



INTERNATIONAL WORKSHOP

"RT-32 ZOLOCHIV: CURRENT STATE, EU COLLABORATION, RADIO ASTRONOMY FRONTIERS"

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Results of Research Long-Haul Time Dessimination System based on WDM and Boundary Clocks for VLBI Application

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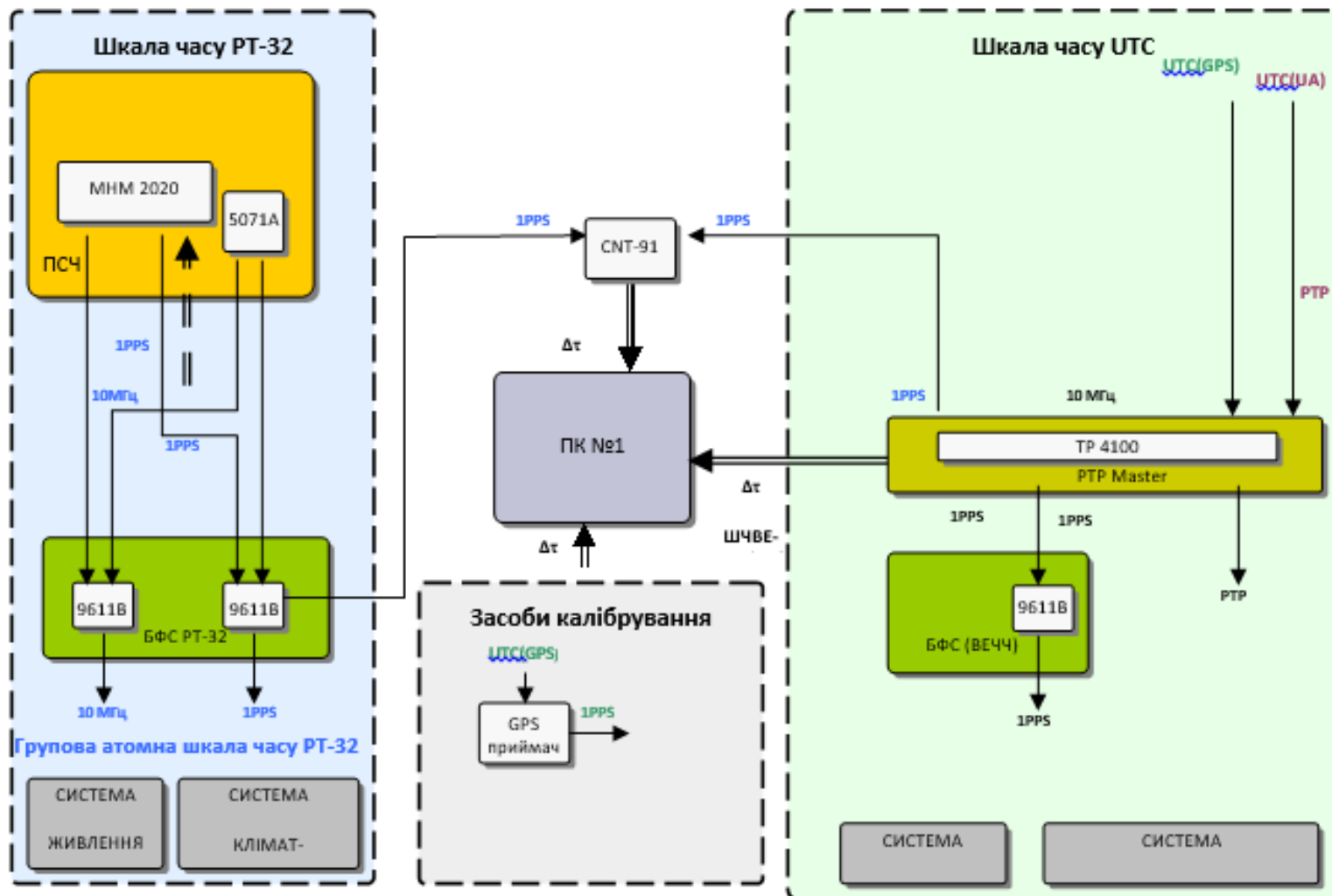


VLBI Time Scale Systems

Applications for Modern Services

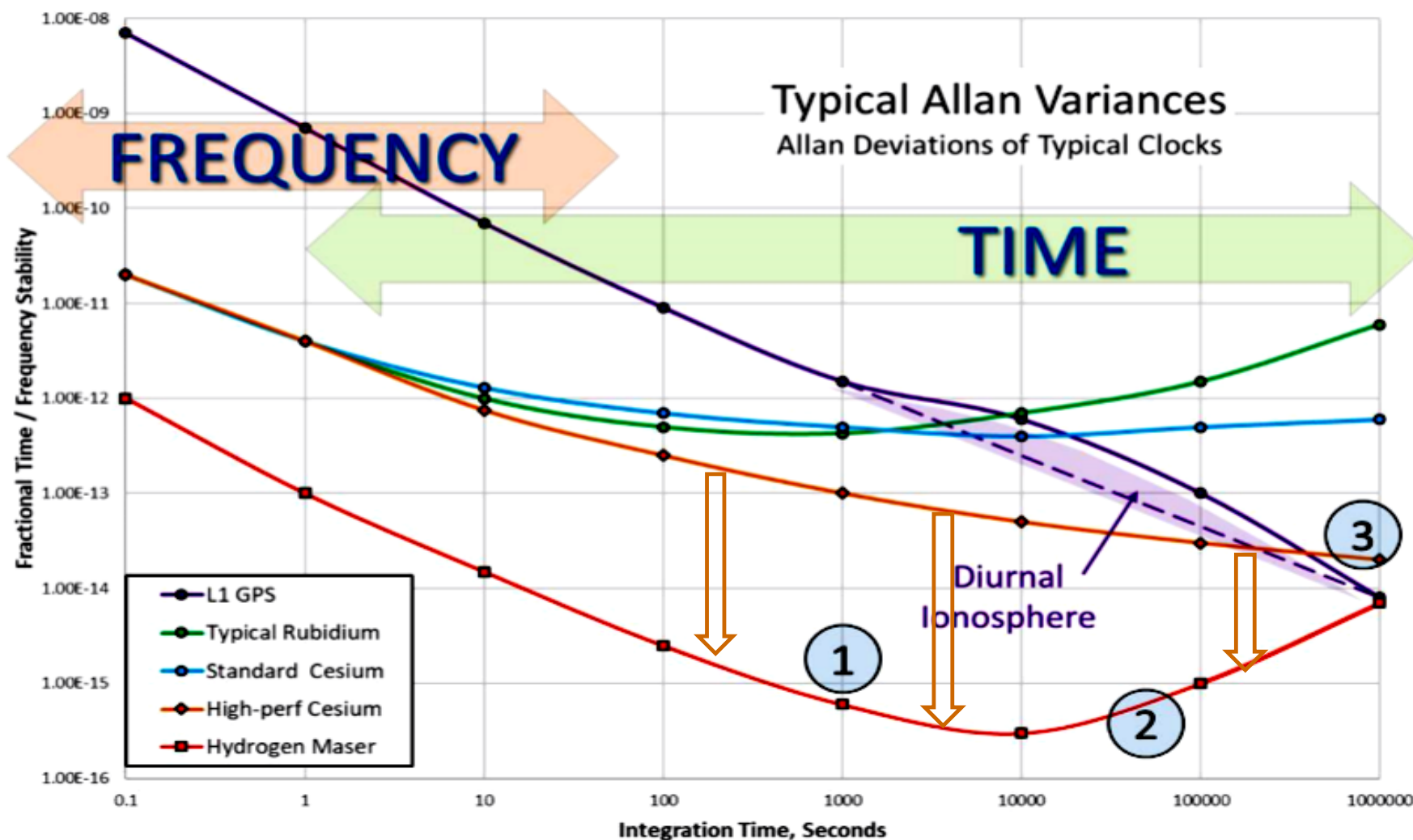


Time Scale v 2.0 (2022) (+Mazer)





