Quantum SPAIN

España | digital 2026

CUNQA

A DISTRIBUTED QUANTUM COMPUTING SIMULATION FRAMEWORK

Jorge Vázquez

Daniel Expósito

Álvaro Carballido

Marta Losada

July, 2025

GOBIERNO DE ESPAÑA · MINISTERIO PARA LA TRANSFORMACIÓN DIGITAL Y DE LA FUNCIÓN PÚBLICA · SECRETARÍA DE ESTADO DE DIGITALIZACIÓN E INTELIGENCIA ARTIFICIAL

Plan de Recuperación, Transformación y Resiliencia

Financiado por la Unión Europea NextGenerationEU

RES RED ESPAÑOLA DE SUPERCOMPUTACIÓN

CESGA

Quantum SPAIN

GENERAL PANORAMA

CONCEPTS, CONFIGURATION AND WORKFLOW

Distributed Quantum computing (DQC)

- No communications.
- Classical distribution.

Distributed Quantum computing (DQC)

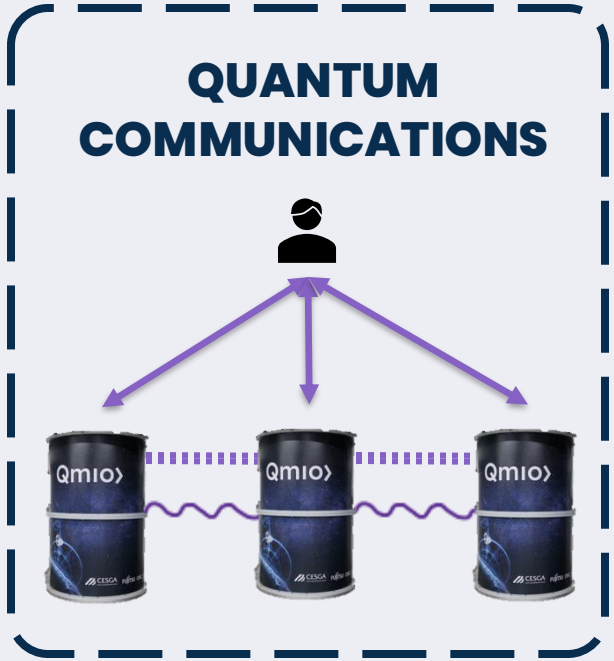
- No communications.
- Classical distribution.

- Classical bits communicated.
- Classical distribution.

Distributed Quantum computing (DQC)

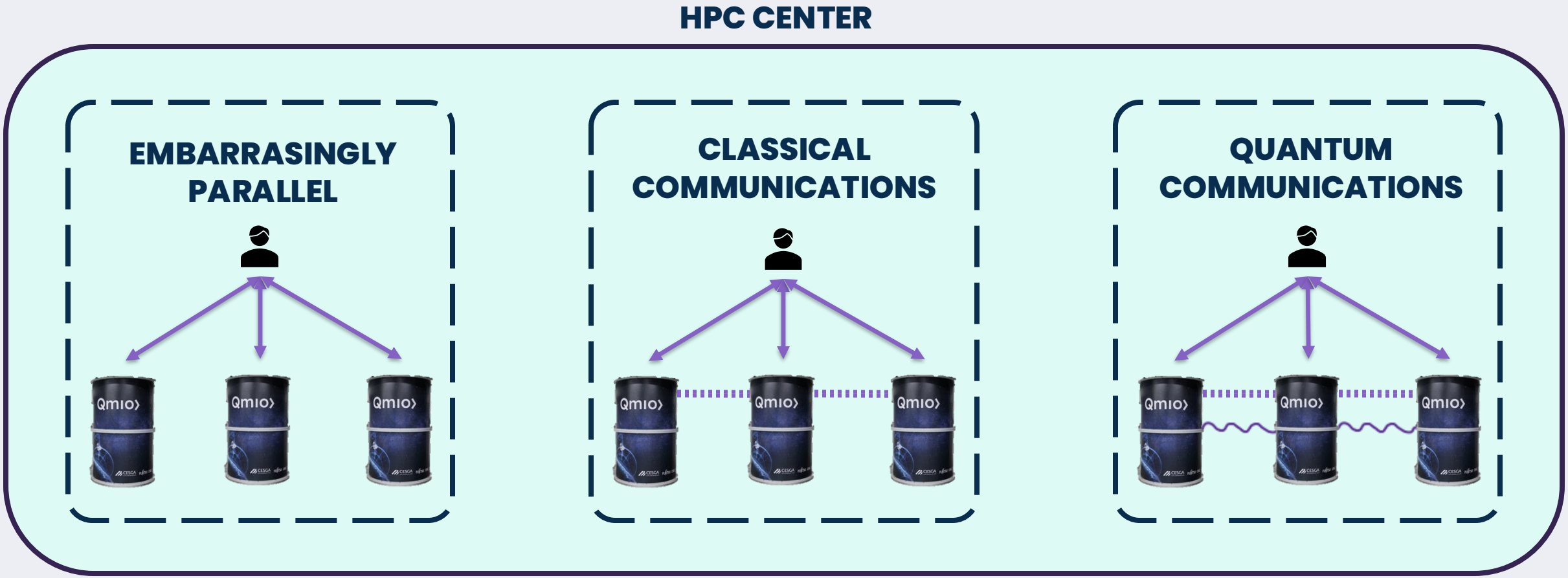
- No communications.
- Classical distribution.

