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# EXPLOITING A HIGH-POWER ELECTRIC SPACE TUG TO SUPPORT THE DEEP SPACE GATEWAY

**Abstract**

"Earth is a small town with many neighborhoods in a very big universe", as quoted by the NASA Astronaut Ronald John Garan Jr. . The new era of space exploration has begun. The strategic objectives, acknowledged by the majority of the space agencies, focus on the expansion of the frontiers of knowledge, capability, and opportunities in space. This outstanding goal will increase robotics missions in the Solar system and returns humans to the Moon before sending them to Mars, starting from the experience gained with the International Space Station (ISS). The first milestone is represented by the settlement of the Deep Space Gateway (DSG) by the mid 2020's in the lunar proximity to speed up the space conquer and open new frontiers. Among all the critical technologies identified as key enablers for the DSG development, the high-power Solar Electric Propulsion will represent the core of its Power and Propulsion Element (PPE), including the 20kW-class European Hall Effect Auxiliary Thruster (e-HEAT). The future lunar gateway will include also an airlock, a logistic module to enable research, a robotic arm and a small habitat to host 4-members crews every year for missions of at least 30 days at a time. Hence, to support the crew for the whole mission duration, cargo ships are required to transport and delivery refurbishment, resupply and fuel to the station. Following acknowledged mission guidelines based on modularity, commonality, extensibility and affordability, the adoption of a high-power SEP platform, based on the same e-HEAT technology, could represent a valid alternative to those already envisioned. This 15-20 kW Hall Effect Thruster (HET) string should be used for orbit maintenance, electric orbit raising (EOR) and attitude control. In this paper, the design of the new building block, represented by a reusable electric space tug, is described and main mission, mass and power budgets are obtained, exploiting the MIssion and Space System (MISS) design tool. In particular, the identification of an optimal working point with respect to a preliminary performance map is investigated, comparing the different platform architecture with respect to mission drivers, system constraints and exploitation feasibility. Further analysis are carried out on the performance degradation rate of the thruster lifetime considering the actual HET working point along the mission with respect to the optimal one considered for the thruster design and development. Main results are presented and discussed, and main conclusions are drawn.