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CONCEPT OF REASONABLY RELIABLE SYSTEMS ENGINEERING FOR MICRO-SATELLITES

Abstract

Under the current development of mid-to-large size satellites, the high reliability is mandatory to avoid failures and their development cost increases enormously to achieve the high reliability. On the other hand, several universities develop and launch micro-satellites with low cost for the purpose of education from around 2000. To generate new market for satellite utilization, low cost and fast development are key points. The balance of cost and reliability is one of the very important points to realize the markets. The theoretical research toward the balance of cost and reliability is being conducted through the governmental first program “New Space Development and Utilization Paradigm by Micro-satellites Introducing Japan-oriented Reasonable Reliable Systems Engineering”. This paper presents the concept of the reasonably reliable systems engineering. Current reliability is based on the assumption that there is no miss-design and it only depends on the random failure of parts. However, many of real on-orbit failures were caused by design errors. And also in the current reliability, the recovery is only considered as part of availability. But for the customer to receive service from the satellite system, the number which shows the probability to receive service is more important. In this paper, we propose the method to calculate the new number to show the probability of service and also show the result of the application of this method to the micro-satellite design to increase the service probability with low development cost. In the new approach to calculate the probability of service, we use the four kinds of failure rates in spite of the one failure rate in normal reliability calculation. Those are the combination of temporal failure/eternal failure and random failure/systemic failure. As far as we can keep recover functionality, the temporally failed component can restart after the recovery operation. We applied this method to the micro-satellite design. We clearly define the functions and components as key functions and components which are required to recover failed components. The key components have to be highly reliable, but we don't have to have redundancy for non-key components. Finally the probability of service will not be decreased so much compared with highly redundant satellite system even if we have no redundancy if the failure mode is temporal failures.