Towards Modular Quantum Computers

A layer model for quantum computing

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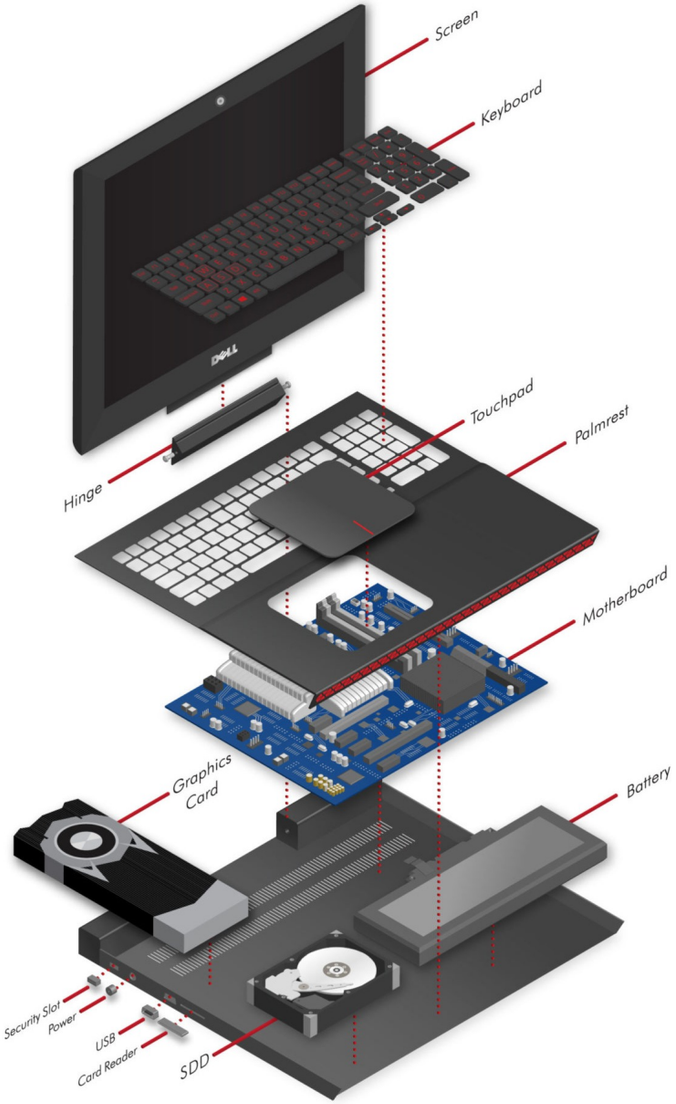
Delft Circuits
Hardware for quantum engineers

Vision on the future: Modular Quantum Computers

What is it?

- Select products from different vendors
- Put together into a full quantum computer



- Modularity made a mass-market for PC’s
- We want the same for quantum computers
- ==>Create a global market for quantum products

Vision on the future: Modular Quantum Computers

What value for customers? (like research institutes)

- More choice on state-of-the art solutions
- Select the best products, since they work together
- Put together into a full quantum computer
- Rely on well-specified functionality and quality
- Easy upgrade by exchanging hardware/software modules
- No vendor lock-in into monolithic solutions
- Reduced price due to large volumes

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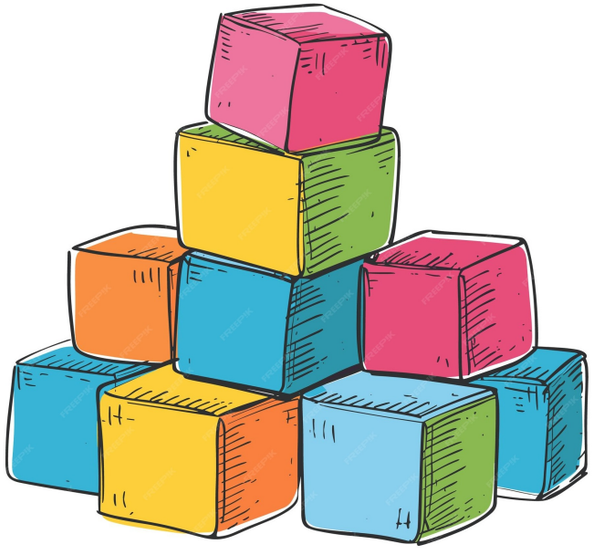
What value for vendors?

- Global market for my products
- Increased sales to more customers
- My innovations sell quicker, due to simple upgrade
- Production in larger volumes, less tailor-made solutions
- Decrease of meaningless requirements from ignorant customers

Vision on the future: Modular Quantum Computers

What is needed for it?

