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MODEL-BASED TECHNOLOGY ROADMAP FOR FUTURE ROBOTIC ON-ORBIT SERVICING

Abstract

We developed a model-based technology roadmap that explores the capacity of on-orbit servicing to perform various in-space operations as a technology enabler for future space missions and satellite services. Robotic on-orbit servicing (OOS) is expected to be a key technology for future sustainable space exploration. We explore a technology strategy for the development of a robotic spacecraft equipped with the tools, technologies, and in-orbit refueling techniques needed to extend the lifespan of orbiting satellites, in order to maximize overall Net Present Value.

We also consider other OOS use cases such as last-mile orbit delivery, in-orbit refurbishing, and payload upgrades. We identified a set of figures of merit (FoMs) for estimating performance and lifecycle cost associated with robotic on-orbit servicing operations. Our FoMs include payload mass, delta-V for the developed service modules, and operational lifetime.

We use an Object Process Model (OPM) to describe the system architecture of the robotic on-orbit servicing system and supporting infrastructure. We use the OPM model as the knowledge backbone of our technology roadmap. We benchmark state-of-the-art in OOS through in-depth content analysis and literature review, as well as describe a technical model to set credible performance targets for future OOS systems. We develop a first-order financial model associated with optimal OOS system architectures in order to inform OOS phased deployment, as well as expected Net Present Value under different operational scenarios (pessimistic, baseline, and optimistic). Ultimately, our technology roadmap provides an unbiased, data-based assessment for informing future decision-making in the development of OOS systems by setting feasible technology targets validated by the described model-based approach.