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Lessons Learned in Space Systems: Achievements, Challenges, Best Practices, Standards. (5)

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THE EFFECTS OF THE DESIGN ON THE SATELLITE REFUELING SYSTEM EFFICIENCY.

Abstract

Satellite on-orbit refueling (OOR) is the process of replenishing the propellant of a satellite while it is orbiting in space. The systems conducting OOR require mechanisms to transfer fuel from the chaser to the target satellites. Advances in technology and spacecraft design are making it increasingly feasible to perform on-orbit refueling, which can help extend the lifespan of satellites and enable more ambitious space missions. In some cases, OOR enables the satellites to perform additional tasks beyond its original design.

There are a few variations of satellite OOR methods, including docking refueling, robotic refueling, crewed refueling (Human-assisted) and self-refueling. These methods take into an account a variety of factors, such as the type of spacecraft, the type of fuel being transferred, and the mission objectives.

This paper discusses the current available technologies and addresses methodologies of measuring the efficiency of the OOR by comparing past missions, as well as displays the potential future developments in satellite orbit refueling technologies. Furthermore, 3D models, simulations and software analysis of **on-orbit refueling concepts** are presented and compared using different configurations. A review of key technologies and missions of OOR systems such as Experimental Test Satellite 7, Orbital Express satellite, Robotic Refueling Mission (RRM) and Restore-L Mission is conducted. An evaluation of implemented mechanisms is done to determine the feasibility and efficiency of OOR missions. Thereafter, the results are depicted through quantitative data within the paper. The efficiency of refueling methods for OOR missions is evaluated based on several factors, such as: transfer rate, reliability, safety, complexity and cost.

OOR technology is still in its early stages and as it continues to develop, more missions are expected to be conducted in the near future. Compatibility between the spacecraft's, fuel transfer and handling, propellant compatibility, standardization of the components are challenges associated with the realization of OOR missions. However, despite these challenges, OOR missions have the potential to provide significant benefits to active missions, such as extending the lifespan of spacecraft and reducing the cost of continuous spacecraft development.