



Poznan Supercomputing and Networking Center

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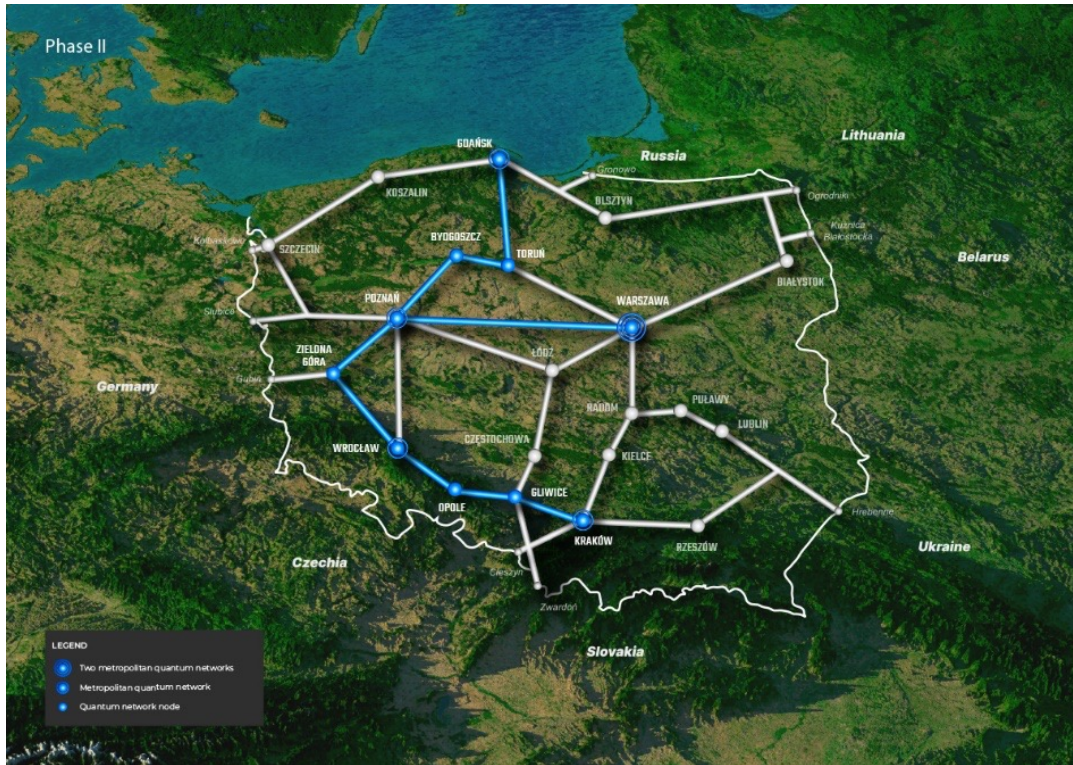


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Piotr Rydlichowski

**QCI network operation and monitoring
tools. Integration and correlation with fiber
sensing systems such as DAS**

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PIONEER-Q project

- 6 partners (PSNC coordinator)
- Start date: 01.02.2023
- Duration: 30 months
- Budget: 10 MEUR
- Deliverables: EU restricted
- Infrastructure
 - 1770 km of intercity QKD links implemented in March 2024, dedicated fibers and KMS network
 - Intermediary nodes in main cities of Poland and ready to QKD metro system installations
 - Each partner has 2 QKD metro systems with encryptors
 - NSA connected by dedicated QKD system
 - Additional MAN networks connected.

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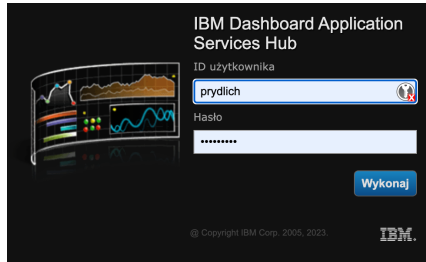
- Constant NOC 24/7 365 monitoring of QCI infrastructure. Full MIB base monitoring
- Ticketing system introduced. DAILY verification of all segments quantum channel and system statistics (QKD hardware, software or KMS)
- Monitoring of QCI systems during the fiber maintenance works and fiber cuts
- Introduction of new procedures for fiber service teams (2023-2024): optical cables during repairs cannot introduce new splices/connectors to maintain average attenuation, fiber service teams should not perform the OTDR on QKD dark fiber channel (in order to not potentially damage the QKD sources and detectors). QKD physical link verification after QKD service restarted.
- Direct QKD system temperature monitoring system introduced in nodes where temperature fluctuations affect performance
- Redundant VM KMS instances
- QKD systems constantly adapt QKD channel characteristics and provide ~700 MB of logs and monitoring data each few days
- QKD system performance can be potentially correlated with fiber measuring system (especially based on fiber strain)

