Standardization is key to shape this future.

April 2022

Standaard voor vooruitgang

Our vision on the future:

The modular quantum computer

- To build-up a quantum computer with modules
- Accelerate developments: buy known solutions and focus on novelties
- Customers: *research institutes, system integrators, …*

Needs

- A supply chain of various modules
- Mature products from different vendors (hardware and software)
- That can interwork with each other
- Meeting requirements from customers

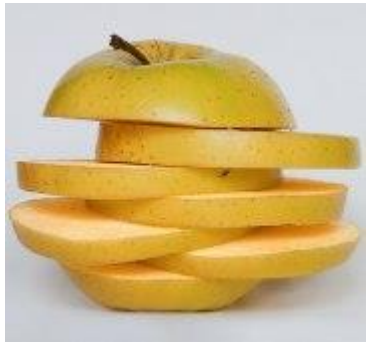
Role of standardisation

- To make this happen
- To write down consensus solutions
- Consensus → global market

Taking the lead == creating a strong position to the Dutch quantum industry

Our vision on the future:

Modular …..?????



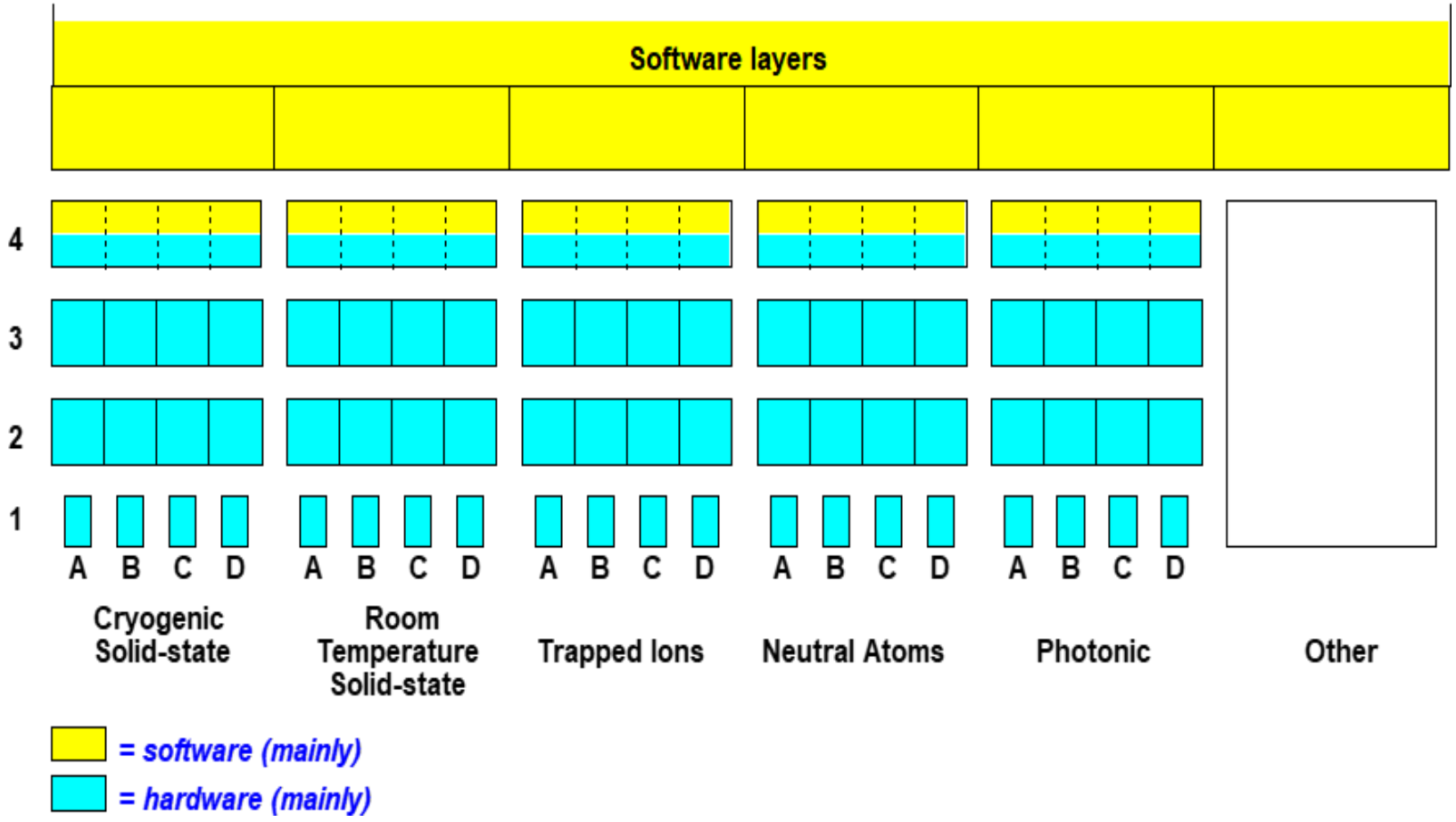
How to break “quantum computing” into smaller chunks ?????

