PSNC

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Piotr Rydlichowski

PSNC activities in the area of Quantum Communication

INTRODUCTION

PRESENTATION OUTLINE

- Poznań Supercomputing and Networking Center
- Quantum Communication activities:
  - Projects, Programs, Initiatives
  - Publications
  - Presentations/Demos
- Summary

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PSNC ACTIVITIES

Center of e-Infrastructure

- National Research and Education Network PIONIER
- Research Metropolitan Area Network - POZMAN
- HPC Center
- Data repositories and Digital Libraries Federation

Center of Research & Development

- New Generation Networks
- HPC, Grids & Clouds
- Grand challenge applications
- New media and visualization technologies
- Knowledge Platforms
- Future Internet - Technology, Applications and Services for IS
- Cyber Security

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PSNC LOCATIONS

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PIONIER NETWORK - POLAND

- Area 312k sq km
- Population 38M
- Main academic centers 21
- State universities 165+
- Students & esearchers 1.5M+
- R&D institutions and Univ. interconnected via PIONIER network 700+

6663 km of fiber infrastructure in Poland

2359 km of fiber in Europe (IRU)

9022 km of fiber in total

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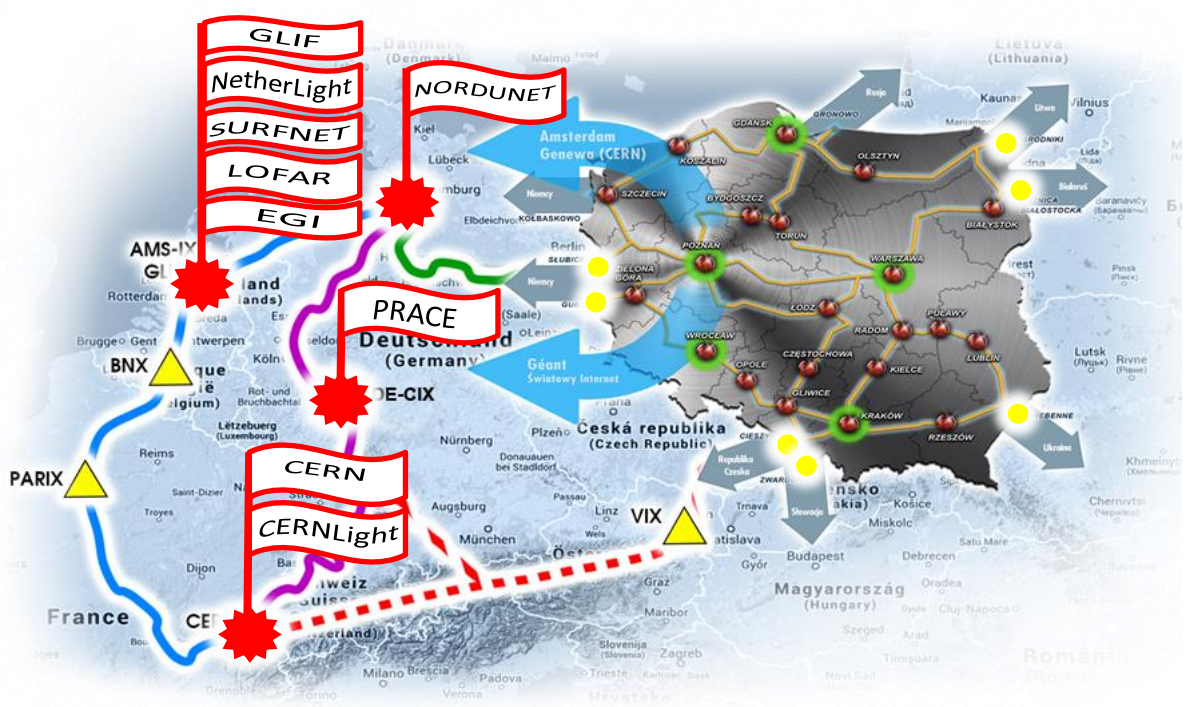
PIONIER NETWORK - EUROPE



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QUANTUM COMMUNICATION ACTIVITIES

- PSNC is active in the areas of quantum computing and quantum communication
- PSNC Qauntum computing projects are focused on algorithms, uses cases and hardware evaluation
- These works and projects are in most cases carried out together under one umbrella project and initiative
- It provides potential foundations for future hybrid networks and quantum communication infrastructure that will potentially connect quantum computing infrastructure

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QUANTUM COMMUNICATION ACTIVITIES

PROJECTS

- PSNC takes part in the following projects and activities connected with Quantum Communication an QKD Technologies:
  - **OPENQKD (Horizon2020)**
  - **NLPQT (NCBiR)**
  - **QUAPITAL**
  - **GÉANT**
  - **Quantum Internet Research Group QIRG (IETF)**

