# SareQuant

Adaptation of the I2Basque NREN to support quantum experimentation and deployment of QKD-based services

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1. Background

- EHU Quantum Center (https://www.ehu.eus/quantum-center)
  - Gathers EHU's quantum related activity (quantum sensors, quantum computing, communications, fibre manufacturing…)
  - Part of the Basque Country IKUR initiative.
- I2T research group (https://i2t.ehu.eus/es) brings:
  - Telecommunications engineering, expertise in networking
    - Software Defined Networking control planes
    - Cybersecurity
    - 5G deployments, operating infrastructures.
- Quantum Information and Communication Technologies
  - Great impact on society expected in medium-term future
  - Enabling technologies for the applications and communication networks of the future
  - Full support of National (Complementary Plan in Quantum Communications) and Regional (IKUR initiative) governments cofunded with NextGEN EU funds
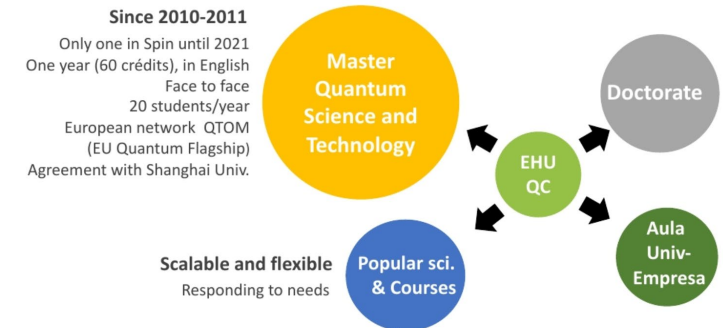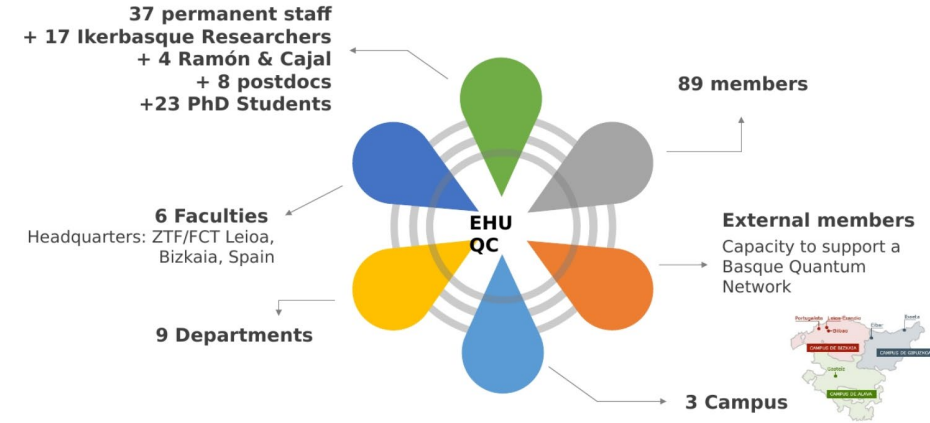
Need for platforms that enable quantum experimentation

