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A PRELIMINARY ARCHITECTURE OPTIMIZATION FOR IN-SPACE ASSEMBLED TELESCOPES

Abstract

The current trend towards larger diameter space-based and ground-based telescopes reflects both improvements in manufacturing abilities and the need for more light-gathering capability. Although ground telescopes can continue to grow in diameter using previous manufacturing and assembly techniques, space-based telescope mirror diameters are limited by the fairing size of a single launch vehicle. Looking towards the future, the demand for larger diameter primary mirrors is expected to quickly outgrow the size of a single launch vehicle fairing. In this case, the only viable option for a larger diameter space telescope will be on-orbit assembly. This paper provides a preliminary framework to optimize the architectural trade-space of in-space assembled telescopes as well as a metric to quantify the relative cost of the designs. Key parameters driving the architecture of such a system were identified and several variations of the parameters enumerated. These include primary mirror segment size, raft (i.e., unit of segments ready for assembly) geometry and configuration, in-space assembly location, and launch vehicle selection.

The results of the paper are presented through a Pareto Analysis which ultimately describes the optimal architecture against the trade-space considered. This includes design of fuel-efficient trajectories generated from the Circular Restricted Three-Body problem for transfer of components to the assembly and mission locations (e.g., Earth-Moon L1, Sun-Earth L2). Furthermore, an optimization scheme is demonstrated for launch vehicle packing/manifest with constraints on component selection, payload limitations for reaching the desired assembly point, and scheduling of launch vehicle and components.