**Project Charter**

**Northrop Grumman, Quantum AI at the Edge**

**Prepared by the CU Boulder Northrop Grumman Capstone Team**

**October 03, 2021**

[1. Introduction 3](#_Toc277623809)

1. [Executive Summary 3](#_Toc277623810)
2. [Business Problems/Opportunities 3](#_Toc277623811)

[2. Objectives and Scope 3](#_Toc277623812)

1. [Business Objectives 3](#_Toc277623813)
2. [High Level Requirements 3](#_Toc277623814)
3. [Project Scope 4](#_Toc277623815)

[3. Project Approach 4](#_Toc277623816)

1. [General Approach – Solution Delivery Process 4](#_Toc277623817)
2. [Assumptions 4](#_Toc277623818)
3. [Project Risks and Issues 4](#_Toc277623819)
4. [Project Changes 4](#_Toc277623820)

[4. Project Plan 5](#_Toc277623821)

1. [Key Deliverables 5](#_Toc277623822)
2. [Timeline 5](#_Toc277623823)
3. [Preliminary Cost Estimates 6](#_Toc277623824)

[5. Key Stakeholder Roles & Responsibilities 6](#_Toc277623825)

1. [Stakeholder Role/Responsibility 6](#_Toc277623826)

# 1. Introduction

## Executive Summary

* Northrop Grumman solves the toughest problems in space, aeronautics, defense, and cyberspace to meet the ever-evolving needs of their customers worldwide. Northrop Grumman defines what is possible every day using science, technology, and engineering to create and deliver advanced systems, products, and services.
* Northrop Grumman is a leading provider of full spectrum cyber across land, air, sea, and space. From preventing cyber-attacks to securing military communications and giving our customers a decisive advantage, our capabilities are second to none.

## 

## Opportunities

* The intersection between machine learning and quantum computing has attracted considerable attention in recent years. This has led to several recently proposed quantum algorithms.
* Current AI solutions require performance improvements in training, and these solutions are being deployed to new domains. Simple classifiers are starting to show promise on quantum processors, and these classifiers are deployable on edge processors for inference.

# 

# 2. Objectives and Scope

## Objectives

* Apply quantum AI to train a simple classifier network and then use that network for inference on an emulated embedded platform. If the quantum piece does not show improvement over traditional techniques, then traditionally trained models will be used for inference on the emulator.

## High Level Requirements

* SVM and MLP classifiers will be trained using OpenCV and/or TensorFlow to establish baselines.
* IBM Qiskit and Google Cirq will be used to implement SVM and MLP and compared with the baselines in terms of accuracy.
* Models should be run first in simulation and then on IBM and Google quantum processors.
* The quantum classifiers should then be used for inference on a XILINX Vitis emulator to demonstrate similar performance to what was seen in training. If the quantum piece fails to show improvement, then traditionally trained models will be used for inference on the emulator.

## Project Scope

**In Scope:**

* Reviewing quantum computing techniques and necessary research papers
* Developing familiarity with the sponsor requested technology stack
* Reviewing appropriate tutorials for developing familiarity with novel quantum technology
* Translating quantum algorithms to utilize qubits in the Qiskit quantum simulator
* Developing familiarity with the constraints of the embedded and edge computing platforms
* Using traditionally trained models to be used for inference on the emulator.

**Out of Scope:**

* Modifications to existing algorithms or creation of new algorithms
* Fundamental research on new quantum algorithmic techniques
* Building novel quantum AI, embedded, and edge computing toolkits

# 3. Project Approach

## General Approach

* Develop familiarity with existing quantum and baseline technology stack via current research, documentation, and tutorials.
* Develop working code for the respective IBM and Google SDK’s and libraries.
* Compare performance on the respective IBM and Google SDK’s and libraries.
* After selecting the more performant SDK and library begin to develop working code for the embedded and edge platforms.
* Analyze and determine performance differences on the quantum versus baseline on the embedded and edge platforms.

## Assumptions

* Since this is an R&D project that is fully exploratory by nature there is an underlying assumption that the project may not succeed.

## Project Risks and Issues

* The sponsor has communicated that there is no guarantee that the project will necessarily work due to the R&D and fully exploratory nature of the project itself.
* During this project, as issues arise that put the success of the project at risk, the issues and risks will be documented in the *Project Log* and tracked through resolution.

## Project Changes

* Changes to project scope and requirements will be reviewed by the project sponsor, manager, and engineering team. This group will assess the potential impact of the change on schedule and resources, then provide a decision for approval or disapproval. All scope and requirements changes will be documented in the *Project Log*.

# 4. Project Plan

## Key Deliverables

**1. Project Charter**

**2. Project Plan,** containing:

* Detailed task list
* Revised milestones and target dates if needed

**3. Requirements Definition,** containing**:**

* Detailed description and documentation of each solution to be developed
* Clear, concise statements of what each solution must accomplish to be considered successful

**4.** **Solution Design,** containing

* An accurate description of each solution
* Change Management Plan for implementing each solution

**5. Solution Construction and Testing,** containing

* Analysis comparing baseline classifiers with quantum versions and libraries
* Datasets used for analysis
* Training Code
* Analysis of inference on emulated platform and code
* Use traditionally trained models for inference on the emulator should the quantum piece not show improvements over traditional techniques.

**6. Ongoing support and management procedures for each component of the KM Solution**

* + Support documentation
  + Knowledge Management governance guidelines

## Timeline

Deliverable Due Date

Project Charter October 03, 2021

Project Plan October 15, 2021

Requirements Definition November 01, 2021

High Level Solution Design November 15, 2021

Detailed Solution Design November 20, 2021

Solution Construction and Testing February 25, 2021

Governance Guidelines March 25, 2021

Submit Written Report to Sponsor April 01, 2021

Present Findings to Sponsor May 05, 2021

## Preliminary Cost Estimates

**Labor Costs Estimate**

Development Time $0

**Hardware/Software Costs Estimate**

Open-Source Software $0

# 5. Key Stakeholder Roles & Responsibilities

## Stakeholder Role/Responsibility

**Dave Motta Project Sponsor**

**Alec Carlisle Project Sponsor**

**Alan Paradise Capstone Instructor**

**Kirby Linvill Project Mentor & TA**

**Jarek Reynolds Project Manager**

**Adam Hoerger Software Engineer**

**Alan Yu Software Engineer**

**Cade Gorman Software Engineer**

**Giovanni Visco Software Engineer**

**John Ortiz Software Engineer**

**Jorge Ortiz Software Engineer**

**Noah Svensson Software Engineer**