Envision of Space Colony on the Moon

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Village, Exploration, Culture, Society (maximum 5 words)

As the 50th anniversary of Apollo 11's lunar landing achievements, the Artemis program has started. It is on going crewed spaceflight program led by NASA with the goal of "the first woman and the next man" landing on the Moon by 2024. It will be the beginning of the era that every people become to be able to go to space travel as overseas trip. For exploration to outer planet, sustainability against extraterrestrial environment, and in situ resource utilization (ISRU) and recycling are required. MHI is considering how to realize moon exploration and build moon society with the heritage of the entire firm. MHI offers not only space transportation system but also power generation systems, air conditioning systems, CO2 capture systems, machinery systems and so on. Moon society will be constructed based on those whole technologies by collaborately working with other companies, agencies and countries.

MHI envisions overall Moon society image and choses two key architectures. First is transportation systems based on hydrogen: launch system, orbital transportation system and landing system.[1] Hydrogen has high specific impulse and high thrust engines to realize fast transport from Earth to Moon surface. Furthermore, because the past mission found hydrogen on Moon, it has the possibility of implementing local production for local consumption. Second is power system based on Moon sources. Power is essential to establish life activity on Moon. Through demonstrating those two technologies mainly on moon, MHI leads to acquire space colony construction engineering for the humankind to explore Mars, asteroid and so on in the future.

[1] S. Hyodo et al, "A GATEWAY SUPPLY MISSION SCENARIO AND FLIGHT PLAN WITH UPGRADED H3 AND HTV-X", 70th IAC, IAC-19, D2.8-A.5.4

Consumer and Producer in the Moon Surface Society

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The presentation provides a summary of the activity in IHI Group regarding the study of the business opportunities in the future moon society. It introduces the discussion about the needed services in the moon society that includes consumer and produce of the services. They started the discussion from what is needed at the start of mankind society on ground in ancient times. Essential part of the services is food, housing and clothing. But mankind in the present day needs more service for mobility, luxury, health, etc. It is the same on the moon society. The connection of the consumer and producer expands to the very wide range of the service and it creates an ecosystem on the moon. Based on the discussion about the ecosystem on the moon society, IHI group studies their area of contribution on the moon such as transportation rover, mining machines, material process plant, water/propellant process plant and it realize that it becomes a consumer to create service on the moon. IHI become an element of ecosystem and needs to work together with all other contributor on the moon.

Elastic Wheel for Lunar Rover

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Brigestone Corporation will take part in an international space exploration mission together with the Japan Aerospace Exploration Agency and Toyota Motor Corporation. Bridgestone's involvement in this mission will include researching the performance needs of tires for use on manned, pressurized lunar rovers to help these rovers make better contact with the surface of the Moon. Bridgestone's expertise and knowledge of tire contact patch will help explore the mobility challenges faced on the Moon surface, with the development of an Elastic Wheel to support the rover's weight, acceleration and braking, minimize shock absorbance, and improve maneuverability, enabling the rover to cruise more than 10,000 km on the Moon surface, required to accomplish the mission. Bridgestone has been developing rubber pneumatic tires for many vehicle types including aircrafts, but rubber cannot withstand the very low temperature conditions of the Moon surface. There is no air existing. Since the air inflation pressure concept cannot be used for supporting rovers' weight, Bridgestone is developing "all metal" elastic wheels. One of the technical issues is how to make contact patch bigger in order to avoid sticking into the regolith. Camel is the specialist of sand walking and we got some hints from foot sole of camel. A demonstration prototype elastic wheel was just developed and we are now preparing some traction tests on the desert.

References

[1] S.Wakabayashi, Y.Kouno, S.Nishida, Low-pressure mobility system for lunar robotic vehicle, The 29th Annual Meeting of Japanese Society for Terramechanics, Vol.29 (2008), Documented in Japanese

ASTRAX Lunar City Development Project Overview

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The ASTRAX Lunar City Development Project started in 2007. Since then, we have gathered over 260 companies, stores, shops, schools, organizations and workers as ASTRAX Lunar City Developers to work together to develop economic areas, merchants and service providers on the Moon. Furthermore, we are making a map of the ASTRAX Lunar City and are developing a smartphone application to connect each Lunar City member and their business activities on the Moon. We are also developing a new platform, application and blockchain technology to establish an economic zone in the solar system, including the Moon. We have events and meetings by Lunar City community members every two months in Japan (usually in the Tokyo area). Taichi Yamazaki is going to introduce the current status of the ASTRAX Lunar City Development Project and our future plan at the International Moon Village Workshop and Symposium in Tokyo in December 2019.

[1] ASTRAX Lunar City Developing Project Overview, T. Yamazaki (International Space Development Conference 2019, Washington D.C. USA, 2019)

[2] ASTRAX SPACE SERVICES PLATFORM BY USING BLOCKCHAIN TECHNOLOGY, T. Yamazaki (70th International Astronautical Congress 2019, Washington D.C. USA, 2019)

To the Moon and Back, Your Comms Made Simple

Relay Communication Services Around the Moon in 2023

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ABSTRACT

The International Astronautical Congress (IAC) last October saw the Japanese, Russian and European agencies enthusiastically support the Moon exploration programme Artemis. As the US-led initiative continues to accelerate, international partners need to find their place in the lunar ecosystem. For ESA, fate will be decided on the last week of November in Seville (Space 19+ ministerial conference), where the 22 member states will vote on its involvement.

Amongst the expected outcome of Space 19+, a mission called Lunar Pathfinder, realised in partnership between ESA and SSTL to pioneer the first commercial application of relay communication services around the Moon. In addition to the technology, Lunar Pathfinder will test and validate an innovative business model, by which industry provides affordable services to Space Exploration and institution contributes to mitigate the market risks, both stimulating scientific research in a win-win scheme.

This innovative model has been developed by ESA, SSTL and GES, in the frame of the Commercial Lunar Missions Support Services (CLMSS) partnership: an off-planet telco capable of offering communication and navigation services to customer assets on and around the Moon, with a shared and standardised infrastructure providing an affordable solution to all programmes.

Due to launch in Q4-2022, Lunar Pathfinder, a single lunar orbiter, will be available for companies and institutions to buy communication services packages, designed to relay data between lunar assets and dedicated GES ground station.

Offering S-band and UHF links between orbiter and lunar asset, Lunar Pathfinder will relay in X-band back to Earth. Thanks to its proximity to lunar assets, it will provide enabling services to polar and far-side missions, in need of relays due to their lack of direct line of sight to Earth. Orbiters and near-side missions will benefit from a better availability, improved data-rate and cheaper alternative to direct to Earth solutions, while pressure on institutional deep space ground stations will be relieved. When used as a main communication node, it will also allow lunar assets to simplify their communication modules, focusing mass and resource to their scientific payloads instead.

In parallel, the CLMSS partnership is working on what comes after Lunar Pathfinder, as the market opens from exploration towards in-situ resource utilisation or purely commercial applications such as tourism. The service will evolve from a single spacecraft to a constellation, building off Lunar Pathfinder's first mover advantage, and offering extended communication availability, capacity and navigation capabilities, from 2030 onwards.

The constellation will be developed in coordination with ESPRIT (the communication module of the Gateway), follow international communication standards, and be part of a fully integrated and interoperable network with space and ground assets.

Keywords: Lunar, Communications, Far-side, Data Relay, Moon, Low-cost