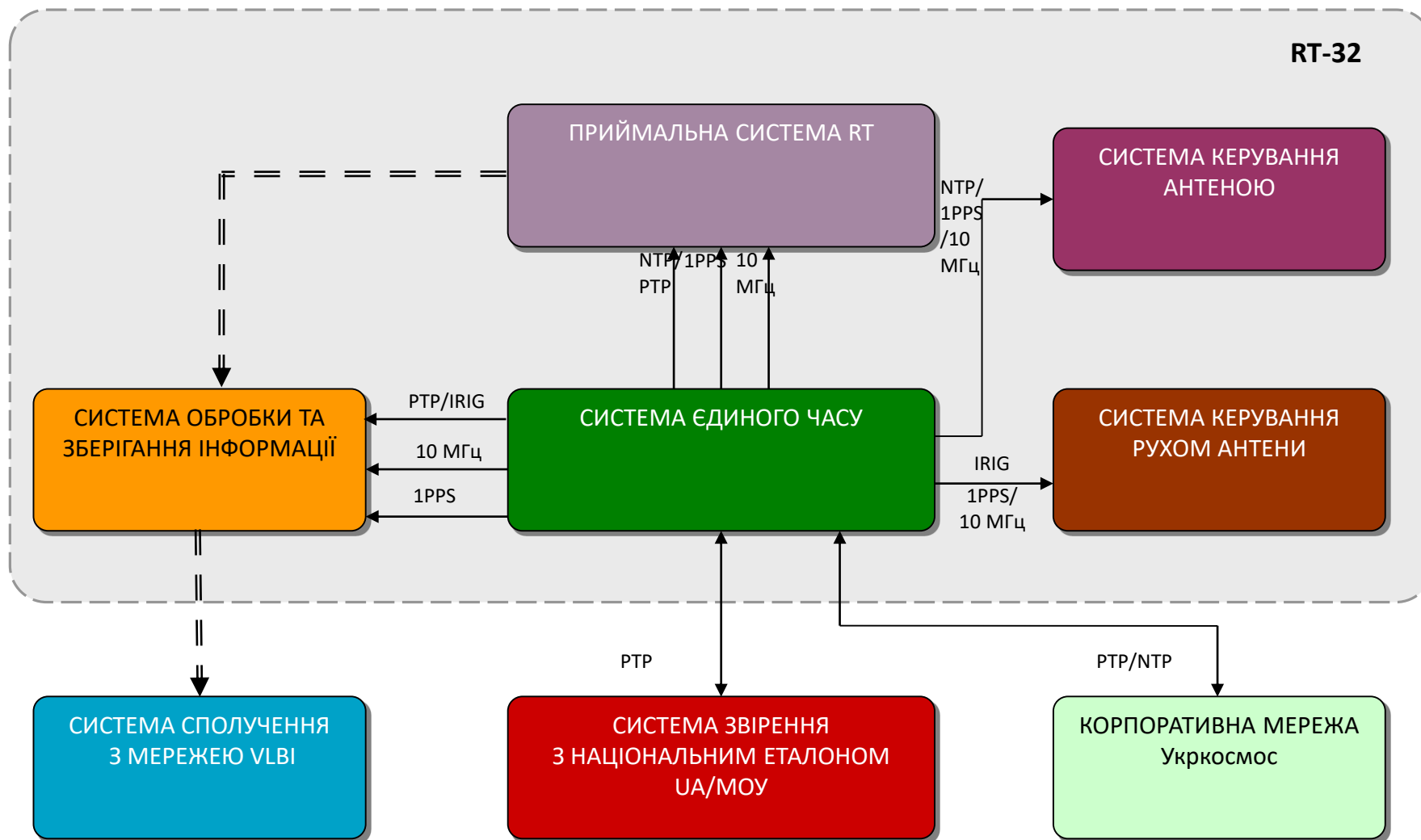
Time and Frequency VLBI (Time Scale System v. 2.0)



Time and Frequency in VLBI

Background

7





Modern services which require precise time signals:

- 1. Cooperation with VLBI networks - Time and Frequency transfer over optical networks - Projects Clock Network Services.**
- 2. Time Keeping Service – The National Service of Time and Reference Frequencies .**
- 3. GNSS technical support projects (Galileo et al.) - EGNOS and Galileo Timing Service.**

Time and Frequency transfer over optical networks in European (Project CLONETS)



