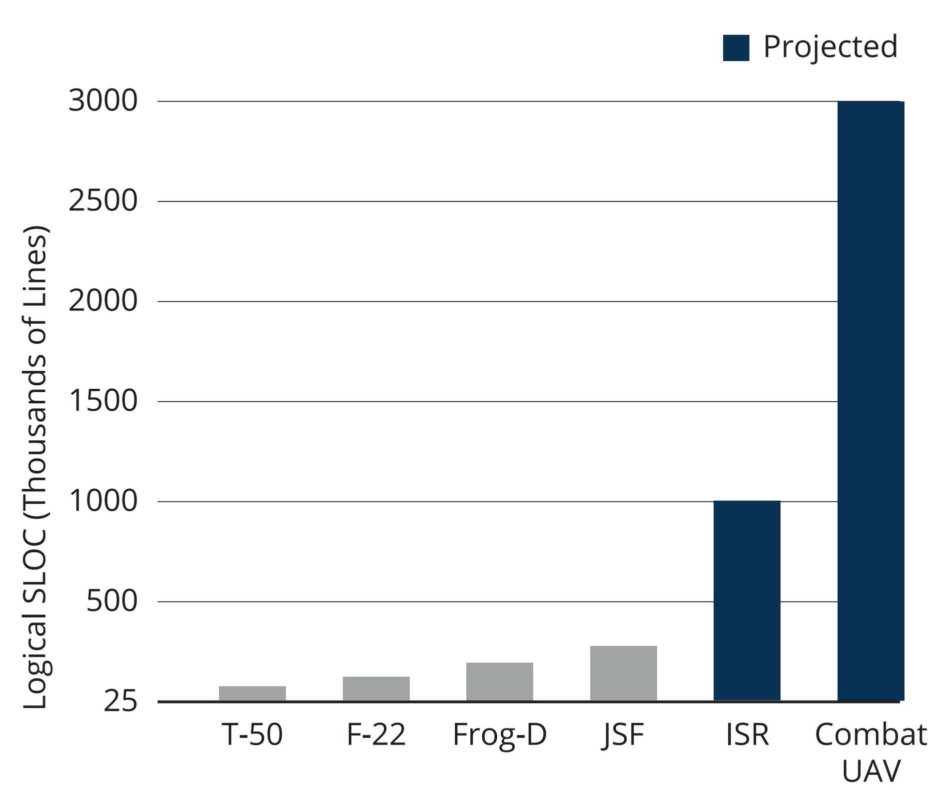
# Projecting Quantum Computational Advantage Versus Classical State of the Art

