QUADRATURE 22: SCALABLE MULTI-CHIP QUANTUM ARCHITECTURES ENABLED BY CRYOGENIC WIRELESS / QUANTUM - COHERENT NETWORK-IN PACKAGE

Description

Today's tremendous interdisciplinary effort towards building a quantum computer promises to tackle problems beyond the reach of any classical computer. Although intermediate-scale quantum computers have been recently demonstrated to exceed the capability of the most powerful supercomputers, it is widely recognized that addressing any real-world problem will require upscaling quantum computers to thousands or even millions of qubits. This proposal focuses on the grand challenge of scalability in quantum computers from a full-stack architectural standpoint and is enabled by communication networks operating within the quantum computing package at cryogenic temperatures. The QUADRATURE project aims to pioneer a new generation of scalable quantum computing architectures featuring distributed quantum cores (Qcores) interconnected via quantum-coherent qubit state transfer links and orchestrated via an integrated wireless interconnect. This novel architecture supports reconfigurability to serve massive flows of heterogeneous quantum algorithmic demands.

The main objectives are:

(i) to experimentally prove the first micro-integrated all-RF qubit-state transfer link within a cryogenic tunable superconducting cavity waveguide in the microwave and THz frequency region for quantum-coherent frequency-multiplex and routing

(ii) to achieve the transfer of classical data through wireless in-package links by integrated cryo-antennas and transceivers

(iii) to build protocols for a quantum-coherent integrated network enabling the exchange of qubits through the coordination of the quantum-coherent data plane and the wireless control plane

(iv) to develop appropriate scalable architectural methods such as mapping, scheduling, and coordination approaches across multiple Qcores and

(v) to demonstrate the scalability of the approach via multi-scale design space optimization and for a set of quantum algorithm benchmarks, with at least 10x improvement in overall performance.

Barcelona Supercomputing Center - Centro Nacional de Supercomputación