Supply and Demand in the Training of Quantum Software Engineering Workforce

[Short paper]

Álvaro Manuel Aparicio-Morales (University of Extremadura);
Enrique Moguel (University of Extremadura);
José García-Alonso (University of Extremadura);
Alejandro Fernandez (Lifia);
Luis Mariano Bibbo (Lifia);
Juan M. Murillo (University of Extremadura).

Unión Europea
Fondo Europeo de Desarrollo Regional
Una manera de hacer Europa
JUNTA DE EXTREMADURA
Consejería de Economía, Ciencia y Agenda Digital
GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN
Interreg España - Portugal
SPILab by Quercus SEG
Software Engineering Group
QUERCUS
UNIVERSIDAD DE EXTREMADURA

INTRODUCTION

```python
from flask import Flask, request, jsonify, send_file
from flask_cors import CORS
import matplotlib.pyplot as plt

from braket.circuits import Circuit
from braket.devices import LocalSimulator

app = Flask(__name__)
CORS(app)

@app.route('/execute', methods=["get"])
def execute_quantum_task():
    bell = Circuit().h(0).cnot(control=0, target=1)
    device = LocalSimulator()
    result = device.run(bell, shots=1000).result()
    counts = result.measurement_counts

    plt.bar(counts.keys(), counts.values())
    plt.xlabel('bitstrings')
    plt.ylabel('counts')
    plt.savefig("result.png")

    return send_file("result.png", mimetype='image/png')

if __name__ == '__main__':
    app.run(host="localhost", port=33888)
```

