# SpaceOps 2023 – NASA’s Deep Space Network (DSN) Lunar Exploration Upgrades (DLEU)

In the near future, the National Aeronautics and Space Administration (NASA) will return to the moon beginning the next era of human exploration. NASA’s Space Communications and Navigation (SCaN) program will play a vital role in establishing communications and navigation support to realize the ambitious goals of the Artemis program. SCaN’s overall lunar communications support plan will be covered in a separate 2023 SpaceOps paper: “NASA’s Communications and Navigation Architecture Plans to Support the Return to the Moon and a Sustainable Lunar Presence”. The plan as it currently stands, includes a three-fold approach of lunar relay services, a dedicated set of new ground stations and support through the Deep Space Network (DSN). This paper will have a more granular focus on the DSN and NASA’s plans to upgrade and expand the network to be better suited for human spaceflight on and around the lunar surface.

NASA’s Deep Space Network (DSN) will be a critical communications component for the upcoming lunar activities. There will be multiple spacecraft, using different bands, and some of those spacecraft will be transmitting and receiving using multiple bands, requiring DSN support of S-band (2 GHz), X-band (7 GHz up, 8 GHz down), and K-band (22.5 GHz up, 26 GHz down). Since there may be more than one spacecraft in the beamwidth of the DSN antennas, the DSN support will require an extension of the DSN’s capability to support multiple spacecraft using one antenna, expanding it to provide two simultaneous uplinks in the different bands at each antenna. Achieving this requires using new techniques for manufacturing the frequency selective surfaces, called dichroics, which steer the different frequency beams from and to the appropriate transmitting and receiving equipment, along with the addition of a new K-band uplink system. Additionally, due to the relative closeness of the moon from Earth (as opposed to the planetary missions the DSN supports daily), significantly higher data rates on both uplink and downlink are required, specifically up to 20 Mbps on the uplink and 150 Mbps on the downlink, both using Low Density Parity Check (LDPC) error correcting codes. And, again due to the relative closeness of the moon, there is a need for low latency data delivery of the high rate downlink telemetry which requires a change in the current DSN paradigm of delivering higher rate data with higher latency.