QKD system monitoring in NOC



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QKD system monitoring in NOC



QKD

Network Views

Widoki sieci - [QKD]

Wyświetl

Widok sieci

QKD

Przeglądarka zdarzeń

NetworkViewTree_BKM_27NCP_VIEW_328264_E

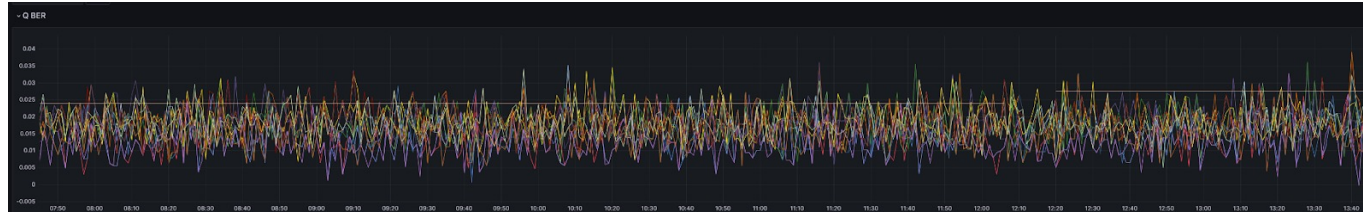
Ackno	Severi	Node	Location	Summary	InterfaceName	Last Occurrence	First Occurrence	Count	Type	ExpireTime	Agent	Alert On
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Razem: 0 Wybrane: 0

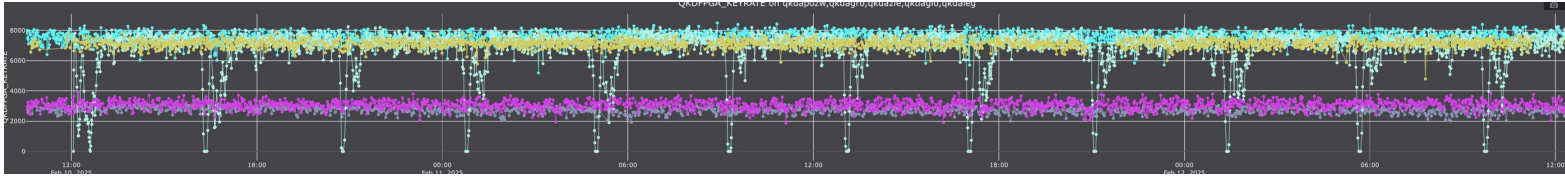
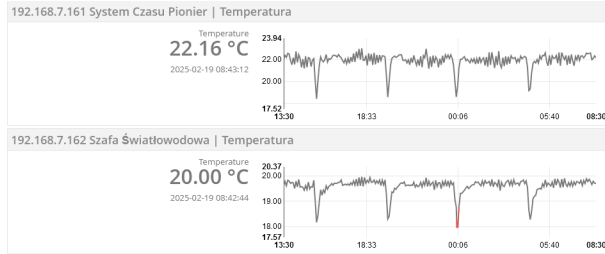
12:52 Odśwież dane zdarzenia (zak. 42min)

Odśwież za:

