Abstract #825

English

SPACE RESOURCE UTILIZATION: NEAR-TERM MISSIONS AND LONG-TERM PLANS FOR HUMAN EXPLORATION

NASA's Human Exploration Plans: A primary goal of all major space faring nations is to explore space: from the Earth with telescopes, with robotic probes and space telescopes, and with humans. For the US National Aeronautics and Space Administration (NASA), this pursuit is captured in three important strategic goals: 1. Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere, 2. Extend and sustain human activities across the solar system (especially the surface of Mars), and 3. Create innovative new space technologies for exploration, science, and economic future. While specific missions and destinations are still being discussed as to what comes first, it is imperative for NASA that it foster the development and implementation of new technologies and approaches that make space exploration affordable and sustainable. Critical to achieving affordable and sustainable human exploration beyond low Earth orbit (LEO) is the development of technologies and systems to identify, extract, and use resources in space instead of bringing everything from Earth. To reduce the development and implementation costs for space resource utilization, often called In Situ Resource Utilization (ISRU), it is imperative to work with terrestrial mining companies to spin-in/spin-off technologies and capabilities, and space mining companies to expand our economy beyond Earth orbit. In the last two years, NASA has focused on developing and implementing a sustainable human space exploration program with the ultimate goal of exploring the surface of Mars with humans. The plan involves developing technology and capability building blocks critical for sustained exploration starting with the Space Launch System (SLS) and Orion crew spacecraft and utilizing the International Space Station as a springboard into the solar system. The evolvable plan develops and expands human exploration in phases starting with missions that are reliant on Earth, to performing ever more challenging and longer duration missions in cis-lunar space and beyond, to eventually being independent from Earth. The goal is no longer just to reach a destination, but to enable people to work, learn, operate, and live safely beyond the Earth for extended periods of time, ultimately in ways that are more sustainable and even indefinite. In Situ Resource Utilization and Importance of Space Resources: In Situ Resource Utilization involves the processes and operations to harness and utilize resources in space (both natural and discarded) to create products for subsequent use. Potential space resources include water, solar wind implanted volatiles (hydrogen, helium, carbon, nitrogen, etc.), vast quantities of metals and minerals in extraterrestrial soils, atmospheric constituents, unlimited solar energy, regions of permanent light and darkness, the vacuum and zero-gravity of space itself, trash and waste from human crew activities, and discarded hardware that has completed its primary purpose. ISRU covers a wide variety of concepts, technical disciplines, technologies, and processes. When considering all aspects of ISRU, there are 5 main areas that are relevant to human space exploration and the commercialization of space: 1. Resource Characterization and Mapping, 2. In Situ Consumables Production, 3. Civil Engineering and Construction, 4. In Situ Energy Production and Storage, and 5. In Situ Manufacturing. Since much of what ISRU encompasses can be considered 'space mining', ISRU developers have used the terrestrial mining philosophy as a starting point to developed a Space ISRU Mining Cycle, or "Prospect to Product", to identify and focus technology, process, and integrated testing activities. There are five major benefits for incorporating the use of space resources into human space exploration missions; mass reduction, cost reduction, risk reduction and increased mission flexibility, enhancing/enabling human expansion into space, and terrestrial/space commercialization. For every kilogram landed on the Moon or Mars, 7.5 to 11 kg must be launched into LEO from Earth. Since propellants make up between 70 and 90% of the mass of chemical propulsion stages and landers, making propellants in-space and on the surface of the Moon and Mars can significantly reduce what needs to be launched from Earth; thereby reducing cost and mass. ISRU can also further reduce costs by enabling reusability of equipment and transportation vehicles that were previously discarded once their consumables had been used. Extraction and production of metals, plastics, and building materials also reduces risks due to failures, reduces logistics from Earth, and enhances or enables the expansion of human exploration and the commercialization of space.

French

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