

OPTIME Time and frequency dissemination system based on fiber optical network - PIONIER

WWW.OPTIME.ORG.PL

The OPTIME project is co-funded by The National Centre for Research and Development from Poland in the Applied Research Programme



M. Lipiński (mlipinski@agh.edu.pl),
Ł. Buczek, J. Kołodziej, P. Krehlik, Ł. Śliwczynski
AGH University of Science and Technology
Krakow, Poland



J. Nawrocki (nawrocki@cbk.poznan.pl)
P. Dunst, D. Lemański, P. Nogaś
Astrogeodynamic Observatory Space Research Centre PAS, AOS
Borowiec, Poland



A. Czubla (a.czubla@gum.gov.pl)
Central Office of Measures, GUM
Warsaw, Poland



W. Bogacki (wojbor@man.poznan.pl),
A. Binczewski, P. Ostapowicz, M. Stroński, K. Turza
Poznan Supercomputing and Networking Center, PSNC
Poznan, Poland

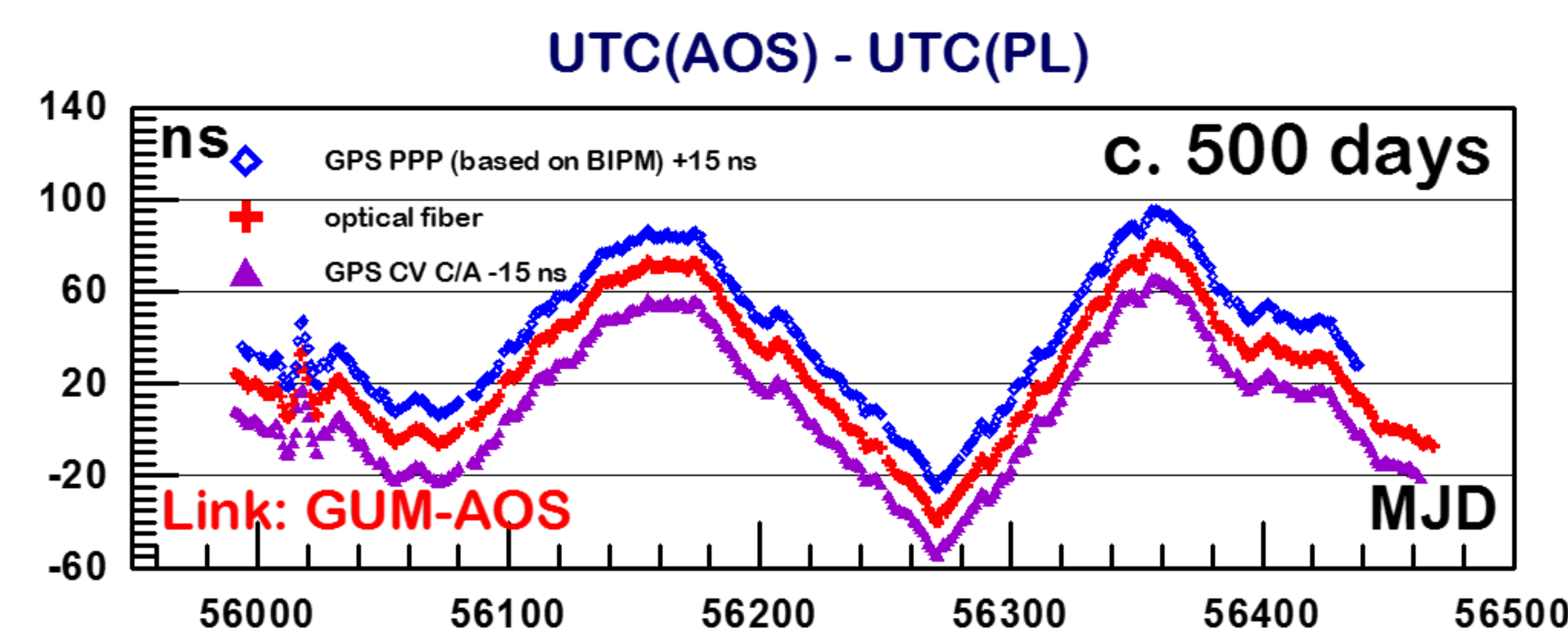


J. Pieczerak (Janusz.Pieczerak@orange.com)
W. Adamowicz, J. Igalson, T. Pawszak,
Orange Poland, TPSA
Warsaw, Poland



Optical link GUM – AOS Borowiec

- Optical link GUM Warsaw – AOS Borowiec as the genesis of the OPTIME project
- Permanent Time and Frequency transfer from GUM to AOS
- Link self-calibration
- Complex uncertainty of Time transfer - 112 ps (induced mainly by TIC measurement)
- More than 500 days of permanent UTC (AOS) – UTC (PL) comparison
- Unique experience in fiber optic long-haul, long-term T&F transfer



Comparison of UTC(AOS) – UTC(PL) during c.500 days operation with:
fiber link(red), GPS PPP(blue), GPS CV C/A(violet)

