Single-photon technology powers 11-mile quantum communications network between two campuses

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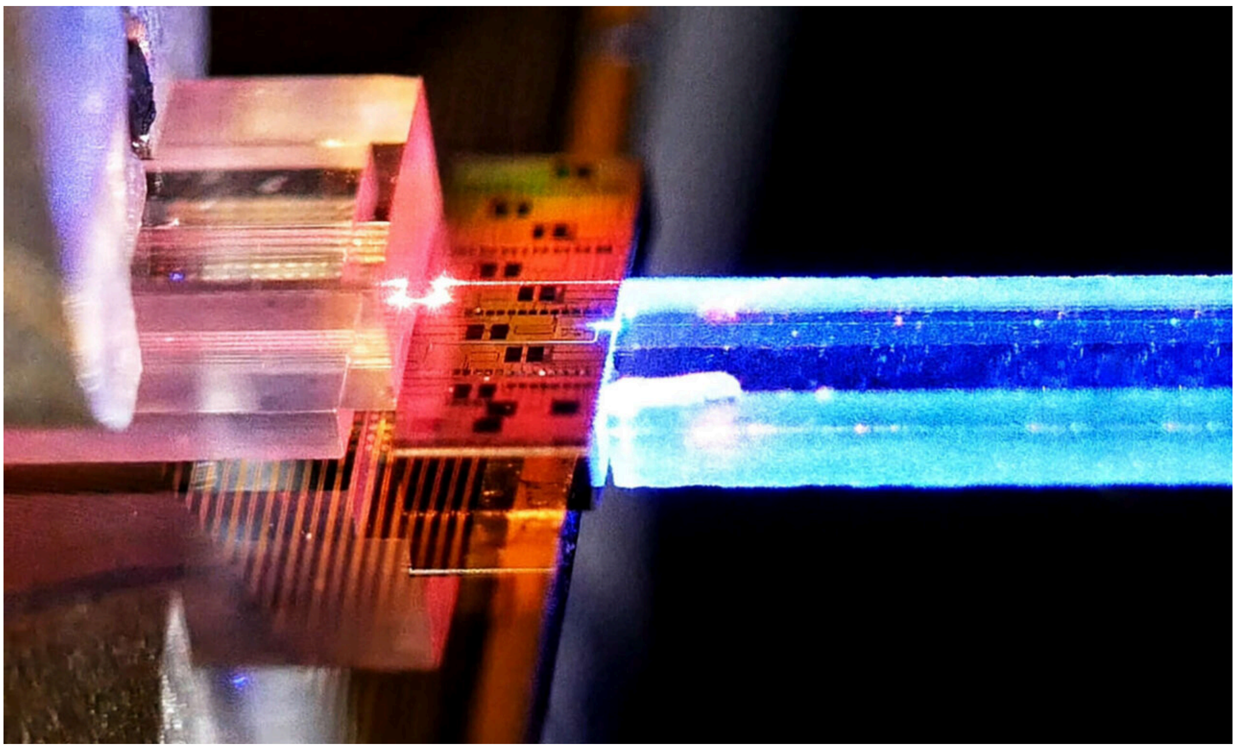


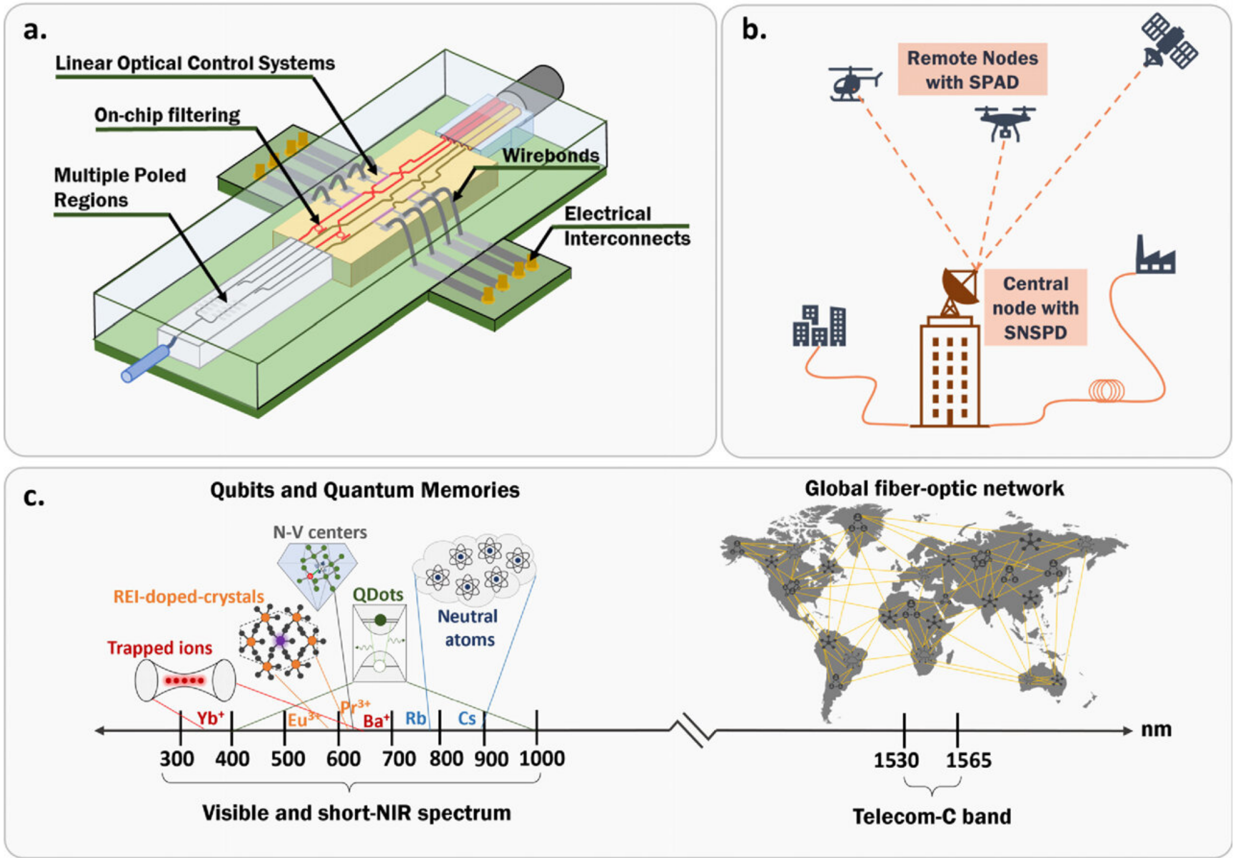
Network IT: A photonic chip coupled to a highly nonlinear crystal and a fiber array unit. The crystal produces entangled visible-telecom photon pairs, which are processed on silicon nitride and silicon photonic integrated circuits enabling a compact and versatile platform to link visibly accessed quantum nodes over existing telecommunications infrastructure. Credit: RIT

