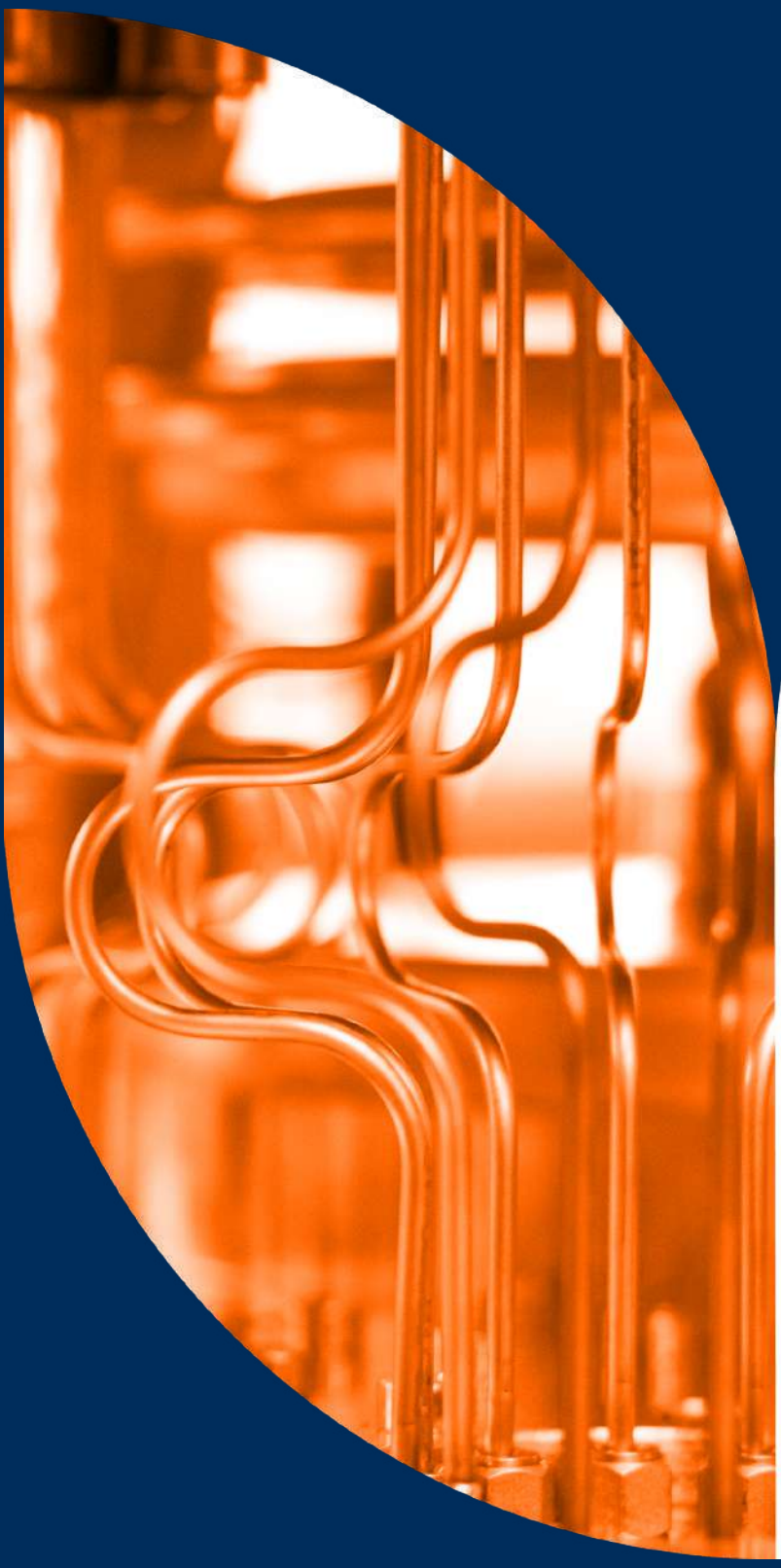

Mapping Quantum Supply Chains

Towards European technology sovereignty in an emerging industry

Quantum Delta Nederland

Mapping Quantum Supply Chains

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Content

Mapping Quantum Supply Chains

1 Introduction

Quantum technology is still in its early days, but the contours of an emergent industry are being shaped today. As one of Europe's leading quantum ecosystems, Quantum Delta NL believes that we have a responsibility to think ahead: how will and should a quantum industry look like and how can we anticipate its impact on the economy, society and global technology landscape…? Quantum computing is a case in point.

