Quantum Networking Hardware

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Questions to address

- What are the leading technology approaches and their readiness level?
- What are the top 3-4 major technical/engineering challenges that need to be addressed in order to build a practical technology?
- What is missing--what are the top 2-3 research challenges, where we need to add expertise/resources to make this happen?
- What is the roadmap over the next 15 years?

What are the leading technology approaches and their readiness level?

Four slides worth of topics/technologies (need to add more)

Many theoretical proposals; gen1 QR highest readiness;

Experimental details tightly coupled to proposal

Large gap between theory proposals and experiments (QR and memory-based entanglement swapping)

TRLs are largely low for critical components; classical tech is not ready to host quantum networks

It is difficult to predict when this tech will be ready to deploy

What are the top 3-4 major technical/engineering challenges that need to be addressed in order to build a practical technology?

- Very difficult to get point solutions to work together (wavelengths, bandwidths, other modes…)
- Integration of several materials is difficult need systems level engineering (chip scale and network scale); fiber to device coupling a big problem
- GHz high probability entangled photon sources; detectors
- High-speed low-loss quantum state preserving quantum network elements: routers, ROADMS, switches, etc.
- Fieldable detectors and lasers

What is missing--what are the top 2-3 research challenges, where we need to add expertise/resources to make this happen?

- **Transduction is a major gap; each solution is largely platform specific**
- **Quantum memory (wavelength; cryo; connection to fiber; hold time, error correction/purification) storage time, efficiency, fieldable**
- **Materials science and engineering; loss reduction; interfaces**
- **Improved resource efficiency repeater protocols**
- **Integration of functionality (codesign) at the network system level**
- **Free-space to fiber interface and network analysis of potential tech.**

What is the roadmap over the next 15 years?

- 3 years: Demo memory- assisted entanglement swap (1 node)
- 5 years: Demo memory- assisted entanglement swap and beat the repeaterless bound (1 node)
- 8 years: scaling with multiplexing and routing (three nodes/swaps)
- 8 years: entanglement swap to two ground networks from space/airborne platform (long-haul backbone demo)
- 10 years: transduction connected quantum memory with error rates of less than 5%
- 12 year: quantum link improved quantum processing/application
- 15 years: non-classical network architecture; space-based sneaker net