IETF126 – QIRG meeting

Exploring hybrid environments to scale quantum-safe networks

(and what comes after)

Blanca Lopez

IMDEA Networks Institute · Universidad Carlos III de Madrid

blanca.lopez@networks.imdea.org

Motivation

We know QKD works, but we don’t know how to work with it at scale

Fragmented interoperability

QKD devices, key-management systems, and encryption applications from different vendors still lack fully mature, universally adopted interfaces.

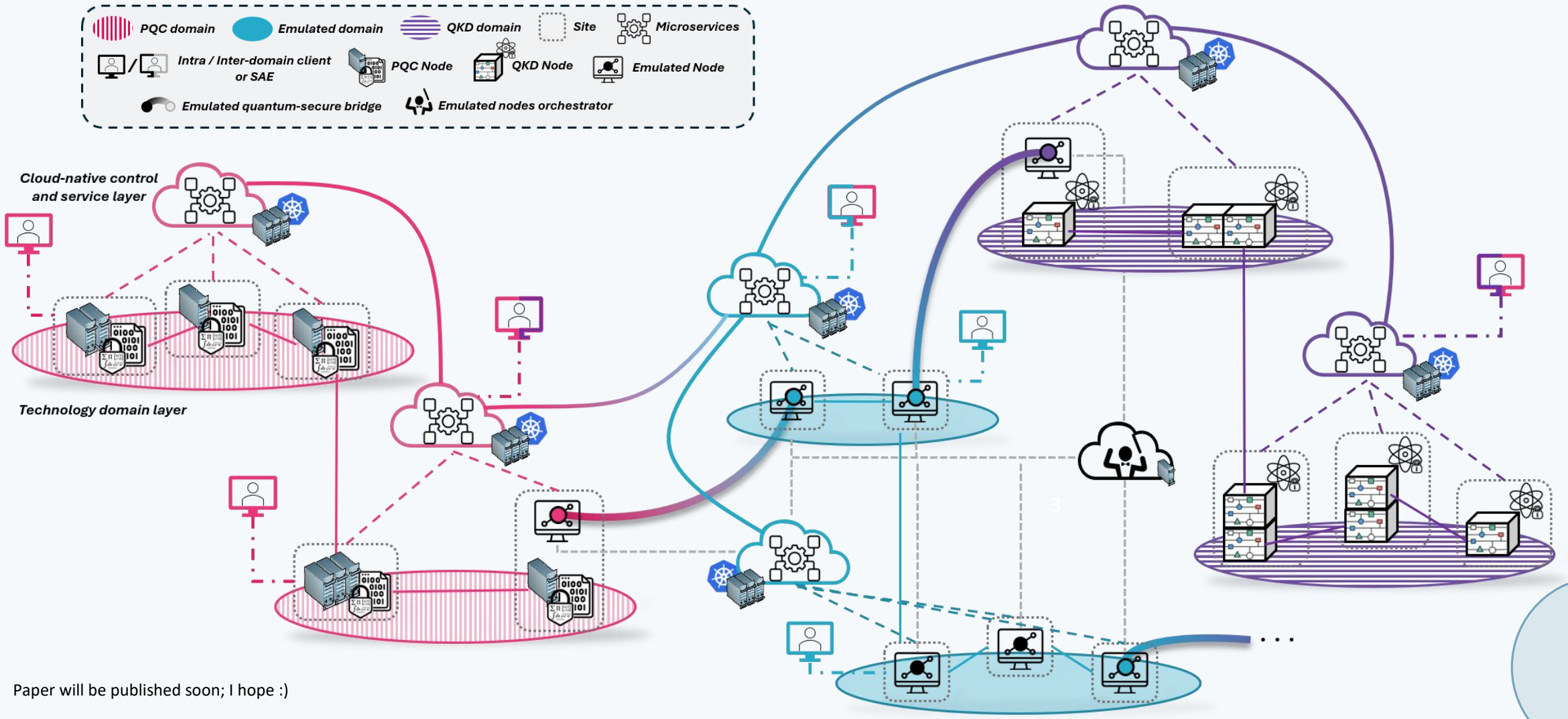
Limited and variable key-generation capacity

The network must allocate a scarce key material across competing applications while maintaining service guarantees. The resource-management problem is absent in isolated point-to-point demonstrations

