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SYSTEM ORIENTED REVIEW OF FLOWN CUBESAT PLATFORMS

Abstract

To promote cost effectiveness and fast development of small satellites missions, we propose a selective review of launched cubesats, highlighting frequent design choices, typical mass budgeting and standard test campaigns. Statistical models for rapid preliminary design will be extrapolated from the especially populated database to capture both performance to mass and performances to cost relationships, capable of details down to the subsystem level.

In the past decade, Cubesat missions have grown at an impressive rate. The cornerstones of the standard, identifiable as low cost and short development time, have proven extremely valuable well beyond their original educational intent. As a result, the undergoing expansion of their use as valuable scientific tools and even as commercial assets is generating a vast but extremely diversified body of knowledge. Information for more than 1000 launched and proposed spacecraft have been identified across peer reviewed journals, conferences proceedings, publicly available satellite databases and commercial off-the-shelves platform datasheets. This wealth of data, which is scattered due to both the versatility of the cubesat platform and the plurality of entities that employ it, has yet be formalized in an organic way.

In this paper, we present the most adopted architectural choices as well as frequent prioritization of funds in both hardware acquisition and qualification testing. Overall, it has been found that the strict limitations of volume and power have reshaped the traditional bus architecture to more directly exploit consumer electronics, while avoiding propulsion and active thermal control. On board computer, typically of commercial derivation, possess high performances with moderate impact on power and volume budgets and are also used to perform power management or attitude control routines. Similarly, batteries, solar panel arrays, and the whole structure are often assembled in house as they do not require extremely specialized facilities. On the other hand, off-the-shelves attitude control actuators are quite mature, and several companies offer complete and precise full 3 axial control. The bottleneck of the spacecraft is still the telecommunication system, which is both power and volume hungry. Depending on mission requirements, performances spans several order of magnitudes, from 1.2 kbps with VHF/UHF radios to 40 Mbps with Ka-band systems. With regard to the test phase, proper test campaigns, which are generally too expensive, are reduced to the vibrational testing. Quantitative statistical relationships are extracted from the database to link subsystem performances, mass and cost, which allow, back of the envelope calculation for preliminary design.