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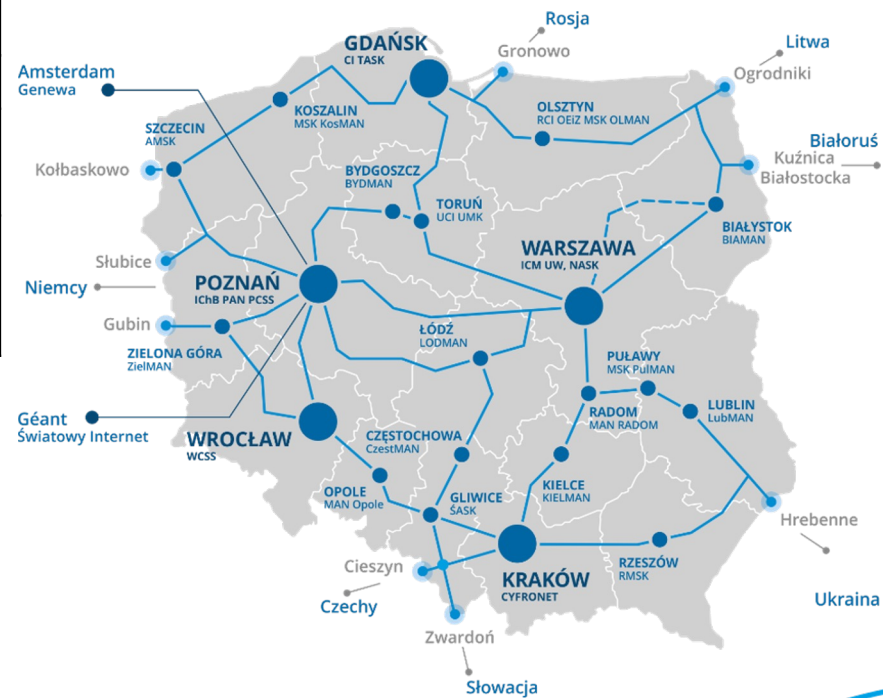
PIONIER - evolution of network services

SIG-MSP meeting  
Prague, 23-10-2025

# Scope of activity of the PIONIER network

Type of connected unit	Number of units
Research institutions	221
Universities	196
Post-secondary schools	21
High schools, middle schools, elementary schools and vocational schools	234
Health care	59
Public safety	27
Government administration	27
Regional administration	59
County, municipal and city administration	73
Administration (other)	9
Court and prosecution	26
Cultural institutions	104
Other educational institutions	27

Year	Network availability
2024	100,000 %
2023	99,9998%
2022	100,000 %
2021	100,000 %
2020	99,9995 %

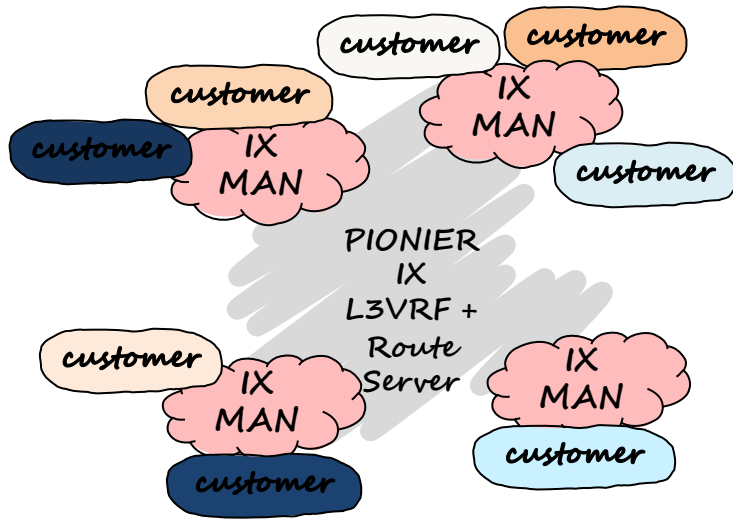




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PIONIER-IX  
PIONIER-Q  
Sensor network  
Time & Frequency

# PIONIER-IX



- Some MANs operate exchanges locally (city-level)
- PIONIER also connects to PLIX and other national exchanges.
- PIONIER provides efficient controlled transmission layer for distributed traffic exchange:
  - L3VRF + RouteServer (currently in pilot)
  - Separate L2 Broadcast domain
- PIONIER consortium provides legal framework (agreements, charges, terms of service, etc.).
- Possibility for MAN to connect clients directly to PIONIER-IX.
- Possibility of peering with CDNs at central locations

# PIONIER-Q: current state

## Operational infrastructure from 2024



- 1770 km of inter-city QKD,
- Intermediary nodes in major Polish cities
- Each partner has 2 metro QKD systems with encryptors
- ABW connected by dedicated QKD system
- Trusted nodes in MAN networks

## Planned



- Connections to all neighboring EU countries
- Secure communications with partner-infrastructures.
- Construction of mobile satellite ground segment QKD.
- Possible extension to Ukraine.

