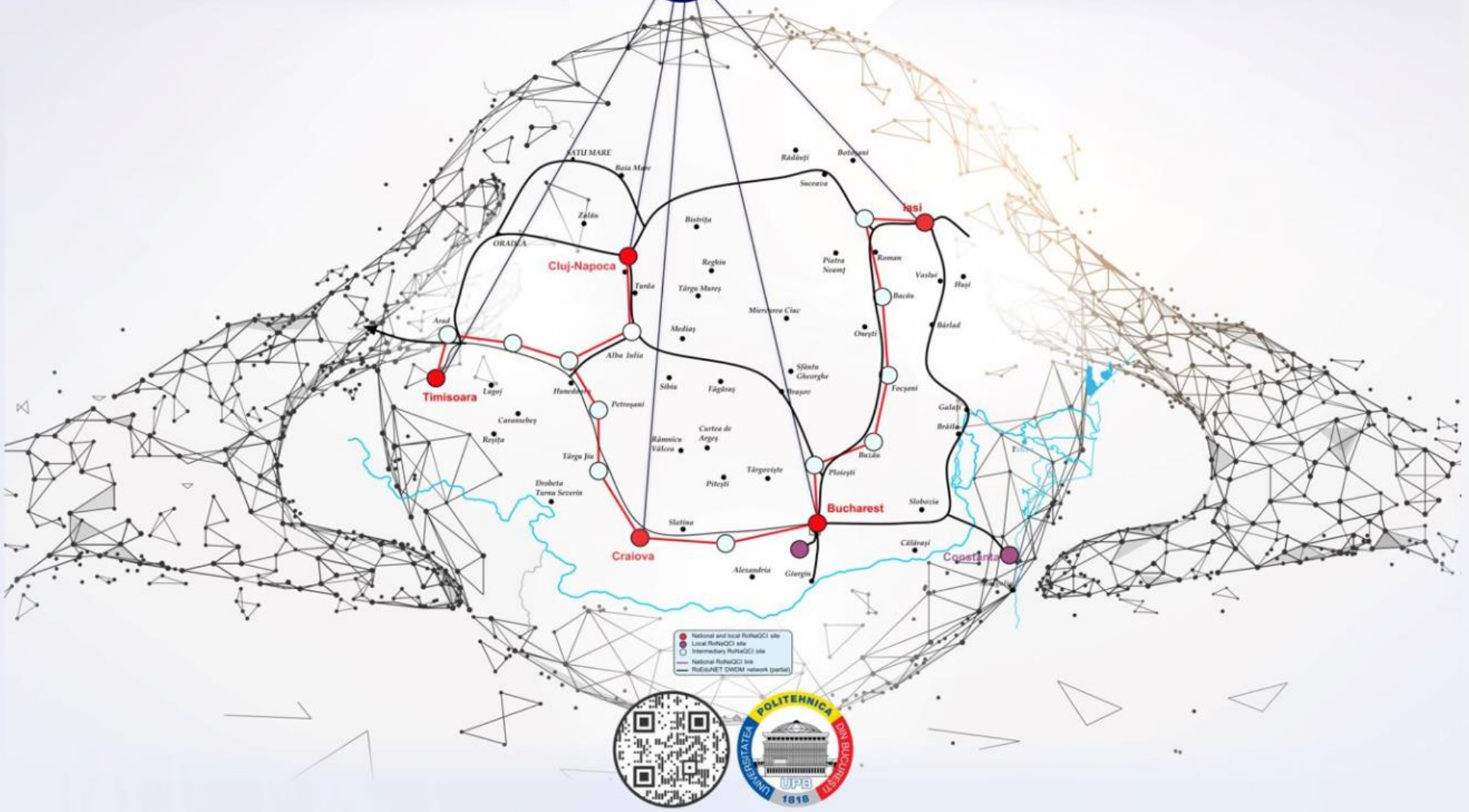
Romanian National
Quantum Communication Infrastructure

ronaqci



UNIVERSITATEA POLITEHNICA DIN BUCUREȘTI
UPB
1818

Current Status of RoNaQCI Project

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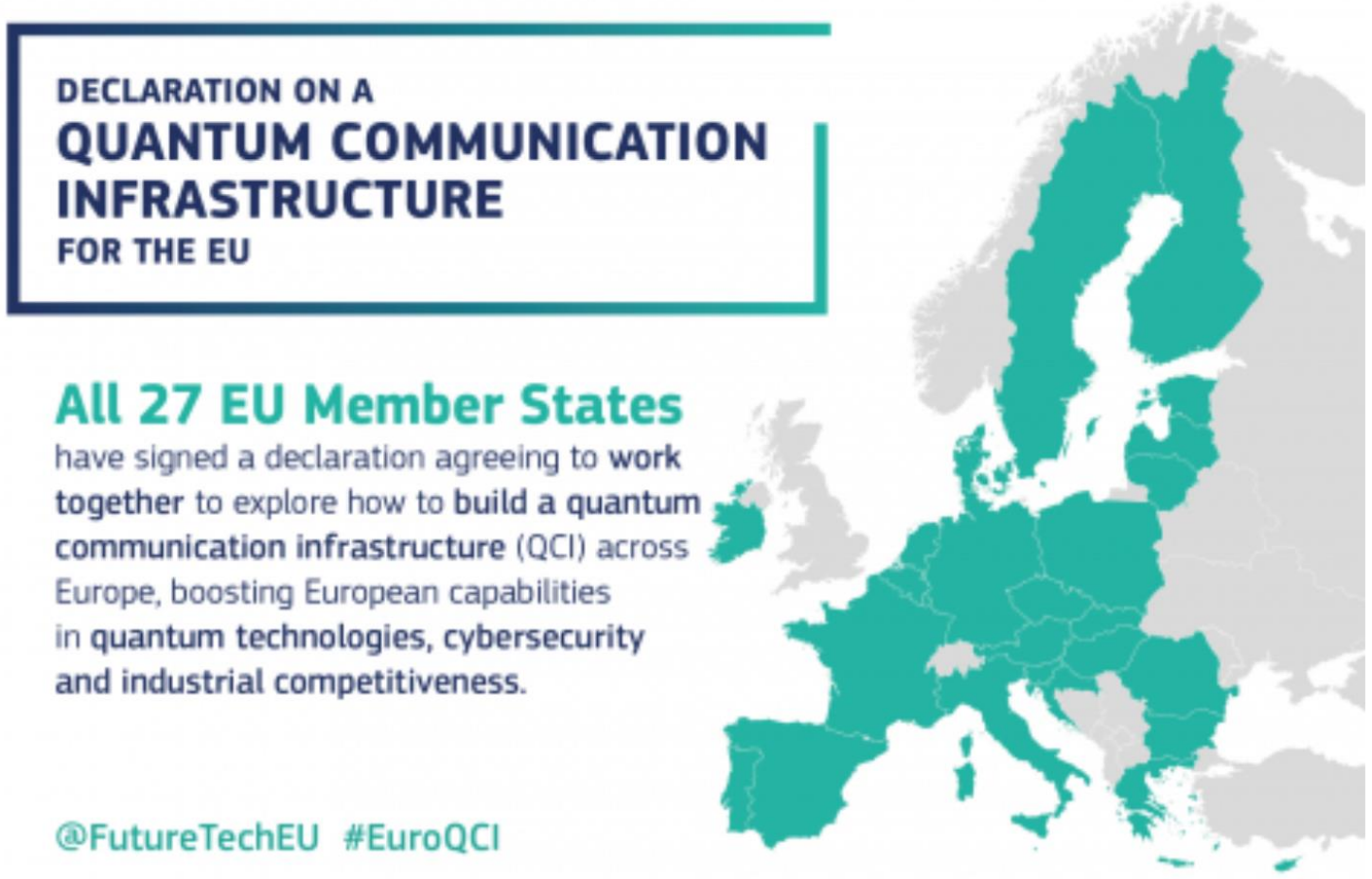
UPB / RoEduNet