- So many different quantum computers
- Everybody builds its own solutions
  (My local suppliers build what I need)
- How to get **consensus** on that choice?
- And who will foster it?

Subdividing “Quantum Computing” into smaller chunks

Multiple hardware stacks

Multiple architecture families



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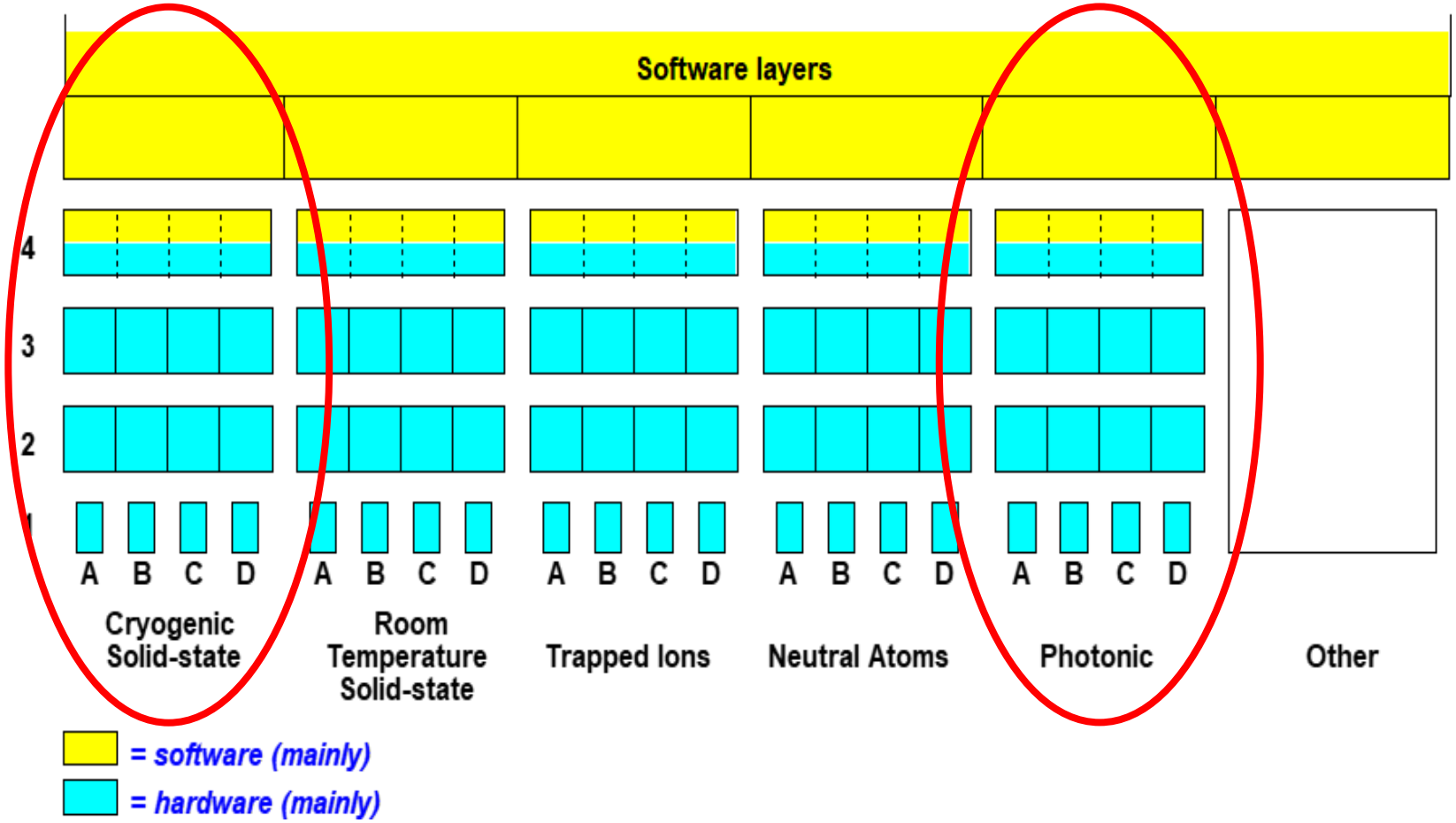
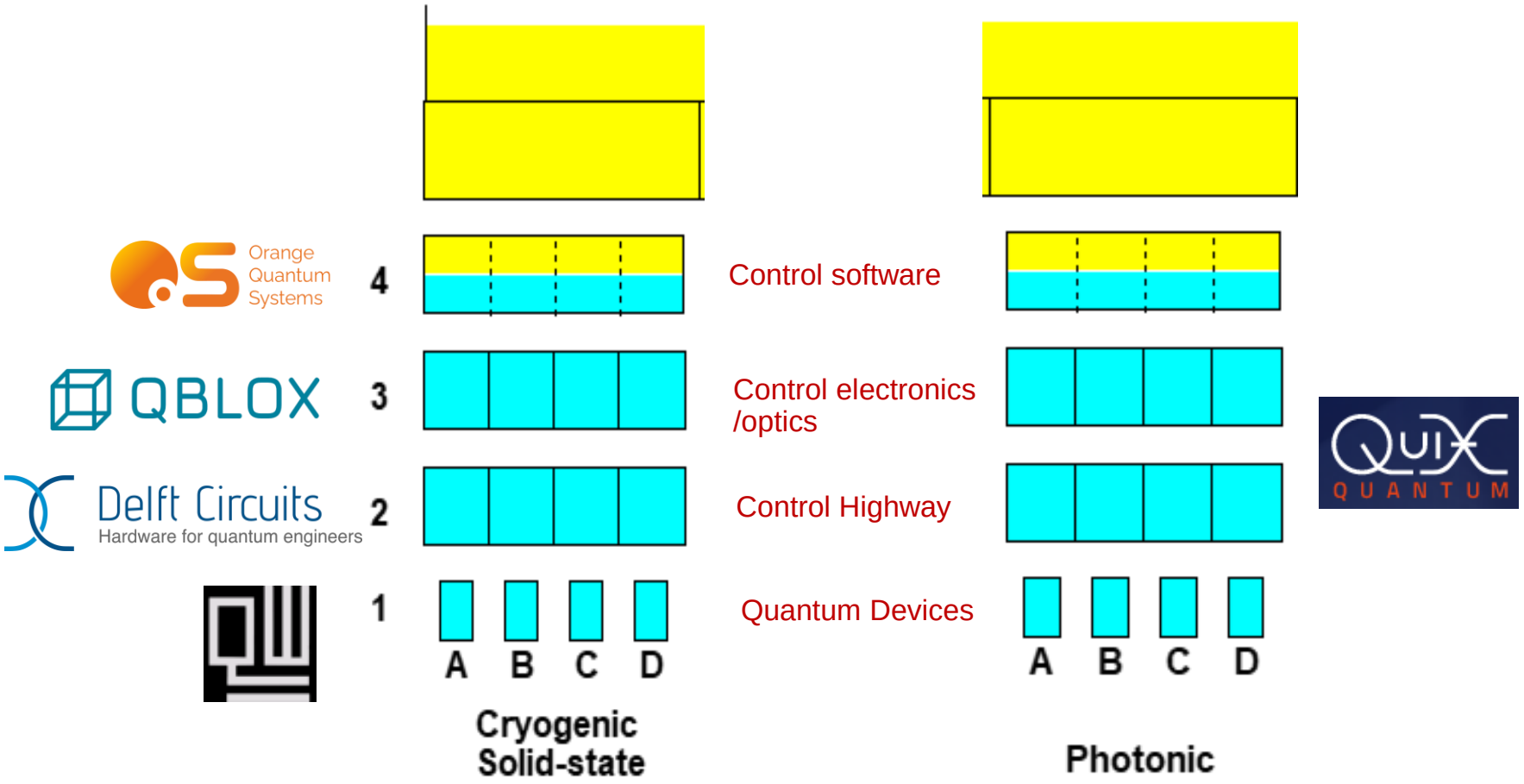