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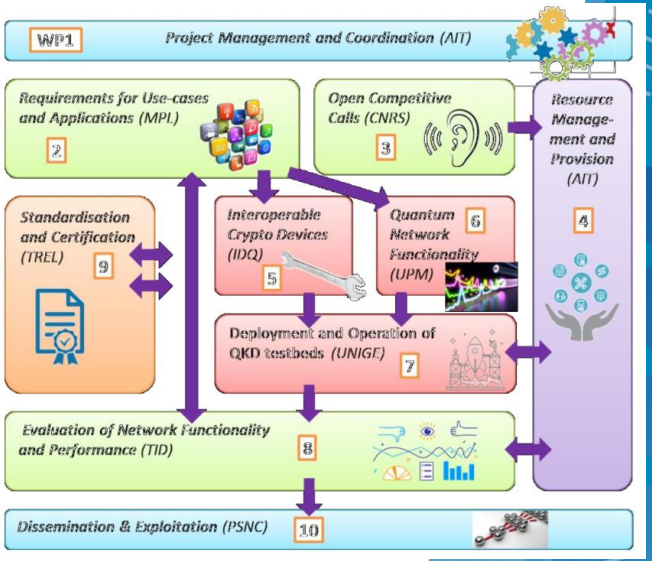
QUANTUM COMMUNICATION ACTIVITIES

OPENQKD

- Construction of QKD testbeds in Europe and implementation of 40 different scenarios for services using QKD technology
- Project start - October 2019
- Poznań is one of the main testbeds. Implementation and integration of QKD technology in the existing infrastructure and services of the POZMAN and PIONIER networks.
- Testing experimental QKD solutions in Poznań
- PSNC participates in works related to standardization activities and IPR
- PSNC will develop data management and analysis software
- Testbeds currently running in Geneva, Madrid, Berlin (June 2021). The epidemiological situation has suspended work for the remaining testbeds.



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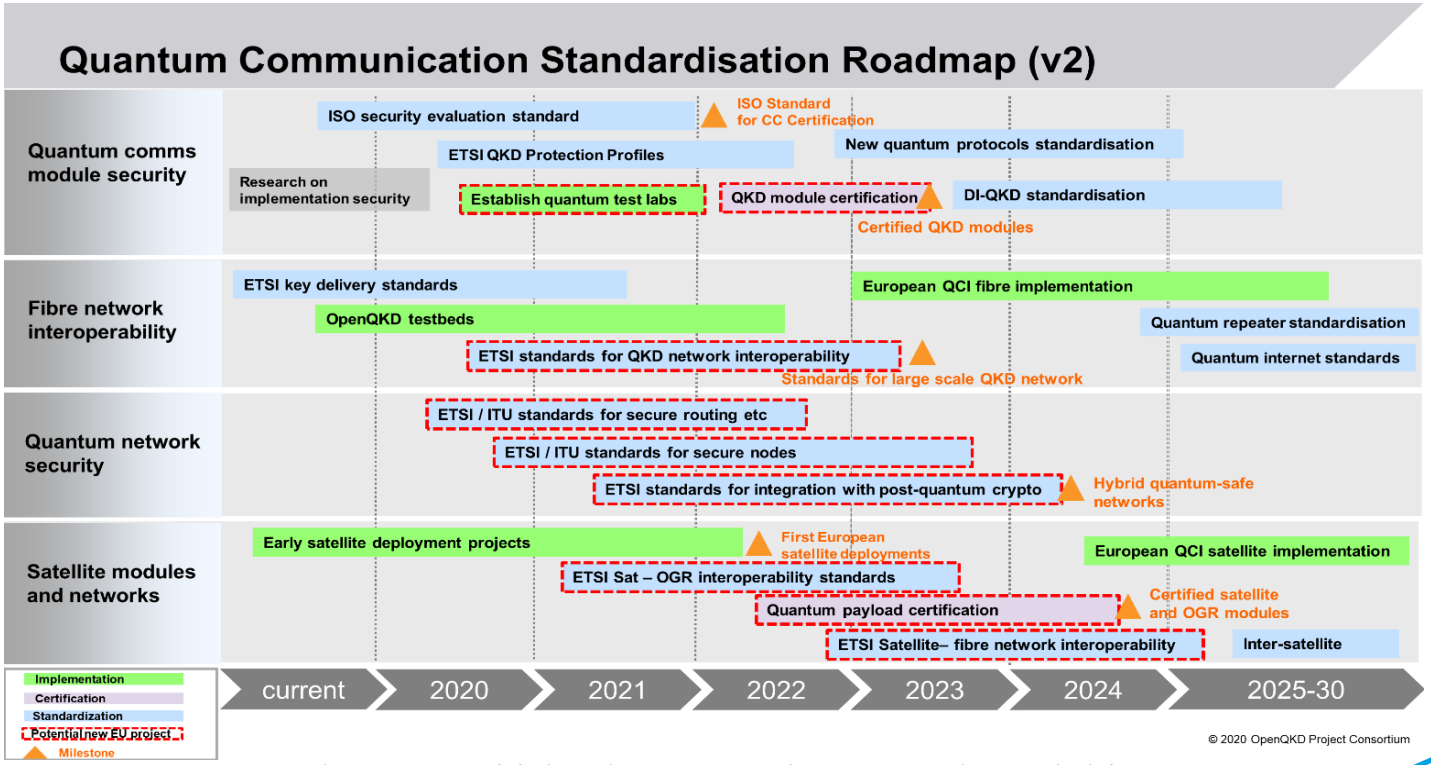
QUANTUM COMMUNICATION ACTIVITIES