NREN QKD Networks

25th of September 2024

EuroQCI: The European Quantum Communication Infrastructure (EuroQCI) Initiative



EuroQCI: Romanian National QCI

- 30 partners, lead by University POLITEHNICA of Bucharest (UPB), joined forces and proposed RoNaQCI in 2022: UPB, RoEduNet, TUIasi, UAIC, UPT, UVT, UBB, UTC-N, UB, UCv, UGAL, ULB, UMC, IFIN-HH, INFLPR, ITIM Cluj, INCDFM, TRC, ICS, TSP, ROSA, ITA, METRA, ISS, IMT Bucharest, RNA, ClusterPower, IMAGO-MOL, CJDJ, PCv;

- RoNaQCI benefits from RoEduNET huge networks expertise

RoNaQCI – in numbers

- Deployment of a 1500km+ QCI network including 6 metropolitan networks in the cities of Bucharest, Iasi, Cluj-Napoca, Timisoara, Craiova and Constanta

- 36 QKD links spanning Romania and connecting 10 universities, 5 research institutes, 5 public bodies, 3 data centers and a medical clinic, and with future links planned for quantum Internet interconnecting with neighbors

RoNaQCI – in numbers

- Budget: 10 mil E
  - EC: 5 mil E
  - Romanian State: 5 mil E

- 30 parteners
  - 24 full
  - 6 associates

RoNaQCI – objectives

- O1. Deploy advanced national quantum systems and networks (RoNaQCI)
- O2. Test, monitor and integrate RoNaQCI with classical communication infrastructure
- O3. Develop advanced use cases tailored around strategic interests in exploiting RoNaQCI, linking Public Authorities, Governmental entities, Universities, Research Institutes and Private Companies
- O4. Upskill to create a large number of trained users based on specific profile and particular interests
- O5. Participate in EU-wide design and development efforts anticipating the Quantum Internet

RoEduNet in RoNaQCI

- RoEduNet is taking care of the WP2 and WP3 - National and Metropolitan networks

