SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Systems and Infrastructures to Implement Future Building Blocks in Space Exploration and Development (2)

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# INNOVATIVE ORBITAL SUPPORT SERVICES FOR SUSTAINABLE LUNAR EXPLORATION AND EXPLOITATION

**Abstract**

As space agencies discuss the stepwise approach to human space exploration beyond low Earth orbit, the speed and length of these steps largely depend on the technological capabilities and the available resources. Similar to the terrestrial exploration and exploitation of new regions, sustainability of the approach will require the careful implementation of critical support and service infrastructure for long-term utilization, based on a thorough analysis of the vision for utilization priorities and scale. However, such a sustainable approach may need larger upfront investments in this service infrastructure and innovative concepts with inherent risk for long-term gain, an investment that some players are unwilling to make without a consensus on the long-term roles and benefits. At the same time, the early availability of such services could enable a faster pace of exploration.

The Global Exploration Roadmap, developed by the space agencies participating in the International Space Exploration Coordination Group (ISECG), currently provides the best baseline planning for the near- and medium-term developments and mission scenario for human space exploration. Building on the GER, this paper tries to sketch opportunities for the installation of critical centralized service elements in the fields of lunar communications, navigation and energy distribution. Innovative ideas like the use of non-Keplerian orbits to provide continuous coverage of lunar polar areas with a single spacecraft are discussed. The spacecraft would then provide a simplified relay node for lunar surface assets, similar to geostationary satellites for terrestrial applications. Furthermore, establishment of orbital support spacecraft at selected locations does not only enhance communications links, but provides synergies with approaches to power beaming and illumination provision for lunar night survival and to support operations in permanently shadowed regions. First feasibility estimations in terms of orbit assessment and technical design of the associated space segments are provided.