



Deploying HellasQCI within the EuroQCI Initiative

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HELLENIC REPUBLIC
Ministry of Digital Governance



According to Laws 4623/2019 and 4727/2019 GRNET is the *coordinator of all Greek digital infrastructures for research and technology*

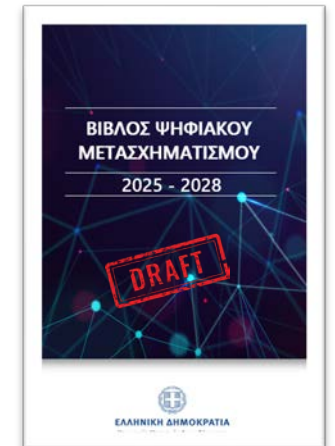
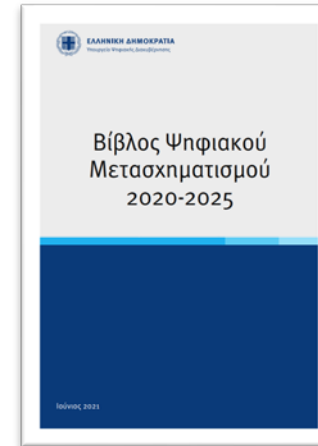
The **Ministry of Digital Governance** signed the EuroQCI Declaration (2019)

EuroQCI is part of the **Digital Transformation Strategy of Greece (2020-2025)**
**new strategy under preparation*

GRNET was appointed (2021) by MinDig to participate to the EuroQCI and be responsible for the EuroQCI **DEP-CEF national proposals** coordination and submission.

GRNET operates under **MinDig** and for more than 25 years provides **e-Infrastructures and services** to the public sector (government, education, research, health, culture)

Greece signed the **European Declaration on Quantum Technologies (2023)** among the first 11 Member States that have endorsed the Declaration



HellasQCI
Budget: €10m

DEP 2 – Terrestrial QKD Deployments

Ranked in the **2nd** along with Germany's, Finland's and Ireland's National QCI proposals.

EU Funding: € 5m
National Funding: € 5m

6M € for equipment and fibers

Project Started:
January 2023

Project Ends:
June 2026

Build the national pilot quantum networks as part of the EuroQCI

- 3 national MAN test-sites: Athens, Thessaloniki, Heraklion-Crete → 200km
- HellasQCI provides terrestrial links to 3 Observatories (OGSs) to the closest MAN QKD network → 430km
- Connecting geostrategic locations in Greece

Space segment connectivity

- Builds on Helmos, Holomontas and Skinakas Observatories
- All Observatories are part of **ESA programmes** such as the Scylight, Hydron, SAGA and Greek Obs2OGS
- Connect to QKD ready satellites for connecting our test-sites and also connect with the rest of the EU



Space segment connectivity

- HellasQCI provides interconnection to 3 Observatories - being transformed to OGSs:
 - ✓ Helmos → Athens (270km)
 - ✓ Holomontas → Thessaloniki (90km)
 - ✓ Skinakas → Heraklion, Crete (70km)
- Upon the availability of Eagle-1, Greece will be among the first countries to validate and test EuroQCI both segments.
- Greece has the advantage (3 OGSs) and the ideal location (clear skies) to serve as a security hub for Space QKD for the SEE.

Helmos Observatory
Altitude: 2340 m 2.3m Aristarchos optical telescope



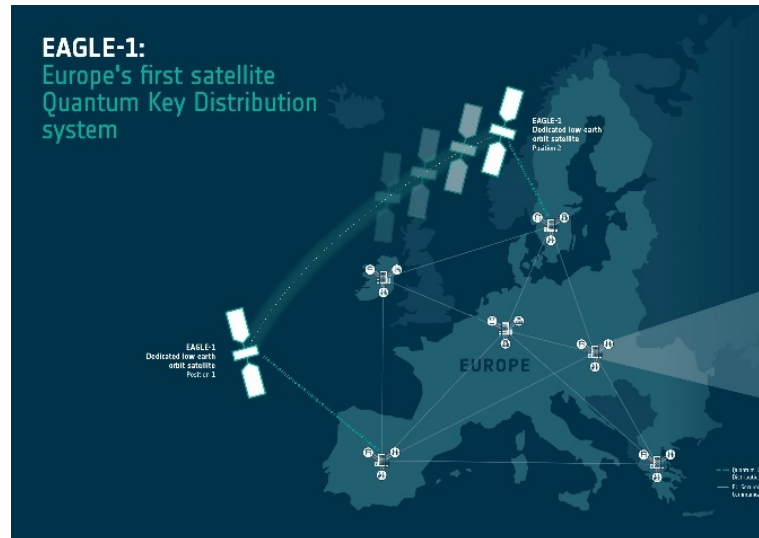
Holomontas Observatory
Altitude: 861 m 0.4m optical telescope