Multiple (qubit) platforms are currently being developed side-by-side, each with specific advantages and disadvantages, with each a different supply chain. As we build a quantum ecosystem, we need to think about preventing supply chain disruptions as we have seen happening for example with Covid-19. This line of thinking serves the goal of the European Union (EU) to increase technology resilience and to work on 'open strategic autonomy'.

As a national technology programme, we are working with partners world-wide. Quantum is a global effort with connections that transcend nation state boundaries across the globe. At the same time, we believe that quantum is part of a truly European deep-tech agenda. In order to ensure that we create a solid foundation for this emerging industry, we are proactively investing in a dialogue with relevant players from science, industry and policy about the role of quantum in strengthening European sovereignty.
In late 2021 Quantum Delta NL took the initiative to map the existing supply chains for quantum computing hardware, in close collaboration with the Dutch national research institute TNO. The result is a supply chain canvas for quantum technology, which provides a comprehensive overview of the various components for some of the leading hardware platforms for quantum computing. We also developed a visualisation tool that can help guide discussions about potential bottlenecks and strategic investments.

Since we started this work, we received a lot of interest in the methodology we developed. There is a wide recognition that the type of insights gained are highly relevant for the future of deep tech in Europe.

We are currently engaging with our European partners to explore the next steps, and we stand ready to work with them to expand this assessment to include other hardware platforms, software developments, etc.

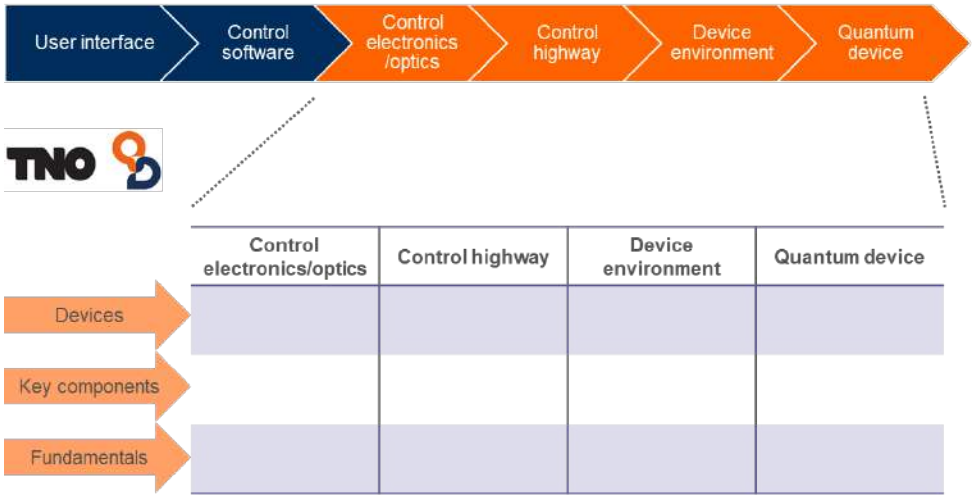
This Quantum Delta NL White Paper serves as a quick manual to our supply chain assessment; in the following you will find the methodology and a summary of the first results for quantum computing.

2 Methodology

Our canvas methodology consists of three steps:

1. **Canvas design.** In order to construct our canvas, we first split a standardised quantum computing stack[1] into four columns and then used three rows to subdivide each hardware layer of the stack into devices, key components and fundamentals (such as raw materials and consumables).
2. **Filling the canvas.** Based on a combination of literature research and expert interviews, we filled the canvas with the most important components of the supply chain. Trivial or generic elements were intentionally left out in this context, such as standard electrical wiring.
3. **Validation.** During each interview, we validated the correctness of the canvas up to that point, both in terms of its structure and its contents.

In total we performed 14 interviews to map the canvas for four qubit types: nitrogen-vacancy centres in diamond, quantum dots in silicon, superconducting transmons and Rydberg atoms.



Canvas methodology developed by QDNL and TNO. The hardware layers of the quantum computing stack are used as columns and the rows are subdivided into devices, key components and fundamentals.