STANDARDIZATION AND CERTIFICATION



https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/horizon-results-platform/29227

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QUANTUM COMMUNICATION ACTIVITIES

NARODOWE LABORATORIUM FOTONIKI I TECHNOLOGII KWANTOWYCH

NATIONAL ŁABORATORY FOR PHOTONICS AND QUANTUM TECHNOLOGIES

- Construction of metro QKD research and operational infrastructure, integration of QKD solutions
  - QKD infrastructure (operational and R&D QKD devices, encoders and quantum random number generators)

- Construction of the QKD Poznań - Warsaw link
  - experiments related to quantum communication between University of Warsaw nodes and PSNC in Warsaw.
  - Experiments related to sources and detectors of single photons
  - Integration of the infrastructure with the optical carrier infrastructure
  - Next generation QKD prototypes testing (based on enatnglement)

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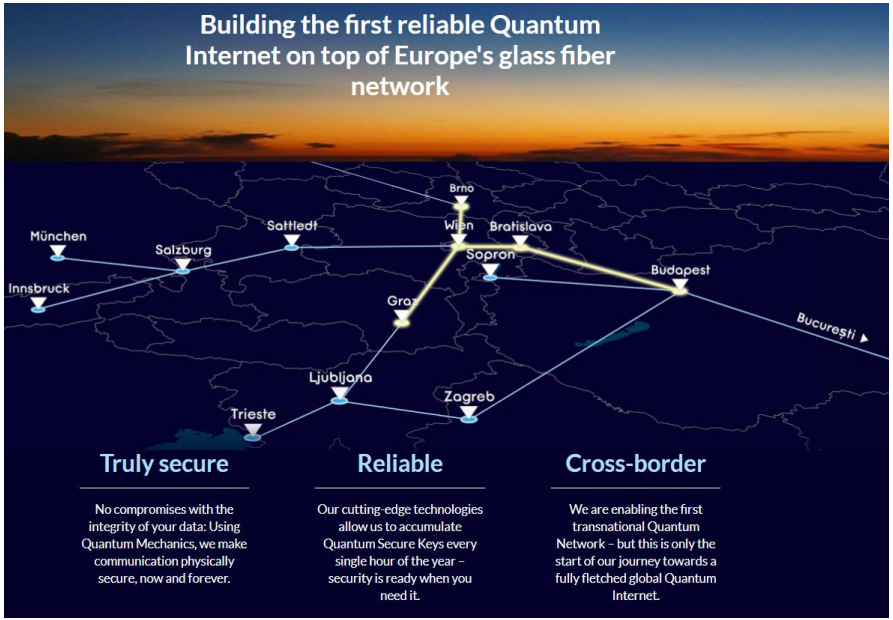
QUANTUM COMMUNICATION ACTIVITIES

QUAPITAL

- Project related to QKD technology and quantum communication in general.
- Talks on cross-border connections



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QUANTUM COMMUNICATION ACTIVITIES

GÉANT

- PSNC is active in the WP6 T1 - QKD task
- Prepared plan, activity proposal for GÉANT and NREN
- Presentations on QKD technology for NRENs
- A survey was conducted among the NRENs on QKD technology to develop a strategy. Common activities, projects, plans and problems were identified
- TNC18/21conference presentaions
- Talks with suppliers of QKD devices: on wider cooperation with NRENs and GÉANT networks
- QCI strategy
- Qauntum networks simulators testbed
- White paper, infoshares for NREN community

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QUANTUM COMMUNICATION ACTIVITIES

QIRG

- Document "Applications and Use Cases for the Quantum Internet" (draft-wang-qirg-quantum-internet-use-cases-06) during the last revision (end of May 2020).
- The document "Architectural Principles for a Quantum Internet" (draft-irtf-qirg-principles-03)
- The GÉANT WP6 T1 QKD Group submits its comments
- Abstract: "The Quantum Internet has the potential to improve Internet application functionality by incorporating quantum information technology into the infrastructure of the overall Internet. In this document, we provide an overview of some applications expected to be used on the Quantum Internet, and then categorize them using various classification schemes. Some general requirements for the Quantum Internet are also discussed. The intent of this document is to provide a common understanding and framework of applications and use cases for the Quantum Internet. "

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QUANTUM COMMUNICATION ACTIVITIES

EuroQCI and Digitial Europe

DECLARATION ON A
QUANTUM COMMUNICATION INFRASTRUCTURE
FOR THE EU

24 Member States
have signed a declaration agreeing to **work together** to explore how to **build a quantum communication infrastructure** (QCI) across Europe, boosting European capabilities in **quantum technologies, cybersecurity and industrial competitiveness.**

The countries taking part in the initiative are **Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden.**

@FutureTechEU #EuroQCI

European Commission

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Shaping Europe's digital future

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Home > The Digital Europe Programme

The Digital Europe Programme

The Digital Europe Programme (DIGITAL) is a new EU funding programme focused on bringing digital technology to businesses, citizens and public administrations.