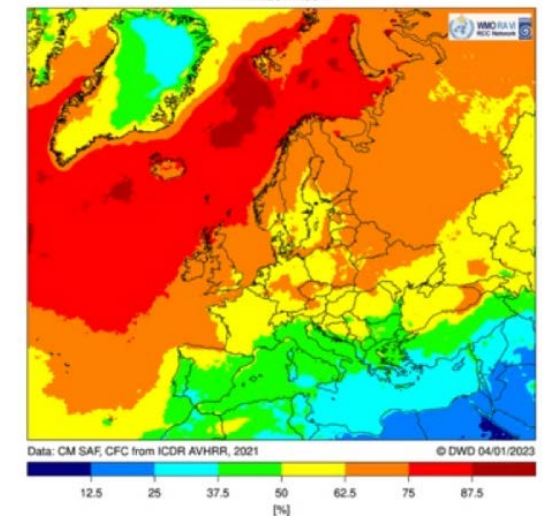
Skinakas Observatory
Altitude: 1750 m
1.3m optical telescope



EAGLE-1: Europe's first satellite Quantum Key Distribution system



Cloud Fractional Cover Year 2022
Annual Mean



HellasQCI domains

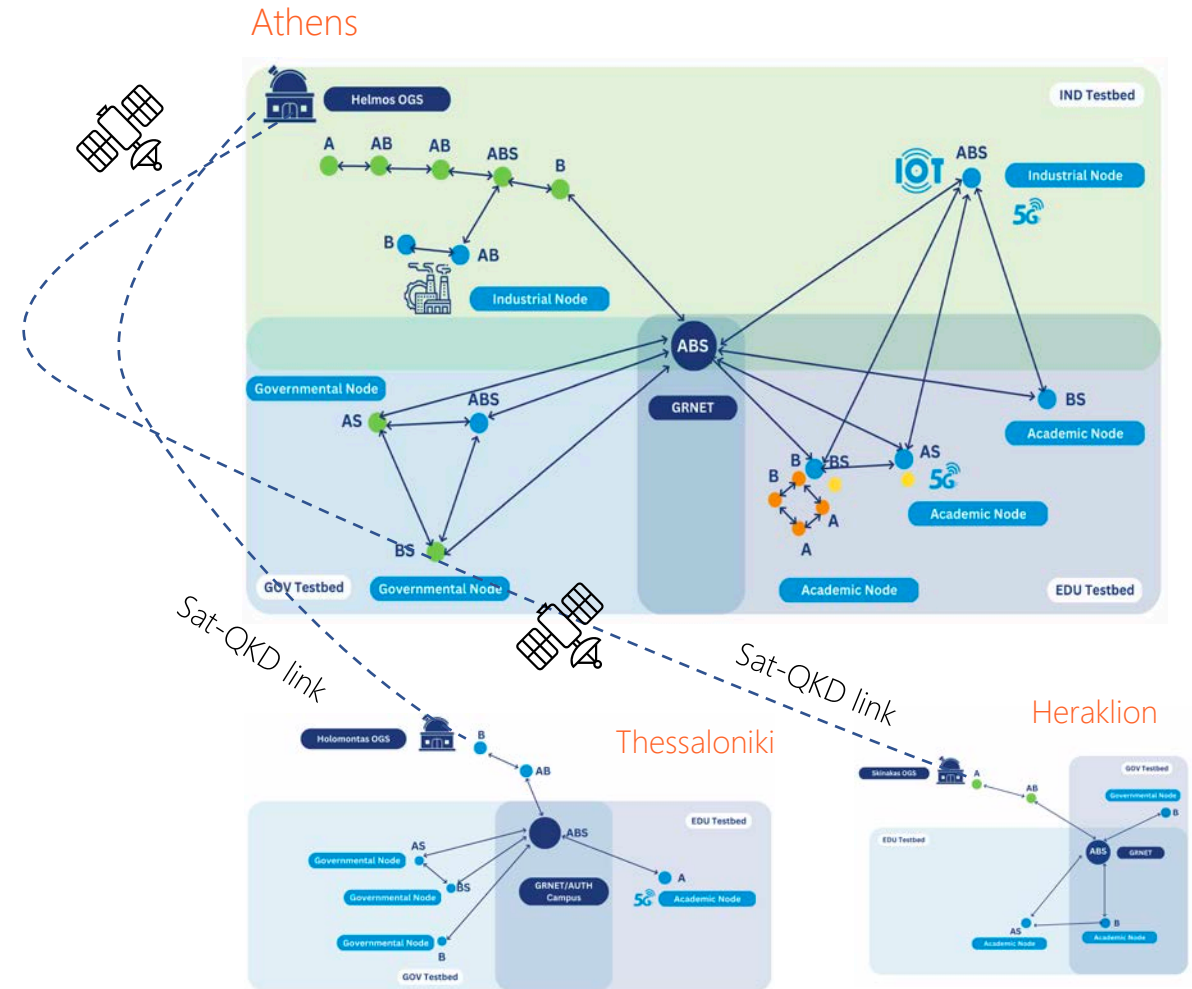
- Governmental (GOV)
- Industrial (IND)
- Research and Innovation (EDU)

HellasQCI nodes

- 27 Total QKD nodes (permanent + non perm.)
- 16 in Athens, 6 in Thessaloniki, 5 in Heraklion Crete

Permanent nodes

- 12 GOV nodes connected (QKD Equipment + Fibers)
- 17 GOV nodes connected (Fibers)
- 2 QKD nodes for the entanglement distribution network – **Quantum Internet** (Fibers + Equipment)
- 6 EDU QKD nodes connected (Fibers)



16 Advanced Use Cases in different application scenarios

Advanced use cases in different application scenarios

- 16 multidisciplinary use cases into four sectors
- The aim is to test the quantum networks in real life use cases and prove their added value in cybersecurity and their readiness - tackle all the challenges of their initial implementation.