Events during 500-Days operation

| MJD | Event Description | Remarks |
|---------------|----------------------------------|---|
| 55963 | System calibration | $\tau_{GUM-AOS} = 2047574.25$ ns |
| 56080 - 56084 | Optical fiber break | new calibration $\tau_{GUM-AOS} = 2047351.05$ ns |
| 56096 - 56097 | Optical fiber break | new calibration $\tau_{GUM-AOS} = 2047751.05$ ns |
| 56120 - 56121 | Optical fiber break | no calibration required |
| 56229 - 56230 | 2-hrs breakdown – unknown reason | no calibration required |
| 56249 - 56250 | Measurement breakdown at AOS | no comments |
| 56330 - 56331 | Fiber replacement | no calibration required |
| 56345 | Dispersion checking | OK |
| 56365 | Measurement reorganization | no comments |
| 56464 | Power supply breakdown at GUM | no comments |

Two types of events:

- Yellow – planned events: current link service such as system calibrations, link or measurement organization changes, dispersion checking.
- Blue – accidental events: any types of system breakdowns.

KEY CONCLUSION

More than one year of non-stop link operation confirmed that the key technology developed is ready to be used in wider concept of OPTIME distribution network for T&F dissemination.

OPTIME Architecture

OPTIME architecture based on three main elements:

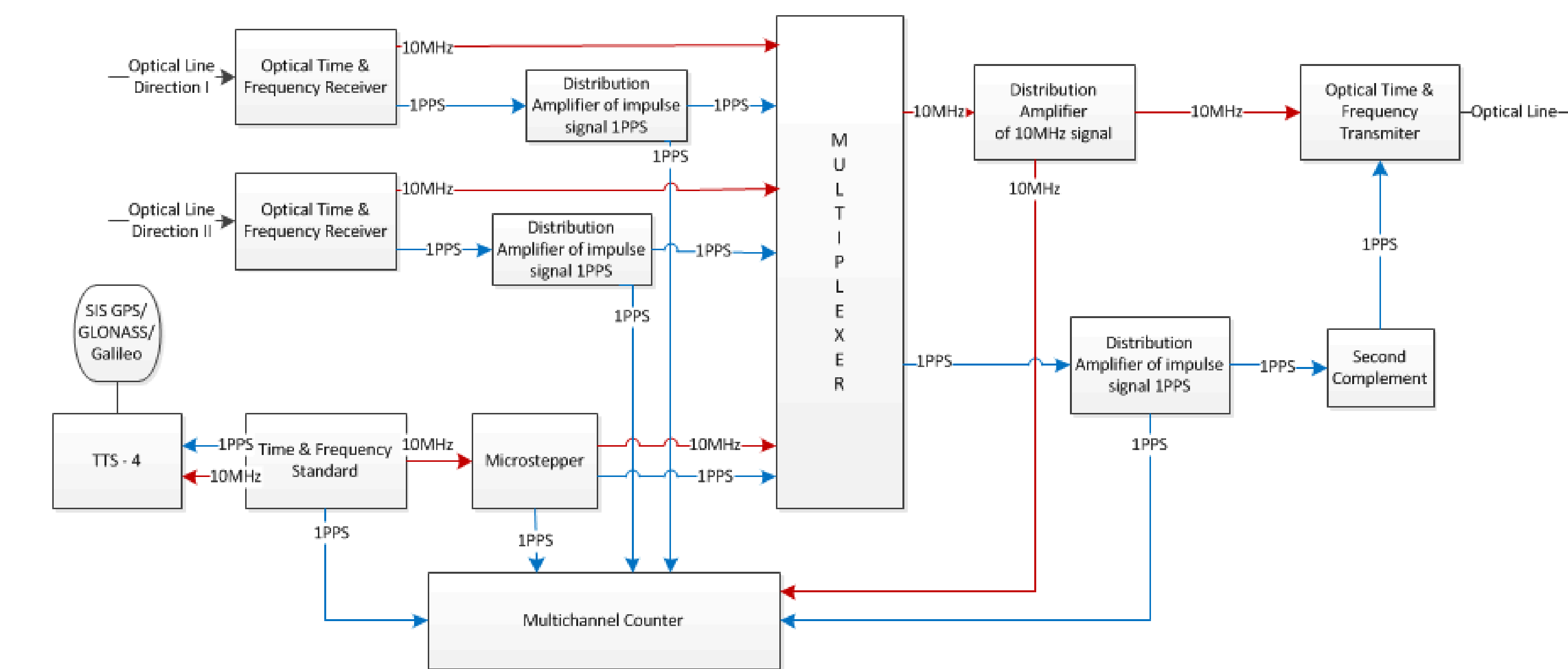
- Reference time and frequency laboratories,
- Local time and frequency repositories,
- Dissemination network.

Reference time and frequency laboratories

Reference time and frequency laboratories will provide time-frequency signals for the entire system. These laboratories must be leading centers with high reliability of signals delivery. The parameters of the whole system are strictly dependent on the accuracy of these laboratories.

