[GMLC] Grid Research, Integration, and Deployment for Quantum (Grid-Q)

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Timeline: FY2024 – present

Challenge:
Next-generation signal routing and grid communication protocols must be resilient against adversarial quantum computing. While effective, traditional quantum-secured links are explicitly point-to-point. To overcome this limitation which precludes widespread adoption, we will develop new key generation, routing, and management algorithms which borrow from existing and emerging ideas in secure multi-party computation. We will leverage our prior work in key swapping to securely extend quantum links and develop new methods in exploring a secure network stack to enable grid communications across a hybrid classical/quantum topology. This innovation combines quantum key management algorithms with postquantum key-switching to allow multiple parties to effectively share secret key material over longer distances through semi-trusted relay nodes. Working with project partners, we will develop an integrated approach that ties together quantum security assets with leading OT security tools.

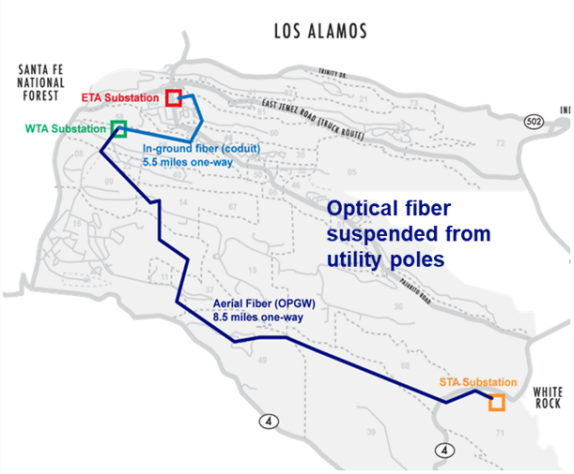

Figure 1: Overhead view of Los Alamos main technical areas, with substations and quantum interconnects highlighted.

These efforts will be complemented with quantum technology and power grid demonstrations performed with a team of leading researchers from Oak Ridge, Argonne, and Lawrence Livermore National Laboratories, the University of Southern California, the University of Denver, the University of Pittsburgh, and the companies IonQ, Qubitekk, EPB, ComEd, and Infleqtion.

Technical Approach:
Scientists and engineers at Los Alamos are developing a novel hybrid quantum-classical secure networking over a trunk-and-branch topology. This includes novel techniques for securely generating quantum keys over semi-trusted nodes linked in chain topologies. In addition, we are pursuing integration of quantum-secured grid communications with sensing and computing resources developed by collaborators at partner labs, universities, and private companies.

Impact:
A first-of-its kind power grid facility with quantum capabilities will be a critical piece of a more efficient technology transfer pathway to grid integration, providing a development platform for quantum innovations that will hasten grid integration, identify technology gaps, and lead to a better understanding of the impact of quantum technologies on power grids. With global energy use increasing, Los Alamos National Laboratory is developing new ideas for reliable, secure, and sustainable carbon-neutral energy solutions for the nation.

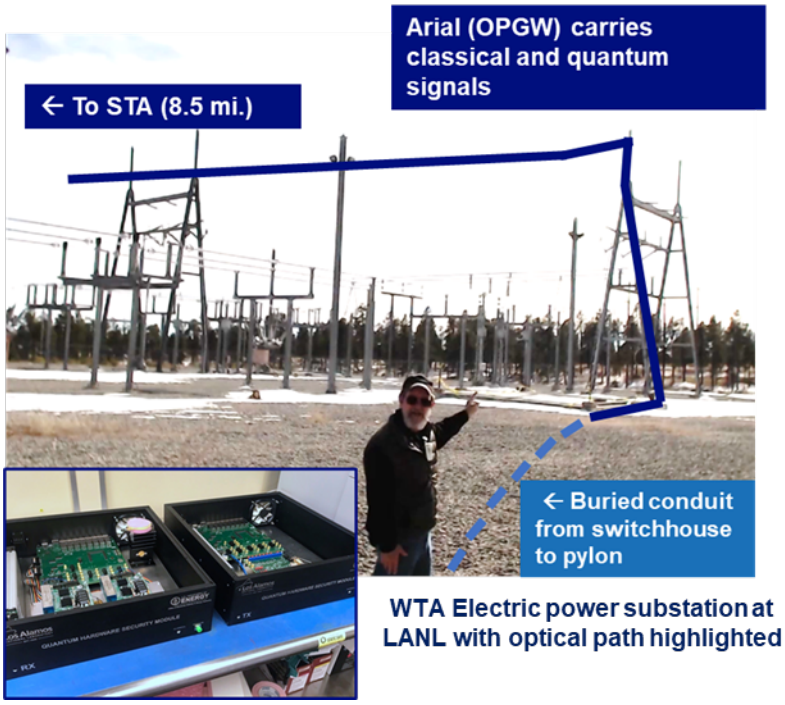

Figure 2: Electric power substation with quantum security equipment installed, Owner/Operator Mike Blair indicating optical fiber used by quantum signals.