[1]Terminology used from the CEN-CENELEC FGQT standardization roadmap (except device environment)

3 Results

We combined the components of all four platforms into one single overview. For this visualisation, we plotted each component in a two-by-two matrix. The horizontal axis represents the concentration of supply (how many suppliers), and the vertical axis represents the so-called EU-substitutability (potential for EU suppliers to offer the same product). This model was modified from an earlier supply chain assessment published by the European Commission.[2]

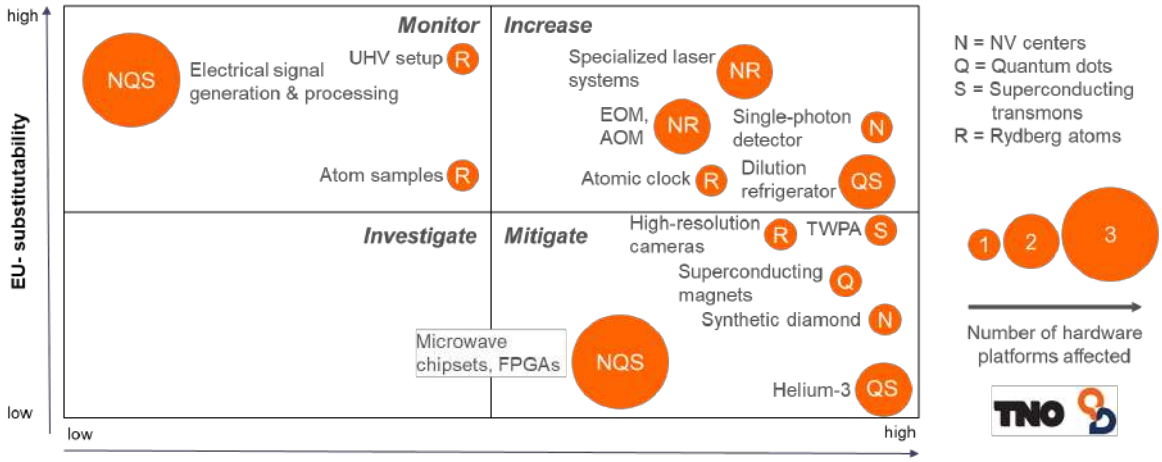
In short: the concentration on the horizontal axis indicates the number of suppliers and their market share. If a small number of suppliers have a high market share, concentration of supply is high. The EU-substitutability on the vertical axis gives an indication of the potential to substitute a component, where a high substitutability implies that there is (a potential) capacity in Europe to produce a substitutive component.

The result is displayed in the figure below. Note that the components are placed based on first-hand vendor information, without taking the underlying supply chains for sub-components into account.

When looking at the four quadrants of this matrix, we can give each a 'title', which reflects its specific characteristics. Each quadrant allows for a different interpretation in view of strategic dependencies and possible responses / (policy) implications:

- **Monitor:** sufficient alternatives exist within and outside the EU.
  Response: monitor the situation and try to consolidate.

- **Increase:** there are few suppliers of the component, although they are already based in (or can be replaced with an alternative supplier within) the EU.
  Response: stimulate an increase in suppliers within the EU.



Result of the supply chain mapping, in which the information from the canvasses of all four hardware platforms is combined in a single matrix.

[2] SWD(2021) 352 final: Commission Staff Working Document: Strategic Dependencies and Capacities, DG GROW, European Commission (2021).

- **Investigate:** there are plenty suppliers, but they all reside outside of the EU. *Response: investigate how to deal with the situation, e.g. by strategic investments to create an EU ecosystem.*

- **Mitigate**: few suppliers exist and there is little potential for finding a substitution within the EU. *Response: mitigate this strategic risk, e.g. by pursuing alternative technical solutions.*

Even though these results represent only a fraction of what is currently available across the EU, we can already derive several valuable insights from this exercise. One is, that most components are placed relatively far to the right, implying that the concentration of vendors that sell these components is quite high. This not surprising, given the fact that most of these components are used for (fundamental) research at universities and corporate R&D labs. It is too early to speak of a commercial market. A second insight is that we can distinguish between a number of components for which EU substitutes are a realistic option, while others (such as Helium-3 or superconducting magnets) require careful consideration vis-à-vis potential disruptions.

4 Conclusions

After this initial exercise, we believe that the proposed canvas and methodology provide a useful tool for mapping supply chains in quantum technology and serves as a valid basis for analysis and visualisation. It is qubit-platform independent and allows for an easy and intuitive mapping of the most important components required. In combination with the proposed substitutability and concentration model, it directly leads to actionable insights.

In future work, we aim to include quantitative data on e.g. patents, trade data, workforce, investments, etc., as well as other computing platforms such as photonics and trapped ions. Moreover, we will perform a similar mapping exercise for the quantum communication and sensing domains. Moving forward, we are engaging with a growing number of partners including the European Commission, industry consortia and standardization bodies.

Please do not hesitate to get in touch with us for feedback, more information, or opportunities to collaborate!

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