Two hardware stacks, relevant for the Dutch industry

Multiple layers

Multiple members per architecture family



A=Transmons, B=Spin Qubits, ….

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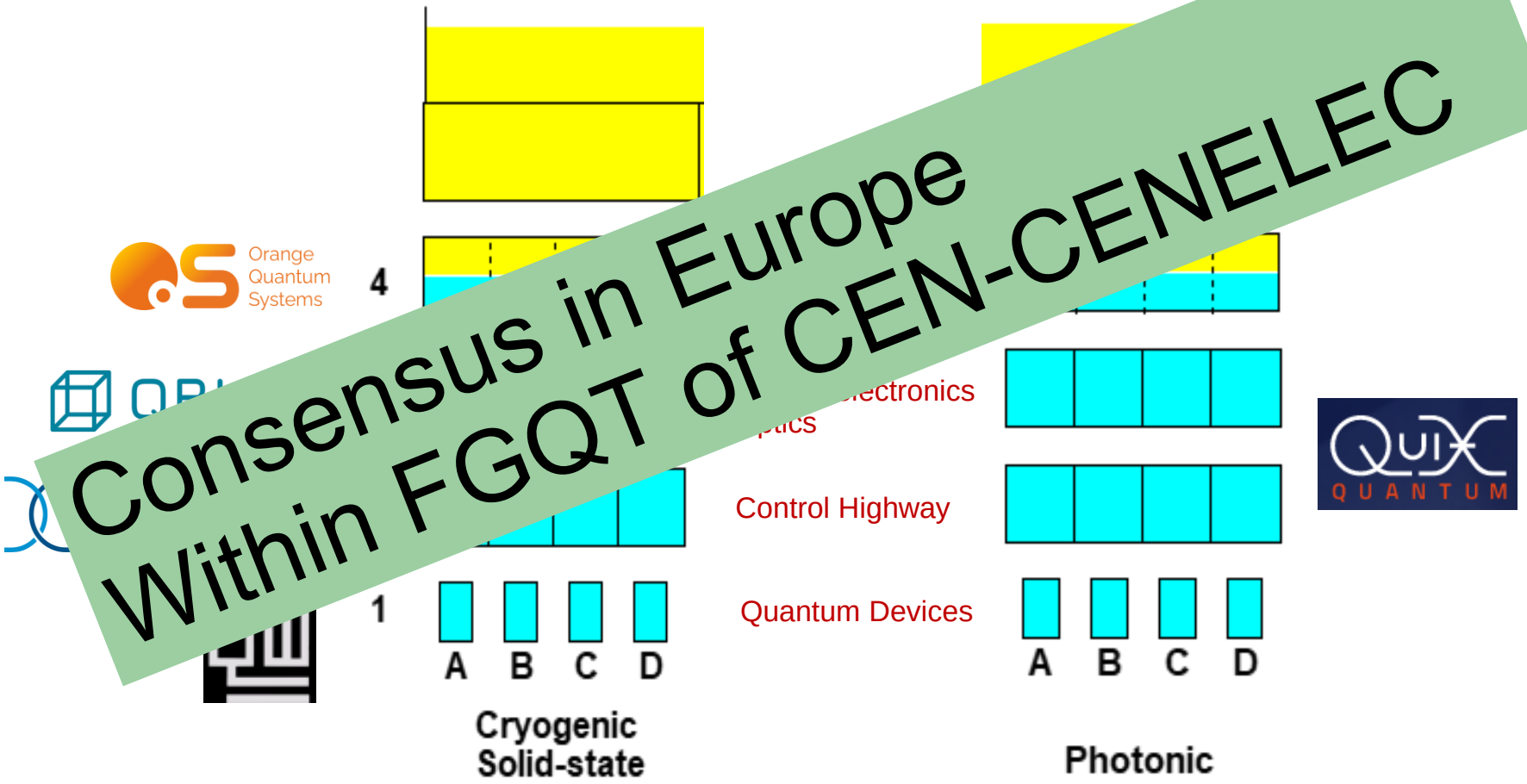
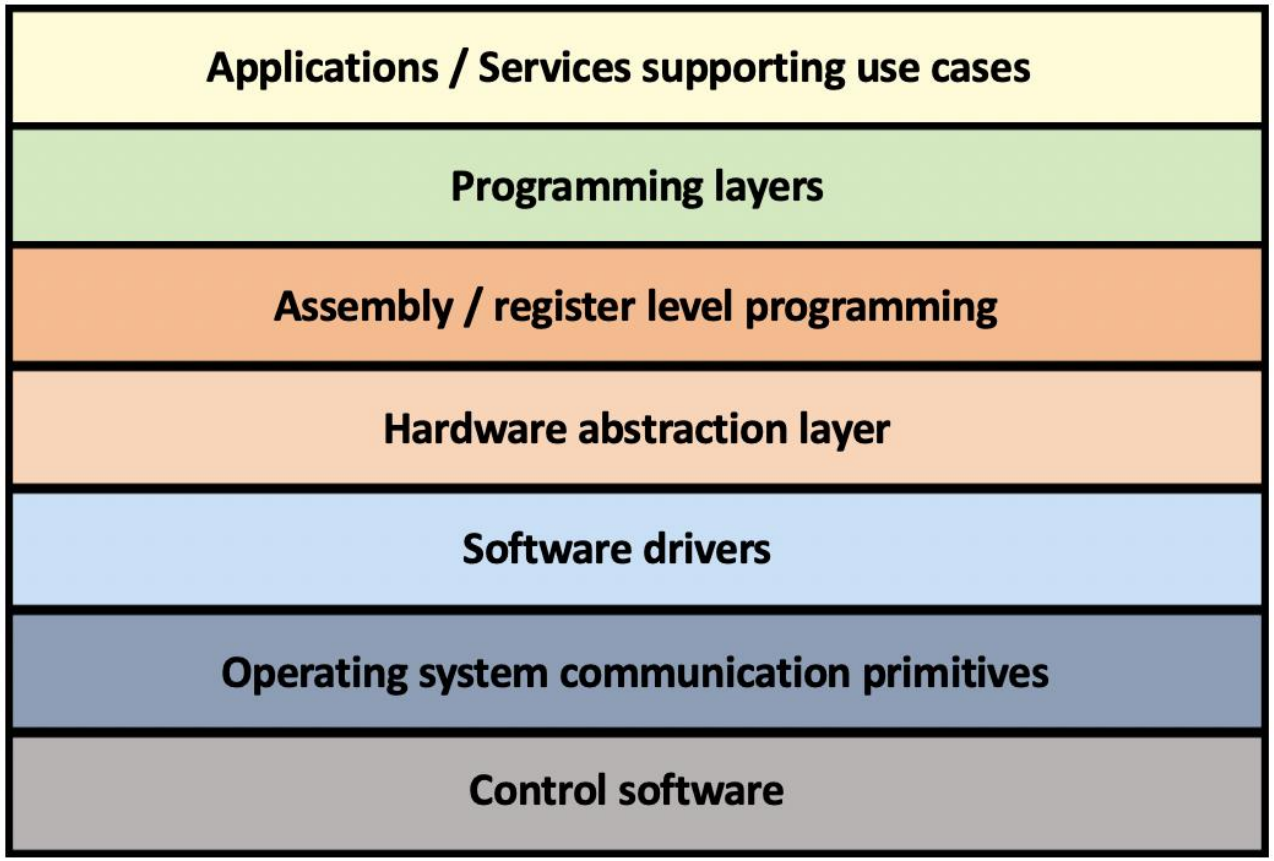