Researchers at the University of Rochester and Rochester Institute of Technology recently connected their campuses with an experimental quantum communications network using two optical fibers. In a new paper published in *Optica Quantum*, scientists describe the Rochester Quantum Network (RoQNET), which uses single photons to transmit information about 11 miles along fiber-optic lines at room temperature using optical wavelengths.

Quantum communications networks have the potential to massively improve the security with which information is transmitted, making messages impossible to clone or intercept without detection. Quantum communication works with quantum bits, or qubits, that can be physically created using atoms, superconductors, and even in defects in materials like diamond. However, photons—individual particles of light—are the best type of qubit for long distance quantum communications.

Photons are appealing for quantum communication in part because they could theoretically be transmitted over existing fiber-optic telecommunications lines that already crisscross the globe. In the future, many types of qubits will likely be utilized because qubit sources, like quantum dots or trapped ions, each have their own advantages for specific applications in quantum computing or different types of quantum sensing.

However, photons are the most compatible with existing communications lines. The new paper is focused on making quantum communication between different types of qubits in a network a reality.



Scope. (a) A representative, fully packaged version of this platform incorporating multiple poled waveguides and on-chip filters for a plug-and-play source of visible–telecom entangled photon pairs. (b) Using a visible–telecom photon pair source enables the generation of telecom single photons heralded by the visible photons. Visible wavelengths can be efficiently detected using compact single-photon avalanche diodes, while telecom wavelengths are ideal for low-loss transmission across long distances in optical fibers. Our visible–telecom pair source would allow chip-scale, field-deployable quantum nodes to securely communicate with a central server using single photons at telecom wavelengths over existing optical fibers. (c) Our visible–telecom photon pair source also paves the way for an heterogeneous quantum network by bridging the gap between various visibly accessed quantum nodes and existing telecommunication infrastructure. Credit: *Optica Quantum* (2025). DOI: 10.1364/OPTICAQ.546774

"This is an exciting step creating quantum networks that would protect communications and empower new approaches to distributed computing and imaging," says Nickolas Vamivakas, the Marie C. Wilson and Joseph C. Wilson Professor of Optical Physics, who led the University of Rochester's efforts.

"While other groups have developed experimental quantum networks, RoQNET is unique in its use of integrated quantum photonic chips for quantum light generation and solid-state based quantum memory nodes."

The teams at the University of Rochester and RIT combined their expertise in optics, quantum information, and photonics to develop technology with photonic-integrated circuits that could facilitate the quantum network. Currently, efforts to leverage fiber-optic lines for quantum communication require bulky and expensive superconducting-nanowire-single-photon-detectors (SNSPDs), but they hope to eliminate this barrier.

"Photons move at the speed of light and their wide range of wavelengths enable communication with different types of qubits," says Stefan Preble, professor in the Kate Gleason College of Engineering at RIT. "Our focus is on distributed quantum entanglement, and RoQNET is a test bed for doing that."

Ultimately, the researchers want to connect RoQNET to other research facilities across New York State at Brookhaven National Lab, Stony Brook University, Air Force Research Laboratory, and New York University.

More information: Vijay S. S. Sundaram et al, Heralded telecom single photons from a visible–telecom pair source on a hybrid PPKTP–PIC platform, *Optica Quantum* (2025). DOI: 10.1364/OPTICAQ.546774

Provided by University of Rochester