How to make Europe greener and more digital are the twin challenges for our generation, and our success in meeting them will define our future.

The European Commission has begun to look at a greener Europe through the lens of the European Green Deal. At the same time, it is opening up discussions about the move to a more digital world: the digital transition.

Digital technology and infrastructure have a critical role in our private lives and business environments. We rely on them to communicate, work, advance science and answer current environmental problems. At the same time, the COVID-19 pandemic highlighted not only how much we rely on our technology to be available to us, but also how important it is for Europe not to be dependent on systems and solutions coming from other regions of the world. Paving the way for achieving this goal is DIGITAL programme.

The Digital Europe Programme will provide strategic funding to answer these challenges, supporting projects in five key capacity areas: in supercomputing, artificial intelligence, cybersecurity, advanced digital skills, and ensuring a wide use of digital technologies across the economy and society, including through Digital Innovation Hubs. With a planned overall budget of €7.5 billion (in current prices), it aims to accelerate the economic recovery and shape the digital transformation of Europe's

Funding & Tender Opportunities >

Horizon Europe >

Connecting Europe Facility >

Work as an expert: Call for

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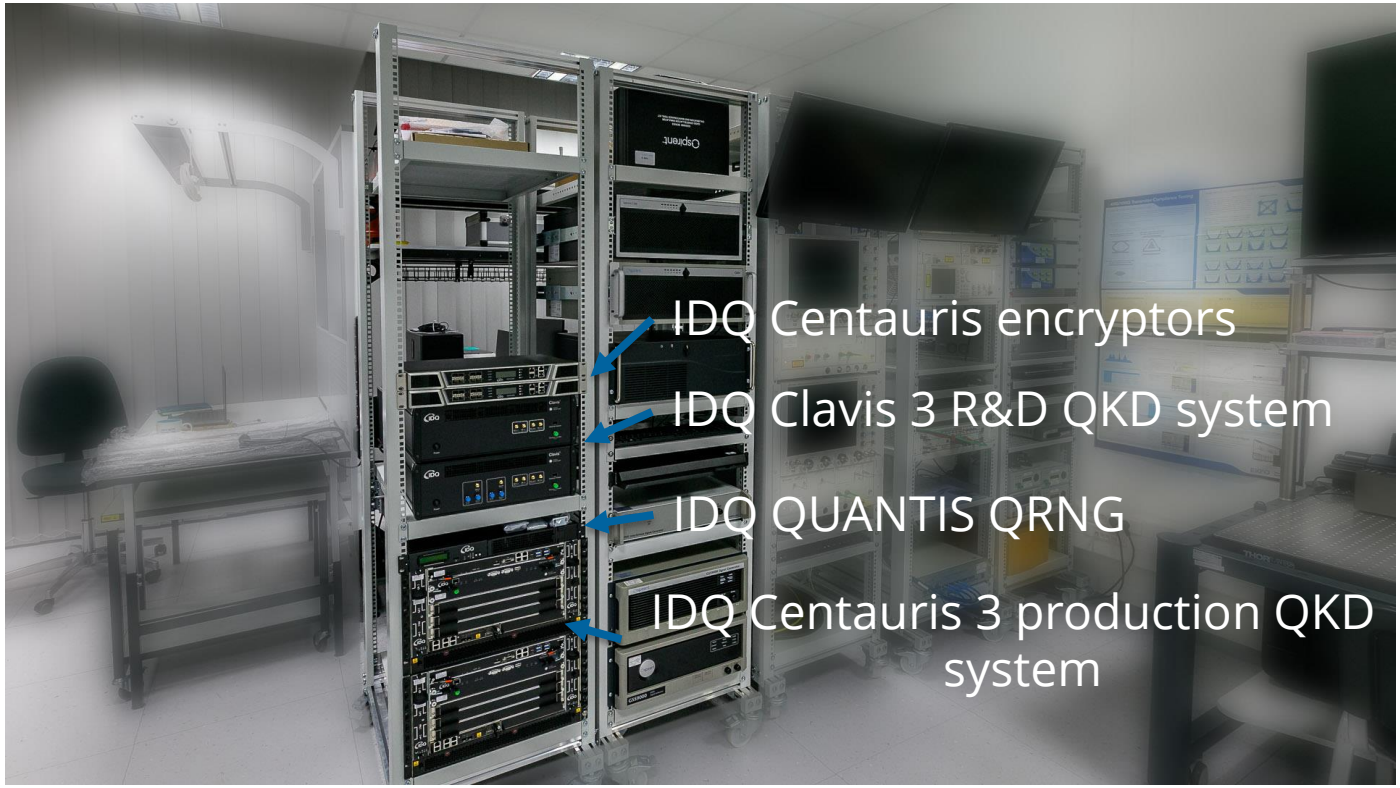
QUANTUM COMMUNICATION ACTIVITIES

