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Special issue on reliable data transmission in real-time systems

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Safety- and mission-critical applications such as autonomous and assisted driving, smart manufacturing, and autonomous robots require to manipulate increasingly large amounts of data to accurately analyze their environment and perform their expected tasks. The critical nature of these applications requires data to be accessible in a reliable, predictable, and analyzable fashion. Timing properties of data transmission are of particular essence as late reception of crucial data may impact the system safety.

This special issue features two papers that tackle the increasingly complex challenge of providing timely and reliable data transmission in real-time systems, at two different architectural levels.

The first paper, "A Formal Framework to Design and Prove Trustworthy Memory Controllers" by Felipe Lisboa Malaquias, Mihail Asavoae and Florian Brandner, addresses the concern of designing correct memory controllers using formal specifications of the properties it must respect both from a functional and timing aspect. The framework presented in the paper allows to write expected memory controllers properties in terms of, for example, timing to forward requested data, as proof obligations that are then proven correct with the Coq proof assistant. This provides trust that a specific design of a memory controller effectively and reliably offers the expected properties on data access and transmission.

The second paper, "Configuration Optimization for Heterogeneous Time-Sensitive Networks" by Niklas Reusch, Mohammadreza Barzegaran, Luxi Zhao, Silviu S. Craciunas, and Paul Pop looks at data transmission over an Ethernet network in a distributed system. It aims at guarantying end-to-end data communication latency in heterogeneous networks that implement Time-Aware Shapers as defined in the IEEE

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Time Sensitive Networking (TSN) 802.1Qbv amendment to the IEEE 802.1Q standard. The paper proposes a new scheduling method and associated tools to configure time-aware shapers and provide end-to-end timing guarantees for critical traffic even when network end-points and TSN switches are not necessarily synchronized. The proposed solution compromises on the configuration optimality to support realistic industrial networks in which not all components may have TSN capabilities.

Initial versions of the two papers featured in this special issue were previously published at the conference RTNS 2022, which was held in Paris, France. Prior to the conference, the two papers were among three that were selected by a committee to receive an outstanding paper award. The earlier version of the paper "A Formal Framework to Design and Prove Trustworthy Memory Controllers" further received a best paper award during the conference. The authors of the two papers were later invited to submit an extended version of their work to this special issue.

RTNS 2022 has been a vibrant conference. Firstly because it was the first main conference of the real-time systems field where the community could meet again physically after 2.5 years of conferences held purely virtually due to the COVID-19 pandemic, but also because the program featured many high-quality papers like those published in this special issue.

We hope this selection of papers will raise interest and motivate further good research in the real-time systems field.