Scalability of Quantum Computing Systems: Device-Architecture Crosslayer Co-design

October 22nd, 10:45 – 14:30 MDT (6:45pm – 10:30pm CET)

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The field of quantum computing has experienced a remarkable progress in the last years with the development of intermediate-scale quantum processors. Despite its tremendous potential, it is still unclear how quantum computing systems will scale to satisfy the requirements of its most powerful applications. For instance, at chip technology level different approaches for integrating higher number of qubits in a single processor are being explored such as crossbar topologies, while at architectural level quantum multi-core architectures are a firm candidate to unlock the scalability of quantum devices. Nevertheless, scaling-up quantum computers requires improvements at all layers of the so called full-stack. Beyond stacking up the different layers, a crosslayer design and optimization are required. This particularly calls for a tight co-design among adjacent layers as well as vertical crosslayer design, therefore requiring researchers from multiple disciplines to collectively address the grand challenge of scalability. To this purpose, in this workshop we are bringing in experts from the different full-stack layers, namely (a) quantum devices, qubit control circuits and chip design, (b) architectural designs and algorithms (c) design methodology, design-oriented models, communications and previous approaches for scalability in conventional computing processors, so as to address the scalability challenges in a multidisciplinary and crosslayer approach.

The workshop will consist of two 1.5h sessions, that will focus on the scalability aspects of the different layers of the quantum computing full-stack. The first session will address technology and architecture aspects, with five invited speakers. In the last session, after two invited talks on transversal aspects aiming scalability, a workshop-wide crosslayer scalability-centric panel will culminate the workshop including all eight presenters participating.

Session 1 (10:45am-12:15pm MDT/6:45pm-8:15pm CET)

Across layers, from the bottom-up: Quantum hardware, qubit control circuits, integrated quantum chips, quantum computer architecture, quantum software, and quantum algorithms/applications (5 presentations of 15min + 2min questions)

- 10:45 - 10:50: Intro to the workshop
- 10:50 - 11:07: “Quantum computing – spins inside” – Mateusz Madzik, QuTech, Technical University of Delft
- 11:07 - 11:24: “Integration and Control of Quantum Dot Arrays and Charge Qubits in 22-nm FDSOI Technology” – Elena Blokina, Equal 1Labs, NovaUCD, Ireland and University College Dublin

Session 2 (1:00pm-2:30pm MDT/9:00pm-10:30pm CET)

Transversal topics: Design, models, simulation, quantum communications and classical scalability analysis (2 presentations of 15min + 2min questions and panel)

• 1:00 - 1:17: "Data movement and communication in conventional architectures" – José Duato, Technical University of Valencia (Universitat Politècnica de València)
• 1:17 – 1:34 : “Quantum networks: towards the quantum internet and distributed quantum computation” – David Elkouss, QuTech, Technical University of Delft
• 1:34 – 2:30: Final panel discussion, “The dawn of the Quantum Architecting era: upscaling the full-stack in the midst of NISQ”, with Mateusz Madzik, Elena Blokina, Edoardo Charbon, Fred Chong, Anne Matsuura, José Duato and David Elkouss.