<http://www.clonets.eu>

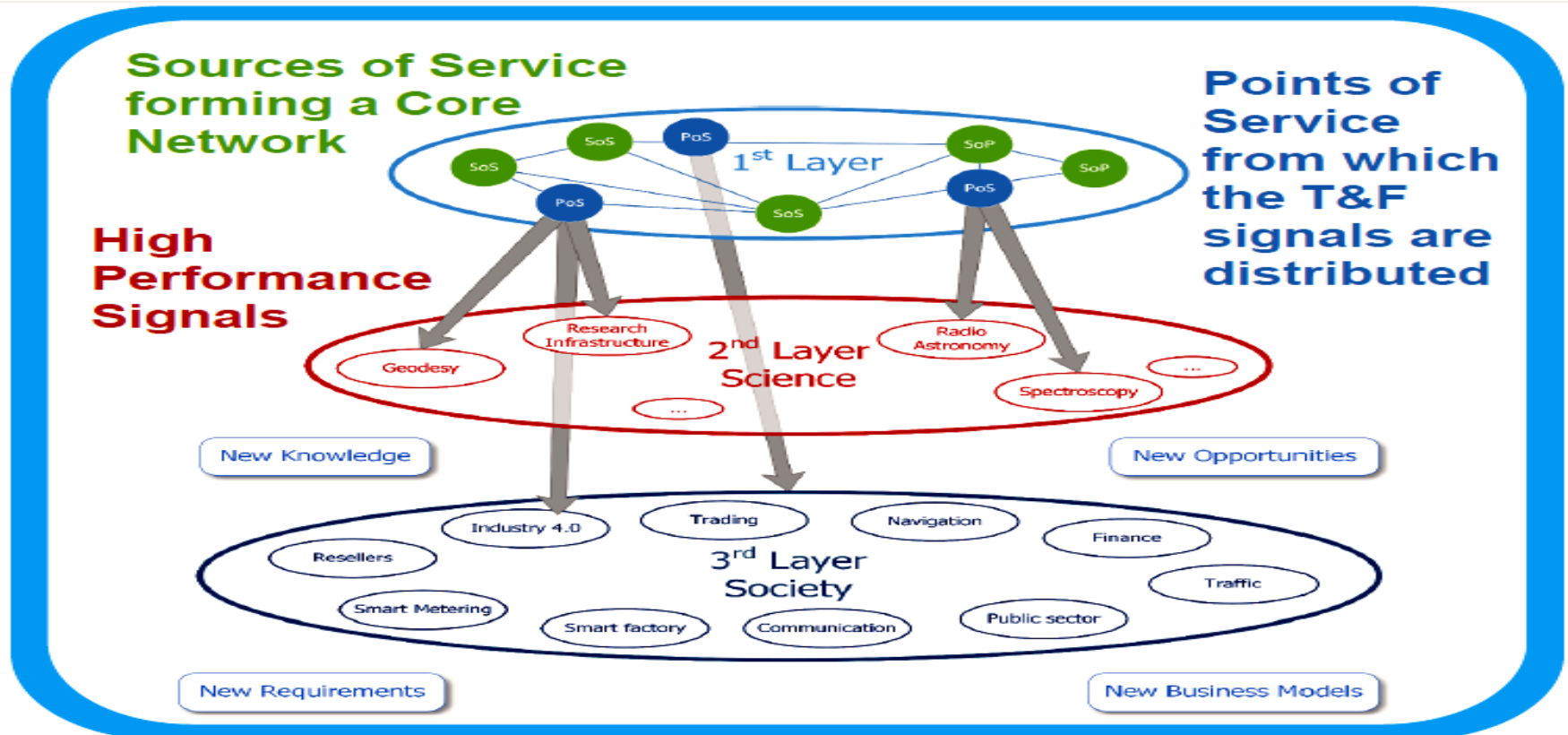
Coordinator



Participants



Third Parties



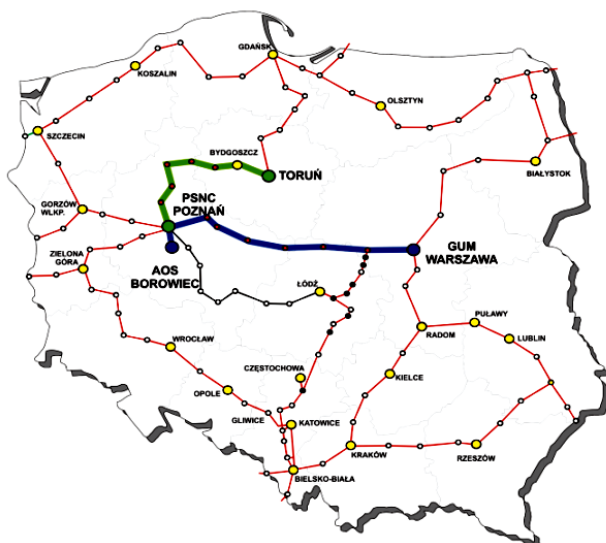
This project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 731107



Project OPTIME

Central Office of Measures (GUM) -
Astrogeodynamic Observatory (AOS) - Toruń
Centre for Astronomy Faculty of Physics,
Astronomy and Informatics at Nicolaus Copernicus
University

Webpage of the OPTIME project, available at
<http://www.optime.org.pl/node/47>



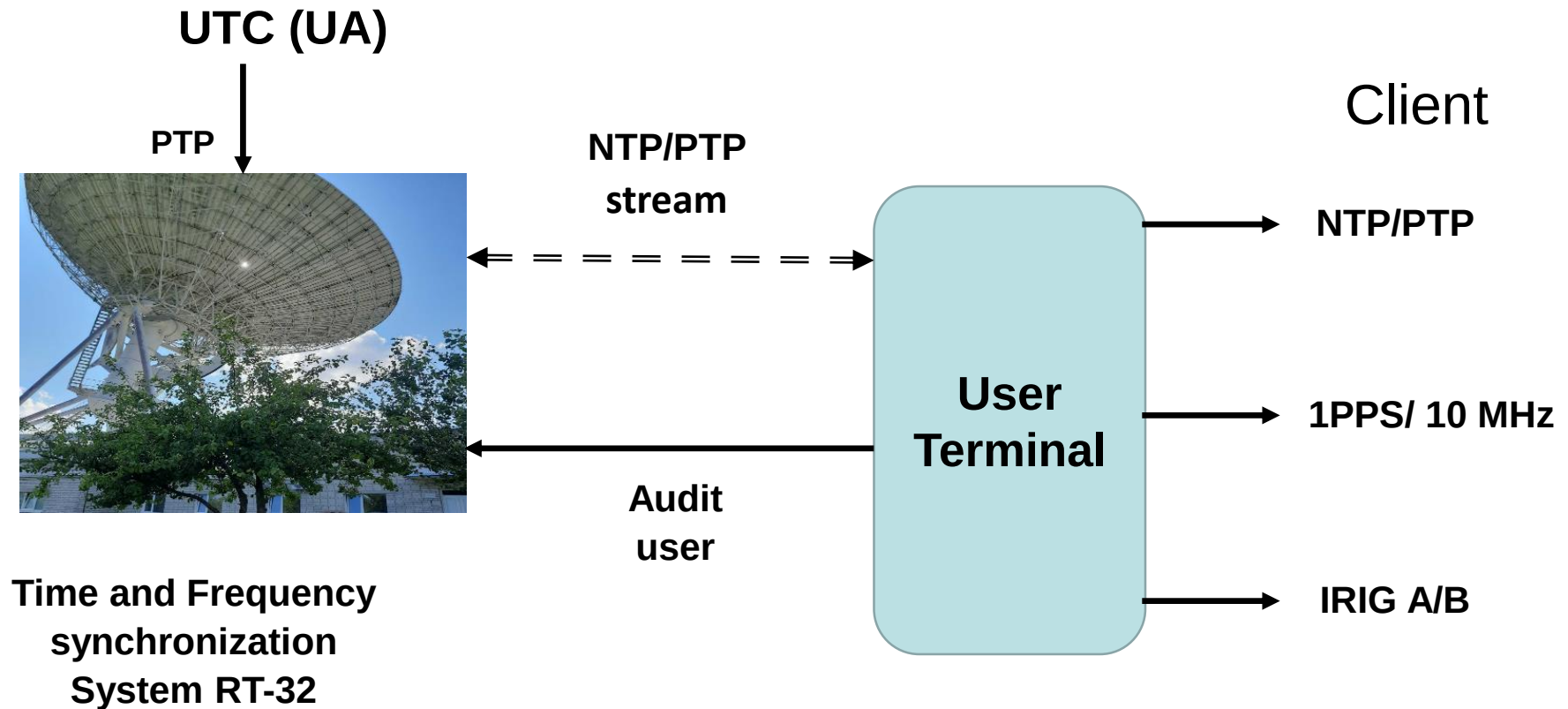
INRIM's Time and Frequency program

https://www.bipm.org/cc/CCTF/Allowed/20/CCTF_15-05_INRIM_report.pdf.





