

Thesis Abstract

No. _____

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Thesis Title: Resource Management in Heterogeneous Quantum Repeater Networks		
Thesis Summary: In this thesis, I explore whether it is possible to build a unified Quantum Internet architecture that supports different types of quantum repeaters---especially the two most distinct and seemingly incompatible ones: memory-based quantum repeaters and all-photonics, memoryless repeaters. These technologies have traditionally been developed with the aim of becoming the single dominant solution, but I ask: Can they work together in the same network? What kind of architecture would support both? And how can simulation help us understand what is needed to manage such a network at scale? To address these questions, I propose an architecture based on an existing recursive network design and programmable RuleSet-based protocols that can coordinate diverse hardware components. I introduce a new emitter-photon building block to bridge memory-based and all-photonics segments, and show how classical networking abstractions can be extended to manage quantum operations. While I have developed a simulation tool grounded in these architectural principles and validated it against existing simulators and analytical models, a full-scale investigation of the resource trade-offs and performance implications remains future work. Nevertheless, the results so far suggest that a unified, heterogeneous quantum network is not only possible but increasingly practical with current technologies---though ongoing experimental progress will be essential to fully realize this vision. Keywords: Quantum Networking, Quantum Repeater, Network Protocols, Quantum Algorithms, Optimization Algorithms		