The race is on for a new internet

October 11 2023, by Jonathan O'Callaghan

Credit: AI-generated image (disclaimer)

Europe is pushing to create a network infrastructure based on quantum physics.

In May 2023, Dr. Benjamin Lanyon at the University of Innsbruck in Austria took an important step toward creating a new kind of internet: he transferred information along an optical fiber 50 kilometers long using the principles of quantum physics.

Information in quantum physics differs from the units of data—binary digits—stored and processed by computers that form the core of the current World Wide Web. The quantum physics realm covers the properties and interactions of molecules, atoms and even smaller particles such as electrons and photons.

Particle power

Quantum bits, or "qubits," offer the promise of transmitting information more securely because the particles get changed by the act of observing and measuring them. That means an eavesdropper can't go undetected.

Lanyon said his work makes the quantum internet appear feasible within cities, after which longer intercity distances will be the goal.

"You could imagine this being a large-city scale," he said.

His breakthrough was part of an EU research project to bring the goal of a quantum internet closer.

Called the Quantum Internet Alliance, or QIA, the project brings together research institutes and companies across Europe. The initiative is receiving €24 million in EU funding over three and a half years until the end of March 2026.

"It is not meant to replace the classical internet, but to work together," said Stephanie Wehner, a German native who coordinates the QIA and is a professor of quantum information at Delft University of Technology in the Netherlands. "We're not going to replace Netflix."

A key concept in quantum physics is entanglement. If two particles are entangled, no matter how far apart they are in space, they will possess similar properties—for example, both having the same measurement of something called "spin," a quantum version of the direction that the particles are spinning.

The spin state of the particles isn't clear until they are observed. Until then, they're in multiple states called superposition.

But when one is observed, the state of both particles becomes known.

Possibilities aplenty

This is useful in secure communications. People hacking a quantum transmission would leave behind an obvious trace of their attempt by causing a change in the state of an observed particle.

"We can use the properties of quantum entanglement to achieve a means of secure communication that is probably secure even if the attacker has a quantum computer," said Wehner.

The secure communications afforded by a quantum internet could open up a much broader range of applications that are well beyond the bounds of the classical internet.

In medicine, for example, the physics of entanglement allows for a level of clock synchronization that can improve telesurgery.

"If I want to perform surgery on some remote node, I want this to be very precisely timed in order to not make any mistakes," said Wehner.

Astronomy is another potential beneficiary.

Telescopes making distant observations could "use a quantum internet to generate entanglement between the sensors to get a much better image of the sky," Wehner said.

A further example might be ATM machines.

At present, were an ATM to crash when a person was withdrawing money, the machine would assume no cash had been delivered while another dispenser would register a money withdrawal. A quantum internet could remove that discrepancy.

Many applications of a quantum internet will likely become apparent only after the technology is created.

"It offers a whole range of new possibilities for making precise measurements of space and time and studying how the world and the universe work," said Lanyon.

Distance test

The trick now is scaling up a quantum internet to use many particles across long distances.

Lanyon and his team have also demonstrated communicating not just between single particles but also 'trains' of particles—in this case light particles called photons—speeding up the rate of entanglement between quantum nodes.

"If you just sent one photon at a time, you have to wait for the travel time," he said. "But if you can make trains of many photons at once, this allows you to increase the rate of entanglement between quantum nodes for the distances we want."

The ultimate goal is to extend quantum nodes to much bigger ranges, perhaps 500 kilometers, and create a prototype of a quantum internet that can link remote cities—much like the classical internet relies on different nodes to create a global internet.

While a quantum internet could exist for specialized applications as soon as 2029, experts are wary of hazarding a guess about when a full version might be available for a wide range of uses.

"It's a very difficult question," said Wehner.

As the QIA advances the components and systems of the quantum internet, Europe is also working to develop quantum computers themselves.

In June 2023, an EU public-private partnership—the European High Performance Computing Joint Undertaking—announced that six countries in Europe would host quantum computers. The countries are the Czech Republic, France, Germany, Italy, Poland and Spain.

The aim is to ensure that Europe is at the forefront of the quantum technologies revolution. Quantum computers are expected to have unprecedented calculation power with many uses, including the ability to break the cryptographic algorithms that secure most of the exchanges of the current internet.

Crowded field

With projections that half of the most used cryptographic systems will be broken by the end of the decade, Europe is hardly the only interested party.

China and the U.S. have made advances in quantum computing and the quantum internet in recent years.

Back on the infrastructure front, Europe is taking other steps. It's developing an integrated space and terrestrial infrastructure for secure communications—a building block of sorts for the quantum internet.

"I'm very proud to say we are world-leading in many domains," said Wehner.

While in all interested countries much work remains, the potential benefits signal further advances and breakthroughs before too long.

"People are developing new applications of quantum networks at quite a high rate," Lanyon said.

More information:

- Quantum Internet Alliance—Phase1
- Shaping Europe's Digital Future

Provided by Horizon: The EU Research & Innovation Magazine

Citation: The race is on for a new internet (2023, October 11) retrieved 28 April 2024 from https://phys.org/news/2023-10-internet.html