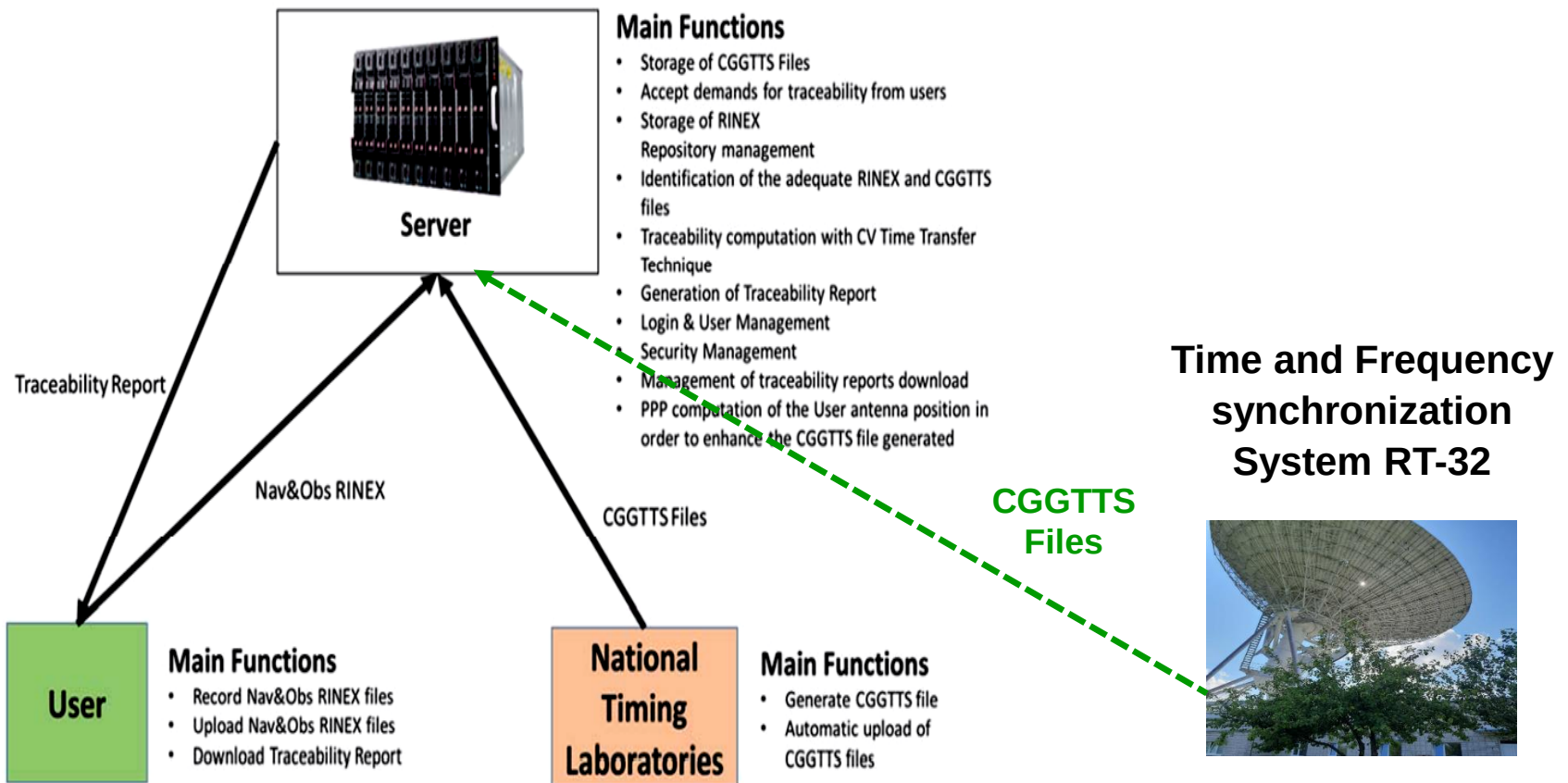
The Service of Time and Reference Frequencies of Ukraine



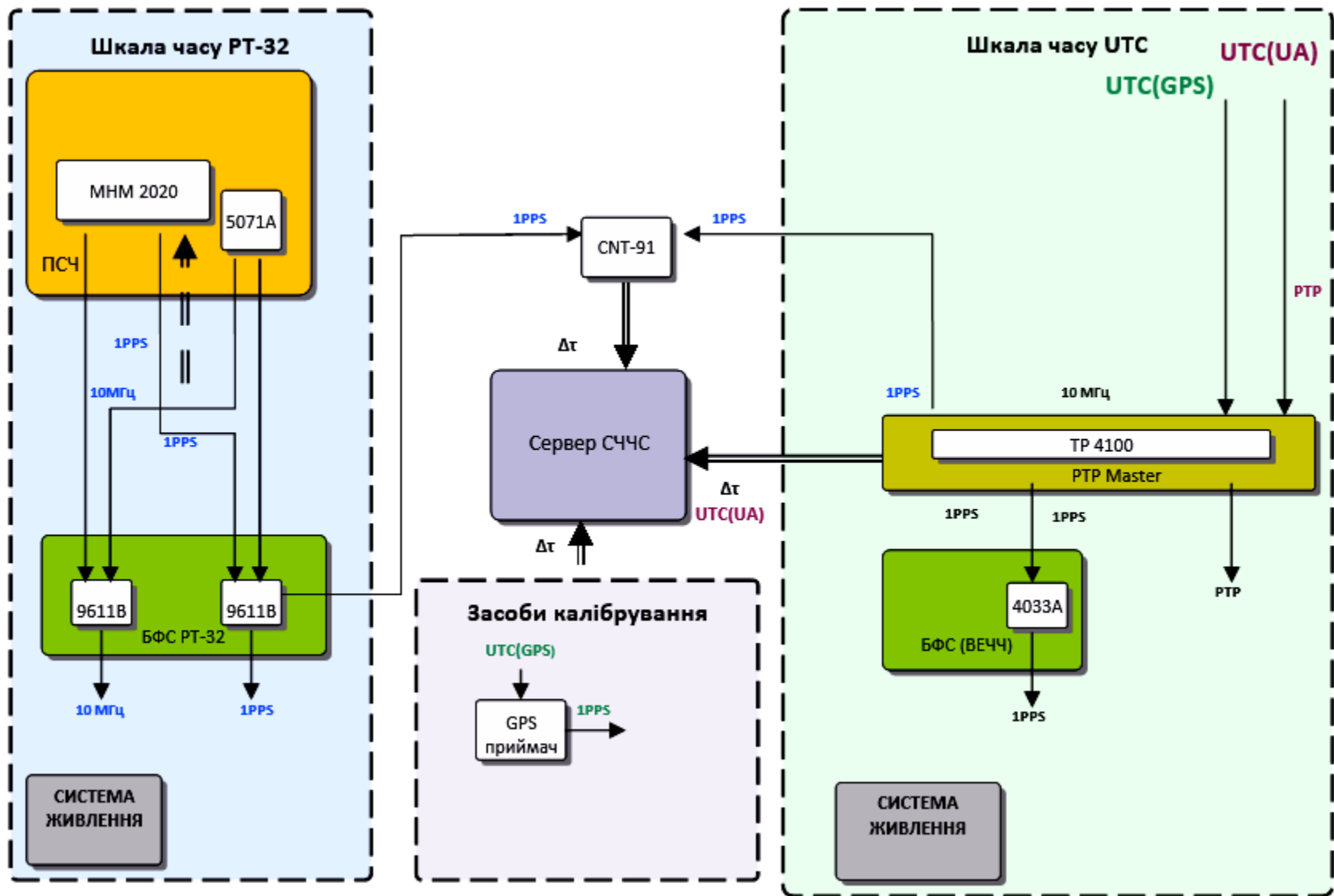
Example: Project DEMETRA (DEMonstrator of EGNSS services based on Time Reference Architecture)