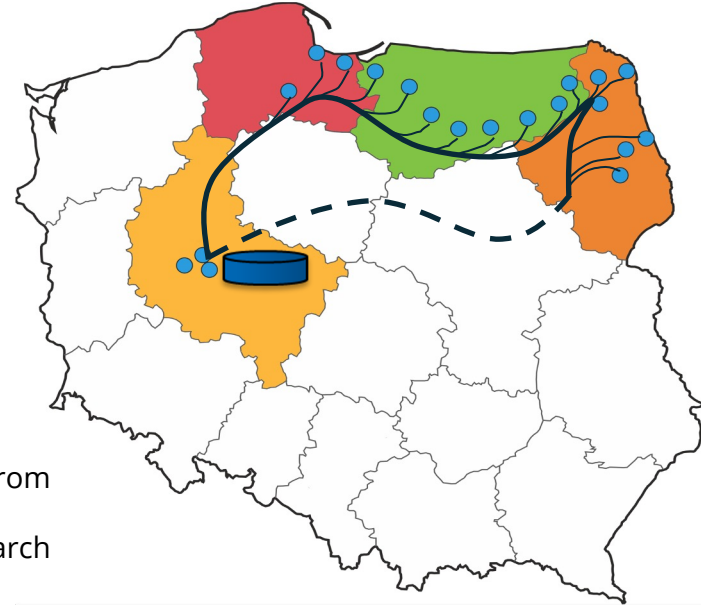
# Sensor network – GNSS/ADS-B

## Infrastructure

- At least 15 GNSS and ADS-B primary signal analysis and recording radio nodes
- Dedicated system data transmission network (the amount of data generated by one node is a minimum of 16 Gbps)
- Central archive of historical data with enough capacity to record for a period of 1 year
- Precise time and frequency distribution system to each radio node
- Three anomaly detection modules including a central one supported by an AI cluster

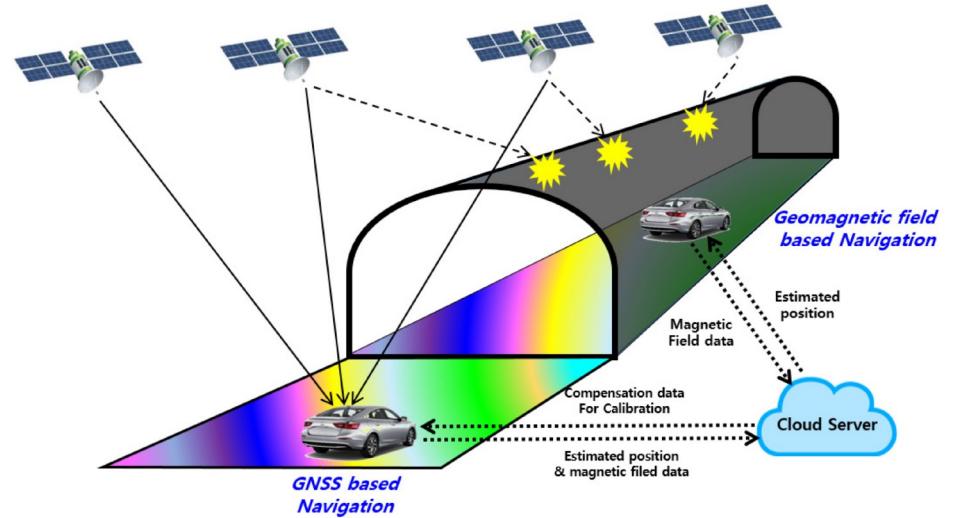
## Functionality of the system

- Archive of historical GNSS and ADS-B radio spectrum data collected from geographically distributed infrastructure with precise time stamps
- Radio node access and ability to customize parameters to meet specific research needs
- Notification module of detected threats in GNSS and ADS-B signals to stakeholders
- Real-time threat detection and classification
- Repository of detected jamming signals