- Consensus view on modularity
- Agreed interfaces
- Mature supply chain of modules that interwork



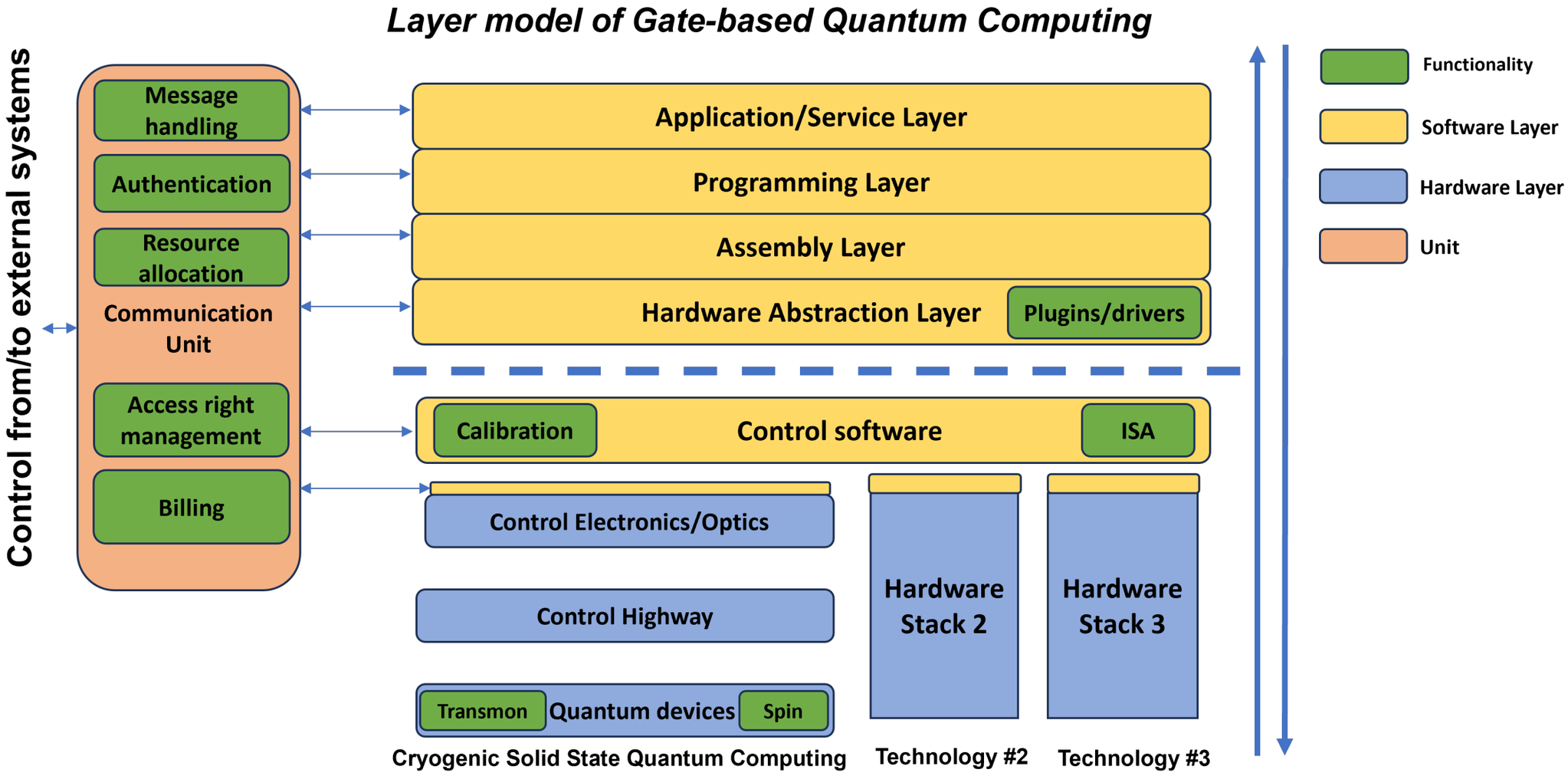
How do we get there?

- Top-down vision on how to divide QC in smaller chunks
- Consensus about layers, functionality, requirements and interfaces
- Written down in standards

