National Quantum Communication Infrastructure in Finland

QKD development and deployment

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NaQCI.fi

National Quantum Communication Infrastructure in Finland (NaQCI.fi) project is a part of **EuroQCI initiative** and it is funded by EU Commission (Digital Europe Programme) and Finnish ministries. The goal of EuroQCI is to create EU-wide QCI that supports QKD by the end of 2020s. European QKD network will be composed of both terrestrial fiber optic links and satellite links.

EuroQCI will contain three main phases:

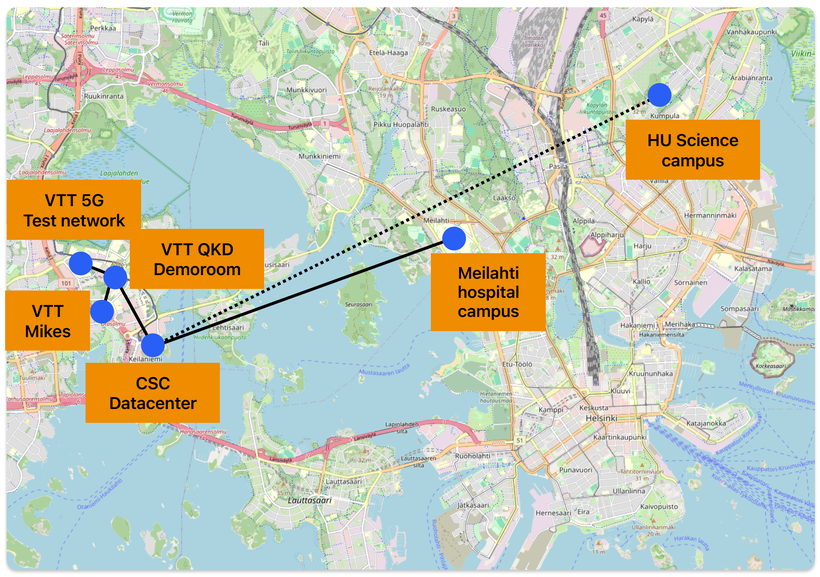
1. National networks and building up competence, strengthen EU27 QKD industry (2023-25)
2. Cross-border links, connections to SOCs (2025-2027)
3. Operational deployment (2027-2030)

NaQCI.fi belongs to 1st phase and our national goals are

- Deploying QKD test networks (public by CSC and VTT, governmental by Cinia and Erillisverkot)
- Planning of cross-border links to Estonia and Sweden
- Studying the feasibility of satellite QKD in Finland
- Dissemination and education

Public demo network

The public QKD demo network will span from Otaniemi via Keilalahti to Meilahti (and possibly Kumpula). The main goal is to demostrate the feasibility of both DV-QKD and CV-QKD in passive and active metropolitan area networks. Demo applications will include transferring medical research data and integration with 5G test network.

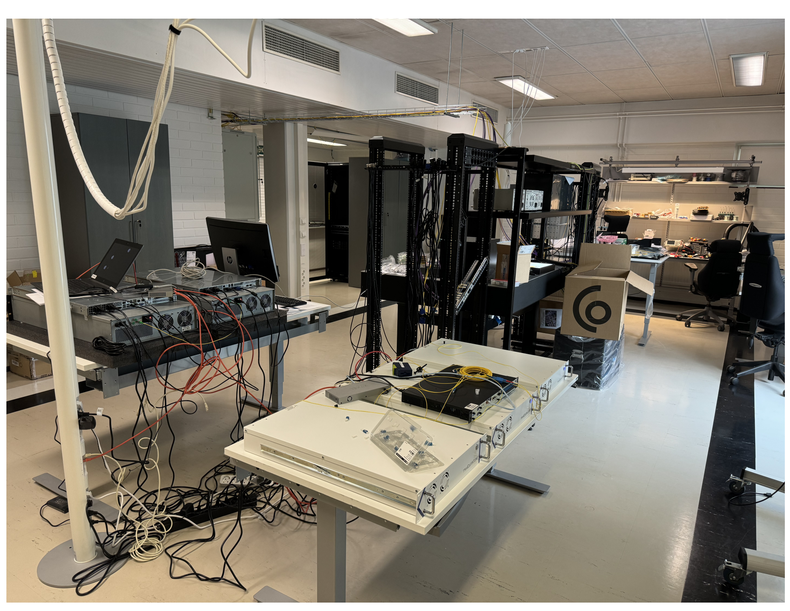


Helsinki area QKD demo network

QKD laboratory

As a part of the project, we will establish QKD demo room that will be available for, e.g., workshops and research activities. Demo room equipment will include:

- Commercial QKD devices, both DV-QKD and CV-QKD
- VTT's own QKD platform
- Ultra bright entangled photon-pair source @ telecom wavelenghts
- Multichannel SNSPD and ps-range time-taggers
- SNSPD testing facilities (1K cryostat etc.)