Develop and deploy advanced quantum systems and networking technologies

HellasQCI project implemented numerous activities/experiments to prepare the ground for the large-scale deployment of the HellasQCI networks and the preparation of the use-cases.

Demonstration of ten (10) experiments

FSO, Switched DV-QKD, QKD over FTTH, Hybrid PQC/QKD integration, QRNG development, PUF-based authentication schemes for QKD, 5G etc

Publication of ten (10) scientific publications

1. National security

- 1 — QKD for National Security
- 2 — Enhanced QKD resilience for National Security
- 3 — Satellite QKD connectivity for remote GOV Nodes
- 16 — HellasQCI space and terrestrial segments

2. Public health

- 4 — Secure communications for Public Safety
- 5 — Quantum Secure technologies for cloud Health Applications
- 6 — Secure transmission of medical imaging data for Hospitals

3. Industry critical infrastructures

- 8 — Quantum cryptography to secure communications
- 9 — ICT sector | Secure storage in cloud data centers
- 10 — ICT sector | QKD over 5G
- 11 — ICT sector | Next Generation Quantum Secured FTTH
- 15 — Preparation of a quantum encrypted software app.
- 7 — QKD for secure connectivity to HPC infrastructure

4. Research

- Use case 12 — Preparing for the quantum internet
- Use Case 13 — Advanced quantum network controls
- Use case 14 — PUF-based hybrid authentication for switched QKD

HellasQCI Architecture 3-layer format

QKD layer

Supports relayed DV-QKD/Switched QKD
 Partial mesh deployment for optimized resource usage

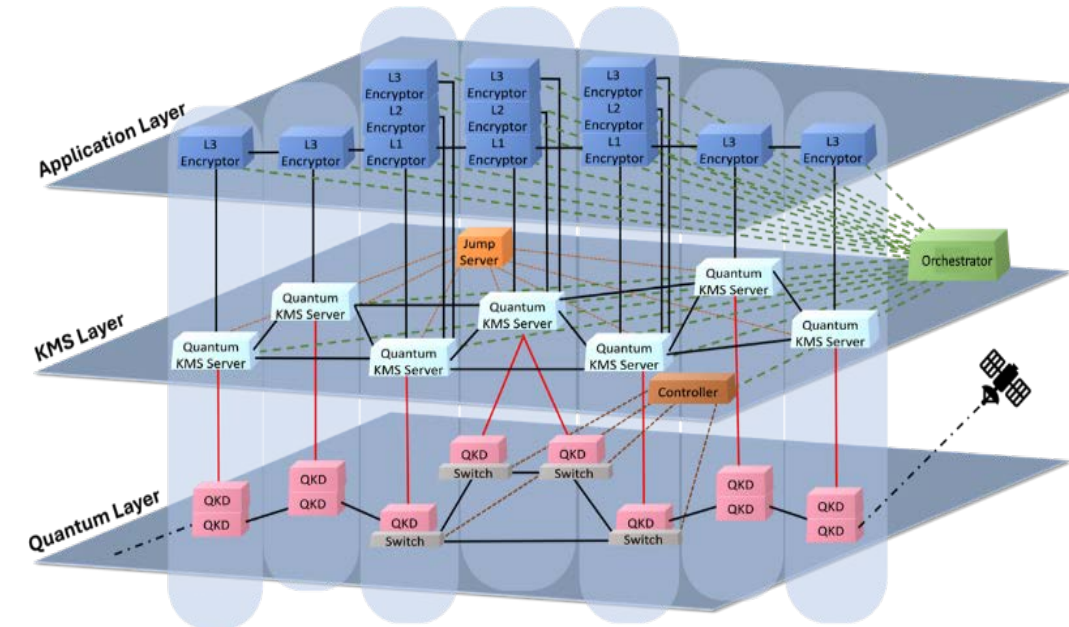
KMS layer

ETSI-QKD-14 GS for key management
 ETSI-QKD 15 GS for QKD-SDN controls
 ETSI-QKD-18 GS for linking with the Application Layer/Orchestration

Application (Service) layer

L1, L2, L3 encryption
 Maintain backwards compatibility with classical encryption schemes

Extensions
 Multi domain QKD
 PQC integration



Tested and validated the architecture through a PoC until the procurements to be concluded

Dark fibers

More than **650km – 27 links**:
3 long-distance and 24 MAN →
20 links for the GOV sector and 7
links for the EDU