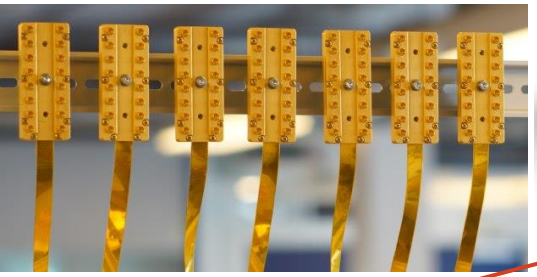
Consensus in Europe
Within FGQT of CEN-CENELEC

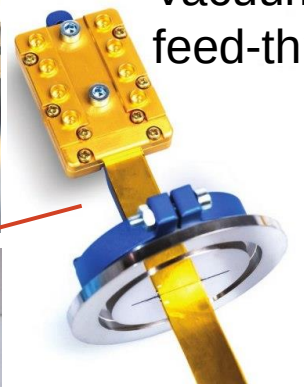
Software stack



Currently under study, within CEN-CENELEC

A “simple” example: “Cabling” in a cryogenic fridge





Vacuum feed-through

Integrated Filters & attenuators

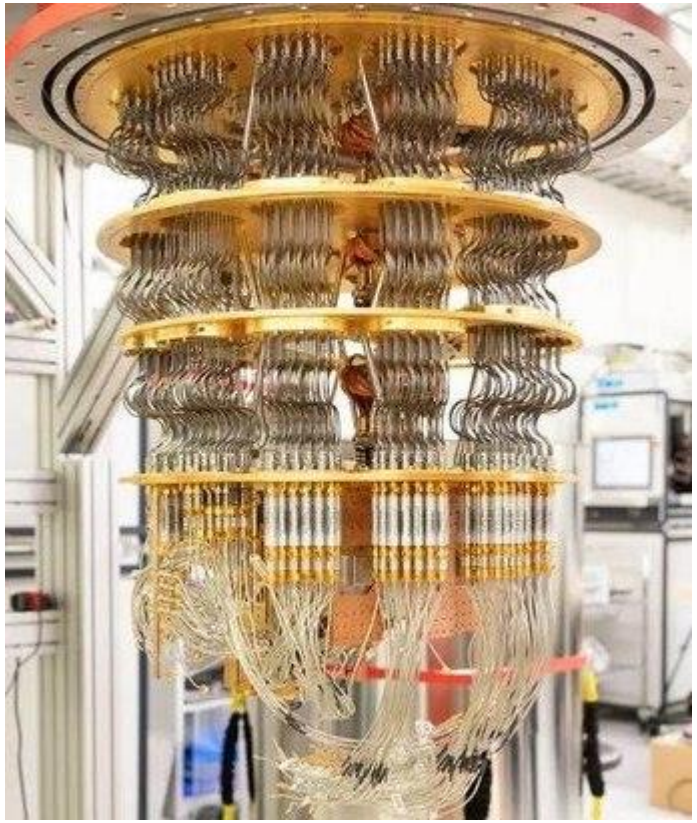
Thermal clamp

Requirements on “Control Highway”:

- Vacuum leakage
- Outgassing
- Thermal conductance
- Superconducting sections
- Filtering & bandwidth
- Attenuation (signal levels)
- Thermal clamping
  (”Heat” dissipation in attenuators)
- Bulk interconnection at top
- Interconnection with Q device
- Footprint

- Noise levels, amplifiers
- Functional descriptions

More examples … towards >1000Qubit computers



Interfacing with control electronics

- Software commands to shape and fire pulses

Functionality to allow for calibration

Interconnection with quantum devices

Hardware abstraction layer

Definition, commands, functionality, ..

Common naming for gates

- not only well known X, Y, H,cNOT , Rx(fi)
- Also for entangled gates (Ising, Molmer-Sorensen, ..)

- ……

How to proceed?

No focus (yet) on actual values

- Functional description of modules
- Functional requirements of modules
- …

If we want to shape the quantum future,
then we need a strong involvement of Dutch stake holders