

PIONIER-LAB and PIONIER-Q projects

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PSNC

CEF Networks Workshop, 18th April 2023

LAB

LABORATORY OF INNOVATIVE NETWORK TECHNOLOGIES

LAB

DISTRIBUTED LABORATORY OF TIME AND FREQUENCY

LAB

SMART CAMPUS AS A SMART CITY LABORATORY

LAB

REGIONAL LIVING INNOVATION LABORATORIES INSPIRED BY ICT

LAB

CLOUD SERVICES LABORATORY

LAB

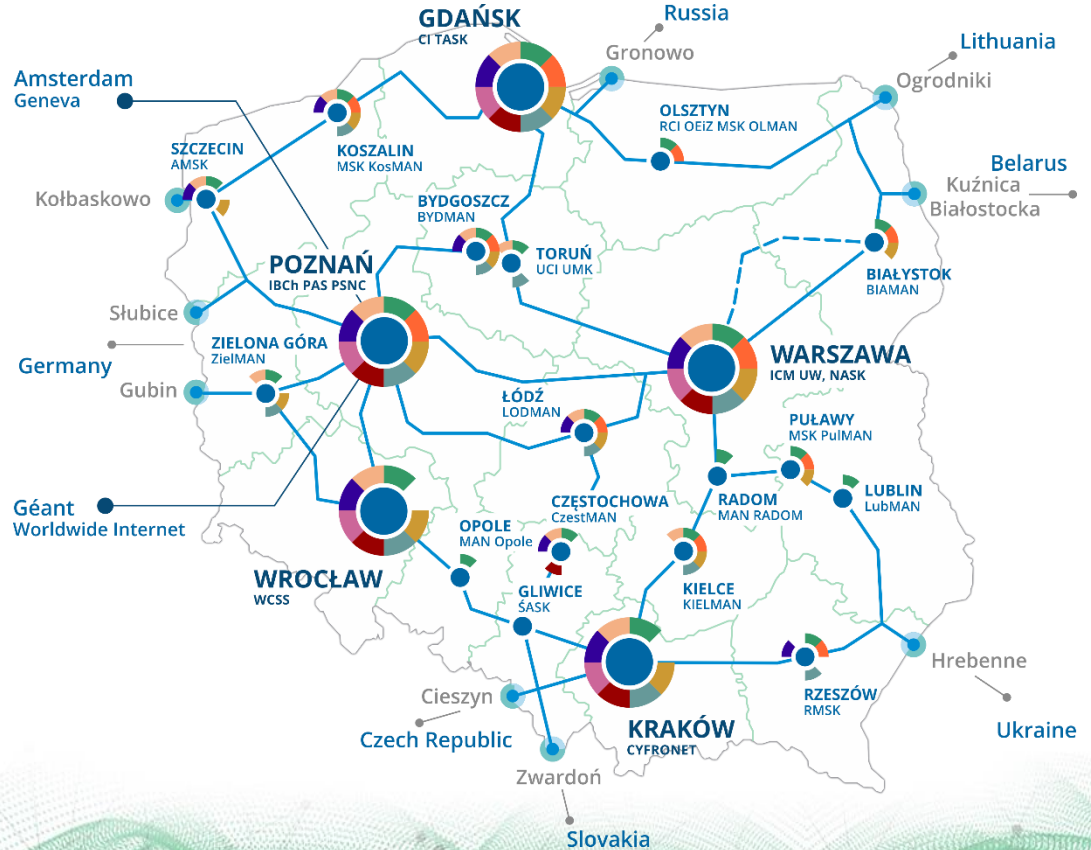
MULTI-SCALE SIMULATION LABORATORY

LAB

LABORATORY AND E-TRAINING SERVICES

LAB

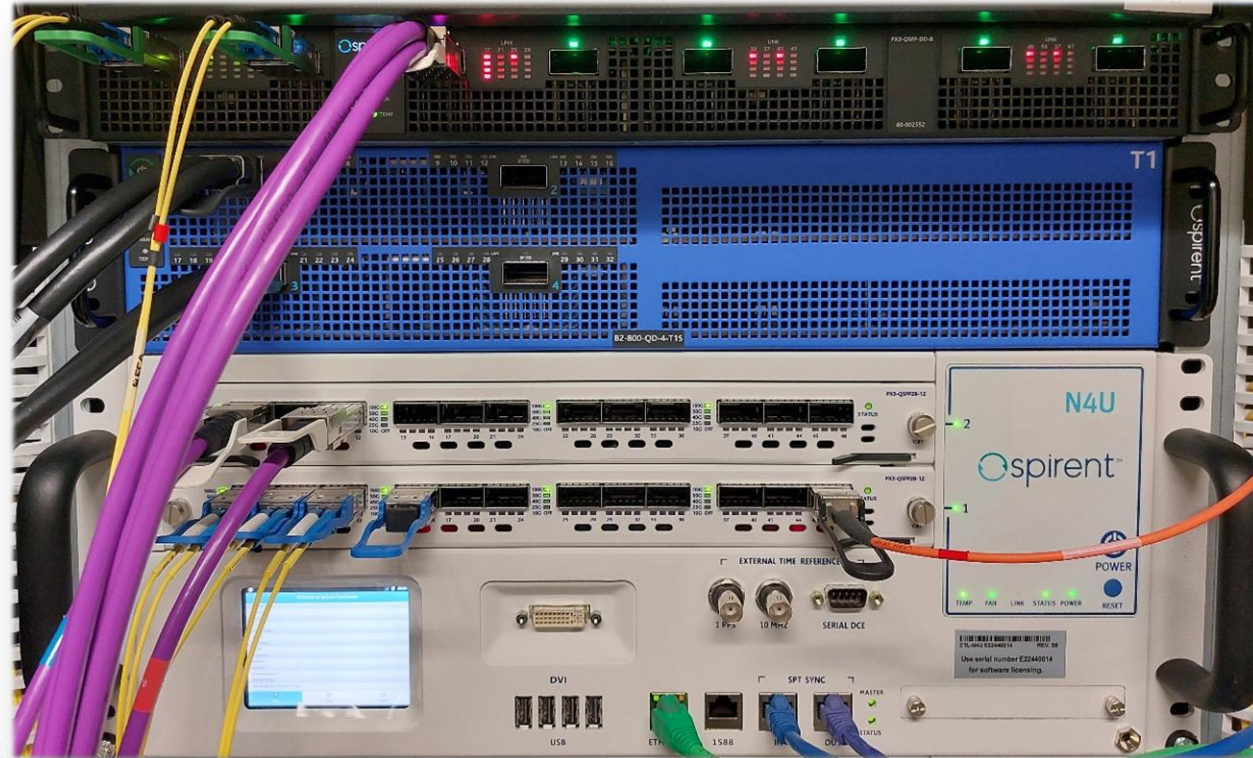
LABORATORY OF PRE-INCUBATION



- Deadline to finish it until the end of 2023
- Problem with innovative technologies availability
 - Delays with 800Gps and 1.6Tbps interfaces
 - Very long delivery times
 - a new perspective on security and network protection
- New organization of tender procedures (national limitations)
 - the new act is much more restrictive for contracting authorities
 - the possibility of validating the offered solutions is retained (providing a sample)
 - warranty and software update until the end of 2028
- The tenders for routers and DWDM opened in 3M2023
- Pending tenders for advanced optical measurement equipment