Contracted:
May 2024

Estimated Completion:
April 2025



QKD Devices

11 x DV-QKDs:
9x IDQ Clavis XG 30db &
2x Thinkquantum QuKY 20db

Contracted:
April 2024

Estimated Completion:
December 2025



Quantum Internet Equipment

16 x SNSPDs
SSPD-1550-80

Contracted:
June 2024

Estimated Completion:
December 2024



2 x EPPSs
→ In Progress (RFP)
Submission of bids:
20/9/2024

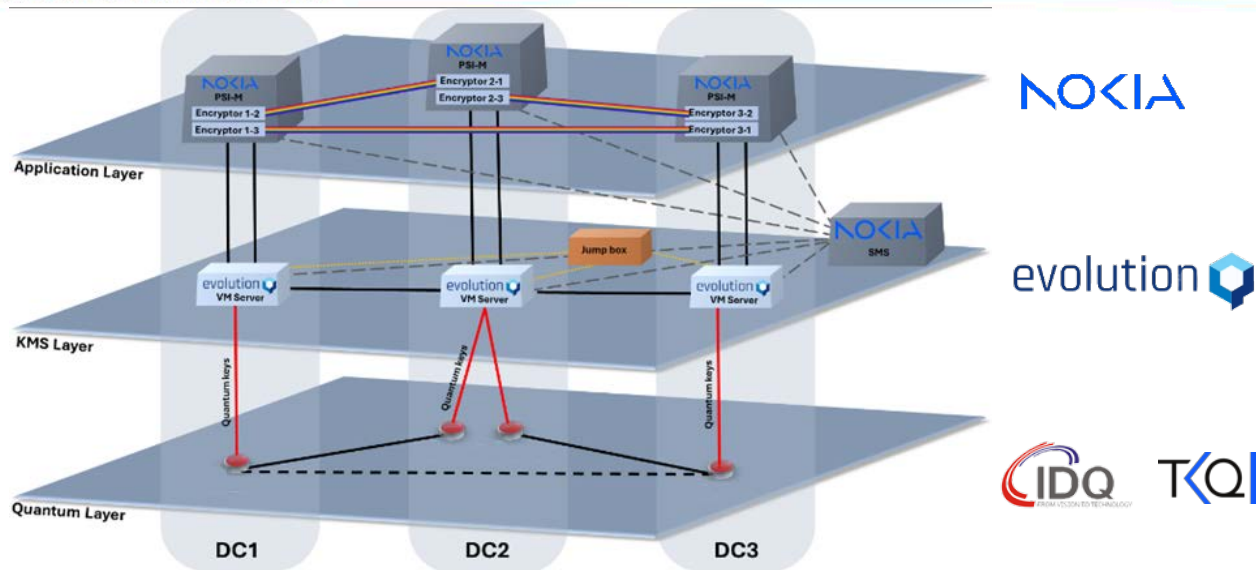
Upcoming procurements

Installation of the trusted nodes
(racks)
→ In Progress (RFP)
Submission of bids:
2/10/2024

Low-loss optical switches
→ In Progress (RFI)

Encryptors
→ In Progress (RFI)

Milestone: PoC Demonstrator in a real field deploy testbed

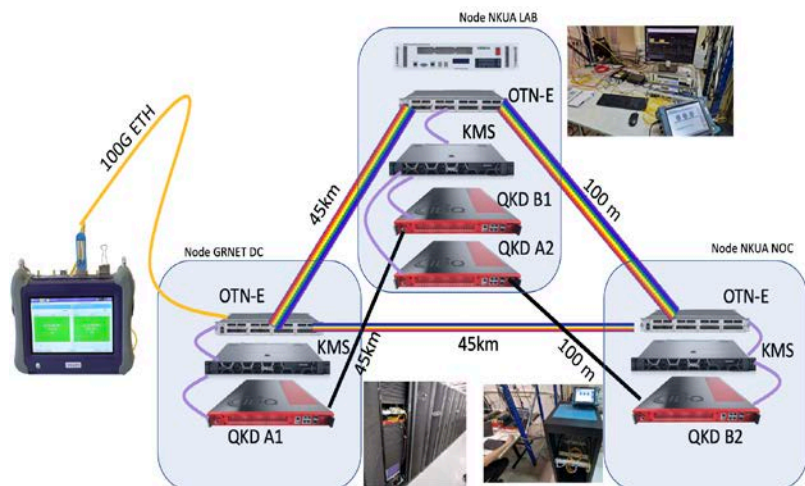


Proof-of-Concept (PoC) to validate HellasQCI Architecture

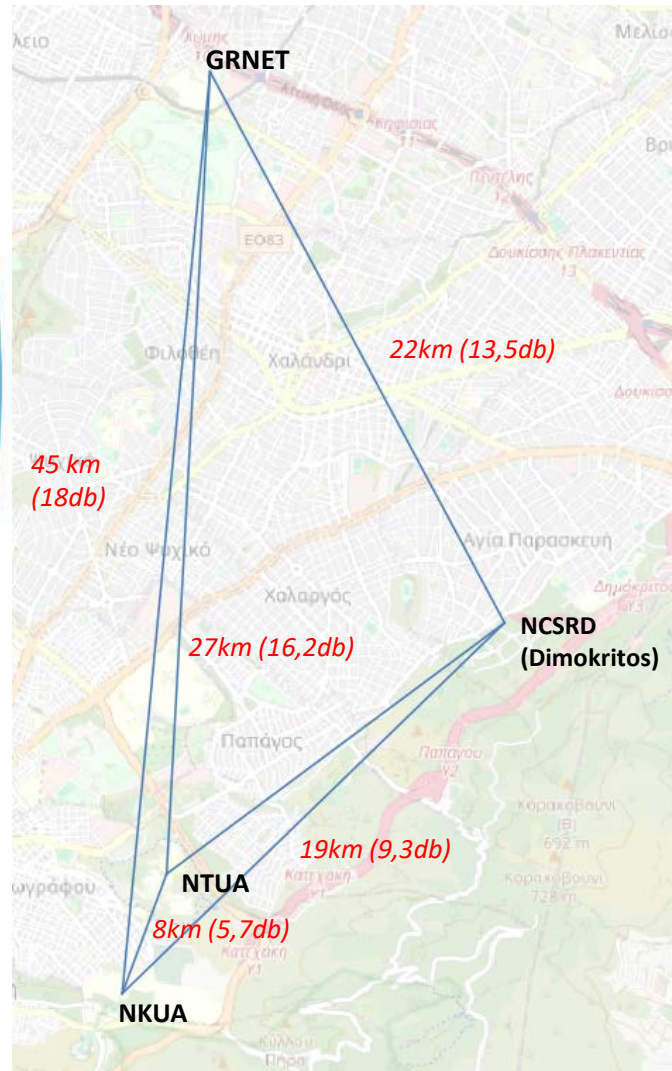
The topology includes a 3-node full ring configuration between GRNET & NKUA (max distance 45km), where every node is a fully integrated vertical stack featuring: 1. a Quantum layer, 2. a KMS layer and 3. an Application layer