PSNC QKD and QRNG equipment



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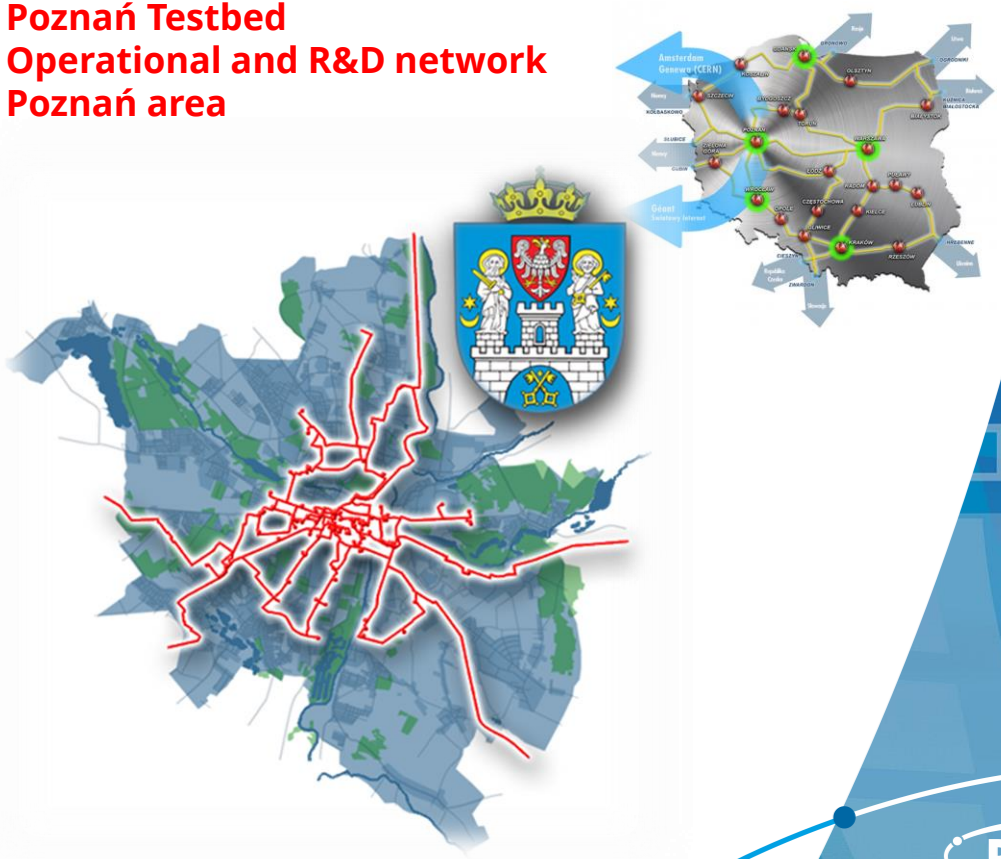
QUANTUM COMMUNICATION ACTIVITIES

PSNC OPENQKD testbed

- **Infrastructure in place as PSNC** is owner and operator of the infrastructure and network
- **Two QKD links installed and running** tests before the final deployment and use cases implementation
- **Various use cases are beeing prepared:** UC-06, UC-07, UC-08, UC-09, UC-10, UC-11 based on existing services and network. UC with VSB involves **QKD cross-border connection. Reference Time and frequency use case involves long distance connection.**
- **PSNC NOC** is working on implementing the monitoring and logging services for QKD infrastructure and services
- **SDN solutions currently analyzed**
- **Real world operational network** with shared infrastructure for quantum and classical communication and services. Connection point with other operators and several types and manufacturers of transmission equipment and encryptors
- **Direct connection with GEANT** node in Poland, network and services.