- Classical bits communicated.
- Classical distribution.

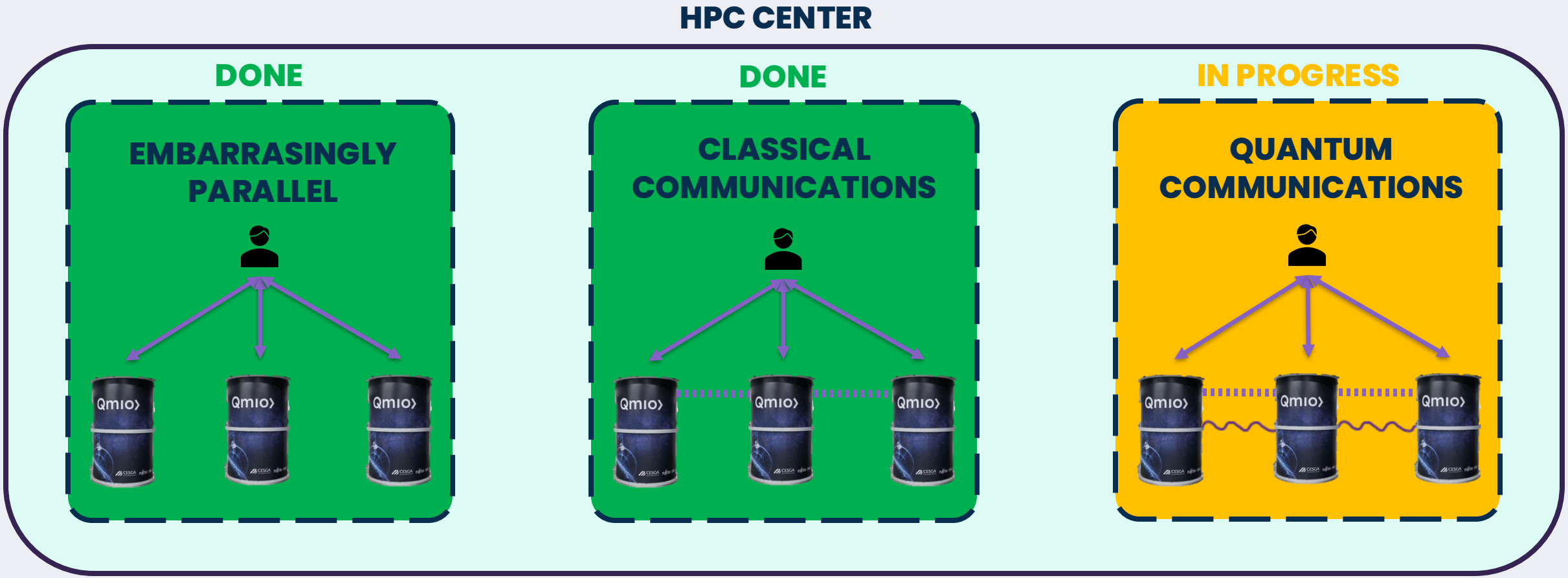


- Shared state between QPUs.
- Quantum distribution.

What does CUNQA intent?



What does CUNQA intent?



Virtual QPUs

Quantum SPAIN

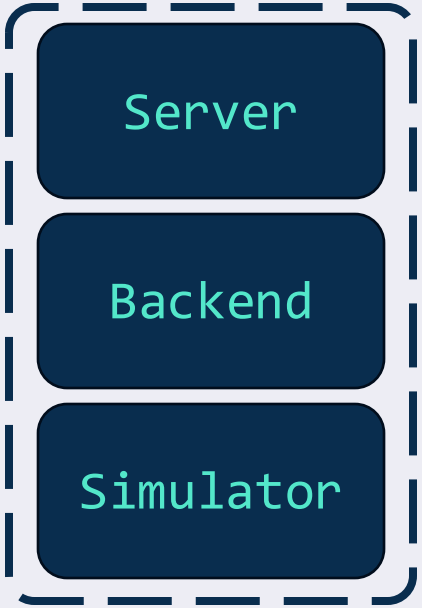
VIRTUAL QPU =

What do we mean by this?

Virtual QPUs

Quantum SPAIN

VIRTUAL QPU =



What do we mean by this?

Quantum SPAIN

How do I setup virtual QPUs?

How do I interact with them?

Workflow

setup

Commands on terminal:

Workflow

setup

Commands on terminal:

qraise

FLAGS

-n : number of QPUs
-t : maximum time
--classical_comm
--quantum_comm
...

Workflow

setup

Commands on terminal:

qraise

FLAGS

-n : number of QPUs
-t : maximum time
--classical_comm
--quantum_comm
...

qdrop

-all
Job id

Workflow

setup

