

SPACE SYSTEMS SYMPOSIUM (D1)
Space Systems Architectures (4)

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DESIGN OPTIMISATION FRACTIONATED SATELLITE SYSTEMS

Abstract

The concept of fractionated satellites involves the decomposition of the traditional monolithic satellite into a system of free flying satellites with specific functions, such as to provide a high speed data relay to the ground. These satellites share resources to achieve the mission. To date, research into fractionated satellites has largely focused on quantifying the programmatic and economic benefits of implementing this concept for the next generation of space systems. However the significant technical and operational challenges to satellite fractionation have not been studied as extensively. This paper examines the many different configurations a fractionated satellite might take and how they might be operated once in space. A variety of fractionated satellite architectures have been simulated taking into account the satellite and subsystem failures based upon a bath-tub type failure rate curve. The architectures are characterised by parameters, such as the degree to which the system is fractionated, the number of satellites in the system, and the distribution of subsystems on the satellites. There are a very large number of combinations and so simulations have been performed to identify the optimum architecture over a long period of continuous operation. The objective of these simulations is to characterise how each fractionated architecture performs over a 50 year lifetime with respect to the failures. Each architecture is assessed with respect to two traits: the percentage of the lifetime that the payload and system operations can be maintained, and the total mass launched. A local search optimisation based on this assessment is used to highlight particular characteristics of fractionated architectures that maximise operational time whilst minimising the mass. Results show that the outcome of this optimisation will be strongly influenced by the redundancy strategy employed, the distribution of subsystems throughout the fractionated system and the degree of fractionation of the system.