Poznań Testbed
Operational and R&D network
Poznań area



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QUANTUM COMMUNICATION ACTIVITIES

QUNATUM NETWORKS SIMULATORS

- QuISP, Keio/WIDE
- SimulaQron, TU Delft http://www.simulaqron.org/
- NetSquid, Dahlberg, TU Delft https://netsquid.org/
- SeQueNCe, Suchara, Argonne https://cpb-us-w2.wpmucdn.com/voices.uchicago.edu/dist/0/2327/files/2019/11/SeQUeNCe.pdf
- SQUANCH, Bartlett https://pypi.org/project/SQUANCH/
- https://arxiv.org/abs/1808.07047
- QuNetSim, DiAdamo https://arxiv.org/abs/2003.06397
- QKD simulator in ns-3, including routing, Mehic et al https://ieeexplore.ieee.org/document/8935373 https://www.qkdnetsim.info/ https://twitter.com/mickeyze2
- Physical-layer, online calculator for SPDC http://spdcalc.org/
- QuISP - Quantum Internet Simulation Package https://aqua.sfc.wide.ad.jp/quisp_website/

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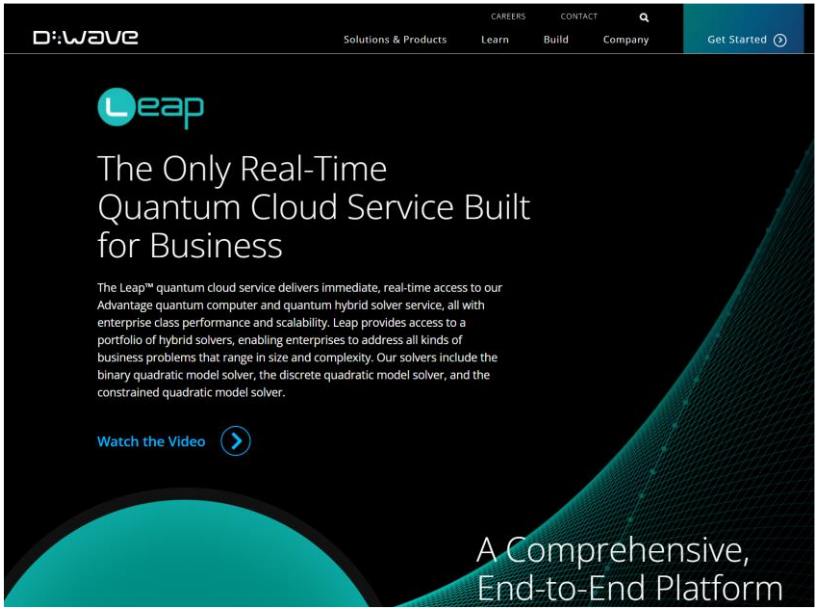
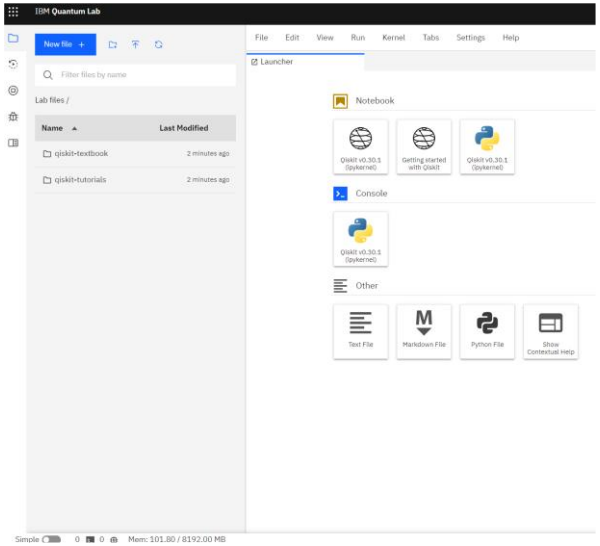
QUANTUM COMPUTING ACTIVITIES