Commands on terminal:

qraise

FLAGS

-n : number of QPUs
-t : maximum time
--classical_comm
--quantum_comm
...

qdrop

-all
Job id

qinfo

Workflow

setup

Commands on terminal:

qraise

FLAGS

-n : number of QPUs
-t : maximum time
--classical_comm
--quantum_comm
...

qdrop

-all
Job id

qinfo

interaction

Workflow

setup

Commands on terminal:

qraise

FLAGS

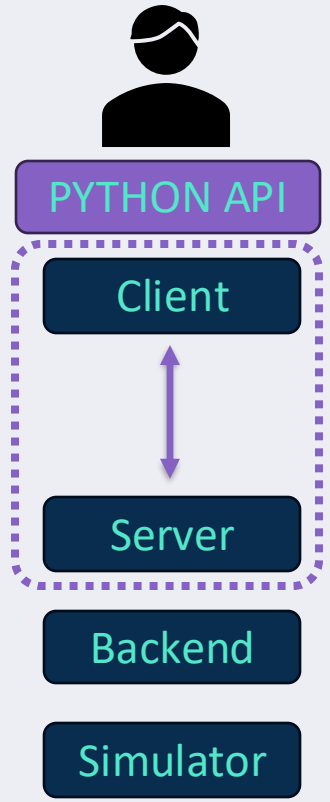
-n : number of QPUs
-t : maximum time
--classical_comm
--quantum_comm
...

qdrop

-all
Job id

qinfo

interaction



Workflow

setup

Commands on terminal:

qraise

FLAGS

-n : number of QPUs
-t : maximum time
--classical_comm
--quantum_comm
...

qdrop

-all
Job id

qinfo

interaction

PYTHON API

Client

Server

Backend

Simulator

from **cunqa** import

getQPUs

qpu.QPU

qjob.Qjob

CunqaCircuit

qjob.Result

...