- Building the specs and the tenders together with UPB

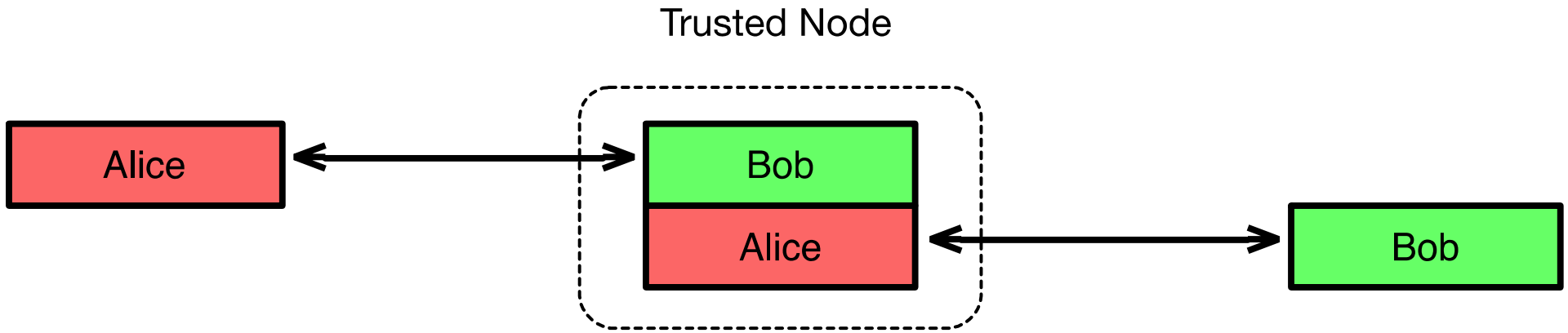
RoNaQCI – National QKD network

RoNaQCI – National QKD network

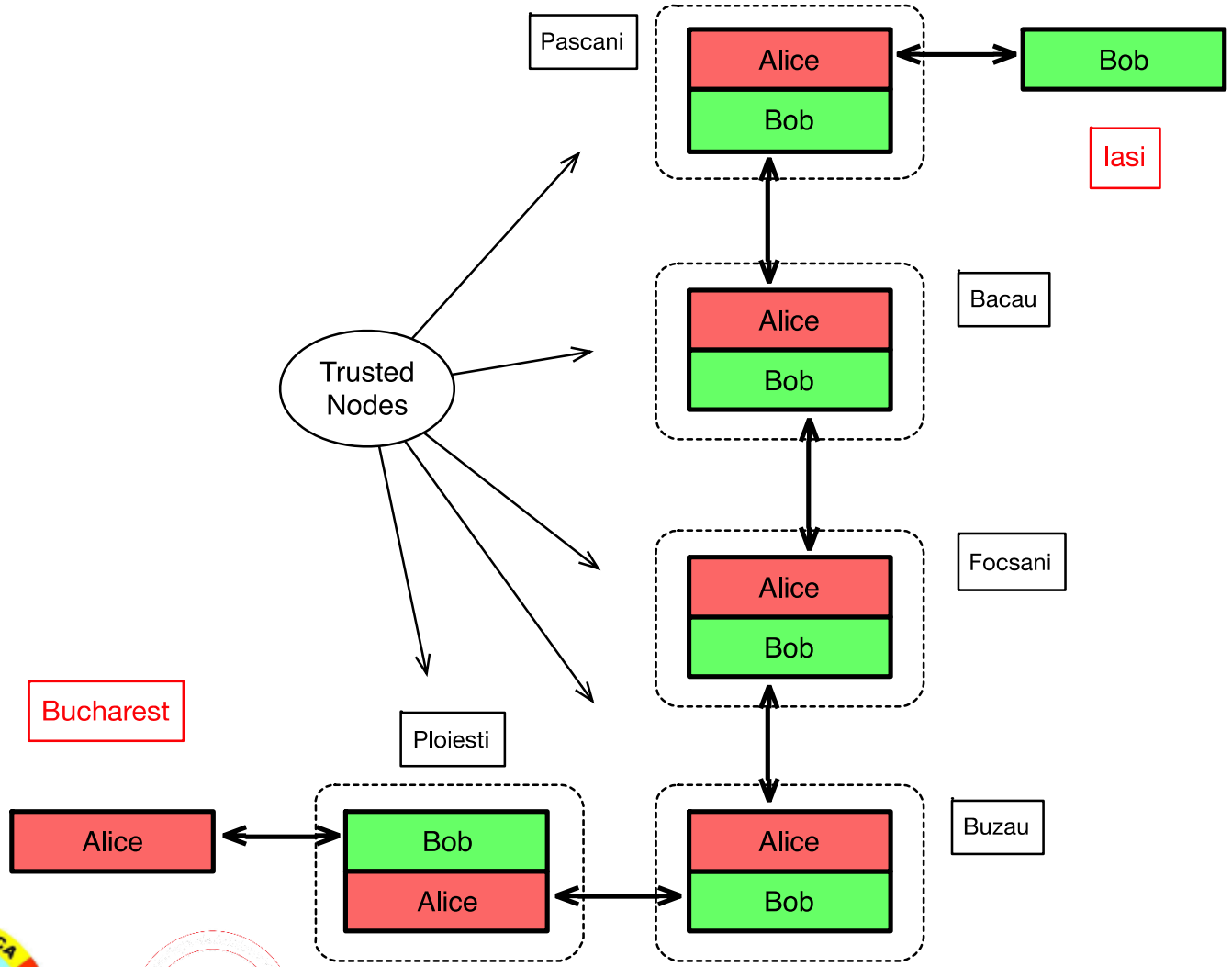
- QKD - exchange encryption keys securely over different physical environments (e.g., fibre optics, free-space)
- RoNaQCI is concentrated on fibre optics transmission
- QKD communication - two endpoints:
  - Alice, as transmitter
  - Bob, as receiver (detector)