QKD system monitoring in NOC



Temperature stability monitoring

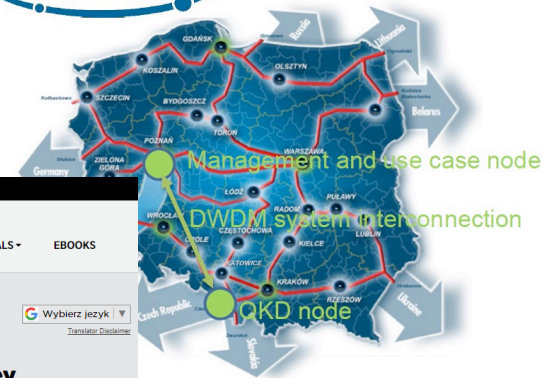


Tradeoff between temperature stability and higher temperature levels

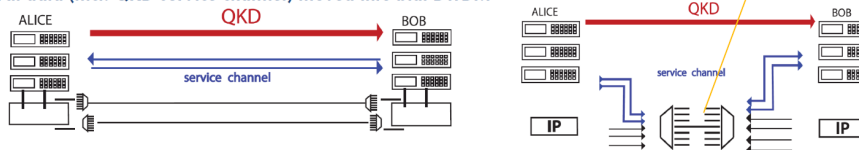
Potential integration with DAS and other measuring systems

- Distributed Acoustic System can monitor activities in the fiber cable area and detect fiber strain introduced by acoustic events
- QKD system performance is sensitive to fiber strain what is usually reflected in QBER fluctuations and changes
- QKD system can provide end-to-end characteristic and performance but cannot locate potential location along optical segment where changes occurred. It can be correlated with DAS system performance, DWDM system performance and statistics
- QKD system operating on dedicated dark fiber can be treated also as specific kind of sensor
- PIONIER-Q network is operating on dedicated dark fibers for quantum channel
- PSNC established DAS system monitoring on one of the QKD segments (~90 km) that runs along railway tracks and few km of cable is exposed on surface close to tracks due to the maintenance works

PSNC – VSB crossborder testbed



- First intercity and international trial in CZ
- Ostrava Cieszyn line – fibre itself 75km, 16 dB
- QKD channel in 1550 nm band, will be disturbed by parallel traffic
- Line is very close to maximum system performance
- QKD system „fibre hungry“, service OOK channel will consume 2 additional optical channels
- Offer for additional fibre pair uncompetitive
- All data (incl. QKD service channel) moved into bidi DWDM



Presentation + Paper

4 October 2022

First cross-border trial of quantum key distribution sharing fiber line with data and accurate time transmissions

Josef Vojtech, Rudolf Vohnout, Ondřej Haviš, Petr Pospíšil, Martin Šlapák, Radek Vejc, Lada Altmannová, Tomáš Horváth, Jan Kundrát, Michal Hažlinský, Elisabeth Andriantsarazo, Piotr Ródlchowski

Author Affiliations +

Proceedings Volume 12238, Quantum Communications and Quantum Imaging XX; 122380H (2022)

<https://doi.org/10.1117/12.2633616>

Event: SPIE Optical Engineering + Applications, 2022, San Diego, California, United States

ARTICLE CITED BY

Abstract

This contribution focuses on experimental verification of the QKD system deployment in a multi-domain network environment managed by Czech and Polish National Research and Educational Network (NREN) operators. We demonstrate full functionality of such a solution for transmission of secret keys in boundary conditions, and with this we open up new possibilities for further use of extremely secure communication between two neighboring network entities, and the services built upon it. Moreover, we have shared the cross-border link among strong QKD service channels, accurate time, and classical data channels together with weak quantum channel to reduce the total number of optical fibers needed for transmission. To our