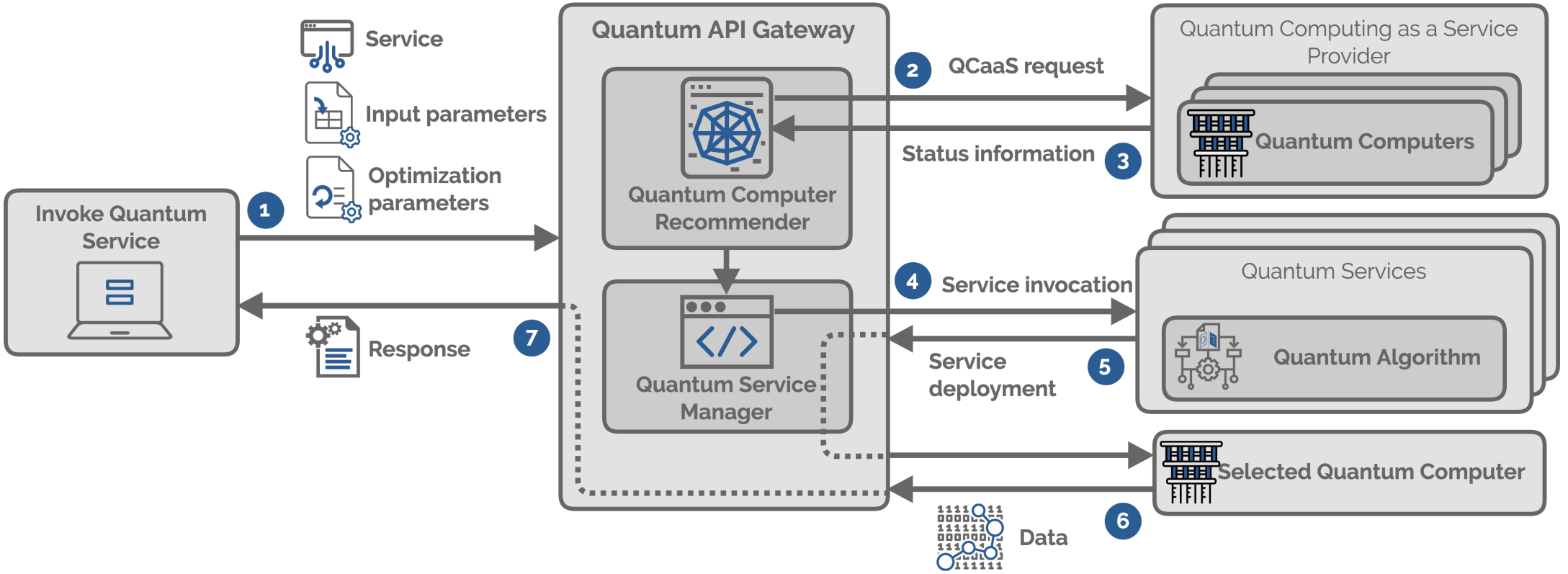
Braket libraries for quantum computing

Classical wrapping service

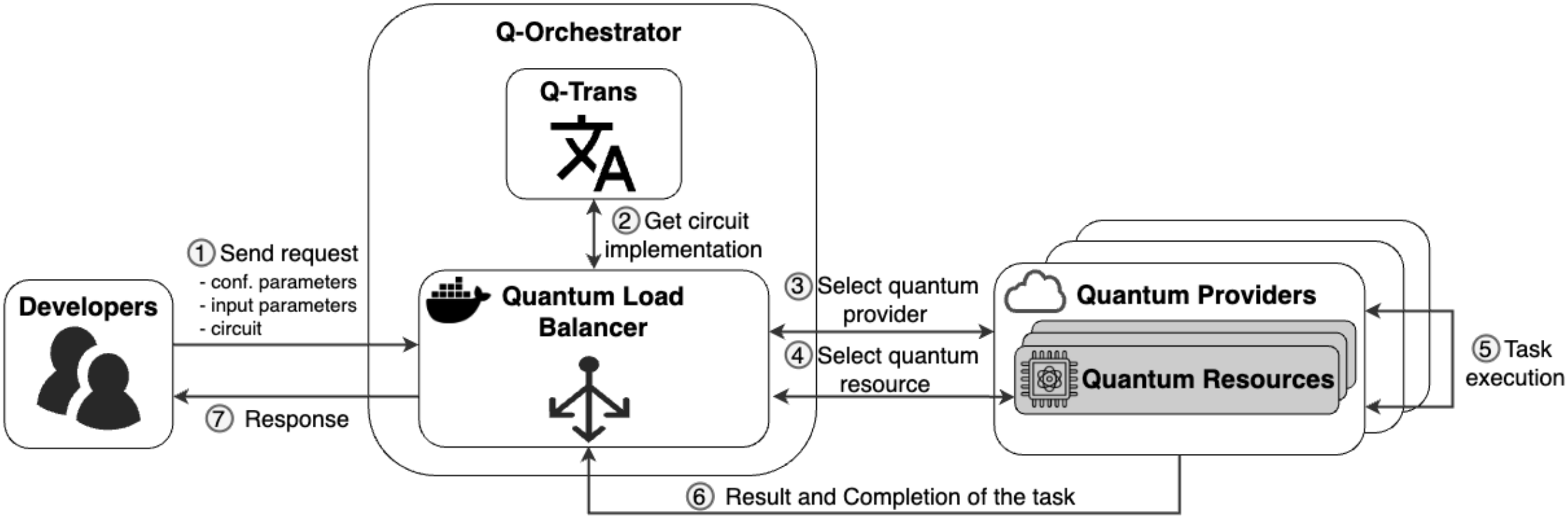
Quantum algorithm

- We started working on the servitization of quantum algorithms.

