CALL FOR PAPERS
Design of Reversible Computing Systems
IEEE Transactions on Emerging Topics in Computing
Special Issue

IEEE Transaction on Emerging Topics in Computing (TETC) seeks original manuscripts for a Special Issue/Section on **Design of Reversible Computing Systems** scheduled to appear in the **first issue of 2019.**

Over the coming decade, the historical trend of exponentially-increasing computer performance for systems at a given cost level is expected to slow, as conventional digital technology approaches practical limits to its computational energy efficiency, which in turn limits system performance within any given power and cooling constraints. In the long term, due to fundamental connections between thermodynamics and information theory, the only possible way to continue improving the energy-efficiency and affordable performance of computing systems indefinitely is if their designs increasingly thoroughly apply reversible computing principles. However, the question of exactly how to design practical, cost-competitive reversible computing systems is an extremely challenging engineering problem, which today still remains far from being fully solved. To overhaul the existing industrial infrastructure of manufacturing processes, design tools and software in all of the ways that will likely be needed to fully realize the potential of this unconventional but essential new computing paradigm will arguably require a multi-billion-dollar sustained investment in associated research and development activities. We cannot assume this investment will be made until the research community builds a sufficiently solid case showing that workable implementation approaches exist and are economically feasible. It is the goal of this special issue to solicit high-quality contributions across all levels of computing that pointedly address the crucial issues in the theory, design, and engineering analysis of reversible computing systems, so as to eliminate all of the remaining conceptual roadblocks that impede investment, and establish that the reversible computing paradigm indeed provides a viable path forwards, towards an unbounded new future for computing.

Topics of particular interest include, but are not limited to, the following:

- **Fundamental physical theory.** Detailed, realistic models of self-contained reversible computing mechanisms based on a pioneering, world-class analysis of all the relevant physics. Rigorous proofs showing that entropy increase per operation in realistically-constructible physical systems that are complex enough to perform universal computation can indeed remain negligibly small ($<< kT$) despite quantum uncertainties and parasitic interactions.
- **Manufacturing processes.** Certain proposals for future reversible devices (*e.g.*, nanomechanical rod logics) invoke manufacturing processes that do not yet exist (here, atomically-precise, scalable molecular nanofabrication). We invite papers showing convincingly that paths towards any needed new manufacturing technologies do indeed exist and are feasible.
- **Novel devices.** Papers on the design and detailed physical analysis of innovative device structures that can perform logically reversible (and almost physically reversible) state transitions. A device may utilize any physical domain (*e.g.*, electronic, mechanical, optical), but the analysis of all of its parasitic loss mechanisms must be thorough.
- **Circuit design methodologies.** One crucial engineering issue for synchronous reversible logic hardware is how to design circuit structures that can generate, distribute and maintain appropriate resonant power-clock signals with high quality factors. Asynchronous reversible logic circuits would be another possible direction that has not been well explored yet.
- **Architectures.** Design techniques for reversible computing hardware architectures that well minimize the overheads required for reversible (or near-reversible) operation. Hardware description languages supporting reversible design.
- **Algorithms & applications.** Well-optimized reversible algorithms for important problems, useful software development tools (including reversible programming languages), and any alternative applications of reversibility (besides saving energy) that are significant enough to help motivate substantial software R&D investments.

Submitted articles must not have been previously published nor currently submitted for journal publication elsewhere. As an author, you are responsible for understanding and adhering to our submission guidelines. You can access them at the IEEE Computer Society web site, www.computer.org. Please thoroughly read these before submitting your manuscript.

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Important dates:	**Guest Editors:**	
Submission deadline: March 1, 2018 **Reviews completed: June 1, 2018** **Major revisions due (if needed): July 1 2018** **Reviews of revisions completed (if needed): August 1, 2018** **Minor revisions due (if needed): September 1, 2018** **Notification of final acceptance: November 1, 2018** **Final publication materials due: December 1, 2018** **Publication date: First Issue of 2019**	**Michael P. Frank** Senior Engineering Scientist Sandia National Laboratories P.O. Box 5800, MS 1322 Albuquerque, NM 87185-1320 mpfrank@sandia.gov	**Marco Ottavi** Associate Professor Department of Electronic Engineering University of Rome Tor Vergata Rome ITALY 00131 ottavi@ing.uniroma2.it