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## OPTIME project

### Description of OPTIME project

The OPTIME proposes a solution that allows end users to obtain ultra-precise time and frequency signals without incurring huge costs for the purchase their own atomic clocks, and receive the service related to laboratories generating international atomic time scales, to which any precise time must be referred. The OPTIME system is based on three main elements:

- Reference time and frequency laboratories,
- Local time and frequency repositories,
- Fiber optical network.

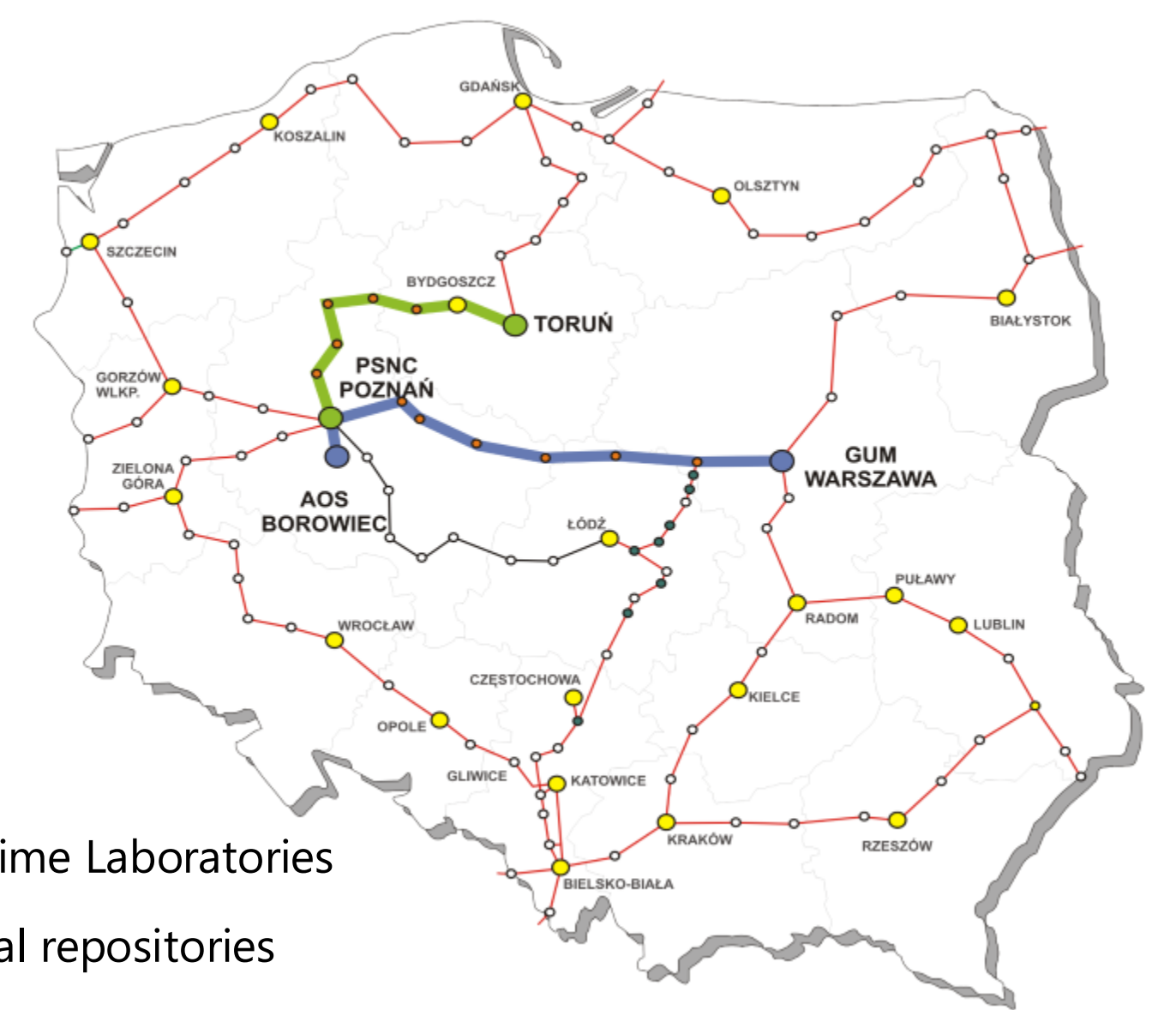
Time and frequency reference laboratories provide time-frequency signals to the OPTIME system. Local repositories – synchronized to these laboratories – are responsible to maintain time-frequency signals during any failures caused by lost of connection with laboratories. Fiber optical network with specialized transmission equipment transfers time and frequency signals between laboratories, repositories and end-users.