QUNATUM COMPUTING SIMULATORS

PSNC works on different Quntum Computing simulators - such as IBM, DWAVE





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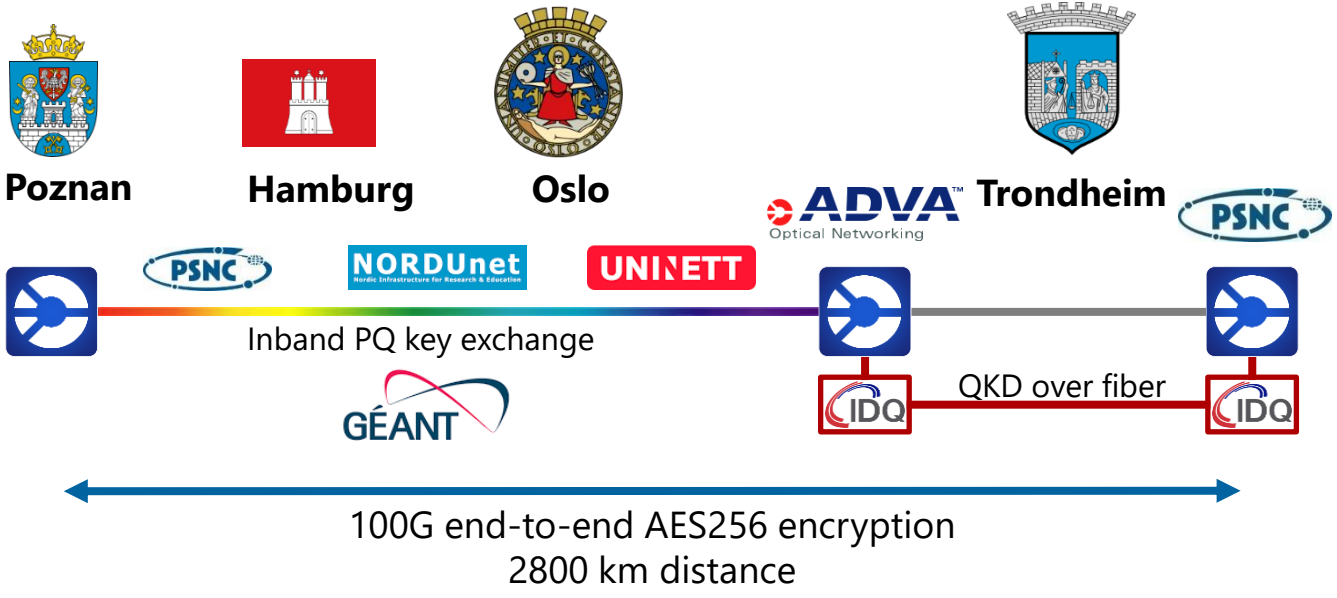
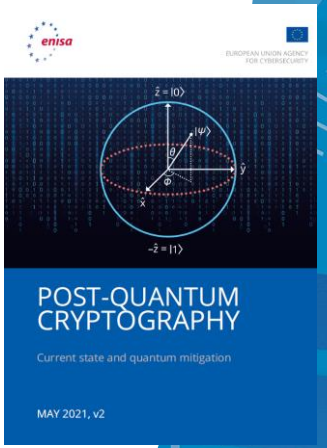
QUANTUM COMMUNICATION ACTIVITIES

Post Quantum and QKD algorithms demo - TNC18 conference





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QUANTUM COMMUNICATION ACTIVITIES

TNC21 conference demo

Demo:

Secure Key Management for Multi-vendor Interoperable Quantum Key Distribution Network

When: 22 June 2021 11.40-12.00
Where: Virtual

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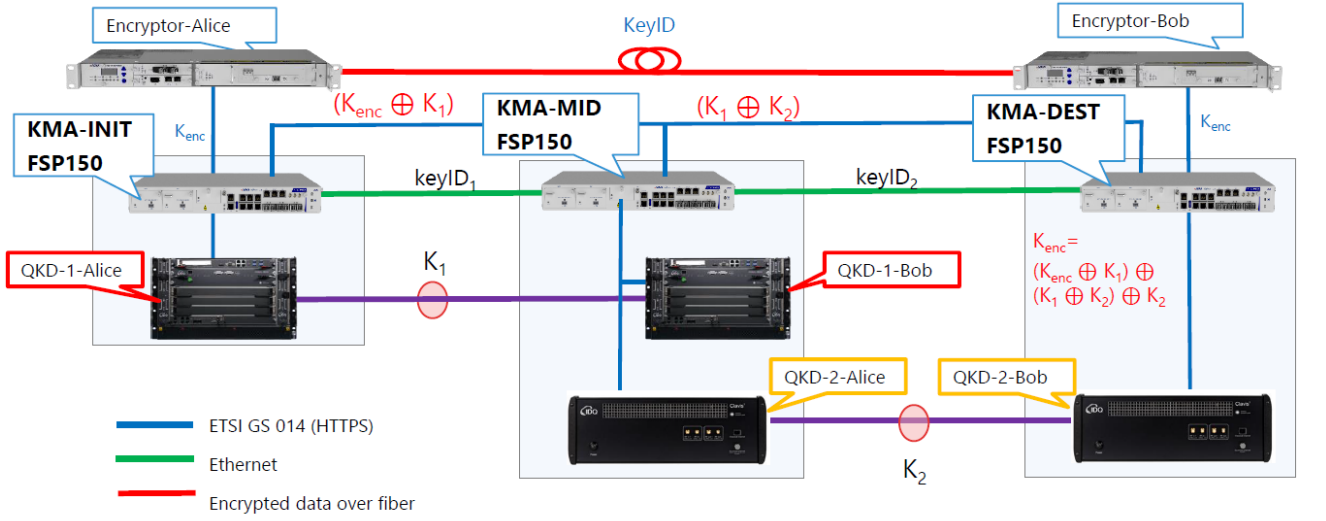
QUANTUM COMMUNICATION ACTIVITIES