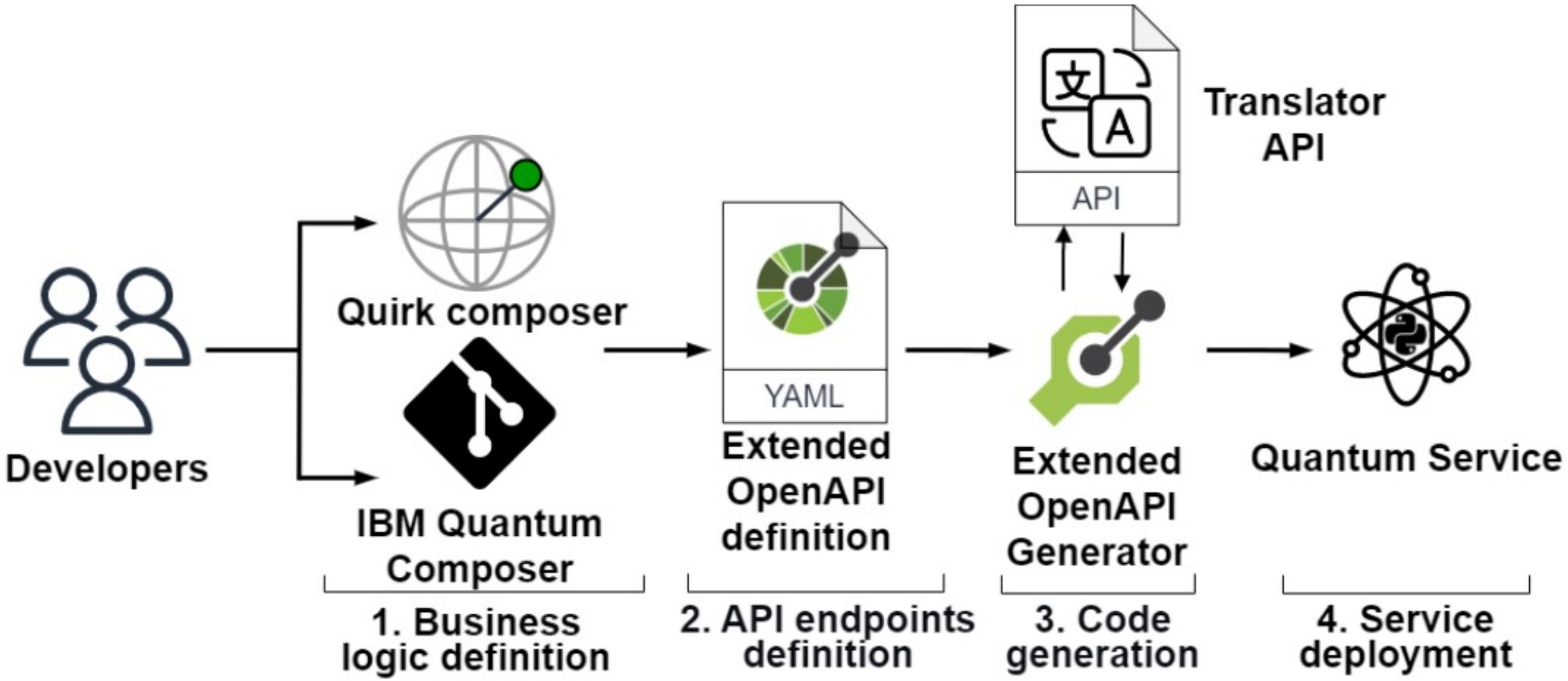
INTRODUCTION



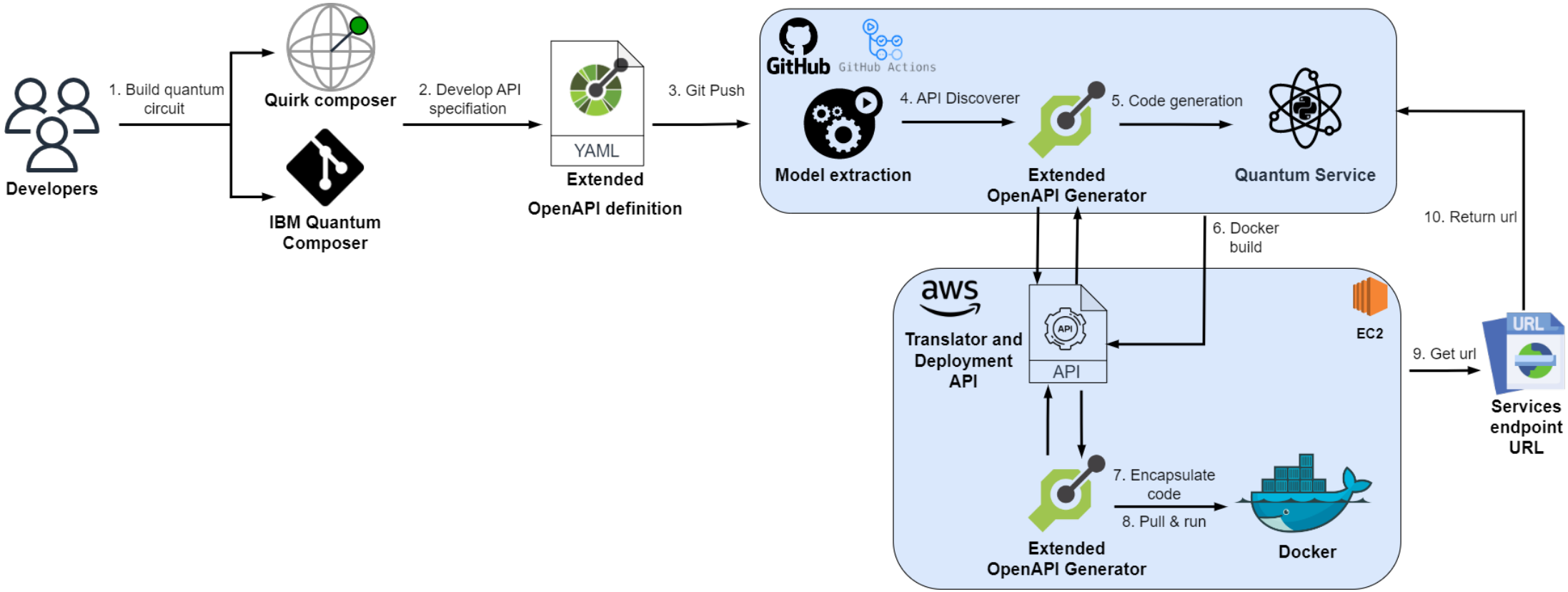
INTRODUCTION



INTRODUCTION



INTRODUCTION



PROBLEM

MOTIVATION

- The **Quantum Flagship initiative** has a budget of e 1 billion in Quantum Projects.

- Various training platforms, such as **EdX** or **Udemy**, and **universities** and organizations such as **IBM**, **Google**, and **Microsoft** offer courses and master's degrees focused on this área.

- Quantum Software Engineering training is necessary.

PROPOSAL

According to the work of **Zhao**, there are several key elements that every future quantum software engineer must understand and learn. These elements are:

- A concise overview of the key principles that underpin quantum computation.
- A description of qubits and fundamental quantum gates and their operations.
- A representation of quantum circuits and algorithms.
- An introduction to quantum algorithms focuses on existing examples such as the Shor or Grover algorithms.
- An overview of quantum hardware technologies elucidating the current state of quantum hard- ware development.
- An introduction to quantum programming languages and current software development kits.
- An initiation to quantum error correction and fault-tolerant quantum computing.