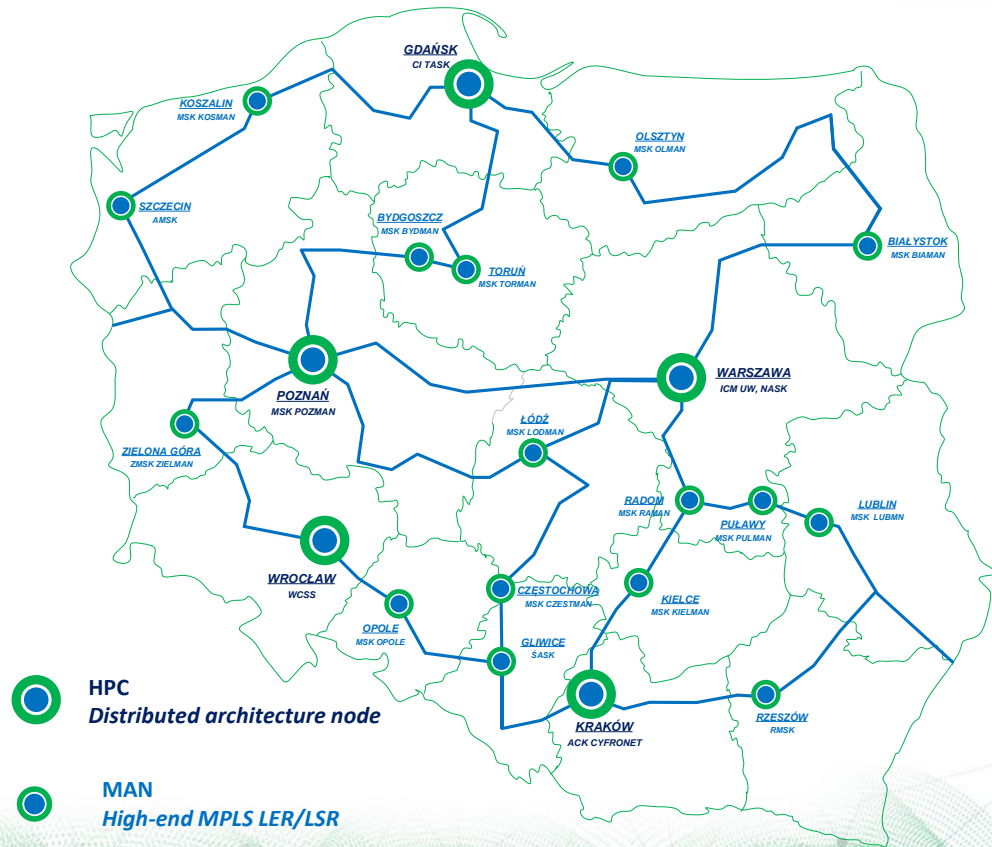
- Spirent TestCenter
 - B2 appliance
 - 4x 800GE / 8x 400GE
 - N4U chassis
 - 24x100GE
 - Full set IP protocols



- Joint purchase for the MANs/PIONIER network community
 - One offer basing on latest networking technologies
 - The devices successfully passed the test procedure
- Routers/switches
 - **Distributed node/switch** architecture for 5 HPC PoPs
 - One device with high 400GE port density
 - High per port cost efficiency
 - High switching capacity
 - One service node supporting flexible services
 - Extensible platform for advanced networking services
 - High and scalable RIBB/FIB capacity
 - **High-end MPLS LER/LSR** for 16 metropolitan area networks (MANs)
 - Extensible platform for advanced IP and MPLS services
 - High and scalable RIBB/FIB capacity
 - **Compact IP/MPLS routers** for Metropolitan Area Networks Core
 - 400GE ready
 - 10/100GE interfaces
 - **Power/space efficient compact access routers** for Metropolitan Area Networks core
 - 1/10/100GE access
 - 100GE uplinks