EGNOS and Galileo Timing Service Extension and Consolidation

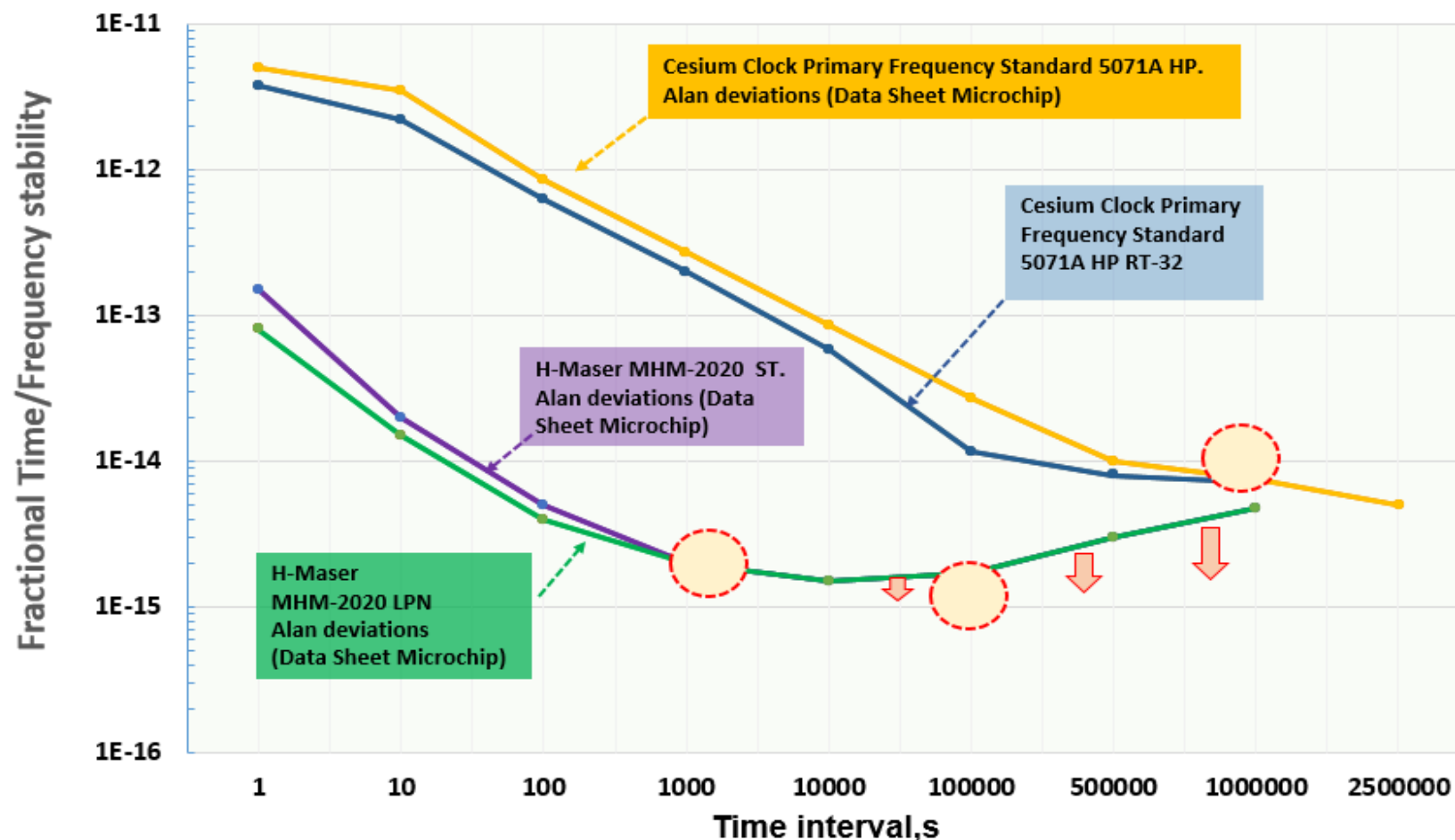


Time Scale v 2.0 RT-32 (2022) (+Mazer)





