Guest Editorial: Special Section on Real-Time Systems—Part II

THE use of embedded computing systems has increased dramatically in our daily life. Processors and microcontrollers are incorporated in most of the devices we use every day, such as mobile phones, PDAs, TVs, DVD players, cameras, cars, dishwashers, etc. Most of such systems are designed under space, weight, and energy constraints imposed by the specific application. Many systems have also demanding quality specifications, whose satisfaction requires the capability to timely react to external events and execute computational activities within precise timing constraints.

Several applications consist of tens or hundreds of concurrent activities that interact with each other and compete for the use of shared resources. In addition, the behavior of some activities depends on sensory data inputs, which can hardly be predicted in advance. As a consequence, the overall computational workload is subject to significant variations that cannot be easily estimated offline. The combination of real-time features in tasks with dynamic behavior, together with cost and resource constraints, creates new problems in the design of such systems, at different architecture levels.

This Special Section on "Real-Time Systems" aims at presenting some of the most significant research works advancing the state-of-the-art in the area of embedded computing systems. In particular, four papers are included in this special issue.

The first paper. entitled "EARQ: Energy Aware Routing for Real-Time and Reliable Communication in Wireless Industrial Sensor Networks," proposes a novel routing protocol for wireless industrial sensor networks providing real-time, reliable delivery of a packet, while considering energy awareness. Before transmitting a message, each node estimates the energy cost, delay, and reliability of a path to the sink node and then selects the path with lowest energy cost able to meet the required timing constraints.

The second paper, entitled "Resource Reservations for General Purpose Applications," considers hybrid real-time systems consisting of several concurrent activities having timing constraints with different criticality, where temporal isolation must be enforced to reduce interference among tasks. The authors discuss the main limitations encountered when using a conventional reservation-based scheduler for handling non-real-time tasks and propose a novel algorithm for using resource reservation techniques to increase the performance of non-real-time applications.

The third paper, entitled "Static Security Optimization for Real-Time Systems," deals with real-time embedded applications requiring high quality of security, like railway signaling, control systems, and medical electronics systems. To meet the needs, a group-based security service model is used, in which security services are partitioned into several groups depending on security types. The security model is integrated with the earliest deadline first scheduling algorithm to manage activities with timing constraints. Given a set of real-time tasks with security services, the proposed scheduling scheme aims at optimizing the combined security value of the selected services while guaranteeing the schedulability of the real-time tasks.

The fourth paper, entitled "A Probabilistic Analysis of End-to-End Delays on an AFDX Avionic Network," shows how to compute a probabilistic upper bound in the context of industrial AFDX applications, where AFDX denotes Avionics Full Duplex Switched Ethernet. A simulation approach is presented to determine experimental upper bounds of avionic flows. The key idea is to model only the elements of the network configuration that have an influence on the end-to-end delay distribution of a flow. End-to-end delay distributions are derived. A stochastic network calculus approach is also proposed to analytically determine probabilistic upper bounds for end-to-end delays on avionic flows. The upper bound is a good candidate for certification, but it is often pessimistic, due to the pessimism of network calculus assumptions.

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