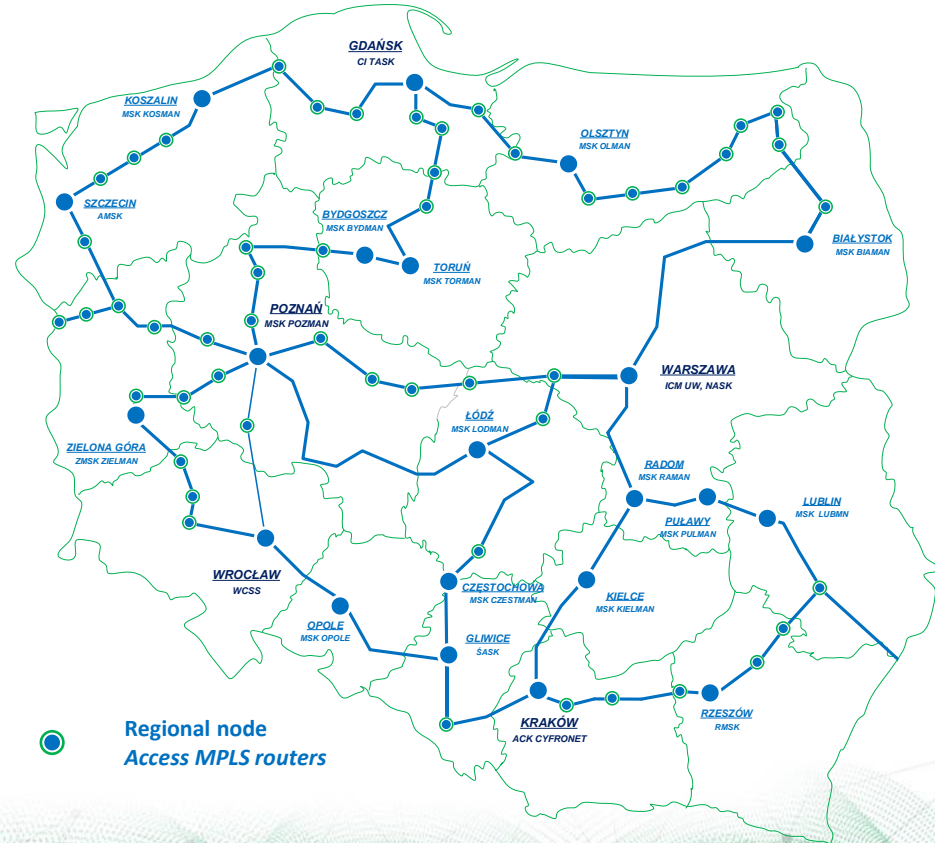
PIONIER-LAB IP Core links

- 5 HPC centers
 - Distributed architecture nodes
 - 400GE, 100GE
- 16 Metropolitan Area Networks
 - High-end MPLS LER/LSR
 - 400GE ready
 - 100GE, 10GE
- Country wide set of consistent services
 - Dedicated research infrastructure
 - Private peerings
 - Internet Exchange



