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DESIGN CASE STUDY OF A NATIONAL SPACE STATION: ORBITAL, LOGISTICAL AND STRATEGIC CONSIDERATIONS

Abstract

Since the launch of Sputnik-I, humanity has seen tremendous leaps in advancements of space technology and dominance in the final frontier. This growth occurs in stages easily demarcated by landmarks ranging from indigenous rockets and satellites to full-scale space programs to advanced missions towards the edges of space. Different geopolitical regions currently stand in different positions on this scale. From a terrestrial perspective, the pinnacle of advancement would be a Spacefaring utopia, for which a mandatory milestone is the establishment and successful operation of a Space Station.

At a global scale, the International Space Station is the state-of-the-art of Space Station architecture, although studies for the Lunar Gateway and other strategically located Space Stations as transit points to advance colonization missions are an area of interest for all Space Agencies worldwide. Adding a polarizing condition of political and national interests, having a dedicated Space Station for the country not only has a variety of techno-commercial applications ranging from scientific experiments and astronomy to astronaut training and missions, but also military and strategic operations such as reconnaissance, surveillance and indigenous RD applications for defense and space.

India, with its first manned mission to space with three astronauts for seven days in the Gaganyaan Capsule, currently being trained in Russia with support from ROSCOSMOS, is slowly but steadily joining this race to be an advanced Spacefaring utopia, highlighting the need for a National Space Station. This work elucidated a cost-effective National Space Station Architecture to support 7 Astronauts for a period of 6 months per Capsule, with the Operational and Logistical Architecture Validation, followed by Mission Design and Life Validation on GMAT for a duration of five years without major system or module replacements. The orbit is designed to strategically support national and technological interests of both defense and civilian entities of the nation, along with optimization of launching to and from India and other locations ranging from locations under protection such as Bhutan and Maldives to supporting countries such as Russia, Japan, Singapore and Italy to strategic bases such as Tajikistan and Assumption Island, along with potential payload applications and reconnaissance. The cumulative results also provide projections and optimal recommendations for the Space Station to support current and in-development projects of the Indian Space Program, with scope areas for future developments. The space station is designed with considerations for future applications such as docking of space crafts for boosted launches to Moon or Mars, in-space 3D Printing, Space Debris Mitigation and Situational Awareness studies, microgravity and technology demonstration applications, space tourism and a wide range of applications to make India self-sufficient in the Space Sector.

With precise planning and effective engineering, this space station would reduce India's reliability for data on other nations, put India on the global map and also mark a milestone for ambitious manned missions to other heavenly bodies, along with the capability to support partnering nations in matters of bilateral interest in the Space Sector.