Machine Learning-based Optical and QKD Network Monitoring

ADVA and PSNC

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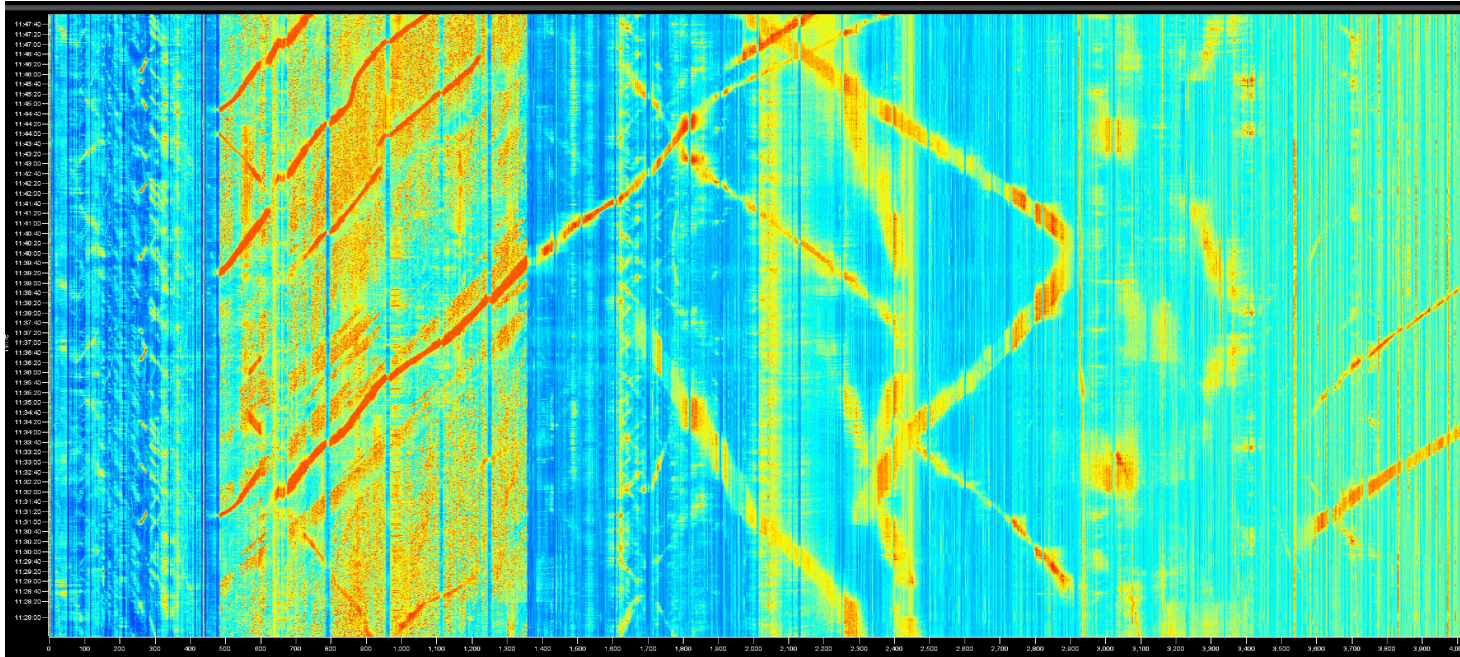
²Christian-Albrechts-Universität zu Kiel, Kaiserstr. 2, Kiel, Germany, 24143

³PSNC, Wieniawskiego 17/19, 61-704, Poznań, Poland

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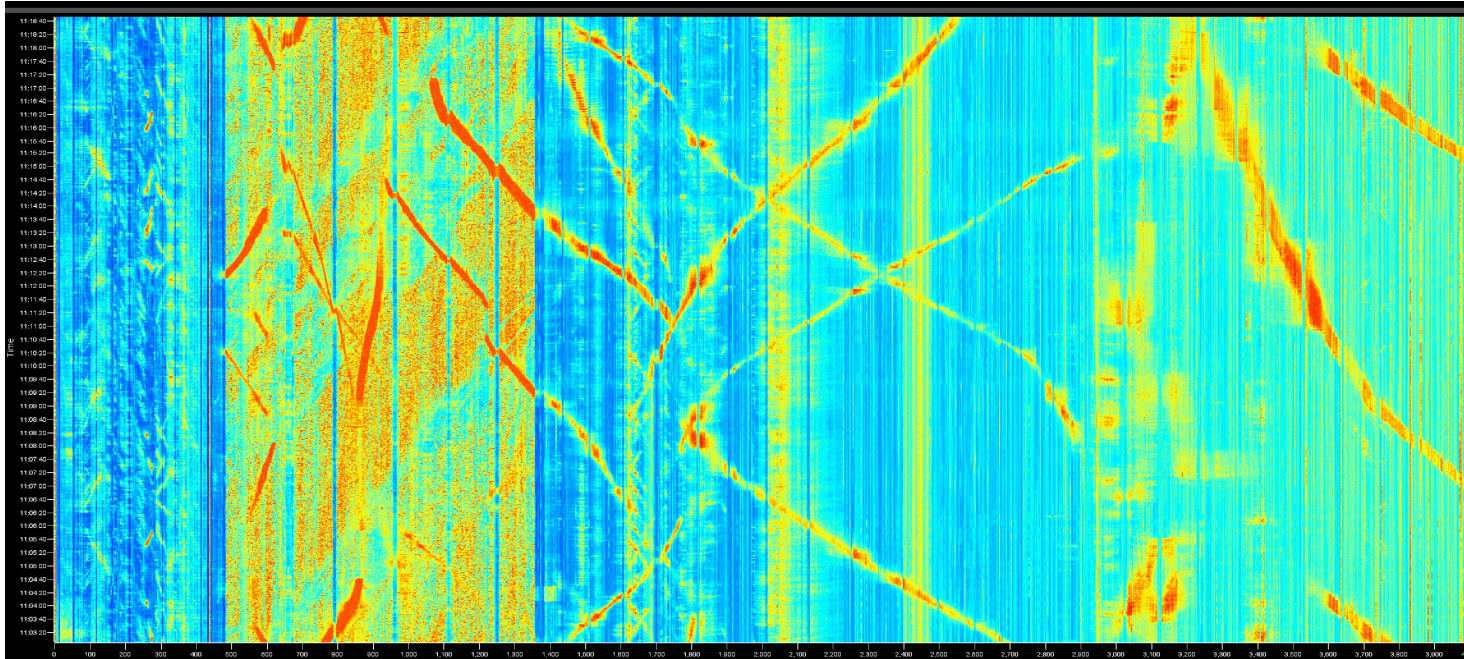
Abstract: We demonstrate a fiber network monitoring system based on machine learning which can detect and diagnose fiber faults and hardware failures in an optical network. Our system also has the capability of monitoring the performance of QKD links.

