Paper ID: 63731
student

IAF SPACE SYSTEMS SYMPOSIUM (D1)
Space Systems Architectures (2)

Author: Ms. Victoria Krivova
Skolkovo Institute of Science and Technology, Russian Federation

Prof. Alessandro Golkar
Skolkovo Institute of Science and Technology, Russian Federation

SYSTEMS ARCHITECTURE STUDY OF ON-ORBIT SERVICING INFRASTRUCTURE DEPLOYMENT SCENARIOS

Abstract

This paper presents a systems architecture study to analyze and identify optimal systems architectures for on-orbit servicing (OOS) infrastructure. In this work, we consider on-orbit servicing in its functionalities of spacecraft refueling, refurbishing, upgrading and orbit transfer services, as potential means for lifetime extension of existing satellites in orbit, and last mile orbit delivery for new launches.

The main goal of this paper is to identify optimal OOS systems architectures for proxy figures of merit evaluating system-level performance and lifecycle cost for the above mentioned functionalities. In the assessment we consider three main servicing strategies, including on-orbit satellite refurbishing, refueling and repositioning. We consider scenarios with a variable number of servicing modules (1 servicer/1 servicer + 1 fuel depot/multiple modules).

Initial orbital location options of the OOS infrastructural elements are determined based on the optimal accessibility to the customer satellites. We estimate the number of servicing missions conducted before a servicer's refueling. A set of parametric models, including OOS infrastructure mass budget and mission cost models, is developed for the analysis. In this paper, we consider an initial deployment scenario of a single servicer aimed at serving customer satellites in geostationary orbits.

We consider and evaluate alternatives of on-orbit servicing using single stage and multiple stage OOS modules, and derive conclusions related to technology selection (e.g. propellant) as well as delta V allocation. We analyze prospective development scenarios under potential demand growth, estimated using parametric models.

Our results set the basis for further exploration of this topic in the future, and define a parametric methodology for deriving traceable, quantitative estimates of OOS performance that could be used by decision makers to inform the development and evolution of future on-orbit services.