Deep Space 9 Mission Concept - Secondary Payload Study for the proposed Next Mars Orbiter

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Abstract

Deep Space 9 (DS9) is a proposed CubeSat-based distributed architecture for the exploration of the Martian surface and atmosphere. It is envisioned to complement and enhance the capabilities of the proposed Next Mars Orbiter (NeMO), a spacecraft concept currently under study as a potential future NASA orbital communication and reconnaissance mission to Mars in the 2020's. For the DS9 study, various NeMO concept parameters and capabilities were assumed. For instance, NeMO could potentially have the capability to carry and deploy secondary payloads into Mars orbit. The DS9 concept assumes and leverages this potential capability to eliminate the need for a dedicated launch vehicle and the propulsive/navigational capability necessary to achieve Mars orbit independently. DS9's use of a distributed architecture would introduce unprecedented coverage and revisit time to Mars climatology science, and could enable frequent high-fidelity radio sounding of the planet's lower atmosphere. Furthermore, it would constitute an excellent validation of various technologies currently under development by JPL and partner institutions to make deep space exploration accessible to CubeSats.

The hypothetical DS9 constellation would consist of four 6U CubeSats in low-Mars orbit that image the surface and atmosphere of Mars in nine spectral bands, and two additional 6U CubeSats in high-Mars orbit to enable radio occultation sounding of the atmosphere by transmitting to the CubeSats below. These observations would enable the characterization of the processes that control the distribution of dust and volatiles in the lower atmosphere as well as define the mechanisms by which these exchange between the surface and atmosphere. Furthermore, they would help determine the characteristics of the atmosphere that affect EDL designs and that may pose a risk to ascent vehicles, ground systems, and human explorers. Successful completion of these science objectives would further NASA's goal of characterizing the state of the present climate of Mars' atmosphere and its underlying processes, as well as the goal of obtaining knowledge sufficient to design and implement a human mission to the Martian surface within acceptable cost, risk, and performance parameters. Lastly, the mission concept would utilize mostly COTS parts and an updated version of the high-heritage Mars Color Imager (MARCI) instrument as the principal science payload. In doing so, Deep Space 9 would accomplish its objectives within minimal cost and risk levels.