DAS monitoring

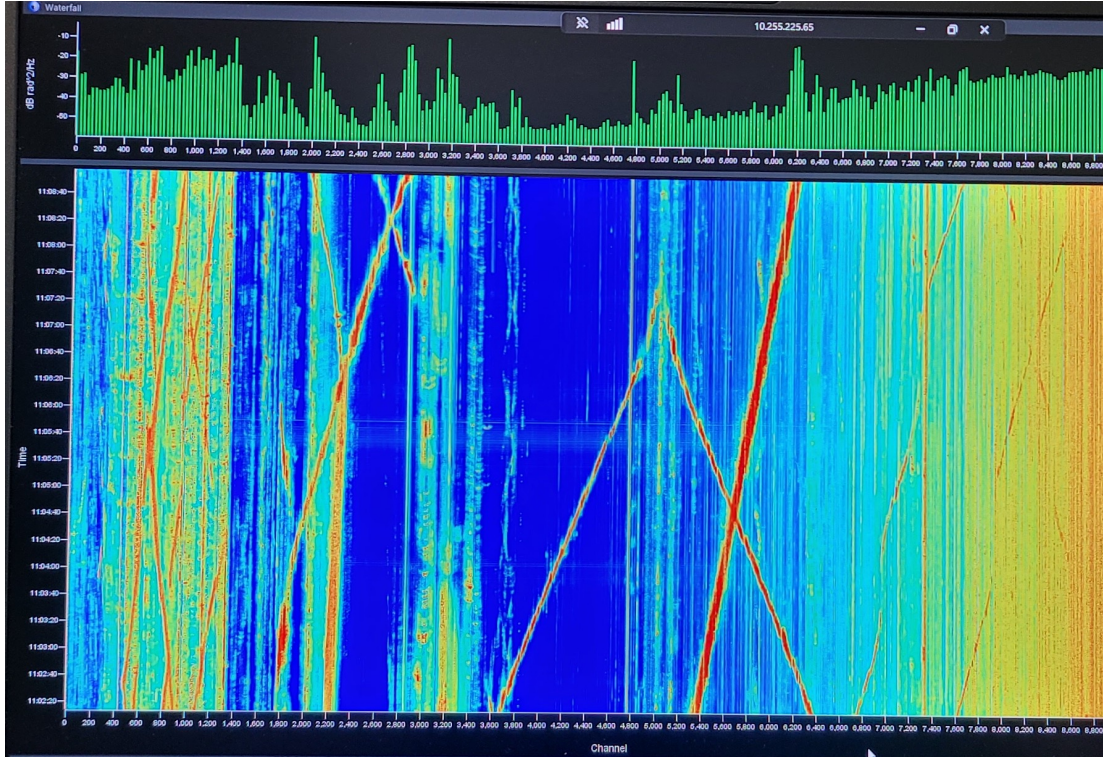


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DAS monitoring



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