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WHY MOON TO MARS: HOW NASA'S MOON THE MARS ARCHITECTURE PAVES THE WAY TO MARS

Abstract

NASA is establishing a long-term presence on the Moon to prepare humanity for the journey to Mars. Crewed lunar and Mars exploration are not two separate efforts; they are deeply entwined. NASA's Moon to Mars Architecture applies a systems engineering approach to achieve the agency's Moon to Mars Objectives, resulting in an evolutionary roadmap that proves capabilities needed for Mars at the Moon while developing requisite flight experience and industrial base.

NASA has over 60 years of experience in sending humans to — and operating in — low Earth orbit, including two decades of continuous human presence in space aboard the International Space Station. The agency has comparatively little experience with lunar exploration — nine Apollo missions on and around the Moon across five years. Thus far, humanity has only explored Mars with robots.

This paper highlights the major differences between these destinations, including the different gravitational environments, distances, communication delay times, human health and performance challenges, and flight dynamics parameters that a mission must account for. These challenges comprise four main facets of the Moon to Mars endeavor: national posture, engineering and design, operations, and the human system. This paper's analysis underscores that the first missions to Mars will be among the most arduous engineering challenges in history, far beyond anything yet attempted in spaceflight.

To ensure that the first human missions to Mars safely achieve their objectives, NASA will build experience in deep space operations by exploring the Moon. Proving Mars-forward technologies and capabilities during lunar exploration missions will reduce the risk of crewed Mars missions and help NASA develop concepts of operation for long-term, deep space exploration.

NASA is not waiting for its return to the Moon to being planning for human Mars missions. Initial planning for Mars, including documenting key driving decisions, has already begun, enabling lunar and

Martian exploration to inform one another. This parallel development approach ensures that the lessons NASA learns by returning to the Moon empowers the success of Mars missions, enabling the agency to achieve its exploration goals for the benefit of all humanity.