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OPEN-MODULAR ARCHITECTURE OF "BAUMANETS 3" SMALL SPACECRAFT

Abstract

Analysis of modern trends in the development of space systems involving large number of small spacecrafts (SSC) shows that the transition to open-modular architecture on the basis of cyber-physical systems is very promising. An SSC is assembled from modules following the same principles both on ground and in space. The openness of the nomenclature of modules constructed according to common standards paves the way for expanding the cooperation and to relatively cheap and fast design new SSCs by integration of various commercially available modules with minimal number of newly developed modules. The openness and decentralization of topological links between modules makes it possible to control the SSC operational characteristics by replacing failed or obsolescent modules without significant impact on the remaining part of the system. In addition, efficient spacecraft scaling is possible by invoking the required number of modules without taking care of considerable resource budget in the original construction. The openness of performance characteristics of a system enables one to tailor an SSC to solving new problems by reconfiguration of modules. Such spacecrafts can operate in orbit over a lengthy time thereby saving the restricted orbital resource—this in turn solves the near-Earth space mitigation problem. This direction is nowadays studied and developed in the USA (Phoenix, SIMPLE projects) and in the European Union (iBOSS project). The report is concerned with the problem of assessing the nomenclature, form, and sizes of modules. As a prototype, we chose the Baumanets 3 student-built SSC of mass 198 kg aimed at remote optical sensing of the Earth. The standard configuration is a parallelepiped of size 1.9 0.8 0.8 m with 5.5 m solar array span. In the new configuration the SSC is divided into three modulus: the propulsion, equipment, and mission-specific ones. The modules are integrated via docking adaptors with necessary interfaces. Two schemes of docking adaptors are considered: the flexible (APAS or IDSS) adapter interface or point pins (Patents RU2583993 and RU2583992). Analysis of four configuration variants shows that the modular architecture increases the SSC mass by 10–30