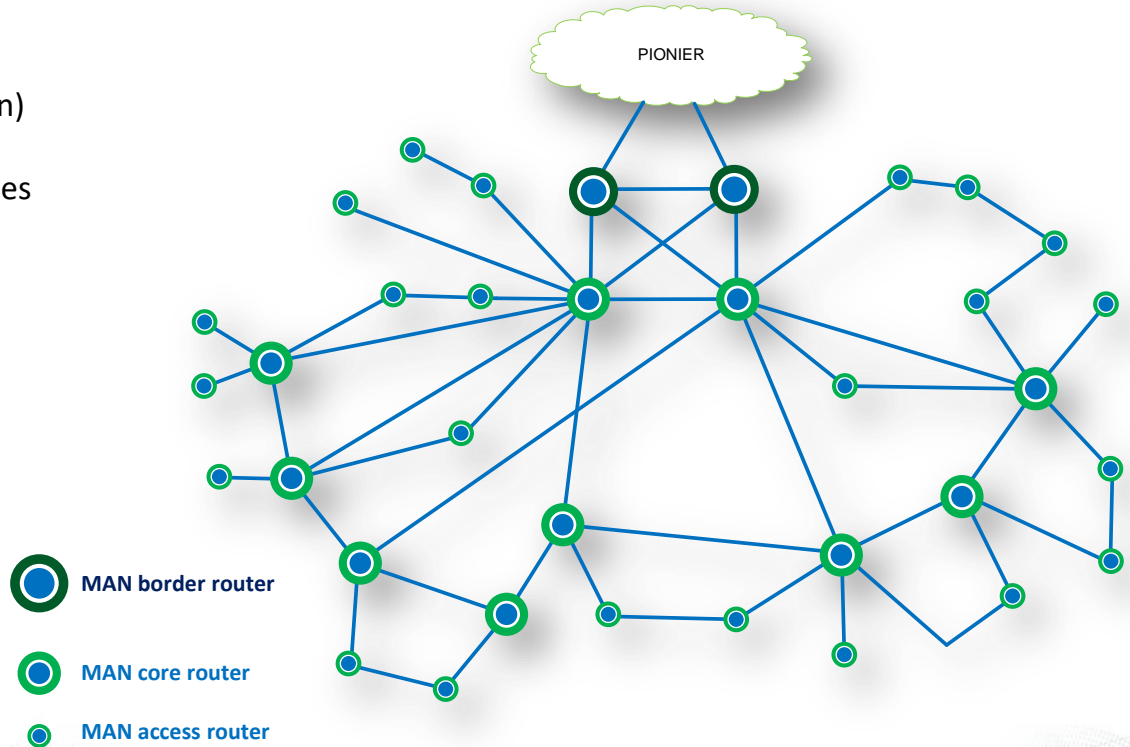
PIONIER-LAB IP Regional links

- 53 regional nodes
 - Compact and power efficient MPLS routers
 - 10GE, 100GE (ready)
 - dark fiber links
- Bridge and backup for R&E MANs infrastructure



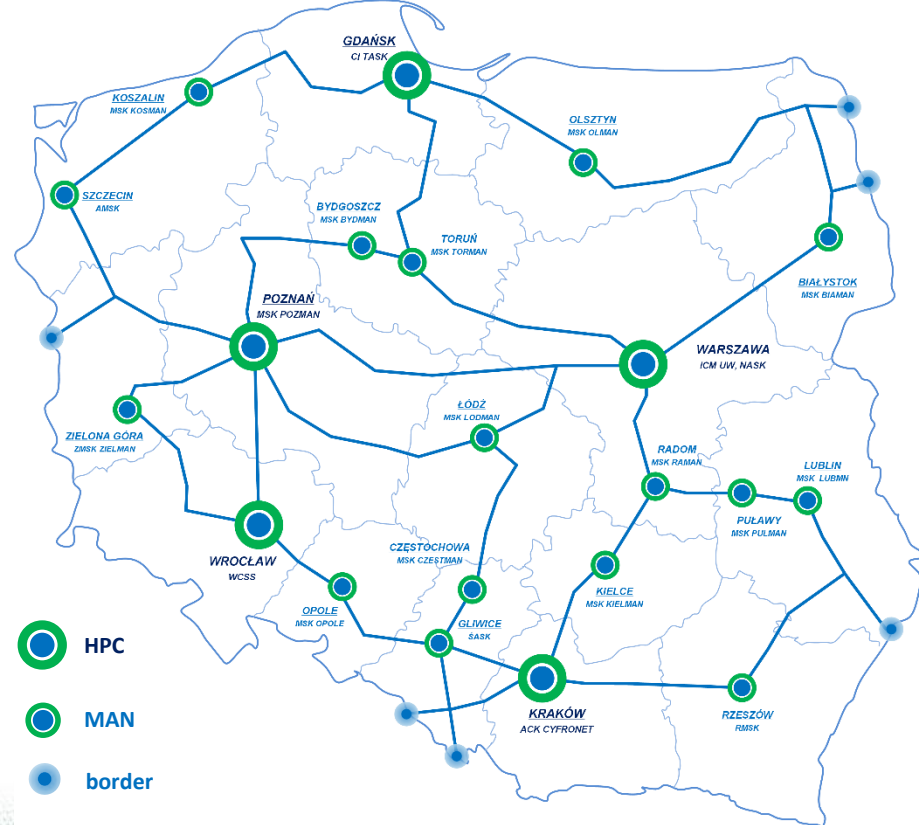
R&E MANs

- Independent domains (AS, administration)
- Consistent set of services and technologies
- MAN border router
 - High-end MPLS LER/LSR
 - Scalable RIB/FIB capacity
- MAN core router
 - Compact MPLS LER/LSR
- MAN access router
 - Power efficient MPLS access node
- 100GE and 10GE interfaces
 - 400GE ready



PIONIER-LAB optical coherent system

- 6570 km of fiber optic routes
- 37 PoP's
 - 5 HPC
 - 16 MAN
 - 6 border PoPs
 - 10 additional PoPs
- 60 ILA nodes
- transceivers with QPSK, M-QAM and hybrid modulation
- ROADM nodes with CD and CDC
- media channel spectrum from 37,5 GHz to 4900 GHz
- WSS with Media Channel and Media Channel Group
- OTDR implemented on all routes



