LIGHTHOUSE EUROPE
Your voice in the EU

The Quantum Frontier: EU's Quantum Technology Endeavour

Lighthouse Europe

April 2024

ANALYSIS

EU Quantum Initiatives

On 22 March 2024, 21 Member States signed the European declaration on quantum technologies with a vision to develop an advanced quantum ecosystem in the EU. The EU's aspirations to pioneer in the quantum field can also be observed in **initiatives from previous years**, namely the Quantum Technologies Flagship for supporting **research**, the EuroHPC for the development of a **supercomputer ecosystem** in Europe and the EuroQCI for establishing cyber-resilient **quantum-based communications** in the EU.

On 21 February 2024, the Commission published a White Paper on "How to master Europe's digital infrastructure needs. The White Paper, among others, expresses concerns about the implications of quantum technologies to the **security of digital communications**, as quantum computers will be capable to bypass modern encryption methods. National authorities and ENISA have already prioritised the development of **Post Quantum Cryptography (PQC),** which is expected to assist in raising defensive walls against the malevolent use of quantum computers.

In addition, the EU Commission adopted a Recommendation on critical technology areas for the EU's economic security for further risk assessment with Member States **on 03 October 2023**. The recommendation categorises Quantum Technologies as one technological field that is likely to present **immediate risks**. It further calls Member States on a dialogue with EU Commission in order to draft a **collective risk assessment** on the relevant technological fields. The EU Commission will use the specific risk assessment as a basis for its **future policy initiatives**.

Whist quantum technologies, such as quantum computers might sound like a sci-fi scenario, they are actually being **developed and optimised** by researchers and companies with the vision to be deployed

by **2030s** [1]. The implementation of quantum mechanics on computers is expected to tremendously affect the way computers will be operating in the future, offering us **insights about our world** that we could never perceive before.

Quantum Technology

Classic computers use the so-called **bits**, data units in the state of 0 or 1. Quantum computers, on the other hand, use **qubits (quantum bits)**, where principles of quantum theory apply, i.e., superposition and entanglement. **Superposition** enables qubits to be 0 or 1 or in **both states** simultaneously. **Entanglement**, is a quantum phenomenon where qubits become **interconnected** and the **state of one qubit can depend on the state of another**, regardless of the distance between them. These two properties cause a **quantum speedup**, meaning that quantum computers are able to solve problems **exponentially faster** than modern computers.[2]. In 2019, Google was the first one to materialise quantum theory and build the first 53-qubit computer, which was able to solve a problem that would take a state-of-art supercomputer **10.000 years, in just 200 seconds**, achieving what Google called "quantum supremacy"[3].

One of the main weaknesses of quantum computers is that are prone to **disruptions due to external factors**, e.g., light, which obstruct effective computations, thus causing **information loss**. Moreover, quantum computers require **extremely low temperatures** (-272.778 °C, near absolute zero!) in order to operate, rendering them impractical[4].

Quantum computing companies currently work on optimising quantum computers via encoding larger number physical qubits into **error-corrected qubits or logical qubits**[5]. Logical qubits are expected to **reduce the error rate and solve problems accurately and inconceivably fast**. In this context, QuEra, one of the pioneers in quantum computing has developed the first 256 - (logical) qubit room-temperature device, Aquila, which is available on Braket, a quantum cloud-service provided by Amazon Web Services[6]. According to its roadmap, QuEra aspires to develop a +10.000-qubit computer by 2026.

Innovation and future challenges

Quantum-powered innovation

[1] McKinsey, A game plan for quantum computing, 2020, https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/a-game-plan-for-quantum-computing.
[2] How M-L. and Cheah S-M., Forging the Future: Strategic Approaches to Quantum AI Integration for Industry Transformation, AI, 2024; 5(1):290-323. https://doi.org/10.3390/ai5010015.
[3] Arute, F., Arya, K., Babbush, R. et al., Quantum supremacy using a programmable superconducting processor, Nature 574, 505–510 (2019), https://doi.org/10.1038/s41586-019-1666-5.
[4] How and Cheah, supra note 2.
[5] Google Quantum AI, Suppressing quantum errors by scaling a surface code logical qubit, Nature 614, 676–681 (2023). https://doi.org/10.1038/s41586-022-05434-1.
[6] Wurtz J, et. al, Aquila: QuEra's 256-qubit neutral-atom quantum computer, 2023, https://arxiv.org/abs/2306.11727.

