

SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND
DEVELOPMENT (D3)

Space Technology and System Management Practices and Tools (4)

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HIERARCHICAL FAULT-TOLERANT MANAGEMENT FOR MICRO-SATELLITE APPLICATION

Abstract

The Commercial-Off-The-Shelf (COTS) devices which have the advantages of high performance, low cost, low power consumption, are widely used in satellite electronic system nowadays. But the COTS components are vulnerable to the effects of space radiation environment. Component-level fault-tolerant technology based on COTS, such as EDAC (error detection and correction) and space environment protection technology, has been studied and applied numerously. However, the extensive use of COTS components for satellites, component-level fault-tolerant reliability cannot meet the mission requirements. Fault-tolerant and protection from system perspective should be considered. A hierarchical fault-tolerant management for low-cost micro-satellite is proposed in this paper to improve the reliability of COTS devices in space. The advantages of high performance and low cost are used to reduce the cost of fault tolerance. Several basic principles are presented for fault-tolerant design. It is supposed that failure masking methods should be principally applied in bottom layers of the system, and failure recovery methods in middle layers, mission degrading in top layers. The application methods of COTS components are given in detail as well as the fault-tolerant designs for BUAA-SAT which is a university micro-satellite project developed by the students of Beihang University (Beijing University of Aeronautics and Astronautics). Following these strategies, a hierarchical fault-tolerant scheme is proposed for a low-cost micro-satellite mission, which improves the reliability with high efficiency. The fault injection tests proved that fault-tolerant measures are effective and could reduce the risks to acceptable level. The research conclusions is useful for space application design based on COTS system.