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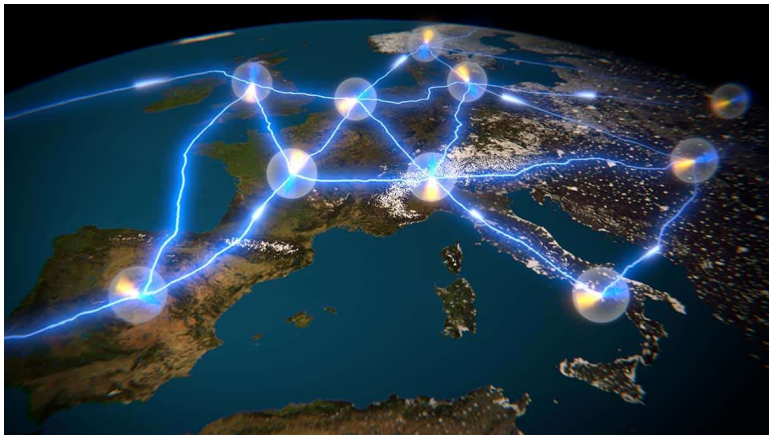
Quantum Optical Networking

This report shines a light on a program that develops new measurement techniques, tests and performance procedures, standards, and best practices to enable industry and government to gain confidence in this new disruptive network technology: quantum optical network technology. Harnessing quantum networking technologies will power our economic competitiveness and provide better communication security. The program is organized around two research/focus areas:

QUANTUM NETWORK METROLOGY

demonstrating remote microwave entanglement of superconducting quantum processor nodes with microwave-optical transducer devices; defining operating thresholds for quantum devices, channels, and protocols that preserve quantum information; and developing precision timing and positioning for quantum network operation. These programs leverage world's-best transducers from CU-JILA collaborators, pioneering work with optical frequency combs, and theoretical foundations in quantum information theory.



WHAT IS QUANTUM TECHNOLOGY?

Quantum technology is an emerging field of physics and engineering, encompassing technologies that rely on the properties of quantum mechanics, especially quantum entanglement, quantum superposition, and quantum tunneling.

WHAT IS QUANTUM ENTANGLEMENT?

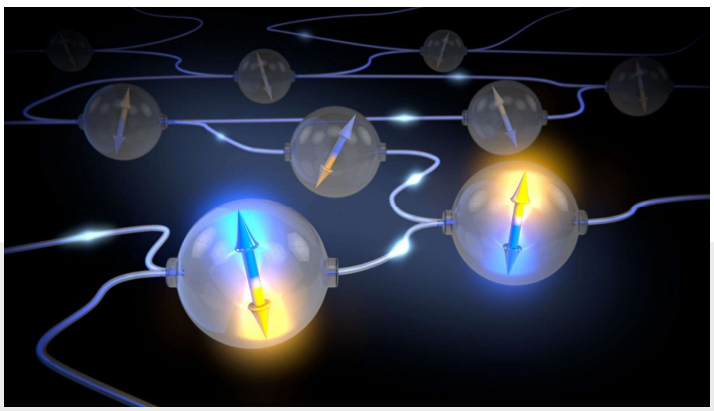
Quantum entanglement is when two particles link together in a certain way no matter how far apart they are in space. Their state remains the same.

Quantum Optical Network Architecture and Protocols

This research area will address the core problem of entanglement distribution and stability by developing efficient and resilient protocols stacks to identify, distribute, manage, and manipulate entangled photons and propose solutions that overcome environment-induced optical and quantum impairments. The main focus is quantum networking protocols design and their performance evaluation and pre-standardization validation. It will also undertake collaborations with NIST partners in CTL, ITL, and PML to design, program, and carry out experiments to collect network metrics for control plane performance evaluation. The technical areas of research include:

- Architecture research for Quantum Optical Networks and integration with classical networks
- Management (Label, identify, track) and Control Plane (Signal & Route optical paths) Software Stacks
- Performance monitoring for end-to-end Quality of Entanglement estimation and End-2-End entanglement traffic engineering capabilities
- Design of entanglement distribution protocols
- Control plane time distribution for data plane stability
- Concepts validation in testbeds: NIST Platform for Quantum Network Innovation (PQNI) in the NIST Gaithersburg campus, and the regional Washington-DC area testbed (DC-QNet).
- Modeling and Simulation of Quantum Optical Networks

Quantum networks form an important element of quantum computing and quantum communication systems.



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