Isolated infrastructure layer

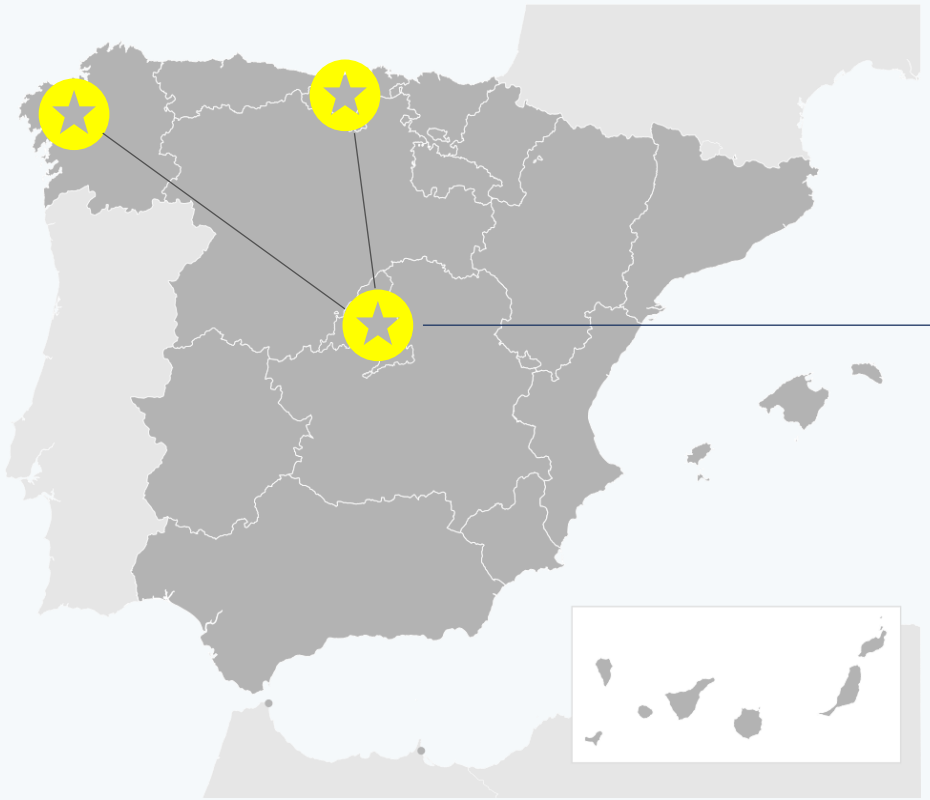
End-to-end orchestration across the quantum and classical domains is still evolving.

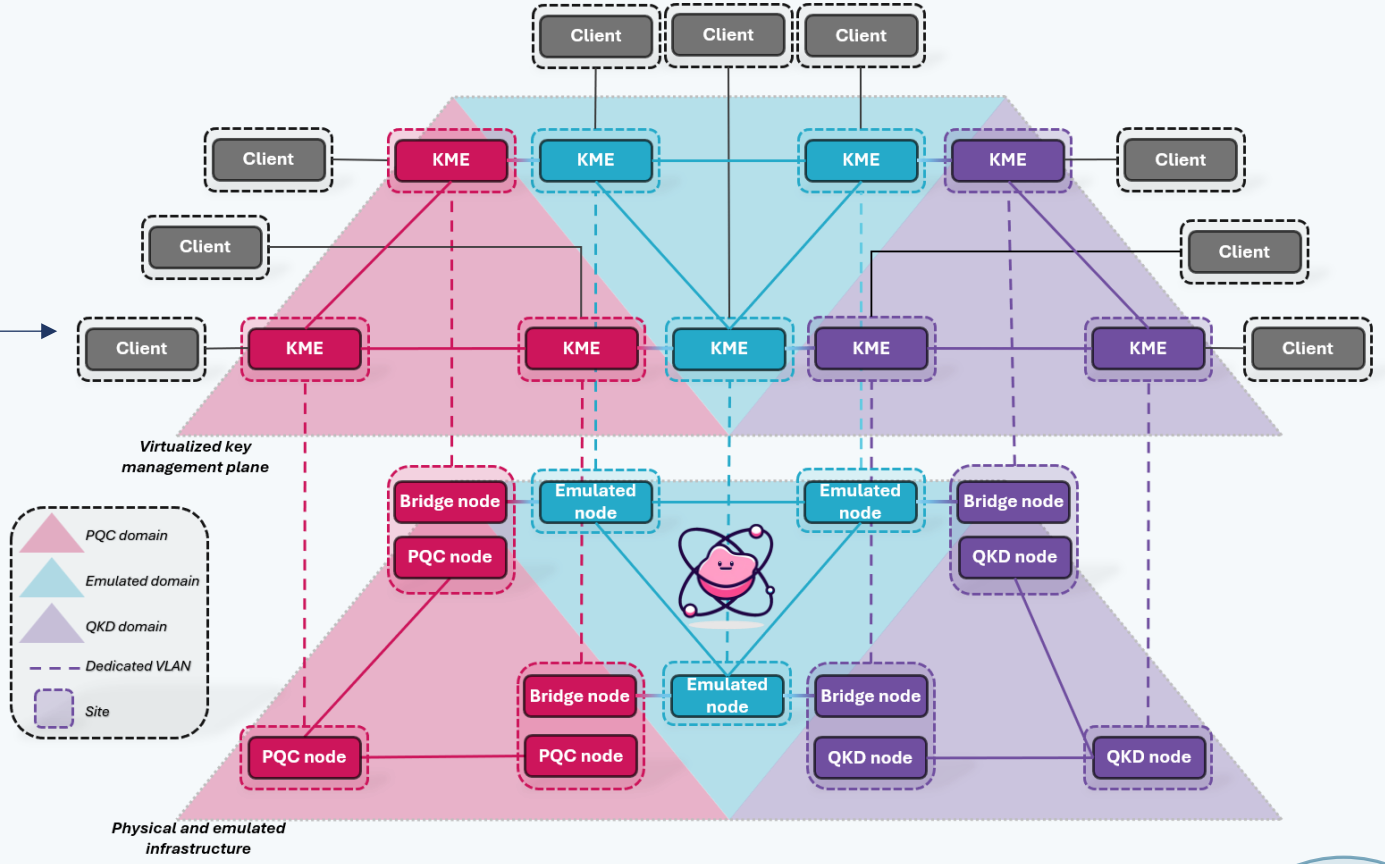
Technology-agnostic orchestration framework