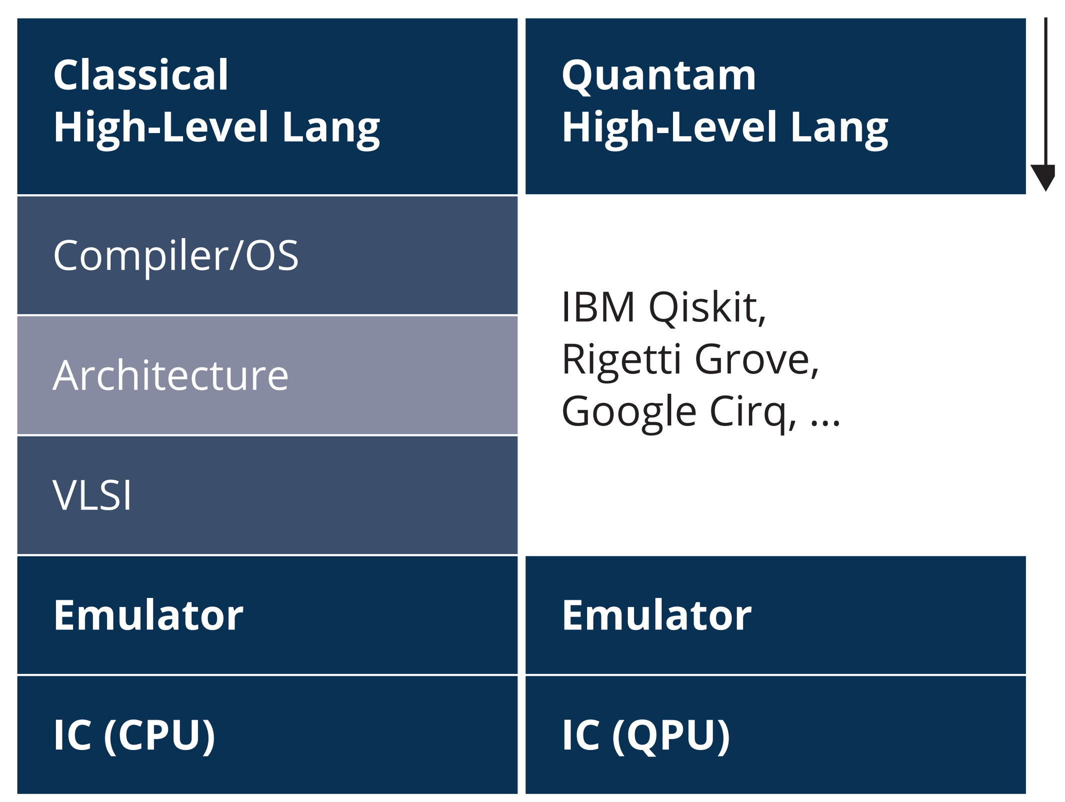
## Introduction

A major milestone in quantum computing research is to demonstrate quantum supremacy, which refers to a quantum computer performing a calculation that is unfeasible for a classical computer [1]. While quantum supremacy may be demonstrable in the near-term noisy intermediate scale quantum computing (NISQ) era [2]–[6], such a demonstration of supremacy does not afford an advantage for practical applications. A common practical problem used in benchmarking high performance classical and quantum computing is Maxcut, with applications in domains such as machine scheduling [7], image recognition [8], electronic circuit layout [9], and software verification and validation [10], [11].




T. Belote, C. Elliott, Safe & Secure Systems & Software Symposium 2014.

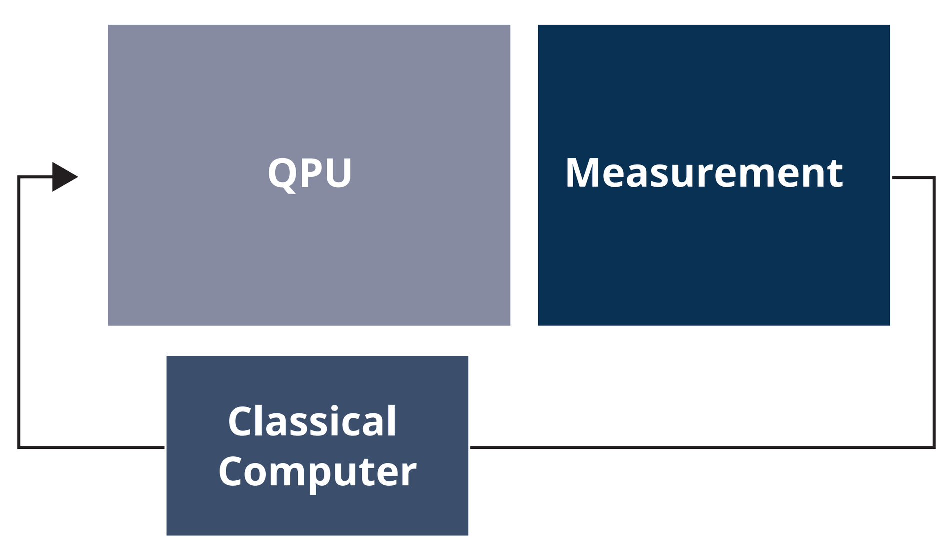
# Achieving **quantum advantage** requires classical state of the art.




## Infrastructure

For practical applications, quantum advantage has to be measured against the best performance that classical computing offers. This work uses the hybrid quantum-classical Quantum Approximate Optimization Algorithm (QAOA) [12].