- A hands-on experience by presenting challenges in QSE.

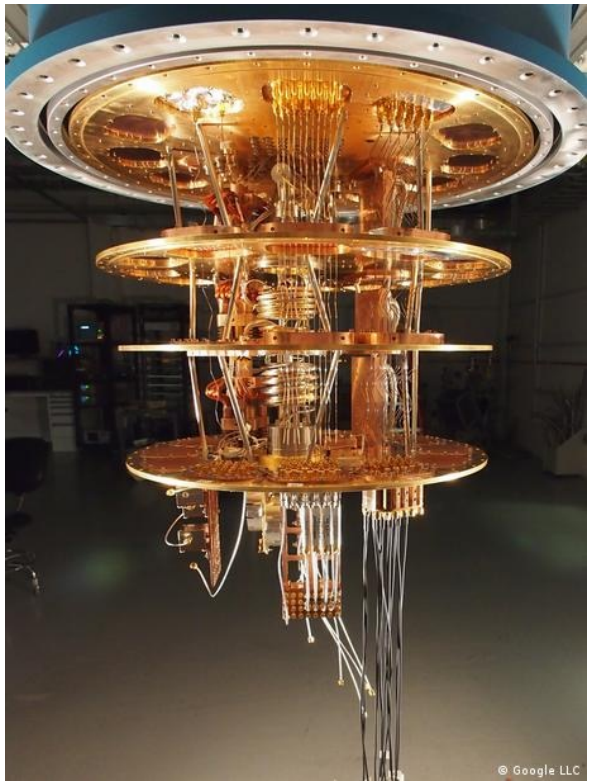
PROPOSAL

We are working on a training plan in 10 steps:

1) Introduction to the fundamentals of quantum mechanics.
2) Description of qubit and quantum gates.
3) Teach the representation of quantum circuits.
4) Teach quantum algorithms.
5) Explain quantum hardware technologies.
6) Introduction to quantum programming.
7) Exploration of quantum error correction and fault-tolerant quantum computing.
8) Explain how quantum software is developed and its applications.
9) Quantum Information Processing Challenges.
10) Hands-On Labs, Simulators, and Real-World Projects.

CONCLUSION

- Not enough QSE professionals.
- There are no detailed/extensive training plans.
- We believe that more efforts should be made in this line of training.



THANK YOU FOR YOUR ATTENTION!

JUNTA DE EXTREMADURA
Consejería de Economía e Infraestructuras
Fondo Europeo de Desarrollo Regional
Una manera de hacer Europa
UNIÓN EUROPEA
GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES
Interreg
España - Portugal
Fondo Europeo de Desarrollo Regional
SPILab by Quercus SEG
Software Engineering Group
QUERCUS
UNIVERSIDAD DE EXTREMADURA
UNIVERSIDAD DE EXTREMADURA