Paper will be published soon; I hope :)

Technology-agnostic orchestration framework

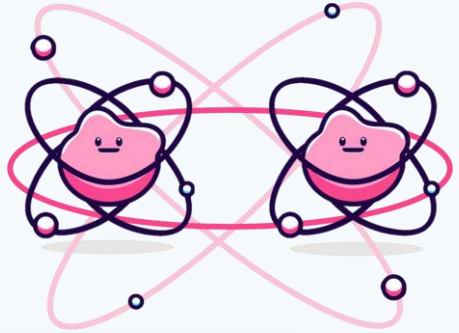




- 3 QKD vendors both prepare-and-measure and entanglement-based.
- 2 types of PQC devices.
- 2 different emulation platforms.
- 3 different key manager implementations.

Moving on

Beyond QKD, toward general quantum networks



Same design, new target

Quditto is “evolving” beyond point-to-point QKD toward general entanglement networks:

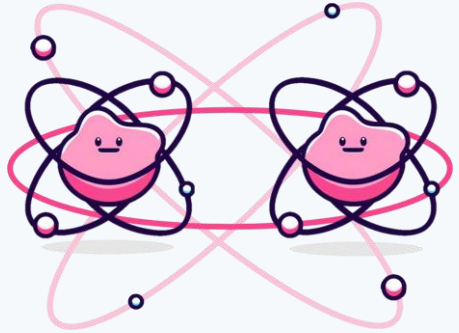
- Simulate quantum memory instead of physical links once entanglement is distributed.
- Model decoherence as time advances between instructions.
- Expose fundamental primitives (“create entangled pair”, “swap”) via a standard-inspired API.

Ongoing experiments

- Implementing Quantum Position Verification (QPV) to test the protocol using physical machines and the emulation platform.
- Experimenting with combinations of Entanglement Purification Selection (EPS) and Swapping and Purification Scheduling (SPS) for different repeater network designs.
- Exploring monitoring protocols and designing control planes for entanglement networks.

B. Lopez, I. Vidal, F. Valera and D. R. Lopez, "Designing an Emulation Platform for Realistic Experimentation on Quantum Networks," 2026 International Conference on Quantum Communications, Networking, and Computing (QCNC), Kobe, Japan, 2026, pp. 495-502, doi: 10.1109/QCNC69040.2026.00087.

Beyond QKD, toward general quantum networks



Open questions we want to solve

- What information must each stratum expose?
- How should cross-domain feedback work?
- How should quantum resources be represented and reserved?
- How should failures and asynchronous operations propagate between strata and domains?
- Which interfaces are required for interoperability?
- How can we validate the architectural design choices?

Take away

Hybrid real–emulated environments are a practical research instrument for designing, validating and refining scalable quantum-network architectures.

Thank you for listening and let's keep thinking!

Blanca Lopez

IMDEA Networks Institute · Universidad Carlos III de Madrid

blanca.lopez@networks.imdea.org

This work is partially funded by the project 6GINSPIRE PID2022-137329OB-C42, funded by MCIN/AEI/10.13039/501100011033/.
This work is also partially supported by the EU Horizon Europe project Quantum Security Networks Partnership (QSNP), under grant 101114043.