### Topology of OPTIME system

System OPTIME consists:

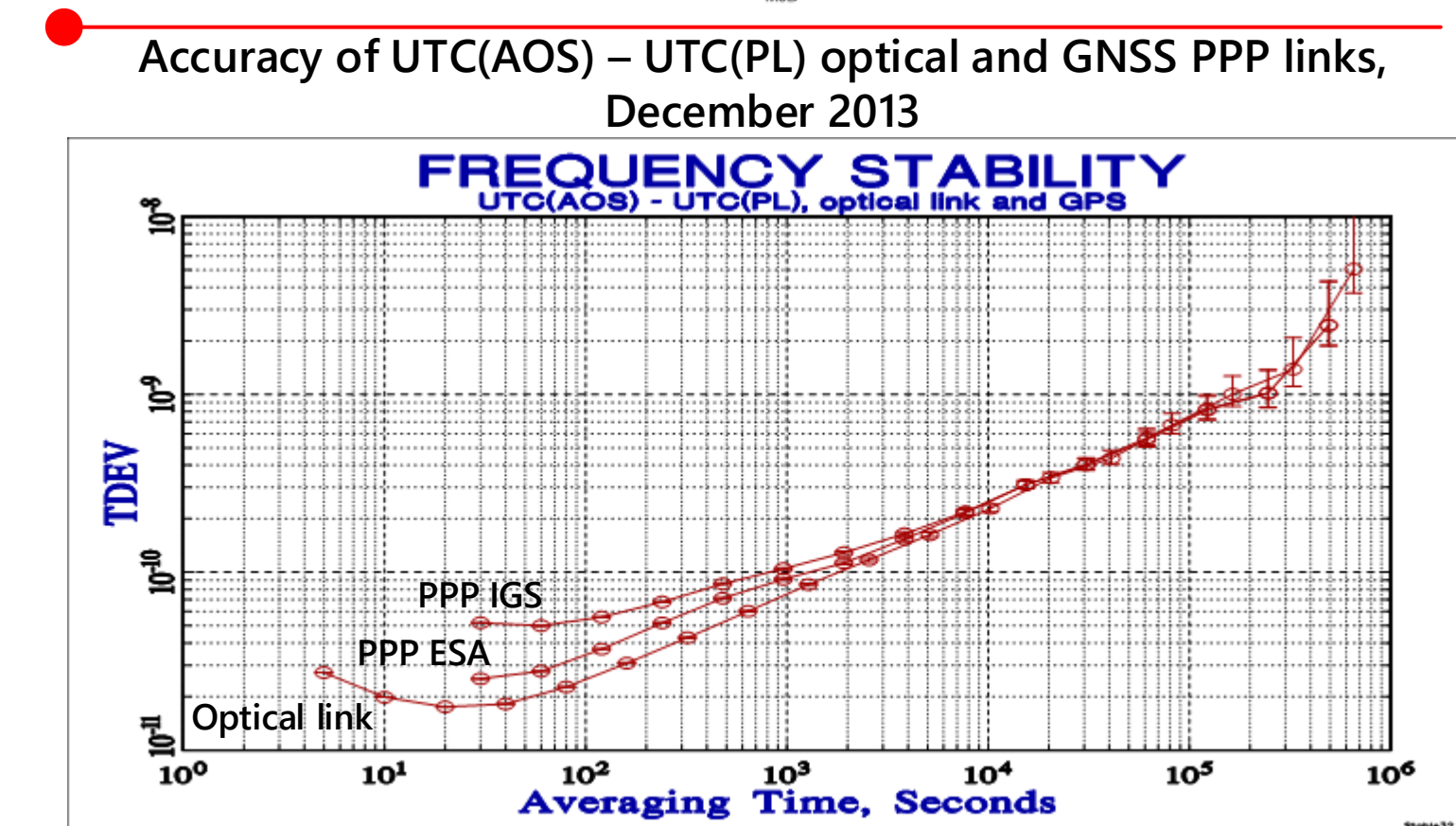
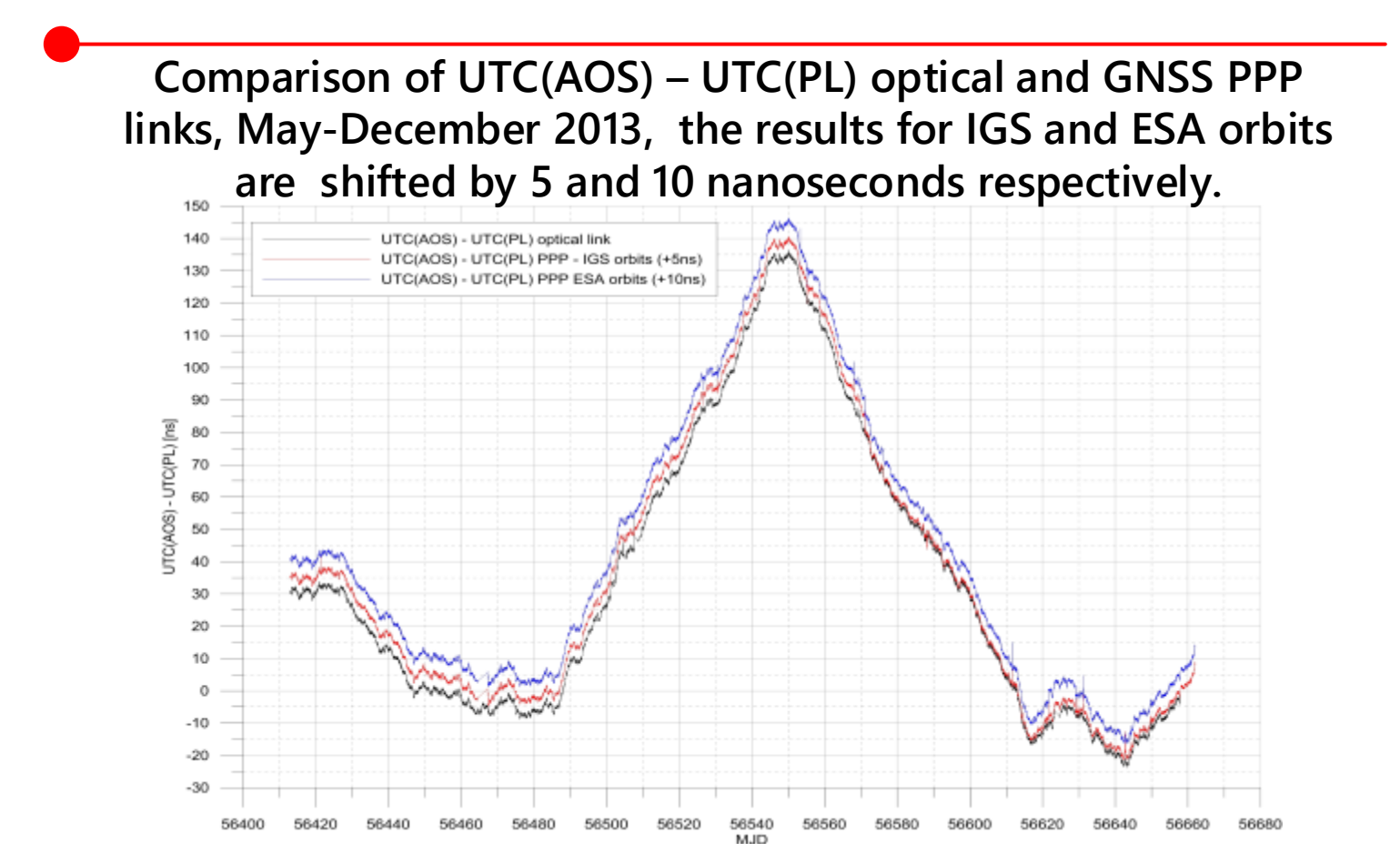
- 2 Time and Frequency Laboratories – the first one is located at GUM in Warsaw and generates UTC(PL) time scale, the second one is located at AOS in Borowiec and generates UTC(AOS) time scale;
- 2 Local Repositories which are under construction – the first one is located at PSNC in Poznan, the second one is located at FAMO in Torun;
- 2 fiber optical links 720 km long – the first 420 km long link is operational 2.5 years, the second one 300 km long is under construction;