First step: a layer model for quantum computers

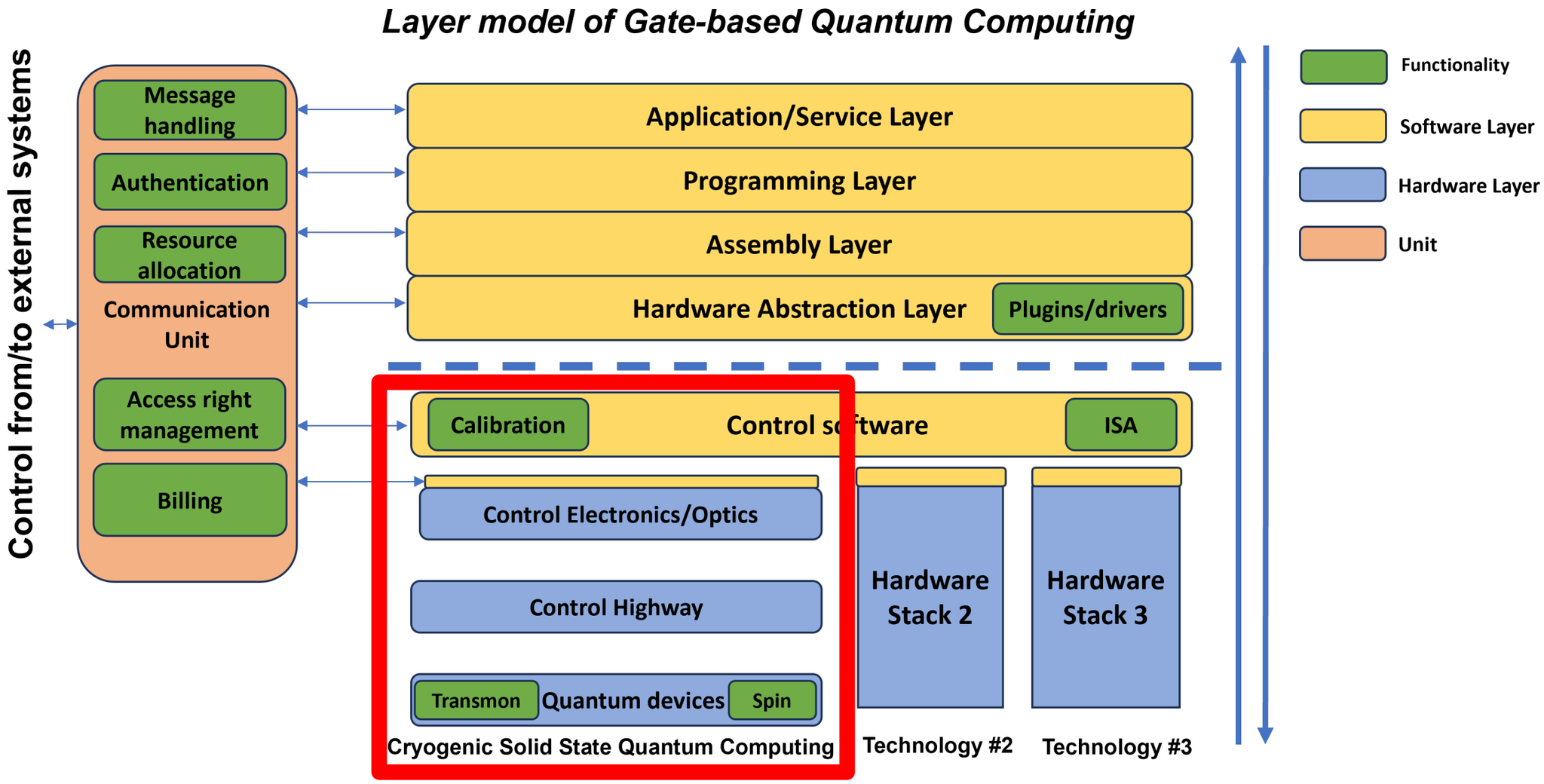
Step 1: Layer Model

Published in Sept 2025 by CEN-CENELEC, JTC22/WG3