1. Background

- Own experimental facility (in fact a part of the ESFRI infrastructure: SLICES-RI (Scientific Large Scale Infrastructure for Computing/Communication Experimental Studies) was the starting point
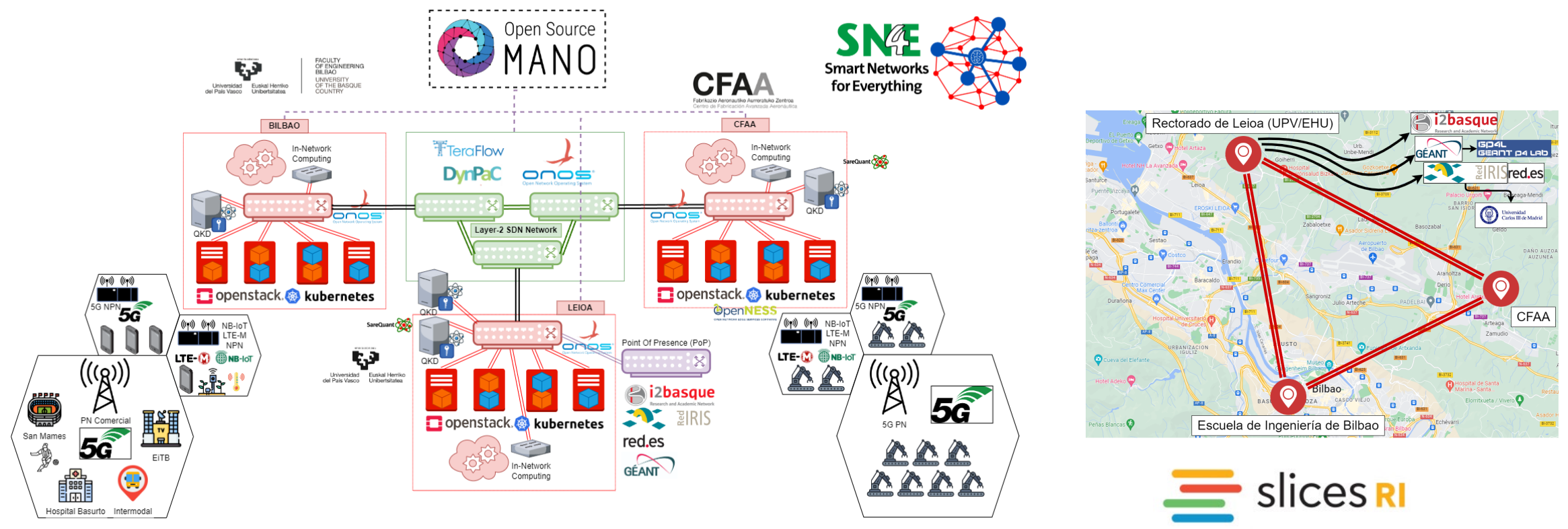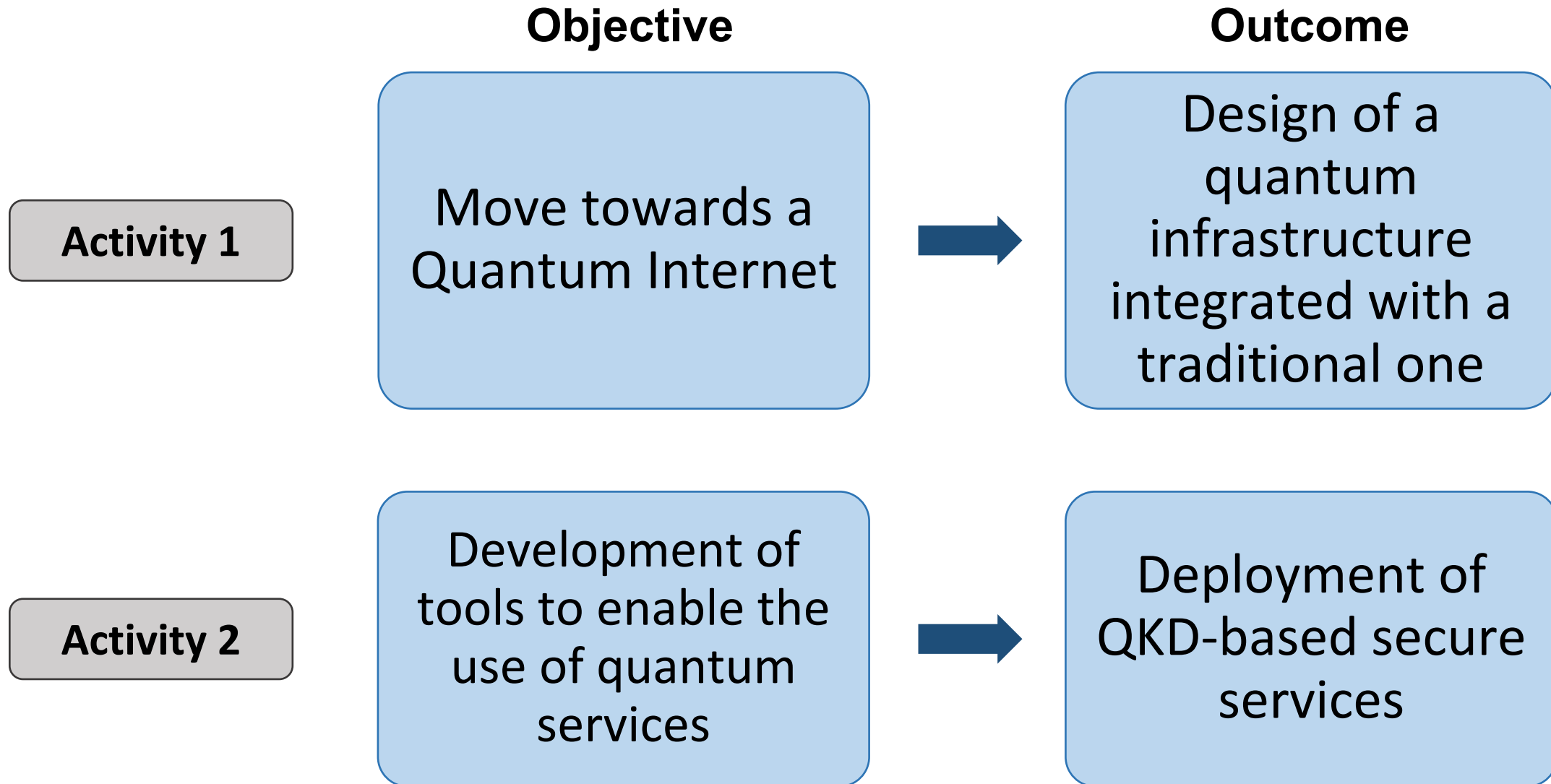
1. Background