Frequency and time stability requirements in VLBI

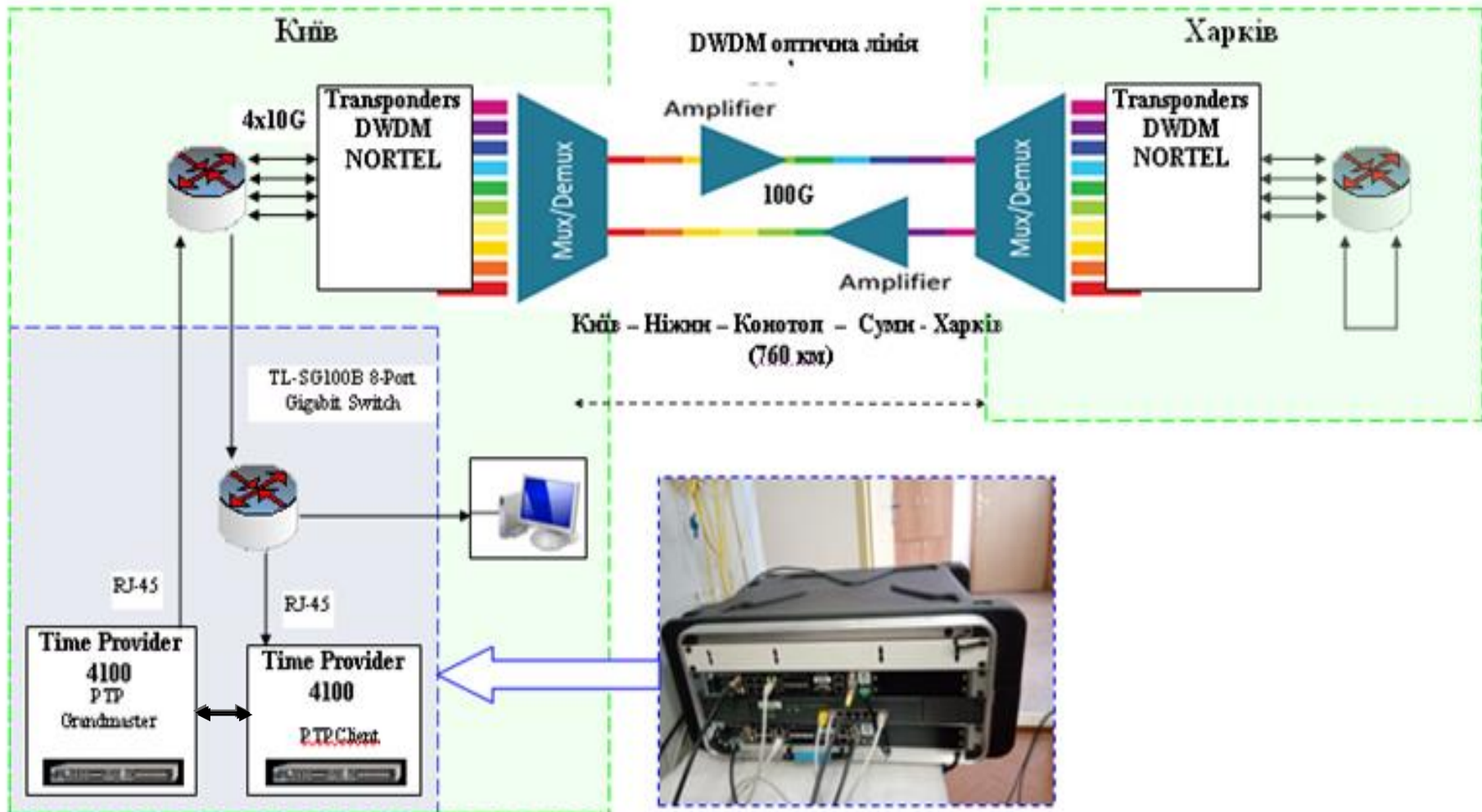


Source:

High-accuracy Time and Frequency in VLBI, Katie Pazamickas, Rick Hambly, IVS Technical Operations Worksh0p 2019, MIT Haystack Observatory 5-9 May 2019

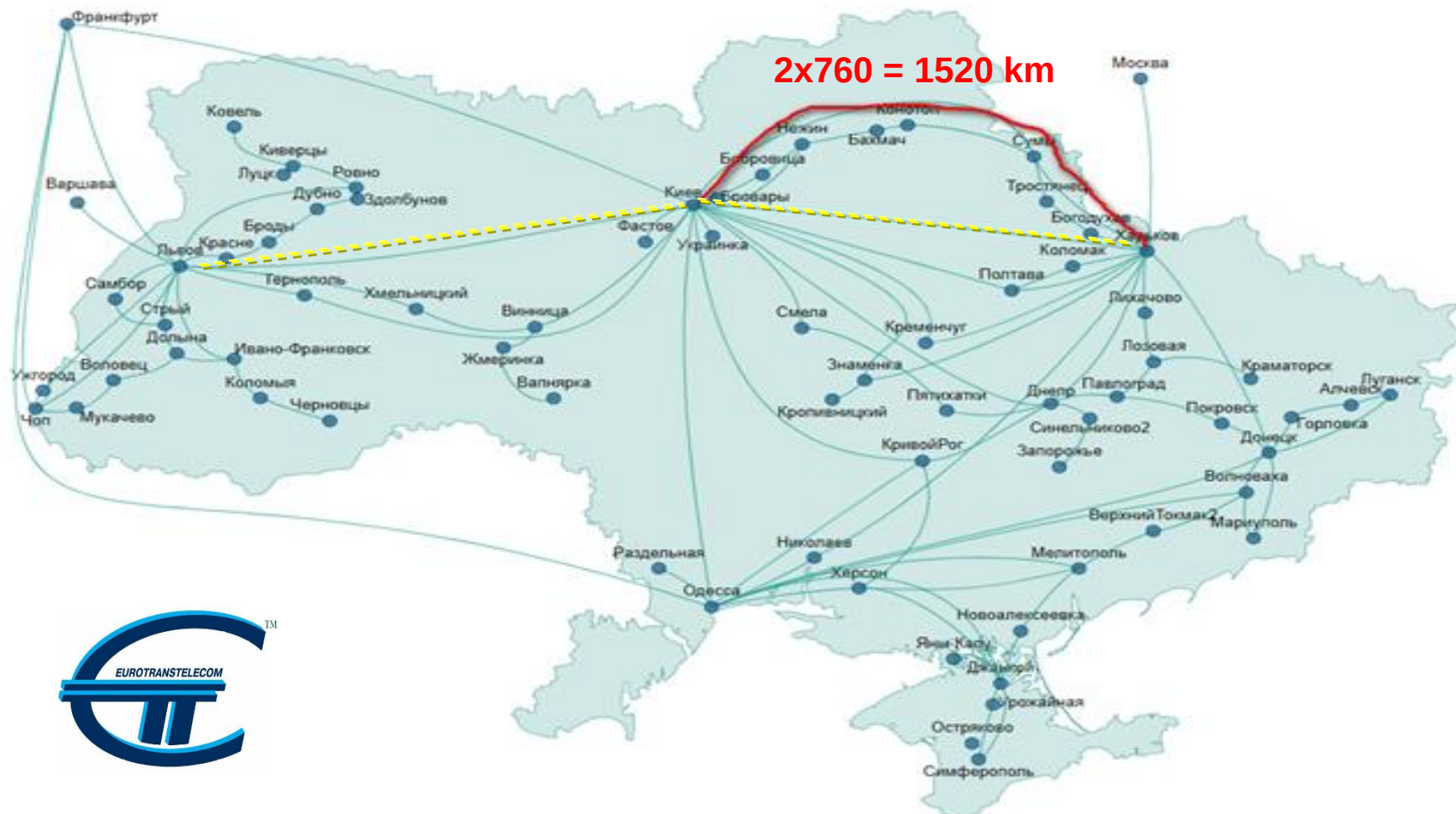
Results of Research Long-Haul Time Dessimination System based on WDM and Boundary Clocks

Scheme for measuring the time synchronization error on the main optical line DWDM Kharkiv - Kyiv - Kharkiv.





DWDM Eurotranstelecom company





Appearance of a set of equipment for measuring the timing error in the main optical line DWDM Kiev - Kharkov - Kiev.