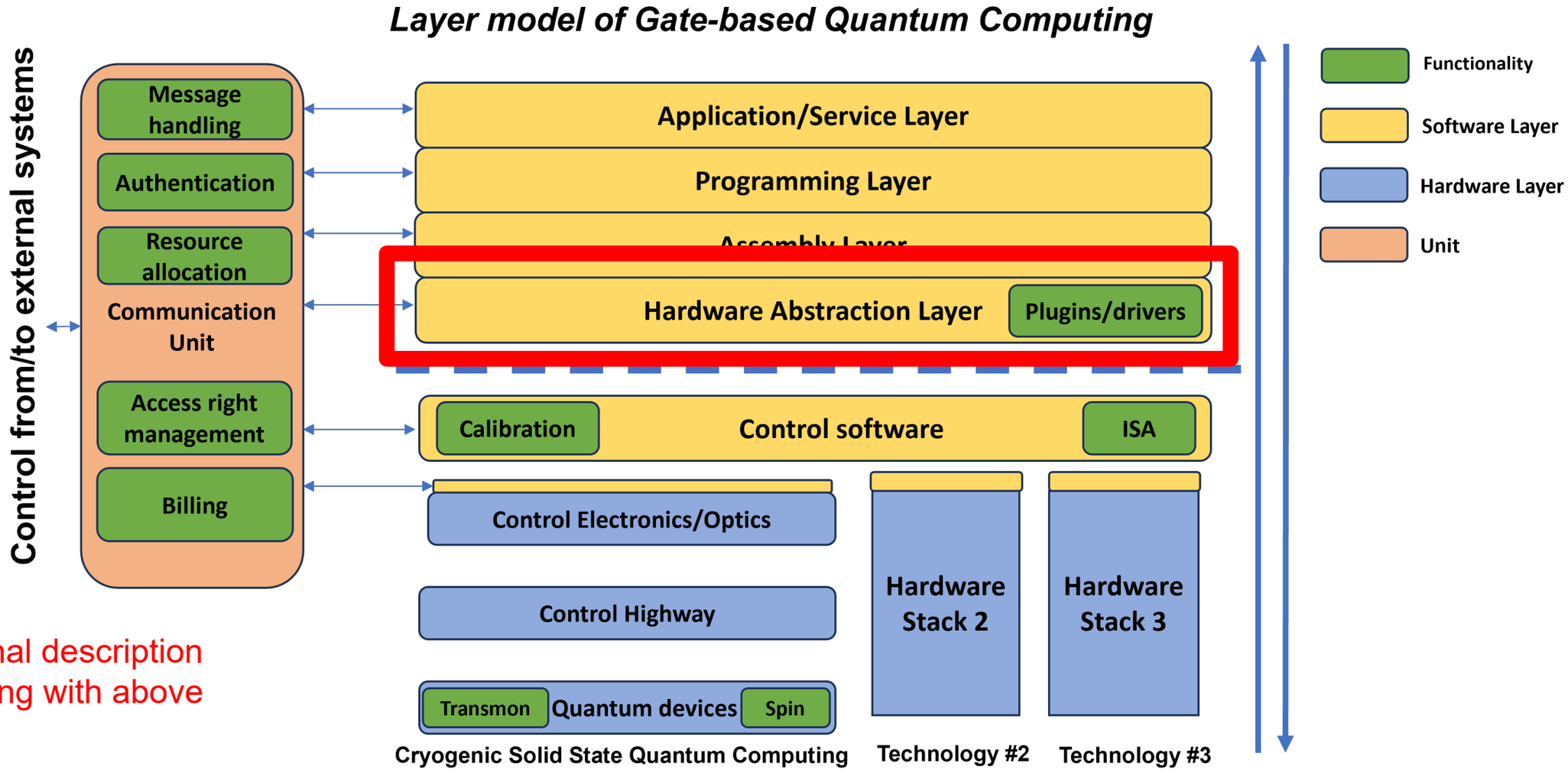
Step 2: Cryogenic Solid State Quantum Computer

Work in progress with JTC22/WG3



Step 3: Hardware Abstraction Layer (HAL)

