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分布式IMA的网络分区方法及其实时性能分析

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Network Partition Method of Distributed IMA and Its Real-time Performance Evaluation

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摘要

针对分布式综合模块化航空电子(IMA)体系结构,在时间、空间分区以及带宽分区的基础上,提出了网络分区的概念,并建立了相应的网络模型、消息模型、流量模型及调度模型。利用网络演算方法,推导了航空电子混合消息集在网络分区下端到端(ETE)延迟的计算公式;搭建典型网络,通过理论计算对比了网络分区与带宽分区的实时性能。计算结果表明:网络分区下两条硬实时数据流的延迟较带宽分区分别降低了33.5%和74.2%;而弱硬实时与软实时数据流的延迟增加约30%。最后通过OPNET仿真对理论分析所得结果进行了验证,证明网络分区方法符合分布式IMA的分布式架构要求,并满足了系统混合关键性的需求。

关键词： 航空电子 分布式IMA 网络演算 混合关键性 实时

Abstract:

The concept of network partition is proposed for the architecture of distributed integrated modular avionics(IMA) which is based on temporal partition, spatial partition and bandwidth partition. Meanwhile, corresponding models are built including a network model, a message model, a traffic model and a scheduling model. The formulas for end-to-end (ETE) delays of mixed avionic message sets are derived with the help of network calculus theory. A typical network is then built, and theoretical computations are performed in order to compare the real-time performance of network partition with that of bandwidth partition. The computational results show that ETE delays of two hard real-time flows using network partition are reduced by 33.5% and 74.2% respectively as compared with that using bandwidth partition. On the other hand, delays of weakly hard real-time and weak real-time flows increaseby about 30%. Finally, simulation using OPNET is done to verify the computational results. It demonstrates that the network partition method satisfies the requirements of distributed architecture of distributed IMA, and the demands of system mixed-criticality.

Keywords: avionics distributed IMA network calculus mixed-criticality real-time

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