**Time Provider 4100 -
GRANDMASTER PTP**

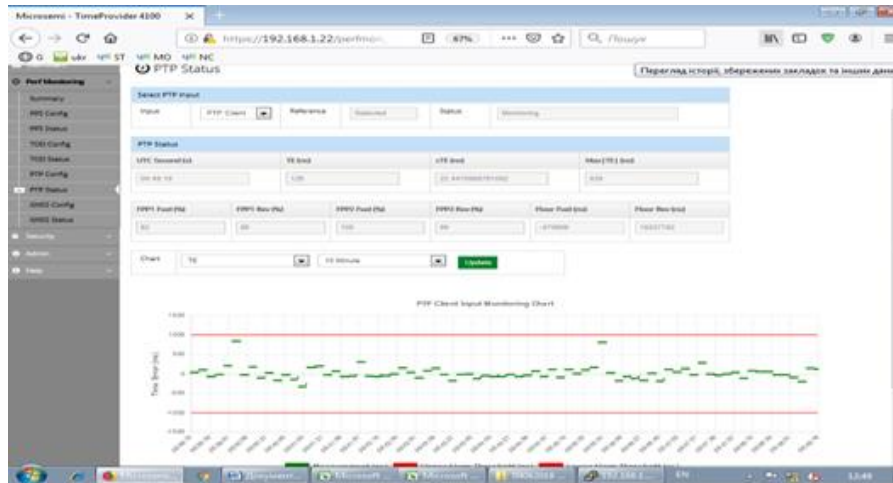
Ethernet switch

**Time Provider 4100 -
CLIENT PTP**



Monitoring Time Error TimeProvider 4100

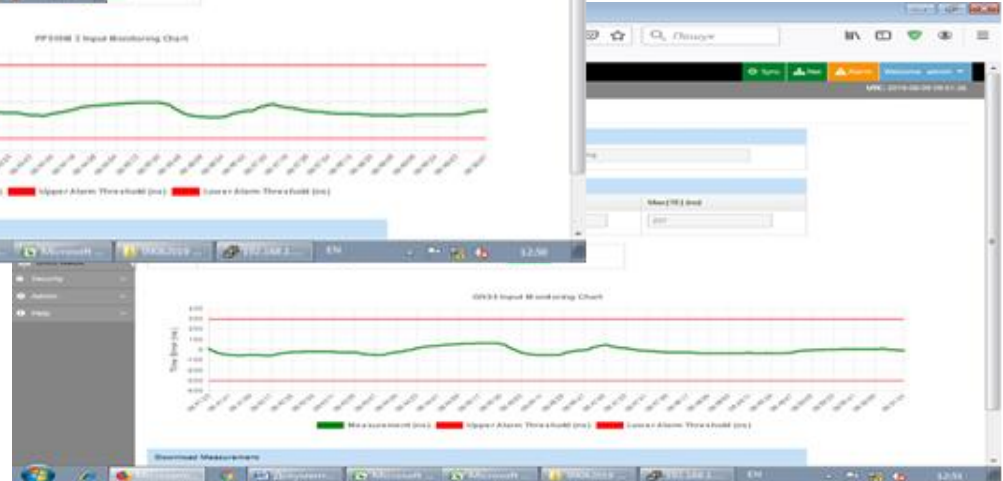
Performance Monitoring Windows (PTP, PPS, GNSS) Web Interface client PTP TimeProvider 4100.



PTP



1PPS

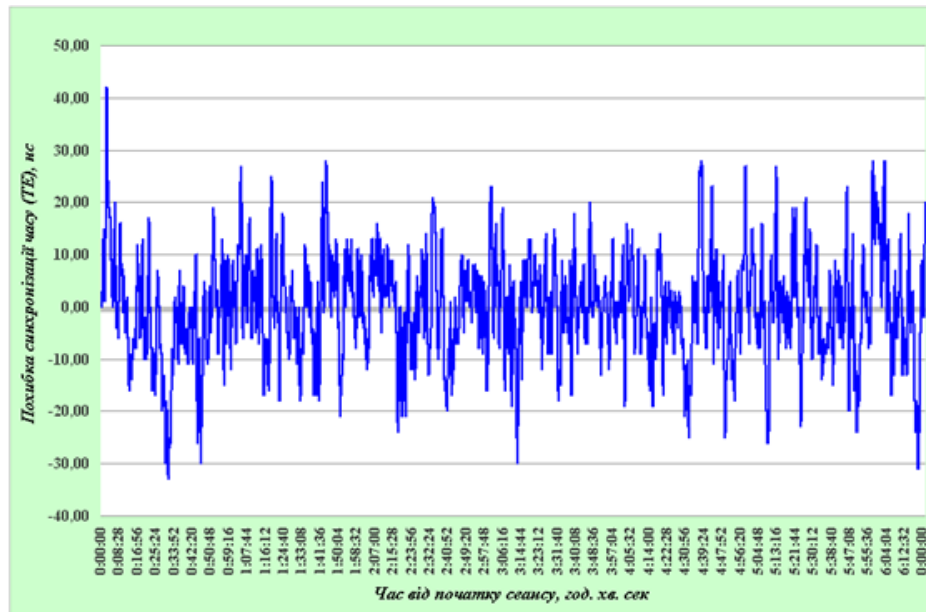


GNSS

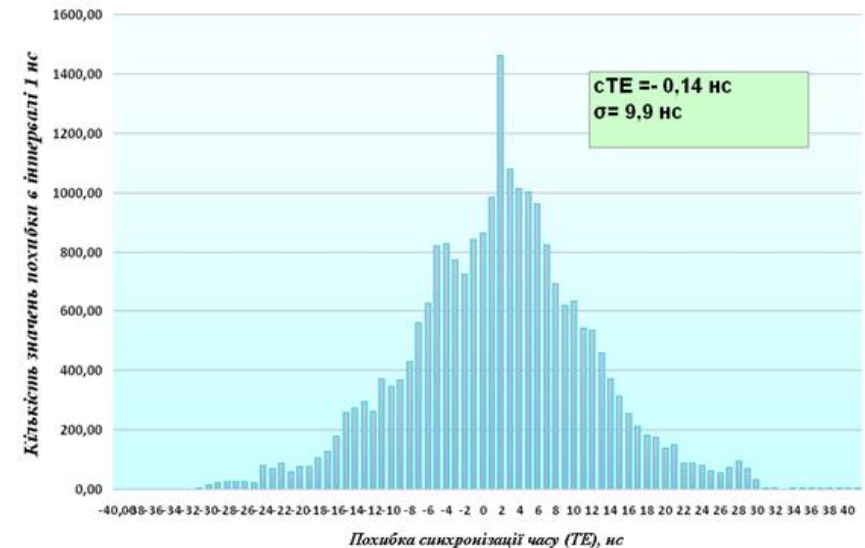


Estimation of time synchronization error of the reference time source (PRTC-TimeProvider 4100)

Time error (output 1PPS) TimeProvider 4100 synchronization from GNSS.