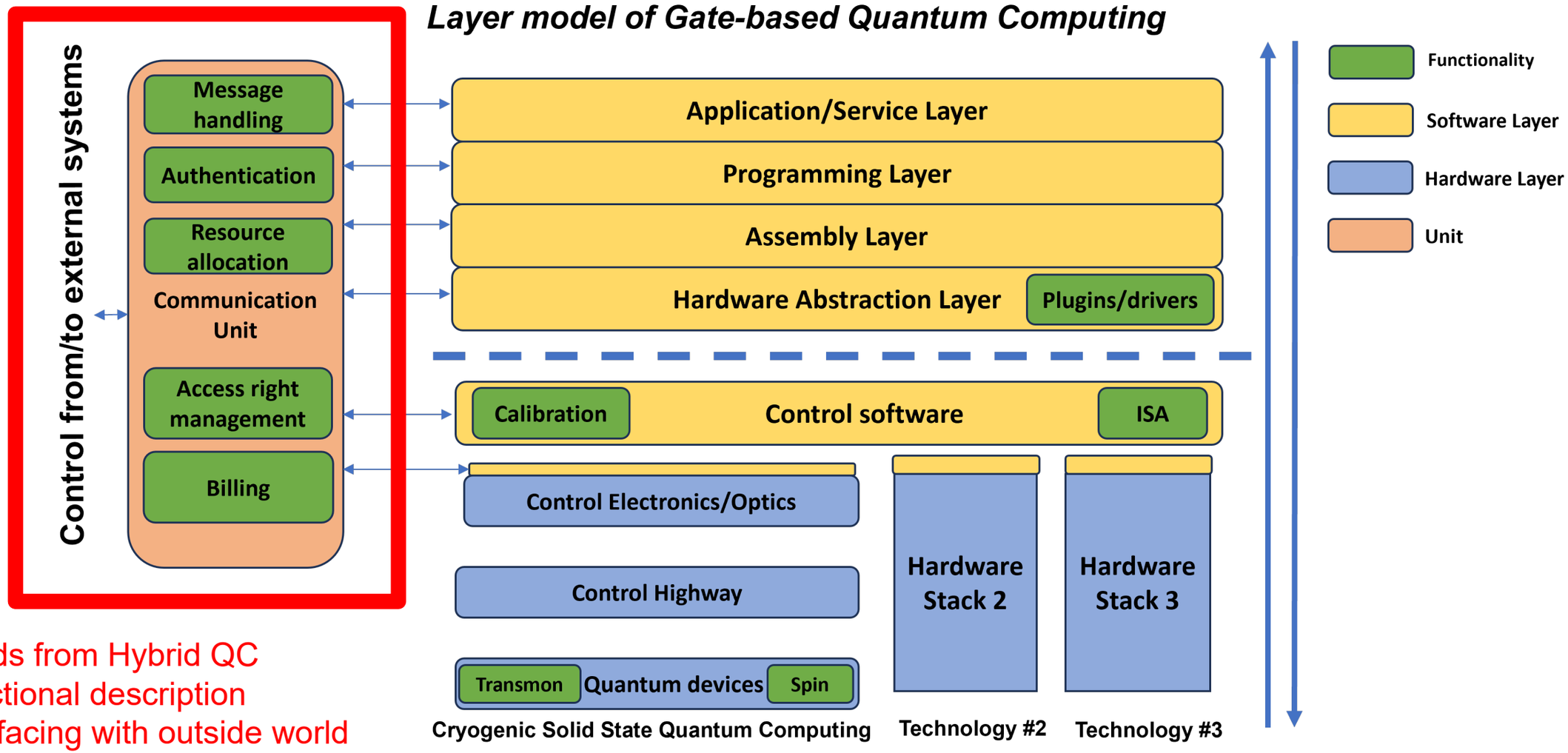
Work being proposed to JTC22/WG3



- Functional description
- Interfacing with above

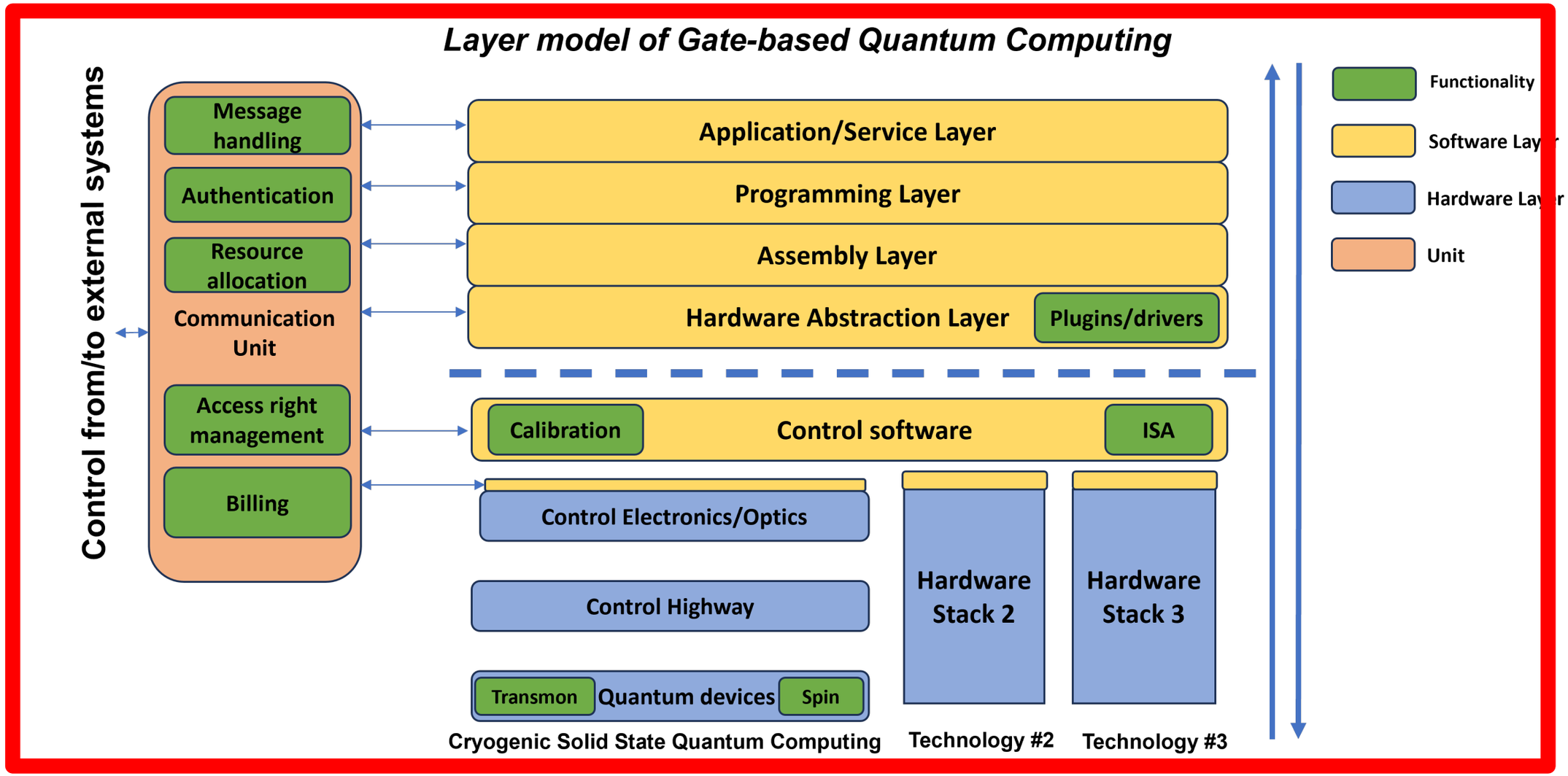
Step 4: Communication Unit