RoNaQCI – National QKD network

- How can amplify the signal in a QKD network?
  - ***You cannot***

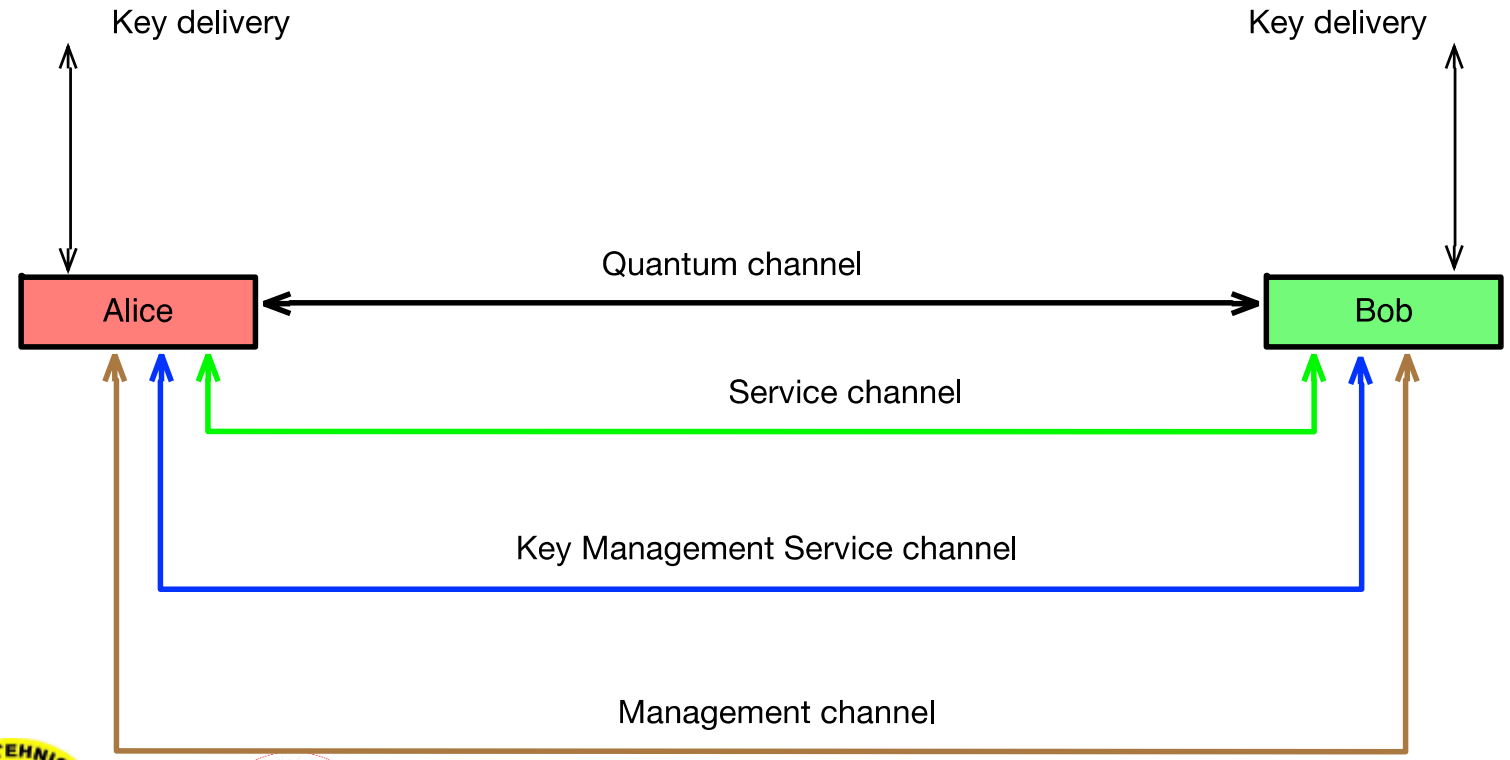


RoNaQCI – National QKD network



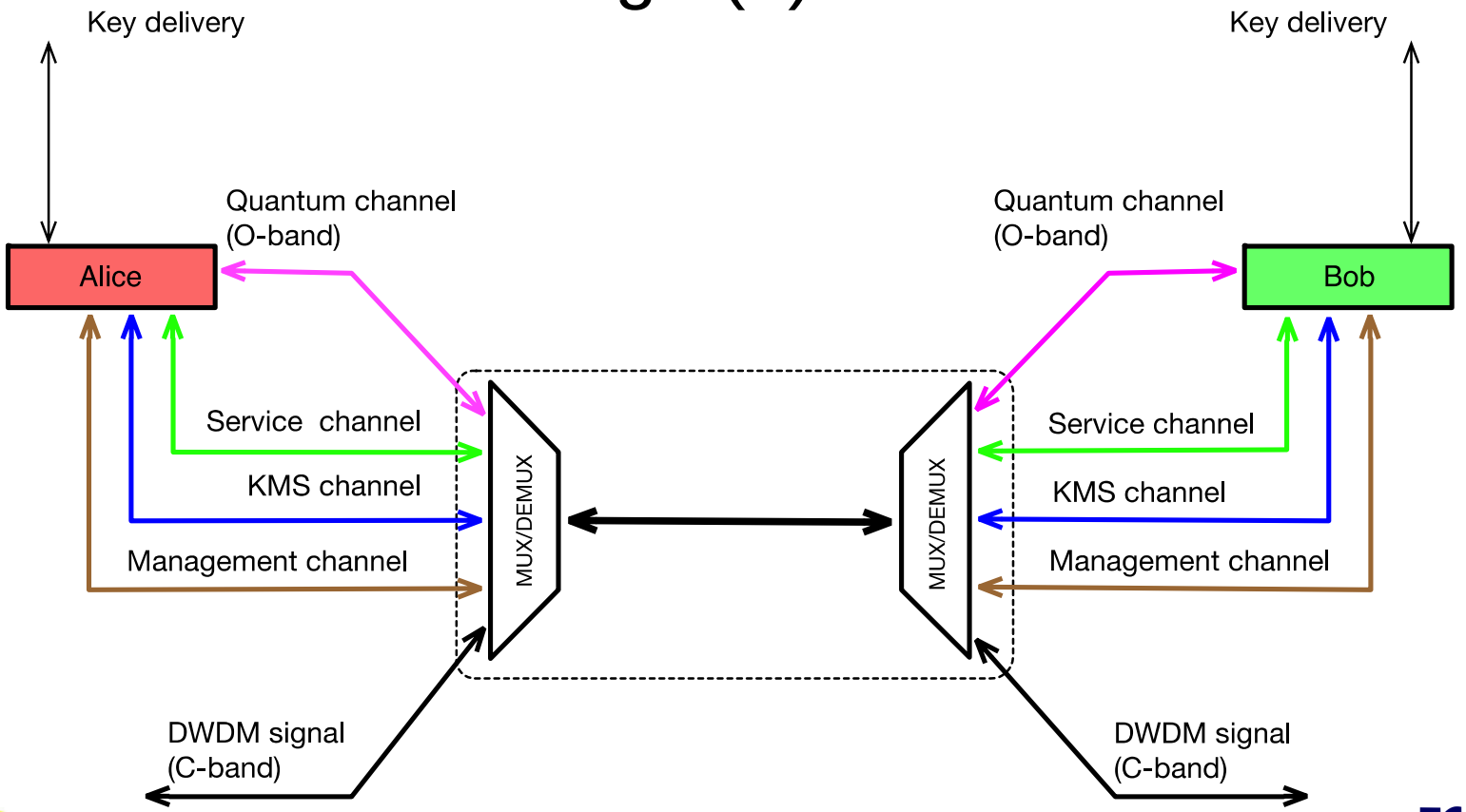
RoNaQCI – National QKD network

- The two sides are using multiple channels to accomplish the secure generation, transmission and management of keys



