Qiskit

Project 39: Tutorial to use K8S Cluster

Qiskit Advocate Mentorship Program: Spring 2021

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Background

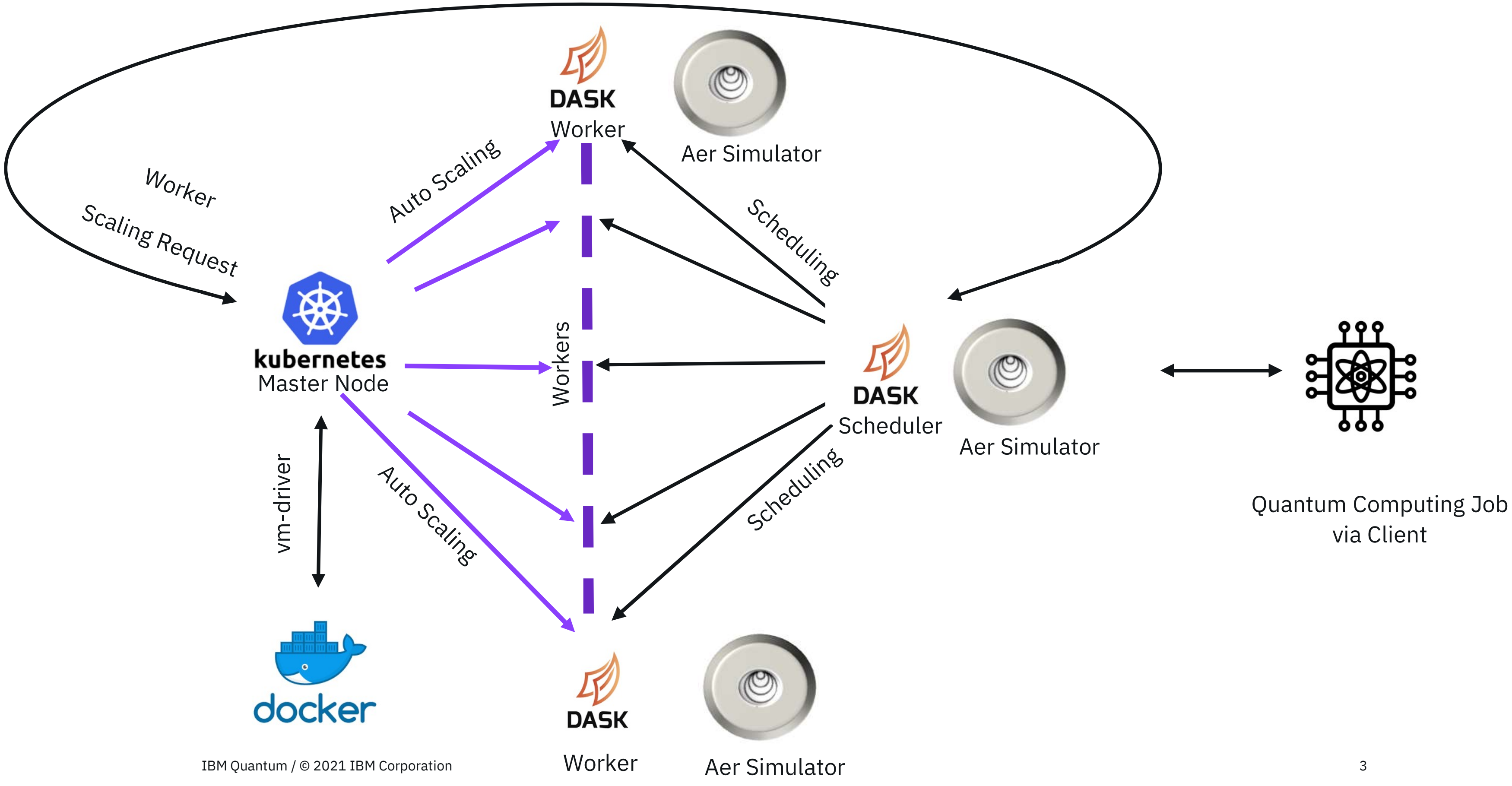
- ✓ Simulation of quantum applications like quantum chemistry, materials science, quantum biology, generates quantum systems which are much larger than computational NISQ devices, this gap can be handled by parallelizing the quantum simulation.
- ✓ Qiskit Aer is a Noisy quantum circuit simulator backend and runs simulation jobs on a single-worker Python multiprocessing ThreadPool executor so that all parallelization is handled by low-level OpenMP and CUDA code.
- ✓ VQE (and the other variational algorithms) already support generating circuits together for parallel gradient computation. In order to customize job-level parallel execution of multiple circuits, a custom multiprocessing executor can be specified, which controls the splitting of circuits using the **executor** and **max_job_size** backend options of **Qiskit AerSimulator**.
- ✓ For large scale job parallelization on HPC clusters, Qiskit Aer executors support the distributed Clients from the **DASK** (parallel computing library for Python). DASK natively scales Python and suitable for applications which require a distributed, auto scaling compute environment that is completely independent of application.
- ✓ Using Kubernetes clusters, DASK worker environment can be either scaled up manually, or can be scaled as the need arises by creating auto scaling rules in Kubernetes configuration, which means DASK only need to manage scheduling across workers in Kubernetes Cluster , as work go up or down.

