Noise Resilient Quantum-Classical Computing Method Can Help Plan Cellular Communication Networks

Researchers successfully implement a novel algorithm on a PASQAL quantum computer addressing a crucial problem in physical cell identifiers

PARIS, FRANCE, February 6, 2024 /EINPresswire.com/ -- PASQAL, a leader in neutral atoms quantum computing, and the research team at LINKS, specialized in applied research, frontier research, innovation, and technology transfer with strong competencies in High-Performance Computing (HPC) and Quantum Computing have successfully implemented a noise-resilient, hybrid quantum-classical algorithm that provides the foundations for efficiently solving the Physical Cell Identifier (PCI) assignment problem in cellular networks.

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> *Chiara Vercellino, researcher at LINKS Quantum Computing Team*

Today's smartphones constantly search for the closest cell to connect and transfer data to. As a person and their smartphone are moving from place to place, the signal is being transferred from cell tower to another. Cell communication networks are typically dense, and for every device to have an equal share of network capacity, the structure needs to be well-organized. To organize the handover process of mobile signals between cells, networks use PCIs, which are limited and prone to impairments with signal assignments.

"The strongest point of this experiment is that it exploits the characteristics of the current PASQAL machine in such a way that the algorithm is resistant to variations in the results," said Chiara Vercellino, researcher at LINKS Quantum Computing team – part of the Advanced Computing, Photonics and Electromagnetics (CPE) research domain. "The code ran smoothly on the machine, and we knew from the beginning that we could expect good results. The time to solve for many nodes grows exponentially if you consider methods using classical computers only, so for very large graphs we will see the real advantage of using hybrid quantum-classical

approaches."

Neutral atom quantum technology is ideal for solving graph-based problems like PCI impairments because it can position atoms in any desired configuration. PASQAL's hardware is particularly ideal for tackling graph problems because the hardware uses intense, highly focused, lasers to capture atoms individually. The atoms are then manipulated to create two-dimensional or three-dimensional shapes. Researchers from LINKSCPE Quantum Computing team, supported by CINECA, chose to run the hybrid quantum-classical algorithm on Fresnel, the first PASQAL commercial device, to solve the graph coloring problem that emerges in PCI assignments. The research teams from LINKS and PASQAL ran an experiment for their hybrid quantum-classical algorithm to solve four graphs. In all four graphs, the algorithm was successful in finding an optimal coloring solution in agreement with the corresponding numerical simulations.

"The most impressive part of this implementation is that the results the LINKS team obtained are very reliable, even if the QPU [Quantum Process Unit] is still noisy," said Mauro D'Arcangelo, senior quantum software developer at PASQAL. "Provided that you can embed the graph in our QPU, the algorithm just works. You can use it right now. You only need to have enough atoms in the register to represent the graph that you want."

The novel algorithm provides the foundations for efficiently solving the PCI assignment problem in cellular networks and for other applications. Using quantum devices and neutral atom technologies as part of computational workflows may be vital to finding solutions for pressing industrial and scientific problems.

To learn more about the application, read the blog post here.

About LINKS

LINKS Foundation was established with an agreement between Compagnia di San Paolo and Politecnico di Torino more than 20 years ago and operates at national and international level in the field of digital transformation with applied research, innovation and technology transfer activities. The Foundation is a dynamic and constantly evolving organization that generates value for the territory through the expertise of 160 researchers – 90% from Italy and 10% from the rest of the world, a turnover of 17 million euros and a strong network of more than 2,500 partners in Italy and Europe. The Foundation deals with technical-scientific disciplines in the fields of engineering and architecture such as, for example, Artificial Intelligence, IoT, the promotion and management of Cultural Heritage and the Environment, Web3 and Quantum Computing to carry out projects in several application domains: from Industry 4.0 to Cybersecurity, from Intelligent Mobility to Agrifood, from Space Applications to Medicine and Well Being, from Smart Cities to Cultural Heritage.

About CINECA
CINECA is a nonprofit consortium composed of 117 institutions among Italian universities and

public institutions. It is led by a Board of Directors composed of the rectors/delegates of the universities and public bodies members of the Consortium, one delegate of the Ministry of Education, and the Ministry of University and Research.
The consortium's institutional mission is to support the Italian scientific community through supercomputing and scientific visualisation tools. Since the 1980s, CINECA has broadened the scope of its mission by embracing other IT sectors, developing management and administrative services for universities and designing ICT systems for the exchange of information between the MIUR and the Italian national academic system. The consortium is also strongly committed to transferring technology to many categories of users, from public administration to private enterprises.
CINECA takes part in several research projects funded by the European Union for the promotion and development of IT technologies (grid computing, bioinformatic, digital content, the promotion of transnational access to European supercomputing centres, etc.)

About PASQAL
PASQAL is a leading Quantum Computing company that builds quantum processors from ordered neutral atoms in 2D and 3D arrays to bring a practical quantum advantage to its customers and address real-world problems. PASQAL was founded in 2019, out of the Institut d'Optique, by Georges-Olivier Reymond, Christophe Jurczak, Professor Dr. Alain Aspect, Nobel Prize Laureate Physics, 2022, Dr. Antoine Browaeys, and Dr. Thierry Lahaye. PASQAL has secured more than €140 million in financing to date. To learn more about PASQAL, visit www.pasqal.com

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