Along with AI, the adoption of quantum computers is expected to **ultimately transform society** in the future. Firstly, they will **upgrade industry** by exponentially upscaling calculations and solve multivariable problems, vertically increasing efficiency (lower costs, economies of scale and quality services). Quantum technology is also expected to apply in the **pharmaceutical and chemical** industry as it can assist simulate complex molecular dynamics and speed up drug and chemical developing processes[7], increasing our lifespan. Furthermore, quantum technology can revolutionise **Machine Learning** through accelerating the algorithmic training, offering us fast and sustainable AI model training. Finally, quantum computers are expected to upgrade **cybersecurity** via their increased computational power rendering them able to **break today's encryption**[8] and reinforce the cyber-resilience of our future devices and communications.

The challenges ahead

Quantum per se

Quantum computing field is galloping and is expected to bring about tremendous progress in the next decades. If **AI** surprised humanity back in November 2022, **quantum technology** should be seriously taken into consideration, as it will give us a **better understanding of the micro and macrocosm**, due to its increased computational capabilities.

However, with great (computational) power comes great responsibility. As quantum computers will overcome conventional encryption. In this case, they will be able to **retrospectively** go through past data, decrypt it and acquire information, putting **privacy**, **intellectual property** and **national security**[9] into risk. Imagine the scenario where, your private online (end-to-end encrypted) conversations are **decoded** and **readable** by others or where a company's **trade secrets** become known due to insufficient cyber-resilience against quantum. The same will apply to national confidential information, if no practical solutions are sought out. Encouraging is that the EU has anticipated the significance of the specific technologies and is moving towards the development **of counter measures** to intercept the malicious use of quantum computers, namely the development of **PQC standards and the use of Quantum Key Distribution** in the future[10]. On a legal point of view, **privacy**, and **IP** law will have to adapt to such developments and be reviewed.

EU institutions

The EU should embrace the fact that technology rapidly advances. In a world, with **AI and quantum** being

[7] McKinsey, supra note 1.
[8] Ibid.
[9] Jeutner V., The Quantum Imperative: Addressing the Legal Dimension of Quantum Computers, 2021, https://doi.org/10.5771/2747-5174-2021-1-52.
[10] See White Paper on "How to master Europe's digital infrastructure needs, 2024.

ubiquitous, the EU will have to adapt to the new landscape. On these grounds, they EU should review the **organisational structure and the hiring process of the EU institutions** in order become flexible and attract talents and people with expertise on the relevant topics, such as engineers, scientists or even experienced professionals. People with **know-how** are becoming all the more quintessential. Last, but not least, Europe should attract **investments** at all costs in order to **grant money** to innovators and seek out **international partnerships** with third countries, universities and companies.

Taking into consideration Nobel prize laureate **Richard Feynman's** famous quote, "I think I can safely say that nobody understands quantum mechanics.", the EU should **avoid rushing when regulating and strive to better understand** cutting-edge technologies, especially the **quantum** ones in conjunction with **AI**. Due to their fast-evolving nature of the said technologies, pre-emptive and rushed regulation could restrict their potential. And even worse render the EU a **technological desert**. Throughout this race towards adapting to a new reality, all of us who are passionate about technology could actively contribute to offering tangible solutions. It is just a matter of **collective effort**.

Contact us

As a public affairs firm based in Brussels and Paris, Lighthouse Europe supports its clients in the analysis of European mechanisms and political priorities, particularly in the digital and environmental sectors. If you would like to learn more about the impact of the new own resources on your activity, please do not hesitate to contact us.

By Georgios Konstantinou