Future plans – interaction with hybrid quantum computing

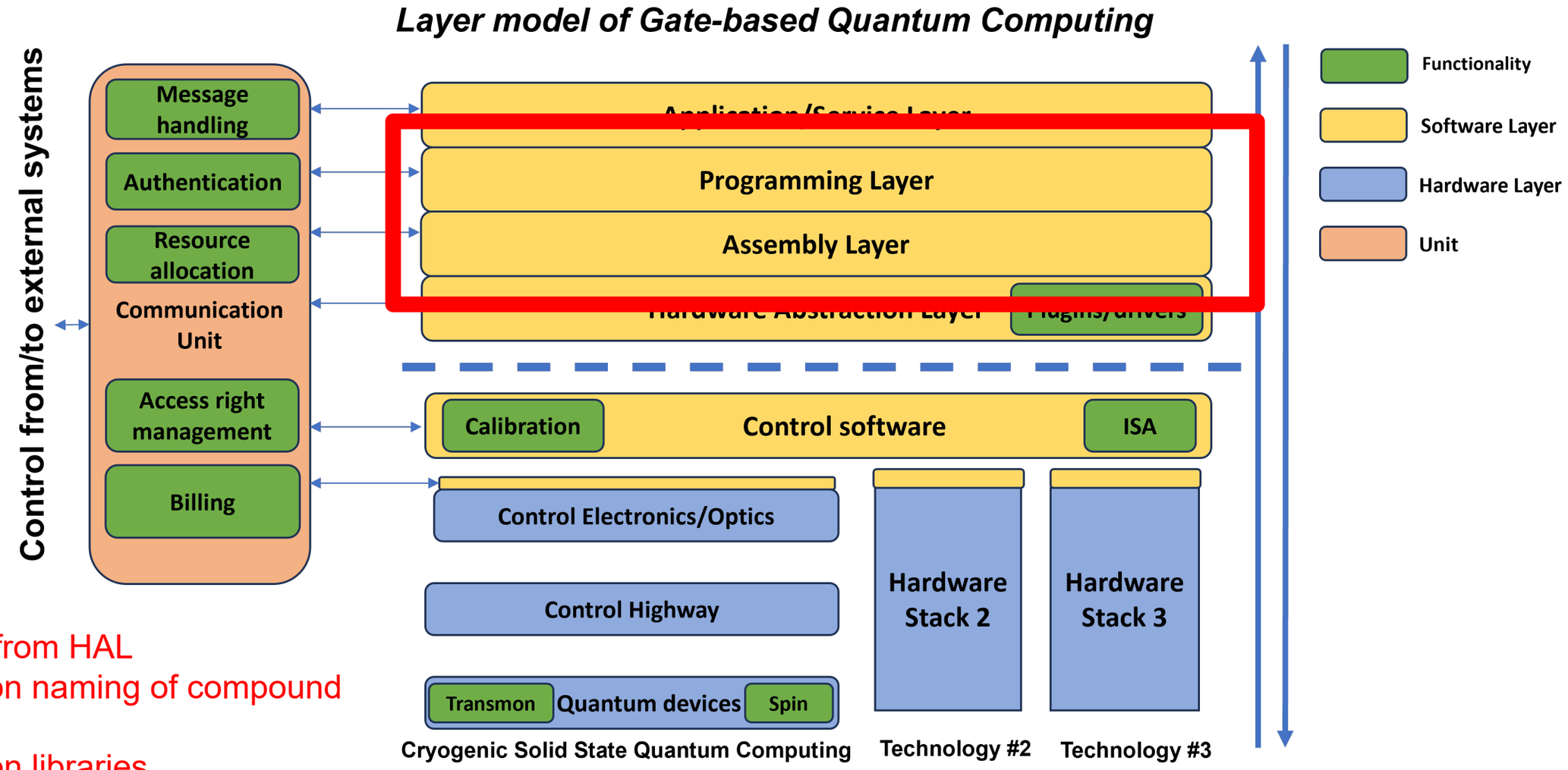


- Needs from Hybrid QC
- Functional description
- Interfacing with outside world

Step 5: Overall upgrade of layer model