- Recent announcement: Basque Quantum (BasQ) initiative, that brings (between others):

  - A IBM Quantum System One computer, to be installed in Donostia-San Sebastian, the sixth 127-qubit IBM Quantum System One in the world, and the second in Europe, managed by Ikerbasque Basque Science Foundation.

  - Many reasons to advance towards experimenting in Quantum Communications.

(Sare, is Basque word for Network)

2. SareQuant objectives and planned activities

Objective

Outcome

Activity 1

Move towards a Quantum Internet

→ Design of a quantum infrastructure integrated with a traditional one

Activity 2

Development of tools to enable the use of quantum services

→ Deployment of QKD-based secure services
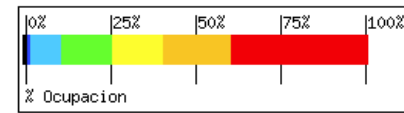
3. Activity 1 - Towards a Quantum Internet

- Quantum Internet
  - Integration of quantum technologies in traditional networks to enable quantum services
- IETF is working in the definition and design of QInternet
  - Deployment in different stages
- Other standardisation bodies are also working in this direction:
  - ETSI standards related to QKD
  - ITU-T recommendations related to QKD networks

Target

| Quantum Internet Stage	Example Quantum Internet Use Cases	Characteristic
Stage-1 Trusted Repeater Networks	Secure comm setup using basic QKD	Trusted nodes
Stage-2 Prepare and Measure Networks	Secure comm setup using the QKD with end-to-end security	Prepare-and-measure capability
Stage-3 Entanglement distribution networks	Secure comm setup using entanglement-enabled QKD	Entanglement distribution
Stage-4 Quantum Memory Networks	Secure/blind quantum computing	Quantum memory
Stage-5 Fault-tolerant few qbit networks	Higher-Accuracy Clock synchronization	Fault tolerance
Stage-6 Quantum Computing Networks	Distributed quantum computing	More qubits

4. Activity 1 - Towards a Quantum Internet

- Design an infrastructure compatible with I2Basque (Basque Country NREN) traditional network to support experimentation with quantum communications, as an step to full support of quantum communication.

