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# Guest editorial: Special issue on Real-Time Systems Symposium (RTSS)

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This special issue features a sample of significant new results presented at the 2019 IEEE Real-Time Systems Symposium (RTSS), the flagship conference in the field of real-time systems.

After more than 40 years, today the real-time systems field is as vibrant as ever due to the rapid growth of the internet of things, autonomous systems, etc. Safety and reliability demands for these applications make real-time systems research no longer an afterthought but a first-class consideration. RTSS is the premier conference in the field of real-time systems, and is a venue for researchers and practitioners to showcase innovations with respect to both theory and practice. As such, RTSS provides a forum for the presentation of high-quality, original research covering all aspects of real-time systems, including theory, design, analysis, implementation, evaluation, and experience.

The 2019 edition of RTSS, celebrating the 40th anniversary of the event, continues the trend of making RTSS an expansive and inclusive event, striving to embrace new and emerging areas of real-time systems research. The scope of RTSS 2019 encompasses two tracks: Track 1—the Real-Time Systems track, and Track 2—the Design and Application track covering Cyber-Physical Systems (CPSs), HW-SW Integration and System-Level Design, and Internet-of-Things. Papers submitted to both tracks were required to address some form of real-time constraints such as deadlines, response times or delays/latency. From a total of 160 complete submissions, 39 full-length papers were selected to appear at the conference, equating to an acceptance rate of 24.4%. These papers allowed the organization of a diverse program covering various aspects like energy-aware

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design, real-time scheduling, real-time techniques for security and quality of service in CPSs, timing and schedulability analysis, multicore and manycore mapping and scheduling, analysis of shared resources or time-sensitive networks, real-time learning and edge computing or mixed-criticality systems.

Among the 39 accepted papers, 3 papers were nominated by the PC members and selected to receive the honor of Outstanding Papers. Papers recognized as Outstanding Papers from RTSS2019 were invited to submit an extended journal version for this special issue of the Real-Time Systems Journal. We received two submissions. After a rigorous peer review process by appropriate experts, the final version of both submissions is included in this special issue.

The first paper of this special issue is co-authored by *Ashik Ahmed Bhuiyan, Kecheng Yang, Samsil Arefin, Abusayeed Saifullah, Nan Guan and Zhishan Guo*. It addresses an important topic: the scheduling of gang tasks on multicore systems, where the tasks are associated with different criticalities. Many safety–critical systems may need to execute tasks with different criticality levels (thus requiring different levels of assurance) on the same computing platform. Though existing work has studied mixed-criticality scheduling of sequential tasks, few have considered mixed-criticality scheduling of parallel tasks which are not uncommon. The authors extend the original Vestal model of mixed-criticality systems to the gang task model on multicore systems and prove the correctness of a utilization based test. They show that an EDF-based global scheduling algorithm with appropriate virtual deadlines provides a scheduling solution for the considered systems. An associated speedup is formally derived and an empirical assessment is proposed to determine how well the proposed scheduling algorithm performs in different settings like tasks degree or average utilization. The work lays the foundation for modeling and analysis of complex task models with mixed-criticality requirements.

The second paper co-authored by *Wei-Ju Chen, Peng Wu, Pei-Chi Huang, Al Mok and Song Han* deals with online reconfiguration of resource partitions in CPSs. Many CPSs (such as intelligent highway control and air information management) have to face two fundamental issues, openness and uncertainty, while must meet stringent safety and reliability requirements. The two issues pose serious system integration challenges because a seemingly minor change in one application component may result in an application missing a critical deadline constraint. The authors transform the open CPS design problem to a composite resource partitioning problem whereby the pool of cyber and physical resources is partitioned into units of different types of composite real-time virtual resources and assigned to individual applications in a hierarchical fashion. Unlike existing efforts that statically partition resources, this paper considers online reconfiguration and provides solutions to issues arising during transitions by considering a regularity-based resource partitioning model. The solution is based on a three-stage algorithm that builds a cyclic schedule and is validated with not

only synthetic requests but also a real-world autonomous system. The proposed approach in this paper considers composite (including both physical and computing) resource partitioning, and has the potential to open a new research area of CPS virtualization.

We hope you enjoy this special issue.

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