TNC21 conference demo

Key Relay using ADVA FSP150



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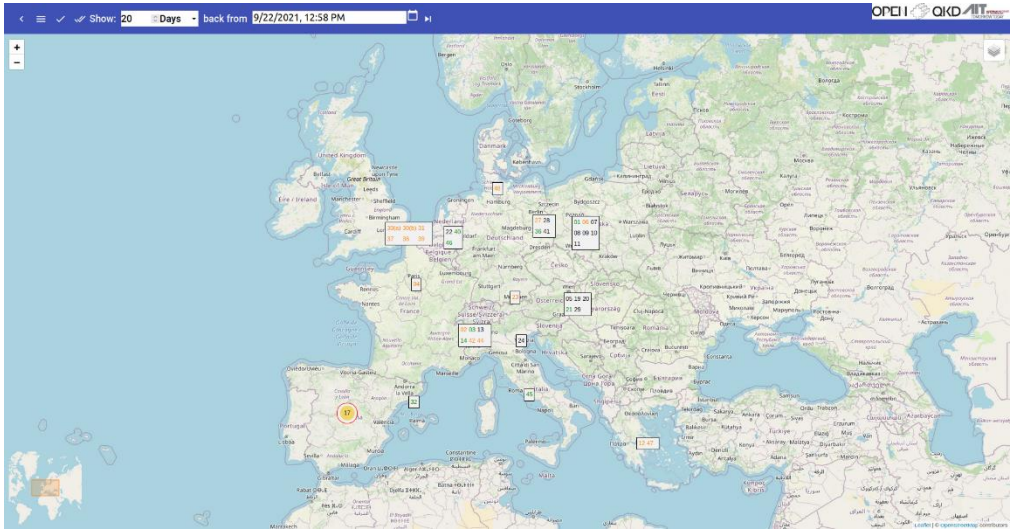
QUANTUM COMMUNICATION ACTIVITIES

PSNC QKD and QRNG equipment

IDQuantique and TOSHIBA QKD systems will be used at PSNC testbed in Poznań POZMAN network under OPENQKD project. Use cases are connected with PSNC various services delivered to partners in POZMAN network.



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QUANTUM COMMUNICATION ACTIVITIES

- QKD Crossborder connection between Cieszyn PL (PSNC) and Ostrava (VSB) under OPENQKD project. The link has ~75 km and 16 dB of attenuation.
- Scheduled to be used in HPC scenarios under OPENQKD project
- PSNC will have 2 different QKD system vendors under the OPENQKD project – TOSHIBA and IDQ.

```
 Actual key rate: 1963.98 bits/s
nBob] Next compression ratio: 0.245032
nBob] Current compression ratio: 0.23804
nBob] Regulating detection ratio: ratio = 2.64052, DATA delay = 2156 ps, MONITOR delay = 2508 ps.
nBob] Regulating detection ratio: ratio = 2.00198, DATA delay = 2145 ps, MONITOR delay = 2497 ps.
nBob] Regulating detection ratio: ratio = 2.68901, DATA delay = 2156 ps, MONITOR delay = 2508 ps.
nBob] Regulating detection ratio: ratio = 3.01444, DATA delay = 2167 ps, MONITOR delay = 2519 ps.
nBob] Regulating detection ratio: ratio = 2.38945, DATA delay = 2156 ps, MONITOR delay = 2508 ps.
nBob] Regulating detection ratio: ratio = 2.05021, DATA delay = 2145 ps, MONITOR delay = 2497 ps.
nBob] Regulating detection ratio: ratio = 2.58593, DATA delay = 2156 ps, MONITOR delay = 2508 ps.
nBob] Regulating detection ratio: ratio = 2.84478, DATA delay = 2167 ps, MONITOR delay = 2519 ps.
 Actual key rate: 1840.98 bits/s
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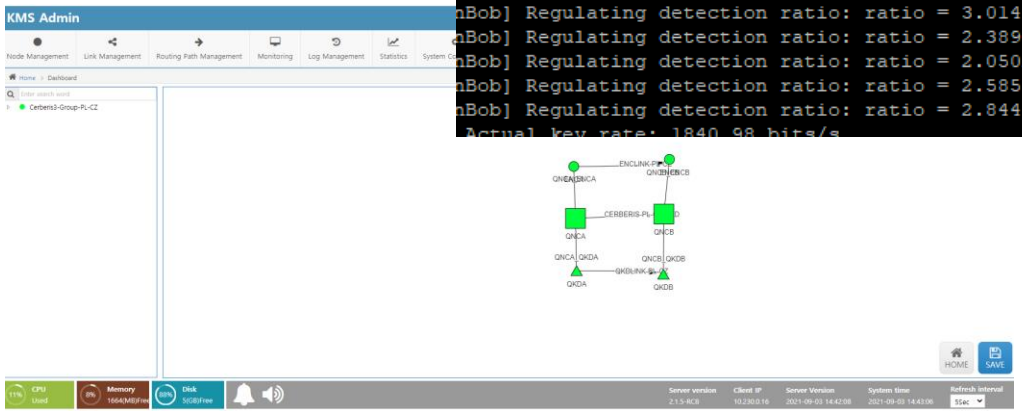

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SUMMARY

- PSNC projects are focused mainly on the implemantation an integration aspects
- Support for the whole NREN and GEANT community in Europe
- Possible suport for QCI initiative
- Cooperation with vendors and R&D partners

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