Problem
When and where can the DoD benefit from investing in quantum computing technology? To answer this question, we are working with noisy intermediate scale quantum (NISQ) computers, but we’re also thinking ahead to fault-tolerant quantum error corrected computation. In particular, we want to determine when and where quantum advantage will exist for the following important DoD applications:

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SEI Collaboration with Carnegie Mellon University
Quantum algorithm performance depends critically on quantum circuit optimization. We are working with CMU ECE Franz Franchetti’s group to adapt their well-known classical computing optimization tool, SPIRAL.

Quantum Circuit Optimization in SPIRAL

QAEF Output: When and where can you leverage quantum computing to achieve advantage in solving your organization’s problems?

- Input: the applications that have most potential for quantum advantage. It is critical to identify “real world” problem instances.
- Output: when and where will quantum advantage exist? Establish timeframe for Quantum Advantage Readiness.

Problem Size/Complexity
Combinatorial Optimization
Materials Science
Timeframe to Quantum Advantage
Fault Tolerant Quantum

1-3 years
10-20 years (see IBM, Google Roadmaps)

CSISR DARPA ONISQ
Superconductivity DARPA ERI, MatGenome

Classical State of the Art: PSC
Quantum Computers (simulated)

Where: to determine quantum advantage, benchmarks on specific problem instances must be performed on “real world” scales (O(100-1000+ nodes) (estimated 3 years IBM, Google)

Evaluation Results

Frameowrk to evaluate current and projected quantum computing advantage.

Application
Quantum Advantage Evaluation Framework

WallTime (s)

p=4 3reg

GW SCS
GW CVXPY
GESOUA2013
random FC
random 2D
optimized FC
optimized 2D
AK


https://github.com/spiralgen/spiral-package-quantum

Carnegie Mellon University
Software Engineering Institute

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Materials Science
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https://spiral.net/
Scheduling to Quantum “Baremetal”

Download SPIRAL-quantum

http://spiral.net/
https://github.com/spiralgen/spiral-package-quantum

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