# Sensor network – Mobile quantum sensors

- Independence from GNSS signals (in terms of safety)
- Method suited to long autonomous missions (drones) or situations where GNSS signals are not available
- System consists of gravimeters, accelerometers and magnetometers

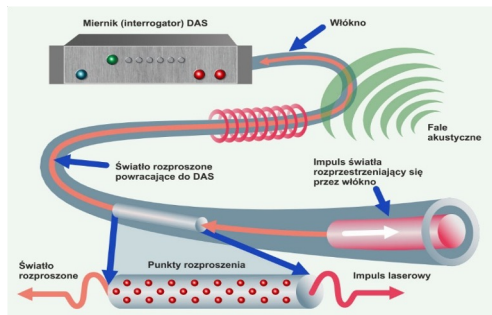


Źródło: Magnetic Field-Based Vehicle Positioning System in Long Tunnel Environment, DOI: 10.3390/app112411641

# Innovative technologies – fiber as a sensor

Distributed sensors - measurements using optical fiber (over a large area), along the entire length of the fiber (more than 100 km):

- DAS (Distributed Acoustic Sensor)
  - monitoring of pipelines, railroads, power lines,
  - securing large areas of land, perimeter protection,
  - detection with high precision, such as people - running, marching, crawling, ...
  - information about the distance of the event and the type of alarm,
  - detection in conjunction with machine learning and artificial intelligence algorithms.
- DTS (Distributed Temperature Sensor)
  - Temperature measurement (continuous or periodic)
- Strain testing of various structures (bridges, buildings, engineering structures).



Prototype - Kąkolewo airfield



# Time and frequency and optical carrier transmission networks (2023)

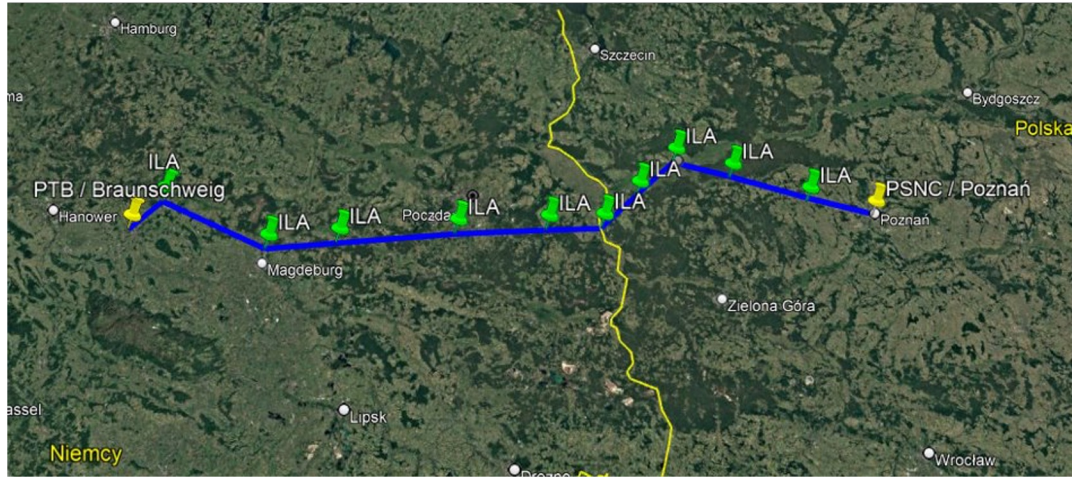
## Time and frequency transmission network



## Optical carrier transmission network



# International PSNC - PTB connection for optical carrier, RF time and frequency transfer



- 2 dark fibers
- Implementation using in-house solutions
- Total length: ~690 km
  - 270 km in Poland, PIONIER network
  - 420 km in Germany, GÉANT network

Devices developed by scientists from Poland:



**Repeater Laser Station (RLS)**  
dedicated to optical carrier transmission



**ELSTAB**  
dedicated to time and frequency transmission



**Two-way optical amplifier**

## Summary

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- PSNC and the PIONIER Consortium are working on new services and solutions that can be used by the administration, industry and the scientific community
- We invite you to cooperate with us, we declare full support (services / infrastructure and research teams) for initiatives at the regional, national and European levels





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