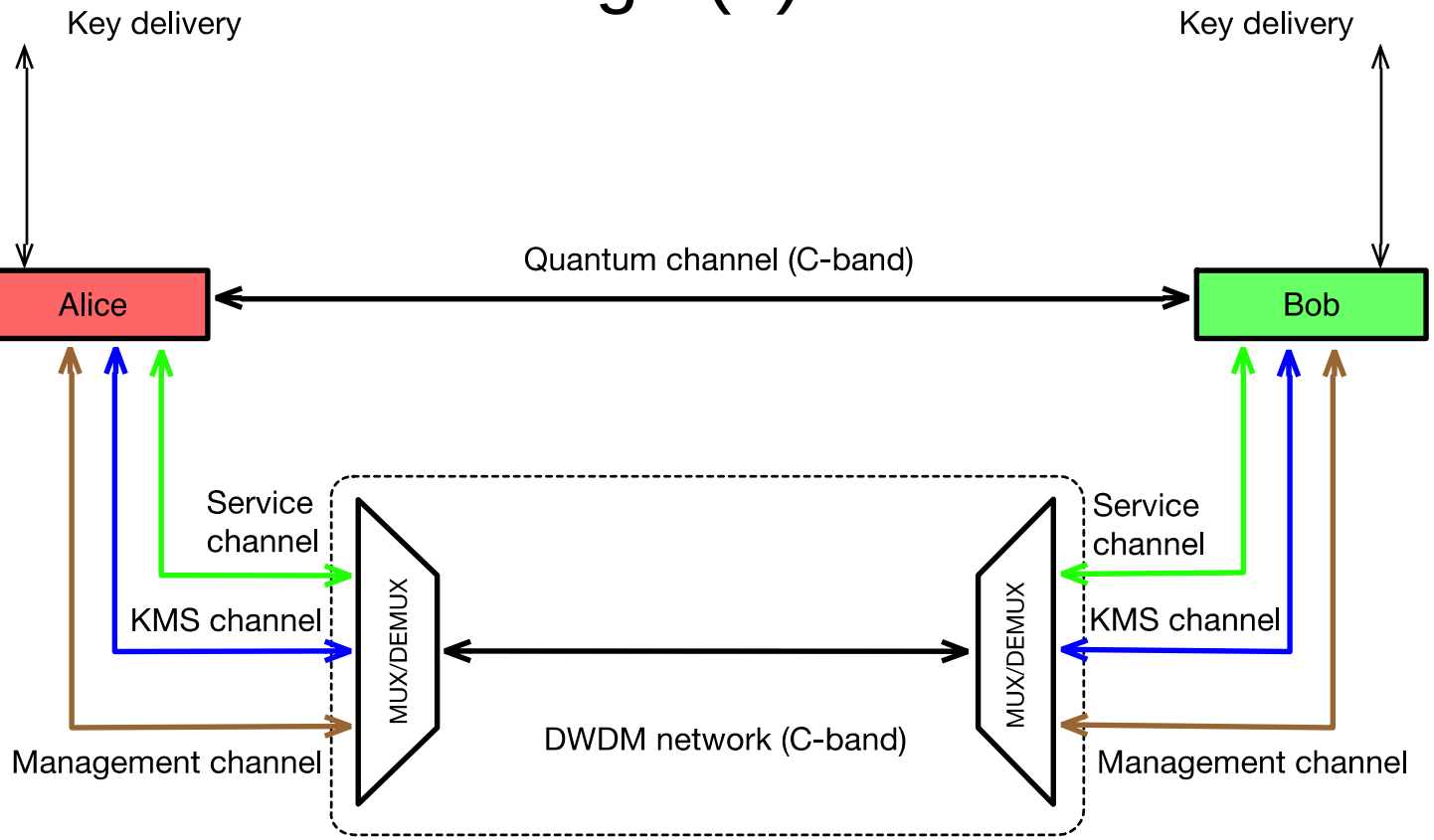
RoNaQCI – National QKD network

- Optimizations of fiber usage (a):



RoNaQCI – National QKD network

- Optimizations of fiber usage (b):

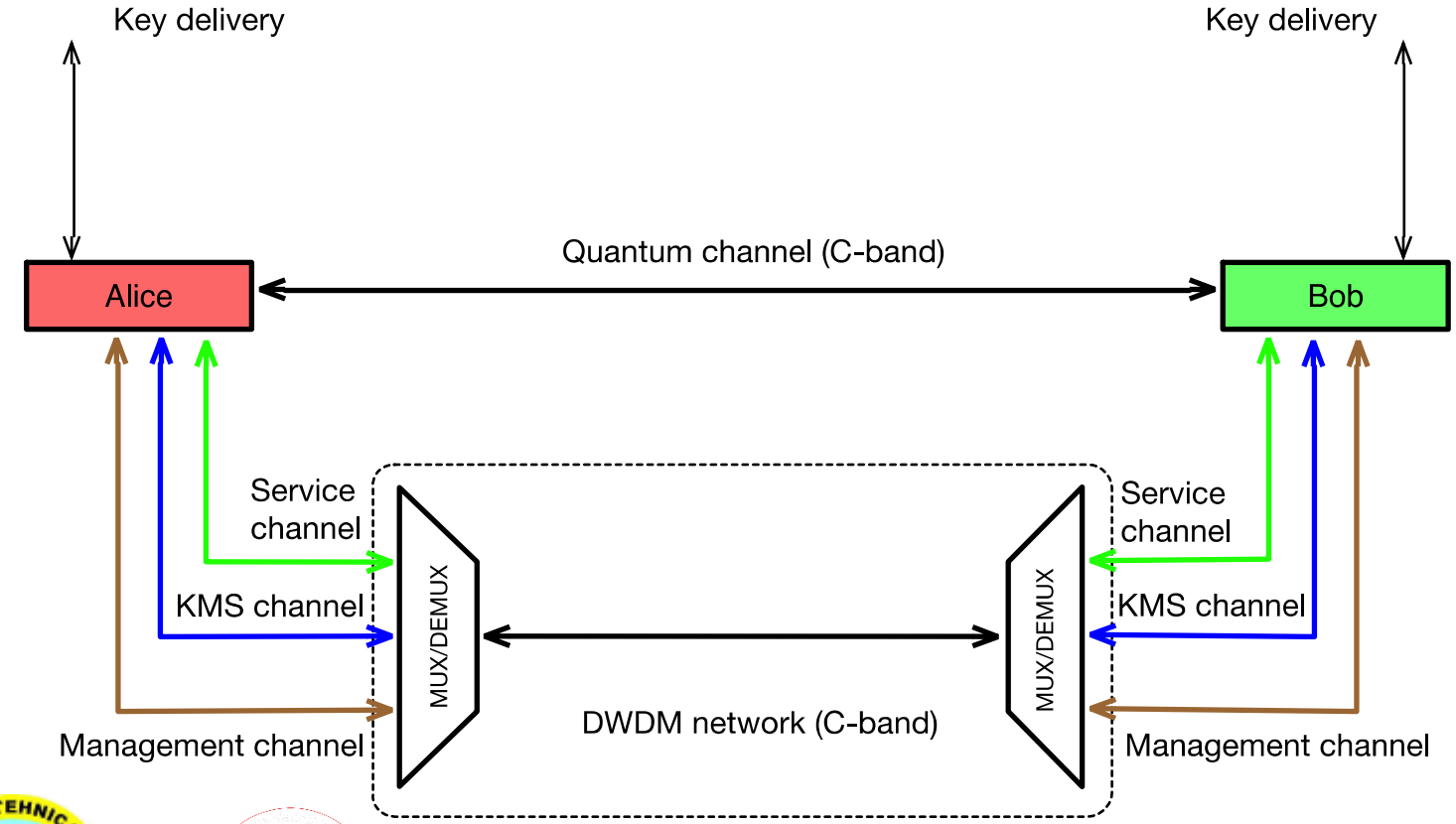


O-band (1310nm) vs C-band (1550nm)