Goal

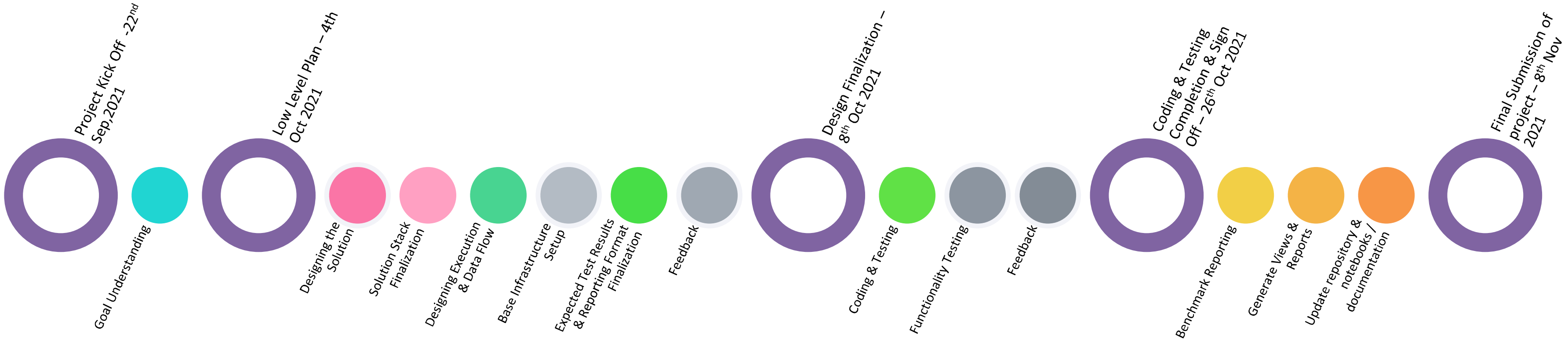
- ✓ Publish a tutorial to use DASK on Kubernetes(K8S) cluster as a (distributed) computation engine of Qiskit-Aer.

Architecture of Clustered Backend for Aer Simulator

Qiskit



Implementation Plan



Project Kick Off -22nd Sep,2021

Goal Understanding

Low Level Plan – 4th Oct 2021

Designing the Solution

Solution Stack Finalization

Designing Execution & Data Flow

Base Infrastructure Setup

Expected Test Results & Reporting Format Finalization

Feedback

Design Finalization – 8th Oct 2021

Coding & Testing

Functionality Testing

Feedback

Coding & Testing Completion & Sign Off – 26th Oct 2021

Benchmark Reporting

Generate Views & Reports

Update repository & notebooks / documentation

Final Submission of project – 8th Nov 2021

Deliverables:

- ✓ Github Repository (with sample codes ,Tutorial, report)
- ✓ Project Report (with test results)
- ✓ Contribute to Qiskit Aer repository (raising issues /bug reporting, share resolutions)

Current Status:

- ✓ Project Goal Understanding Complete.
- ✓ Base Infrastructure Design & Setup Complete using DASK, Minikube, Dockers, Python 3.8 on Ubuntu 20.04 LTS OS platform.
- ✓ Proof of Concept Testing Initiated
- ✓ Contributed to Qiskit Aer repository : Issue #1364 : Serialization Error while submitting Quantum Objects to compute engine (DASK workers) of Qiskit Aer.
- ✓ Issue #1364 was fixed by #1365 PR from Hitomi Takahashi (Core Developer for Clustered Aer Backend).