- Operational 420 km long link
- Constructed 300 km long link
- PIONIER optical network
- Reference Time Laboratories
- OPTIME local repositories
- OPTIME regeneration points



## Optical link GUM – AOS

- 2.5 years of successful operation of the optical link between Central Office of Measures (GUM) in Warsaw and Astrogeodynamical Observatory (AOS) in Borowiec near Poznan, the first optical fibre connection between UTC(k) laboratories.
- This link allows for a continuous real-time comparisons of the UTC(PL) and UTC(AOS) time scales with unprecedented accuracy.
- In July 2013 BIPM conducted a series of calibrations using their GNSS mobile station and optical-fiber link. AOS-PL optical fibre link is being taken into consideration in the process of establishing novel methods and techniques for time scale comparisons for the realization of UTC and TAI.
- Upper figure on the right presents results of UTC(AOS) - UTC(PL) differences from May 2013 till December 2013. The OPTIME optical link is compared to GNSS phase measurements, post-processed using Precise Point Positioning method.
- For the computations, (CSRS-PPP ver. 1.05/03812/2012-02-07) software by Natural Resources Canada was used. The PPP results were obtained using two different sets of precise ephemerides and satellite clocks from IGS and ESA. The results obtained with ESA orbits show slightly better accuracy than the IGS ones.
- Time stability calculations show that optical link achieves better precision and stability for short averaging times, up to about 10<sup>4</sup> seconds.
- The short term stability of the results obtained for the optical link is, seriously limited by Austron 2055A phase microstepper used for the realization of UTC(PL) at GUM. This will be improved at the end of 2014, by the application of the phase femto-stepper and active H-maser as a source of UTC(PL). Also measurement noise of the Stanford SR-620 used at the AOS increases the instability of the link, it is planned to replace it with a new WAT counter of picoseconds precision.

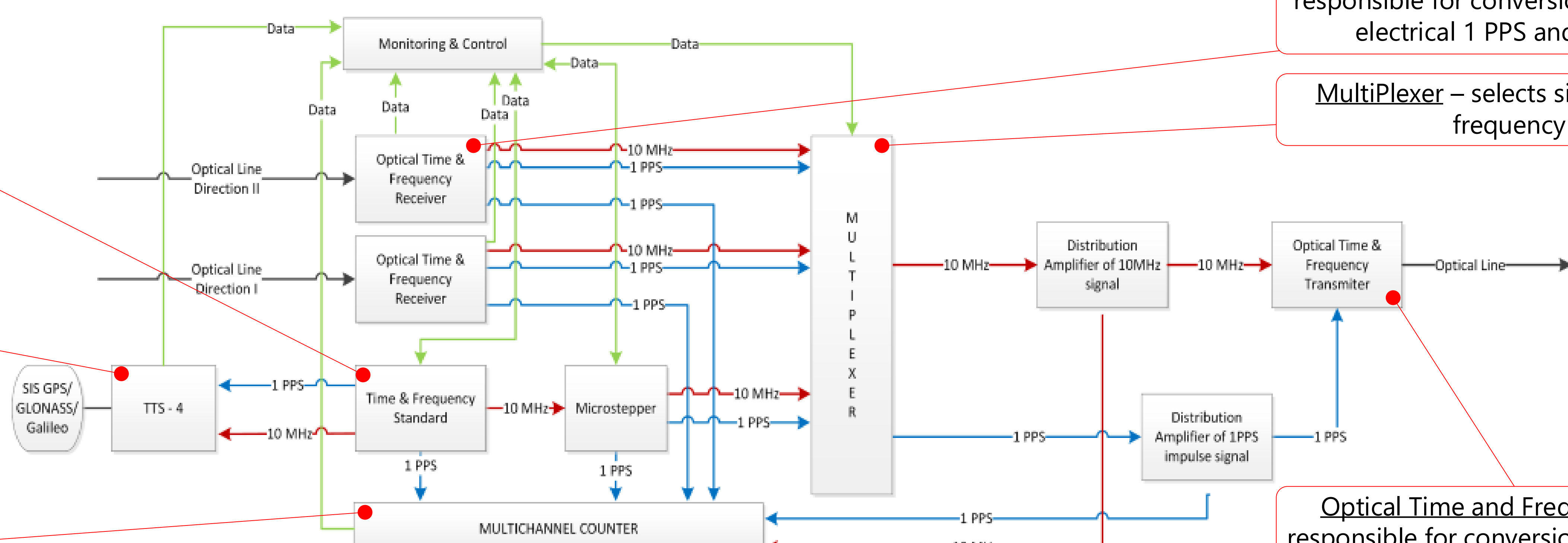


## Local repository architecture

**Time & Frequency Standard**  
– responsible for delivery of local time and frequency signals and maintaining time and frequency signals during link failures.

**Time Transfer System TTS-4**  
– responsible for back-up synchronization of Time & Frequency Standard via GPS/GLONASS/GALILEO systems to reference laboratories.

**Multichannel Counter**  
– constantly compares time and frequency sources.



**Optical Time & Frequency Receiver** – responsible for conversion of optical signals to electrical 1 PPS and 10 MHz signals.

**MultiPlexer** – selects signals from time and frequency sources.

**Optical Time and Frequency Transmitter** – responsible for conversion of 1 PPS and 10 Mhz signals to optical signals which can be transmitted through fiber links.