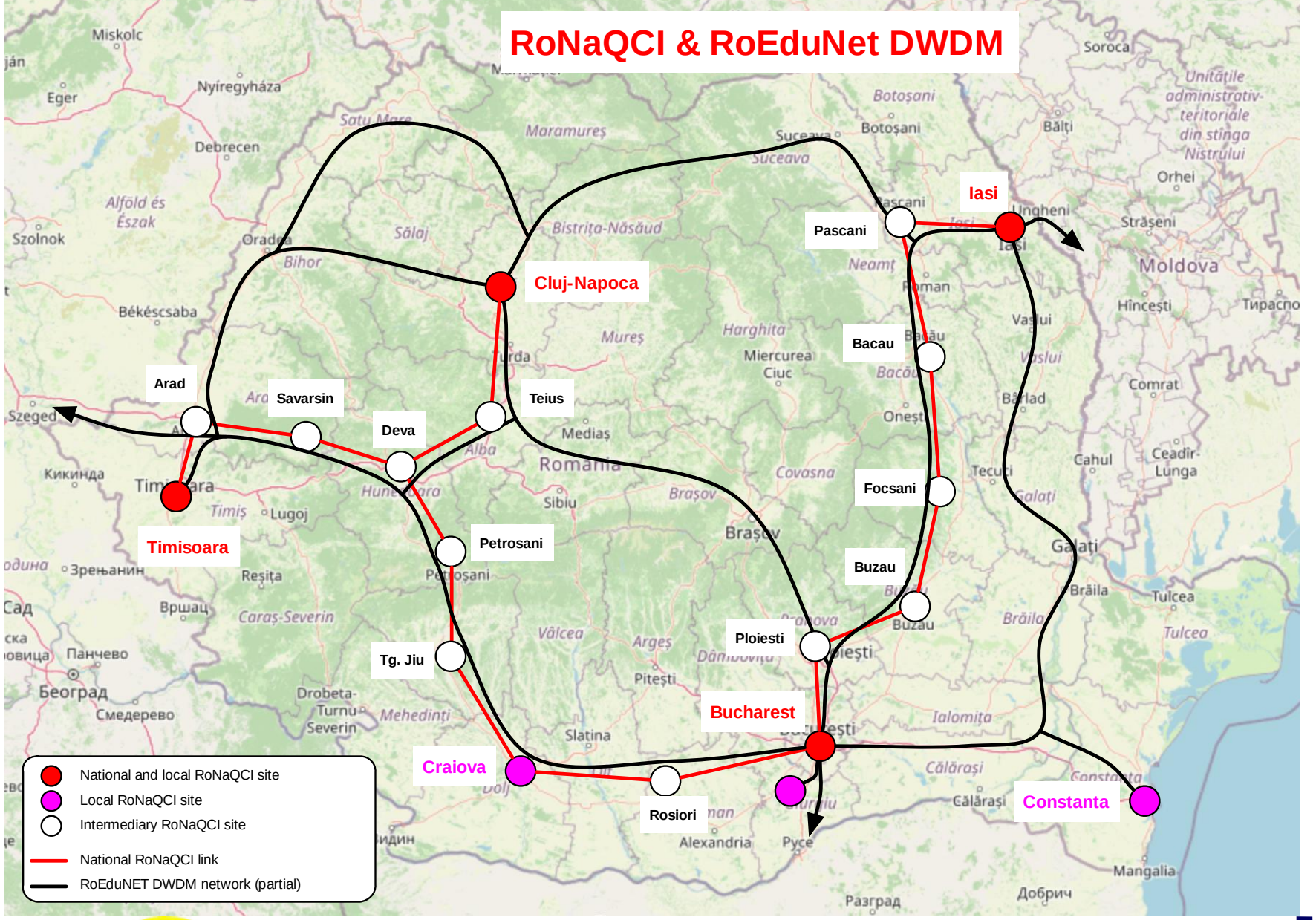
- In C-band there is a loss 0.25 db/km and in O-band is almost double
- Transceivers nowadays can work with a loss of 30db without amplifiers (in any technology)
- 30 / 0.25 -> 120km without amplifiers (in C-band!) and ~60km in O-band (because the loss is double)

O-band (1310nm) vs C-band (1550nm)

