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Systems and Infrastructures to Implement Future Building Blocks in Space Exploration and Development (2)

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MARS MOLNIYA ORBIT ATMOSPHERIC RESOURCE MINING

Abstract

Landing on Mars is extremely difficult (Braun Manning, 2006) and is considered one of NASA's biggest technical challenges on the journey to Mars. Science magazine (Kerr, 2012) reported the following about the NASA Mars Science Lab (MSL) Mission:

"Not only will NASA have to slow the most massive load ever delivered to another planet's surface from hypervelocity bullet speeds to a dead stop, all in the usual "7 minutes of terror." But NASA is also attempting to deliver Curiosity to the surface of Mars more precisely than any mission before, within a 20-kilometer-long ellipse some 240 million kilometers from Earth. Both feats are essential to NASA's long-term goals at Mars: returning samples of Martian rock and sending humans to the Red Planet."

As a result of the thin Mars atmosphere, this challenge is exacerbated as the payload mass is increased. This NASA Innovative Advanced Concepts (NIAC) project has studied one of the top challenges for landing large payloads and humans on Mars by using advanced atmospheric In-Situ Resource Utilization (ISRU) methods that have never been tried or studied before. The proposed Mars Molniya Orbit Atmospheric Resource Mining concept mission architecture changes the paradigm of Mars landings for a wide range of vehicle classes to make the Earth-Mars round-trip travel robust, affordable, and ultimately routine for cargo and crew, therefore enabling the expansion of human civilization to Mars.

In-Situ Resource Utilization (ISRU) on the surface of Mars has been proposed and studied for making rocket propellants, in order to fuel a Mars Ascent Vehicle (MAV), (Drake et al, 2010; Zubrin, 1991) but using ISRU in Mars orbit to make propellants for retro-propulsion enabled Entry, Descent and Landing (EDL) is a new concept, that creates an unprecedented association of ISRU and EDL. A new architecture with associated infrastructure and elements will be presented which enables routine operations of a 20 metric ton payload capacity single stage reusable lander (SSRL) for routine landings and launches on Mars without transporting the needed propellants from Earth.

References:

Braun, R. D., Manning, R. M. (2006, March). Mars exploration entry, descent and landing challenges. In Aerospace Conference, 2006 IEEE (pp. 18-pp). IEEE.

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Kerr, R. A. (2012). Hang on! Curiosity is plunging onto mars. Science, 336(6088), 1498-1499