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ENABLING NEXT-GENERATION COMMERCIAL SPACE STATIONS: CASE STUDY ON TESSELLATED HABITATS IN LOW EARTH ORBIT

Abstract

As NASA moves to bolster commercial space station activity in Low Earth Orbit (LEO), building forward from last year's NextSTEP announcement and the commercial module appendage to the International Space Station (ISS), we expect to see continued growth and interest in new space architecture concepts for mixed-use crew scenarios. The next decade of habitat development and deployment will likely serve astronauts, scientific and expeditionary crews, and space tourism. As the space industry collectively prepares for a broadening of access to spaceflight, we must design in-space habitat infrastructure that both scales to meet a growing demand and offers a user-centric, user-flourishing approach to architecture.

This paper will build on the TESSERAE (Tessellated Electromagnetic Space Structures for the Exploration of Reconfigurable, Adaptive Environments) concept presented previously [1], and will share a detailed, prospective case study on the application of this habitat building technology in LEO. A roadmap will be presented from current TRL maturity to achieving steady-state TESSERAE habitat occupation in a prospective "Phase 2" of commercial habitats in LEO. In the authors' framing, Phase 0 captures the "International Space Station Era" (including precursors from SkyLab, Mir, and Tiangong); Phase 1 presents the family of concepts vying for the 1st standalone commercial space station platforms including proposals from Axiom [2], Bigelow [3,4], Nanoracks [5] and others; and Phase 2 posits a next-generation technological approach to scaling in-orbit space habitation where autonomously self-assembling habitats supplement in-space infrastructure (in combination with traditional pre-fabricated and unibody pressure-shell models). We will show how the flexibility of TESSERAE ConOps provides for agile mission scenarios and answers certain use-cases for architecture in orbit uniquely suited to the approaching expansion in access to spaceflight. After covering the case study and discussing the roadmap, this paper will go into detail on a 1st generation TESSERAE habitat concept, presenting a series of interior use ConOps (Concept of Operations) for the TESSERAE model that integrate new ECLSS (Environmental Control and Life Support Systems) systems into modular tiles and architectural renderings for day-to-day functional zones.

[1] Ekblaw, Ariel, Anastasia Prosina, Dava Newman, and Joseph Paradiso. "Space Habitat Reconfigurability: TESSERAE platform for self-aware assembly." 30th IAA SYMPOSIUM ON SPACE AND SOCIETY (Space Architecture: Habitats, Habitability, and Bases). Proceedings of the IAF International Astronautical Congress 2019. [2] "Axiom Commercial Space Station." Axiom. https://www.axiomspace.com/axiom-station [3] "Bigelow Expandable Activities Module (BEAM)," Bigelow Aerospace and NASA, Available: https://www.nasa.gov/content/ bigelow-expandable-activity-module. [4] "B330: XBASE." Bigelow Aerospace. https://bigelowaerospace.com/pages/b330/ [5] "Outpost." NanoRacks. https://nanoracks.com/outpost/