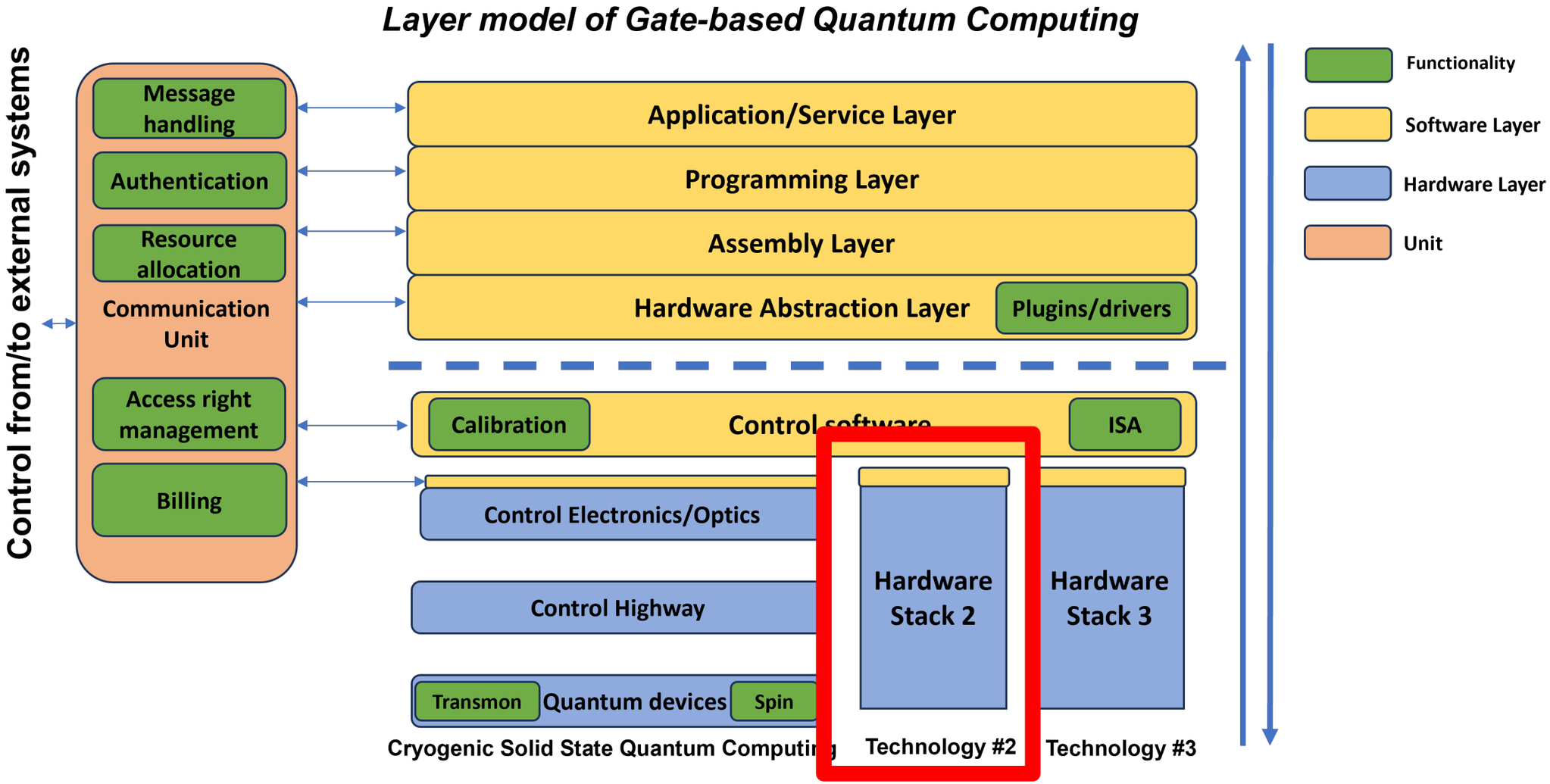
Next? - Quantum Programing Languages?



- Needs from HAL
- Common naming of compound gates
- Common libraries

Next: - Other hardware solutions

Future plans – Photonics? Ion Traps? …?



