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Insuring Quality and Safety in a Cost Constrained Environment: Which Trade-Off? (1)

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USING COMMERCIAL-GRADE ELECTRONICS IN SPACE: ANALYSIS OF BENEFITS, RISKS AND COSTS

Abstract

A harsh environment, long lifetimes, no possibilities for repair, small production volumes, trade restrictions and a fragile supply chain: space electronics face a myriad of challenges. In addition, dedicated technology developments have to cope with the complexity of advanced electronic architectures and manufacturing processes. To tackle these challenges, both traditional and emerging actors in space have developed an elaborate, but remarkably different approach to quality control of the electronics that are used on their spacecraft. This paper contains the results of an extensive survey of the European space industry and agencies, focussed mainly on the use of commercial-grade 'off-the-shelf' (COTS) EEE components in space, as opposed to traditional space-qualified electronics.

Commercial-grade parts have been used in some large space projects, for specific high performance needs. To ensure the reliability of these relatively unknown parts, the traditional product assurance approach demands an extensive set of tests on the individual devices. If all goes well, this gives them reliability figures that are comparable to the other, space qualified parts. The tests are expensive, time-consuming and unpredictable, partly negating the lower price and ready availability of the COTS parts.

Thanks to their exponential evolution, commercial-grade electronics have recently proven an enabling technology for building relatively small and cheap satellites for short missions in Lower Earth Orbit, such as ESA's PROBA technology demonstration satellites and SSTL's smallsat series. The applied set of failure mitigation techniques is similar to bigger projects, but shows a distinct difference in focus. Instead of proving the reliability of the individual parts through testing, the focus is on making the spacecraft as a whole failure-tolerant. This has proven possible through advanced vertical integration in the satellite design. A second significant factor is the bootstrapping approach used in many small satellite projects, allowing for an effective build-up and exploitation of expertise with COTS electronics.

Through survey results and several case studies, the potential, as well as the limits of COTS parts are illustrated. The total ownership cost of commercial-grade parts is critically reviewed. Special attention is paid to the issues of standardization and information exchange. Finally, suggestions are made as to what bigger space projects can learn from the small satellite approach to commercial-grade electronics.