PoC key features and innovations

- ✓ Hybrid operation – SMS orchestrates and uses both QKD-keys and quantum-safe classical keys in case of QKD fail
- ✓ Supports Optimized QKD resources - requires less QKD pairs (two QKD pairs for 3 nodes) → Operate in a relayed function
- ✓ Co-ordinates Application layer and key management layer - Deployed Key consumers in all three nodes.

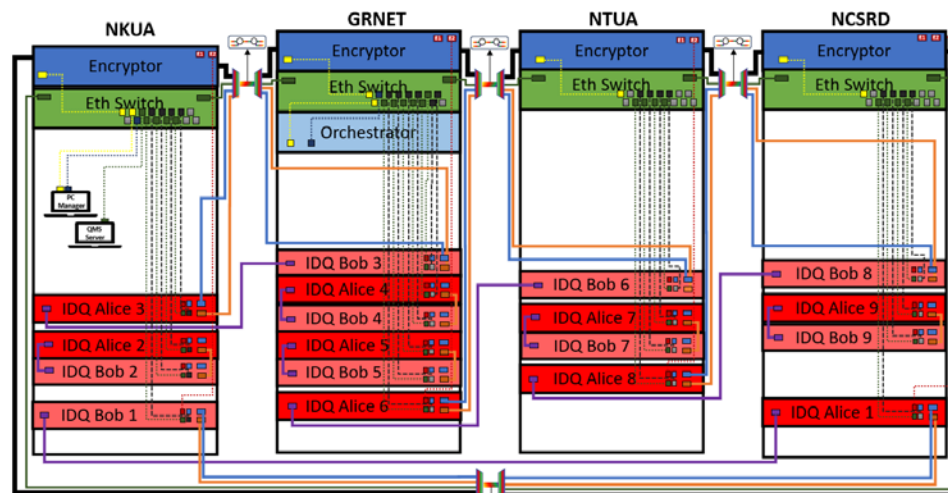
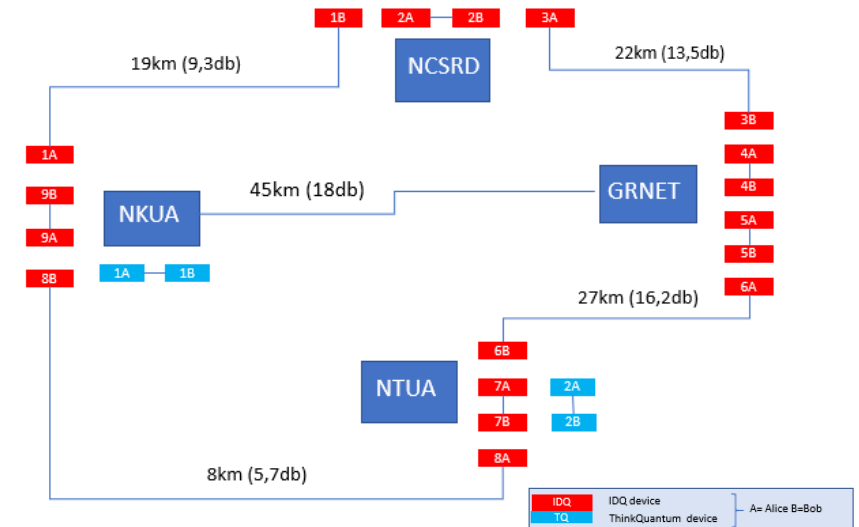