PIONIER-LAB optical network services

- Transmission modules
 - 1200G (M-QAM and hybrid modulation) with 400GE client ports
 - 800G (M-QAM and hybrid modulation) with 400GE client ports
 - 800G (M-QAM) with 800GE client ports
 - 200G/100G (pluggable coherent interface, M-QAM) with 100GE and 10GE client ports
 - encryption 400G (pluggable coherent interface, M-QAM) with 100GE and 10GE client ports,
 - Built-in encryption
 - Layer 1 AES-256 encryption using a Diffie-Hellman key exchange, dynamic key exchange every minute
 - **the function of uploading own algorithms**
 - **ready to Quantum-safe encryption via PQC or third-party QKD attach**
- Transmission service:
 - HPC nodes: $n \times 400\text{GE}$, $n \times 100\text{GE}$
 - other nodes: $n \times 100\text{GE}$ and $n \times 10\text{GE}$
- Spectrum (all PoPs)
 - alien wavelengths (Media Channel 37.5 GHz, 50.0 GHz, 75.0 GHz)
 - optical spectrum as a service / spectrum service / spectrum sharing (flexible grid, from 37,5 GHz to 4900 GHz - Media Channel and Media Channel Group)

Out-of-Band Access to Ethernet Management Interfaces and Console Ports

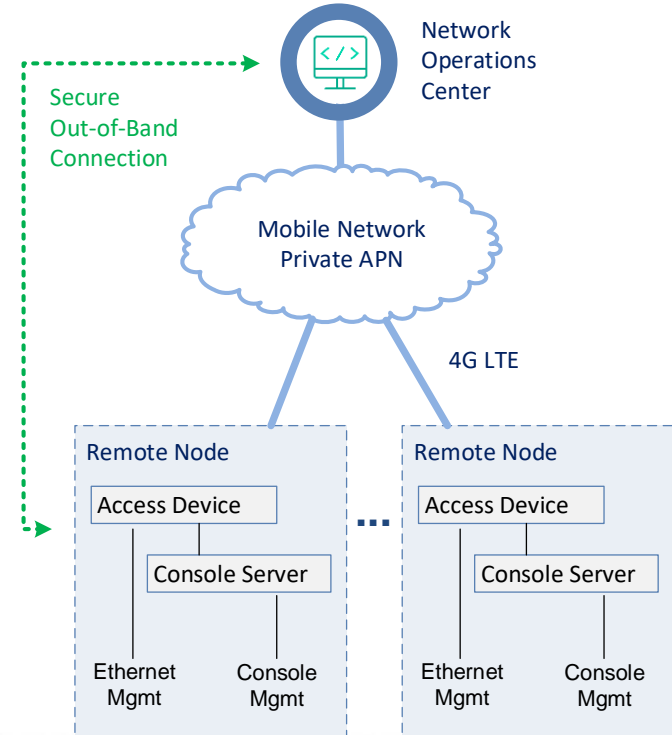
- Connection with use dedicated private APN in 4G LTE mobile network
- Major improvements in network troubleshooting
- Reducing the time it takes to detect a network problem
- Continuous access to intermediate nodes
- Console access to the device in case of serious failures
- Minimize network downtime by quickly detecting issues

Access Device

- Ethernet and 3G / 4G LTE cellular connectivity
- Firewall, Routing and Switching features

Console Server:

- Access to 32 or 16 serial ports
- Support equipment with USB console ports



Firewall services and secure remote access

Firewall services

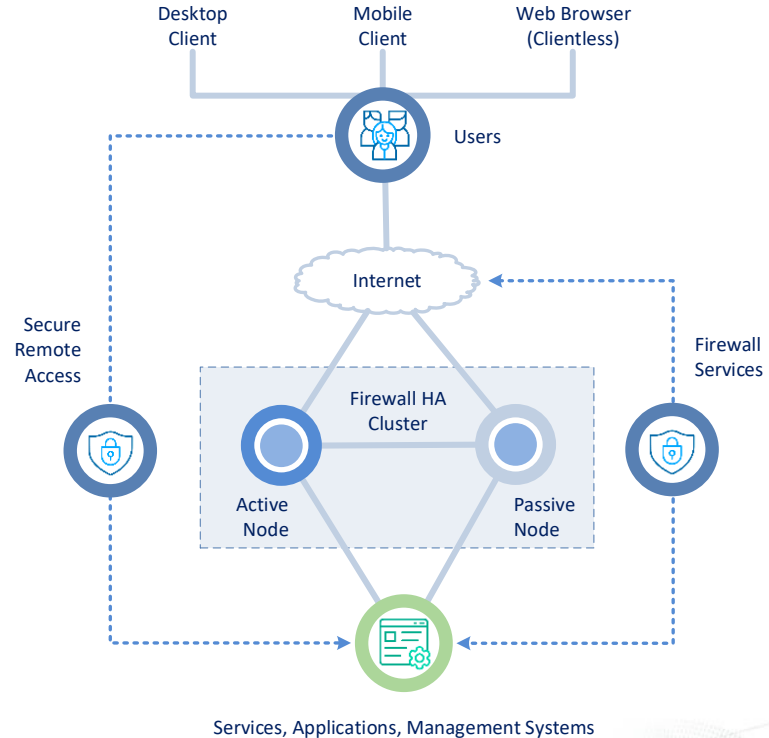
- Increased security of services and applications
- Ensuring high availability of protected resources
- Intrusion Prevention Systems (IPS)

Secure Remote Access

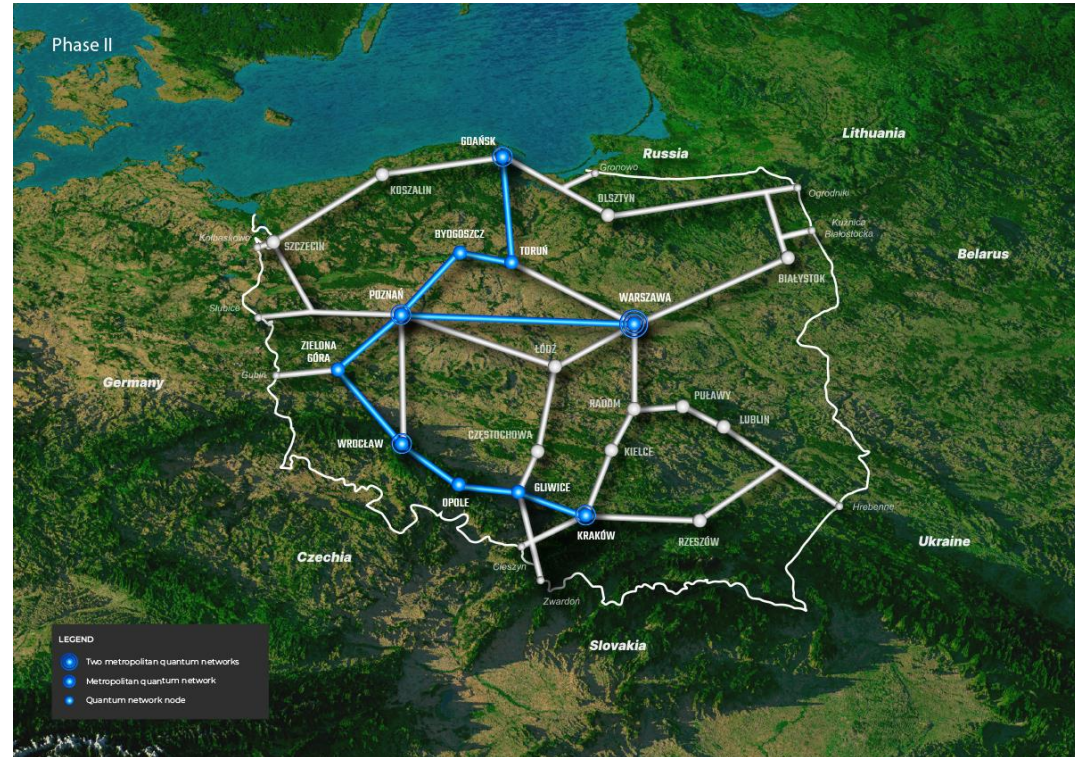
- Remote access to management systems and network applications
- Clientless VPN access to internal resources via web browser
- VPN access with using desktop and mobile client applications
- Collecting information about the security status of the endpoints