- We need to use a different fiber for the quantum channel



RoNaQCI & RoEduNet DWDM

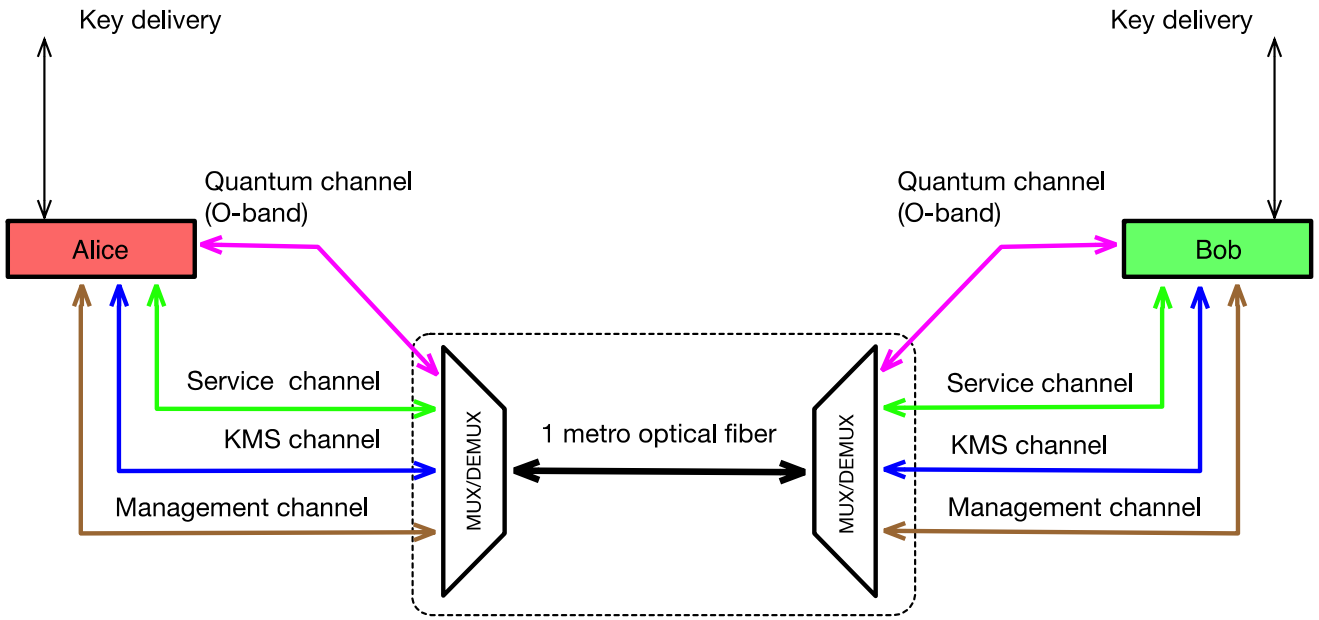


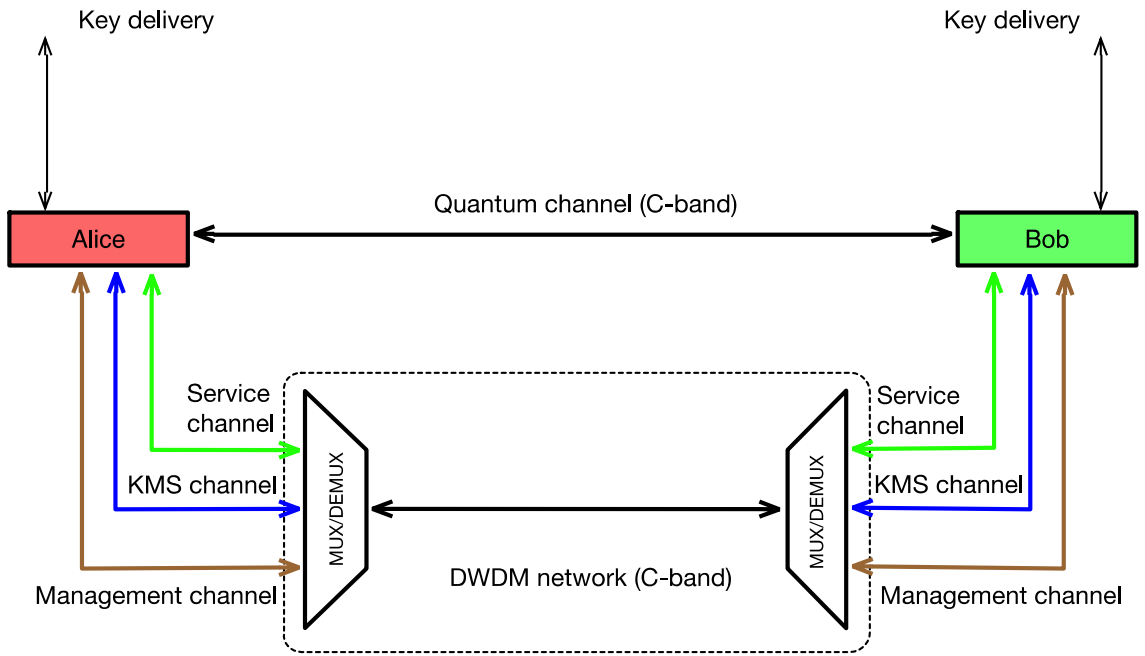
RoNaQCI – National QKD network

- Bucharest - Iasi: 5 amplifier points and 497 km total length, resulting in 6 QKD pairs.
- Bucharest - Deva – Timisoara: 7 amplifier points and 698 km total length, resulting in 8 QKD pairs.
- Deva – Cluj-Napoca: 1 amplifier point and 194 km total length resulting in 2 QKD pairs.
- 16 QKD pairs (links) and a fibre length of 1389 km.

