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Introduction to the special section on Real time computing and distributed systems

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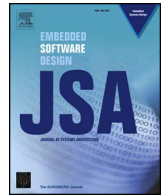
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Abstract



Introduction to the special section on Real time computing and distributed systems



1. Introduction

Modern distributed systems are increasingly complex both on their architectural design and on the computational logic that they execute. Their timely operation is challenged, which is critical for some domains such as cyber-physical systems where timeliness and dynamic behavior must be satisfied simultaneously. Providing real-time operation whereas supporting the inherent dynamic behavior of cyber-physical systems requires solutions that are not yet available. A number of challenging scientific and engineering problems that span across a variety of research areas are raised. The new challenges go far beyond those of traditional networked real-time systems; cyber-physical systems are autonomous, open, large-scale, real-time, embedded, and control systems that make intensive use of networks, distribution, and wireless technology. Such complex systems have different [sub]parts/systems with different levels of real-time requirements.

From different (though related) research communities, researchers are trying to solve similar problems faced by cyber-physical systems; they walk parallel paths with the goal of effectively and efficiently providing the level of temporal guarantees required by these challenging complex systems, spanning from temporal predictability to probabilistic QoS guarantees. Solutions from different communities present interesting approaches that can benefit from meeting at a common forum with the goal of drawing complementary pictures of the problem to identify novel research directions as resulting from this crossbreeding.

In 2016, we organized the 4th *International Workshop on Real-Time Computing and Distributed Systems in Emerging Applications (REACTION)* co-located to the 36th IEEE Symposium on Real-Time Systems (RTSS). The objective of the 4th edition of REACTION was to bring together researchers, practitioners, designers, and developers of distributed software systems and communication middleware technologies that have special requirements of reliability and time-sensitivity. The topics of the contributions gathered around a following set of highly interesting and timely topics:

- Scheduling and resource management for Quality of Service support and Real-Time operation in distributed systems
- Real-time middleware
- Real-time reconfiguration in distributed computing
- Scalable computing models and algorithms and massively parallel real-time distributed computing
- System modeling and component technology
- Technologies for modeling and programming distributed real-time systems and CPS
- Operating system support and resource management for dynamic distributed real-time systems and cloud computing applications
- Real-time assurance in virtualized environments and performance assessment
- QoS properties for distributed systems
- Self-healing and survivability of distributed real-time systems
- Optimization of the network operation and performance
- Energy-aware resource management
- Service-oriented architectures and composition

This paper presents the special issue derived from the best papers from this edition; these were further extended and underwent a blind review reviewed process. This introductory paper summarizes the content of the manuscripts that are part of this special issue.

Contributions were, both, on practical and theoretical aspects applied to the solving the real-time problems of distributed real-time systems distributed systems architectures across different domains such as automotive or cloud or more fundamental aspects such as improvement of clock synchronization.

The special issue opens with this presentation paper *Introduction to real-time computing and distributed systems*, presenting the inspirational scientific event that attracted these papers and the selected special issue papers.

The second contribution of this special issue is the paper of title *Feedback for increased robustness of forwarding graphs in the cloud* [1] that provides some strategies based on optimization for controlling virtual nodes across under latency and buffer constraints on node chains, complemented with some concepts from feedback theory for resource dynamic adjustments to face possible modeling error.

The third contribution of this special issue is the paper of title *End-to-end timing analysis of cause-effect chains in automotive embedded systems* [2] that deals with the problem of information aging across the task pipeline of distributed automotive systems.

<https://doi.org/10.1016/j.sysarc.2017.11.003>

The fourth paper is *Integration of data distribution service and distributed partitioned systems* [3] provides an integration architecture for using middleware based on the Data Distribution Service (DDS) in partitioned systems which heavily use virtualization technology. The proposal shows how the natural hierarchical scheduling of ARINC 653 compliant systems encapsulates the communication effects of the communication middleware. The architecture is proposed in the context of the FACE (Future Airborne Capability Environment) architecture.

The special issue closes with the paper with title *FLOPSYNC-QACS: quantization-aware clock synchronization for wireless sensor networks* [4]. It addresses the technical challenge of quantization in the design of the compensator for clock synchronization in cost-sensitive wireless sensor networks by improving its inspirational FLOPSYNC strategy.

We hope that the reader will find this special issue interesting for his/her scientific purposes regarding distributed computing, distributed systems, and the real-time related problems that these systems undergo.

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