Emerging Capabilities for Mars Exploration

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Emerging capabilities in a variety of technology domains will play a key role in enabling the next decade of Mars exploration. Future Entry, Descent, and Landing systems will support pinpoint landing capabilities and increases in delivered mass, while innovative small, hard lander concepts can offer low-cost methods for deploying ruggedized payloads to the surface. Tethered rovers and aerial rotorcraft systems can provide methods for accessing extreme terrains on the surface, beyond the mobility capabilities of current rovers. New remote sensing methods as well as deep drilling and sampling techniques can enable access to previously unexplored regions of the Martian subsurface, compelling targets in the search for modern habitable environments. Increased autonomy can enable large advances in the productivity of *in situ* explorers and maximize the science value returned from the Martian surface and from orbit; these autonomy advances will in part be made possible by orders-of-magnitude increases in flight computing capability, while avionics miniaturization will drive reductions in spacecraft mass, volume, power, and cost. Improvements in battery specific power and energy will be critical for mass-constrained vehicles such as Mars helicopters, while next-generation radioisotope power systems could be enabling for polar missions probing climate processes over the full Mars year. Key required in-space propulsion advances include a Mars Ascent Vehicle, an enabling capability for Mars Sample Return, as well as advances in chemical and electric propulsion systems for a wide range of spacecraft masses and mission scenarios. Emerging capabilities for small satellite missions, including innovative Earth-to-Mars transfer methods, can create the possibility for a new class of low-cost (sub-Discovery class) Mars missions with high science return, particularly when leveraging an evolving Mars telecommunication relay infrastructure.

This white paper will provide an overview of emerging capabilities and key technologies relevant to future Mars exploration. The paper will survey developments in a number of areas, including:

- Entry, Descent, and Landing
- Surface & Aerial Mobility

- Subsurface Access
- Autonomy
- Avionics
- Communications & Navigation
- Power
- Propulsion
- Small Satellite Technologies

The white paper will provide an assessment of the current state-of-the-art and trends in key capability/technology areas relevant to Mars exploration, forecasting current technology developments that can influence next-decade Mars mission plans while also identifying key capability gaps that motivate targeted future technology investments.

Status/Schedule: Initial outline established; first draft by May 1; mature near-final draft by June 1.

Collaboration: We welcome additional contributors, reviewers, and/or co-signatories; please contact Chad Edwards (chad.edwards@jpl.nasa.gov).