RoNaQCI – Metropolitan QKD network

QKD channels

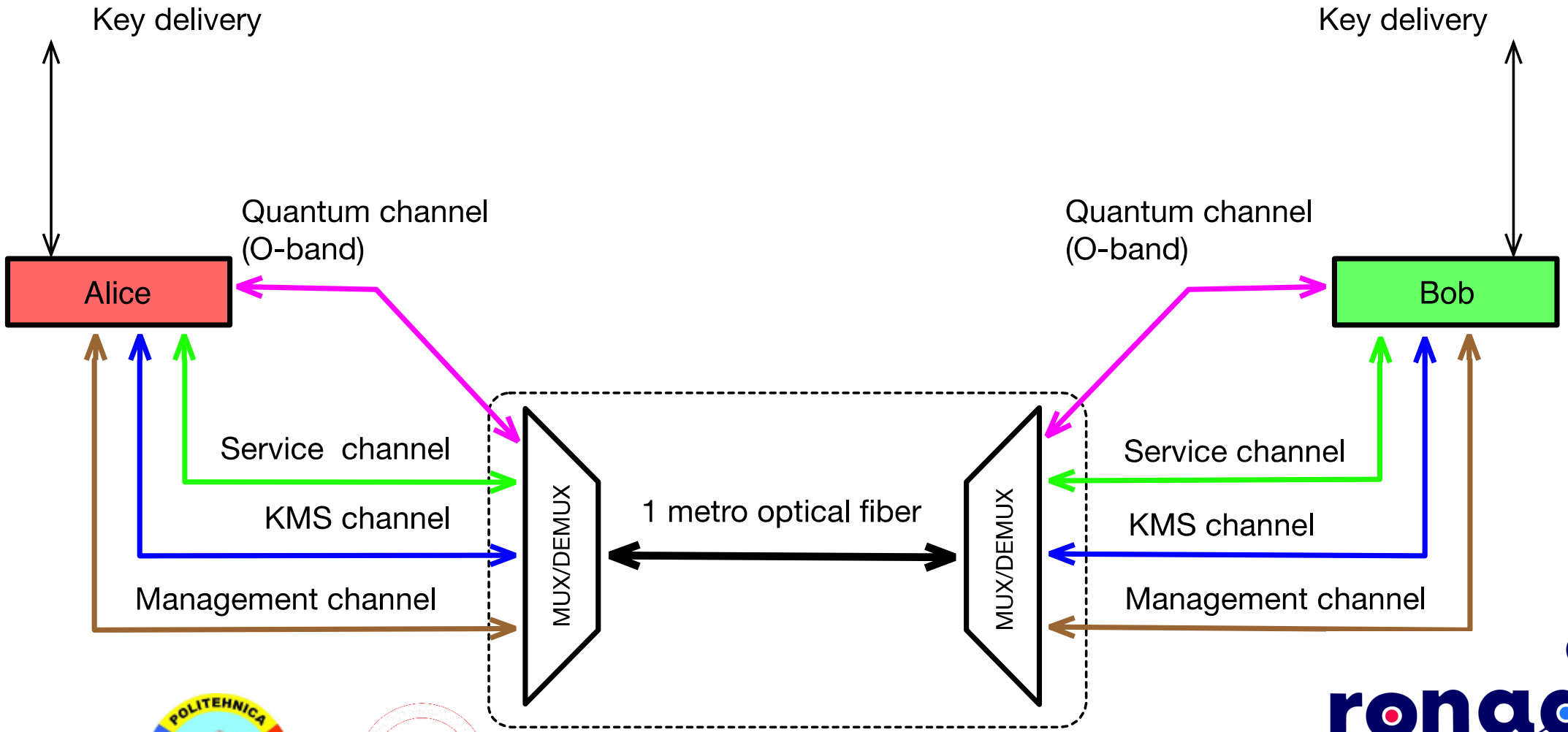




Metropolitan Networks Particularities

- Short distances (usual <10km, 1-2 exception ~20km)
- Dark fiber availabilities – more providers but all the ducts are almost occupied
- No DWDM available on the metropolitan networks in the cities

Metropolitan Network Channel Transport



DWDM MUX/DEMUX 4 channels and 1310nm port

RoNaQCI – Quantum Training and Education HUB

RoNaQCI WP6. D6.1 Training materials – The Book

Contents

RoNaQCI WP6. D6.2 Examination certification

3. Bases, operators and measurements
4. Gates

3. **Multiple Qubits and Universality**
   1. Systems with multiple qubits
   2. Universal gates
4. **Entanglement and Quantum Teleportation**
   1. Entanglement
   2. Partial measurement in quantum mechanics
   3. Generation of the Bell states
   4. The Einstein - Podolsky - Rosen paradox
   5. The Bell inequality
   6. Quantum teleportation
5. **Quantum Cryptography**
   1. The Quantum Gift: both threat and blessing
   2. QKD
   3. The BB84 protocol
   4. The E91 protocol
   5. The B92 protocol
   6. Real-world application and technologies
   7. Post-Quantum Cryptography

Certification exam

✔ **Done:** View

To do: Receive a grade

To do: Receive a passing grade

Certificate

Mark as done

Not available unless: The activity **Certification exam** is complete and passed

https://cnq.ronaqci.upb.ro/certificari/

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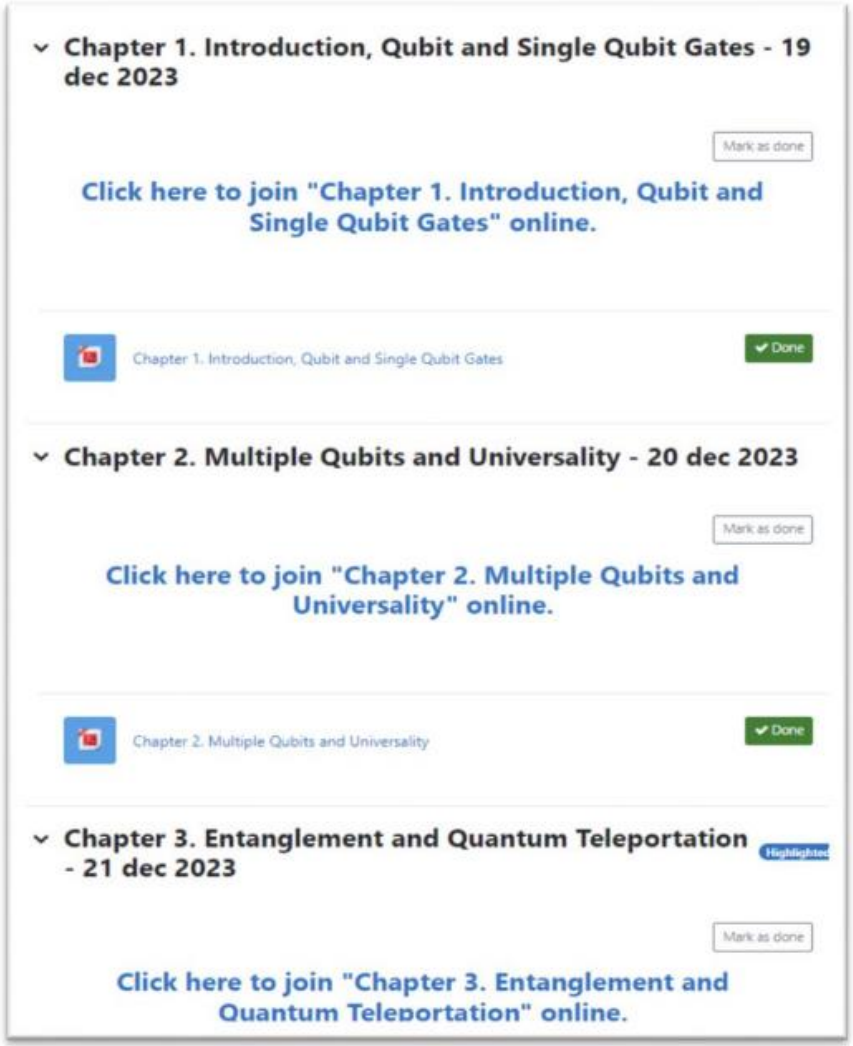
RoNaQCI WP6. T6.4-T6.6 Training for Academia, Public Authorities and Industry M11-M30



https://cnq.ronaqci.upb.ro/training/

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QKD Quantum Hubs

- **Establishment of 17 Quantum Hubs**
- Covering all regions of Romania and the cooperation of all involved partners
- Trainings are in progress (Bucharest / Constanta done, Craiova / Cluj to come)

RoNaQCI – Advanced Use-Cases

QKD Basic Use-Cases – WIP!

- File Transfer using OTP (One Time Pad)
- VPN using PQC