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MARS LINK: MULTI-LAYERED MARS EXPLORATION FRAMEWORK TO SUPPORT HUMAN SETTLEMENT AND RESOURCE UTILIZATION

Abstract

A comprehensive, systematic understanding of the Martian atmosphere, geology, and subsurface conditions is essential for successful human exploration of Mars. Existing missions have become scattered views: with limited, localized, and piecemeal information, predicting environmental hazards, locating resource-rich areas, or ensuring long-term habitability would simply not be shown anymore. MARS LINK provides a cost-effective multi-tiered exploration framework that incorporates satellites, autonomous aerial surveyors, and seismic landers into an information real-time survey network across the face of Mars. An AI-driven mission control system that ensures optimization of data exploitation with respect to resource allocation and real-time coordination among the satellite, aerial units, and landers would be provided. The proposed connecting networks are indeed capable of enabling high-resolution mapping, adaptive exploration, and in-situ assessments of resources, giving mission planners critical data toward future human habitation.

A low-cost satellite constellation guarantees continued access to global coverage of atmospheric dynamics, dust storm activity, and surface changes on the orbital end. This distributed system, unlike earlier missions with a single orbiter of limited coverage, enables almost real-time hazard forecasting for the implementation of entry, descent, and landing (EDL) systems. Among other things, the constellation does subsurface radar mapping and locating major geological features, for instance, lava tubes, possible water reservoirs, and structurally stable zones where the future humans will be outposted.

In the atmosphere, the Self-Sustaining Aerial Network (SSAN) of autonomous surveyors flying on solar power ensure continuous atmospheric surveillance. These flying machines are adaptive and dynamically alter their altitudes and trajectories to perform in-situ sampling of wind-currents, dust concentrations, and climate variabilities directly. SSAN contributes to arriving at the first predictive Martian climate model, thus improving the precision of landing site selection, mission safety, and habitat planning.

On the surface, a consortium of multifunctional landers serves as seismic observatories, energy hubs, and command centers for the Aerial Network. Among their compulsory features is an active seismic wave generator that will allow controlled vibrational mapping of the subsurface. This will show identified water-ice deposits, mineral-rich zones, and structurally stable areas of future human outpost areas. Alongside this, autonomous robotic explorers will penetrate lava tubes utilizing navigation and sampling AIs to carry out high-resolution imaging and chemical assessment to determine their suitability for human habitation in those regions.

MARS LINK integrates orbital, aerial, and surface assets-for real-time, global-scale planetary perspectives and, This scalable, modular paradigm represents those initial survey data to support sustained human presence on Mars.