Local time and frequency repositories

Local repositories will be synchronized with references laboratories and will provide time and frequency during signal failures in reference laboratories. It is meant to increase the reliability and robustness of the system. Repository structure should enable the automatic detection of network failures and reliable switchover to redundant and backup source of time and frequency.

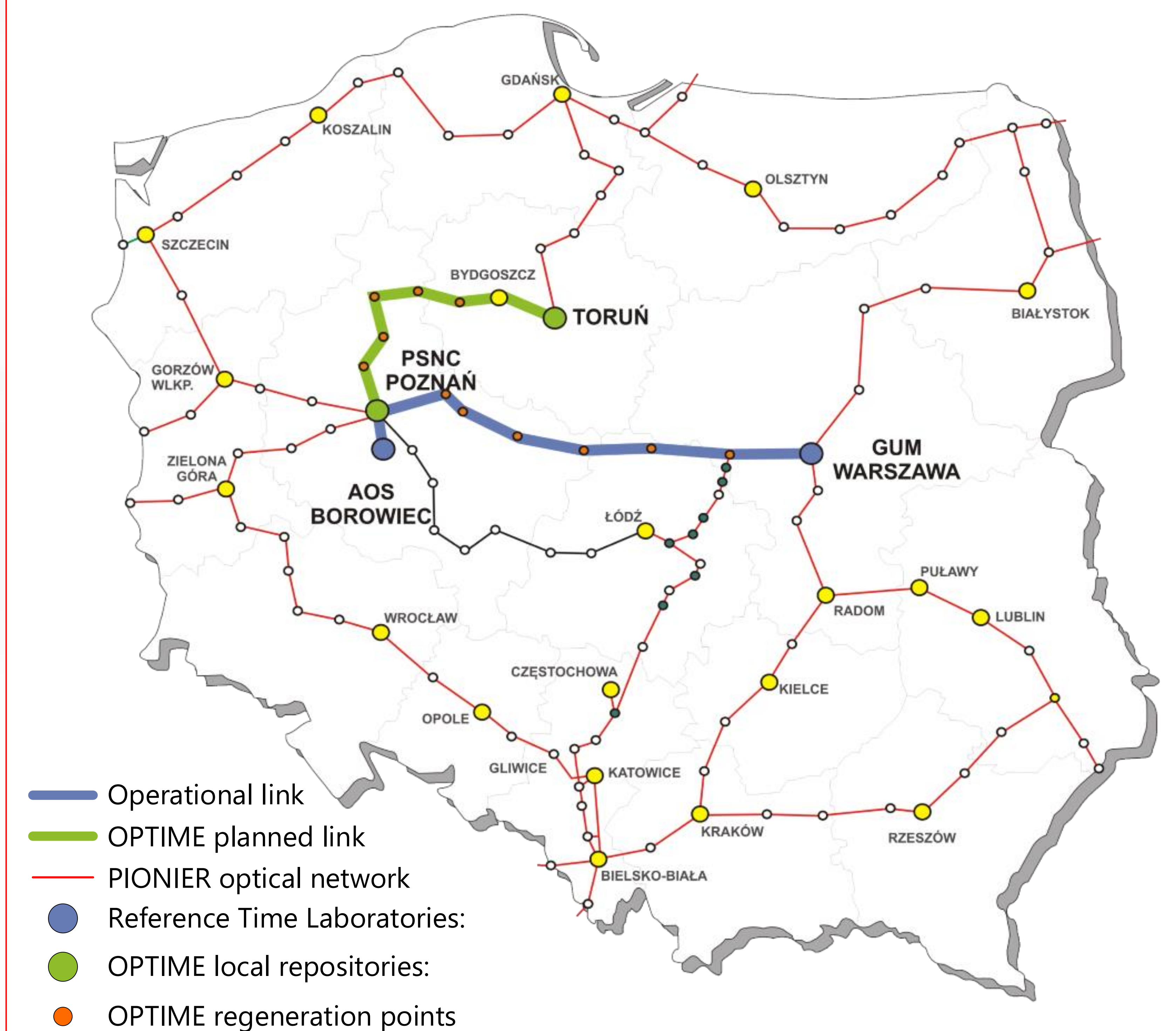


Dissemination network

The reference laboratories, local repositories and the most advanced users will be connected by optical fiber network to ensure the highest accuracy of signals. OPTIME users, with less critical requirements, will be able to use dedicated solutions hosted by TPSA, which utilizes IP networks, or other popular methods of receiving time and frequency signals.

First Phase of OPTIME

Topology of OPTIME system



Description of OPTIME system

The first phase will focus on creation of connection between two reference laboratories and two local repositories. The first reference laboratory will be AOS located in Borowiec with UTC(AOS), the second one will be GUM located in Warsaw with UTC(PL). Two local repositories will be created in Poznan in PSNC, and in Torun. The whole system will have fiber link more than 700 km long.

Summary

Reference laboratories:

- AOS Borowiec - UTC(AOS)
- GUM Warsaw - UTC(PL)

Local repositories:

- Poznan - PSNC
- Torun

Range:

700 km