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# FROM LUNAR ORBITAL PLATFORM-GATEWAY TO INTERPLANETARY TRANSPORT SPACECRAFT-GETAWAY (M-ITS DEVELOPMENT UPDATE 2024)

**Abstract**

One of the main objectives of the near-term Cis-Lunar Space Exploration is to set foundation for the future robotics and crewed Deep-Space Exploration. Definement and incorporation of the Deep-Space Exploration architecture and elements into Cis-Lunar Exploration architecture is necessary for seamless transition and sustainable exploration. Lunar Orbital Platform-Gateway (LOP-G) is one of the core elements of Artemis Program, and has potential to be incorporated into this transition and future Deep-Space Missions. First part of the paper provides a reference overview of the LOP-G Phase 1 Configuration as of early 2024. LOP-G's primary use is to provide a transfer hub between the Earth-(in)bound and Moon-(in)bound spacecraft. Paper discuses challenges of the transfer hub driven design for the post-Artemis missions, and reuse options of the outpost elements for the future use cases. Second part onward, paper presents updates on the Modul Interplanetary Transport System (M-ITS) development. M-ITS aims to develop Interplanetary Transport Spacecraft for the late and post-Artemis applications. This can be achieved by converting LOP-G into Interplanetary Transport Spacecraft (G-ITS). Since the last update in 2022, M-ITS development has shifted to studying conversion as part of the LOP-G Phase 2 (Sustainable Phase) expansion. Second part outlines LOP-G conversion into G-ITS under the Phase 2. This is done through a five-phase plan. Each phase adds modules to the station, consequently expands its footprint, habitation volume and introduces new capabilities to the station. In addition to new modules, G-ITS reuses LOP-G Phase 1 elements by incorporating them into its design. Third part provides a comprehensive overview of the G-ITS design. G-ITS is designed to be orbit-to-orbit transport spacecraft. Sustainability of the spacecraft is achieved through modularity and reusability. Modular design future-proofs spacecraft, by allowing for expansion and reconfigurability. Addition of the Free Flyer furthermore enhances and expands G-ITS capabilities. Fourth part presents mission profiles for uncrewed Mars Demo Mission, followed by crewed Mars Demo Mission. Both missions utilize Short-Stay Mission profile with the departure from the Near-Rectilinear Halo Orbit (NRHO), Mars Orbit insertion, and Highly-Elliptical Orbit (HEO) return. In addition it discusses the possibility of incorporating Mars Surface and Mars Moon Mission elements in both mission profiles, and outlines spacecraft required for both missions. Fifth part of the paper explores alternative (re)use cases of the Phase 1 modules. Those include Asteroid Retrieval Spacecraft (ARS) for the Asteroid Redirect Mission (ARM) and Anchor Element (AE) for the NEO Asteroid and Martian Moons Missions.