Initial installation for testing and accepting the HellasQCI equipment



The 11 HellasQCI QKD pairs arrive in September 2024 → 3 setups

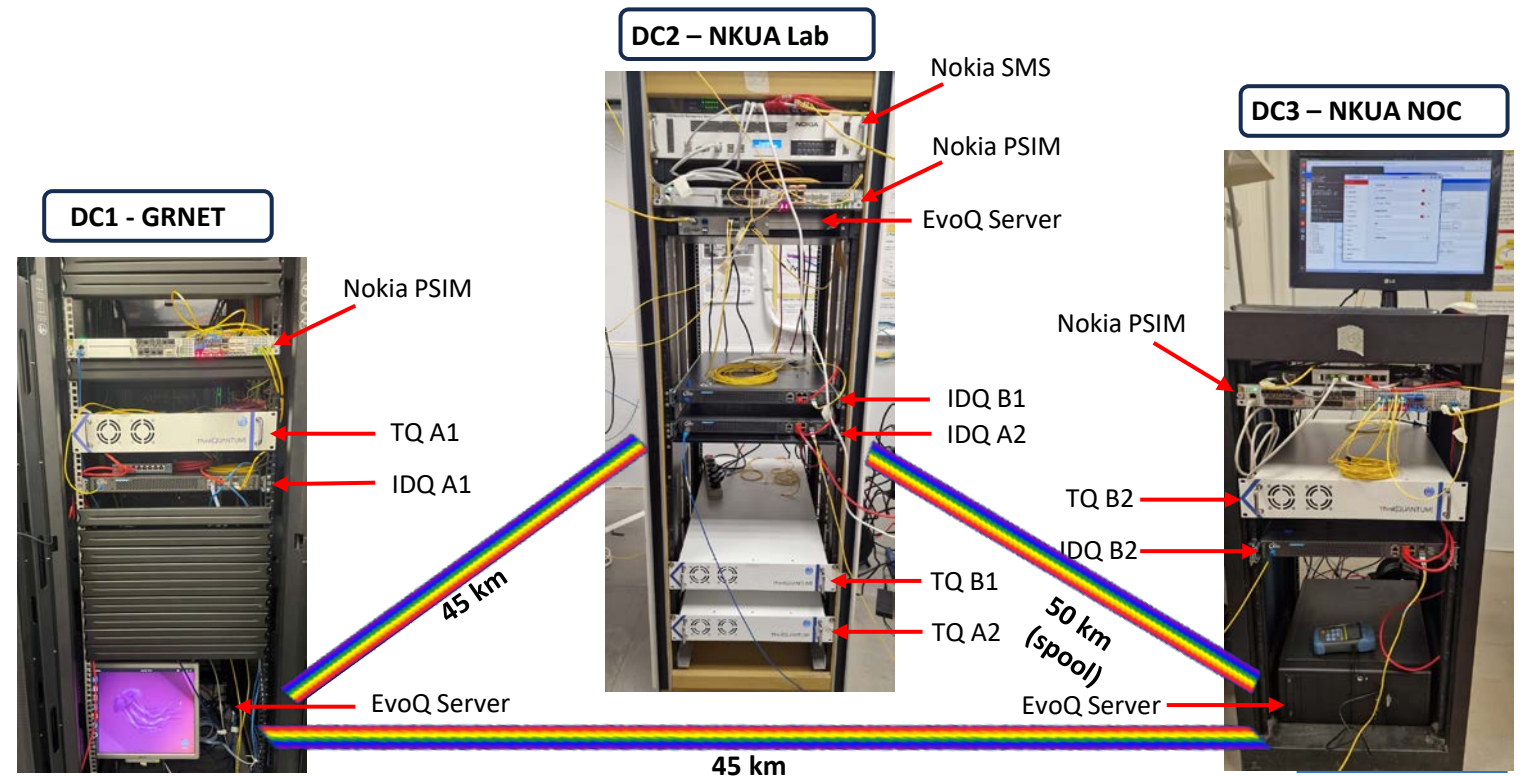
- Initial setup:** in Athens in a complex network topology of 4 nodes: GRNET, NKUA, NTUA, NCSR (5 links) will be implemented in order to test & accept delivery.
- Use-cases setup:** Upon the acceptance, the QKD devices will move to the HellasQCI Consortium for the use-cases implementation.
- Final Setup:** Upon the completion of the Use-Cases, the devices will move to the GOV & NSA nodes.



