Work Item

on Cryogenic Solid State Quantum Computing

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Abstract

One of the quantum computing hardware architectures that has been identified in the Roadmap document of FGQT is "Cryogenic Solid State Quantum Computing". These architectures include solutions based on superconducting qubits (like Transmons and Flux Qubits), or semiconductor spin-qubits, topological qubits, artificial atoms in solids, etc.

This contribution proposes to start working on creating a document, in multiple parts, where the first part is restricted to functional descriptions and functional requirements

1 Cryogenic Solid State quantum computing

One of the quantum computing hardware architectures that has been identified in the Roadmap document of FGQT is "Cryogenic Solid State Quantum Computing". These architectures include solutions based on superconducting qubits (like Transmons and Flux Qubits), or semiconductor spin-qubits, topological qubits, artificial atoms in solids, etc.

The commercial interest in this kind of quantum computer is growing rapidly, and a supply chain of associated products from different vendors is growing as well. This justifies the need for a document that offers associated functional descriptions and functional requirements

2 Proposal: Working item on Cryogenic Solid State QC

We propose to start a "working item" on creating a formal standard on cryogenic solid state quantum computing in multiple parts. The first part is to be restricted to functional descriptions and functional requirements, and could have initial descriptions on low-level benchmarking of the involved hardware (high-level benchmarking based on algorithms are out of scope of this document)

Annex B of the Roadmap document from FGQT offers already a nice blueprint of the aimed document. It contains a good description of the scope and objective, has example content to illustrate a functional description and functional requirements of a particular layer (control highway) and an initial table of content. The present proposal is based on that, with some improvements.

3 Proposed Table of Content

Start of proposal

Cryogenic solid state quantum computing
Part 1: Functional descriptions and functional requirements

1. Scope and objectives

The scope of this document comprises the hardware layers and control software dedicated to cryogenic solid state quantum computing, as shown in figure 1. This is an architecture family of which all members make use of a cryogenic fridge. The quantum device(s) within the fridge are controlled from outside by room-temperature control electronics, through a (huge) number of I/O channels. Examples of members within this architecture family are superconducting transmons, superconducting flux qubits, semiconductor spin qubits, topological qubits and artificial atoms in solids.

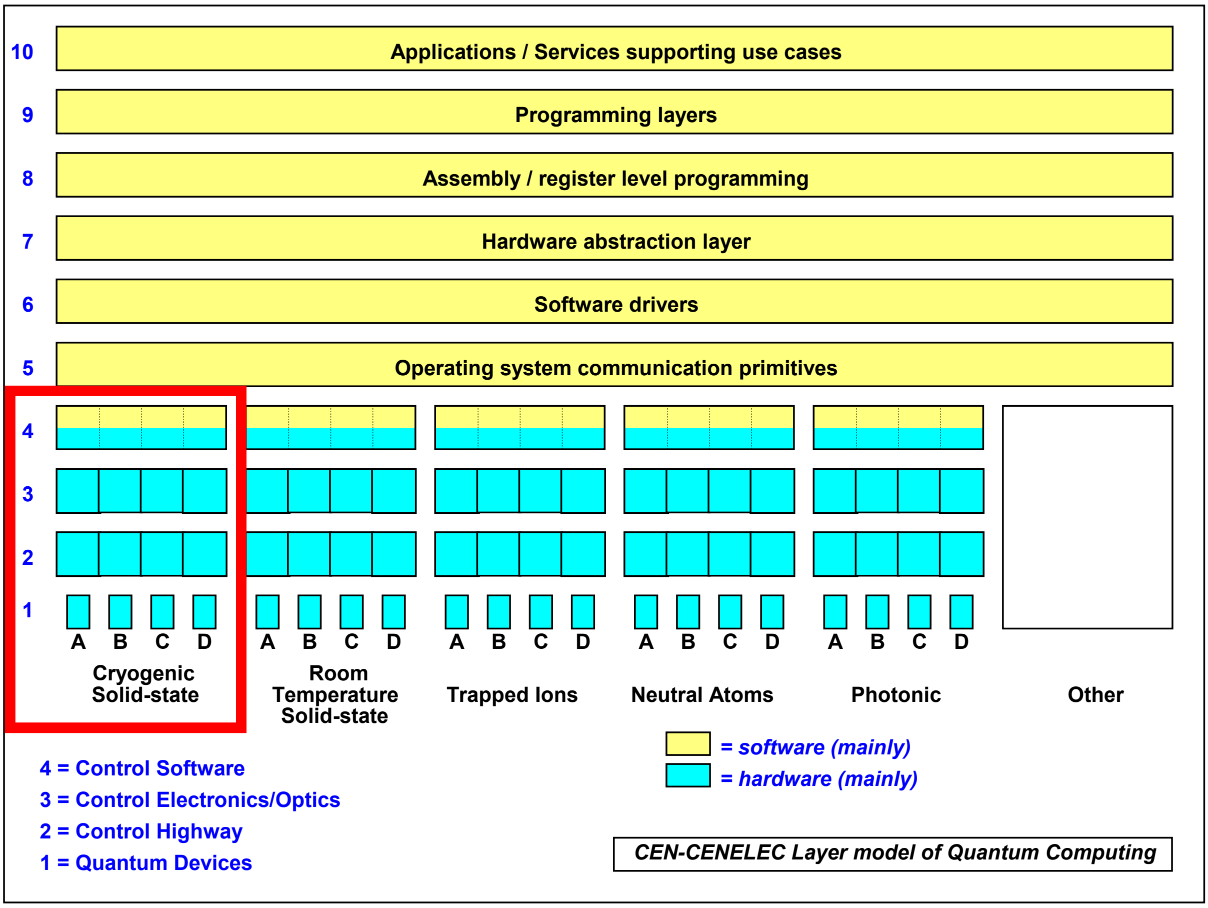

***Figure 1**: The scope comprises hardware layers and control software dedicated to cryogenic solid state quantum computing,*

The objectives of this first part from a series of documents are functional descriptions and functional requirements of the involved layers. The specification of limiting requirements and associated values is reserved for future parts. Descriptions of multiple best-practices on implementations are within scope as long as their description does not exclude similar other solutions.

Normative references

- [1] <a first reference>
- [2] <more references as needed>

3. Terminology and abbreviations

4. Overall functional description

5. Layer 1: Quantum Devices

5.1 Functional descriptions

- Superconducting qubits
  - Transmons
  - Flux Qubits
- Semiconductor spin qubits
- Topological qubits
- Artificial atoms in solids

5.2 Functional requirements

6. Layer 2: Control Highway

6.1 Functional descriptions
6.2 Functional requirements

7. Layer 3: Control Electronics

7.1 Functional descriptions
7.2 Functional requirements

8 Layer 4: Control Software

8.1 Functional descriptions
8.2 Functional requirements

9 Benchmarking (low level)

End of proposal