Paper ID: 63233
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IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

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INTRODUCING A NEW PARADIGM IN TACKLING THE LUNAR NIGHT SURVIVAL CHALLENGE

Abstract

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During the latest years, the Moon has become the primary target for advancing human space exploration. In the current scenarios, human settlements will be preceded by a robotic exploration phase that will provide a clearer vision of the technological challenges to overcome to create a life-supporting ecosystem. The robotic exploration phase will take advantage of swarms of semi-autonomous rovers whose deployment should start as soon as 2021.

One of the main operational limitations developers should face is represented by the harsh environmental conditions in which rovers should operate, the crucial one being the severe day-night temperatures' cycles. Lunar nights last about fourteen days and the temperatures on the surface could drop to unacceptable values for any present electronics and power supply. The problem has been addressed from different perspectives, including nuclear power to warm up the critical components, thermal shielding design for power elements such as batteries, and the drilling of heat pumping systems. Preliminary testing with nuclear power sources has promised to keep rovers alive for some days/night cycles. Despite these encouraging results, the standard scenario accepted so far foresees that rovers will be active during the Lunar day and die out during the long Lunar night.

A common trend is tackling the Lunar Night survival problem by focusing on protecting single rovers or structures. The starting point of the following feasibility study, is based on a more systemic hypothesis that has a more significant attractiveness at the technological level and the level of a future Lunar economy. The focus is on the imagine that the Moon will and should be provided with infrastructures, e.g. highways, linking the separate hubs where human settlements, mining sites, power production, or water extraction will take place. In that optics, it is conceivable to create autonomous shelters rented by rovers' providers to survive the Night conditions.

Those shelters will represent the backbone of a service industry on the Moon that will grow with the spreading of the human presence and robotic exploration. The proposed study also outlines a technological solution based on a combination of composite aerogels made from regolith coupled with a heat pumping system as the essential elements for building protecting shelters. An economic evaluation of the advantages of this solution against alternatives is given. The potential net value of survival shelter services is finally presented.