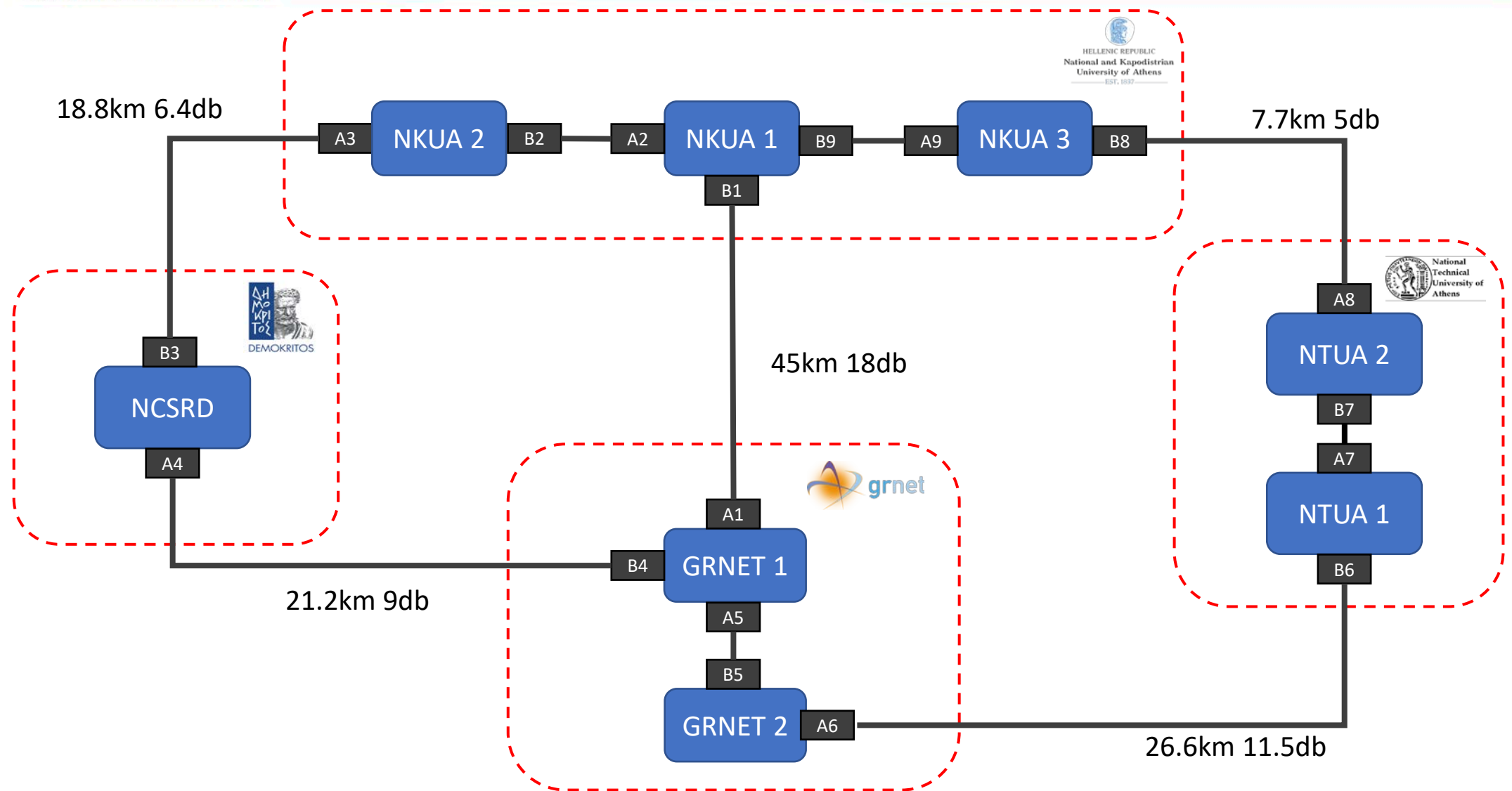
GRNET - NKUA Total length: 45km (18db)	} PoC Link
NTUA - GRNET Total length: 27km (16,2db)	
GRNET - NCSR Total length: 22km (13,5db)	
NCSR - NKUA Total length: 19km (9,3db)	
NKUA - NTUA Total length: 8km (5,7db)	
} 4 New Links	
Total fiber: 75km (new) + 45km old (PoC) = 120 km	

HellasQCI QKD pairs installations

- Phase 0**
PoC: not owned HellasQCI QKD devices: OTN-Sec in Athens 3-node full ring configuration between GRNET & NKUA (max distance 45km) [only IDQ QKD devices] → Feb 2024 - July 2024 (ended)
- Phase 1**
PoC with owned HellasQCI QKD devices: OTN-Sec in Athens 3-node full ring configuration between GRNET & NKUA (max distance 45km) [IDQ and ThinkQuantum QKD devices - Interoperability in KMS layer] → Aug 2024 – Sept 2024 (current)
- Phase 2**
Initial setup: in Athens in a complex network topology of 8 nodes: GRNET, NKUA, NTUA, NCSR D (5 links – 4 new, max distance 120km) will be implemented in order to test & accept delivery → expected to end by December 2024
- Phase 3**
Use-cases setup: Upon the acceptance, the QKD devices will move to the HellasQCI Consortium for the 16 use-cases implementation (GA) + Kryoneri → expected to end by October 2025
- Phase 4**
Final Setup: Upon the completion of the Use-Cases, the devices will move to the GOV & NSA nodes → expected: by December 2025



Phase 2 Initial setup: Testing and accepting the HellasQCI equipment



HellasQCI training methodology

Addresses the needs in three pillars of users:

- a. academic/research staff,
- b. experts in digital security and
- c. end users from public and private sector

HellasQCI Training event in Athens (9/2023)

Workshop on Quantum Key Distribution (QKD) Systems

Workshop on Cybersecurity with QKD and PQC

- ✓ 20 Lessons performed, 4 Labs took place, 375 attendees, 4 days
- ✓ Hybrid format (livestreamed and recorded) in EN
- ✓ PETRUS CSA and 4 NatQCI: IE, LX, PL and CY presented their activities.

HellasQCI Training event in Crete (9/2024)

3RD TRAINING EVENT

HYBRID

Quantum Key Distribution (QKD) and Cyber Security

- ✓ 415 participants, 2 days
- ✓ 40 Speakers, 16 trainers
- ✓ Hybrid format (livestreamed and recorded) in EN
- ✓ PETRUS CSA, Nostradamus and 10 NatQCIs were present.

1ST TRAINING EVENT @ A GLANCE

4 DAYS OF TRAINING | **4 LABS** | **20 LESSONS**

16 TRAINERS | **5 SPEAKERS** | **375 ATTENDEES**

TYPE OF PRESENCE:

PHYSICAL 175 | **ONLINE 200**

HOCI Training Platform is ON AIR & AVAILABLE!