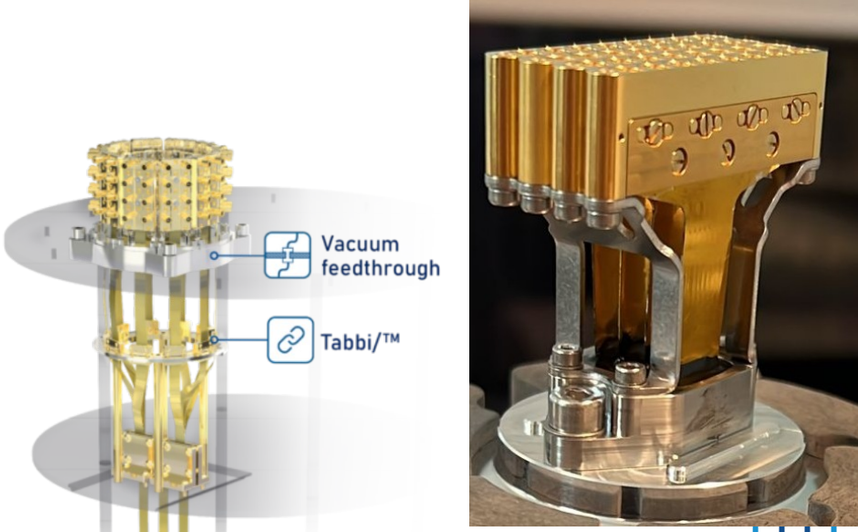
Why is Delft Circuits is doing this?

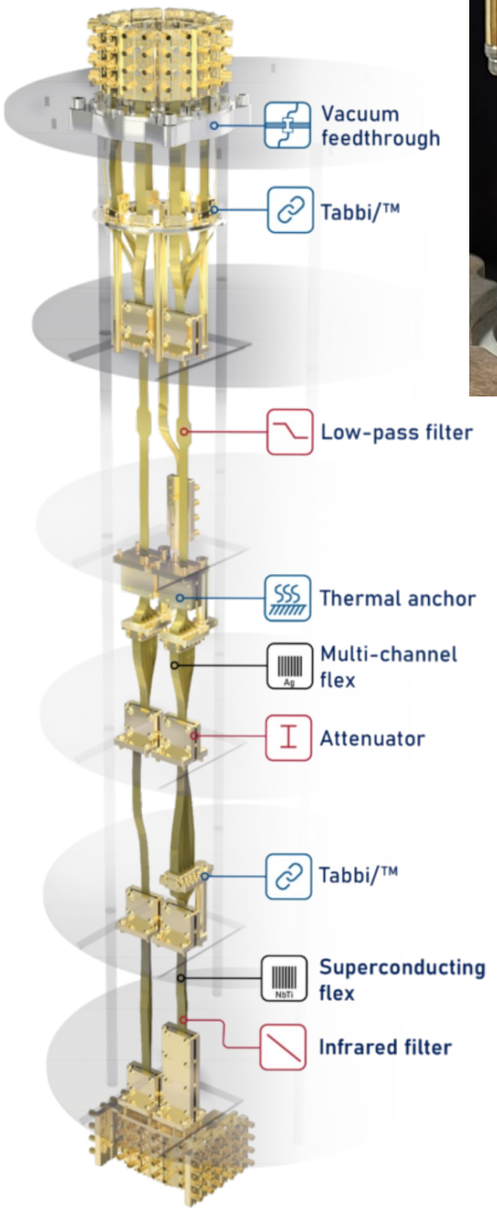
Why are we active in standardisation?

- To develop a global market for our products
- To position our products in standards
- Set meaningful but tough requirements
- Learn more from about customer requirements
- Make sure our products interwork with others

Why taking leading position in standardisation?

- Be the first, and shape the future in our interest
- Visibility to stimulate sales and funding
- To build a network of contacts
- To improve our vision into future-proof

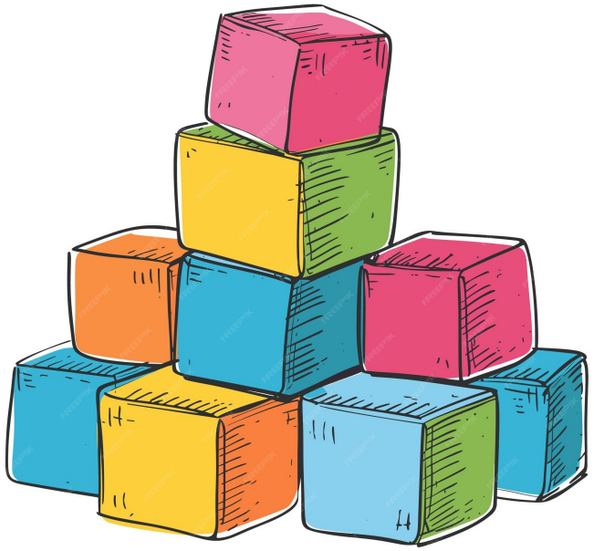




Conclusions

Today: rapid growing Dutch industry & eco-system on quantum

- Mainly about sub-systems → modular approach (hardware+software)
- If successful → global market
- If successful → standard modules that can interwork
- If successful → standards



Europe is quite ahead with quantum standardisation

- Good ideas will be copied
- Layer model first standard on QC being published
- Clear plan on how to proceed
- Strong dutch involvement

If we want to shape the quantum future,

we should do it now