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MODULAR ON-ORBIT RENEWABLE & EVOLVABLE SATELLITE (MORE-SAT): A NOVEL SPACECRAFT ARCHITECTURE

Abstract

Traditional satellites are usually application specific, which are typically designed for one-time use and constructed in monolithic way. Therefore, functionality and capability of a traditional satellite are usually unchangeable during the lifecycle once it is deployed. Moreover, when unexpected faults occur, it is difficult for the satellite to adequately respond in order to continue the mission, except for substituting the entire satellite. To overcome drawbacks of the monolithic spacecraft architecture, some other architectures for spacecraft design are explored in recent years, such as the fractionated spacecraft architecture. Although fractionated spacecraft architecture is demonstrated as a promising way to provide space systems with more flexibility, scalability, maintainability, and responsiveness, there exist some bottleneck technologies that make it difficult to realize an ideal fractionated space system under state-of-the-art technological conditions, such as long-range wireless power transfer, non-contact attitude and orbit control, etc. This paper introduces a novel spacecraft architecture named More-Sat (Modular On-orbit Renewable Evolvable Satellite). In the More-Sat architecture, a satellite is composed of a host structure and a set of discrete parasitic modules. Host structure acts as an integration framework, which provides rigid support and attachment interfaces to the parasitic modules. Each parasitic module incorporates one or more equipment/subsystem functions of monolithic spacecraft and can be conveniently attached to or detached from the host structure during operation according to needs. There are some advantages of More-Sat architecture, including: (1) Renewability: parasitic modules that are failed or near end of life can be individually replaced to recover or renew the system. (2) Evolvability: system's functionality or capability can be reconfigured, extended or upgraded throughout the operational cycle by simply adding or replacing parasitic modules. (3) Resource reusability: as standard replaceable resources, the parasitic modules can be reused in different systems or over different missions during their lifetime. This is meaningful for the low-cost and intensive space system construction. So, a space system with More-Sat architecture is not a satellite designed for one specific mission and one time use. On the contrary, its function could be extended arbitrarily and its lifetime could be prolonged infinitely. Just as there are more than one satellites. This is another reason why we name the architecture as More-Sat. We will identify the enabling technologies for realizing the More-Sat architecture and illustrate the advantages of More-Sat architecture in flexibility and anti-risk ability by quantitatively comparing with the monolithic and fractionated spacecraft architectures using a hypothesis mission.