

# Simultaneous entanglement distribution across a five-node, 275 km, deployed quantum network.

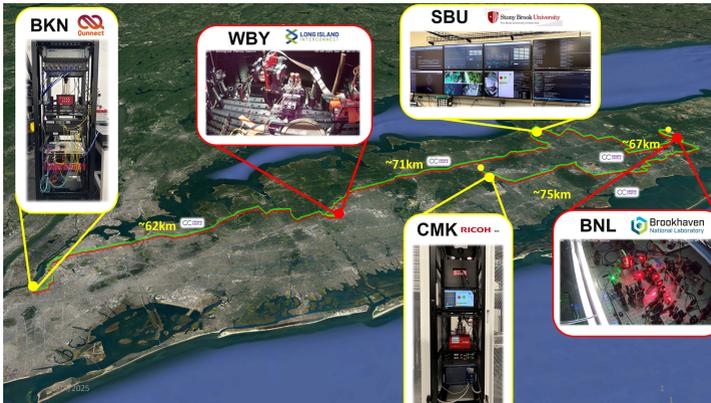
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Entanglement distributed over long distances is the primary resource for building quantum internet networks. We describe the implementation of a layered long-distance entanglement distribution five-node network, connecting laboratories at Stony Brook University and Brookhaven National Laboratory, as well as data center facilities in Commack, Westbury, and Brooklyn, New York, all connected by  $\sim 275$  km of field-deployed inter-city optical fibers.



**Fig. 1:** The five-node network testbed. The root node at SBU oversees the operation of all systems. The Level-1 BNL and WBY nodes create 1324 nm polarization-entangled photon pairs and polarization states for compensation. The Level-2 BKN and CMK nodes verify the faithful transmission of entangled photon streams and perform non-local tomography operations using deployed nanowire detectors.

We use two 2-qubit, 4-detector polarization quantum state tomography systems adapted for long-distance operation and have performed simultaneous full tomography measurements of the entangled states transmitted across the two subnetworks. The transmitted entanglement from the BNL source to SBU/CMK, has a fidelity of  $\sim 65\%$  with respect to  $\Phi^+$ . At the same time, the entanglement transmitted from the WBY source to SBU/BKN, has a fidelity of  $\sim 77\%$ . This indicates the simultaneous distribution of entanglement over both halves of the 275 km network and paves the way for entanglement swapping experiments across deployed quantum networks.

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