Quantum SPAIN

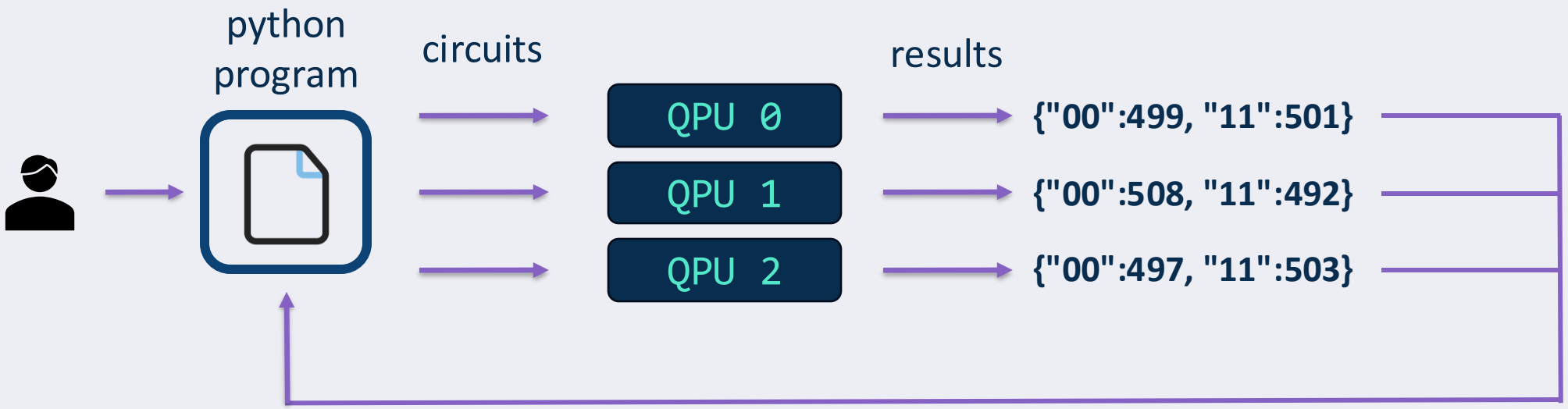
PYTHON API

Work flow

1. Raise QPUs

2. Set up environment
(modules, variables,...)

3. Run python file using python API



Work flow

```
>> from cunqa import getQPUs

>> qpus = getQPUs()

>> qpu_0 = qpus[0]

>> job = qpu_0.run(qiskit_circuit, shots = 1000)

>> result = job.result

>> result.counts
   {"00": 534, "11": 466}
```

Work flow

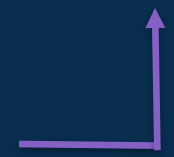
```
>> from cunqa import getQPUs

>> qpus = getQPUs()

>> qpu_0 = qpus[0]

>> job = qpu_0.run(qiskit_circuit, shots = 1000)

>> result = job.result

>> result.counts
   {"00": 534, "11": 466}
```

list of cunqa.QPU objects

Work flow

```
>> from cunqa import getQPUs

>> qpus = getQPUs()

>> qpu_0 = qpus[0]

>> job = qpu_0.run(qiskit_circuit, shots = 1000)

>> result = job.result

>> result.counts
   {"00": 534, "11": 466}
```

cunqa.QJob object



Work flow

```
>> from cunqa import getQPUs

>> qpus = getQPUs()

>> qpu_0 = qpus[0]

>> job = qpu_0.run(qiskit_circuit, shots = 1000)

>> result = job.result
```

cunqa.Result object

```
>> result.counts
   {"00": 534, "11": 466}
```

Quantum SPAIN

EXAMPLE

Quantum SPAIN

THANKS

mlosada@cesga.es jvazquez@cesga.es
dexposito@cesga.es acarballido@cesga.es

CUNQA GitHub

CESGA