Managed by

iкerbasque
Basque Foundation for Science

Most of the links of "very reasonable" lenght

BasQ
127-qbit Quantum Computer
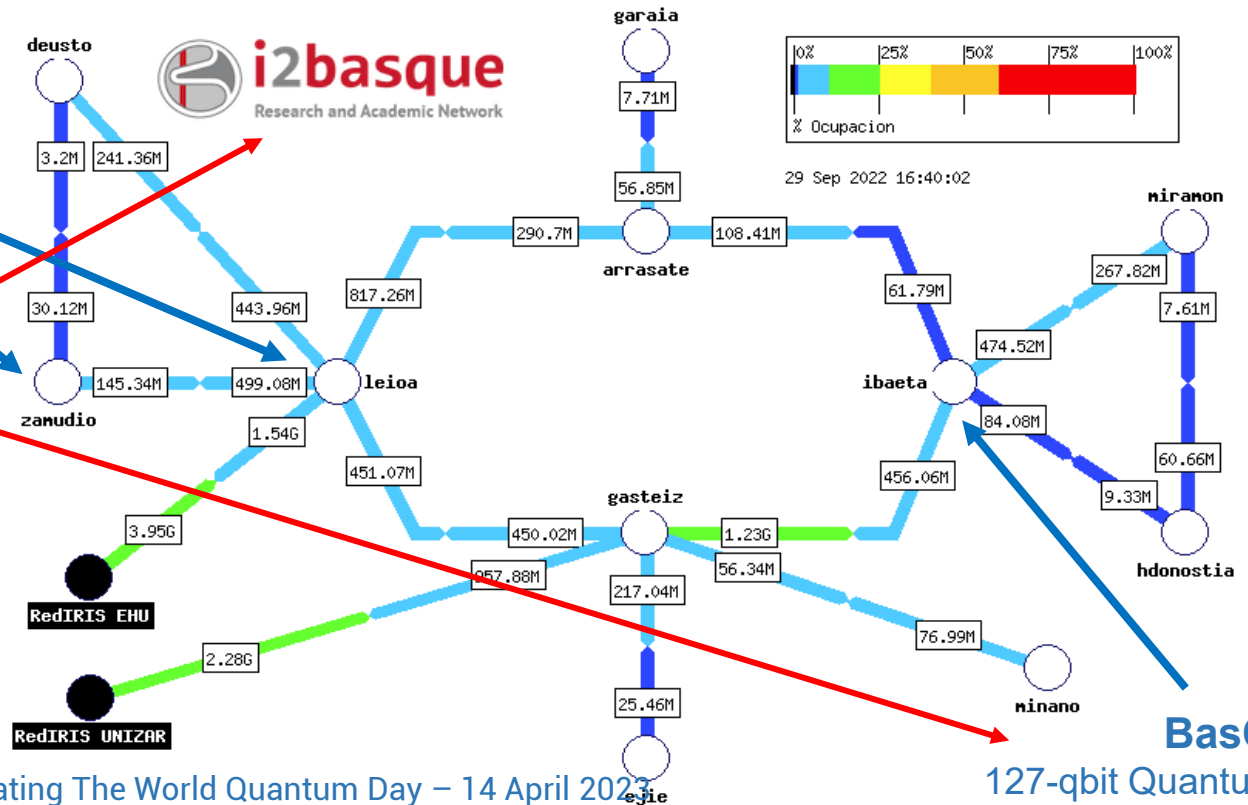
4. Activity 1 - Towards a Quantum Internet

- Our objectives and expected results
  - Study how a traditional NREN infrastructure network can be adapted in order to support quantum experimentation.
  - Study the compatibility and integration of quantum technologies with traditional ones.
  - To have an architecture design for an infrastructure that can serve as a real testbed for quantum research.
  - Integrate SN4E in the experiment

5. Activity 2 – QKD-based secure services

- Objectives:
  - Deployment and integration of quantum technologies in real-world scenarios and applications (targeting 3 different technologies)
  - Understanding the technical implications for deploying secure quantum service
  - Laying the foundations for the development of future quantum services
- QKD: maturity, first stage towards QInternet
  - Appropriate technology to start working with quantum technologies and acquire knowledge
  - Starting point for moving on to more advanced stages of development in the future

5. Activity 2 – QKD-based secure services

- Secure service deployment based on QKD, integrating the technology into real operational solutions.
  - Use case: securing distributed data centers supporting virtualised environments to secure the network services that are deployed in the system.
  - Additional use case: integration in 5G/6G

6. Ongoing related research activities

- QFIRST (Quantum Devices) (2022-2023)
  - Integration of low level technologies in new telecom use cases.
    - Point to multipoint
    - Characterisation of needs for new use cases: Industry/Access networks for low cost equipment design.

- GN5-1 (2023-2025)
  - Participation in the quantum communication work package
  - The same two lines as here: Making Quantum Communication usable for NRENs and deploying services.

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