VTT's quantum communication lab / demo room under construction.

QKD research

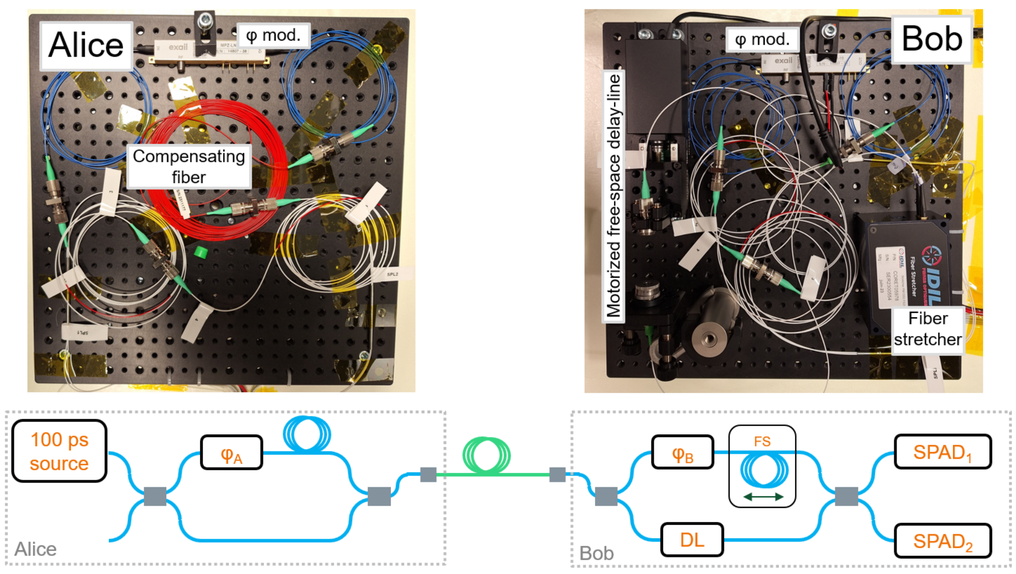
Our main research and development interests include:

- Finalize the development of our QKD testbed and deploy it in QKD demo network
- Investigate and test some new ideas about QKD
- Interdomain key relaying utilizing SR-BGR
- Hybrid PQC–QKD systems
- PQC based authentication for QKD
- Evaluate security of QKD protocols and implementations
- Study quantum security mechanisms beyond QKD
- Quantum entanglement distribution
- High-speed QRNG development
- Further quantum communication topics like Quantum Internet

QKD testbed

We have developed our own QKD system and the main goals are first to learn how QKD works and then use it as a platform for our own research. We are also planning to utilize this platform in hands-on workshops to demonstrate how QKD actually works. Furthermore, one goal is to use this for integrating and testing new components from companies and other research projects.

Our QKD platform implements very basic BB84 protocol with time-bin encoding. We have used ARTIQ control system for the quantum channel but, as it has turned out be the performance bottleneck, we are currently moving the control tasks to Xilinx MPSoC environment. Furthermore, components like modulators, lasers and such are being updated. Support for decoy-states is also under development.



VTT's QKD testbed

Furthermore, we have implemented key distillation and key management software. The first version of key distillation was coded in Python but currently we are porting the software to MPSoC and improving some algorithms like error correcting (LDPC in FPGA). The key manager is implemented in Scala with Pekko toolkit and at the moment, it provides just basic ETSI QKD 014 functionality. We have also implemented test client interfaces with Rust. Furthermore, we have started to develop PoC for SR-BGP based interdomain interworking.

Visit our Web site `https://NaQCI.fi/` for further information.

EuroQCI NaQCI.fi

Cinia CSC Erillisverkot VTT

Summary

- **NaQCI.fi aims to deploy 1st QKD test networks in Finland.**
- **In NaQCI.fi project, we are deploying, together with CSC, QKD demo network in Helsinki metropolitan area.**
- **We are developing full QKD system for research purposes.**
- **QKD demo room and development platform will be available in 2025.**

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beyond the obvious