Security system

- Two firewall nodes in high availability cluster
- Reduced downtime with an additional „cold spare” device
- Centralised management system



- 6 partners
- Start date: 01.02.2023
- Duration: 30 months
- Budget: 10 Meuro
- Deliverables: EU restricted
- Web page: www.pionierq.pl
- Infrastructure
 - 1300km of intercity QKD links over dedicated fibers
 - Trusted nodes in main cities of Poland and ready for metro QKD system installations with different topologies
 - Each partner has 2 metro QKD systems with encryptors set
 - NSA connected by dedicated QKD system
 - Separate “QKD services” layer and integrated with PIONIER infrastructure and services



Project objectives

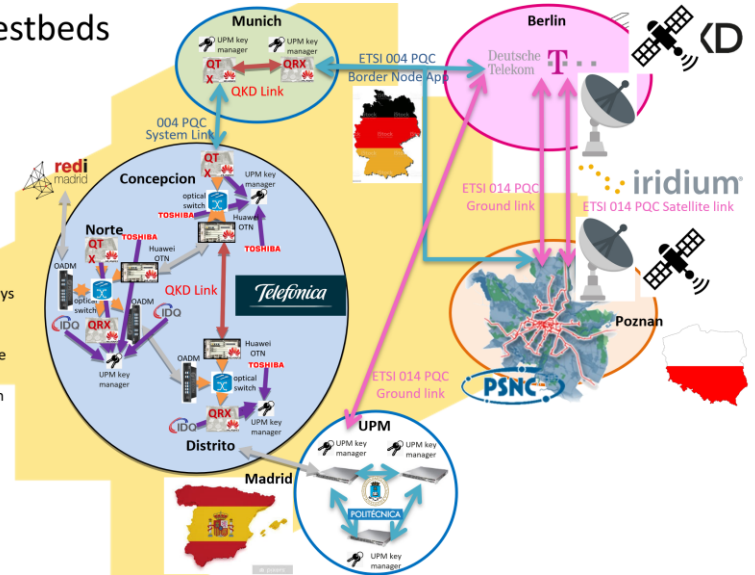
- Open QKD Infrastructure for government, research institutions and industry
- 5 HPC Centers connected by PIONIER-Q
- Collaboration
 - ✓ **EUROQCS-POLAND** project (one of European quantum computers located in PSNC based on trapped ions) and **LUMI-Q** (computer is located in Ostrava (CZ) and based on superconducting qubits – CYFRONET (PL) is project partner)
 - ✓ Pan-European Research Network **GÉANT**
 - ✓ National Laboratory of Photonic and Quantum Technologies (**NLPQT**) – current link Poznan – Warsaw (380km)
- 3 funding organizations
 - ✓ European Commission
 - ✓ The Chancellery of the Prime Minister
 - ✓ Ministry of Education and Science

- Municipal City Kraków Interconnect
- Regional Interconnect for Marshall Offices
- National Distributed Datacenter Interconnect
- QKD and Blockchain Technologies Integration
- Medical DataHub
- QKD adaptation for public institutions
- Industrial Interconnect

- QKD with encryptors integration - PoC in 2021 in many european QKD testbed sites (ID Quantique/TOSHIBA & ADVA Optical/THALES/Rohde&Schwarz) under OPENQKD
- Demonstration of QKD and PQC - testbed with Deutsche Telekom and University of Madrid and PSNC interconnected by Iridium
- Demonstration of QKD with MAC-SEC protocol integration – e.g. SC2022 in Dallas – demo on PSNC booth: ID Quantique & Arista Networks

OpenQKD testbeds interconn

- 014 PQC is a direct E2E testbed interconnection
- PQC Border Node App transport QKD keys protected with PQC algorithms
- Experiments
 - High throughput of PQC keys based on 014 PQC REST API Calls
 - Iridium link key interchange
 - Full QKD key transport on different link types from on testbed to another
 - Distrito-Concepcion-Meera-Jojen-[Berlin|Poznan]
- Multiple border nodes on the same network



Next steps

- Connections with neighboring EU countries
- Secure communication between LUMI-Q site in Ostrava & EUROQCS-POLAND site in Poznań
- Construction of the ground satellite segment of QKD
- Expansion of national connections

