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SPACE EXPLORATION SYMPOSIUM (A3)
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Author: Mr. Jeremy Straub
University of North Dakota, United States

A MULTI-TIER MARS MISSION ARCHITECTURE

Abstract

Space missions have normally consisted of a single orbital craft or an orbital craft that operated in conjunction with a ground rover. Due to this, the area that is surveyed generally falls within a small radius of the landing zone. Each area to be explored, thus, requires another expensive mission. An area or object of interest discovered by an orbital craft from one mission will generally require another mission to perform in-situ data collection.

Fink [1] has proposed a multi-tier mission concept, which has been extended by [2]. Under this approach, a single interplanetary craft is dispatched. Once the interplanetary craft is in orbit of the target, small satellites, aerial vehicles and surface rovers and progressively deployed. The orbital craft will image the target area and, when areas or items of interest are found, deploy aerial craft for additional more detailed inspection. If the data collected by the aerial craft confirms the initial assessment that the area or object is of interest, the aerial craft will deploy one or more ground craft to perform more detailed analysis.

A Mars survey mission architecture is proposed which utilizes the multi-tier mission architecture to identify prospective locations for a human outpost and ascertain their suitability. This architecture incorporates an orbital tier consisting of a large interplanetary craft and five CubeSat class craft, which provide imaging, communications relay and relative positioning services to the lower-tier craft. The aerial-tier incorporates H2 blimps and UAVs, which perform more detailed imaging and deploy the ground craft. The surface tier consists of rovers with imaging and soil sampling and analysis capabilities.

This paper presents a brief overview of the multi-tier mission architecture. It presents, in detail, an architecture for a multi-tier Mars mission, discussing the craft capabilities for each tier, the autonomous collaborative control approach utilized, and prospective mission goals and a discussion of how they would be attained. The proposed mission architecture is compared, in terms of cost and science return, to the historic mission approach style.

References: [1] W. Fink, et al., "Tier-Scalable Reconnaissance Missions for the Autonomous Exploration of Planetary Bodies," Proceedings of the 2007 IEEE Aerospace Conference, 2007. [2] Straub, J. and R. Fevig. 2012. Multi-Tier Planetary Exploration: A New Autonomous Control Paradigm. Submitted for publication in the proceedings of the AIAA SPACE 2012 Conference.