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APPLICATION ANALYSIS OF TIME TRIGGERED ETHERNET FOR DISTRIBUTED AEROSPACE ELECTRONIC SYSTEM

Abstract

With the increasing complexity and diversification of space exploration, aerospace electronic system has been developing gradually from the traditional centralized system architecture into the distributed system architecture that might connect multiple devices, payloads or even spacecrafts, which means aerospace communication network have to provide high bandwidth, strong reliability, good maintainability and flexibility to support its normal operation. Although current aerospace networks, such as SpaceWire, MIL-STD-1553, Avionics Full Duplex Switched Ethernet (AFDX), are deterministic and reliable, their performance will be limited by bandwidth and flexibility, especially for distributed aerospace electronic system. Time Triggered Ethernet (TTE), a novel communication system that expands classical Ethernet with services to meet time-critical, deterministic or safety-relevant conditions, is being considered as the next generation of communication network for critical aerospace applications.

Starting from the TTE protocol, this paper provides an analysis of its features, which encompasses supported topology, mechanism of communication, time synchronization calculation and fault-tolerant performance to make comparisons with other aerospace networks. And further, based on design method of Orion Multi-Purpose Crew Vehicle (MPCV), which already use TTE as its high-speed backbone network and accomplished the ETF-1 experiment successfully, and other domestic spacecrafts, the characteristics of communication network for distributed aerospace electronic system are generalized and discussed in this paper. Then, considering various applications, a unified distributed aerospace electronic system architecture that apply TTE as backbone network is proposed in this paper. In this architecture, clock synchronization, redundancy fault-tolerant, node bandwidth allocation and multi-data communication are analyzed respectively. This paper ends with the performance analysis of proposed unified architecture based on network calculus. The results represent that TTE are able to satisfy the requirement of current distributed aerospace electronic system and it should be considered for additional aerospace application because it provides real-time deterministic communication and TCP/IP Ethernet on the same network in parallel, simplifying design and reducing costs.