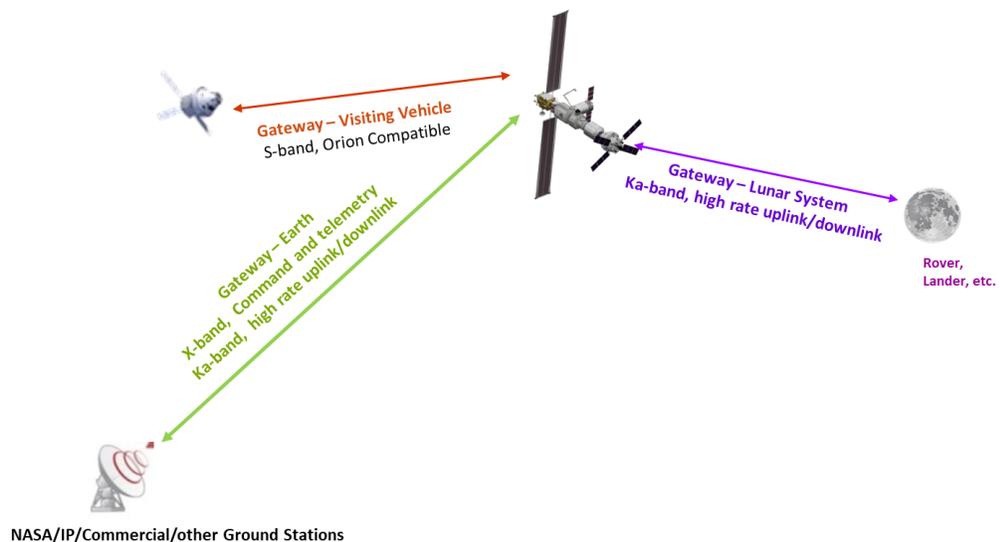


Figure 2. Gateway Link Diagram