A SpaceWire Extension For Distributed Real-Time Systems

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Long Paper

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Abstract

In real-time systems, every real-time task has a time constraint including a deadline or a cycle. The time constraint is guaranteed by real-time scheduling algorisms. Almost all real-time scheduling algorithms for single/multi-core processors are based on preemption and the estimation of the worst-case execution time (WCET). Distributed real-time scheduling algorithms are being investigated by extending these algorithms. Here, preemption is achieved by context switches in processors. In order to employ the distributed real-time scheduling algorithms, networks are also required to be preemptive. Preemption on the networks can be achieved by overtaking prioritized packets at each node. Hence, we propose a packet overtaking scheme for SpaceWire.

The WCET, which is one of the most important requirements for real-time scheduling algorithms, is estimated by analyzing a program in non-distributed systems. In distributed systems, the estimation of the worst-case network latency is also required. The network latency depends on the size of a packet. Since the size of packets is not fixed on a SpaceWire network, we divide a SpaceWire packet into fixed size flits. Preemption of packets and the estimation of the worst-case network latency are realized by overtaking prioritized packets and the fixed size flits, so that distributed real-time scheduling algorithms especially for Responsive Link, which is the ISO/IEC 24740 real-time communication standard, can be applied to the SpaceWire with our proposed scheme.

We designed and implemented the proposed SpaceWire on a Responsive Multithreaded Processor, which is a system-on-chip for parallel/distributed real-time control, and evaluated the time constraints on the SpaceWire networks.