**QAOA**
- GW (SDP) [13]
- AKAXSAT (BnB) [14]
- MBO (Laplacian) [15]
- UFO [16]




## QAOA

AWS: C5 Intel Xeon
PSC: Bridges (12 TB)
IBM Melbourne 16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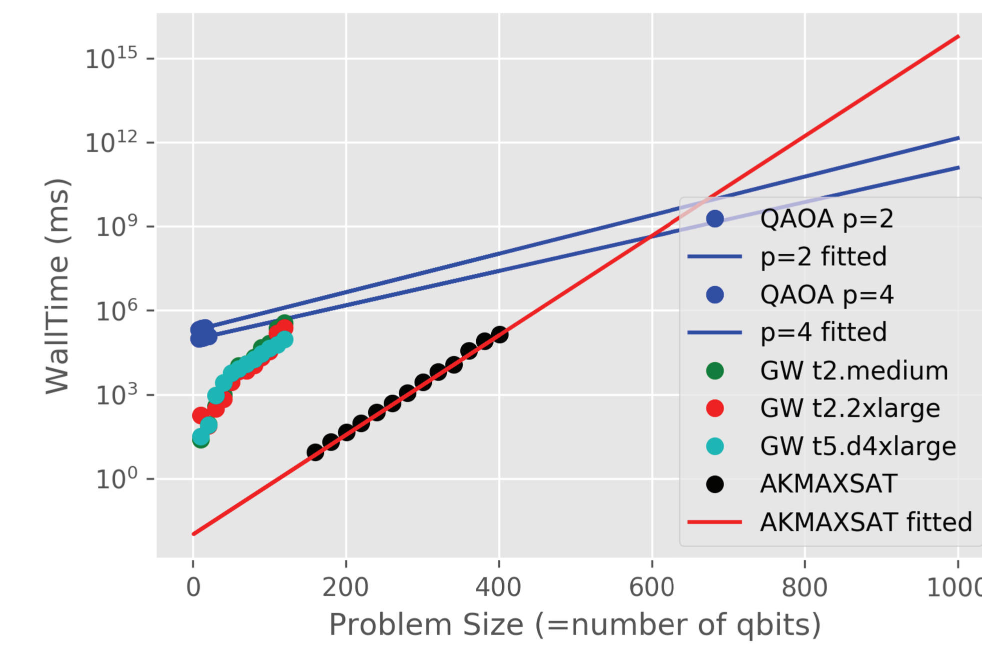
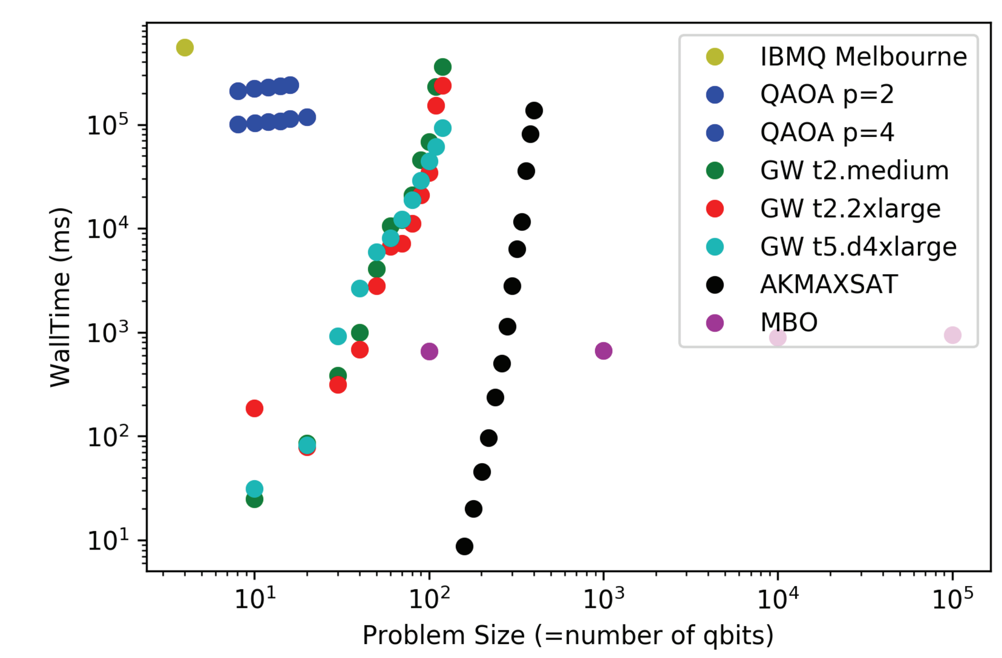
## Performance Results

The quality of solutions (cut value, bounds) are all comparable among algorithms (classical and QAOA).




## Future Work

- Improve QAOA parameterization.
- Increase number of hardware configs. What is needed from hardware to achieve advantage?
- Understand MBO and UFO performance. Is there a quantum version?

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