(<https://training.hellasqci.eu/>)

TRAINING EVENT IN CRETE 2024

2 DAYS OF TRAINING | **1 DAY EUROQCI DEPLOYMENTS & COOPERATION** | **2 DAYS QKD+PQC FOR CYBERSECURITY**

2 LABS | **2 DEMOS** | **40+ SPEAKERS** | **4 PANELS**

415 ATTENDEES | **50+ PEOPLE VISITED THE SKINAKAS OBSERVATORY**

PHYSICAL 126 | **ONLINE 289**

14 COUNTRIES PARTICIPATED

GREECE: HELLASQCI | AUSTRIA: QCI-CAT | MALTA: IQSIH
 CYPRUS: CYQCI | LUXEMBOURG: QUANTIS | PORTUGAL: IQCI | ROMANIA: IQSIQCI
 SPAIN: EUROQCI-Spain | HUNGARY: QCI-HUNGARY | ITALY: TRAIK-QUANTUM
 POLAND: IQSI-POL | SWITZERLAND: QCI-QUANTUM | NETHERLANDS: IQCI-QUANTUM

HellasQCI 4-day Training event in Athens



HellasQCI 2-day Training event in Crete



Active participation to the PETRUS CSA, NOSTRADAMUS and collaboration with QT EU research projects

- ✓ HellasQCI participates to **PETRUS CSA** and contributes to five (5) Thematic Working Groups: Roadmap, Use Cases, QKD Landscape, Architecture, Interoperability & Standards
- ✓ GRNET and MinDig participate to the **NOSTRADAMUS** project for building EU's quantum communications testing infrastructure
- ✓ Collaboration of the HellasQCI with **EU QT Projects** such as: LaiQa, QSNP, and QT Pathfinder

Synergies – Close Cooperation with 16 NatQCIs

- ✓ HellasQCI supported **16 events in total and 10 NatQCIs events**: IR (2), AU, ES (2), PT, NL, ML (2) and RO and **organized 5 events**.
- ✓ HellasQCI participates actively to **GÉANT** through **GRNET** (NREN of Greece) on a regular basis (GN5-1 Proj. & Quantum Strategy Group) and cooperate with 10 NatQCIs → PL, CR, BE, IR, HU, RO, CZ, NL, CY.
- ✓ **HellasQCI, QCI-Cat and EuroQCI Spain** co-organize **QCI DAYS 2025 in Athens** → under the auspices of the Ministry of Digital Governance.

HellasQCI in Austria receives the key for hosting the QCI Days 2025 in Athens



Let's build Europe's Quantum Communication Infrastructure together!



QCI DAYS
Athens 2025

Save the Date!
28-30 April 2025

Info & Register 

Organised by




Under the Auspices of

HELLENIC REPUBLIC
 Ministry of Digital Governance

To stay informed please register here: qci-days.eu

National stakeholder engagement

- Establishment of the HellasQCI community from all national stakeholders that can benefit and support the HellasQCI networks, gather expertise and share knowhow.
- Raise Awareness and Ensure better participation into the EuroQCI and leverage new end-users for the expansion of the HellasQCI networks.

Provide a secure architecture compatible with QKD standards and certifications

- HellasQCI monitors: European (ETSI, CEN/CENELEC) and International level (ITU, ISO, IEC, IEEE)



HellasQCI participates in several activities for QKD standards and certifications

- Cen/Cenelec JTC 22, in WG4 and contribute to Large scale QKD networks
- QuIC (European Quantum Industry Consortium) Standardisation WG4
- Petrus EuroQCI TWG on Interoperability and Standards
- NOSTRADAMUS DEP – EuroQCI Certification Project

HellasQCI Community Registry established

- ✓ More than 22 registrations (GOV,EDU,IND) have been attracted so far in the HellasQCI community registry
- ✓ Invite all stakeholders from Greece to participate in the HellasQCI Community <https://hellasqci.eu/community-repository/>



Building the HellasQCI Community in National Events



Interviews to Raise Awareness



HellasQCI at the ESA – ScyLight conference Kalavryta, Greece 17 May 2023

Next steps on the HellasQCI infrastructure

- Following the success of the PoC in Athens and the validation of the architecture → **Large scale deployment of the HellasQCI networks.**
- Develop the **multi-domain QKD network solution**, to support the individual GOV, IND and EDU quantum network domains and the **PQC integration** into the HellasQCI architecture ([EC recommendation](#)).
- Address the **next phase of EuroQCI (EuroQCI CEF)** → cross border connectivity (in discussions with MinDig and NatQCIs) for terrestrial/space connections



Key Requirements for an Operational and Secure EuroQCI

- Strong cooperation among the **EU and MS + Public and Private** sectors (GOV, IND, EDU) → to build state-of-the-art and an interoperable EuroQCI and QKD services.
- Synergies and complementarity in **funds** between National and EU activities:
 - a. for the sustainability and the expansion of the national QKD backbone networks
 - b. for the advancement of quantum technologies.
- **Invest and support EU's regional dimension:** Particularly to the SEE countries → By matching national funding, EU can prevent a two-speed Europe, bridge the digital gap, and mitigate brain drain from the region.



Brussels, 11.4.2024
C(2024) 2393 final

COMMISSION RECOMMENDATION
of 11.4.2024
on a Coordinated Implementation Roadmap for the transition to Post-Quantum
Cryptography

Thank you

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HellasQCI.eu



HellasQCI - Quantum Communication Infrastructure for Greece



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EuroQCI

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