The current value of the time error



Statistical analysis



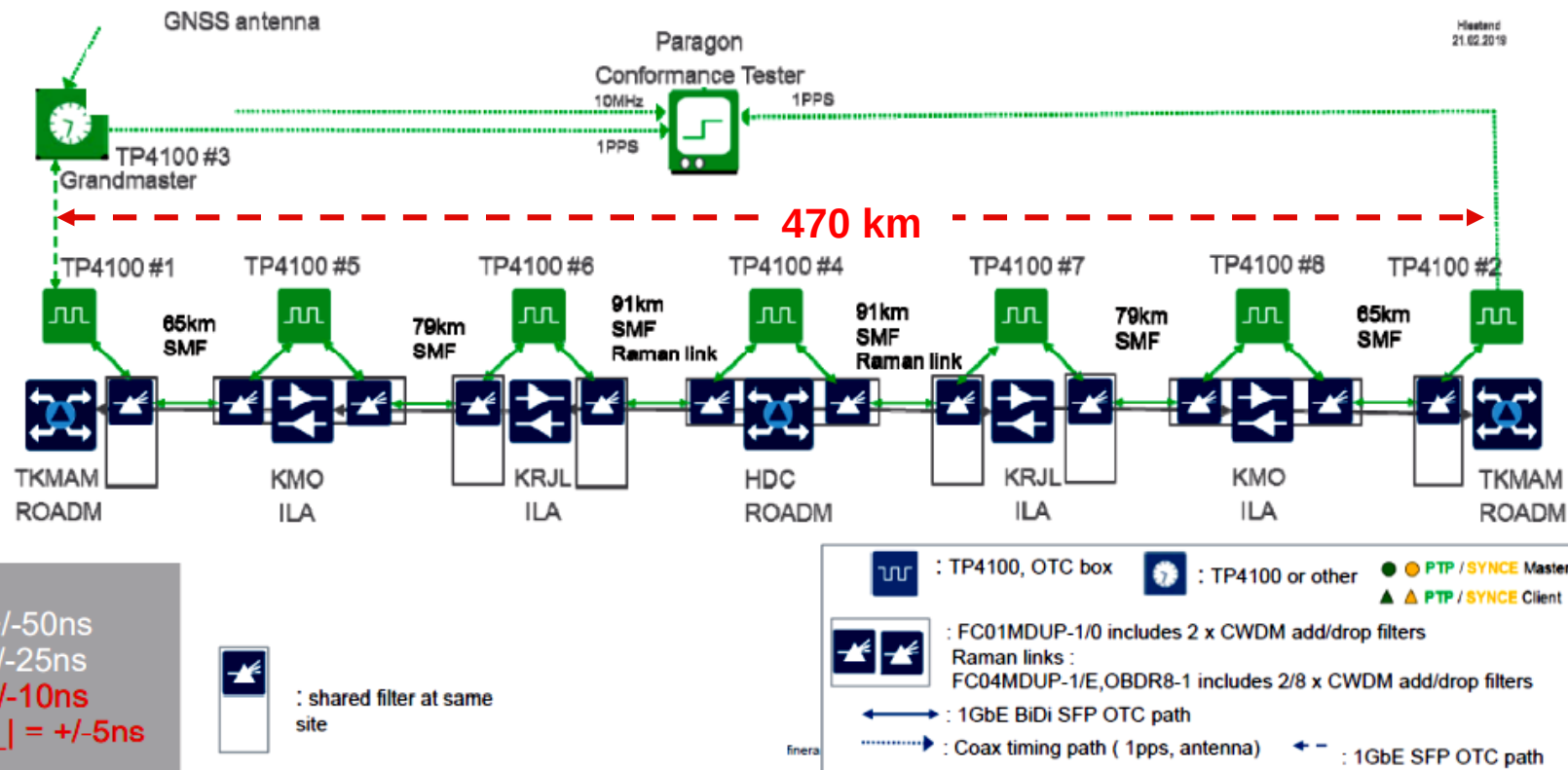
Accuracy of time synchronization on optical main DWDM

Time synchronization error using the RTR IEEE 1588 protocol on the main optical lines DWDM Kyiv - Kharkiv - Kyiv

Client PTP / Profile PTP	TimeProvider 4100 / Profile PTP G.8275.2			
Grandmaster PTP / Profile PTP	TimeProvider 4100 / Profile PTP G.8275.2			
Release Client PTP, Grandmaster PTP	TimeProvider 4100 , Software Version: 1.0.5			
Mode PTP	Profile PTP unicast ITU-T G.8275.2, one-step, Sync– 64/s, Delay-reg – 64/s, Announce – 4/s.			
Measurement of time error between....	GNSS – Output PTP (Grandmaster PTP)	Input PTP – GNSS (Client PTP, load <20%)	Input PTP – GNSS (Client PTP, load =20...40%)	GNSS- Client PTP (Client PTP)
Constant Time Error (cTE), ns	-0,14	24,0	30,0	-1,5
RMS (σ), ns	9,9	131,9	165,6	51,9



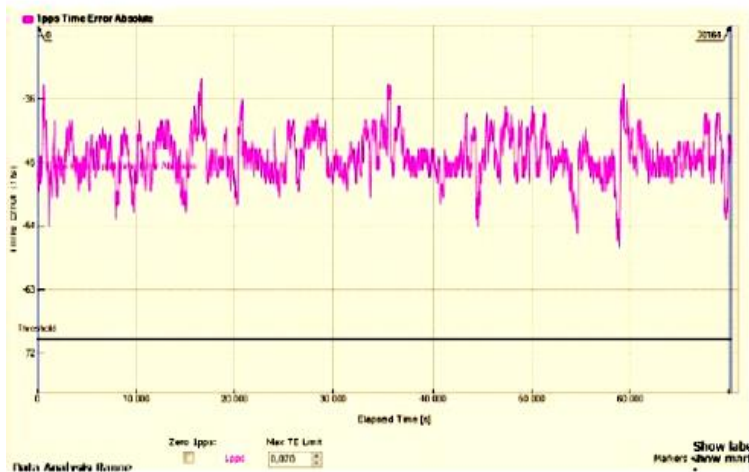
Testing Microchip:





«White Rabbit» vs HP Boundary Clock Mode

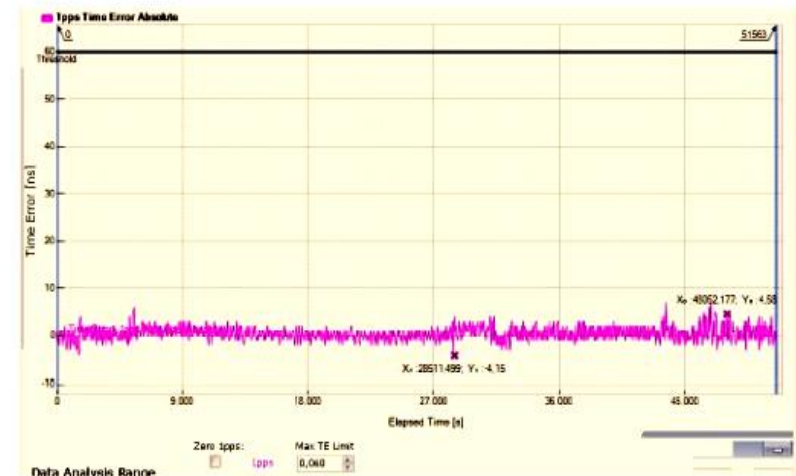
High Performance Boundary Clock Mode: Time Error: < 5 ns (RMS)



7 hops E2E Performance
Min/Max TE/cTE : 54/-28ns/-43ns
Class C Compliant

470 km

With hp-bc



6 hops E2E Performance
Min/Max TE/cTE : -4/+4.5/0.5ns
Significantly better than Class C
Meets very good Class D

470 km



Thank you for your attention!

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