Standardisation Needs

for building quantum computers

Delft Circuits
Hardware for quantum engineers

Rob F.M. van den Brink
20 sept 2020

Why standardization?

To solve the following problem:

- Your product is identified as best in class
- A selected group of customers has confirmed this claim
- However, it is does not fit nicely into ***mainstream*** QC implementations
    - Customers have to do significant modifications to their installed base
    - So they will buy lower-performing products from your competitor

Solution: commonly accepted set of specifications

- Interworking between products
- Modules that can interwork with each other
- Interfaces between those modules that are compatible

Secure those specification at an “official” place

The primary stake holders are industrial partners, NOT the academia !!

Step 1: get agreement on modularity of QC

The most simple description of modularity in a quantum computer

Software layers

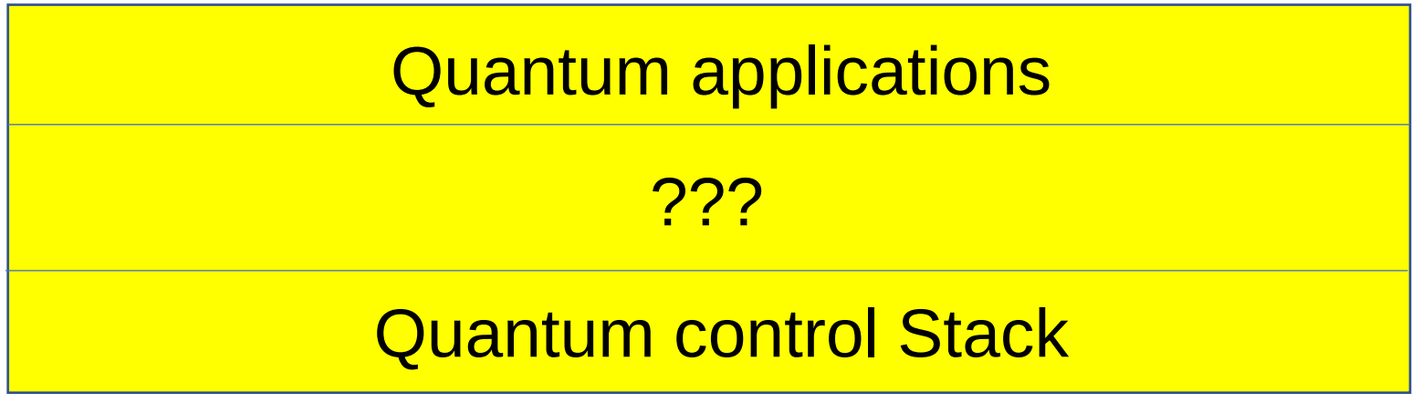
Superconducting hardware

Ion trap hardware

Other hardware solutions

Step 1: get agreement on modularity of QC

The most simple description of modularity in a quantum computer



Superconducting hardware

Quantum Control Unit

Quantum Highway

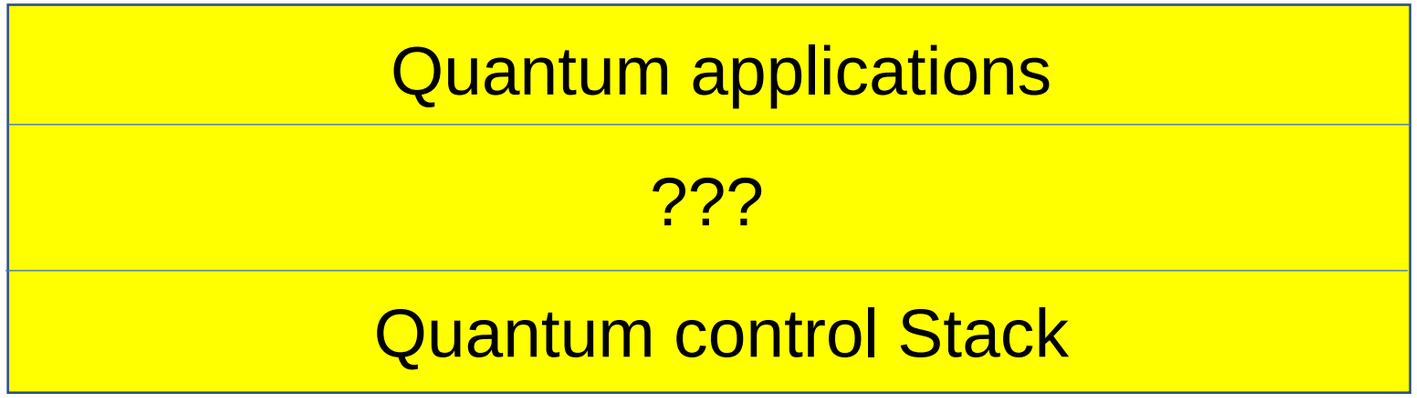
Quantum Processor

Ion trap hardware

Other hardware solutions

Step 1: get agreement on modularity of QC

The most simple description of modularity in a quantum computer



Superconducting hardware

QBLOX — **Quantum Control Unit**

Delft Circuits — **Quantum Highway**

Quantware — **Quantum Processor**

Ion trap hardware

Other hardware solutions

Today we don't have consensus on this *YET* !!!

Step 2: Identify what to standardize → See “N010”

QCU: Quantum Control Unit (room temperature electronics)

- Functional description for pulses and read-out
- Signal levels, sensitivity, noise floors, pulse shapes, etc
- Instruction set and protocol to communicate with higher software layers
- etc

QCH: Quantum Control Highway (wiring into cryogenic environment)

- Functional description: filtering, coupling, amplification, ..
- Transmission requirements: loss, bandwidth, crosstalk, …
- Thermal requirement: max heat flow, thermal clamping, etc
- Vacuum requirements: thou shalt not leak air into my fridge
- Footprint requirements: How to feed signals into >1000 qubits
- Connectivity requirements: with both QCU and QPU

QPU: Quantum Processor Unit (wiring into cryogenic environment)

- Signal levels, pulse shapes, readout, ...

Step 3: Cosigned contributions to FGQT

Cosigned by at least a few vendors of quantum solutions

1. Cosigned contribution on desired modularity

- Restricted to gate-based super conduction quantum computers (or at least covering our busines interests

2. Cosigned contribution on standardization needs

- Just a list of identified topics
- NO values, TODAY nothing specified
- Contribution N010 (june 2020) provides examples