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MARSDROP ARCHITECTURE: LANDING MICROPROBES AT EXCITING SITES ON MARS

Abstract

From canyons to glaciers, from geology to astrobiology, the amount of exciting surface science awaiting us at Mars greatly outstrips the available mission opportunities. Whether from the destination risks or just from the vast expense of a single Mars lander, the majority of proposed scientific surface missions are eliminated from consideration. To help bridge this shortfall, we propose an architecture to enable low cost delivery of small (30 cm diameter, 3-4kg), useful scientific payloads to designated spots on Mars. Such deliveries would piggyback on Mars-bound spacecraft, making use of often-available excess launch vehicle and cruise-stage mass capability, thereby permitting a greater variety of surface missions targeting a greater variety of landing locations.

The Aerospace Corporation's and JPL's experience with very small reentry vehicles (REBR, DS2) forms the starting point for a passively stable entry vehicle, whose low mass/low ballistic coefficient allows for a subsonic deployment of a steerable parawing glider, capable of up to 20 min and $10-20+$ km of guided flight at a 3:1 glide ratio. Originally developed for the Gemini human space program, the parawing is attractive for a volume-limited micro-probe, minimizing descent velocity, and providing sufficient remaining volume for a useful scientific payload. The ability to steer the parawing during descent opens up unique opportunities not traditionally available, including the possibility to add a terrain-relative navigation system to enable pinpoint landing within tens of meters of one of several specified targets within a target ellipse.

Our multi-disciplinary, inter-organizational team is tackling the challenge of developing the basic framework into a full-fledged mission architecture. On the technology front, ongoing high-altitude drop testing using weather balloons is demonstrating the parawing deployment under velocities and atmospheric densities expected during an actual Mars entry. The testing demonstrates the ability to integrate a parawing within a microprobe entry vehicle and gathers data on deployment loads and glide performance to feed back into the mission design. We are also working to map out technology maturation and demonstration steps along the way that could lead to the full capability, while also targeting intermediate capabilities, such as long glide without precision landing to emplace network sensors simply requiring geographic dispersion. On the science front, we are engaging with the broader community to identify exciting destinations and missions not well suited for the larger, primary-payload landers.

In sum, MARSDROP represents a new approach to augment Mars exploration by enabling precisely-targeted science at minimal cost.